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Superseding ARP1507

Helicopter Engine/Airframe Interface Document and Checklist

FOREWORD

Changes in this revision are format/editorial only.

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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 is intended to provide complete relevant information on the characteristics, performance, and engine interfaces. Of most importance is the identification of the data and the location of data to assure that the engine manufacturer and the airframe manufacturer supply information that can be easily located by either manufacturer.

2. REFERENCES:

2.1 Recommendation:

The Helicopter Engine/Airframe Interface Document and Checklist should be organized into five sections: a general description of the engine and the engine subsystems, engine functional characteristics, engine physical characteristics, installation drawings, and interface checklist.

During the preparation of the interface document and checklist, the following documents should be evaluated for applicability:

AS681	Gas Turbine Engine Steady State Performance Presentation for Digital Computer Programs
ARP704	Helicopter Engine - Rotor System Compatibility
ARP721	Turbine Drive Shaft Connection
AIR947	Engine Erosion Protection (Helicopter)
ARP949	Turbine Engine Starting System Design Requirements
AIR984	Air Bleed Objective for Helicopter Turbine Engines
ARP996	Cooling of Turbine Engines in Helicopters
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
ARP1257	Gas Turbine Engine Transient Performance Presentation for Digital Computer Programs
AIR1262	Aircraft, Fire Protection for Helicopter Gas Turbine Powerplant and Related Systems Installations

2.1 (Continued):

ARP1279	Standard Indoor Method of Collection and Presentation of the Bare Turboshaft Engine Noise Data, for Use in Helicopter Installations
AIR1286	Helicopter and V/STOL Aircraft Noise Measurement Problems
AIR1289	Evaluation of Helicopter Turbine Engine Linear Vibration Environment
ARP1420	Gas Turbine Engine Inlet Flow Distortion Guidelines
AIR1423	Electromagnetic Compatibility on Gas Turbine Engines for Aircraft Propulsion
ARP1587	Aircraft Gas Turbine Engine Monitoring System Guide
ARP1702	Defining and Measuring Factors Affecting Helicopter Turbine Engine Power Available

3. HELICOPTER ENGINE/AIRFRAME INTERFACE DOCUMENT AND CHECKLIST CONTENTS:

3.1 General Description:

3.1.1 Engine Description: The engine description should include the 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 should be provided.

3.1.2 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, Steady State: A definition of engine ratings such as takeoff power, 2½ minute power, 30 minute power, etc., must be included. 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 described.

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. Starting times as a function of ambient temperatures must be addressed, and it is recommended that they be graphically depicted as a function of ambient temperature.

3.2.3 Operating Attitudes: The engine capability for continuous attitude operation and transient attitude operations must be described.

3.2.4 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.

3.2.5 Operating Flight Limit Loads: The engine flight limit loads must be identified. Figure 2 depicts a typical limit load envelope.

3.2.6 Vibration Limits: The engine 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 the definitions for steady state transients and frequency/spectral range.

3.2.7 Control System: The control system philosophy control modes and characteristics should be completely described in paragraph 3.1.2. 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. 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. Engine transient response characteristics should be described based upon control lever movement.

3.2.8 Fuel System:

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

b. Maximum fuel flow should be identified.

c. Fuel inlet conditions should be identified which address fuel system 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.

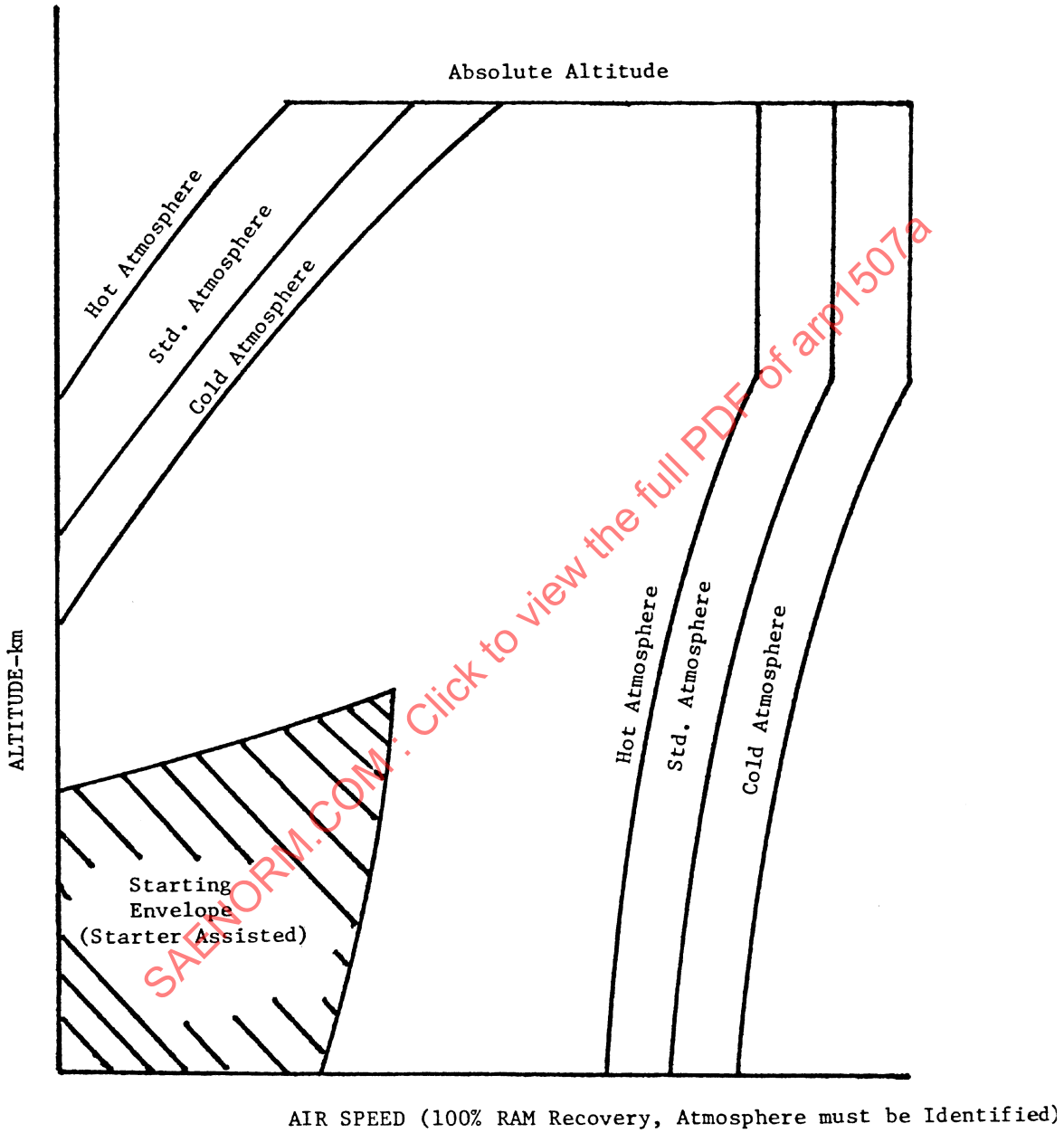


FIGURE 1 - Starting and Operating Envelope

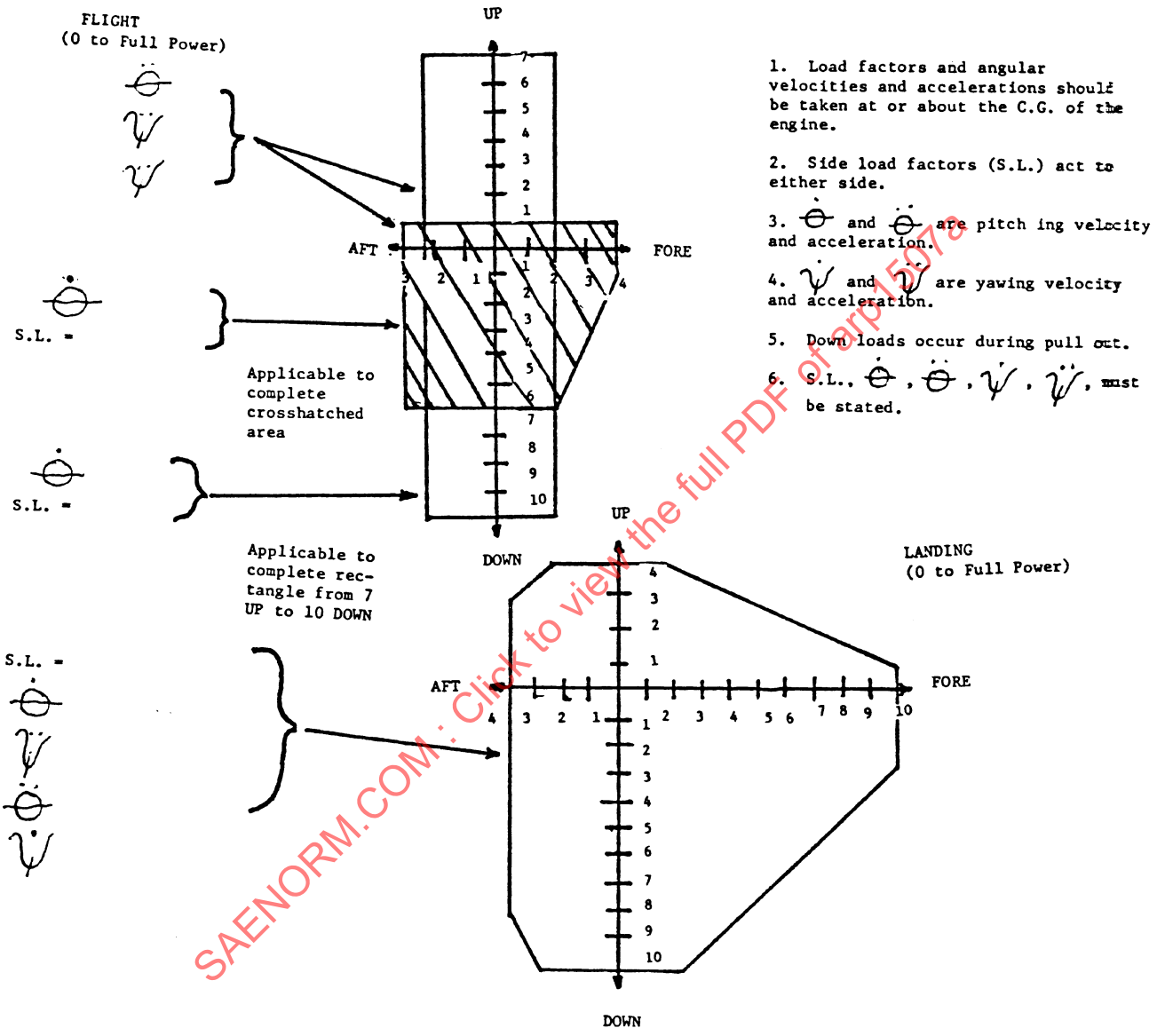


FIGURE 2 - Externally Applied Forces

3.2.9 Oil System:

a. The oil for normal use must be identified with any necessary restrictions.

b. Oil system operating pressures and temperature must be identified throughout the operating envelope and the location of sensors must be stated.

c. Oil system flow and cooling requirements must be identified if the engine requires a helicopter furnished engine oil cooling.

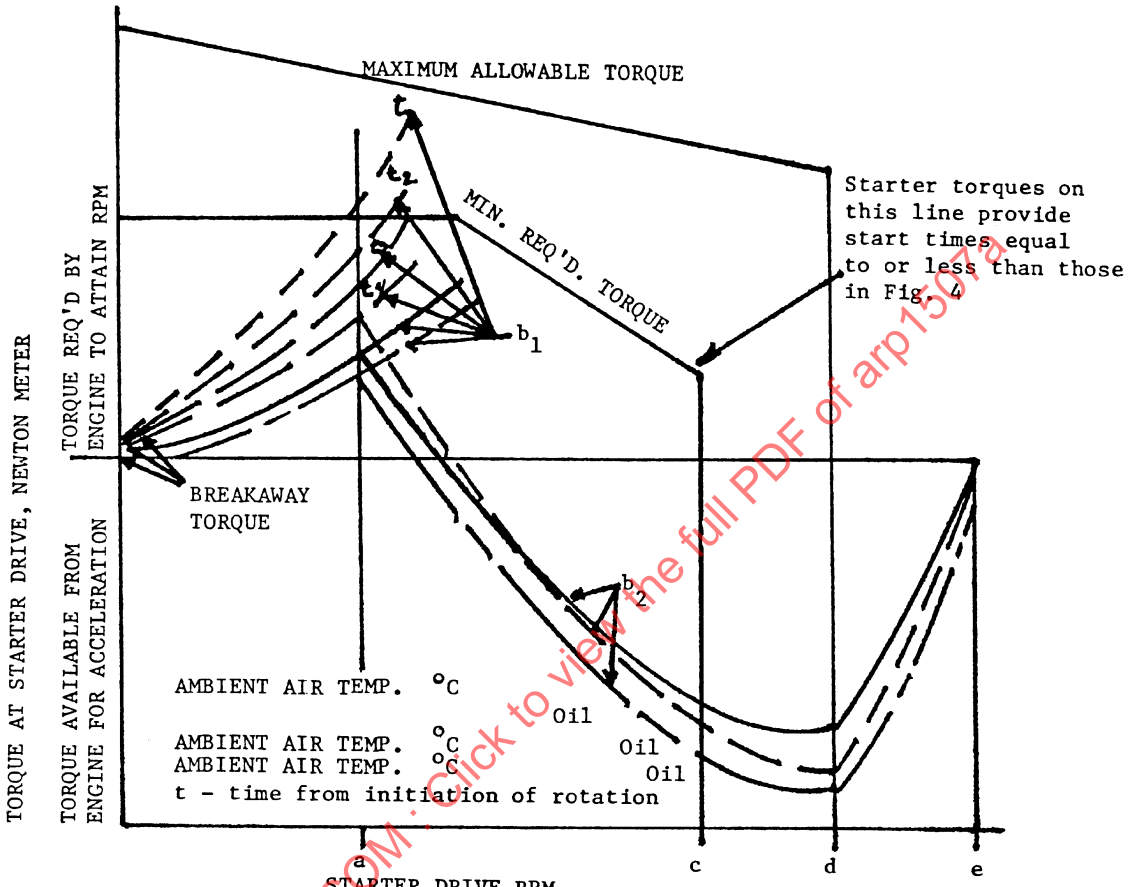
d. Oil consumption rate and oil flow must be identified if the engine requires a helicopter furnished engine oil tank.

e. Oil system vent requirements including location, maximum flow rates, and vent pressure restriction limits must be identified.

f. Oil filter location and characteristics such as type of filter, filtration capability, bypass or impending bypass capability, etc., should be described.

3.2.10 Starting System: The required starter torques and drive speeds will be stated and shown in a figure, such as Figure 3. The figure should include engine drag, breakaway torque, engine accessory drag, and customer accessory gearbox drag. The figure should show the effects of ambient temperatures and altitudes and alternate fuels. A figure should be included which shows the effect on starting time caused by ambient temperature and altitude (Figure 4). The maximum effective mass moment of inertia of engine rotating parts to be rotated by the starter, referred to the starter drive, and the speed ratio between the starter pad and the driven rotor system must be stated. The torsional spring constant for the engine starting drive system at the starter drive pad must be stated. The maximum backlash of the starting drive system in radians at the starter drive pad should be identified.

3.2.11 Compressor Air Bleed: If a compressor air bleed source is available, the mounting type, location, dimensions and limit loads must be identified. The maximum permissible air bleed must be identified. The air bleed purity must be stated. The responsibility for limiting the air bleed must be established.



a. REQUIRED RPM BEFORE FIRING
(WHERE APPLICABLE THE ENGINE MANUFACTURER SHALL STATE THE MINIMUM TIME AND THE NUMBER OF REVOLUTIONS OR ANY COMBINATION OF CONDITIONS THAT MUST BE SATISFIED BEFORE FIRING.)
MAXIMUM REQUIRED CRANKING TIME AT FIRING SPEED -----SEC

b. STEADY-STATE TORQUE AT THE STARTER DRIVE
1. IN AN UNFIRED ENGINE. (CURVES AT -54°C SHOW DRAG TORQUE AFTER TIME FROM INITIATION OF ROTATION)
2. IN A FIRED ENGINE

c. MINIMUM STARTER CUTOUT SPEED-----RPM

d. MAXIMUM STARTER CUTOUT SPEED-----RPM. (MAXIMUM CUTOUT SPEED SHOULD BE AT LEAST 10 PERCENT ABOVE MINIMUM CUTOUT SPEED).

e. ENGINE IDLE CONDITION

FIGURE 3 - Starting Torque and Speed Requirements
(Sea Level Static Conditions)

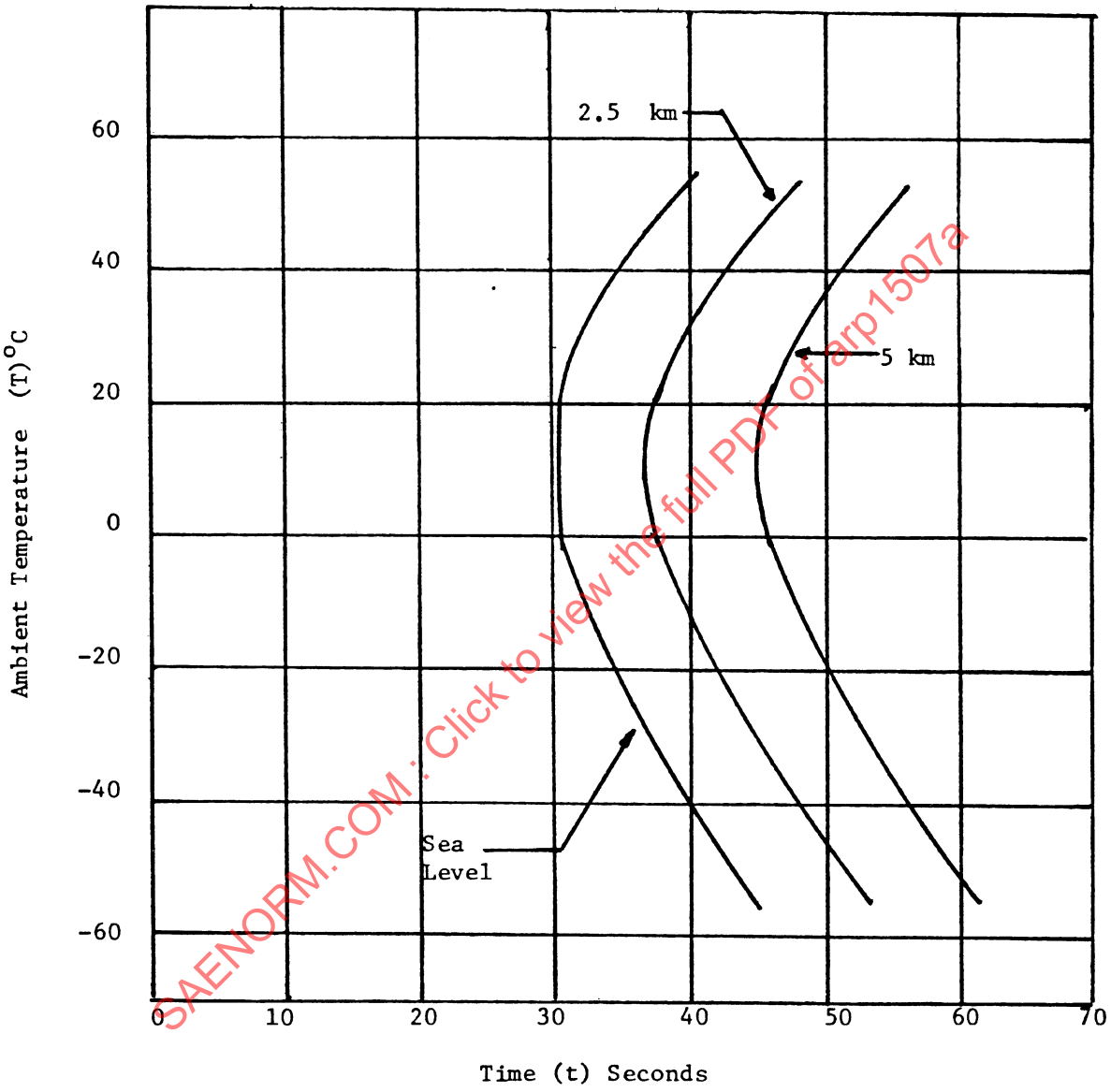


FIGURE 4 - Engine Ground Starting Time Versus Ambient Air Temperature - (Static Sea Level to 5 km)

3.2.12 Engine Heat Rejection and Cooling:

a. The engine heat rejection and cooling should be described as defined in ARP996.

b. If there are engine component limiting temperatures, the components and their temperature limits will be stated and the installation drawing will identify the thermocouple location and type.

3.2.13 Electrical System: The electrical system must be described on the installation drawing. Individual engine component power requirements and power characteristics from the helicopter and requirement duration must be identified. The engine electrical output signals to the helicopter, signal characteristics and the signal duration must be identified.

3.2.14 Air Induction System:

a. The air induction system should be described, especially such features as inlet connection and any integral protection from foreign objects or required foreign object protection from the helicopter.

b. The air induction anti-icing system should be described, especially system function with electrical supply failure.

c. Inlet distortion limits should be identified.

3.2.15 Exhaust System: The exhaust connection mounting type, location, dimensions, and limit loads must be identified. If an exhaust centerbody is required, the mounting type, location, dimensions, and limit loads must be identified. The engine manufacturer should identify a recommended exhaust configuration which is compatible with engine performance.

3.2.16 Engine Condition Monitoring and Diagnostics: The condition monitoring and diagnostics capabilities should be described. If component power requirements exist, they should be identified in paragraph 3.2.13, Electrical System. The instrument range, system accuracy, time response, and electrical characteristics for each parameter that is required for safe engine operation and operation within established operating limits shall be presented in the Helicopter Engine/Airframe Interface Document and Checklist.

3.3 Engine Physical Characteristics:

3.3.1 Weight: The engine dry weight must be stated. It is recommended that the weight of residual fuel and oil be identified when the engine is in a horizontal attitude. If there are components which may be furnished with an engine, such as accumulators, fuel flow meters, etc., it is suggested that the component part number and weight be stated.

3.3.2 Engine Dimensions: The engine dimension must be on the installation drawings which must be a part of the Helicopter Engine/Airframe Interface Document and Checklist.

3.3.3 Engine Mounts: Any engine mounting considerations should be stated. Specific information on mount locations, dimensions and static, dynamic and limit loads must be identified. It is recommended that this information be on the installation drawing.

3.3.4 Mass Moments of Inertia: The following will be stated:

a. The mass moment of inertia of the complete dry engine about three mutually perpendicular axes with the origin at the center of gravity.

b. The mass moment of inertia of each engine rotor system about the resultant rotational axis, together with the effective direction of rotation of the inertia and the direction and location of the resultant rotational axis. For engines with geared rotor systems, the shaft to which all inertias of each rotor system have been algebraically referred will be stated.

c. The mass moment of inertia of the complete power output system (including the reduction gear train) referred to the output shaft speed.

3.3.5 Output Shaft: The output shaft configuration, i.e., internal spline, external spline, etc., must be stated and the direction of rotation must be stated. Specific information on the spline pad location and limit loads must be identified on the installation drawing. Any special consideration such as wetted spline oil control or angular misalignment should be identified.

3.3.6 Accessory Drives: A table similar to Table 1 must be included to describe the accessory drive characteristics. The accessory drive pad locations, dimensions and limit loads must be identified on the installation drawings.

3.3.7 Fuel System and Control System:

a. Fuel System and Control System connection locations, dimensions and limit loads must be identified.

b. Fuel filter location and characteristics should be described such as type of filter, filtration capability, time to impending bypass or bypass based on a specified fuel contamination concentration, and any signal and its characteristics provided to indicate pending filter bypass or bypassing conditions. Any limitations on fuel line characteristics such as slope, line diameter, etc., must be described.

3.3.8 Oil System:

a. Oil system connection locations, dimensions, and limit loads as applicable must be identified.

b. Oil chip detector location and type should be identified if applicable.

TABLE 1 - Gearbox Pads and Drives

Name of Accessory or Component	Type of Drive (1)	Ratio of Pad to Rotor Speed	Direction of Rotation (Facing Pad)	Torque Rated	Torque Overload (2)	Torque Static	Overhung Moment

NOTES:
(1) Give the type of drive including AND or MS number and type.
(2) Specify duration and frequency of overload.

3.4 Drawings:

The Helicopter Engine/Airframe Interface Document and Checklist should contain copies of the engine installation drawing and the engine electrical system drawing.

3.4.1 Installation Drawing: Installation drawing data should include:

a. Notes which address the following:

(1) Dimensions, tolerances, and the temperatures which are used for basic dimensions (e.g., 15 °C or room temperature) including hot engine dimensions for mounts, exhaust flanges, etc.

(2) Orientation or reference datums.

(3) Engine center of gravity dry, including tolerances, and if significantly different, serviced.

(4) Vibration pickup locations and applicable vibration limits.

(5) Mounting restrictions.

(6) Maximum permissible loads on each connection point. For example, the maximum permissible loads on the accessory pads, exhaust connection, fuel inlet connection should be identified.

b. Tables which contain the information on installation connections and servicing points. Tables should address:

(1) Item identification (number of symbol).

(2) Item nomenclature.

(3) Item description (view, description, etc.).

(4) Sheet number and zone location of the item detailed description.

(5) Item location (station, waterline, buttock line) coordinates.

3.4.1 (Continued):

c. An engine installation drawing may consist of several sheets. A suggested presentation of data for each sheet could be as follows:

(1) Sheet 1: Presenting notes, tables, and left side view of the engine.

(2) Sheet 2: Presenting the engine front view, right side view, and rear view.

(3) Sheet 3: Presenting the engine envelope, access envelopes for removal and replacement of components, and access envelopes for the engine interface connections.

(4) Sheet 4 and subsequent sheets: Presenting the detailed definition of all interface connections that are not defined by referenced standards.

3.4.2 Electrical System Drawing: The electrical system drawing data should include:

a. Notes which address the following:

(1) Definition of all engine provided signals and if necessary, the required electrical characteristics of these signals, and the required electrical characteristics of circuits external to the engine.

(2) Definition of all electrical power required by each separate power input circuit of the engine and the required electrical characteristics of this power.

(3) Definition of the electromagnetic interference limits that may be introduced by airframe circuits or tests/checks that may be done to find problems.

b. Tables which contain the following information:

(1) Connector reference designation.

(2) Drawing zone location.

(3) Shell size and insert arrangement.

(4) Reference the document for shell size and insert arrangement.

(5) Notes as required.

c. Schematic wiring diagram.

3.5 Interface Checklist:

It is recommended that an interface checklist be used to assure complete coverage of all interface characteristics. A sample checklist is contained in Appendix A.