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5 May 1982
SUPERSEDING
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MILITARY SPECIFICATION

GUN SYSTEM, 25 MM (Av-8)

This specification is approved for Use by Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE.

1.1 Scope. This specification establishes the performance design, manufacture, test, and acceptance requirements for the 25mm gun system, referred to herein as the gun 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 that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation from a part of this specification to the extent specified herein.

Beneficial conments (recommendations, additions, deletions) and anY Pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Naval Air Engineering Center, Engineering Specifications and Standards Department (ESSD), Code 93, Lakehurst, NJ 08733, by using the self addressed Standardization Document Improvement proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 1005

SPECIFICATIONS

MILITARY

MIL-T-152	Treatment, Moisture- and Fungus-Resistant of Communications, Electronic, and Associated Electrical Equipment.
MIL-S-901	Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
DOD-D-1000	Drawings, Engineering and Associated Lists.
MIL-B-5087	Bonding, Electrical, and Lighting Protection for Aerospace Systems.
MIL-W-5088	Wiring, Aircraft, Selection and Installation of.
MIL-E-5400	Electronic Equipment, Airborne, General Specification for.
MIL-H-5440	Hydraulic Systems, Aircraft, Types I and 11 Design Installation Requirements for.
MIL-P-5518	pneumatic Systems, Aircraft; Design, Installation, and Data Requirements for.
MIL-E-6051	Electromagnetic Compatibility Requirements Systems.
MIL-E-7080	Electric Equipment, Aircraft, Selection and Installation of.
MIL-I-8500	Interchangeability and Replaceability of Component Parts for Aerospace Vehicles.
MIL-P-8564	Pneumatic System Components, Aeronautical, General Specification for.
MIL-I-8670	Installation of Fixed Guns and Associated Equipment in Naval Aircraft.
MIL-L-46000	Lubricant, Semi-Fluid (Automatic WeaPons.
MIL-W-81381	Wire, Electrical, polyimide-Insulated, Copper or Copper Alloy.
MIL-H-83282	Hydraulic Fluid, Fire Resistant Synthetic Hydrocarbon Base, Aircraft.

Department of The Army, Rock Island Arsenal
(Code Indent 19204)

AS12013545	Production Specification, Cartridge, 25mm, High Explosive Incendiary Tracer, Self-destruct, M792.
AS12013518	Product Specification, Cartridge, 25mm, Target Practice Tracer, M793.
AS12013525	Product Specification, Cartidge, 25mm, Armor Piercing Discarding Sabot Tracer, M791.

STANDARDS

FEDERAL

FED-STD-H28	Screw-Thread Standards for Federal Services.

MILITARY

MIL-STD-109	Quality Assurance Terms and Definitions.
MIL-STD-129	Marking for Shipment and Storage.
MIL-STD-130	Identification Marking of U.S. Military Property.
MIL-STD-143	Standards and Specifications, Order of Precedence for the Selection of.
MIL-sTD-461	Electromagnetic Emmission and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-471	Maintainability Verfication/Demonstration/Evaluation.
MIL-STD-704	Aircraft Electric Power Characteristics.
MIL-STD-721	Definitions of Effectiveness Terms for Reliabiliy, Maintainability, Human Factors, and Safety.
MIL-STD-785	Reliability Program for System terms and Equipment Development and Production.
MIL-STD-81O	Environmental Test Methods.
MIL-STD-882	System Safety Program Requirements.
MIL-STD-1472	human Engineering Design Criteria for Military Systems, Equipment and Facilities.
MIL-STD-45662	Calibration System Requirements.

HANDBOOKS

MILITARY

MIL-HDBK-5	Metallic Materials and Elements for Aerospace Vehicle Structures.
MIL-HDBK-237A	Electromagnetic Compatibility Management Guide for Platforms, Systems and Equipment.

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

DOD 4145.26M	DOD Contractors' Safety Manual for Ammunition, Explosives, and Related Dangerous Material.

(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.)

2.2 Other publications. The following documents(s) form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 380-76 (ANSI 2210.1-1976)	Metric Practice Guide.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA. 19103.)

General Electric Company
(Code Ident 05606)

A10220	Prime Item Development Specification for Cartridge, 25mm, PGU-20/U (API).

(Application for copies should be addressed to the General Electric Company Armament Systems Department, Lake Side Avenue, Burlington, VT 05402.)

2.3 Order of precedence. In the event of a conflict between the test of this specification and the references cited herein, the test of this specification shall take precedence.

3. REQUIREMENTS.

3.1 Item description. The gun system is a double-ended percussion fired 25 millimeter (urn) automatic gun system intended for mounting on the AV-8 aircraft. The gun system consists of a gun pak mounted on the port side of the fuselage, and ammunition storage and handling pak mounted on the starboard side of the fuselage, and an ammunition crossover unit with chuting and conveyor to transfer

ammunition from the ammunition pak to the gun transfer unit in the gun pak. The gun system is remotely fired by pilot cockpit controls. Major components of the gun system consists of a 25mm gun, gun system drive unit and speed control, ammunition handling system, electrical controls, blast suppressor and structures and fairings. The drive power for the gun system shall utilize engine bleed air.

3.1.1 Gun system functional diagram. The gun system breakdown structure and functional flow block diagram are shown in Figures 1 and 2.

3.1.2 Gun system interface definition. The gun system shall be installed on the integrated into the AV-8 aircraft. The major comonents shall interface mechanically, functionally, and electrically with each other and with the aircraft in accordance with the requirements specified herein and in other referenced documents.

3.1.2.1 Aircraft interface definition. The gun system shall be installed on an integrated with the aircraft in accordance with the applicable requirememts of MIL-I-8670. The ammunition pak and the gun pak shall mount to the aircraft by means of gun pak attach points.

3.1.2.2 Electrical interface definition. The gun system shall accept, be controlled by, and provide the electrical signals as follows:

a. Master arm. The master arm function shall activate the gun control unit. Without this signal, the gun system shall not respond to any control signal.

b. Gun select. The gun select function signal shall cause the gun system to be replaced in a ready-to-fire condition.

c. Trigger. The trigger function shall cause the gun system to fire. Removal of the trigger signal shall cause the gun to cease fire and reverse clear.

d. Unlear gun signal. The system shall provide a signal to the aircraft to indicate that the gun did not clear after firing a burst.

e. Rounds remaining. The gun system shall provide a signal to actuate the appropriate counter in the cockpit to indicate the number of rounds remaining to be fired within +20 rounds.

All control functions shall be 28 volts direct current Vdc nominal. The arm function shall be not greater than 5 ampers (A) maximum. The full firing current shall be not greater than 15 A total.

3.1.2.3 Ammunition interface. The gun system shall accept, store, handle, and fire, without adjustment. Standard Service Class 25mm ammunition as follows (see 3.7.4.1):

a. M792, High Explosive Incendiary - Trace (HEI-T), AS12013545.

b. M793, Target Practice - Traced (TP-T), AS12013518.

c. XM794, Dummy Ammunition.

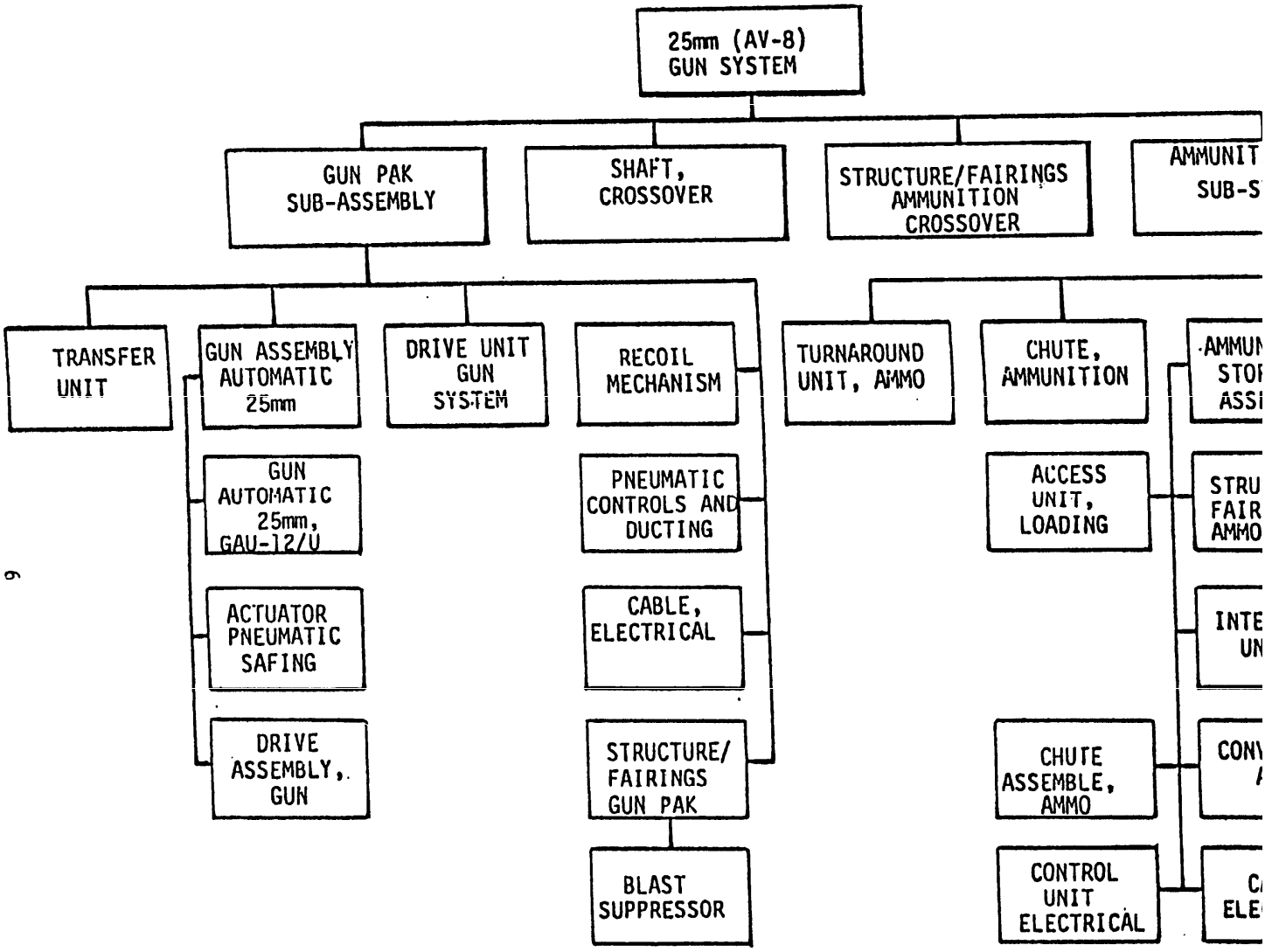

FIGURE 1. Breakdown structure.

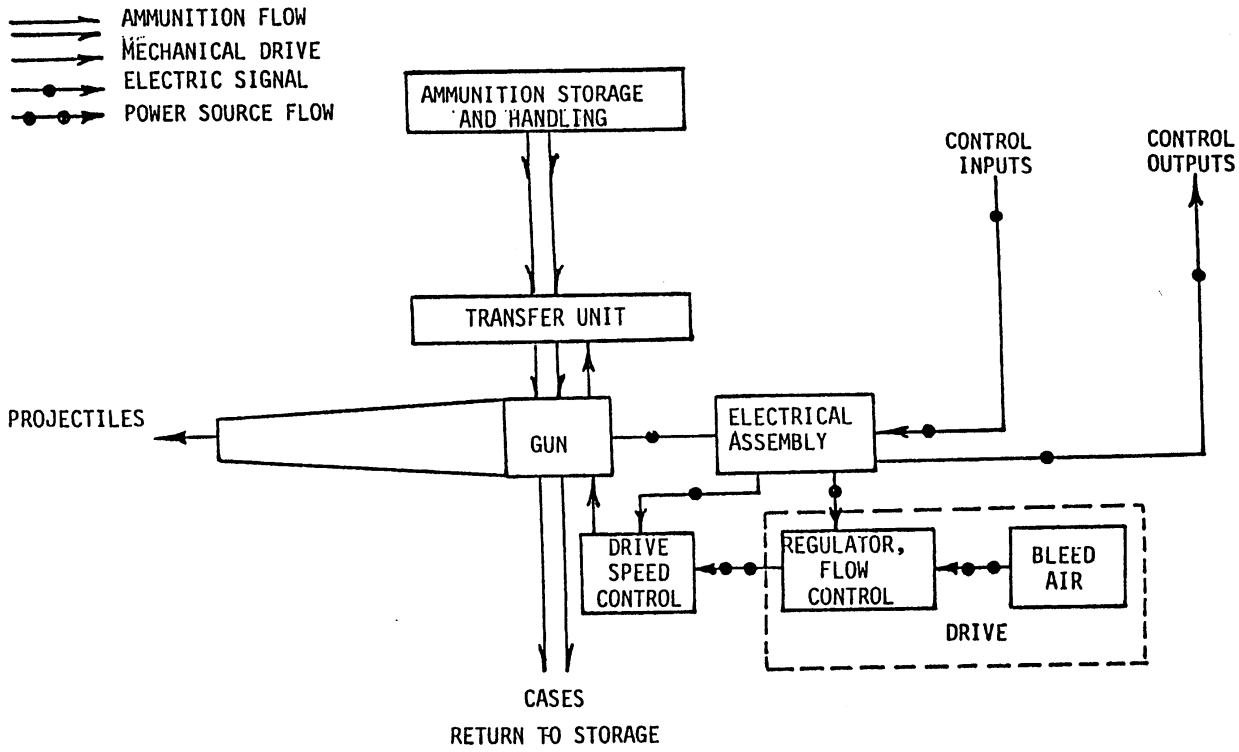

FIGURE 2. Gun installation functional block diagram.

d. PGU-20/U, Armor Piercing Incendiary (API), A1022O.

e. M791, Armor Piercing - Discarding Sabot - Traced (APDS-T), AS12013525. The gun shall be capable of handling and firing this round.

Ammunition in the gun shall be smoothly accelerated and decelerated to reduce handling loads, and to increase durability and reliability.

3.1.3 Major components list. The gun system shall consist of, but not be limited to, the components shown in Figure 1.

3.1.4 Government-furnished property (GFP). The following GFP shall be furnished to support contractor testing, as specified in the contract or the purchase order (see 6.2).

a. Standard Service Class 25mm ammunition.

b. Standard Service Class 25mm links.

c. Such other materials as may be required, the procurement of which, would be more expedient if furnished by the Government.

3.2 Characteristics.

3.2.1 Performance.

3.2.1.1 Electrical power. The gun system shall maintain performance as specified herein when supplied with 28 Vdc (nominal) 15 A (maximum) electrical power in accordance with MIL-STD-704 for Category B equipment.

3.2.1.2 Dispersion and accuracy. When installed on a restrained AV-8 aircraft or when installed on a ground firing test stand, the gun system shall place 80 percent minimum of all fired projectiles in 178mm (7.0 inches) diameter circle at a range of 25.4 meters (m) (1,000 inches) for dispersion. Data taken during test firing shall be used to determine the location limits of the center of the 80 percent group in relation to the true boresight point for accuracy (see 6.3.1).

3.2.1.2.1 Gun subsystem dispersion. The gun subsystem shall place 80 percent minimum of all fired projectiles in a 127mm (5.0 inch) diameter circle at a range of 25.4 m (1,000 inches) for dispersion. Data taken during test firing shall be used to determine the location limits of the center of the 80 percent group in relation to the true boresight point for accuracy (see 6.3.1).

3.2.1.3 Firing rates. The gun system shall be capable .of firing 3,600 rounds per minute. The steady state firing rate shall remain within the limits of 3,400 to 4,000 rounds per minute. The gun system shall fire a minimum of 45 rounds in 1.0 second after application of the trigger on signal. The time between successive bursts, which is the time measured for the last round fired of the previous burst of the first round fired or the succeeding burst, shall be kept to a minimum and shall not exceed 0.8 second.

3.2.1.4 Clearing. The gun system shall incorporate positive clearing safety features. The cleared gun shall not have any portion of a live round in

the firing barrel chamber or in the firing barrel bolt assembly. The gun system shall automatically clear after each firing burst. However, the ability of the gun to fire a subsequent burst shall not be delayed until the clearing cycle is complete. The 45 rounds fired in the first second requirement may not be met in this mode. Live rounds shall not be ejected to achieve clearing. The gun, as a component of the gun system shall be capable of reverse rotational clearing. The gun system, after loading, shall be in a safe cleared condition.

3.2.1.5 Burst firing schedule. The gun system normal burst firing schedule, defined as a burst cycle, shall consist of a continuous burst of at least 1 second, followed by 5 minutes of static ambient cooling. The burst cycle is repeated until the complement of ammunition is exhausted.

3.2.1.6 Extended burst firing. The gun system shall be capable of firing a minimum of 300 rounds of ammunition in a single burst without destructive damage to the gun system or surrounding structure.

3.2.1.7 Recoil forces. The gun system shall reduce recoil forces to a minimum level compatible with the existing aircraft gun pak attachment points. Gun pak recoil forces shall be reacted into the aircraft through the forward pak mounted lugs at station 318.88.

3.2.1.8 Muzzle blast pressure. There shall be no evidence of structural damage to the aircraft fuselage due to muzzle blast when the gun pak is installed on the ircraft. Muzzle blast pressure may be reduced by a muzzle device attached to the gun barrels, or built into the gun pak nose structure of a conbination of the two methods. The muzzle blast reduction devices shall cause the muzzle gas force vector to pass through the nominal aircraft center of gravity.

3.2.1.9 Gun system performance envelope. The gun system shall perform as specified herein when subjected to the AV-8 flight strength envelope of Figure 3.

3.2.1.10 Bleed air power. The gun shall operate when supplied by aircraft engine bleed air from the engines eighth stage bleed port at pressures and temperatures shown in Figure 4. The gun system shall perform as specified herein whenever bleed air pressure at the engine port equals or exceeds 60 pounds per square inch gage and a minimum of 5.0 cubic feet per second.

3.2.2 Physical characteristics.

3.2.2.1 Mass. The gun system, including 150 kilograms (kg) (330 lb) of load ammunition, shall not greater than 567 kg (1250 lb). The gun, as a component of the gun system shall be not greater than 127.3 kg (280 lb) mass.

3.2.2.2 Gun system envelope dimensions. When installed on the aircraft, the gun pak and ammunition pak shall have the same opposite hand aerodynamic shape, with installation symmetry about the aircraft centerline. The gun shall be positioned such that the nominal projectile velocity vector is 2 degrees nose down from an aircraft water line and in an aircraft butt plane.

3.2.2.3 Boresight. The gun system shall be installed in a boresight position with no adjustment provided.

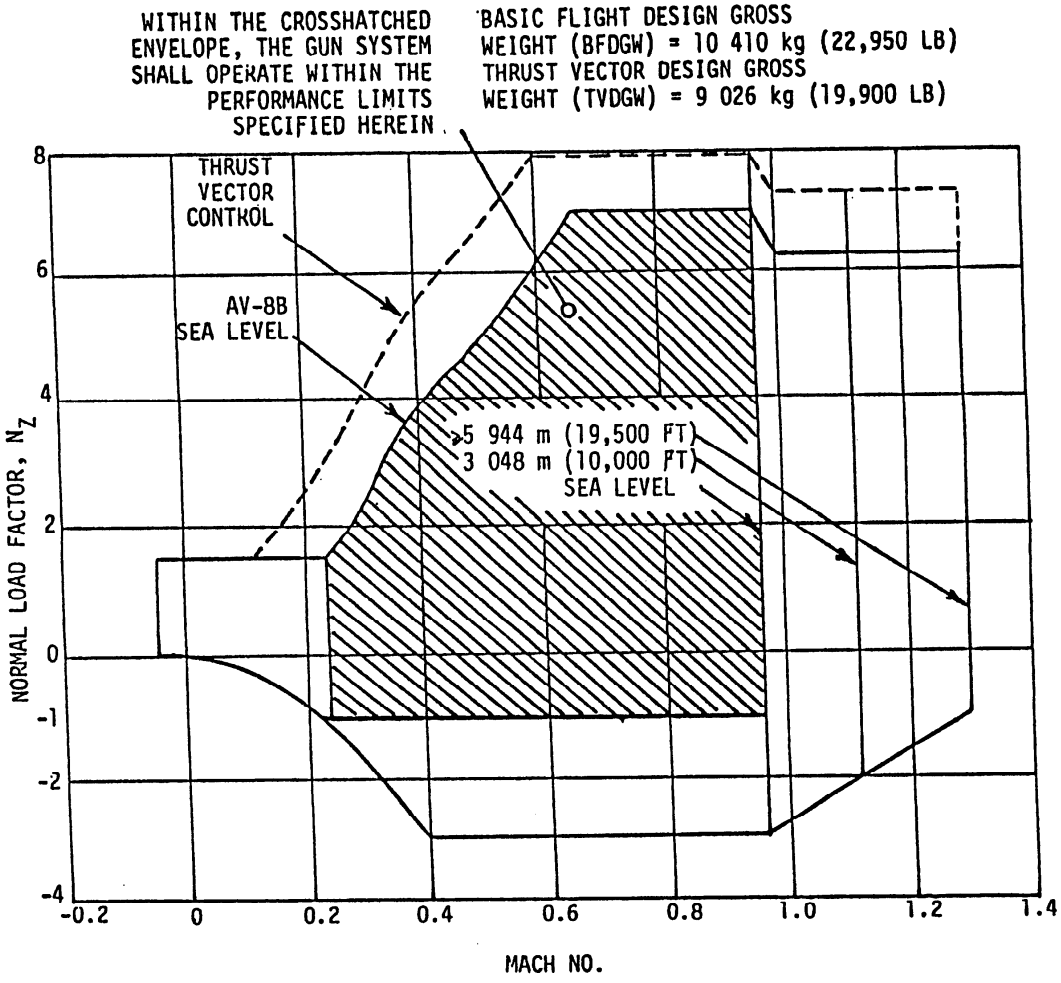

FIGURE 3. AV-8B flight strength envelope.

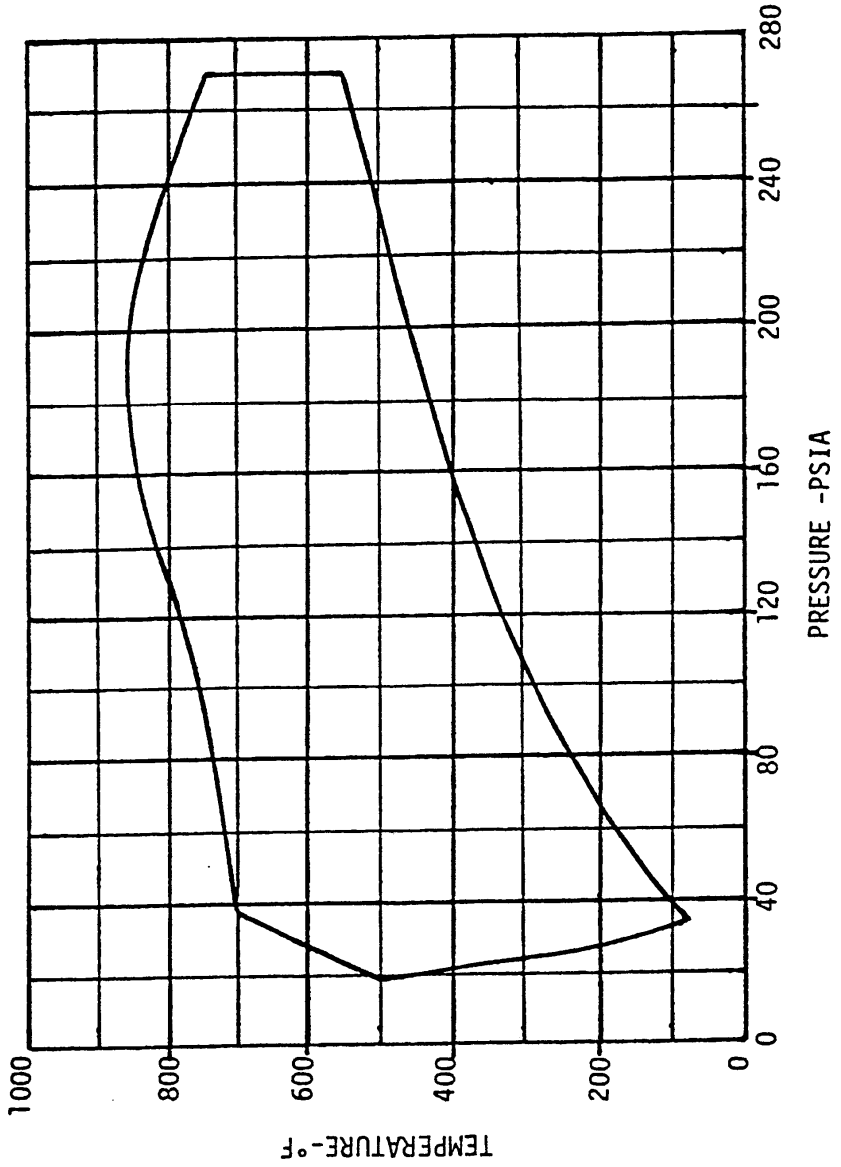

FIGURE 4. Eighth stage engine compressor bleed air pressure and temperature envelope.

3.2.2.4 Center of gravity. The gun system, when installed on the aircraft, shall make minimum excursions from the aircraft baseline composite center of gravities.

3.2.2.5 Ammunition capacity. The gun system shall have the capacity to contain a minimum of 300 rounds, which is defined as a complement.

3.2.3 Reliability. The gun system, when installed on the AV-8 aircraft, shall provide a minimum reliability, at a confidence level of 90 percent, of 0.95 probability of firing a 1-second burst of ammunition at any given firing sequency within the limitations specified herein, without a stoppage as defined in 6.3.3. Failures which have been corrected by test, analyze and fix procedures, subject to government approval, may be eliminated from system reliability calculations. The contractor shall provide objective evidence that the corrective action is effective. Failures which have-been eliminated in this manner shall be reinstated in the analysis if a failure in the same mode reappears in subsequent tests. When specified in the contract or purchase order, the reliability program plan for monitoring, testing, demonstration, and reports shall be in accordance with MIL-STD-785 (see 6.2).

3.2.3.1 Barrel durability. The gun barrels shall have a design requirement of 3,750 rounds per gun barrel when the gun is fired in accordance with the burst firing schedule-of 3.2.1.5 when firing at a rate specified in 3.2.1.3, and when firing ammunition with any one type of rotating band. Barrel life is defined in 6.3.5.

3.2.4 Maintainability. The gun system shall be maintained at three levels of maintenance: O (Organizational), I (Intermediate), and D (Depot). Total maintenance shall be performed within these levels. Flight line maintenance shall be performed by O level. Shop maintenance shall be performed by I level. Rework shall be performed by D level. Maintenance allocation shall be at the level consistent with the shipboard environment. The design shall require the least human skills and board environment. The design shall require the least human skills and minimum variety and complexity of tools, utilities, and eqUiputent to perform maintenance at the allocated maintenance levels. The following design requirements shall be incorporated into the gun subsystem:

a. The gun shall incorporate quick change barrels.

b. The gun sybsystem shall provide ready accessibility and quick removal/installation of major components.

c. Major components, disassembly, and assembly shall be accomplished without special tools or fixtures other than a handling fixture at I level.

d. Major components shall be interchangeable without requiring calibration or adjustment at time of replacement.

e. Each major component shall be capable of being restored to serviceable condition without use of system integration tests.

f. Major components requiring timing, when attached to other major components, will have timing devices and timing marks readily accessible for activation and visual contact.

g. If a libricator is required, the gun system shall be capable of using MIL-L-46000 lubricant; and a visual method of checking the fluid level in the reservoir shall be provided.

3.2.4.1 Parts replacement. The gun system shall have a parts replacement schedule interval of 15,000 rounds minimum, and shall be capable of firing 105,000 rounds before requiring D level overhaul and repair.

3.2.4.2 Maintenance dountime. The maintenance downtime specified in Table I shall not be exceeded. Downtime shall be as defined in MIL-STD-721.

3.2.4.3 Maintenance support. The maintenance support values shall be not greater than as specified in Table 11.

TABLE I. Maintenance downtime.

Maintenance action	Elapsed maintenance time (min.)	
	80th percentile of distribution	Arithmetic average
1. Preventative maintenance for each cycle 1/ at the organizational level.	21.5	15.0
2* Corrective maintenance for each individual failue at the organizational level.	28.3	20.0
3. Installation onto aircraft (including loading ammunition adjacent to aircraft).	70.7	50.0
4. Removal from aircraft.	56.6	40.0

1/Cycle: one full complement of ammunition.

TABLE II. Maintenance support.

Maintenance action	Average direct maintenance (man-minutes for each cycle)	
	Corrective	Corrective and preventive
1. Organizational	6.0	30.0
2. Intermediate	15.0	15.0
3. Organizational and intermediate	18.6	39.0

3.2.5 Environmental requirements. Unless otherwise specified herein, the gun system shall not suffer damage, deterioration, or degradation of performance beyond the limits of this specification when subjected to any environment of any natural combination of environments specified herein. Unless otherwise specified herein, the gun system shall sustain steady state firing after being subjected to the applicable environmental tests as specified in 3.2.5.1 through 3.2.5.11.

3.2.5.1 Altitude. The gun system shall sustain steady state firing while bing subjected to ambient pressures at altitudes from sea level to 15,200 m (50,000 ft) (see 404.2.1.1).

3.2.5.2 High temperature. The gun system shall redesigned to be capable of withstanding continuous exposures to 93 degrees Celsius (°C) and intermittent 5-minute exposure to 121°C. The gun system shall sustain steady state firing after being subjected to 4 hours exposure at 71°C (see 4.4.2.1.2).

3.2.5.3 Low temperature. The gun system shall sustain steady state firing while stabilized at -54°C (see 4.4.2.1.3). The performance may be degraded during exposure to -54°C temperature as follows (see 4.4.2.1.3):

a. Fire a minimum of 35 rounds in first second after trigger on.

b. Firing rate shall be 3,000 rounds per minute or greater.

3.2.5.4 Humidity. The gun system shall sustain steady state firing after being subjected to humidity tests (see 4.4.2.1.4).

3.2.5.5 Solt fog. The contractor corrosion control program shall ensure control of corrosion in the earliest design states Of the system design and equipment development. The gun system shall sustain steady state firing after being subjected to 144 hours of salt fog (see 4.4.2.1.5).

3.2.5.6 Rain. The gun system shall sustain steady state firing while being subjected to the rain test (see 4.4.2.1.6).

3.2.5.7 Sand and dust. The gun system shall sustain steady state firing/cycling after being subjected to the sand and dust tests (see 4.4.2.1.7).

3.2.5.8 Vibration. The gun system shall withstand, without damage, and shall sustain steady state firing after vibration tests (see 4.4.2.1.8).

3.2.5.9 Fungus. The materials selected for the gun system shall be non-nutrient for fungus Or shall have fungus resistant treatment in accordance with MIL-T-152 (see 4.4.2.1.9 and 6.2).

3.2.5.10 Acceleration.

3.2.5.10.1 Nonfiring during acceleration. After being subjected to the acceleration levels specified in Table III, the gun system shall not sustain damage and shall sustain steady state firing after the tests (see 4.4.2.1.10.1).

TABLE III. Gravity level.

Plane	Gravity Units (g)	
	Nonfiring	Firing
Vertical	+8g, -3g	+7g, -lg
Lateral	+1.5g	+1.5g
Longitudinal	+3.5g. -1.5g	+3.5g, -1.5g

3.2.5.10.2 Firing during acceleration. Degradation will occur during firing while subject to high "g" loads. Allowable degradations are shown in Figure 5 (see 4.4.2.1.10.2).

3.2.5.11 Shock.

3.2.5.11.1 Design shock. The gun system shall sustain steady state firing after being subjected to the design shock test (see 4.4.2.1.11.1).

3.2.5.11.2 High impact shock. When specified in the contract or purchase order (see 6.2), the gun system shall be tested, and shall show no structural failures creating a hazard to personnel or equipment. The gun system is not required to sustain steady state firing after this test (See 4.4.2.1.11.2)-

3.3 Design and construction.

3.3.1 Materials, processes, and parts. Materials, processes, and parts used shall be of high quality, suitable for the purpose, and shall conform to applicable military, federal, Aerospace Material Specifications wherever possible. Particular attention shall be given to the selection of materials, processes, and parts to facilitate interchangeability, stocking, and maintainability. The number of different types and sizes of consumable bulk maintenance materials shall be kept to a minimum. Noncritical materials shall be used wherever practicable when performance, interchangeability, safety or reliability will not be adversely affected. Specifications and standards for materials, processes, and parts shall be selected in accordance with the order of precedence specified in MIL-STD-143.

3.3.1.1 Minimum guaranteed material properties. Minimum guaranteed material design mechanical properties, as defined in MIL-HDBK-5, or source of material properties acceptable to the procuring activity, shall be used in calculating the strength of single structural components, the faulure of which would endanger personnel or prevent the gun system from accomplishing its intended mission.

3.3.1.1.1 Recycled, virgin, and reclaimed materials. Without jeopardizing the intended use of the gun system, determination shall be made that:

a. The use of recycled materials is permissible.

b. An item need not be manufactured from virgin materials.

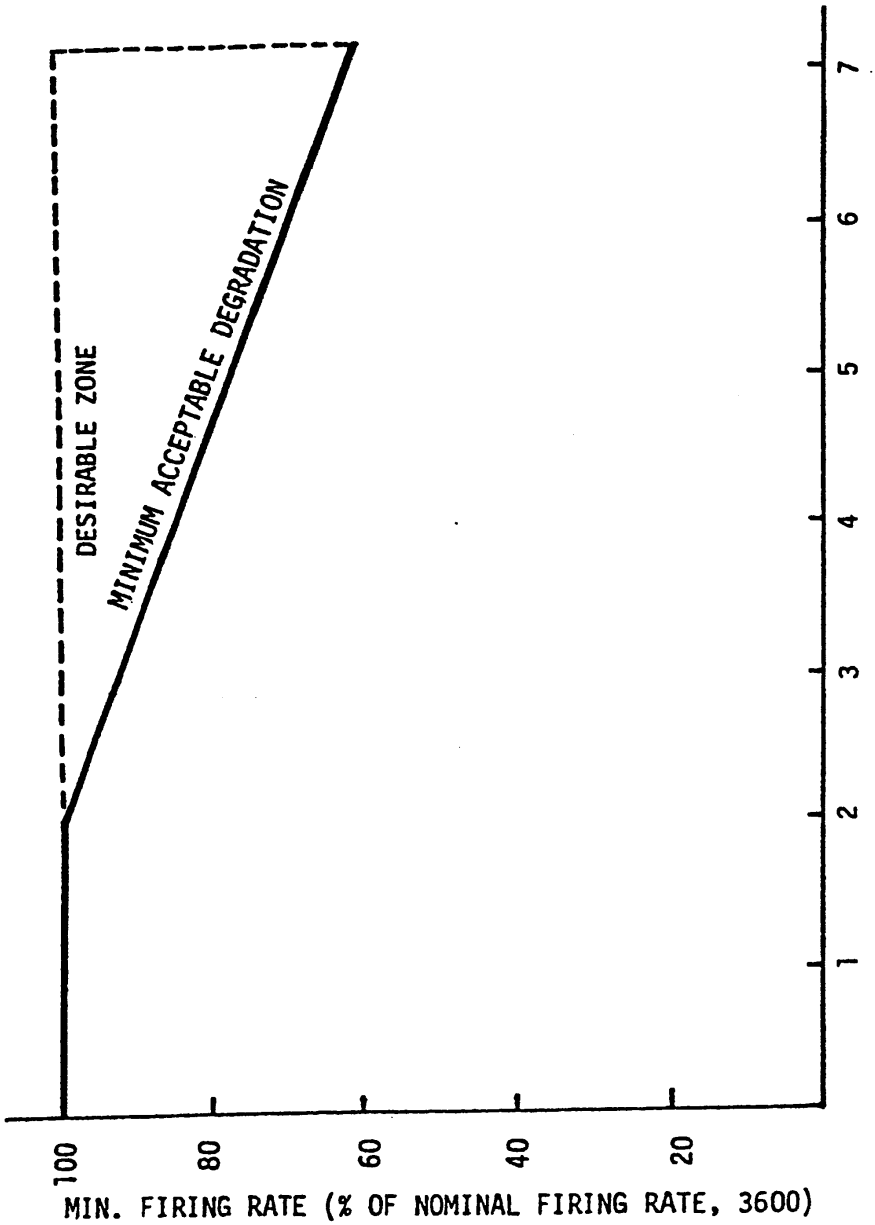

FIGURE 5. Firing rate during acceleration.

c. Reclaimed materials shall be used to the maximum extent possible.

3.3.1.2 Electrical wiring. The gun system shall be wired in accordance with MIL-W-5088 and installed in accordance with MIL-E-7080. Electrical wire shall be in accordance with MIL-W-81381,

3.3.1.3 Screw threads. Screw threads shall be in accordance with FED-STD-H28. Metric Screw threads shall be in accordance with 3.4.2.

3.3.2 Electromagnetic environmental effects (E^3). The E^3 compatibility program shall ensure control of radiated and conducted emissions, and radiated conducted susceptibility in the earliest design stages of the system design and equipment development. Contractor furnished equipment shall be designed to meet the limits of MIL-STD-461B, when tested to the methods of MIL-STD-462. The gun system shall be designed to facilitate the aircraft meeting the requirements of MIL-E-6051D. The contractor shall establish an electromagnetic compatibility program in conformity with MIL-E-6051D, AR-43. Bonding and lightning protection shall be in accordance with MIL-B-5087 (see 6.2), Guidance for establishing an effective E program throughout the life cycle of the system should be in conformity with MIL-HDBK-237A.

3.3.3 Identification and marking. The gun system shall be identified and marked in accordance with MIL-STD-130 and the applicable drawings.

3.3.4 Interchangeability. The components of the gun system shall be completely interchangeable without field adjustment. All parts having the same part numbers shall be completely interchangeable in accordance with MIL-I-8500.

3.3.5 Safety. Provisions shall be made in the design to assure safety for personnel and equipment during all phases of operations, including storage, transportation, handling, test operations, and checkout. System safety engineering and management activities shall be in accordance with MIL-STD-882.

3.3.5.1 Gun system clearing. The gun system shall contain positive safety clearing features to assure that the gun is in a safe condition to prevent ammunition cookoff between bursts (see 3.2.1.4). By visual means it shall be possible to determine that the gun is in a cleared condition.

3.3.5.2 Round control. The gun system shall maintain positive control of the ammunition. Smooth acceleration and deceleration of the ammunition is necessary to reduce handling loads during the cycles of operation.

3.3.5.3 Case control. Fired cases and misfired rounds shall be kept in the gun system and in full control.

3.3.5.4 Induced voltage. There shall be no induced voltage in the gun system at any time which could energize the firing circuits and accidentally fire ammunition.

3.3.5.5. Safety during maintenance. Positive means shall be provided to preclude inadverent gun system starting or firing of the percussion primed ammunition during loading, unloading or maintenance operations. The gun shall have a positive means to prevent the firing pin from touching the primer during all possible ground maintenance actions. Safety during maintenance shall include

a provision neutralizing the transfer unit at any time the gun is being removed or is being installed.

3.3.5.5.1 Safety during nongunnery missions. A positive means shall be provided to isolate the gun system from the aircraft control inputs in order to prevent gun firing during nongunnery missions.

3.3.5.6 Gun gas ventilation. The gun system shall provide sufficient ventilation to prevent accumulation of gun gas concentration which may result in a gun gas explosion when installed on the aircraft throughout the flight envelope of Figure 3, and during ground firing with the access doors open.

3.3.6 Human performance/human engineering. The gun system design shall consider and apply the principles, analyses, criteria, and philosophies of human engineering as defined in MIL-STD-1472. This shall include the knowledge of man's unique capabilities and limitations regarding the installation, operation, and maintenance of the gun system.

3.3.7 Pneumatic system construction. The gun system pneumatic system shall be designed, constructed, and meet all applicable requirements in accordance with MIL-P-8564, Type I and MIL-P-5518, Type B, Class 2.

3.3.8 Hydraulic system construction. The gun system hydraulic system shall be designed, constructed, installed, and meet all applicable requirements in accordance with MIL-H-5440, Type I, Class 3000. Hydraulic fluid shall meet the requirements of MIL-H-83282.

3.3.9 Electrical system construction. The gun system electrical system shall be designed, constructed, and shall have workmanship to meet all applicable requirements of MIL-E-5400 for Class 1 equipment.

3.3.10 Structural capability.

3.3.10.1 Crash survivability limit loads. The gun assembly (structural attach points, mounting means, and mechanical interface) shall have crash survivability limit load of at least 20 g in a 20 degree forward longitudinal cone, and 12 g vertically and laterally.

3.3.10.2 Limit loads. Critical load factors for design consideration shall be as specified below:

n_z (vertical) +8.0g
-3.0g

n_y (lateral) ±1.5g

n_x (longitudinal) 3.5g forward (aircraft braking)
1.5g aft (aircraft accelerating)

Aircraft roll rate: 270 degrees per second maximim

Aircraft roll acceleration: 18 radians per second squared

Aircraft roll acceleration: +6 radians per second squared

3.3.10.3 Yield factor of safety. The minimum yield factor of safety shall be 1.33. Any deformation remaining after application and removal of loads which are 1.33 times the limit loads shall not adversely affect the aircraft or gun system installation, nor shall such deformation be detectable upon visual inspection.

3.4 Documentation.

3.4.1 Drawings. As a minimum, when specified in the contract or purchase order, gun system drawings shall include detail, subassembly, assembly, and schematics to completely define the gun system in accordance with DOD-D-1000, Level II (see 6.2).

3.4.2 System of units. The design and documentation of the gun shall be in units defined by the International System of Units based on "Le Systeme International d'Units (SI)" of the International Bureau of Weights and Measures* These units are described in ASTM E 380-76 (ANSI Z210.1-1976) or successor documents as listed in DODISS. All other gun system parts shall be in English units of measure.

3.4.2.1 Existing designs. Existing designs dimensioned in U.S. customary (inch-pound) units will be converted to metric units only if determined to be necessary or advantageous.

3.4.2.2 Commercial designs. Material components, parts, subassemblies, and semifabricated materials which are of commercial design shall be specified in metric units only when economically available and technically adequate. Bulk materials shall be specified in metric units when it is expedient or economical to do so.

3.4.2.3 Dual dimensioning. Use of dual dimensions (i.e, both metric and U.S. customary) on drawings shall be avoided unless it is determined in specific instances that such usage will be beneficial. However, the use of tables to translate dimensions from one system of measurement to the other is acceptable.

3.4.3 Test plans. Contractor proposed test plans and procedures shall specify methods to be used for acceptance and qualification of the gun system, including environmental, EMC, reliability, and maintainability tests. Test plans and procedures shall be subjected to review by the procuring activity (see 6.2).

3.5 Logistics. The gun system shall be capable of being supported logistically within the Navy and Marine operations environment, ashore and afloat, in accordance with the integrated logistics support requirements specified in the contract or purchase order (see 6.2).

3.6 Personnel and training. Personnel and training shall be in accordance with the integrated logistics support requirements specified in the contract or purchase order (see 6.2).

3.7 Major component characteristics.

3.7.1 Ammunition pak. The ammunition pak consists of the mounting hardware, structure, aerodynamic fairings, ammunition container, and electrical

assembly. The pak contains the ammunition storage device, conveyors, and chuting as necessary to store and handle the ammunition specified in 3.2.2.5. The complement of ammunition shall be capable of being loaded by two men in twenty minutes. Except for the blast deflector contours, the exterior ot the pak shall be the opposite hand aerodynamic shape of the gun pak with installation symmetry about the aircraft centerline when both paks are installed.

3.7.1.1 Mounting hardware. The mounting hardware used to attach the pak structure to the airframe attach points shall be accessible. Parts requiring alignment shall be self centering, and parts requiring force for installation/ removal shall not have machine threads.

3.7.1.2 Aerodynamic fairings. The aerodynamic fairings shall provide rapid access for loading ammunition into the ammunition storage device or shall provide for rapid removal/replacement if removable ammunition container/containers are utilized.

3.7.1.3 Ammunition storage device or removable ammunition container. If an ammunition storage device for linked or linkless ammunition is considered, the logistic impact shall be defined at the initial design review.

3.7.1.3.1 Removal ammunition container. If a removable ammunition container (or containers) is considered, removal of empty or partially loaded container/containers and replacement or preloaded container/containers shall be affected within the loading time as specified in 3.7.1.

3.7.1.4 Electrical assembly. The electrical assembly shall contain such power supplies, control logic, control circuits, rounds remaining circuit, unclear light circuit, etc., as necessary to control and operate the gun system.

3.7.2 Ammunition crossover. The ammunition crossover consists of the structure, fairings, and conveyor as necessary to smoothly transfer the ammunition from the ammunition pak to the gun transfer unit in the gun pak. The fairings shall blend with the existing aircraft fuselage and make a minimum drag index change over the baseline gun pod installation. The crossover interface with the gun feeder will require critical interface between the gun developer and the ammunition storage and handling developer.

3.7.3 Gunpak. The gun pak mounted on the aircraft consists-of the mounting hardware, structure, aerodynamic fairings, gun subsystem, and gun muzzle blast suppressor. Except for th eblast deflector contours, the exterior of the gun pak shall be the opposite hand aerodynamic shape of the ammunition pak with installation symmetry about the aircraft centerlne when both paks are installed. Mounting hardware shall be fully interchangeable with mounting hardware in 3.7.1.1. Rapid access shall be provided for safing the gun in a flight deck environment.

3.7.4 Gun subsystem. The gun subsystem is a major component of the gun system and shall consist of the following components:

a. Gun

b. Transfer unit

c. Drive assembly

d. Recoil control device.

3.7.4.1 Gun. The gun is a major component Of the gun subsystem and shallbe capable of firing and handling the ammunition specified in 3.1.2.1 without barrel modification or any other adjustment. The gun shall provide the TP-T and HEI-T projectile with a muzzle velocity of 1,050 meters per second (3,444 feet per second) at 21°C. The HEI-T and TP-T projectiles shall be dynamically and gyroscopically stable when forward from an aircraft flying at 500 knots indicated airspeed at mean sea level at a temperature of -51°C, with -54°C desirable.

3.7.4.1.1 Gun barrel indexing. If the gun is a rotary mechanism, there shall be a method of manually indexing each barrel in order to provide gun timing and a true boresight point (see 6.3.1).

3.7.4.1.2 Gun drive attachment. The gun drive attachment shall not be an integral part of the gun mechanism. The drive assembly shall attach to the gun with bolts, pins, or other positive means in order to provide the gun with drive motor options in other possible application.

3.7.4.1.3 Transfer unit. The transfer unit shall not be an integral part of the gun mechanism and shall bolt on.

3.7.4.1.4 Barrels. The barrels shall be designed for minimum weight consistent with the burst schedule and barrel durability defined herein. Barrel rifling shall be optimized to provide minimum barrel erosion and apply minimum torque to the projectile consistent with the projectile performance specified herin. The barrels shall provide a method of attaching optional muzzle devices such as blast diffuser, muzzle brake, or flash hider for other installations.

3.7.4.1.5 Additional features. The gun shall have the following features to enhance the utility of the gun in other possible applications:

a. By the attachment of an appropriate feeder or loader, the gun shall be capable f accepting ammunition, linked or linkless, double ended or single ended handling and storage systems.

b. Be capable of firing a minimum of 4,000 rounds per minute with no significant degradation of durability and reliability.

c. Be capable of providing reverse clearing.

3.7.4.2 Transfer unit. The transfer unit shall attach to the gun by means of bolts. A positive means shall be provided for indexing the transfer unit to the gun to assure proper timing of the two components. The transfer unit shall accept ammunition from a hand-off.

3.7.4.3 Drive. The drive shall accelerate the gun from rest to firing rate and provide means of controlling the firing rate during the firing burst. The drive shall contain the necessary motor, gearing, speed sensor devices, and speed control devices. A break shall be provided to assist gun stopping at the end of the firing burst and to hold the gun from functioning before and after firing

bursts. A power take-off shall be provided to power and synchronize the ammunition handling system.

3.7.4.4 Recoil control devices. The recoil control devices shall reduce the gun recoil and counter-recoil loads to levels specified herein. The recoil control devices may be integral with the gun mechanism or a separates bolt-on item. The recoil control devices shall carry all fore and aft loads, including firing loads.

3.8 Workmanship. Workmanship and finish shall be in accordance with the highest grade practice used in manufacturing military weapons. Finished items and parts shall not exhibit poor material and processing such as seams, laps, laminations, cracks, visible steps, sharp edges, nicks, scratches, burrs, deformations, and missing operations which may affect serviceability, functioning, operation, or safety. Fins and other extraneous metal shall be removed from case of forged parts. When doubt exists concerning acceptability or the contractor's workmanship, the questionable physical item shall be submitted to the responsible technical agency for decision. No welding shall be allowed on gun high pressure areas. Nonconforming material, salvage operation, and repair operations shall be in accordance with the established procedures of the contractor material review board with government approval.

4. QUALITY ASSURRANCE PROVISIONS.

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspctions. The inspection requirements specified herein are classified as follows:

a. Quality conformance inspection (see 4.3).

b. Qualification inspection (see 4.4).

4.3 Quality conformance inspection.

4.3.1 Quality conformance examination and tests. Each gun system shall be subjected to the examination and tests of Table IV, Group I and II.

TABLE IV. Quality conformance.

Examination or test	Requirement paragraph	Method paragraph
Group I		
Visual Examination	3.1.2.2, 3.1.2.3, 3.1.3, 3.2.2.1, 3.2.2.2, 3.2.2.3, 3.3.3, 3.8	4.4.1.1
Certification	3.2.1.1, 3.2.1.10, 3.3.1, 3.3.1.1 thru 3.3.1.3, 3.3.2, 3.3.4, 3.3.6, 3.3.7, 3.3.8, 3.3.9, 3.3.10, 3.5, 3.6	4.4.1.2
Group II - Performance		
Dispersion & accuracy	3.2.1.2	4.4.1.3, 4.4.2.9
Gun subsystem dispersion	3.2.1.2.1	4.4.1.3
Firing rate	3.2.1.3	4.4.1.3, 4.4.2.9
Clearing	3.2.1.4	4.4.1.3, 4.4.2.9
Burst firing	3.2.1.5	4.4.1.3

4.3.2 Qualification inspection. The qualification sample shall consist of one gun system which has successfully completed the examination and tests of 4.3.1. The qualification inspections shall consist of the examination and tests of Table V, Groups I, II, III and IV.

TABLE V. Qualification inspection.

Examination or test	Requirement paragraph	Method paragraph
Group I - Environment		
Altitude	3.2.5.1	4.4.2.1.1
High temperature	3.2.5.2	4.4.2.1.2
Low temperature	3.2.5.3	4.4.2.1.3
Humidity	3.2.5.4	4.4.2.1.4
Salt fog	3.2.5.5	4.4.2.1.5
Rain	3.2.5.6	4.4.2.1.6
Sand and dust	3.2.5.7	4.4.2.1.7
Vibration	3.2.5.8	4.4.2.1.8
Fungus	3.2.5.9	4.4.2.1.9
Acceleration	3.2.5.10	4.4.2.1.10
Shock	3.2.5.11	4.4.2.1.11
Group II		
Recoil force	3.2.1.7	4.4.2.2
Muzzle blast pressure	3.2.1.8	4.4.2.3
Reliability	3.2.3	4.4.2.5
Barrel durability	3.2.3.1	4.4.2.6
Maintainability	3.2.4	4.4.2.7
Extended burst firing	3.2.1.6	4.4.2.9
Group III		
Clearing	3.3.5.1	4,4.2.8
Round control	3.3.5.2	4.4.2.8
Case control	3.3.5.3	4.4.2.8
Induce voltage	3.3.5.4	4.4.2.8
Safety during maintenance	3.3.5.5	4.4.2.8
Gun gas ventilation	3.3.5.6	4.4.2.8
Group IV		
Electromagnetic compatibility	3.3.2	4.4.2.4

4.3.3 Failure criteria. Should failure occur during or following the examination and tests of 4.3.1 or 4.3.2, the following action shall be taken by the contractor:

a. A failure report shall be prepared, a failure investigation shall be conducted, the cause of failure shall be determined, and corrective action shall be recommended.

b. Unless otherwise specified herein, the contractorshall repair the equipment and resubmit the equipment to the applicable test and inspection requirements. The procuring activity may elect to waive any or all retest/inspection requirements (see 6.2).

A failure is defined as the inability of the gun system to perform within the requirements of this specification (see 6.3).

4.3.4 Test conditions and equipment. All firing tests shall be accomplished with the gun system affixed to a Government approved mount by its normal means of attachment. The mount shall have a rigidity so that not more than 4mm (0.166 inch) deflection occurs in gun fire recoil. Torsional deflection of the mount shall not degrade accuracy or dispersion. The contractor shall furnish the applicable measuring devices and instrumentation to measure and record test data. Calibration of the test equipment shall be in accordance with MIL-STD-45662. The contractor shall interface the gun system with the necessary chuting and necessary anmunition storage capacity to complete each test. The chuting and storage device shall be provided by the contractor. The contractor shall provide all-necessary supplies and services except GFP to accomplish the testing specified herein. Unless otherwise specified, all gun system test firing shall be with TP-T ammunition. Unless otherwise specified herein, all tests shall be conducted under environmental conditions existing at the test site.

4.4 Qualification inspection.

4.4.1 Examination and test methods.

4.4.1.1 Visual and mechanical inspection.Each gun system shall visually and mechanically inspected for conformance to the applicable Table IV, Group I requirement paragraphs.

4.4.1.2 Certification. The contractor shall have available written certification accompanied by objective evidence, as defined in MIL-STD-109, that materials and processes meet the applicable requirements of Table V, Group I.

4.4.1.2.1 Performance certification. In those instances where it is impossible or very difficult for the contractor to perform the inspection or tests as specified herein, the contractor shall have available objective evidence that the gun system meets the requirements of this specification. acceptability of evidence shall be subject to approval of the procuring activity.

4.4.1.3 Performance characteristics tests. Teh gun system shall be installed as specified in 4.3.4 and loaded with 300 rounds of TP-T ammunition. Unless otherwise specified herin, the gun system shall be fired in accordance with the burst firing schedule of 3.2.1.5.

4.4.2 Qualification inspection tests.

4.4.2.1 Environmental.

4.4.2.1.1. Altitude. The gun system shall be subjected to the altitude test of MIL-STD-810, Method 500.1, Procedure II, to an altitude of 5,200 m. While at this pressure altitude, the gun system shall be fired or cycled in one 1-second burst. The gun system shall meet the requirements of 3.2.1.3 and 3.2.5.1.

4.4.2.1.2 High temperature. The gun system, when subjected to the high temperature environment specified in MIL-STD-810, Method 501.1, Procedure I, with the test chamber at a temperature of 71°C for 4 hours, shall have the heat input removed and shall fire or cycle one 1-second burst. After the gun system

has cooled to ambient, it shall be fired or cycled again in one 1-second burst. The gun system shall meet the requirements of 3.2.1.3 and 3.2.5.2.

4.4.2.1.3 Low temperature. The gun system, when subjected to the low temperature environment specified in MIL-STD-810, Method 502.1, Procedure I, stablized at -54°C, shall be fired or cycled in two 1-second bursts with 5 minutes between bursts. The gun system shall meet the requirements of 3.2.1.3 and 3.2.5.3.

4.4.2.1.4 Humidity. The gun system after exposure to the humidity environment of MIL-STD-810, Method 507.1, Procedure V, Steps 1 through 9, for a total of 10 cycles (240 hours), shall be fired or cycled in one 1-second burst. The gun system shall meet the requirements of 3.2.1.3 and 3.2.5.4.

4.4.2.1.5 Salt fog. The gun system shall, after exposure to salt atmosphere specified in MIL-STD-810, Method 509.1, Procedure I, be fired or cycled in one 1-second burst. After a 48-hour holding period at ambient atmosphere, the gun system shall be fired or cycled again in one 1-second burst. The gun system meets the requirements of 3.2.1.3 and 3.2.5.5.

4.4.2.1.6 Rain. The gun system, while being subjected to the rain environment of MIL-STD-810, Method 506.1, Procedure 1, and shall fire or cycle two 1-second bursts with 5 minutes between bursts. The gun system shall meet the requirements of 3.2.1.3 and 3.2.5.6.

4.4.2.1.7 Sand and dust. The gun system shall be subjected to the sand and dust test of MIL-STD-810, Method 510.1, Procedure I, and shall cycle 50 dummy rounds. The gun system shall meet the requirements of 3.2.1.3 and 3.2.5.7.

4.4.2.1.8 Vibration. The gun system, after being subjected to the sand and dust test of MIL-STD-810, Method 514.2, Procedure IIb, Table 514-2-IV, Figure 514.2-A4, shall cycle dummy rounds in two 1-second bursts. The gun system shall meet the requirements of 3.2.1.3 and 3.2.5.8.

4.4.2.1.9 Fungus. Fungus test in accordance with MIL-STD-810, Method 508.1, is applicable if a test is required. Test shall not be required if sufficient documentary evidence is provided to demonstrate that only non-nutrient materials are used throughout, or that all parts are suitably treated to resist fungi.

4.4.2.1.10 Acceleration.

4.4.2.1.10.1 Nonfiring. The gun sytem shall be subjected to the acceleration tests in accordance with MIL-STD-810, Method 513.2, Procedure I. The gravity levels shall be specified in Table IV. The gravity levels specified shall be applied through the center of gravity of the gun pak within ±75mm. The gun system shall cycle one 1-second burst of dummy rounds after being tested in each plane. The gun system shall meet the requirements of 3.2.1.3 and 3.2.5.10.

4.4.2.1.10.2 Firing. The gun system shall be subjected to the acceleration test as specified in MIL-STD-810, Method 513.2, Proceudre II. The gun system shall be fired or cycled in one 1-second burst while being subjected to the gravity levels of Table III. The gun system shall meet the requirements of 3.2.1.3 and 3.2.5.10.

4.4.2.1.11 Shock.

4.4.2.1.11.1 Design Shock. The gun system shall be subjected to the basic design shock test of MIL-STD-810, Method 516.2, Procedure I, Figure 516.2-2, amplitude, duration c, for three shocks in each direction along the gun's three mutually perpendicular axes, for a total of 18 shocks. After this test, the gun system shall cycle dummy ammunition in two 1-second bursts. The gun system shall meet the requirements of 3.2.1.3 and 3.2.5.11,1.

4.4.2.1.11.2 High impact. The gun system shall be subjected to the high impact test of MIL-S=901, Grade B. The gun system shall meet the requiremnts of 3.2.5.11.2.

4.4.2.2 Recoil force. A separate test is not required. Sufficient data shall be accumulated during other firing tests to determine the gun recoil loads. The data shall be examined for compliance with 3.2.1.7.

4.4.2.3 Muzzle blast pressure. A separate test is not required. Sufficient data shall be accumulated during other firing tests to determine the gun muzzle blast pressure pattern. The data shall be examined for compliance with 3.2.1.8.

4.4.2.4 Electronmagnetic compatibility tests. The gun system shall be tested in accordance with the interference Control plan specified herein and MIL-STD-462 to determine if the system meets the requirements of 3.3.2.

4.4.2.5 Reliability. Data taken during the tests of 4.4.2.6 shall be analyzed to determine if the gun system meets the requirements of 3.2.3.

4.4.2.6 Durability. One gun system shall be subjected to a 30,000 round firing test during which nonmaintenance other than scheduled maintenance shall be performed, and no unscheduled parts replacement shall be made. During the test a minimum of three complements shall each be fired in a continuous burst. The remaining rounds shall be fired in accordance with the burst firing schedule of 3.2.1.5. The test data shall be analyzed for compliance with the requirements of 3.2.1.3, 3.2.3, and 3.2.3.1. Bore erosion criteria data will be collected and developed during this test.

4.4.2.7 Maintainability. The maintainability requirements of 3.2.4 shall be demonstrated in accordance with MIL-STD-471, Method 9.

4.4.2.8 Safety. A separate test is not required. Data taken during other firing tests shall be analyzed to determine if the gun system meets the requirements of 3.3.5.1 through 3.3.5.6.

4.4.2.9 Extended burst firing. The gun system shall be loaded with 300 rounds of TP-T ammunition. The gun system shall be fired in a single burst until the ammunition is exhausted. The gun system and test data shall be examined for compliance with 3.2.1.2, 3.2.1.3, 3.2.1.4, and 3.2.1.6.

5. PACKAGING.

5.1 Preservation, packaging, and packing. Unless otherwise specified in the contract or purchase order (see 6.2), the gun system shall be preserved in a

manner to provide protection from damage during delivery to the first receiving activity.

5.2 Marking. The exterior of the shipping container shall be marked in accordance with MIL-STD-129.

6. NOTES .

6. Intended use. The gun system is intended to provide 25mm fire power when installed on the AV-8 aircraft. The gun, a major component of the gun system, is intended to provide 25mm fire power when mounted internally in aircraft, in gun pods, or on surface vehicles.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification.

b. Government-furnished property (see 3.1.4).

c. Preservation-packaging (see 5.1).

d. Fungus test, if required (see 3.2.5.9).

e. Drawings required (see 3.4.1).

f. Test plans required (see 3.4.3).

g. Failure reports (see 4.3.3).

h. High impact test, if required (see 3.2.5.11.2).

i. Reliability program, if required (see 3.2.3).

j. Interference control plan (see 3.3.2).

k. Integrated logistics support (see 3.5).

l. Personnel and training (see 3.6).

m. Responsibility for inspection, if other than as specified in 4.1.1.

6.3 Definitions.

6.3.1 True boresight point. The true boresight point of the gun is defined as the geometric center of all the individual barrel boresight points generated when each of the barrels is in the indexed firing position. Each individual barrel boresight point is determined by inserting a boresight tool in the muzzle of the barrel and marking a target at 25.4 m.

6.3.2 Steady state firing. Steady state firing is continuous firing of a least thirty rounds within the firing rate specified in 3.2.1.3.

6.3.3.Stoppage. A stoppage occurs when gun firing is involuntarily interruped and connot be resumed by the use of the remote gun system control.

6.3.4 Failure. A failure is defined as the inability of the gun system to meet the requirements as specified herein. Malfunction due to Government-furnished equipment or human error will not be considered a failure.

6.3.5 Barrel life. The barrel life is considered as having ended when the average velocity of a burst of 60 rounds, ±10 rounds, drops 61 meters per second or more with respect to that of a similar burst with new barrels, or when the projectiles from 20 percent of the rounds in any burst show keyholing, which is defined as yaw exceeding 15 degrees at 25.4 m range, or whichever occurs first.

6.4 Safety precautions. The loading, assembly, and handling of the explosives and the finished items covered by this specification involve hazardous operations and therefore require explosive safety precautions. Standard precautions for explosive-loaded items are contained in DoD 4145.26M.

6.5 Changes form previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

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