



AEROSPACE RECOMMENDED PRACTICE

ARP1507™

REV. B

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Superseding ARP1507A

Helicopter Engine/Airframe Interface Document and Checklist

RATIONALE

During the SAE Five-Year Review, it was identified that although the scope of ARP1507A stated that it provided “complete relevant information” on engine-airframe interfaces, it primarily covered mechanical interfaces and not electronic interfaces. The integration of the engine electronic systems with aircraft electronic systems has greatly expanded in the industry since last update of this document in 1997. Another SAE E-36 document, AIR6181, covers most of the needed information on electronic engine-aircraft interface. Rather than redundantly add this information to ARP1507, a reference to AIR6181 has been added in ARP1507 to point to the electronic interface information that it covers. Secondly, there are additional mechanical interface considerations that have been added to ARP1507 document text and checklist.

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) provides a guide for the preparation of a helicopter engine/airframe interface document and checklist. This document and checklist should identify the information needed by the engine manufacturer and the aircraft manufacturer to integrate the engine design with the aircraft design and either provide this information or give reference to where this information is located. The intent is to assure that the engine manufacturer and the airframe manufacturer identify and make provision for this information so it can be easily accessible to either manufacturer as needed in the development stages of an engine-airframe integration project.

A related document, SAE Aerospace Information Report AIR6181, provides guidance on creating an interface control document (ICD) which addresses a subset of the aircraft-engine interface information concerning the physical and functional interfaces of the electronic engine control system (EECS) with the aircraft systems. This would include signal interfaces, digital data busses and integrated functionality with the aircraft electronic systems and avionics displays. The engine/airframe interface document should reference this EECS ICD rather than duplicate its information. Similarly, as information is documented in the engine installation manual or engine installation drawings, the engine/airframe interface document should make references to the engine installation manual or engine installation drawings, rather than duplicate the information. Typically, the engine/airframe interface document will be the initial document in the project to capture the interface information which can then transition to referenced information as the engine installation manual, EECS ICD, and engine installation drawings are developed.

2. REFERENCES

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 Applicable Documents

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR6181 Electronic Propulsion Control System/Aircraft Interface Control Documents

ARP996 Cooling of Turbine Engines in Helicopters

2.1.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

AC 20-128A Design Considerations for Minimizing Hazards Caused by Uncontained Turbine Engine and Auxiliary Power Unit Rotor Failure

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR947 Engine Erosion Protection

AIR984 Air Bleed Objective for Helicopter Turbine Engines

AIR1087	Aircraft Accessory Drag Torque During Engine Starts
AIR1160	Aircraft Engine and Accessory Drives and Flange Standards
AIR1191	Performance of Low Pressure Ratio Ejectors for Engine Nacelle Cooling
AIR1262	Aircraft Fire Protection for Helicopter Gas Turbine Powerplant and Related Systems Installations
AIR1286	Helicopter and V/STOL Aircraft Noise Measurement Problems
AIR1289	Evaluation of Helicopter Turbine Engine Linear Vibration Environment
AIR1423	Electromagnetic Compatibility on Gas Turbine Engines for Aircraft Propulsion
ARP704	Helicopter Engine - Rotor System Compatibility
ARP721	Turbine Drive Shaft Connection
ARP949	Turbine Engine Starting System Design Requirements
ARP1257	Gas Turbine Engine Transient Performance Presentation for Digital Computer Programs
ARP1279	Standard Indoor Method of Collection and Presentation of the Bare Turboshaft Engine Noise Data for Use in Helicopter Installations
ARP1420	Gas Turbine Engine Inlet Flow Distortion Guidelines
ARP1587	Aircraft Gas Turbine Engine Health Management System Guide
ARP1702	Defining and Measuring Factors Affecting Helicopter Turbine Engine Power Available
AS681	Gas Turbine Engine Performance Presentation for Computer Programs

2.3 Abbreviations

AIR	Aerospace Information Report
ARP	Aerospace Recommended Practice
AEO	All Engines Operative
EECS	Electronic Engine Control System
IBF	Inlet Barrier Filter
ICD	Interface Control Document
LRU	Line Replaceable Unit
Nr	Helicopter Rotor Speed
OEI	One Engine Inoperative
SFC	Specific Fuel Consumption
SOAP	Spectrometric Oil Analysis Program
T1	Engine inlet Air Temperature

3. HELICOPTER ENGINE/AIRFRAME INTERFACE DOCUMENT AND CHECKLIST CONTENTS

The helicopter engine/airframe interface document and checklist should be organized into five sections: a general description of the aircraft and engine and relevant subsystems of each, engine functional characteristics, engine physical characteristics, installation drawings, and interface checklist.

3.1 General Description

3.1.1 Aircraft Description

The aircraft description should provide a general explanation of the aircraft type, civil certification or military mission, weight and power class, single or multi-engine powerplant, and a description of the transmission and rotor system. It should include a high level description of key attributes such as engine compartment, inlet, exhaust, and other aircraft systems and features relevant to the propulsion system.

3.1.2 Engine Description

The engine description should include the inlet air flow class and a general identification of the compressor configuration, combustor configuration, number of turbine stages, exhaust configuration, and output shaft configuration with direction of rotation and speed. If the engine has a reduction gearbox, the speed reduction should be addressed. When an engine uses modular construction, the modules should be described. An engine cutaway illustration should be provided.

3.1.3 Engine Subsystem Description

Each engine subsystem such as fuel, control, oil, electrical, starting, compressor air bleed, induction, exhaust, condition monitoring, and diagnostics should be described. The descriptions should address the components in the subsystems, general operating characteristics, and unique features. Subsystems schematics should be provided.

3.2 Engine Functional Characteristics

3.2.1 Performance

A definition of uninstalled engine power ratings must be provided including normal and contingency or OEI ratings, as applicable. Tables are recommended which include engine performance at standard, sea level, static conditions at minimum rated delivered shaft power, rated delivered shaft speed, maximum specific fuel consumption, and measured gas temperature. Performance estimating procedures should be explained or adequate tables or figures provided. If the primary source of estimated performance is a computer program, the computer program should be identified and described.

A definition of installed performance requirements of the aircraft should be specified so the engine manufacturer can understand and assist the aircraft manufacturer's installation and interface design to achieve these requirements.

3.2.2 Starting and Operating Envelope

The engine starting and operating envelope with any associated engine limitations necessitated by ambient conditions or flight speed must be described. Figure 1 depicts a typical starting and operating envelope. Any unique requirements for pilot start procedure should be identified. Critical speed range dwell limitations should be specified. Automatic start, abort, and auto re-light features should be described. Time limitations (for example, waiting period between start attempts) should be specified as applicable to engine or starting system. Tail wind starting limitations should be specified, if applicable.

3.2.3 Idle Operation

A definition of idle operation speed range and idle output torque should be described as it can affect rotor brake capacity to stop and hold the rotor. On some aircraft it can affect the ability of rotor system droop stops to extend at idle rotor speeds prior to shutdown. In-flight idle speed and torque should be described over the flight envelope as it can affect ability for rotor speed (N_r) to go higher than power turbine speed in autorotative descent maneuvers. Any limitation on idle speed range operation of accessory pad driven generators and other accessories should be specified to assure compatibility with engine idle speed range. Idle customer bleed temperature and pressure should be described to determine sufficiency for cabin heating and anti-ice systems, if applicable.

Limitations on idle operation with locked power turbine (rotor brake engaged) should be specified. Interlock provisions to prevent acceleration to FLY with rotor brake engaged should be specified.

3.2.4 Shutdown

Engine shutdown function and necessary aircraft interfaces should be specified including normal shutdown, engine overspeed or emergency shutdown, and aircraft means of redundant shutdown such as firewall fuel cutoff. Any unique requirements in the shutdown procedure sequence, such as idle cool down period, should be explained. Engine windmilling restrictions should be identified, as applicable.

3.2.5 Operating Attitudes

The engine capability for continuous attitude operation and transient attitude operations must be described.

3.2.6 Mechanical and Thermal Limits

The gas generator speed, power turbine speed, output shaft torque, and measured gas temperature limits at rated powers and during transients must be stated.

Aircraft transmission steady state and transient speed and torque limits should be specified as necessary where the engine control maintains engine operation within these aircraft limitations.

3.2.7 Operating Flight Limit Loads

The engine flight limit loads must be identified including limits on gyroscopic moments. Figure 2 depicts a typical limit load envelope.

3.2.8 Vibration Limits

The engine vibration limits (engine induced and aircraft induced) must be identified and the installation drawing must identify the vibration pickup location. Steady state and transient limits provided over applicable ranges should be identified with explanatory definitions and criteria for steady state and transient limits and frequency/spectral range.

3.2.9 Control System

The control system philosophy, control modes, and characteristics should be described and/or references made as appropriate to the engine control system ICD (refer to AIR6181). Engine overspeed and emergency shutdown provisions should be described including necessary aircraft interfaces. This should include a description of the failure design such as fail off, fail fixed, fail idle, etc., and if there are auto re-light provisions for flameout.

Engine transient response characteristics should be described based upon control lever movement particularly prevention of torque or temperature exceedence during rotor run up acceleration from ground idle to flight condition. Also engine transient response requirements should be defined as necessary for aircraft handling qualities.

Control system lever(s) minimum and maximum torque required to rotate the levers should be stated. Information must be provided on the lever rotation dwell bands. Rigging method and tolerances for mechanical linkages should be specified. If the control system uses electrical inputs, the signal characteristics must be defined. Components may be added to the control system to enhance stability, i.e., stability accumulators. These components must be coordinated between the engine manufacturer and the helicopter manufacturer and the location, allowable loads, etc., shown on the installation drawing.

Mechanical or electrical interfaces with aircraft collective pitch for engine control collective anticipation function should be described including rigging characteristics and collective signal versus rotor load characteristics specified. Typically, this information should capture the characteristic of rotor torque versus rotor speed versus collective position over the operating envelope plus how this collective position translates to the mechanical or electrical collective position signal provided at the engine interface. Some rotor system and flight control architectures may have variation on how rotor system load is translated to the engine control and how it is used for load anticipation.

3.2.10 Fuel System

The fuels for normal use and special use must be identified with any necessary restrictions. Fuel additives, if approved, should be identified.

Maximum fuel flow should be identified.

Fuel inlet conditions should be identified which address any required fuel system boost assist from the helicopter throughout the operating envelope, ground and air starting, vapor/liquid ratio capability, and any limitations on fuel inlet pressure at/after engine shutdown. Engine suction pump dry and wet lift capability should be specified. The capability to maintain fuel prime should be explained.

Fuel ecology provisions such as ecology collector, return to tank, etc., shall be specified including temperature and flow quantity.

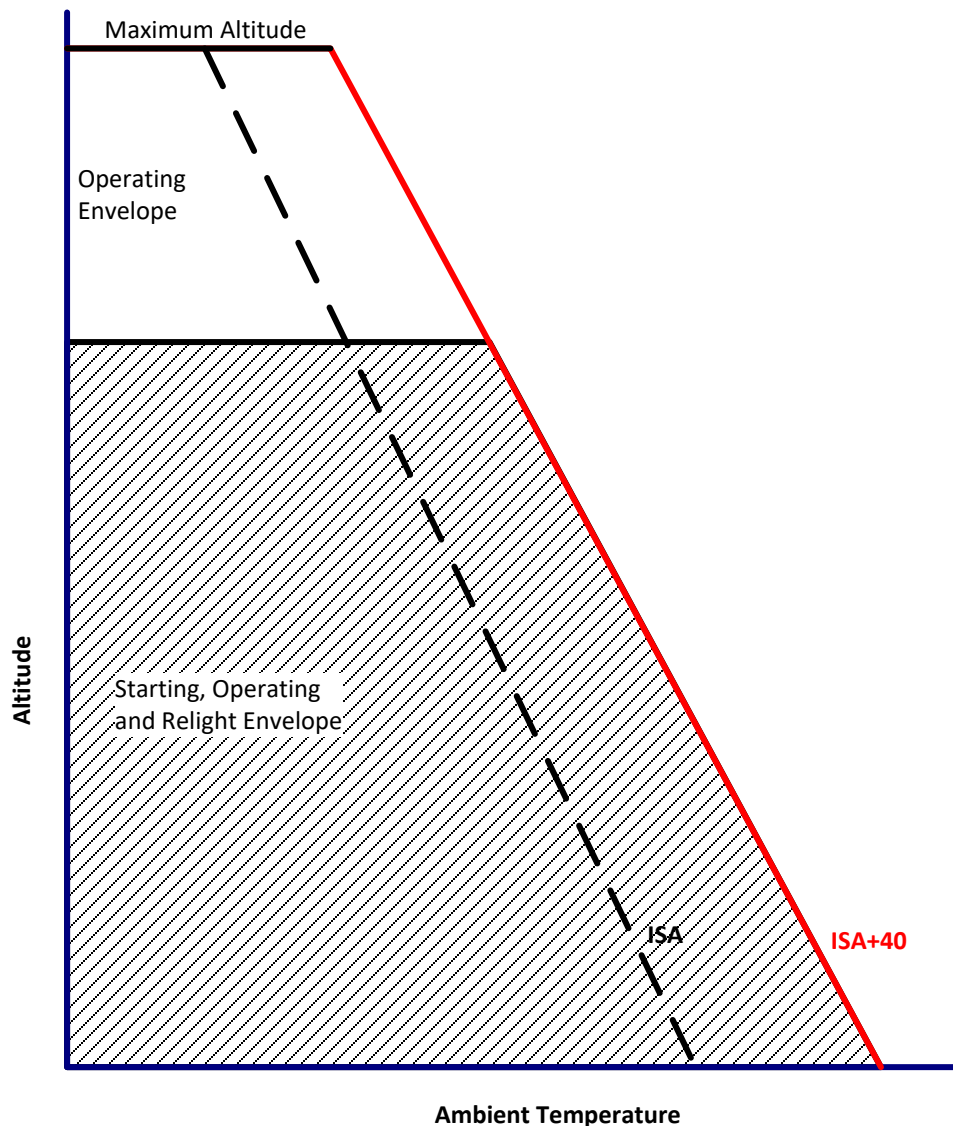


Figure 1 - Starting and operating envelope