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MILITARY SPECIFICATION

DESIGN AND EVALUATION OF CARTRIDGES FOR CARTRIDGE ACTUATED DEVICES

*This specification has been approved by the Naval Air Systems Command,
Department of the Navy.*

1. SCOPE

1.1 This specification covers the general requirements for design and establishes uniform methods for testing cartridges used in cartridge actuated devices. Cartridges designed as stores separation cartridges used in stores separation equipment and single discrete units which are used as electric initiators do not fall within the scope of this specification but do fall within the scope of MIL-D-81303(AS) and MIL-I-23659(AS), respectively. For purposes of this specification, the term cartridge includes any assembled unit containing an explosive, propellant, or pyrotechnic material either singly or in any combination designed as the energy source for cartridge actuated devices. Linear shaped charge, explosive energy transfer lines, devices with the cartridge (s) "sealed-in" (see 6.3.1) and their associated ballistic assemblies used in cartridge actuated device applications shall fall within the scope of this specification. The purpose of the testing program is to determine performance, safety, soundness of mechanical design, and resistance to environments encountered during storage, handling, and service use. Cartridges must be safe for handling and must not deteriorate to a degree which would render their performance or safety doubtful after being subjected to the testing program of this specification.

1.2 Classification of the types of cartridge release to service.

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Type I

Safety of handling and installation. Certification as to safety of handling and installation is required prior to any flight of naval aircraft, target drones, or missiles with cartridges installed or use of the cartridge in the device of application. For requirements, see 3.15.1.

Type II

Interim service release. This type of release is required prior to any flights or use of a device containing cartridges involving naval personnel and, will be granted in accordance with the provisions of 3.15.2. The Naval Air Systems Command has the prerogative to authorize procurement of cartridges for Fleet use, subsequent to a type II release.

Type III A

Final release to service (fully documented). This type of release is required for admission of the cartridges into the naval supply system as a fully documented cartridge (see 3.9). For requirements see 3.15.2.

Type III B

Special release to service (documented by a Source Control Drawing). If the data required for a type III A release are not available (i.e. proprietary rights, patents, etc.) then a type III B release to service for Fleet use is permissible. For requirements for a type III B release see 3.15.2. For documentation and data requirements for a type III B release see 3.9.

Type IV

Use of approved cartridge in a new application. If a cartridge has previously been granted a type III A or type III B release and is to be used in a new application, type I release is automatic. A type IV release to service for the new application will be granted in accordance with the requirements of 3.15.3.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issues in effect on date of invitation for bids or request for proposals form a part of this specification to the extent specified herein.

SPECIFICATIONS

Military

MIL-P-116	Preservation-Packaging, Methods of
MIL-D-1000	Drawing, Engineering and Associated List
MIL-S-5002	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems
MIL-C-5541	Chemical Conversion Coatings of Aluminum and Aluminum Alloys
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-C-10464	Cans, Hermetic Sealing, Metal Light Gage, Tear-Strip Type
MIL-N-18307	Nomenclature and Identification for Electronic, Aeronautical, and Aeronautical Support Equipment Including Ground Support Equipment
MIL-D-23615	Cartridge Actuated Devices, Design and Evaluation of
MIL-I-23659	Initiators Electrical, General Design Specification for
MIL-D-81303	Stores Suspension Equipment Design and Evaluation of Cartridges for
MIL-D-81980	Design and Evaluation of Signal Transmission Subsystem: General Specification for
MIL-C-83125	Cartridges for Cartridge Actuated/Propellant Actuated Devices, General Design Specification for

Department of the NavyNaval Air Systems Command

AS 2998	Propellant for Cartridge Actuated Devices
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STANDARDS

Military

MIL-STD-143	Standards and Specifications, Order of Precedence for the Selection of
MIL-STD-331	Fuze and Fuze Components, Environmental and Performance Tests for
MIL-STD-810	Environmental Test Methods
MIL-STD-831	Test Reports, Preparation of
MIL-STD-875	Type Designation System for Aeronautical and Aeronautical Support Equipment
MIL-STD-889	Dissimilar Metals
MIL-STD-1166	Radiographic Testing Requirements for Solid Propellants

Department of the Navy

WR-43	Preparation of Quality Assurance Provisions
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Instructions

NAVORDINST 8020.12	Qualification Procedures for Navy Explosives
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PUBLICATIONS

Department of Defense

DSM 4120.3-M	Standardization Policies, Procedures and Instructions
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Code of Federal Regulations

49 CFR 171-178	Transportation
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(Copies of specifications, standards, 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. REQUIREMENTS

3.1 Selection of specifications and standards. Specifications and standards for necessary commodities and services not specified herein shall be selected in accordance with MIL-STD-143.

3.2 Special requirements. Special requirements for specific applications shall take precedence over those listed herein, provided such special requirements are more stringent. Other conflicting requirements are subject to the approval of the cognizant design agency for the specific application involved.

3.3 Materials. Materials for cartridges shall be compatible with the explosive, propellant, delay composition, pyrotechnic, and propellant gas and shall withstand environmental, electromagnetic, functional, service, and storage conditions to which the cartridges will be exposed. Acceptance or approval of materials for design or during the course of manufacture shall in no case be construed as a guarantee of acceptance of the finished cartridges. Pyrocellulose materials shall not be included as wads, spacers, or closure discs. Sealants used in close proximity to explosives, propellants, delay composition or pyrotechnics shall be compatible with these materials. Materials which are nutrients for fungi shall not be used.

3.3.1 Metals. Exposed metals shall be of the corrosion-resisting type or suitably treated to resist the corrosive effects of fuels, salt spray, or atmospheric conditions to which the cartridges may be subjected in storage or normal service use.

3.3.1.1 Dissimilar metals. Dissimilar metals shall not be used in intimate contact with each other unless suitably protected against electrolytic corrosion. Dissimilar metals are defined in MIL-STD-889.

3.3.2 Plastic parts. The use of plastic parts shall be subject to the approval of the cognizant design agency for the specific application involved.

3.4 Finishes. Protective coatings and finishes shall be used which will not crack, chip, or scale during normal service life or when subjected to environmental conditions specified herein. Surface treatments, coatings, and finishes shall conform to MIL-S-5002 except that aluminum and aluminum alloy parts shall be anodized in accordance with 3.4.1.

3.4.1 Anodizing. Aluminum and aluminum alloy parts subject to wear, abrasion, and erosion or exposed to corrosive environmental elements shall be anodized in accordance with

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MIL-A-8625, type II or III. Chemical conversion coatings conforming to MIL-C-5541 may be used to repair mechanically damaged areas from which the anodic coating has been removed.

3.5 Color coding . Color coding of cartridges for identification purposes is strictly forbidden.

3.6 Design and construction . The cartridges shall be of the simplest and most efficient design consistent with the proposed use. Specific consideration shall be given to the factors of minimum size and weight, resistance to deleterious environments, reliability of performance, and safety of operation. All cartridges submitted for or subjected to the requirements of 3.15 shall be of final design configuration, identical in design, and manufactured by the same process and shall be from the same lot.

3.6.1 Explosive, propellant, delay composition, or pyrotechnic material. Any explosive, propellant, delay composition, or pyrotechnic material used in a cartridge shall be approved by the cognizant design agency prior to use in a cartridge. Any explosive or propellant used in a cartridge shall meet the requirements of NAVORDINST 8020.12 and AS 2998 as applicable.

3.6.2 Assembly. The cartridge shall be as simple and as safe to assemble as possible. The propellant, explosive, or pyrotechnic material shall be as tightly confined as practicable without hand stacking the charge. Spacers shall not be used for this purpose.

3.6.3 Cartridge cases. Cartridge cases shall be as lightweight as practicable. The cases must be strong enough to withstand environmental and functional tests as specified herein. For electrically initiated cartridges, the cartridge case shall not be a part of the electrical circuit.

3.6.4 Sealed-in type cartridges actuated devices. In addition to meeting the design, environmental, and functional requirements of this specification, sealed-in type cartridge actuated devices (see 6.3.1) shall meet the structural, firing mechanism, shear pin, sand and dust, submersion, iced condition, and structural integrity requirements of MIL-D-23615.

3.6.5 Stab primers/detonators. Stab primers/detonators shall not be used in cartridges nor for initiating any other portion of the explosive components used in cartridge actuated devices.

3.6.6 **Electric initiators.** Electric initiators used in cartridges shall meet the applicable release requirements of MIL-I-23659.

3.6.7 **Service life.** Cartridges, when packaged in hermetically sealed metal containers, shall have a service life of not less than 5 years from date of manufacture or 30 months after opening of the hermetically sealed metal container, provided the 5 years (or total service life if longer than 5 years) from date of manufacture is not exceeded by the 30 months. Service life assignments must be approved by the Naval Air Systems Command prior to application in service hardware.

3.6.8 **Cartridges for signal transmission subsystems.** Cartridges employed in signal transmission subsystems shall meet all additional requirements specified in MIL-D-81980.

3.7 **Nomenclature.** The contractor shall follow the procedure outlined in MIL-N-18307 and MIL-STD-875 when submitting the DD Form 61 for cartridge nomenclature. The nomenclature requested by the contractor on DD Form 61 shall be concurred in by the Naval Air Systems Command prior to use.

3.8 **Marking.** Each cartridge shall be clearly and permanently (nondefaceable through normal storage and service handling) marked with the cartridge nomenclature (see 3.7) identifying number, lot number, manufacturer's symbol, and loading date (month and year cartridge was loaded).

3.9 **Contractual documentation and data requirements.** The cognizant government contracting agency when preparing a contract which includes cartridge development shall include, as a minimum, on the DD Form 1423 the following data requirements.

3.9.1 Reports in accordance with MIL-STD-831 of all tests performed by the prime or subcontractor during development (see 3.14) and qualification of the cartridge and any statistical analysis of these results.

3.9.2 Drawings including special tooling required in accordance with MIL-D-1000 category E, form 1. Also packaging and packing drawings to supplement 3.9.5.1 of this specification.

3.9.3 If full disclosure cannot be obtained for category E, form 1 drawings in accordance with MIL-D-1000 then a source control drawings, as defined by MIL-D-1000 category F, form 3, shall be submitted. Also the source control drawing shall include packaging and

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packing information in sufficient detail to meet the requirements of section 5 of this specification. If category F, form 3 drawings are submitted, complete drawings containing restrictive use notation shall be supplied to facilitate in-service support/malfunction investigation.

3.9.4 Detail and assembly drawings of test sets, including special tooling required, in accordance with MIL-D-1000 category E, form 3, and procedures used during testing, to permit manufacture and use of identical test sets for following on production testing.

3.9.5 Design, production, and acceptance specifications in accordance with DSM 4120.3-M.

3.9.5.1 Packaging and preservation procedures. (See section 5.)

3.9.6 Classification of characteristics in accordance with WR-43.

3.9.7 Complete manufacturing drawings of the cartridge and of test sets used in the development and evaluation/qualification of the cartridge should be submitted to the cognizant design agency concurrently with or prior to the submittal of the test report.

3.9.8 The contractor shall prepare the above data, drawings, specifications, etc., for cognizant design agency approval.

3.10 Performance. The cartridges shall satisfy all design, environmental and functional requirements specified herein and reliability and performance requirements outlined in the detailed cartridge design specification.

3.10.1 Dimensions. Unless otherwise specified, dimensions shall apply after all machining, process treatments (plating, anodizing, heat treating), and nondestructive testing have been completed. No cartridge shall deviate from the drawing configuration, dimensions, and tolerances.

3.10.2 Leakage. The cartridges shall pass a dry gas leak test. Cartridges which exhibit a leak rate in excess of 10^{-5} cubic centimeters per second of air at a pressure differential of 1 ± 0.1 atmosphere shall be considered defective. The leak test shall be conducted as specified in 4.5.2.

3.10.3 Radiographic examination. Each cartridge shall be subjected to radiographic examination such as x-ray, neutron bombardment, gamma ray etc., as specified in 4.5.3. Use of radiographic techniques not covered by military specifications or previous approval by the cognizant design agency shall be submitted for approval. Radiographic safety procedures shall be in accordance with MIL-STD-1166. Radiographic plates shall be retained until acceptance of the qualification test report by the cognizant design agency.

3.11 Environmental conditions.

3.11.1 Forty-foot drop. To ensure safety of handling, the cartridge shall not fire when dropped from a height of 40 feet as specified in 4.6.1 and shall be safe for handling and disposal.

3.11.2 Six-foot drop. The cartridges shall not fire when dropped from a height of 6 feet as specified in 4.6.2. After being subjected to the 6-foot drop test, the cartridges shall meet the design performance requirements when test fired.

3.11.3 Shock. The cartridges shall withstand shock conditions as specified in 4.6.3. After subjection to the shock test, the cartridges shall meet the design performance requirements when test fired.

3.11.4 Temperature and humidity cycling. The cartridges shall withstand the temperature and humidity cycling conditions as specified in 4.6.4 and shall meet the design performance requirements when test fired.

3.11.5 Vibration. The cartridges shall withstand vibration conditions as specified in 4.6.5. After subjection to the vibration test, the cartridges shall meet the design performance requirements when test fired.

3.11.6 Salt fog. The cartridges shall withstand exposure to salt fog as specified in 4.6.6 and shall meet the design performance requirements when test fired.

3.11.7 High-temperature storage. The cartridges shall withstand the high-temperature storage conditions as specified in 4.6.7 and shall meet the design performance requirements when test fired.

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3.11.8 **Cookoff temperature.** The maximum temperature to which a cartridge can be exposed for a period of 1 hour without cookoff shall be established to within 25° F. The maximum temperature shall be determined by the cookoff test of 4.6.8 and shall be 225° F or greater.

3.11.9 **High-temperature exposure (12 hours).** The maximum temperature to which cartridges may be exposed for 12 hours and function within design performance requirements when fired after cooling to 70° F shall be established to within 25° F. The maximum temperatures shall be determined by the high temperature exposure test of 4.6.9.

3.12 Functional tests.

3.12.1 Operation at -65° F and sea level pressure. (See 4.7.2.)

3.12.2 Operation at 200° F and sea level pressure. (See 4.7.3.)

3.12.3 Operation at 70° F and sea level pressure. (See 4.7.4.)

3.12.4 Operation at 80,000-foot altitude and -65° F. (See 4.7.5.)

3.13 **Damage and deterioration.** Damage to or deterioration of any internal or external part of the cartridge after environmental testing which could in any manner prevent it from meeting functional requirements shall be reason to consider the cartridge as having failed to meet the test to which it was subjected.

3.14 **Development testing.** Development tests shall be conducted to provide data to be used in the design freeze of the cartridge. Development tests may be used to determine operating characteristics. Stress to failure tests shall be conducted during development to provide failure mode characteristics for verification of analysis and determination of strength and operating margins of safety. It is required that development tests be run on the cartridge under simulated thermal environments to assure design compatibility with the requirements of this specification. Vibration amplification factors shall be substantiated during development testing. Development tests shall be categorized as follows:

- a. Design feasibility tests (3.14.1)
- b. Design verification tests (3.14.2).

3.14.1 Design feasibility tests. Prior to design feasibility tests, conceptual drawings and critical supporting calculations shall be reviewed by the cognizant design agency to determine compliance with the requirements specified herein. Design feasibility tests shall include all tests conducted for the following purposes:

- a. Component and part selection.
- b. Investigation of development model performance shall include as a minimum, functional test performance to indicate rupture, operating margins, and structural integrity.
- c. Demonstration of safety and operating margins or other analytical assumptions.

3.14.2 Design verification tests. Design verification tests are advanced stage development tests which are performed on the cartridges for the purpose of substantiating the design for its intended mission. These tests shall include as a minimum, radiographic inspection, the tests listed in table I, humidity tests, and certification of 3.14.1. Successful completion of the design verification tests and concurrence and approval by the cognizant design agency provides the assurance to permit a design freeze decision to be made.

3.15 Criteria of acceptance.

3.15.1 Minimum test requirements. After successful completion of the design verification tests (see 3.14.2), minimum requirements for a type I release are satisfactory performance in the tests listed in table I as performed by the government, contractor, or an independent testing laboratory. If the requirements of 3.14.2 are met without design change, the results may be accepted in fulfilling the requirements for a type I release. If the tests are performed by a contractor or by an independent testing laboratory, the test facility must be approved by the cognizant design agency and the tests witnessed by government personnel. A certified copy of the test data shall be submitted to the cognizant design agency for approval prior to granting of a type I release.

3.15.2 A type II, type III A, or type III B release to service can be given only after the cartridge satisfies the environmental and functional requirements and after successful performance in the complete testing program as set forth in table II. If the tests are to be performed by a contractor or by an independent testing laboratory, the test facility must be approved by the cognizant design agency and the tests witnessed by government personnel. A certified copy of the test data shall be submitted to the cognizant design agency for approval prior to granting of a type II, type III A, or type III B release to service. Applicable documentation for either a type III A or type III B release in accordance with the requirements of 3.9 shall be prepared as determined by contractual agreement. Distribution of cartridges for the various environmental and functional tests shall be in accordance with

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table II. Cartridges which have met the requirements of MIL-C-83125 may be considered acceptable for a type II, type III A, or type III B release provided all applicable requirements of this specification have been met.

Table I

DESIGN VERIFICATION TESTING

Test	Number of cartridges required	Applicable section for test procedures	Discard	Functional test at indicated temperature ¹
Visual	42	4.5.1	—	—
Leakage	42	4.5.2	—	—
Radiographic inspection	42	4.5.3	—	—

Expend to Test Listed Below

40-Foot drop	6	4.6.1	6	—
6-Foot drop	6	4.6.2	—	6 at 70° F
Shock	6	4.6.3	—	6 at 70° F
Vibration	6	4.6.5	—	6 at 70° F
Low temperature (-65° F)	6	4.7.2	—	6 at -65° F
High temperature (200° F)	6	4.7.3	—	6 at 200° F
Normal temperature (70° F)	6	4.7.4	—	6 at 70° F

¹Firing program shall be continuous as work day permits. Rounds shall be fired in random sequence. All firing temperatures specified in table I shall have a tolerance of $\pm 5^\circ$ F.

Table II

SERVICE RELEASE TESTING

Test ¹	Number of cartridges required	Applicable section for test procedures	Discard	Functional test at indicated temperature ²
Visual	200	4.5.1	—	—
Leakage	200	4.5.2	—	—
Radiographic inspection	200	4.5.3	—	—

Expend to Test Listed Below

40-Foot drop	6	4.6.1	6	—
6-Foot drop	6	4.6.2	—	6 at 70° F
Shock	12	4.6.3	—	12 at 70° F
Temperature and humidity cycling	18	4.6.4	—	18 at 70° F
Vibration	12	4.6.5	—	12 at 70° F
Salt fog	12	4.6.6	—	12 at 70° F
High temperature storage	18	4.6.7	—	18 at 70° F
Cookoff	12	4.6.8	12	—
High-temperature exposure	12	4.6.9	—	12 at 70° F
Low temperature (-65° F)	12	4.7.2	—	12 at -65° F
High temperature (200° F)	12	4.7.3	—	12 at 200° F
Normal temperature (70° F)	12	4.7.4	—	12 at 70° F
High altitude	12	4.7.5	—	12 at -65° F

¹If the tests of table II are performed by a contractor at an independent testing laboratory the 44 cartridges that were not allocated to the destructive test of table II are to be furnished to a designated Navy activity. These cartridges will be used to verify production lot acceptance procedures and test set functioning as being appropriate for acceptance and follow-on support for production lot procurements. If the test of table II are performed by a Government laboratory the cartridges that were not allocated to the destructive tests of table II shall be retained for investigative purposes.

²Firing shall be continuous as work day permits. Rounds shall be fired in random sequence. All firing temperatures specified in table II shall have a tolerance of $\pm 5^\circ$ F.

3.15.3 Acceptance of a standard cartridge in an additional device. When it is desired to use a previously approved cartridge (a cartridge which has had a type III A or type III B release to service) in a new application, certification of 3.15.1 is automatic. A type IV release for service use will be granted upon satisfactory performance in any special tests required by the new application (see 3.2) and the tests of table II deemed appropriate for the new application by the cognizant design agency.

3.16 Workmanship. Workmanship shall be subjected to the inspection of all requirements as specified herein and as specified in 3.9 as applicable.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the supplier may utilize 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 when such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Materials. Inspection and testing of component parts and assemblies shall be made to determine compliance with 3.3. Where defects or inferior quality are evident and the Government deems material analysis necessary, the contractor will be requested to submit samples or specimens to the cognizant design agency for analysis and approval.

4.3 Measurements and records. All functional tests of cartridges shall be performed with the equipment mounted and loaded in a manner to simulate service conditions as closely as possible. Applicable performance parameters such as the following shall be recorded during functional tests:

- a. Pressure versus time for ballistic cycle time
- b. Velocity (at end of power stroke)
- c. Displacement of simulated load versus time
- d. Thrust versus time for ballistic cycle time
- e. Acceleration versus time
- f. Resistive load versus time
- g. Time interval between actuating firing mechanism and beginning of movement of load or start of pressure rise
- h. Time interval between actuating firing mechanism and completion of operating cycle.

4.3.1 Instrumentation. Any state-of-the-art type of instrumentation and recording equipment may be used, e.g., oscillograph, oscilloscope, or magnetic tape. Transducers may be any state-of-the-art type, e.g., piezoelectric, strain gage, variable reluctance, capacitive, or potentiometer. However, accuracy of all test apparatus shall conform to requirements of MIL-STD-810. Documented calibration records shall be maintained and be available for inspection by the cognizant design agency.

4.4 Rejection and retest. Failure of any cartridge subjected to the environmental and functional test to conform to the applicable requirements of this specification or the predetermined critical design requirements may be cause for rejection of the entire lot (see 3.6). Full particulars concerning the failure, recommended action to correct the defect(s), and plan for retest shall be submitted to the cognizant design agency for approval. The retest must be approved by the cognizant design agency.

4.5 Nondestructive tests. Individual tests shall be conducted on each cartridge submitted for environmental and functional test. If any cartridge fails a part of the nondestructive test, the cognizant design agency may reject the entire lot (see 3.6). Following concurrence and approval by the cognizant design agency, the contractor shall correct all deficiencies prior to resubmitting the rejected articles for nondestructive retest. Nondestructive tests shall consist of those specified in 4.5.1, 4.5.2, and 4.5.3.

4.5.1 Examination of product. Each cartridge shall be completely inspected for compliance with the requirements specified herein, workmanship (see 3.16), and its applicable drawings and specification requirements (see 3.9) prior to environmental and functional testing.

4.5.2 Leakage test. All cartridges shall be tested with a dry gas leak tester of sufficient sensitivity to ascertain whether the cartridges meet the leak rate requirement of 3.10.2.

4.5.3 Radiographic inspection. All cartridges shall be inspected by radiographic means as specified in 3.10.3 and plates examined for defects and misassembly.

4.6 Environmental tests. All temperatures specified in 4.6.1 through 4.6.9 shall have a tolerance of $\pm 5^\circ$ F. If the cartridge cannot be fired in the test chamber, the cartridge shall be placed in the test device and fired within 5 minutes after removal from the test chamber. Whenever it is necessary to repeat low (-65° F) temperature conditioning of a cold device, all condensation shall be removed from the device before it is returned to the temperature conditioning chamber.

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4.6.1 **Forty-foot drop test.** This test shall be conducted in accordance with test 103 of MIL-STD-331. Six cartridges shall be dropped to impact in the following positions: (1) two with head up, (2) two with head down, and (3) two horizontal. The cartridges shall meet the requirement of 3.11.1.

4.6.2 **Six-foot drop test.** Six cartridges shall be dropped onto a 2-inch-thick steel plate (minimum) embedded in concrete to impact as follows: (1) two with head up, (2) two with head down, and (3) two horizontal. A new cartridge shall be used for each drop and no cartridge shall fire during this test. Subsequent to the drop test, the cartridges shall be test fired at 70° F.

4.6.3 **Shock.** This test shall be conducted in accordance with method 516, procedure 1 of MIL-STD-810. The shock pulse wave form shall be terminal peak sawtooth. The peak amplitude shall be 20 g and the duration shall be 11 milliseconds. After being subjected to the shock test the cartridges shall be test fired at 70° F.

4.6.4 **Temperature and humidity cycling.** This test provides for cycling between temperatures of -65° (or -80°), 70°, and 160° F (90 percent relative humidity) with additional storage at -80° and 160° F for two periods of 2 days each. Provision has been made for withdrawal of cartridges at two times during the cycling (see schedule below). This is to provide an opportunity to observe the extent of progressive deterioration, if such exists. The schedule has been arranged in such a manner that operations are not required outside regular working hours except for such supervision as may be necessary to insure proper operation of the controlled temperature cabinets. Cartridges shall be supported on screen trays so that all areas are exposed to the prescribed atmospheric conditions at all times throughout the test. Cartridges shall be free of visible damage and shall produce satisfactory ballistic performance when test fired. Cartridges will be conditioned at 70° F for functional tests. The schedule to be followed is:

Monday	1300	Place in cabinet or room maintained at -65° F
	1600	Remove from -65° F room and place in room maintained at 160° F, (90% relative humidity) and allow to remain overnight
Tuesday	0800	Remove from 160° F and place in 70° F
	1300	Remove from 70° F and place in -65° F
	1600	Remove from -65° F and place in 160° F (90% relative humidity)

Wednesday	0800	Remove from 160° F and place in 70° F
	1300	Remove from 70° F and place in -65° F
	1600	Remove from -65° F and place in 160° F (90% relative humidity)
Thursday	0800	Remove from 160° F and place in 70° F
	1300	Remove from 70° F and place in -65° F
	1600	Remove from -65° F and place in 160° F (90% relative humidity)
Friday	0800	Remove from 160° F and place in 70° F
	1300	Remove from 70° F and place in -65° F
	1600	Remove from -65° F and place in 160° F (90% relative humidity)
Saturday and Sunday		Maintain in 160° F (90% relative humidity)
Monday	0800	Remove from 160° F and place in 70° F
	1300	Remove from 70° F and place in -65° F
	1600	Remove from -65° F and place in 160° F (90% relative humidity)
Tuesday	0800	Remove from 160° F and place in 70° F
	1300	Remove from 70° F and place in -65° F
	1600	Remove from -65° F and place in 160° F (90% relative humidity);
Wednesday	0800	Remove from 160° F and place in 70° F
	1300	Remove from 70° F and place in -65° F
	1600	Remove from -65° F and place in 160° F (90% relative humidity)

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Thursday	0800	Remove from 160° F and place in 70° F
	1300	Remove from 70° F and place in -65° F
	1600	Remove from -65° F and place in 160° F (90% relative humidity)
Friday	0800	Remove from 160° F and place in 70° F
	1300	Remove from 70° F and place in -80° F
Saturday and Sunday		Maintain at -80° F
Monday	0800	Remove from -80° F and place in 70° F. Remove six cartridges. Condition three at 70° F and fire in device or test set. Store remaining three cartridges (at 70° F) which are to be fired at end of cycling program.

The second 2-week period follows the same schedule of temperature and humidity cycling. Withdrawals of cartridges during the second 2-week period are to be as follows:

Fourth Monday, withdraw six cartridges, condition three at 70° F and fire. Store remaining three cartridges (at 70° F) which are to be fired at end of cycling program.

The completion of the two periods occurs at 0800 on the 5th Monday after starting. At this time the remaining six cartridges are to be removed, conditioned at 70° F, together with remainder of cartridges from 2 and 3 weeks cycling, and fired.

4.6.5 Vibration. This test shall be conducted in accordance with the vibration test selection chart in table 514.1-1 using Curve Z of MIL-STD-810, except that for each resonant and cycling period the test specimens shall be divided equally for vibration at -65°, 70°, and 200° F. After vibration testing has been completed, the cartridges shall be test fired at 70° F.

4.6.6 Salt fog. This test shall be conducted in accordance with method 509 of MIL-STD-810. After the salt fog test has been completed, the specimens shall be test fired at 70° F.

4.6.7 High-temperature storage. Cartridges shall be placed in the temperature conditioning chamber in such a manner that the air can circulate freely about the cartridge.

Temperature shall be maintained at 160° F. The following schedule provides for a total storage time of 24 days, with periodic withdrawals for functional test.

Tuesday	0800	Place in 160° F storage
Second Wednesday	0800	Remove six cartridges
Third Tuesday	0800	Remove six cartridges
Fourth Friday	0800	Remove six cartridges

No attention is required outside normal working hours except that necessary to ensure that proper temperature is maintained. Cartridges shall be free from visible damage and shall produce satisfactory ballistic performance when test fired at 70° F.

4.6.8 Cookoff test. Three cartridges shall be placed in an oven preheated to the highest temperature which it is estimated that the cartridges will withstand for 1 hour. If no cartridges cookoff during 1 hour, the temperature shall be increased 25° F and the test repeated with three new cartridges. The test shall be repeated in 25° F increments until cookoff of at least one cartridge occurs within a 1-hour period. If cookoff occurs in the first group tested, the temperature shall be decreased 25° F and the test repeated with three new cartridges. The test shall be repeated in 25° F decrements until cookoff does not occur within a 1-hour period.

4.6.9 High-temperature exposure (12 hours). Three cartridges shall be placed in an oven preheated to a temperature 25° F less than the maximum determined for exposure without cookoff in 4.6.8. The temperature shall be maintained for 12 hours. If no cartridge cooks off, the three cartridges shall be cooled to 70° F and functionally tested. If any cartridge cooks off or fails to meet design performance requirements after cooling, the test shall be repeated with additional groups of cartridges, decreasing the temperature in increments of 25° F until design performance requirements are met.

4.7 Functional tests.

4.7.1 General. Insofar as possible, cartridges and the devices for which they are designed will be tested together. If additional cartridge tests in a special test device are required, these results shall be correlated with results obtained using the device for which they were intended. All temperatures specified in 4.7.2 through 4.7.5 shall have a tolerance of $\pm 5^\circ$ F. Test data shall be recorded as applicable. (See 4.3.)

4.7.2 Low-temperature tests (-65° F). Equipment and cartridges shall be conditioned at a temperature of -65° F for a period 1 hour longer than that required to reach thermal equilibrium and then fired. If additional cartridge tests in a special test device are required, these results shall be correlated with results obtained using the service device.

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4.7.3 High-temperature tests (200° F). Twelve rounds shall to be fired at a temperature of 200° F. Conditioning time and method of firing shall be as specified in 4.7.2.

4.7.4 Normal-temperature tests (70° F). Equipment and cartridges shall be conditioned as in 4.7.2 to a temperature of 70° F. The minimum number of devices of intended application, whose operation is nondestructive, shall be six and firings shall be divided to provide as nearly as possible an equal number of rounds in each device. For the device of intended application, whose operation is destructive, and of which the minimum number of twelve is accepted for testing, one new cartridge conditioned at 70° F without previous environmental treatment shall be fired in each of six devices. Six rounds conditioned as above and the rounds from environmental tests shall be fired in a test vehicle.

4.7.5 High-altitude tests (80,000-foot altitude and -65° F). The device under test or the test vehicle, together with cartridges, shall be conditioned at a temperature of -65° F, until temperature equilibrium is reached. The absolute pressure in the chamber shall then be reduced to 0.82 inch of mercury (corresponding to an altitude of 80,000 feet above sea level). These conditions shall be maintained for 1 hour. At the end of this time, the cartridges are to be fired. The schedule of firing shall be as specified in 4.7.2.

4.8 Packaging, packing, and marking inspection. Inspection of packaging and packing of cartridges and container markings shall be made to determine compliance with section 5.

5. PREPARATION FOR DELIVERY

5.1 Packaging and packing. In addition to the following, packaging and packing shall meet the requirements of 49 CFR 171-178 for the transportation of explosives.

5.1.1 Packaging. Packaging shall be level A or C, as specified, (see 6.2). (For definitions of levels A and C, see 6.3.2 and 6.3.3)

5.1.1.1 Level A. Cartridges supplied by a contractor for service use shall be packaged in hermetically sealed metal containers in accordance with the requirements of MIL-C-10464.

5.1.1.2 Level C. Cartridges supplied by the contractor to an independent test laboratory or to a government activity for qualification testing shall be packaged in accordance with method III of MIL-P-116.

5.1.2 Packing. Packing shall be level A or C, as specified, (see 6.2). (For definitions of level A and C, see 6.3.4 and 6.3.5.)

5.1.2.1 Level A. Level A packing shall be used for all cartridges supplied by a contractor for service use.

5.1.2.2 Level C. Level C packing shall be used for cartridges which are shipped to an independent testing laboratory or to a Government activity for qualification testing.

5.2. Marking.

5.2.1 Special markings. Marking of shipping containers shall be in accordance with 49 CFR 171-178.

5.2.2 Normal markings. Marking of unit packs and shipping containers shall be as follows:

	<u>Unit pack</u>	<u>Shipping containers</u>
a.	Federal Stock No. and DOD Code (if available)	Same
b.	Cartridge nomenclature	Same
c.	Contractor part number	Same
d.	Quantity	Same
e.	Lot number, manufacturer's symbol and loading date (month and year cartridge was loaded)	Same
f.	Explosive class	Same
g.	—	Gross weight and code
h.	—	Contract or purchase order number

6. NOTES

6.1 Intended use. The cartridges covered by this specification are intended to be used in cartridge actuated devices.

6.2 Ordering data. Procurement documents should specify the following:

- a. Title, number, and date of this specification
- b. Selection of applicable levels of packaging and packing (see 5.1, 5.2, and 5.3)
- c. Quantity per pack.
- d. Data requirements (see 3.9).

6.3 Definitions.

6.3.1 Sealed in type cartridge actuated device. Cartridge actuated devices in which the propellant, explosive, or pyrotechnic components become an integral part of the device and which by design are not to be disassembled and reassembled for inspection are termed sealed in cartridge actuated devices.

6.3.2 Level A packaging. The degree of preservation and packaging which will afford adequate protection against corrosion, deterioration, and physical damage during shipment, handling, indeterminate storage, and world-wide redistribution.

6.3.3 Level C packaging. The degree of preservation and packaging which will afford adequate protection against corrosion, deterioration, and physical damage during shipment from supply source to the first receiving activity for immediate use. This level may conform to the supplier's commercial practice when such meets the requirements of this level.

6.3.4 Level A packing. The degree of packing which will afford adequate protection during shipment, handling, indeterminate storage, and world-wide redistribution.

6.3.5 Level C packing. The degree of packing which will afford protection against damage during direct domestic shipment from the supply source to the first receiving activity for immediate use. This level in general will conform to applicable carrier rules and regulations and may be the supplier's commercial practice when such meets the requirements of this level.

6.3.6 Cognizant design agency. Unless the contract specifically indicates otherwise, all reference herein to the cognizant design agency are defined as referring to the Naval Air Systems Command.

6.4 Follow-on support for contractor furnished equipment (CFE).

6.4.1 Quality assurance levels for CFE. The following guidelines are recommended for production lot testing of cartridges furnished by contractors for service use:

a. For testing linear shaped charges and explosive energy transfer lines use MIL-STD-105, inspection level II and AQL of 0.25 percent.

b. For testing of impulse and delay cartridges use MIL-STD-105, inspection level II and AQL of 0.15 percent.

6.4.2 The recommended production lot size for cartridges supplied by a contractor for initial service use should not exceed 200 units.

Custodian:

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Preparing activity:

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Project No. 1377-N587

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DOCUMENT IDENTIFIER AND TITLE MIL-D-21625F(AS) DESIGN AND EVALUATION OF CARTRIDGES FOR CARTRIDGE ACTUATED DEVICES		
NAME OF ORGANIZATION AND ADDRESS	CONTRACT NUMBER	
	MATERIAL PROCURED UNDER A <input type="checkbox"/> DIRECT GOVERNMENT CONTRACT <input type="checkbox"/> SUBCONTRACT	
<p>1. HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE? A. GIVE PARAGRAPH NUMBER AND WORDING.</p> <p>B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES</p>		
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