

Engine; Rocket, Solid Propellant
5 Second Duration, 4500 Pounds Thrust

FSC 2845

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1. SCOPE:

1.1 This specification established the requirements for a 5 second duration, 4500 pound thrust (when determined at 60°F) solid propellant rocket engine hereinafter specified as 5 S-4500.

1.2 Classification:

The 5 S-4500 rocket engine is a moderate duration, low-thrust, self-contained power plant employing a solid propellant. The engine is designed specifically for jet assist take-off (JATO) of aircraft, and to deliver a nominal thrust of 4500 pounds for 5 seconds duration at 60°F and sea level. The engine contains aircraft attachment fittings and an ignition system.

2. APPLICABLE DOCUMENTS:

2.1 Government documents:

2.1.1 Specifications, standards and handbooks: Unless otherwise specified, the following specifications, standards and handbooks of the issue listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-P-116	Preservation, Methods of
DoD-D-1000	Drawings, Engineering and Associated List
MIL-S-5002	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems
MIL-D-5480	Data, Engineering and Technical, Reproduction Requirements for
MIL-I-6867	Magnetic Inspection Units
MIL-I-6868	Inspection Process, Magnetic Particle
MIL-I-6870	Inspection Program Requirements, Non-Destructive for Aircraft and Missile Materials and Parts
MIL-F-7179	Finishes and Coatings, Protection of Aerospace Weapon Systems, Structures and Parts, General Specification For
MIL-J-8667	Jet Assisted Take-Off Systems - Design and Installation of, in Naval Aircraft
MIL-C-16173	Corrosion Prevention Compound, Solvent Cutback, Cold Application
MIL-S-28786	Switches, Preparation For Delivery Of

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2.1.1 (Continued):

STANDARDS

MILITARY

DoD-STD-100	Engineering Drawing Practices
MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-109	Quality Assurance Terms and Definitions
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-320	Fuse Explosive Component Terminology, Dimensions and Materials
MIL-STD-410	Non-Destructive Testing Personnel Qualification and Certification (Eddy Current, Liquid Penetrant, Magnetic Particle, Radiographic and Ultrasonic)
MIL-STD-480	Configuration Control - Engineering Changes, Deviations and Waivers
MIL-STD-481	Configuration Control - Engineering Changes, Deviations and Waivers (Short Form)
MIL-STD-810	Environmental Test Methods
MIL-STD-889	Dissimilar Metals
MIL-STD-1595	Qualification of Aircraft, Missile and Aerospace Fusion Welders

Copies of specifications, standards, handbooks, drawings and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.

2.1.2 Other government documents, drawings, and publications: The following other Government documents, drawings, and publications form a part of this specifications to the extent specified herein.

DoD Manual

DoD 4145.26M	Safety Manual for Ammunition, Explosives and Related Dangerous Material
DoD 5154.4S	DoD Ammunition and Explosives Safety Standards

Naval Air Systems Drawings

NAF Dwg. 502706	JATO Unit, 30° Canted Nozzle, 4500 lb. Thrust Envelope Dimensions
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Naval Sea Publications

NAVSEA S9086-AA-STM-000	Naval Ship's Technical Manual Chapter 700
OP-5	Ammunition and Explosives Ashore
FEDERAL TEST METHOD 151	Test Methods Metals

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2.1.3 Order of precedence: When the requirements of the contract, this military specification, or applicable subsidiary specifications are in conflict, the following precedence shall apply:

2.1.3.1 Contract: The contract shall have precedence over any specification.

2.1.3.2 Military Specification: This specification shall have precedence over all applicable subsidiary specifications. Any deviations from this specification, or from subsidiary specifications where applicable, shall be specifically approved by the procuring agency.

2.1.3.3 Model Specification: A specification shall be prepared by the contractor in which the particular characteristics of his rocket engine model shall be defined. The model specification shall contain information which is supplementary to the military specification and shall state specifically any deviations from the requirements of the latter. The model specification shall be incorporated as a part of the procurement contract.

3. REQUIREMENTS:

3.1 Engine performance characteristics:

The performance of the rocket engine shall be reliable and uniform throughout the storage and operating limits specified herein. Performance curves shown in the attached figures shall constitute the performance part of this specification. Variation in average thrust, thrust duration and total impulse shall be kept at a minimum by the best methods of quality and process control. The performance ratings of the rocket engine shall be as shown in Figures 1, 2 and 3.

3.1.1 Operating temperature range: The engine performance shall be reliable and consistent throughout the temperature range of -30°F to +140°F. To demonstrate this performance requirement, test firings shall be made at -40°F and +150°F, respectively.

3.1.2 Duration of thrust variation: Variation in duration of thrust of the rocket engine fired at any temperature within the operating temperature shall not exceed that specified in Figure 1.

3.1.2.1 Thrust duration measurement: Thrust duration shall be measured on the thrust-time curve (see Figure 4, sample) between the point at which the tangent to the initial rise of the curve crosses the zero thrust ordinate and the point at which the tangent to the final decline of the curve crosses the zero thrust ordinate.

3.1.3 Average thrust variation: Variation of the average thrust of the rocket engine fired at sea level and at any temperature within the firing temperature range shall not exceed that specified in Figure 2.

3.1.3.1 Average thrust: Average thrust shall be obtained by dividing the total impulse (3.1.3.2) by the duration of thrust (3.1.2.1).

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- 3.1.3.2 Total impulse: Total impulse shall be determined by integration of the thrust-time curve from the point where a line tangent to the initial rise of the thrust curve intersects the line of zero thrust, to the point where a line tangent to the final decline of the thrust curve intersects the line of zero thrust.
- 3.1.4 Total impulse variation: Variations in total impulse (3.1.3.2) of the rocket engine within the operating temperature range of -30°F to +140°F shall not exceed that specified in Figure 3.
- 3.1.5 Ignition interval limit: The ignition interval at any temperature within the operating temperature range (3.1.1) shall not exceed 0.230 seconds.
- 3.1.5.1 Ignition interval: Ignition interval is defined as the time from switch operation to the time when a minimum continuous thrust of 3000 lb. at -40°F, 3500 lb. at 60°F, and 4500 lb. at +150°F is obtained during the initial three seconds of thrust duration.
- 3.2 Qualification Inspection:
- When specified, a sample shall be subjected to qualification inspection (see 4.2).
- 3.3 Material:
- Material used shall conform to applicable government specifications or contractor's specifications. Materials conforming only to contractor's specifications may be used to provided the specifications are approved by the cognizant customer representative. The use of contractor's specifications will not constitute waiver of customer inspection.
- 3.4 Parts:
- 3.4.1 Standard parts: Army-Navy Standard parts and references to their AN part numbers shall be used whenever possible.
- 3.4.2 Dissimilar metals: Contact between dissimilar metals, especially brass, copper or steel, in contact with aluminum or its alloys shall be insulated in the best practicable manner. Refer to MIL-STD-889 for the compatibility for the metals.
- 3.4.3 Interchangeability: Design of components shall be such as to insure interchangeability of parts and assemblies wherever possible. Quality control of components shall be exercised to assure such interchangeability. Exceptions to this specifications shall be limited to the following:
- (a) Nozzle throat diameters shall be assigned specifically for a batch of propellant when throat resizing is required to bring performance within allowable limits.
 - (b) Safety diaphragms shall be assembled per applicable drawings and specifications, and shall be interchangeable as assemblies only.

3.5 Design and Construction:

All drawings shall be prepared in accordance with DoD-D-1000 (Level Established by Contracting Officer) and MIL-D-5480; and shall be reviewed and approved by the customer or its duly authorized representative before being issued for production purposes. Drawing changes shall be made in accordance with the procedure outlined in MIL-STD-480 and MIL-STD-481.

A complete stress analysis for the rocket engine design shall be prepared and submitted to the customer for approval before manufacturing begins.

3.5.1 Engine: The rocket engine shall be composed of the following major components which shall be specified in detail in the applicable Model Specification.

- Chamber Assembly
 - Attachment fittings
- Aft Cap Assembly including:
 - Nozzle and weather seal
 - Safety release diaphragm
- Igniter Assembly
- Propellant Grain Assembly
- Shipping Cap - Fore End

3.5.2 Chamber assembly: The chamber, when fitted with igniter assembly and aft cap assembly (including nozzle and safety diaphragm assemblies), constitutes a pressure vessel, which shall be constructed in accordance with the best engineering practice to protect the enclosed propellant grain from all foreign matter including moisture and to satisfy operating pressure requirements.

3.5.2.1. Fittings: The attachment fittings shall satisfy installation under MIL-J-8667. The over-all envelope shall be within the outline established by NAF Drawing 502706, except that envelope deviations not violating the satisfaction of attachment fittings shall be permitted by contractual agreement between customer and contractor.

3.5.2.2 Proof test: Hydrostatic proof test of each pressure vessel assembly as composed of aft cap assembly, chamber and nozzle shall be made of sufficient magnitude to demonstrate that, at the temperature to be encountered in these parts, adequate strength has been provided for the highest predictable operating pressure and the estimated acceleration loads during JATO operation as set forth in the stress analysis (3.5).

3.5.2.3 Welding: All welding on the chamber shall be done by operators certified in accordance with MIL-T-5021.

3.5.3 Aft Cap Assembly: The aft cap assembly shall form the aft and closure of the chamber and retain the propellant grain in position within the chamber. The aft cap assembly shall incorporate the nozzle and safety diaphragm sub-assembly.