

MIL-P-60416A (AR)  
23 MARCH 1982  

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SUPERSEDING  
MIL-P-60416 (MU)  
20 December 1966

MILITARY SPECIFICATION

PROPELLANT M1  
FOR USE IN CHARGE, PROPELLING, 155MM, M3A1

This specification is approved for use by the US Army Armament Research and Development Command, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 This specification covers M1 Propellant for use in the M3A1 Propelling Charge.

1.2 Classification. The propellant shall be Type II, cylindrical, single-perforated grains.

2. APPLICABLE DOCUMENTS

2.1 Government documents

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

SPECIFICATIONS

MILITARY

MIL-A-48078 - Ammunition, Standard Quality Assurance Provisions, General Specification for

FSC: 1376

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, US Army Armament Research and Development Command, Attn. DRDAR-QA, Dover, New Jersey 07801 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1428) appearing at the end of this document or by letter.

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MIL-C-60418 - Charge, Propelling, 155MM, M3A1  
Loading, Assembling and Packing

STANDARDS

MILITARY

MIL-STD-286 - Propellants, Solid: Sampling,  
Examination And Testing

MIL-STD-414 - Sampling Procedures and Tables for  
Inspection by Variables for Percent  
Defective

MIL-STD-652 - Propellants, Solid for Cannons,  
Requirements and Packing

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

DRAWINGS

U.S. ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND (ARRADCOM)

8887277 - Charge, Propelling, 155MM, M3A1 for Cannon  
M1, M45, M126, M185, M199

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

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

3. REQUIREMENTS

3.1 Material. The propellant shall be M1, Type II conforming  
to the requirements of MIL-STD-652 and Drawing (Dwg) 8887277.

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3.2 Ballistic assessment requirements. The propellant, when fired in the M1 cannon with the M107 projectile shall be capable of assessment to the velocities and pressures at 70°F as specified in Table I.

TABLE I

Velocity and Pressure

<u>Zone</u>	<u>Velocity (fps)</u>	<u>Average Pressure (psi)</u>	
		<u>Minimum</u>	<u>Maximum</u>
1	680	--	--
2	770	--	--
3	900	--	--
4	1040	--	--
5	1230	18,000	28,000

3.3 Ballistic uniformity requirements. The propellant, when fired in the M1 cannon with the M107 projectile shall comply with the following requirements when tested as specified in 4.5.1.2. All charges shall be manufactured in accordance with MIL-C-60418.

3.3.1 Uniformity of velocity. The standard deviation of velocity for the lot at zone 5 at 70°F shall not exceed 3.0 feet per second.

3.3.2 Average pressure. At 70°F and standard weapon conditions, the propellant shall not produce an average pressure greater than 28,000 psi at zone 5.

3.3.3 Individual maximum pressure (IMP). The propellant shall not produce an individual pressure greater than 30,500 psi when fired at 70°F.

3.4 Initial production. This specification contains provisions for initial production inspection. Requirements for the submission of initial production inspection samples by the contractor shall be as specified in 4.5.1.2.1.

3.5 Preproduction inspection. This specification contains provisions for preproduction inspection. Requirements for the submission of preproduction inspection samples by the contractor shall be as specified in 4.3.1.

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3.6 Potassium sulfate. The total potassium sulfate content of the propellant on an added basis shall be  $1.00 \pm 0.30$  percent when determined as specified in 4.5.2.

3.7 Workmanship. The best commercial practices shall be used in the formulation of propellant furnished under this specification, and all other applicable documents. The propellant and its standard ingredients shall be protected from the action of direct sunlight and acid fumes. Unless otherwise specified, no reground propellant or nitrocellulose shall be used in the manufacture of propellant procured under this specification.

## 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection and standard quality assurance provisions. Unless otherwise specified herein or in the contract, the provisions of MIL-A-48078 shall apply and are hereby made a part of this detail specification. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements, specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspections. The following types of inspection shall be conducted on the unit product:

- a. Preproduction Sample Inspection
- b. Quality Conformance Inspection

4.3 Preproduction sample (pilot lots). The preproduction sample is intended to provide the necessary information to establish the propellant granulation needed to meet the required ballistic parameters.

4.3.1 Submission. The Contractor shall select three (3) propellant granulations which, from experience, should best fit the requirements of this specification. The contractor shall submit a preproduction sample as designated by the Contracting Officer for evaluation in accordance with 4.3.2, consisting of three (3) pilot lots of 1000 lbs to 1200 lbs each representing three (3) candidate granulations.

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4.3.2 Evaluation. Each of the pilot lots submitted per 4.3.1 will be tested for conformance to those specification requirements selected by the Government. Following analysis of the test results by the contractor and the Government, the Contracting Officer, after considering the recommendations of the Contractor, will notify the Contractor as to the granulation selected for production. If none of the pilot lots submitted meets the requirements of this specification, a new preproduction sample to be submitted per 4.3.1 will be requested by the Contracting Officer.

4.4 Quality conformance inspection

4.4.1 Inspection lot formation. Inspection lots shall comply with the lot formation provisions of MIL-A-48078.

4.4.2 Examination and testing.

PRECAUTION - This specification covers sampling and testing of chemical, toxic or explosive materials which are potentially hazardous to personnel. Accordingly, it is emphasized that all applicable safety rules, regulations and procedures must be followed in handling and processing these materials.

4.4.2.1 Sampling for laboratory testing (see 3.1). Each lot of propellant shall be sampled and tested for composition, form, dimensions and chemical/physical properties in accordance with MIL-STD-652. (see 6.4).

4.4.2.2 Sampling for ballistic testing (see 3.2). Each lot of propellant shall be sampled for Proving Ground tests in accordance with MIL-STD-652.

4.4.2.3 Charge establishment (see 3.2). If the lot does not meet the applicable requirements, testing shall cease and the Test Director shall immediately notify the procuring activity.

4.4.2.4 Velocity uniformity (70°F) (see 3.3.1). If the product of the factor (.72 for initial production, .69 for subsequent production) times the velocity standard deviation of the rounds tested in accordance with 4.5.1.2 exceeds the applicable requirement, apply referral criteria in accordance with 4.5.1.4. If the referral criteria cited do not apply,

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the lot shall be rejected. The factor makes allowance for the probability that a standard deviation from a smaller sample size exceeds the true standard deviation by chance alone. The standard deviation shall be calculated with  $(n-1)$  as the divisor in a standard statistical technique equivalent to that shown in MIL-STD-414.

4.4.2.5 Average pressure (see 3.3.2). If the average pressure obtained exceeds the applicable requirement, apply referral criteria in accordance with 4.5.1.4. If the referral criteria cited do not apply, the lot shall be rejected.

4.4.2.6 Individual maximum pressure (IMP) (see 3.3.3). If any individual pressure observed during the uniformity series, when corrected to standard conditions and recommended charge weight, exceeds the applicable requirement, the lot shall be rejected.

#### 4.5 Test methods and procedures

4.5.1 Proving ground assessments. This test shall be performed at a Government Proving Ground in accordance with the applicable acceptance test procedure using M107, HE projectiles inert loaded within 0.01 lb of an as fired weight of 95.0 lb using Primer, Percussion, MK2A4, and fired in an M1 Cannon with 50 percent (minimum) remaining life. All charges shall be temperature conditioned in a large conditioning box, with adequate air circulation to assure uniform conditioning, at the required temperature for a minimum of 24 hours and assurance will be made that, when fired, the charges are at the conditioning temperature. The following tolerances shall apply to all temperature conditionings:  $-50^{\circ}\text{F}$ ,  $+5^{\circ}\text{F}$ ;  $70^{\circ}\text{F} + 2^{\circ}\text{F}$ ;  $145^{\circ}\text{F}$ ,  $-5^{\circ}\text{F}$ . Copper crusher gages (2) shall be used to measure the maximum chamber pressure of each charge. Velocity coils will be used to measure the muzzle velocity of each charge. Test charges shall be assembled in accordance with drawing 8887277 and MIL-C-60418.

##### 4.5.1.1 Charge establishment (See Table II)

4.5.1.1.1 Charge slope method. Charges loaded with selected charge weights of propellant for zones 1, 2, 3, 4, 5 and 5+ shall be conditioned and fired at  $70^{\circ}\text{F}$ . Five calibration charges at zones 1, 2, 3, 4 and 5 shall also be conditioned and fired at  $70^{\circ}\text{F}$ , with the test charges. From the data obtained, a charge weight shall be calculated which will yield the prescribed service velocity (see 3.2). This calculated charge weight shall then be loaded into charges for the uniformity series (see 4.5.1.2.1). The difference between

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the corrected velocity obtained during the uniformity series and the service velocity shall be compensated for by a final adjustment in charge weight using the slope of the velocity charge weight curve previously established. The resultant will be the recommended charge weight.

4.5.1.1.2 Constant slope method. After ten (10) lots of a given production series have been fired to provide a good knowledge of the propellant characteristics, the charge slope method of assessment may be discontinued and the charge weight determined by the constant slope method. A composite charge weight versus velocity curve and charge weight versus pressure curve can be established from test results generated. This curve can then be used as in 4.5.1.1.1 to calculate the charge weight needed to achieve service velocity. This calculated charge weight is then to be loaded into charges for the uniformity series and final adjustment is to be made as indicated above for the charge slope method (see 4.5.1.1.1). The resultant will be the recommended charge weight.

4.5.1.2 Uniformity (see Table II)

4.5.1.2.1 Initial production. Thirty (30) charges shall be assembled with the calculated charge weight (See 4.5.1.1.1) of propellant at zone 5. Ten charges each shall be conditioned to  $-50^{\circ}\text{F}$ ,  $70^{\circ}\text{F}$  and  $145^{\circ}\text{F}$  (as indicated by thermo-coupled control charge). Charges fired at  $70^{\circ}\text{F}$  shall be fired alternately with calibration charges and shall be corrected to standard weapon/firing conditions. Firing results at all temperatures shall be corrected to standard projectile weight (see 4.5.1) and to recommended charge weight conditions (i.e., the difference between calculated (as fired) charge weight and recommended charge weight). The means and standard deviations of the velocities and pressures at all firing temperatures shall be calculated using corrected results. The initial production lots represent the first three consecutive lots from each manufacturer which have been produced and met the acceptance criteria of this specification.

4.5.1.2.2 Subsequent production. Seven (7) charges shall be assembled with the established charge weight (see 4.5.1.1.2) of propellant. Each charge shall be conditioned to  $70^{\circ}\text{F}$  (as indicated by thermo-coupled control round). Test charges shall be fired alternately with calibration charges and shall be corrected to standard weapon/firing conditions (i.e., the difference between calibration performance under test conditions and standard conditions). Firing results shall be corrected to standard projectile weight (see 4.5.1) and to



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recommended charge weight conditions (i.e., the difference between as fired charge weight and recommended charge weight). The means and standard deviations of the velocities and pressures shall be calculated using corrected results. Throughout production, if 3 consecutive lots fail on first test, testing shall revert back to the initial production plan (see 4.5.1.2.1).

4.5.1.3 Retest criteria. A lot shall be retested whenever any of the following conditions exist or whenever the proving ground deems it necessary.

a. The final adjustment in charge weight exceeds 2.0 ozs of the charge weight used in uniformity firings, retest for uniformity in accordance with 4.5.1.2.

b. If for any reason, the Proving Ground considers that test conditions have detrimentally affected the test results, additional charges as required shall be tested.

4.5.1.4 Referral criteria. A test lot shall be referred to the procuring activity for disposition whenever any of the following conditions exist or whenever the proving ground deems it necessary.

a. Calibration rounds fired in any test phase fail to comply with Section 3 of this specification.

b. Calibration correction applied exceeds two percent of the expected muzzle velocity.

c. Calibration components are not available.

d. Number of test or calibration results utilized in calculations is less than specified.

e. Any unusual occurrences during ballistic testing, such as excessive delays between rounds, stickers, poor projectile flights, etc. Each such event shall be reported in detail on the applicable firing record.

f. Test lot fails velocity standard deviation or average pressure requirement at 70°F and any extreme test value is an outlier.



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The following test shall be performed to determine if a single test result is an outlier. With a sample size of 7 at a significance level of 0.05, the critical value ( $T_C$ ) is 0.507. Calculate a test value ( $T_t$ ) as follows:

For Low Outlier

$$T_t = \frac{(X_2 - X_1)}{(X_7 - X_1)}$$

For High Outlier

$$T_t = \frac{(X_7 - X_6)}{(X_7 - X_1)}$$

Where:

- $X_1$  = test result being tested as low outlier
- $X_2$  = test result adjacent to  $X_1$ , after all the test results are ordered from smallest to largest
- $X_6$  = test result adjacent to the largest test result
- $X_7$  = test result being tested as high outlier

$X_1$  or  $X_7$  is an outlier if  $T_t$  is greater than  $T_C$ .

With a sample size of 10 at a significance level of 0.05, the critical value ( $T_C$ ) is .477. Calculate a test value ( $T_t$ ) as follows:

For Low Outlier

$$T_t = \frac{(X_2 - X_1)}{(X_9 - X_1)}$$

For High Outlier

$$T_t = \frac{(X_{10} - X_9)}{(X_{10} - X_2)}$$

Where:

- $X_1$  = test result being tested as low outlier
- $X_2$  = test result adjacent to  $X_1$ , after all the test results are ordered from smallest to largest.
- $X_9$  = test result adjacent to largest test result.
- $X_{10}$  = test result being tested as high outlier

$X_1$  or  $X_{10}$  is an outlier if  $T_t$  is greater than  $T_C$ .

4.5.2 Potassium sulfate. The potassium sulfate content shall be determined in accordance with MIL-STD-286, Method 310.4.

## 5 PACKAGING

5.1 Packing and marking. Packing and marking shall be in accordance with MIL-STD-652, except that all propellant designated for use as reference shall be packed level A.

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## 6 NOTES

6.1 Ordering data. Ordering data shall be in accordance with MIL-A-48078 with the following exceptions:

6.1.1 Acquisition requirements. Acquisition requirements of MIL-A-48078 shall apply.

6.1.2 Contract data requirements. One copy each of the Propellant Description Sheet and the Acceptance Test Summary shall be forwarded to each office designated by the contracting officer. Copies of data item description required by the contractor in connection with specific acquisition functions should be obtained from the procuring activity.

6.2 Proving ground test summary (see Table II).

6.3 Drawings. Drawings listed in Section 2 of this specification under the heading US Army Armament Research and Development Command (ARRADCOM) may also include drawings prepared by, and identified as, Edgewood Arsenal, Frankford Arsenal, Rock Island Arsenal or Picatinny Arsenal drawings. Technical data originally prepared by these activities is now under the custodianship of ARRADCOM.

6.4 Surveillance sample. Samples shall be forwarded to US Army Armament Research and Development Command, Dover NJ 07801, ATTN: DRDAR-LCE-MP for the propellant surveillance test program in accordance with MIL-STD-652.

6.5 Individual maximum pressure. Individual maximum pressure specified in 3.3.3 is based on firing with an M107 projectile loaded to an as fired weight of 95.0 lbs. Any change in weight or projectile will require an adjustment of this pressure requirement.

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

TABLE II  
PROVING GROUND TEST SUMMARY

<u>Test Phase</u>	<u>Zone</u>	<u>Temp</u>	<u>Sample Size</u>		<u>Velocity Requirements</u>		<u>Pressure Requirements</u>	
					<u>Service</u>	<u>Standard Deviation</u>	<u>IMP</u>	<u>Average Pressure</u>
					<u>Velocity</u>	<u>of Velocity</u>		
		<u>°F</u>	<u>Cal</u>	<u>Test</u>	<u>FPS</u>	<u>FPS</u>		
Charge Establishment	1	70	5	5	680	N/A	N/A	N/A
	2	70	5	5	770	N/A	N/A	N/A
	3	70	5	5	900	N/A	N/A	N/A
	4	70	5	5	1040	N/A	N/A	N/A
	5	70	5	5	1230	N/A	30,500	18,000 - 28,000
	5+	70	N/A	3	N/A	N/A	N/A	N/A
Uniformity	5	-50*	N/A	10	N/A	N/A	N/A	N/A
	5	70*	10	10	1230	3.0	30,500	18,000 - 28,000
	5	145*	N/A	10	N/A	N/A	N/A	N/A
	5	70**	7	7	1230	3.0	30,500	18,000 - 28,000

\*Initial production only

\*\*Subsequent production

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Custodian:  
ARMY-AR

Preparing Activity  
ARMY-AR  
(Project 1376-A161)