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MILITARY STANDARD

MOCKUPS, AIR VEHICLE ENGINES, CONSTRUCTION AND INSPECTION OF



MIL-STD-1592

DEPARTMENT OF DEFENSE  
WASHINGTON, D C 20301

Mockups, Air Vehicle Engines, Construction And Inspection Of

MIL-STD-1592

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## MOCKUPS, AIR VEHICLE ENGINES, CONSTRUCTION AND INSPECTION OF

## 1. SCOPE

1.1 Purpose. This standard establishes the general procedures for the construction and inspection of engine mockups. The engine mockup procedures described herein refer to the following types of engines:

- a. Turbojet engine
- b. Turboprop engine
- c. Turboshift engine
- d. Turbofan engine
- e. Ram jet engine
- f. Liquid propellant rocket engine
- g. Solid propellant rocket engine
- h. Reciprocating and rotary type engines
- i. Combinations of the above engines.

## 2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein:

## STANDARDS

## FEDERAL

FED-STD-595            Colors

## MILITARY

MIL-STD-1247           Markings, Functions and Hazard Designations of Hose,  
Pipe, and Tube Lines For Aircraft, Missile, and  
Space Systems

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

## 3. DEFINITIONS

3.1 Mockup. The engine mockup is a full scale representation of the engine under consideration.

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3.2 Mockup inspection. The mockup inspection is the evaluation by the services of the installation interfaces and external configuration of the engine or parts represented by the mockup.

3.3 Mockup board. The mockup board is a group of individuals responsible for conducting the mockup inspection.

3.4 Mockup board chairman. The mockup board chairman is the presiding individual over the mockup inspection.

3.5 Technical advisors. The technical advisors are individuals designated by the mockup board to act in an advisory capacity to board members and may include one of the services' plant representatives.

3.6 Observers. The observers are individuals other than board members and technical advisors who represent the air vehicle contractors and other agencies.

3.7 Recorder. The recorder is the individual designated by the using service to record the actions of the mockup board.

3.8 Using service. The using service is the service whose model dash number has been assigned to the engine in accordance with MIL-STD-879.

3.9 Contractor. Contractor, when used in this standard, refers to the engine manufacturer.

3.10 Request for change or study. The requests for changes or studies are recommended changes to the mockup and are submitted on prepared forms similar to the form as shown on figure 1.

3.11 Categories of changes. The categories of changes are the mockup board's disposition of the request for changes. The categories are as follows:

#### CATEGORY I

Change approved by the board and the contractor will comply with the request as a part of current contract.

#### CATEGORY II

Study approved by the board and contractor will submit study by \_\_\_\_\_.  
(Contractor will specify date subject to approval by the chairman.)

### CATEGORY III

Request approved by the board; however, it requires further evaluation, coordination, or approval of the using service and may require negotiation with the contractor. Requests which do not affect the installation features of the engine may also be assigned this category. This category will not be used if the request is within the scope of the mockup board. The contractor and initiator will be informed of the decision on the request.

### CATEGORY IV

When it is determined that changes to the mockup are required which cannot be made during the initial inspection, the request(s) will be deferred until the contractor can make the changes. Then the request(s) will be reconsidered as designated by the chairman.

### CATEGORY V

Request approved by the board for consideration for other engine models in the future but does not affect present engine. If the board desires a study to be submitted, this will be indicated on the request for change form by the recorder.

### CATEGORY VI

Request is of a specification nature. These requests will be explained by the initiator and discussed by the board if they so desire, then these requests will be deferred until official specification coordination.

### CATEGORY VII

Request disapproved by the board.

## 4. GENERAL REQUIREMENTS

4.1 Engine mockup. Engine mockups are intended to provide a means of conceiving a project in its entirety through the use of a full scale model of the engine, or parts thereof. The mockup may be constructed of wood, metal, plastic materials, or actual components and items of the engine. The mockup shall represent the engine external configuration as shown on the Engine Configuration and Envelope (Installation) Drawing. The mockup shall include all pipe, hose and tube lines and fittings and their attaching hardware; attached accessories and components, etc.; and shall show clearances and interferences. The use of the mockup should provide solutions of general configuration details covering operational suitability, accessibility, serviceability, and maintainability, and should avoid future difficulties which normally could not be foreseen from examination of drawing details. Engine mockups are also intended

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to provide an engine configuration that can be used in as many air vehicle installations as practicable thus reducing the number of separate engine models required.

4.2 Engine mockup inspections. Engine mockup inspections are intended to provide an orderly process for obtaining such changes to the configuration of an engine as are necessary to make it suitable for installation and use in a specific air vehicle. The inspections are also intended to give the contractor the benefit of the most up-to-date experience of specialized individuals of the Government and air vehicle manufacturers with respect to installation and operating requirements. Approval of the mockup enables the contractor to proceed with assurance that the arrangement of the engine and accessories will not be radically modified.

## 5. DETAIL REQUIREMENTS

### 5.1 Responsibilities.

#### 5.1.1 Contractor's responsibilities.

5.1.1.1 Mockup availability. The contractor shall make the mockup available for inspection after all preliminary installation features have been established, in order that changes found necessary may be made without delaying previously established program schedules.

5.1.1.2 Notification. The contractor shall notify the using service at least 30 days in advance of the firm date on which the mockup will be ready for inspection by the mockup board. The engine mockup shall be complete and ready for inspection at the time appointed for arrival of inspection personnel. The contractor may submit a suggested schedule of events for the inspection.

5.1.1.3 Engine description data package. The contractor shall provide copies of the engine description data package furnishing information in accordance with appendix A or B as applicable. For engine types not covered by appendix A or B, a similar description shall be provided. This data package shall be submitted to the using service at the time the service is notified of the proposed date of the engine mockup inspection. The data package shall have a cover sheet similar to the sample as shown on figure 2. Data and descriptions furnished may be estimated if actual or guaranteed data is not available. Estimated data shall be so indicated.

5.1.1.4 Accessory mockups. Air vehicle accessory mockups, or mockups of the applicable clearance envelopes, shall be provided.



5.1.1.5 Color coding and labeling. All components, fittings, and sections of the engine mockups shall be labeled. All external lines will be color-coded in accordance with MIL-STD-1247 wherever possible to conform to the fluid contained within the lines. An additional means of color-coding and labeling shall be used to complete the mockup and to identify all parts as mockup parts. All parts of the engine, its components, and accessories will be color-coded using colors conforming to FED-STD-595 as indicated below:

- a. Steel parts - silver, #17178
- b. Aluminum parts - gray, #16187
- c. Magnesium parts - light gray, #16357
- d. Titanium parts - blue, #15102
- e. Nickel and cobalt alloys - red, #11136
- f. Composite parts - brown, #10049
- g. Ceramic and ceramic coated parts - white, #17875
- h. Aircraft accessory clearance envelopes - yellow, #13655
- i. Engine components (fuel pump, control, etc.) - color for basic material plus stripes of black, #17038
- j. Installation connections - color for basic material plus stripes of orange, #12197
- k. Items requiring frequent removal or adjustment - color for basic material plus stripes of green, #14187.

5.1.1.6 Engineering assistance. The contractor shall provide engineering personnel for consultation as required. Engine drawings shall be made available during the inspection as well as copies of the engine model specification, copies of this standard, and copies of the engine description data package. Copies of request for change or study forms similar to figure 1, will also be made available.

5.1.1.7 Other assistance. The contractor shall provide personnel during the mockup inspection to arrange, modify, or rework various items of the mockup equipment as may be requested by the mockup board. The contractor shall also provide secretarial service for typing and duplicating the requests for change forms in support of the board activities.

5.1.1.8 Working area. The contractor shall have the working area so arranged that the mockup inspection and the open board meetings can be held in the same room or area. An additional room shall be made available during the inspection for executive meetings of the mockup board. The working area shall be maintained at a comfortable temperature and sufficiently quiet so that work can be performed satisfactorily.

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5.1.1.9 Contractor's request for changes. The contractor may submit request for changes or studies on unestablished items which must be decided upon by the mockup board.

5.1.1.10 Contractor's response to requests for changes. The contractor shall review all change or study requests and prepare a response for each. These comments shall be provided to the recorder prior to the scheduled open meeting.

5.1.1.11 Minutes of inspection. The contractor shall prepare minutes of the inspection which shall consist mainly of the attendance list and the requests for changes with a discussion of what was covered during the open meeting including significant results.

5.1.2 Using service responsibilities. The using service shall appoint the mockup board; notify all parties concerned of the date, nature, and extent of the inspection; and notify the contractor at least 7 days prior to the inspection of the names and security clearances of the chairman, mockup board members, recorder, technical advisors and observers. The using service shall make the engine description data package available to all concerned parties prior to the inspection. The mockup board should represent the following areas of interest with each board member being responsible for one or more of these interests:

- a. Engine development and performance
- b. Engine installation
- c. Engine procurement
- d. Weapon system
- e. Engine accessories and components
- f. Maintenance and service engineering
- g. Air vehicle accessories and equipment
- h. Air vehicle design
- i. Instrumentation
- j. Other services which may use the engine (each of these services will be entitled to have one board member).

5.1.3 Mockup board responsibilities.

5.1.3.1 Mockup suitability. The mockup board shall determine the suitability of the installation configuration of the engine and direct such immediate changes to the mockup as are feasible and necessary to evaluate alternate arrangement.

5.1.3.2 Board's authority and limitations. The mockup board shall determine the proper category for each change or study request. The mockup board does not have the authority to direct changes to basic contractual requirements. Changes recommended by the board which alter basic requirements of the engine, or materially affects its weight, cost, or delivery schedule, shall be referred to the using service for approval. Therefore, any such actions by the board are not an authorization for the contractor to make any changes to any document or to change any work or to initiate any new work.

5.1.4 Recorder responsibilities. The recorder shall be the focal point for receipt of the request for change or study forms. Rough drafts will be reviewed by the recorder for clarity and for duplication. The recorder will assign log numbers, have the forms typed, and make the required distribution and will coordinate the flow of the requests through the contractor's review and the board's review, recording all board actions.

5.1.5 Responsibilities and limitations of others. Any attendee at the mockup inspection may initiate a request for change. The responsibilities of the technical advisors besides inspecting the engine mockup and submitting requests for changes shall consist of supplying technical information on installation details, latest equipment, specifications, arrangements of equipment, and general design requirements of air vehicle engines and furnishing advice on the technical utilization of the engine. Request for changes which affect the engine model specification may be submitted; however, the mockup board chairman may choose not to discuss these items at the mockup inspection. Requests for changes are allowed to be withdrawn by the initiator if a previous request had satisfactorily covered the subject.

## 5.2 Procedures for the inspection.

5.2.1 Opening of the inspection. The chairman of the mockup board shall open and preside over the mockup inspection.

5.2.2 Contractor briefing. The contractor shall at the beginning of the inspection give a brief description of the engine, its background, performance, and program schedules and explain the installation features of the engine.

5.2.3 Board chairman comments. Following the briefing by the contractor, the chairman of the mockup board, or a representative appointed by him, shall explain the scope, procedure, and schedule of the mockup inspection. This will include the history of the project, the applicable specifications, any new requirements which have become applicable since the contract, etc.

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5.2.4 Inspection and preparation of request for changes. The board members, technical advisors, and observers shall inspect the engine mockup and shall prepare any request for changes of studies in rough draft form using the requests for change and study forms. The requests should be submitted within the allotted time to give the contractor adequate time to review the requests and to prepare responses. The forms shall be filled out and routed as follows:

a. The initiator will:

- (1) Enter the complete engine model designation and date in Section 1.
- (2) Indicate the subject by marking the appropriate block of Section 2.
- (3) Enter the individual's name in Section 3.
- (4) Enter the name of the organization which the individual is representing in Section 4.
- (5) Discuss the request with a contractor's representative and enter the representative's name in Section 5.
- (6) Mark the request as a change or a study, and then describe the request in Section 6. (Only one change or study will be presented on each request. The initiator will be prepared to explain and substantiate his request and, when possible, should present a proposed solution for the problem.)
- (7) Enter the reason for requesting the change or study in Section 7. (Reasons should be as clear and concise as practicable.)
- (8) Submit the draft of the request to the board member responsible for the subject of the change.

b. The board member will enter his recommendation for board action in Section 8, and then submit the request to the recorder.

c. The recorder will:

- (1) Review the rough drafts for clarity, completeness and duplication.
- (2) Assign the request a log number and have the forms typed.
- (3) Make distribution of the copies as follows: at least three copies for the mockup board, one copy for the recorder's file, original and at least three copies for the contractor and one copy for the initiator.

d. The contractor will:

- (1) Prepare comments for each request and enter these comments in Section 9 on the original copy of the request form.
- (2) Return the original forms back to the recorder after copies have been made for contractor's use.

e. The recorder will have copies made of the original forms for the mockup board and the initiators of the forms.

5.2.5 Changes to the mockup. During the inspection those changes directed by the mockup board will be made to the mockup. These changes will be examined by the board for final approval. No changes will be accomplished on the mockup at the direction of any individual board member, technical advisor or observer, as the decision must be given by the board in conference after discussing all recommendations on the item. In cases where the the mockup is not completed for the purpose intended, or if changes requested are such that they could not be properly made during the period of inspection, the board chairman may, at his discretion, request a re-mockup of the portion under consideration. The manner in which the re-mockup inspection will be held, and the personnel to attend, will be as specified by the chairman.

5.2.6 Open meeting. At the pre-established time, the board chairman shall convene an open meeting with the board members, technical advisors, observers, recorder, and contractor's representatives, to discuss the requests and to determine the action to be taken upon these requests. Each request and reason shall be read, and the initiator may offer further explanation, if necessary. The contractor shall then be asked to state his comments upon the request. The chairman will allow discussion on the subject. Technical advisors and observers may present their opinions when recognized by the chairman. The chairman will assure himself that the board is in agreement before announcing a decision. The recorder shall indicate the decision of the board in Section 10 of the form, in accordance with the categories of changes listed in 3.11. Section 11 of the form may be used to explain any board decision. The chairman of the board shall sign the completed form in Section 12.

### 5.3 Final actions.

5.3.1 Communication. Within 10 days after the mockup inspection, the contracting officer shall prepare a communication to the contractor confirming the decisions of the board. He shall also take such action as is necessary to implement the additional recommendations of the board.

5.3.2 Report. The recorder shall prepare a report for approval and signature of the chairman or higher authority, for distribution to the using service and to all board members and observers. The report shall contain the following:

- a. Purpose of the meeting
- b. Date convened
- c. Board members

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- d. Technical advisors
- e. Observers
- f. Any special subject matter covered
- g. Recommendations and conclusions
- h. The report shall include as an appendix a copy of each request submitted to the board with indications of the action taken.

5.4 Disposition of contractor's mockup. The contractor's mockup shall be retained by the contractor for reference purposes until the actual engine represented has been finally accepted, or until dismantling is authorized by the using service. No part or component of the mockup shall be installed on an actual engine without prior authorization from the using service.

5.5 Mockups for air vehicle contractors. When additional engine mockups are required for air vehicle contractors, they will be identical to the approved mockup configuration. A dimensional check of these mockups shall be made against the installation drawing on all critical installation dimensions with hot and cold dimensions being considered. The engine contractor shall be responsible to update these mockups for all approved installation changes up through the completion of the first production engine contact, or as required by the using service.

## Custodians:

Army - AV  
Navy - AS  
Air Force - 11

## Preparing activity:

Air Force - 11

Project No. 2895-0001

## Review activities:

Air Force - 99

REQUEST FOR CHANGE OR STUDY		
1. MODEL:	DATE:	REQUEST NR.
2. SUBJECT (CHECK ONE)		
<input type="checkbox"/> MODEL SPEC	<input type="checkbox"/> FUEL & CONTROL	<input type="checkbox"/> STARTING & IGNITION
<input type="checkbox"/> INDUCTION	<input type="checkbox"/> INSTRUMENTATION	<input type="checkbox"/> ACCESSORIES & DRIVES
<input type="checkbox"/> LUBRICATION	<input type="checkbox"/> LINES & FITTINGS	<input type="checkbox"/> PROPELLANT FEED SYSTEM
<input type="checkbox"/> EXHAUST	<input type="checkbox"/> MAINTENANCE	<input type="checkbox"/> MOUNTING & HANDLING
<input type="checkbox"/> THRUST CHAMBER INSTALLATION		<input type="checkbox"/> OTHER _____
3. SUBMITTED BY:	4. REPRESENTING:	5. DISCUSSED WITH CONTRACTOR'S REP: NAME:
6. <input type="checkbox"/> CHANGE <input type="checkbox"/> STUDY (CHECK ONE)		
7. REASON:		
8. BOARD MEMBER'S RECOMMENDATION AND SIGNATURE:		
CATEGORY:      COMPLETION DATE IF STUDY:		
9. CONTRACTOR'S COMMENTS INCLUDING IMPACT:		
10. MOCKUP BOARD DECISION:		11. REMARKS:
I <input type="checkbox"/> CHANGE APPROVED II <input type="checkbox"/> STUDY APPROVED, COMPLETION DATE _____ III <input type="checkbox"/> APPROVED PENDING USING SERVICE EVALUATION IV <input type="checkbox"/> DEFERRED PENDING MOCKUP REVISION V <input type="checkbox"/> APPROVED FOR FUTURE MODEL CONSIDERATION VI <input type="checkbox"/> SPECIFICATION COORDINATION ITEM VII <input type="checkbox"/> DISAPPROVED		
		12. BOARD CHAIRMAN:

FIGURE 1. Request for change or study.

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Engine, Aircraft, Turbofan, Description

Engine Model Designation \_\_\_\_\_

Engine Model Specification Nr. \_\_\_\_\_

Date of Model Specification \_\_\_\_\_

Contract Nr. \_\_\_\_\_

Air Vehicle Designation \_\_\_\_\_

Prepared By \_\_\_\_\_

Date \_\_\_\_\_

FIGURE 2. Sample of a cover sheet for engine description data package.



## APPENDIX A

## Turbine Engine Description

A10. SCOPE. This appendix provides the outline to follow and the type of data required for engine description data packages for turbofan, turbojet, turboshaft and turboprop engines.

A20. ENGINE DESCRIPTION, GENERAL

A20.1 Describe briefly the engine type:

- a. List ratings of the engine including rated gas temperatures.
- b. List all applicable fuel and oil specifications for the engine.
- c. List engine dry weight and include accessory breakdown if available.
- d. List residual fluid weight and weight of additional equipment.

A20.2 Describe provisions for compressor air bleed:

- a. Describe location and type of bleed air fittings.
- b. In case of multiple fittings, describe whether air has to be bled in equal amounts from each fitting or from symmetrically located fittings.
- c. Describe whether mass bleed air flow is required by the engine or if it may be intermittent according to the air vehicle's requirements.
- d. Describe interstage compressor air bleed and variable compressor geometry for use during starting and engine acceleration.

A20.3 Attach copy of preliminary engine installation layout or drawing.

A20.4 Describe interchangeability of engine components.

A20.5 Describe vulnerability resistance characteristics and explosives and ordinance survivability.

A30. CONTROL SYSTEM

A30.1 Describe the control system briefly including the fuel control, A/B control, air bleed control or provisions for limiting, exhaust nozzle control, turbine(s) governor control(s), etc.:

- a. List all component assemblies and a brief description of their operation.

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- b. List the ambient temperature limits for each component for operating and non-operating conditions.
- c. Describe **operation** and location of control safety devices such as over-temperature and overspeed, manual provisions, etc. Describe engine parameters utilized for control sensing.
- d. List all adjustments and their location including fuel control, A/B control, compressor geometry adjustment, exhaust area adjustment, etc.
- e. Describe all external sources of power required to operate the control components or actuators.

A30.2 Power levers and switches:

- a. List all the levers and switches required for operation of the engine control and their functions.
- b. Describe any required sequencing between the levers and switches.
- c. Describe the thrust versus power lever relationship for the engine.

A40. STARTING SYSTEM

A40.1 Describe starting system, including inter-relation with power or condition lever.

A40.2 Describe ground and air starting procedures in detail, itemizing all functions which must be performed by equipment not furnished with the engine.

A40.3 Describe and show the installation of the type(s) of starter(s) requested by the using service prior to the mockup inspection.

A50. IGNITION SYSTEM

A50.1 Describe the main and afterburner ignition systems provided, method of installation, and power requirements.

A60. INDUCTION SYSTEM

A60.1 Describe type of customer's attaching flange and quick disconnect fitting required or provided on the engine air inlet.

A60.2 Describe any provisions made to allow for misalignment between engine and inlet duct(s).

A60.3 State if engine air intakes are provided with retractable screens. If provided, describe mesh, type, and anti-icing provisions.

A60.4 Describe engine anti-icing provided. (List components for which protection is provided, method of anti-icing for each component, and method of anti-icing system control.)

A60.5 Describe inlet noise abatement provisions or design considerations.

A60.6 Describe sand and dust separator, filter or screens and provisions to reduce foreign object ingestion damage.

A60.7 Describe provisions to allow for variable inlet area.

A60.8 Describe inlet air pressure variation limits and rate of temperature change limits.

#### A70. EXHAUST SYSTEM

A70.1 Describe the components of the exhaust system provided and identify the exhaust system components furnished by the air vehicle contractor.

A70.2 State if all the exhaust system components furnished with the engine are detachable from the engine and describe detachment.

A70.3 Describe any provisions made to take care of expansion and misalignment between engine and tailpipe, and maximum angle of obliquity in degrees.

A70.4 State if the exhaust mounting flange permits the use of oblique tailpipe installation.

A70.5 If afterburner is furnished, describe the following:

a. Mounting provisions.

b. Insulation provisions, if any, and type.

c. If shrouding or bulkheading is provided, describe type and attached fittings.

A70.6 Describe infrared and noise abatement provisions.

A70.7 Describe exhaust nozzle area adjustment and actuation provisions.

A70.8 Describe fail-safe features of variable area nozzles.

A70.9 Describe thrust reverser and fail-safe provisions.

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A80. FUEL SYSTEM

A80.1 Describe briefly the fuel system provided, including the following:

- a. Type and number of pumps, manifolds, etc.
- b. State where positive fuel shut-off is provided, and describe (including means of actuation).
- c. Describe location of fuel filter provided, micron size of filter, impending by-pass indication and other features.
- d. In the event the engine required that the aircraft fuel system provide a fuel filter, describe requirements.
- e. Describe fuel filter cleaning or replacement and draining provisions. Describe other component drains.
- f. If fuel manifold and combustion chamber drains are provided, describe their actuation.
- g. Describe provisions for disposition of drained fuel.
- h. Describe fuel nozzles accessibility for field inspection and replacement.
- i. Describe required fuel inlet conditions with all specified fuels.
- j. Give type, capacity, quantity and location of fuel flowmeters.
- k. Describe other limitations of the fuel system such as: minimum and maximum fuel flows.

A90. LUBRICATION SYSTEM

A90.1 Describe briefly the type of lubricating system provided (pressure, wet or dry sump, oil-air mist, metered pressure no-return type, integral or external to the engine, negative and zero "g" provisions, etc.) and include the following:

- a. If an oil system external to the engine is required, list the following:

Engine Ratings	Oil Inlet Temp °C	Oil Press. P.S.I.	Oil Flow #/min.	Heat Rejec. BTU/min.	Residual Oil Req.

- b. If an external oil system is required, describe location and type of oil tank vent connection on engine.
- c. Describe any oil pressure adjustment provided.
- d. Describe the oil reservoir and give the capacity in gallons and relate to engine operating time.
- e. If an external system is used, describe provisions for separating entrained air from scavenged oil.
- f. State if a breather is required.
- g. If an integral oil reservoir is provided, describe filling and oil level measuring provisions.
- h. Describe accessibility for cleaning tank, etc.
- i. Describe oil drain provisions.
- j. Describe provisions for oil sampling for spectrographic analysis.
- k. Describe provisions for oil temperature control, type of heat exchanger, etc.
- l. Describe magnetic chip detector(s) and location(s).

#### A100. ACCESSORY DRIVES

A100.1 List the type and number of accessory and component drives provided:

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Drive	Type	Number
Generator Fluid power pump Power take-off Starter Power control Fuel pump(s) Propeller governors Ignition alternator Power turbine governor Tachometer Other		

If any of the above drives deviate from an AS, MS or AN Standard, describe deviations. Describe any special features such as constant speed drive provisions, etc. Describe drive spline lubrication system for each drive.

#### A100.2 Adapter or remote accessory gearbox:

- a. Describe configuration, mounting provisions, and type and number of drives if applicable.
- b. Describe any gearbox lubrication required, which is not engine furnished.
- c. State if connecting shaft between engine power take-off and remote gearbox is furnished; describe.
- d. Describe means provided to restrain the power transmission shaft after a shearing failure.

A100.3 Describe accessory drives arrangement and indicate if any accessory may not be removed independently of any other accessory or engine part.

A100.4 Describe clearance envelopes maintained with all accessories mounted on the accessory drive gearbox.

A100.5 Describe fluid pumps and components location with respect to electrical accessories or actuators and describe any scuppers and drains provided for the fluids.

#### A110. LINES AND FITTINGS

## A110.1 Fittings

- a. List all customer's connections and identify all AIDS readouts, giving:

Type of Connection	Location (Describe)	Size and Type of Fitting
		(If control, specify amount of travel) (If quick disconnect, describe type) (List all customer's connections by AN, AS or MS Standards where applicable. If non-standard, indicate so)

## A110.2 Lines and fittings

- a. Describe type of fluid lines and fittings provided.

A120. EXHAUST GAS TEMPERATURE (OR TURBINE INLET) SENSING SYSTEM

A120.1 Describe the exhaust gas temperature sensing system with regard to type of temperature sensors, configuration of temperature sensors, method of obtaining signals from temperature sensors, response rate, circuit diagram or calculations and any other peculiarities of the system.

A130. COOLING SYSTEM

A130.1 When insulation blankets are required for engine or airframe protection, and they cannot be provided, explain reasons why.

A130.2 Give maximum skin temperature profile of the engine and heat rejection rates by sections. The section and stations should be numbered and labeled.

A130.3 Give maximum and ambient operating zone temperatures of the compressor, combustion, turbine, and afterburner.

A130.4 State if the accessories are "canned" or covered. If so, describe how they are cooled and state amount of heat rejection.

A130.5 List maximum temperature permitted for engine components critical with respect to temperature not previously covered. List short-time elevated temperature limits and post-shutdown temperature limits for engine components.

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A130.6 If secondary cooling air is required for an engine mounted shroud or exhaust nozzle cooling, describe any special flows, pressure, variation, limits, etc.

A140. MOUNTING AND HANDLING

A140.1 Describe engine mounting system including number and type of fittings, location with respect to CG and provisions for engine mount vibration isolators and thermal expansion requirements.

A140.2 Describe both hoisting and supporting fittings provided including special adapters or special equipment and hoists required.

A150. MAINTENANCE

A150.1 Describe briefly routine maintenance requirements of the installed engine including borescope inspection provisions and other features for inspection and replacement of engine components. Describe detail features of each major component which establishes the degree of maintainability of the engine.

A150.2 Describe provisions for servicing, rapid removal, repair or replacement, adjustment including accessibility of engine components and aircraft accessories. Describe field checks on engine components such as the ignition system, thermocouple harness, etc.

A150.3 Describe field level, depot level and organizational maintenance functions.

A150.4 Describe maintenance tools, facilities and replacement parts capability required at each maintenance level.

A160. PROPELLERS OR OUTPUT SHAFT POWER ABSORBER (IF APPLICABLE)

A160.1 Describe method of propeller mounting.

A160.2 State if engine oil system provides oil to operate propeller controls.

A160.3 State what air vehicle controls, if any, are required and describe operation.

A160.4 Describe provisions made to separate gearbox and power unit.

a. Describe intermediate bearing, if not mounted on engine, and extension shaft provisions.

A160.5 Describe gearbox, including mounting provisions.



A160.6 Describe torquemeter, negative torque limiter and output shaft brake.

A160.7 In the case of turboprop engines with separate reduction gearboxes, state requirements for vibration isolation and misalignment tolerance between gearbox and power units and state if any engine-contractor-furnished structural connection between gearbox and power units are provided.

A160.8 Specify provisions for deicing of propeller spinner or inlet dome.

A160.9 For turboshaft engines, explain dimensions for proper output shaft alignment with the power absorber.

A170. MISCELLANEOUS

A170.1 Breathers and drains:

- a. Describe all breathers and drains provided, the amount and type of fluids to be handled by each and access requirements to each.
- b. Identify any common fluid drains and manifold drains provided.

A170.2 Fire seal:

- a. Describe location, type and material of fire seals, if provided.
- b. Show that all lines, harnesses, etc., running from the forward to the aft end of the engine pass through the fire seal.
- c. Describe how all lines are sealed at the firewall.

A170.3 Indicators:

- a. Describe all indicators required for satisfactory engine operation.
- b. Describe the range of indication for these indicators.

A170.4 External power requirements:

- a. List all external power requirements for ground and air starting and operation.
- b. Describe customer connections for external power not previously covered.

A170.5 Water or water-alcohol injection systems:

- a. Describe water, water-alcohol or other liquid injection system used for augmentation including the pump, flow rate, spray nozzles and other equipment necessary for operation of the system.

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A170.6 Quick engine change (QEC) kit:

- a. Describe QEC kit including all accessories, fire and overheat detection and fire extinguishing parts.
- b. List the instrumentation and all equipment which forms a part of the QEC kit.

## APPENDIX B

## Rocket Engine Description

B10. SCOPE. This appendix gives the outline to follow and the type of data required for engine description data packages for rocket engines with liquid or solid propellants.

B20. ENGINE DESCRIPTION, GENERAL

B20.1 Describe the engine type.

B20.2 List ratings.

B20.3 List all applicable propellant and lubrication specifications.

B20.4 List maximum gas temperatures, metal surface temperatures, etc.

B20.5 Dry weight (estimated component weight breakdown).

B20.6 Describe engine mount provisions, including alignment provisions.

B20.7 Describe type and number of engine removal fittings.

B20.8 Describe markings of engine change disconnect points.

B20.9 List any engine change disconnect points inaccessible without disassembly of major engine components.

B20.10 Describe engine hoisting and supporting provisions.

B20.11 Give location of engine to vehicle connections, and describe attachment.

B20.12 Describe any heating and cooling requirements of engine components which are not provided with the engine. Cover operating and non-operating conditions. Include any positioning requirements.

B20.13 List any engine accessories to be mounted on the airframe.

B20.14 List any air vehicle components to be engine mounted.

B20.15 List any flight or ground checkout instruments to be furnished with the engine.

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B20.16 Describe preflight checkout procedures and ground support equipment needed to fully ready the engine for flight including methods of obtaining access to the engine where required (e.g., attachment of electrical fittings, determining torque of turbopumps, etc.).

B20.17 List any provisions required so that normal servicing does not create any safety hazard to maintenance personnel. Marking, purges, etc.

B20.18 List all engine electrical components which are potential ignition sources. Discuss any other possible ignition sources.

B20.19 Describe any insulation used on the engine, and state whether it will act as a wick in the event of propellant leakage or spillage.

B20.20 Describe lubrication provisions.

B20.21 Describe general checkout, maintenance and servicing procedures (include depressurizing, de-arming, purging, etc., prior to general servicing. Location of filters, screens, sump plugs, etc. should be described.).

B20.22 Attach copy of preliminary engine installation drawing.

### B30. CONTROL SYSTEM

B30.1 Describe the control system briefly:

a. List all components and assemblies and give a brief description of their operation.

b. List all adjustments, their location, and state which are field adjustments.

c. Describe all external connections required to operate the control components or actuators prior to launch.

B30.2 List and give location of all levers and switches required for operation of the engine.

B30.3 List and give location of all indicator lights, their colors, and their range of indication.

B30.4 Describe the thrust versus power lever relationship for variable thrust engines.

**B40. PROPELLANT FEED SYSTEM**

B40.1 Describe type of feed system including:

- a. Type and number of pumps.
- b. Type of pump drive.
- c. Type and number of gas generators, giving propellants and gas temperatures.
- d. Give type and number of turbine drives, and maximum temperature of the exhaust gases (without energy extraction).
- e. Describe pump seal drainage provisions.
- f. List pressurizing gases.
- g. List type and number of pressurizing gas tanks.
- h. Describe type, number, and working pressures of propellant tanks.

B40.2 Fluid:

- a. Describe air vehicle tank systems.
- b. Describe fill and return connections.
- c. List burst diaphragms or relief valves provided to prevent over-pressurization or negative pressures.
- d. Describe external provisions for expansion space control during filling of any fluid tank.
- e. List all rigid tanks not supported by padded cradles.

**B50. THRUST CHAMBERS AND NOZZLE ASSEMBLY**

B50.1 Describe thrust chamber assemblies:

- a. List overall heat rejection rates from combustion chamber and housing temperatures.
- b. Give the exhaust gas temperature pattern.
- c. List attitudes throughout which the thrust chambers are self draining.

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B50.2 Describe the nozzle assembly (include the nozzle throat, blast tube and exit cone).

B50.3 List all materials used in the nozzle assembly.

B60. LINES, FITTINGS, AND VALVES

B60.1 Describe fluid and electrical lines.

B60.2 Describe fittings.

B60.3 List all air vehicle (interface) pneumatic, hydraulic, electrical and lubricant connections, giving type, general location and fitting designation.

B60.4 List all propellant lines that can have vapor traps in liquid lines or liquid traps in vapor or vent lines.

B60.5 List and give location of all drain lines and note those in which any combination of propellants or other fluids can contact one another in the event of simultaneous draining.

B60.6 List all manually operated drain valves and identify fluids.

B60.7 Indicate most probable sources of fluid leakage and the possible consequences of this leakage.