

INCH-POUND
MIL-C-70822(AR)
9 March 1989

MILITARY SPECIFICATION

CANNON, 155MM HOWITZER: M284

This specification is approved for use by the Department of the Army and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification supports the acquisition of the Cannon, 155MM Howitzer: M284 consisting of a barrel assembly (tube, bore evacuator, and muzzle brake), a breech assembly, and a firing mechanism assembly. This specification includes the minimum essential Engineering and Packaging Requirements and the necessary Quality Assurance Provisions to determine that these requirements have been met, and consists of one type of cannon.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

MIL-C-13931 - Cannon, General Specification for

MIL-P-14232 - Parts, Equipment and Tools for Army Materiel, Packaging of

MIL-I-45607 - Inspection Equipment, Acquisition, Maintenance and Disposition of

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Armament Research, Development and Engineering Center, US Army Armament, Munitions and Chemical Command, ATTN: SMCAR-CCB-SAS, Watervliet, NY 12189-4050 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 1025

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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STANDARDS

MILITARY

- MIL-STD-129 - Marking for Shipment and Storage
- MIL-STD-1189 - Standard DOD Bar Code Symbology
- MIL-STD-1235 - Continuous Sampling Procedures and Tables for Inspection by Attributes
- MIL-STD-2073-1 - Procedures for Development and Application of Packaging Requirements

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 Other Government drawings and publications. The following government drawings and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DRAWINGS (see 6.7)

U.S. Army Armament Research, Development and Engineering Center (ARDEC)

- 11580150 - General Drawing, Cannon, 155MM Howitzer: M284
- 11580122 - Firing Mechanism Assembly M49
- EPL 11580150 - Engineering Parts List, Cannon, 155MM Howitzer: M284
- SPI AM11580150 - Special Packaging Instruction, Cannon, 155MM Howitzer: M284
- DL 11580150 - List of Inspection Equipment for Cannon, 155MM Howitzer: M284

PUBLICATIONS

- Master LQAP
11580150 - Master List of Quality Assurance Provisions for Cannon, 155MM Howitzer: M284
- QAP-APPENDIX
WVA - General Quality Assurance Provisions

(Copies of drawings, and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the Procuring Contracting Officer.)

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2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

ASTM (American Society for Testing and Materials)

ASTM D 3951 - Commercial Packaging, Practice for

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103-1137.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General requirements. Cannon and component parts shall be in accordance with the applicable drawings, General Drawing 11580150, Engineering Parts List EPL 11580150, the requirements of this specification, the applicable paragraphs of the General Cannon Specification - MIL-C-13931 as incorporated in this document, and all referenced documents. Any conflicts are to be resolved by means of the order of precedence (see 2.3).

3.2 First article. The contractor shall submit a first article unless it is specifically waived in the contract (see 4.4, 6.2, and 6.4). No first article requirements shall be waived without review and approval by the Procuring Contracting Officer (see 6.5).

3.2.1 Marking. When specified, marking shall be in accordance with the requirement specified in MIL-C-13931.

3.3 Reliability, maintainability, and durability. The specified performance and design requirements result in a cannon and parts thereof having inherent reliability, maintainability, and durability (see Appendix B).

3.4 Functioning. All parts shall function smoothly without interference, erratic movement or malfunction at the maximum loading elevation of 16 degrees above the horizontal plane.

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3.4.1 Breech mechanism. Camming of the operating crank during counter-recoil or rotating the operating handle rearward and to the right shall force the breechblock operating rack downward and to the right. This action shall cause the breechblock to rotate counterclockwise to disengage the sectored threads. At this time sufficient force shall be exerted, through action of the operating crank, to overcome the carrier-latching plungers thereby releasing the plungers from the catches attached to the breechring and in turn allowing the carrier and breechblock assembly to swing to the open position. The breech mechanism shall be retained in the open position by means external to the cannon (engagement of the operating crank roller in the operating cam of the mount).

3.4.2 Breech closing. With the adjustor set on the minimum preload position and the cannon at the maximum loading elevation (16 degrees), closing of the breech shall be accomplished by lifting the operating-cam of the mount clear of the operating crank rollers. Release of the crank shall allow the torsion springs to drive the crank clockwise and forcibly return the breechblock and carrier to the closed position. Action of the rack springs against the breechblock operating rack shall rotate the breechblock clockwise to engage the sectored threads. If the breech fails to close fully, manual closing shall be accomplished by engaging the clutch in the notch of the operating crank assembly and rotating the operating handle to the left and forward. The operating handle shall latch in the closed position. Counter-clockwise rotation of the adjustor shall increase the pre-load on the torsion springs.

3.4.3 Obturator surface. The obturator surfaces shall conform to the requirements prescribed in MIL-C-13931.

3.5 Primer headspace. Primer headspace, the distance between the front face of the firing mechanism tray assembly and the rear face of the obturator spindle, shall be not less than 0.054 inch nor more than 0.062 inch.

3.6 Firing pin protrusion and retraction. The firing pin protrusion measured from the front face of the block shall be not less than 0.114 inch and not more than 0.118 inch in the fired position. Firing pin retraction behind the front face of the block shall be not less than 0.008 inch.

3.7 Firing mechanism assembly. The firing mechanism assembly shall consist of a percussion type firing mechanism XM49 (11580122).

3.8 Performance.

3.8.1 High pressure resistance. The cannon, repair tubes, and muzzle brakes shall be capable of withstanding a chamber pressure of 59000 ± 2300 psi.

3.8.2 Material soundness. After completion of acceptance testing, all parts shall comply with soundness requirements specified on the applicable drawings.

3.8.3 Bore enlargement. Bore diameters across lands, after firing no more than 15 rounds, shall not exceed the before firing diameters by more than the amounts shown in Table I.

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TABLE I. Bore enlargement.

<u>Distance forward of Commencement of rifling</u>	<u>0.10 inch</u>	<u>1 inch</u>	<u>1 cal.</u>	<u>2 cal. to muz.</u>
Amount in inches	0.008	0.008	0.006	0.004

NOTE: Interpolate to determine the allowable enlargement between the distances listed.

3.8.4 Firing mechanism assembly. The firing mechanism assembly shall operate without evidence of interference, erratic movement, or malfunction.

4. QUALITY ASSURANCE 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 (examinations and tests) 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 this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

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

- a. First article inspection (see 4.4).
- b. Quality conformance inspection (see 4.7).

4.3 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in the applicable test document, applicable paragraph(s) in the specification, or in the applicable drawing (see 4.7).

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4.4 First article inspection. Unless otherwise specified in the contract (see 6.2), first article items shall be submitted for inspection in accordance with QAP-APPENDIX-WVA and applicable ITEM QAPs. First article items shall be representative of the production processes used during quantity production. Quality Assurance Provisions (QAPs) are listed in Master LQAP 11580150. First article quantities are specified in the applicable item QAPs.

4.5 First Article - Initial Production Test (FA-IPT). The requirements, tests, and test methods for FA-IPT are contained in APPENDIX A.

4.6 Reliability, maintainability, and durability. The requirements, tests, and test methods for reliability, maintainability, and durability are contained in APPENDIX B.

4.7 Quality conformance inspection.

4.7.1 Inspection provisions. Cannon and parts thereof shall be inspected for conformance to the requirements of this specification, to MIL-C-13931, QAPs listed in Master LQAP 11580150 and QAP-APPENDIX-WVA.

4.7.2 Inspection approval stamp. The application of the inspection approval stamp shall be as specified in MIL-C-13931.

4.7.3 Inspection equipment.

4.7.3.1 Acquisition, maintenance, and disposition. Unless otherwise specified (see 6.2), responsibility for acquisition, maintenance, and disposition of inspection equipment listed in List of Inspection Equipment DL 11580150, shall be in accordance with MIL-I-45607.

4.7.3.2 Accuracy of commercial inspection equipment. When commercial and modified commercial inspection equipment is used, it shall be capable of repetitive measurements to an accuracy of 10 percent of the total tolerance of the characteristic being inspected.

4.7.3.2.1 Accuracy of proof pressure measuring devices. The devices for measuring proof firing pressures shall have the following accuracy:

<u>Device</u>	<u>Maximum error of measurement</u>
copper crusher gages	<u>±</u> 3% of reading
pressure transducers	<u>±</u> 2% of reading

4.7.4 Examinations.

4.7.4.1 Primer headspace. The primer headspace shall be gaged on each cannon with gage prescribed in applicable item QAP, or with Government approved equivalent gage. Failure to comply with the requirements of 3.5 shall be cause for rejection.

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4.7.4.2 Firing pin protrusion and retraction. Firing pin protrusion and retraction shall be gaged on each cannon with gages prescribed in applicable item QAP, or with Government approved equivalent gage. Failure to comply with the requirements of 3.6 shall be cause for rejection.

4.7.4.3 Material soundness.

4.7.4.3.1 Tube. Each tube shall be magnetic particle inspected in accordance with applicable drawings, QAPs, and specifications. A borescope shall be used during inspection of the tube bore. Failure to comply with 3.8.2 shall be cause for rejection.

4.7.4.3.2 Breech, evacuator and muzzle brake. Each breechblock, carrier, breechring, evacuator and muzzle brake shall be magnetic particle inspected in accordance with applicable drawings, QAPs, and specifications. Failure to comply with 3.8.2 shall be cause for rejection.

4.7.4.4 Packaging. Unless otherwise specified, inspection to determine compliance with the packaging requirements of Section 5 and the applicable Special Packaging Instructions (SPIs) for the level of protection required in the contract shall be as specified in MIL-STD-2073-1.

4.7.5 Functional inspection.

4.7.5.1 Breech mechanism and firing mechanism. This inspection shall be done either manually or through the use of a functional tester. A minimum of five complete cycles of breech operation shall be performed on each breech mechanism and firing mechanism. Each time the breechblock assembly reaches the fully closed position, the firing mechanism block assembly shall be cycled between the load, the extract, and the firing positions. Each time the firing mechanism block assembly is cycled into the firing position, the lever shall be pulled and released. Failure to comply with 3.4, 3.4.1, 3.4.2, and 3.8.4 shall be cause for rejection.

4.7.6 Tests and test methods.

4.7.6.1 Proof acceptance. Each cannon shall be accepted through proof firing, simulation testing, or both. Failure to comply with 3.8 shall be cause for rejection.

4.7.6.1.1 Breech mechanisms. Each breech mechanism, including all breech mechanisms which will be a part of each cannon to be proof fired, shall be simulation tested using the method of 4.7.6.2.1.

4.7.6.1.2 Cannon and repair tubes. Unless otherwise specified by the Procuring Contracting Officer, cannon and repair tubes shall be sampled for proof firing (see 4.7.6.2.2), in accordance with MIL-STD-1235, using plan CSP-1. The appropriate sampling parameters, "i" and "f", and AQL shall be designated by the Procuring Contracting Officer in the contract (see 6.2).

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4.7.6.1.3 Successive production buys. Successive production buys shall not require "i" quantities. However, a new "i" quantity shall be used if any of the following conditions apply:

- a. The time lapse between two successive buys from the same contractor is one year or more.
- b. A new contractor is utilized.
- c. Significant change is made in a manufacturing process or material.
- d. A design change is made which influences the functional or structural performance of the item.

4.7.6.1.4 Weapon record data. Each cannon and repair tube shall be furnished with applicable data on DA Form 2408-4 (Weapon Record Data), as specified by the Procuring Contracting Officer.

4.7.6.2 Proof acceptance test methods.

4.7.6.2.1 Breech mechanisms. Breech mechanisms shall be simulation tested at a Government specified weapon test facility in accordance with the following procedure:

- a. The breech mechanism shall be tested once by means of hydraulic pressure testing equipment at a pressure of 59,000 + 2,300 psi. Test pressure shall be immediately released upon its attainment. The pressure-time graph shall be subject to approval by the Procuring Contracting Officer.
 - (1) When difficulty is encountered in attaining test pressure, the number of attempts in which over 95 percent of the test pressure is attained, shall not exceed five.
 - (2) If the cause of difficulty cannot be identified and corrected within five pressure cycles, the breech mechanism shall be subjected to proof firing as part of the cannon (see 4.7.6.2.2). This fact shall be noted on inspection records identifiable with the specific breech mechanism.
- b. The peak pressure shall be recorded for each test and added to inspection records identifiable with the specific breech mechanism undergoing test.
- c. After the pressure test:
 - (1) The breech mechanism shall be examined for looseness or interference of fit.
 - (2) The breech mechanism shall be disassembled and examined for soundness of material. All components shall be visually examined to assure freedom from cracks and fractures. The breech ring, breechblock, and carrier shall be magnetic particle inspected (see 4.7.4.3.2).

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- (3) The breech mechanism shall be cleaned and reassembled.
- (4) The breech mechanism and firing mechanism shall be functioned (see 4.7.5.1). In addition, two dummy primers (max and min metal) shall be used to check headspace, firing pin protrusion and retraction, and ejection.

4.7.6.2.2 Cannon and repair tubes. Cannon and repair tubes shall be proof fired at a Government specified proving ground in accordance with the following procedure:

- a. Cannon and repair tubes shall be proof fired once at $59,000 \pm 2,300$ psi.
- b. A facility mount may be used if necessary.
- c. Chamber pressure shall be measured and recorded.
- d. After proof firing:
 - (1) The bore of each tube shall be measured for bore enlargement using an air gage, an electronic gage, or other approved gage. The measurements shall be recorded. Bore enlargement shall meet the requirements of 3.8.3 and Table I.
 - (2) The tube shall be magnetic particle inspected and borescoped (see 4.7.4.3.1).
 - (3) The evacuator and muzzle brake shall be magnetic particle inspected (see 4.7.4.3.2).
 - (4) The breech mechanism shall be examined for looseness or interference of fit.
 - (5) The breech mechanism shall be disassembled and examined for soundness of material. All components shall be visually examined to assure freedom from cracks and fractures. The breechring, breechblock, and carrier shall be magnetic particle inspected (see 4.7.4.3.2).
 - (6) The breech mechanism shall be cleaned and reassembled.
 - (7) The breech mechanism and firing mechanism shall be functioned (see 4.7.5.1). In addition, two dummy primers (max and min metal) shall be used to check headspace, firing pin protrusion and retraction, and ejection.
- e. Cannon or repair tubes found to be defective at the proving ground shall be reported to the Procuring Contracting Officer; the Product Assurance Directorate, Watervliet Arsenal, Watervliet, NY 12189-4050; and Benet Laboratories, Watervliet Arsenal, Waterlviet, NY 12189-4050. The test agency shall forward a Test Incident Report (TIR) of the incident within ten working days, unless it is a critical defect which must be reported TTY (teletype) message within 12 hours of the incident.

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5. PACKAGING

5.1 Cannon - Levels A, B and C. Cleaning, drying, preservation, unit packaging and packing of cannon shall be in accordance with Special Packaging Instruction SPI AM11580150 and MIL-STD-2073-1 for the level of protection specified in the contract (see 6.2.1.p).

5.2 Repair parts - Levels A, B and C. Cleaning, drying, preservation, unit packaging and packing of repair parts, shall be in accordance with the applicable repair part SPI and MIL-STD-2073-1 or the applicable repair part PDS and MIL-P-14232 for the level of protection specified in the contract (see 6.2.1.p).

5.2.1 Level X - Industrial Packaging. Cleaning, drying, preservation, unit packaging and packing of repair parts shall be in accordance with ASTM D 3951 when industrial packaging is specified in the contract (see 6.2.1.p).

5.2.1.1 Quantity in unit package (QUP). When level C packaging in accordance with MIL-STD-1190 or industrial packaging of repair parts is specified in the contract, the QUP shall be the same as specified in the contract (see 6.2.1.p).

5.3 Marking of packages.

5.3.1 Levels A, B and C. Marking of unit package, intermediate packages and exterior shipping containers shall be in accordance with MIL-STD-129. When specified (see 6.2), bar code marking shall be in accordance with MIL-STD-129 and MIL-STD-1189.

5.3.2 Level X - Industrial. Marking of unit, intermediate packages and exterior shipping containers shall be in accordance with ASTM D3951. When specified, (see 6.2) Bar Code Marking shall be in accordance with MIL-STD-129 and MIL-STD-1189.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The cannon specified herein is intended to be used in the Howitzer, Medium, Self-Propelled, 155MM M109A4-M109A3E2 Systems. The tube temperature sensor is covered in the mount specification MIL-M-70821(AR).

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6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number and date of the specification.
- b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1 and 2.2).
- c. Requirements for and the number of cannon, components thereof, or both to be submitted for first article by the contractor (see 3.2).
- d. The examinations and tests to be performed by the contractor and the examinations and tests to be performed by the Government.
- e. All inspection and test data that is required.
- f. At whose expense a retest may be performed.
- g. Any additional or extended examinations and tests beyond the scope of this specification.
- h. Serial numbers for the cannon and repair tube assemblies.
- i. Inspection equipment, responsibility for acquisition, maintenance, and disposition thereof, if other than as specified (see 4.7.3).
- j. Availability of inspection equipment from the Government.
- k. Extent of contractor's responsibility for Government furnished and for contractor-required final inspection equipment.
- l. Applicable acceptance test procedures.
- m. When a proof firing sampling plan is authorized, the proof firing sampling plan parameters: initial consecutive quantity (i), sampling frequency (f), and AQL (see 4.7.6.1.2).
- n. Under what conditions simulated firing may be performed, the test equipment available, and the procedures to be followed.
- o. When applicable, the sampling plan for the actual firing of repair tubes.
- p. The levels of preservation, packaging, and packing required for cannon assemblies (see 5.1) and repair parts (see 5.2).
- q. When applicable, bar code marking requirements (see 5.3).

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- r. When warranted, the application of MIL-Q-9858 or MIL-I-45208, as appropriate.
- s. Unless otherwise specified, the application of MIL-I-45607 and MIL-STD-45662.

6.3 Consideration of Data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

<u>Reference Paragraph</u>	<u>DID Number</u>	<u>DID Title</u>	<u>Suggested Tailoring</u>
4.4	DI-T-4902	First Article Inspection Report	

The above DID's were those cleared as of the date of this specification. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 First article. When first article inspection is required, the Procuring Contracting Officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first four production items, a standard production item from the contractor's current inventory (see 3.2), and the number of items to be tested as specified in 4.4. The Procuring Contracting Officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.5 Waivers and deviations. The Procuring Contracting Officer shall coordinate all requests for waiver or deviation to this specification with Benet Laboratories and the Product Assurance Directorate at Watervliet Arsenal.

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6.6 Subject term (key word) listing.

Cannon, 155MM Howitzer: M284

Howitzer, Medium, Self Propelled 155MM M109A4-M109A3E2 System

6.7 Drawings. Drawings listed in Section 2 of this specification under the heading "U.S. Army Armament Research, Development and Engineering Center" (ARDEC) may also include drawings prepared by, and identified as Watervliet Arsenal, Ordnance Corps, Weapons Command, or U.S. Army Armament Research and Development Command, U.S. Army Armament, Munitions and Chemical Command, etc. Technical data originally prepared by these activities are now under the cognizance of ARDEC.

Custodian:

Army-AR

Preparing activity:

Army-AR

(Project 1025 - A166)

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APPENDIX A

FIRST ARTICLE - INITIAL PRODUCTION TESTING REQUIREMENTS

AND INSPECTION METHODS FOR CANNON: 155MM XM284

10. SCOPE

10.1 Scope. This Appendix details all requirements and inspection methods necessary for First Article - Initial Production Testing (FA-IPT). This Appendix A is a mandatory part of the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS. This section is not applicable to this Appendix A.

30. REQUIREMENTS

30.1 FA-IPT testing. FA-IPT tests shall be conducted on cannon or critical assemblies or parts thereof when:

- a. A new contractor is utilized.
- b. A time lapse of one year has occurred since the item was last produced by the contractor.
- c. Significant changes have been made in a manufacturing process or material.
- d. A design change is made.

If the cannon or critical assemblies or parts thereof fail FA-IPT testing, then failure analysis shall be invoked (see 40.4).

30.2 Performance. The requirements for performance are contained in 3.8.1, 3.8.2, and 3.8.3.

30.3 Climatic. The cannon will be employed in all types of areas, terrain and climates in which the supported units may operate. This includes operation in geographical areas which include temperature extremes from +125F to -50F.

30.4 RAM-D. The requirements for RAM-D are contained in Appendix B of MIL-C-70822(AR). When specified in the contract (see 6.2.1), RAM-D tests shall be conducted after successful completion of FA-IPT (Appendix A of MIL-C-70822(AR)).

40. INSPECTION METHODS

40.1 First Article Initial Production Test (FA-IPT). When specified in the contract (see 6.2), first article cannon shall be subjected to first article initial production testing (FA-IPT) by a Government activity to assure compliance with the requirements of this specification and the contract.

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APPENDIX A

40.1.1 Sample. Four first article cannon shall be randomly selected from the first month's production. First Article Cannon and parts thereof shall be representative of the production processes used during quantity production. When specified, these cannon shall be used for RAM-D testing.

40.1.2 Inspection provisions. First article cannon shall be subjected to normal inspection per applicable item QAP's, quality conformance inspection (see 4.7); including proof acceptance (see 4.7.6.1) through proof firing and simulation testing.

40.1.2.1 Physical configuration audit. One cannon selected from the first article sample shall undergo 100 percent inspection (no sampling) of all characteristics in addition to the normal inspection cited in 40.1.2.

40.1.2.2 Proof acceptance. First article cannon shall have successfully passed proof acceptance (see 4.7.6.1), through proof firing and simulation testing, prior to commencement of First Article Initial Production Testing.

40.1.3 Tests. Unless otherwise specified herein or in the contract, first article cannon tests listed in this specification shall be performed in a fully operational Howitzer, 155MM, M109A3E2 System, and shall not normally be integrated with other tests. Integration with Operational Testing by the user is allowable provided all components of the system conform to technical requirements. All tests shall be conducted by the Government or any agency specified by the Government.

40.2 TESTS

40.2.1 Climatic test. A climatic test shall be conducted on four cannon using the test method of 40.3.1. If the requirements of 30.3 are not complied with, acceptance shall be deferred and 40.4 shall apply.

40.2.2 RAM-D tests. The tests to verify the RAM-D requirements are contained in Appendix B of MIL-C-70822(AR).

40.3 TEST METHODS

40.3.1 Climatic test. A climatic test shall be conducted on four cannon with both the cannon and ammunition conditioned to the temperature specified in Table II. Ammunition used in this test shall be inert loaded dummy fuzed projectiles compatible with zone 8 M203A1 charges. Magnetic particle (see 4.7.4.3.1 and 4.7.4.3.2) and borescope (see 4.7.4.3.1) examinations shall be conducted on each cannon after firing in accordance with Table II. Facilities components may be used if necessary. If the requirements of 30.3 are not complied with, acceptance shall be deferred and paragraph 40.4 applies.

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APPENDIX A

TABLE II. Climatic test schedule.

<u>No. rounds</u>	<u>Temperature of cannon and ammunition</u>
5	+125F <u>±</u> 5F
5	-25F <u>±</u> 5F
5	-50F <u>±</u> 5F

40.4 Failure analysis. The contractor shall conduct a failure analysis by performing a dimensional, physical and visual examination of the components which are suspected to have caused the failure. Results shall be submitted to the Government for a failure cause determination. If it is determined that failure occurred because of deviation from specified dimensions or physical properties or both, the contractor shall accomplish, as applicable, the following actions:

a. Evaluate and correct the applicable production processes and procedures to prevent recurrence of the same defect in future production.

b. Examine completely assembled cannon and partially assembled cannon and components to ensure that material containing the same defect is purged from the inventory and not presented to the Government for acceptance.

c. Submit the results of the failure analysis and the corrective actions taken to the Government for evaluation and approval of retest or continuation of test.

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APPENDIX B

RELIABILITY, MAINTAINABILITY, DURABILITY REQUIREMENTS AND

RELIABILITY SCORING CRITERIA FOR CANNON: 155MM: M284

10. SCOPE

10.1 Scope. This Appendix details all requirements and inspection methods necessary for Reliability, Maintainability and Durability. This Appendix B also provides Reliability assessors guidelines for the consistent classification of failure for assessing the Reliability requirements of the Cannon: 155MM: M284. This Appendix B is a mandatory part of the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

STANDARDS

MILITARY

MIL-STD-721 - Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety

MIL-STD-882 - System Safety Program Requirements

30. REQUIREMENTS

30.1 Reliability. The cannon, as a component of a fully operational 155MM: M109A3E2 Howitzer System, shall have for the Operational Mode Summary/Mission Profile (OMS/MP) a Minimum Acceptable Value (MAV) of 2,600 Mean Rounds Between Operational Mission Failure (MRBOMF) with 80 percent confidence (see 40.2). The scoring criteria for assessing the reliability requirements are stated in 40.6.

30.1.1 Mission profile. A typical wartime/peacetime scenario shall consist of 24-hours operating time and a firepower of 51 missions consisting of 254 rounds total.

30.2 Maintainability. The cannon parts and components shall have the following maintainabilities:

- a. Tube: Cleaning and lubricating the tube after firing, in accordance with applicable maintenance procedures, to prevent corrosion shall be the only maintenance required.
- b. Breech: Service of the breech shall be carried out by the crew and shall be limited to minor maintenance and cleanup. Disassembly, cleaning and reassembly of the breechlock, firing mechanism block assembly, and associated operating linkage shall be carried out by the crew within 1.5 man-hours. Repair shall be carried out at unit (company or battalion) level.

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30.3 Durability. The cannon parts and components shall have the following durability (see 50.1 and 50.2):

- a. Breech ring and breechblock - 5,300 EFC rounds.
- b. Tube fatigue life - 3,600 EFC rounds (interim).
- c. Tube wear life - 2,500 EFC rounds (interim).
- d. Bore evacuator life - 2,500 EFC rounds (interim).
- e. Muzzle brake life - condemn when crack length exceeds one inch (interim).
- f. All other parts and components will be replaced as required in the scheduled maintenance.

40. INSPECTION METHODS

40.1 Pre-reliability test inspections. Upon completion of climatic and tube temperature sensor tests (see Appendix A), all examinations (see 4.7.4) and functional inspections (see 4.7.5) shall be repeated before reliability and durability tests are performed.

40.2 Reliability test. The test shall be conducted on two cannon. Each cannon shall be fired 2092 times for a total of 4184 rounds. Ammunition shall be inert loaded projectiles with zone 8 M203A1 charges, at 70F + 3F. To demonstrate that the reliability requirements have been achieved with 80 percent confidence, this test shall be completed without failure. Failure scoring criteria for assessing reliability requirements shall be in accordance with 40.6. If the requirements of 30.1 are not complied with, acceptance shall be deferred and paragraph 40.4 applies.

NOTE: Rounds fired in other tests (see Appendix A), may be counted as rounds for this test.

40.3 Durability test. The durability test shall be conducted on two cannon. Ammunition shall be inert loaded projectiles with zone 8 M203A1 charges, at 70F + 3F. Rounds fired in the reliability test (see 40.2) may be counted towards the rounds necessary for this test. If the requirements of 30.3 are not complied with, acceptance shall be deferred and paragraph 40.4 applies.

40.3.1 Tube. Durability shall be demonstrated by measuring wear after every 250 rounds until 0.100 inch wear has occurred at 41.75 inches from the rear face of the tube, or until 0.060 inch wear has occurred at 60.0 inches from the rear face of the tube. The firing rate shall not exceed one round every 1.0 minutes and shall be such that the tube temperature sensor does not exceed 250F. If the preceding wear occurs in either or both tubes before 2500 rounds has been reached, paragraph 40.5 applies.

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40.3.2 Muzzle brake and bore evacuator. After firing 2500 rounds on each cannon, the muzzle brake and the evacuator shall be magnetic particle inspected in accordance with applicable drawings and specifications.

40.3.3 Breechring-Breechblock. Durability shall be demonstrated by dynamic pressure cycling the breechring and breechblock at Benet Laboratories or other approved facility. Rounds fired in other tests of 40.1 and 40.2 may be counted as cycles for this test.

40.4 Failure analysis. The contractor shall conduct a failure analysis by performing a dimensional, physical and visual examination of the components which are suspected to have caused the failure. Results shall be submitted to the Government for a failure cause determination. If it is determined that failure occurred because of deviation from specified dimensions or physical properties or both, the contractor shall accomplish, as applicable, the following action:

- a. Evaluate and correct the applicable production processes and procedures to prevent recurrence of the same defect in future production.
- b. Examine completely assembled cannon and partially assembled cannon and components to ensure that material containing the same defect is purged from the inventory and not presented to the Government for acceptance.
- c. Submit the results of the failure analysis and the corrective actions taken to the Government for evaluation and approval of retest or continuation of test.

40.5 Tube wear data. If tube requirements are not met, (see 40.3.1) the results shall be analyzed in accordance with currently available wear data for the XM284 tube and a determination made as to whether the results indicate performance substantially below expected levels. If it is determined the results so indicate, then the following procedures shall apply:

- a. Conduct a failure analysis study performing a dimensional, visual and metallurgical examination of the tube.
- b. Review the ammunition elements (propellant, charge, and projectile characteristics) for abnormalities or changes in design or configuration since last tested.
- c. Evaluate applicable production processes and procedures and correct as warranted.
- d. Examine tubes at in-process and final assembly point to assure that defects are purged from the inventory and are not presented to the Government for acceptance.
- e. Submit results of the failure analysis and corrective actions taken to the Government for evaluation and approval to retest or continue the test.

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40.6 Scoring criteria. The scoring criteria is based on the reliability scoring procedure approved by the Department of the Army. The failure scoring procedure (see 40.6.4) provides for the use of the failure definition (see 50.4) which is amplified (see 40.6.1). Failure modes (see 40.6.2), and degraded modes of operation (see 40.6.3) pertaining to the cannon provide additional failure scoring guidelines.

40.6.1 Failure definition amplification.

40.6.1.1 The following are not considered as reliability failures:

1. Scheduled replacement of parts before failure.
2. An incipient malfunction corrected during scheduled preventive maintenance on the part in question provided a higher level of maintenance is not necessary.
3. A malfunction resulting from not following the prescribed operational or maintenance procedures or schedule dictated by the equipment manuals.
4. A malfunction resulting from test item abuse, unrealistic operation conditions or accident.
5. Actual or incipient malfunctions detected or corrected during initial technical inspections and incipient malfunction detected during final technical inspection.

40.6.1.2 The following are considered as reliability failures:

1. A failure detected and/or corrected during the correction of another failure provided the failures are totally unrelated.
2. Corrected incipient malfunctions not covered by 40.6.1.1 examples 2 and 5.
3. Failures resulting from lack of clarity of instruction or other fault in the maintenance test package.

40.6.2 Failure modes. The following are two typical failure modes for use in assessment of mission reliability failures. These failure modes are subject to performance degradation (see 40.6.3).

1. Breechblock cannot be closed or opened.
2. Gun will not fire.

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40.6.3 Degraded modes of operation. A certain amount of performance degradation must take place before a reliability failure can be assumed. If the system ceases to function, performance becomes unacceptable (i.e., non-existent); however, if performance is only degraded, then some threshold must be established to define where reliability failures begin. Allowable degradation thresholds have been established for the various performance parameters. Performance beyond these thresholds constitutes a reliability failure. As long as performance remains above the threshold or is returned above the threshold within five minute maintenance period, no reliability failure is charged.

1. Rate of Fire - maximum 4 rds/min for three minutes (or as determined by tube temperature sensor)
2. Rate of Fire - sustained 1 rd/min (or as determined by tube temperature sensor)

40.6.4 Failure scoring procedure. The following scheme provides the instructions for the use of the failure definition (see 50.4) for assessing reliability requirements of the Cannon, 155MM Howitzer: M284 (see 30.1). These instructions assume that an incident or malfunction has occurred during test, and a record has been prepared against this action to the extent where it is necessary to determine the chargeability of the action. Incidents where the identification of a reliability failure is in doubt will be deferred to a user-developer-tester Scoring Conference. The step-by-step instructions for using the failure definition are as follows:

Step 1. Record the incident information when a malfunction of the cannon occurs or is detected (rounds on test item and system, description of incident, nature of maintenance action required, maintenance time in hours, maintenance manhours, etc.). Proceed to the next step answering the question posed and taking action according to the answer given.

Step 2. Is this a scheduled replacement of parts before failure? If yes, do not charge a failure; if no, proceed to Step 3.

Step 3. Is this a malfunction resulting from not following the prescribed operational or maintenance procedures or schedule dictated by the equipment manuals? If yes, do not charge a failure; if no, proceed to Step 4.

Step 4. Is this malfunction resulting from test item abuse, unrealistic operating conditions or accident? If yes, do not charge a failure: if no, proceed to Step 5.

Step 5. Is this an actual or incipient malfunction detected or corrected during initial technical inspection or an incipient malfunction detected during final technical inspection? If yes, do not charge a failure; if no, proceed to Step 6.

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Step 6. Is this an incipient malfunction corrected during scheduled preventive maintenance on the part in question, provided a higher level of maintenance is not necessary? If yes, do not charge a failure; if no, proceed to Step 7.

Step 7. Is this incident related to or caused by another reliability failure? If yes, do not charge a failure; if no, proceed to Step 8.

Step 8. The following statements are addressed collectively. (A) The malfunction did not and would not cause a critical or catastrophic hazard to personnel or equipment as defined by MIL-STD-882. (B) The system performance is above acceptable levels (see 40.6.3). (C) The malfunction did not and would not preclude the ability to commence or cease any mode of operation (e.g., load and fire at any range, charge, elevation, or direction, (see 40.6.2). If all three of the above statements are true, do not charge a reliability failure; if any are not true, proceed to Step 9.

Step 9. Is the operator or crew authorized and able to remedy the malfunction by adjustment, repair, or replacement action within five minutes, using the controls, Basic Issue Items (BII), Items Troop Installed or Authorized (ITIA) and parts authorized to the crew? If the answer is yes, do not charge a reliability failure; if no, proceed to Step 10.

Step 10. If the previous 9 steps provide inconclusive evidence as to the chargeability or non-chargeability of a reliability failure, the incident should be checked against the criteria of 40.6.1 - 40.6.4. If categorization of the incident remains in doubt, defer classification to a user-developer-tester Scoring Conference.

50. Definitions.

50.1 RAM-D terms and definitions. Reliability, availability, maintainability and durability terms and definitions used in this specification are in accordance with MIL-STD-721. Durability is further defined in 50.2.

50.2 Durability. Durability is the probability that an item will successfully survive its projected life, overhaul point, or rebuild point (whichever is the more appropriate durability measure for the item) without a durability failure. A durability failure is considered to be a malfunction that precludes further operation of the item and is great enough in cost, safety, or time to restore, that the item must be replaced or rebuilt.

50.3 EFC (Equivalent Full Charge). An EFC round is a zone 8 M203A1 charge, fired at $70F \pm 3F$.

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50.4 Failure definitions. For the purpose of assessing reliability and to correspond with the definitions given in Annex E of the Howitzer Improvement Program (HIP) Letter of Agreement (LOA), the failure rate definitions are as follows:

F1 - Those failures that will prevent the system from continuing to fire or operate (mission abort).

F2 - Those failures (including F1's) which cannot be deferred until the next scheduled maintenance action and which should be corrected at the earliest convenient opportunity.

F3 - Those failures (including F1's and F2's) plus all incidents-malfunctions of parts-components which, while not substantially affecting system operations, would require corrective action at a convenient opportunity.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER
MIL-C-70822 (AR)

2. DOCUMENT TITLE
CANNON, 155MM HOWITZER: M284

3a. NAME OF SUBMITTING ORGANIZATION

4. TYPE OF ORGANIZATION (Mark one)

VENDOR

USER

MANUFACTURER

OTHER (Specify): _____

b. ADDRESS (Street, City, State, ZIP Code)

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER (Last, First, MI) - Optional

b. WORK TELEPHONE NUMBER (Include Area Code) - Optional

c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional

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