METRIC
MIL-DTL-32040(OS)
19 March 1999

DETAIL SPECIFICATION

PROPELLANT, GUN, HIGH ENERGY NITRAMINE

This specification is for use by the Naval Sea Systems Command, Department of the Navy and is available for use by all departments and agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers high energy nitramine gun propellant, Ex-100, for use in the 5"/62 Mk 45 Mod 4 Gun Weapons System (see 6.1).

1.2 Classification. The propellant is cylindrical multi-perforated grains and is a high energy nitramine propellant, similar in formulation to the Army's M43. This formulation is designed here for specific use in the 5"/62 Extended Range propelling charge, but with modifications in grain geometry may be used in other applications.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents specified in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 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

DEPARTMENT OF DEFENSE

MIL-DTL-398	RDX
MIL-G-155	Graphite (For use in Ammunition)
MIL-DTL-244	Nitrocellulose
MIL-E-255	Ethyl Centralite (Carbamite)
MIL-C-005537	Cellulose Acetate Butyrate

(Copies of MIL-C-005537 are available from Commander, US Army TACOM-ARDEC, Attn: AMSTA-AR-EDE-S, Bldg 12, Picatinny Arsenal, NJ 07806-5000.)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to the Commander, Indian Head Division, Naval Surface Warfare Center, Standardization Team (Code 840M), 101 Strauss Avenue, Indian Head, MD 20640-5035, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by sending a letter.

AMSC N/A **FSC 1376**

STANDARDS

DEPARTMENT OF DEFENSE

MIL-STD-129 Marking for Shipment and Storage

MIL-STD-286 Propellants, Solid; Sampling, Examination and Testing

(Unless otherwise indicated, copies of Federal and Military Specifications and Standards, are available from Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other government documents, 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.

SPECIFICATIONS

NAVAL SEA SYSTEMS COMMAND (CAGE Code 53711)

WS 12797 Triethylene Glycol Dinitrate

(Copies of these weapons specifications are available from Indian Head Division, Naval Surface Warfare Center, Code 8410P, 101 Strauss Ave, Indian Head MD 20640-5035.)

CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 100-199 Transportation

(The Code of Federal Regulations is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402)

DRAWINGS

NAVAL SEA SYSTEMS COMMAND (CAGE Code 53711)

10001-138439 Packing Box Mark 7 (For Smokeless Powder), General Arrangement

(Application for copies of this NAVSEA drawing should be addressed to: Commander, Naval Surface Warfare Center, Crane Division, Louisville Detachment, Attn: Code 802, Louisville, KY 40214.)

53711-x7263177 Charge, Propelling, CARGO, Extended Range, Ex-175 Mod 0

(This NAVSEA drawing may be obtained from: Commander, Naval Surface Warfare Center, Indian Head Division, 101 Strauss Ave, Code 8410, Indian Head MD 20640-5035.)

NAVAL ORDNANCE STATION (CAGE Code 14083)

5755 Leverpak, Fibre Drum

(This Naval Ordnance Station drawing may be obtained from: Commander, Naval Surface Warfare Center, Indian Head Division, 101 Strauss Ave, Code 2150, Indian Head MD 20640-5035.)

2.3 Non-Government publications and drawings. The following documents 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 solicitation. Unless otherwise specified, the issues of documents not listed in DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 537	Standard Test Method for Assessing the Thermal Stability of Chemicals by Methods of Differential Thermal Analysis
ASTM D 817	Standard Test Methods of Testing Cellulose Acetate Propionate and Cellulose Acetate Butyrate
ASTM D 941	Standard Test Method for Density and Relative Density (Specific Gravity) of Liquids by Lipkin Bicapillary Pycnometer
ASTM-D-1343	Standard Test Method for Viscosity of Cellulose Derivatives by Ball-Drop Method
ASTM D 1744	Standard Test Method for Determination of Water in Liquid Petroleum Products by Karl Fischer Reagent
ASTM D 1807	Standard Test Method for Refractive Index and Specific Optical Dispersion of Electrical Insulating Liquids
ASTM-D-4795	Standard Test Method for Nitrogen Content of Soluble Nitrocellulose - Alternative Method
ISO-1392	Determination of Crystallization Point

(Application for copies of ASTMs should be sent to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959)

2.4 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 Preproduction. Unless otherwise specified (see 6.3), a sample shall be submitted for preproduction testing and inspection (see 4.3).

3.2 Ingredients. The ingredients used in a specific formulation of the propellant shall meet the appropriate requirements set out in this section.

3.2.1 Nitrocellulose

3.2.1.1 Nitrogen content. The nitrogen content shall be between 12.55 and 12.65 percent with no blend component having a nitrogen content below 12.45 percent (see 4.6.1.1.1).

3.2.1.2 Viscosity. The viscosity shall be between 10 and 15 seconds (see 4.6.1.1.2).

3.2.1.3 Source. The nitrocellulose shall be continuously nitrated and manufactured from baled cotton linters only.

3.2.1.4 Fineness. The fineness before dehydration shall be 80 ml $\pm$ 10 ml (see 4.6.1.1.3).

3.2.1.5 Heat test. The nitrocellulose shall yield a result of 35 minutes or greater both before dehydration and after packing (see 4.6.1.1.4)

3.2.1.6 Total volatiles. The nitrocellulose shall be wet with 25 to 28 percent total volatiles of which a minimum of 88% shall be alcohol (see 4.6.1.1.5).

3.2.2 RDX

3.2.2.1 Melting point. The melting point of the RDX shall be no lower than 190 ^{o} C (see 4.6.1.2.1).

3.2.2.2 Acidity. The acidity of the RDX, expressed as percent acetic acid, shall be no greater than 0.02 (see 4.6.1.2.2).

3.2.2.3 Particle size. The median particle size shall be between 4.7 and 5.7 microns, with at least 90 percent of the particles being below 10.5 $\pm$ 0.5 microns and no more than 10 percent of the particles being less than 1.4 $\pm$ 0.1 microns (see 4.6.1.2.3).

3.2.2.4 Purity. No more than 0.05 percent by weight of the RDX shall consist of acetone insoluble material (see 4.6.1.2.4) and no more than 0.03 percent by weight of the RDX shall consist of inorganic insoluble material (see 4.6.1.2.4).

3.2.3 Cellulose acetate butyrate (CAB)

3.2.3.1 Butyryl content. The butyryl content of the CAB shall be between 35.0 and 39.0 percent by weight (see 4.6.1.3.1).

3.2.3.2 Acetyl content. The acetyl content of the CAB shall be between 12.0 and 15.0 percent by weight (see 4.6.1.3.1)

3.2.3.3 Hydroxyl content. The hydroxyl content of the CAB shall be between 1.2 and 2.2 percent by weight (see 4.6.1.3.1)

3.2.3.4 Free acidity. The free acidity content, expressed as acetic acid, shall be no more than 0.03 percent (see 4.6.1.3.2).

3.2.3.5 Ash. Ash shall be less than 0.05 weight percent (see 4.6.1.3.3).

3.2.3.6 Viscosity. The viscosity shall be between 17.0 and 24.0 seconds (see 4.6.1.3.4).

3.2.3.7 Softening point. The CAB shall soften between 195 and 205 ^{o} C (see 4.6.1.3.5).

3.2.3.8 Moisture. Moisture content shall be no greater than 3.0 percent by weight (see 4.6.1.3.6).

3.2.4 Triethylene glycol dintrate

3.2.4.1 Percent nitrate ester. The material shall be a minimum of 98 percent nitrate ester (see 4.6.1.4.1).

3.2.4.2 Acidity or alkalinity. The material shall have a maximum acidity or alkalinity weight percentage of 0.002 (see 4.6.1.4.2).

3.2.4.3 Water content. The percent of water shall be a maximum of 0.20 percent by weight (see 4.6.1.4.3).

3.2.4.4 Potassium iodide thermal stability. The material shall *not* change the color of the standard potassium iodide starch indicator paper in less than 10 minutes when subjected to the 82.2°C oven test (see 4.6.1.4.4).

3.2.4.5 Stabilizer content. The stabilizer content shall be a minimum of 0.20 and a maximum of 0.40 percent by weight (see 4.6.1.4.5).

3.2.5 Ethyl centralite (EC).

3.2.5.1 Solidification point. The solidification point shall be a minimum of 71 ^{o}C and a maximum of 72.5 ^{o}C (see 4.6.1.5.1).

3.2.5.2 Melted material. The melted material shall be a bright liquid, free of scum (see 4.6.1.5.2).

3.2.5.3 Volatile content. The volatile content shall be 0.10 percent by weight or less (see 4.6.1.5.3)

3.2.5.4 Ash content. The ash content shall be 0.10 percent by weight or less (see 4.6.1.5.4).

3.2.5.5 Acidity. The acidity shall not exceed 0.04 percent by weight (see 4.6.1.5.5).

3.2.5.6 Particle size. 99.9 percent or more of the material shall pass through a No. 30 US sieve (see 4.6.1.5.6).

3.2.6 Graphite.

3.2.6.1 Moisture. The moisture content shall be 0.50 percent by weight or less (see 4.6.1.6.1).

3.2.6.2 Ash. Ash content shall be 6.0 percent by weight or less (see 4.6.1.6.2).

3.2.6.3 Acidity. No acidity is permitted (see 4.6.1.6.3).

3.2.6.4 Particle size. The particle size of the material shall be such that a minimum of 96 percent by weight passes through a No. 325 US sieve (see 4.6.1.6.4).

3.3 Composition (M101). The propellant shall meet the requirements of Table I. (See 4.6.2)

TABLE I. Composition of EX-100

Component	Percent by Weight
Nitrocellulose Grade A Type 1	4.00 ± 0.25
RDX1/	76.00 ± 0.50
Ethyl Centralite	3.00 ± 0.04
Cellulose acetate butyrate	11.00 ± 0.30
Triethylene glycol dinitrate	6.0 ± 0.10
Total volatiles	0.20 max
Graphite	0.10 ± 0.05

1/ The RDX shall be ground in a fluid energy mill to the particle size requirements of 3.2.2.3.

3.4 Grain form and dimensions. (M102) The grains shall be right circular cylinders with seven cylindrical perforations parallel to the axis of the grain and evenly spaced across the circular face of the grain. Generally, the length of the grain shall be between 1.0 and 2.5 times the outer diameter of the grain, but may vary for specific applications. The length of the grain shall be no greater than fifty times the diameter of the perforation of the grain (see 4.6.3).

3.5 Glaze. The propellant shall be glazed with graphite, MIL-G-155, Grade IV (see 4.6.4).

3.6 Integrity. The propellant grains shall be without visually discernible cracks between the perforations or between the perforations and the outside edge of the grain (see 4.6.4)

3.7 Stability (C1). Using differential thermal analysis, the propellant shall not exhibit an exotherm onset at a temperature lower than 225^{o} C. (See 4.6.5).

3.8 Packing depth (M103). The production packing depth of the assessed charge weight shall be between 5 and 10 centimeters as measured from the case mouth (see 4.6.6).

3.9 Gun ballistic assessment requirements

3.9.1 Velocity (M104). The charge weight of the propellant lot under test shall be assessed to result in a nominal average new gun velocity of 1,066 m/s. (See 4.6.7)

3.9.2 Pressure (M105) The maximum allowed chamber pressure shall be 448 MPa (piezoelectric pressure measurement) as measured in the base of the cartridge case. (See 4.6.7)

3.9.3 Velocity variation (M106) The maximum allowed velocity standard deviation shall be 8.5 m/s. (See 4.6.7).

3.9.4 Pressure variation (M107) The maximum allowed pressure standard deviation shall be 14 MPa. (See 4.6.7)

3.10 Propellant interface test. All preproduction lots and production lots, when directed by the procuring activity, must be subjected to the propellant interface test (see 4.6.10 and 6.4)

4. QUALITY ASSURANCE PROVISIONS

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

a. Preproduction inspection (See 4.3).
b. Quality conformance inspection (See 4.4).

4.2 Inspection conditions. All test activities identified in the contract shall submit to the technical activity and the design agent for review, prior to first article (preproduction), a description of the proposed procedures and equipment to be used to perform the examination and test.

4.3 Preproduction testing and inspection. Preproduction inspection (except for production packing depth determination and ballistic testing) shall be performed by the contractor, after award of contract and prior to production, at a location acceptable to the Government. Preproduction inspection shall be performed on sample material which has been produced with equipment and procedures normally used in production. Preproduction approval is valid only on the contract under which it is granted, unless extended by the Government to other contracts. The preproduction sample is intended to provide necessary information to establish the propellant granulation needed to meet the required ballistic parameters. A preproduction sample should be required any time a change is made to the formulation of

the propellant, one of its ingredients, the production process for the propellant or certain changes to the propelling charge design expected to alter the ballistics.

4.3.1 Submission. The Contractor shall select three propellant granulations which, from experience and/or analysis, are expected to bracket the ballistic requirements of this specification. The contractor shall submit a preproduction sample as designated by the Contracting Officer for evaluation in accordance with 4.4.2, consisting of three pilot lots of between 350 and 450 kg each, representing the three candidate granulations.

4.3.2 Inspections to be performed. Each of the granulations comprising the preproduction sample and submitted in accordance with 4.3.1 shall be tested by the Government. Preproduction inspection shall consist of the tests specified in Table II.

TABLE II. Preproduction and quality conformance tests

Characteristic	Requirement	Test Method
Composition	3.2	4.6.1
Grain form and dimensions	3.4	4.6.2, 4.6.3
Glaze	3.5	4.6.3
Integrity	3.6	4.6.3
Stability	3.7	4.6.4
Packing depth	3.8	4.6.5
Velocity and pressure	3.9	4.6.6

4.3.3 Authorization. Government Engineering and Product Assurance personnel and the Contractor shall review the pilot lot test data and shall select a granulation size which best fits the requirements of this specification. The Technical Agency shall notify the Contracting Officer of the selected granulation. The Contractor shall request approval from the Contracting Officer to produce the selected granulation. If the pilot lots submitted to meet the requirements of this specification do not bracket the required performance, a new preproduction sample shall be submitted in accordance with 4.3.1. All future production lots shall be of the same basic granulation.

4.3.4 Failure. Failure of the sample to meet the requirements of this specification shall be cause for rejection of the preproduction sample.

4.4 Quality conformance inspection. Quality conformance inspection shall consist of the examinations and tests of 4.6 to determine conformance to the requirements of this specification. Failure of any sample to conform to any requirement specified herein shall be cause for rejection of the lot represented. Alternate methods and test procedures may be used provided prior written approval has been obtained from the procuring activity and the gun ammunition propelling charge design agent, Indian Head Division, Code 621, 101 Strauss Avenue, Naval Surface Warfare Center, Indian Head, Maryland. Requirements and their corresponding tests are summarized in Table II.

4.4.1 Lot size. Unless otherwise specified in the contract or purchase order, the propellant shall be produced in lots of not less than 10,000 nor greater than 250,000 kilograms (kg).

4.4.2 Sampling. The samples shall be selected from full Mark 7 boxes (Drawing 138439) or leverpaks (Drawing NOS 5755) so as to be representative of the lot. All samples shall be selected following the final packing of the lot. All samples shall be packed in moisture-proof airtight containers and marked with the following in accordance with MIL-STD-129:

a. Propellant description
b. Propellant lot number
c. Number of kilograms in lot
d. Manufacturer
e. Contact number
f. Net weight in container

4.4.2.1 For gun performance tests. Sample size shall be approximately 1100 kg randomly selected from full Mark 7 boxes or leverpaks.

4.4.2.2 For physical characteristic tests. A 5-kg sample shall be randomly selected from full Mark 7 boxes or leverpaks.

4.4.2.3 For surveillance tests. A 3-kg sample shall be randomly selected from full Mark 7 boxes or leverpaks and forwarded to the Navy's designated surveillance activity for propellants; Indian Head Division, Naval Surface Warfare Center, Attn: Code 621F, 101 Strauss Avenue, Indian Head, MD 20640-5035.

4.5 Classification of characteristics. The characteristics verified by the tests and examinations herein are classified as critical, major, or minor in accordance with DOD-STD-2101. Requirements for critical characteristics are identified by the symbol (C) and major characteristics by the symbol (M). The number following the classification symbol indicates the serial number of the characteristic. Requirements which are not annotated with a classification code are classified minor.

4.6 METHODS OF INSPECTION.

PRECAUTION - This specification covers sampling and testing of chemical, toxic or explosive materials which are potentially hazardous to personnel.

4.6.1 Ingredient analyses. The ingredients shall be analyzed as described in this section. The requirements of 3.2 shall be met or the ingredients shall not be used in making the propellant. Propellant made with ingredients which do not meet the requirements of 3.2 shall be rejected.

4.6.1.1 Nitrocellulose inspections.

4.6.1.1.1 Nitrogen content. The nitrogen content shall be determined using ASTM-D-4795. The requirements of 3.2.1.1 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.1.2 Viscosity. The viscosity shall be determined using ASTM-D-1343. The requirements of 3.2.1.2 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.1.3 Fineness. The fineness before dehydration shall be determined by taking a 10-ml specimen, previously dried at 100 ^{o} to 105^{o} C, and weighed to the nearest decigram, and placing that specimen in a 250-ml beaker. A 100 to 150-ml portion of distilled water shall be added and mixed gently rotating the beaker. The mixture shall be transferred to a 250-ml glass-stoppered measuring cylinder, graduated in 2-ml divisions over a length of approximately 25 cm. The beaker shall be rinsed several times with small washes of distilled water, adding each wash to that present in the cylinder until the suspension measures approximately 200 ml. The cylinder shall be stoppered and shaken vigorously with a vertical motion. The stopper shall be removed and the stopper and sides of the cylinder shall be rinsed down until the volume of the suspension reaches 250 ml. The stopper shall be replaced and the cylinder allowed to stand for one hour. At the end of this time, the volume in ml occupied by the nitrocellulose, shall be read and this value shall be considered as the fineness. The requirements of 3.2.1.4 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.1.4 Heat test. The stability of the nitrocellulose under mild heating shall be tested in accordance with MIL-N-244 section 4.4.8. The requirements of 3.2.1.5 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.1.5 Total volatiles. The total volatiles in the nitrocellulose shall be determined in accordance with MIL-N-244 section 4.4.9. The requirements of 3.2.1.6 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.2 RDX Inspections

4.6.1.2.1 Melting point. The melting point of the RDX shall be determined in accordance with ISO-1392. The requirements of 3.2.2.1 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.2.2 Acidity. The acidity of the RDX shall be determined in accordance with MIL-R-398 section 4.3.5. The requirements of 3.2.2.2 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.2.3 Particle size. A Microtrac analyzer shall be used for determining particle size. The requirements of 3.2.2.3 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.2.4 Purity. The amount of material insoluble in acetone and inorganic insolubles shall be determined in accordance with MIL-R-398 sections 4.3.2 and 4.3.3 respectively. The requirements of 3.2.2.4 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.3 Cellulose acetate butyrate (CAB) inspections

4.6.1.3.1 Butyryl, acetyl and hydroxyl content . Determine the butyryl, acetyl and hydroxyl contents using the method given in ASTM D 817 sections 13 through 39. The requirements of 3.2.3.1, 3.2.3.2 and 3.2.3.3 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.3.2 Free acidity. Determine free acidity as directed in ASTM D 817 sections 8 through 12. The requirements of 3.2.3.4 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.3.3 Ash. Determine ash content as directed in ASTM D 817 sections 6 and 7. The requirements of 3.2.3.5 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.3.4 Viscosity. Viscosity shall be determined by ASTM D 1343. The requirements of 3.2.3.6 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.3.5 Softening point. The softening point shall be determined with a hot stage melting point apparatus. The requirements of 3.2.3.7 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.3.6 Moisture. Determine the moisture content as directed in ASTM D 817 sections 4 and 5. The requirements of 3.2.3.8 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.4 Triethylene glycol dinitrate (TEGDN) inspections

4.6.1.4.1 Percent nitrate ester. The percent nitrate ester shall be determined as directed in MIL-STD-286 Method 209.3.2. The requirements of 3.2.5.1 for TEGDN shall be met or the material shall be rejected for use in making the propellant.

4.6.1.4.2 Acidity. The acidity shall be determined as directed in MIL-STD-286 Method 107.1 The requirements of 3.2.5.2 for TEGDN shall be met or the material shall be rejected for use in making the propellant.

4.6.1.4.3 Water. The water content shall be determined in accordance with ASTM D 1744. The requirements of 3.2.5.3 for TEGDN shall be met or the material shall be rejected for use in making the propellant.

4.6.1.4.4 Thermal stability. The thermal stability shall be determined in accordance with the method described in MIL-N-246 paragraph 4.3.4. The requirements of 3.2.5.4 for TEGDN shall be met or the material shall be rejected for use in making the propellant.

4.6.1.4.5 Stabilizer content. The stabilizer content shall be determined in accordance with MIL-STD-286 Method 208.4.1. The requirements of 3.2.5.5 for TEGDN shall be met or the material shall be rejected for use in making the propellant.

4.6.1.5 Ethyl centralite (EC) inspections

4.6.1.5.1 Solidification point. The solidification point shall be determined in accordance with the method described in MIL-E-255 paragraph 4.3.1. The requirements of 3.2.5.1 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.5.2 Melted material. The appearance of the melted material shall be determined visibly during the test of 4.6.1.5.1. The requirements of 3.2.5.2 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.5.3 Volatile matter. A weighed portion of approximately 5 grams of the sample shall be transferred to a tared shallow dish, heated for two hours at 60^{o}C, cooled in a desiccator and weighed. The loss in weight shall be calculated as percentage of volatile matter in the sample. The requirements of 3.2.5.3 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.5.4 Ash. The ash content shall be determined as directed in MIL-STD-286 method 106.1.2. The requirements of 3.2.5.4 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.5.5 Acidity. The acidity shall be determined in accordance with the method described in MIL-E-255 paragraph 4.3.6. The requirements of 3.2.5.5 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.5.6 Particle size. The particle size shall be determined in accordance with the method described in MIL-E-255 paragraph 4.3.8.1. The requirements of 3.2.5.6 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.6 Graphite inspections

4.6.1.6.1 Moisture. Moisture shall be determined in accordance with MIL-STD-286 method 101.2.2. The requirements of 3.2.6.1 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.6.2 Ash. The ash content shall be determined as directed in MIL-STD-286 method 106.1.2. The requirements of 3.2.6.2 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.6.3 Acidity. Acidity shall be determined by transferring a 10-gram sample of material to a 250-ml beaker, adding 100 ml of neutral distilled water and heating quickly to boiling while stirring. Filter immediately and cool to room temperature. Test the filtrate by adding two drops of phenolphthalein and then two drops of methyl red. If colorless to phenolphthalein and yellow to methyl red, acidity shall be reported as none. The requirements of 3.2.6.3 shall be met or the material shall be rejected for use in making the propellant.

4.6.1.6.4 Particle size. The particle size shall be determined in accordance with MIL-G-155 paragraph 4.3.8. The requirements of 3.2.6.4 shall be met or the material shall be rejected for use in making the propellant.

4.6.2 Chemical Composition. The chemical composition of the propellant shall be witnessed by certified production mix documentation. The requirements of 3.3 shall be met or the lot shall be rejected. A chemical analysis performed according to the methods cited in Table III shall be performed for information only.

TABLE III. Chemical analysis test methods.

Ingredient/Property	Test Method
RDX 5.5 μ Fluid Energy Milled (FEM)	MIL-P-70818 para 4.5.1.1
Cellulose acetate butyrate	MIL-P-70818 para 4.5.1.14
Nitrocellulose	MIL-P-70818 para 4.5.1.14
Triethylene glycol dinitrate	MIL-STD-286C Method 208.3.1
Ethyl Centralite	MIL-P-70818 para 4.5.1.1
Total volatiles	MIL-STD-286C Method T103.5
Graphite	MIL-STD-286C Method 308.1.4
Heat of Explosion1/	MIL-STD-286C Method 802.1
Density1/	MIL-STD-286C Method 510.3.1

1/ These tests are for informational purposes only; they are not requirements. Based on previous evidence, expected minimum Heat of Explosion is 860 calories/gram, and minimum Density is 1.640 grams per cubic centimeter.

4.6.3 Grain Dimensions. Grain dimensions shall be determined in accordance with MIL-STD-286, method 504.1.1 or 504.6.1. The requirements of 3.4 shall be met or the lot shall be rejected.

4.6.4 Visual Examination. The propellant grains selected for the physical characteristic tests shall be visually examined prior to conducting the physical characteristic tests (4.6.3 and 4.6.5) to verify that:

a. The grain form conforms to the requirements of 3.4 and 3.6.
b. The grains are uniformly coated with graphite, conforming to the requirements of 3.5.

4.6.5 Stability. Stability shall be determined in accordance with ASTM E 537. The requirements of 3.7 shall be met or the lot shall be rejected.

4.6.6 Packing Depth. The production packing depth (PPD) is the distance, measured to the nearest 3 mm, from the case mouth to the upper level of any given propellant charge in a loaded cartridge case. A chart of loading depth versus charge weight will be determined at the load, assemble and pack (LAP) facility by loading the lot on the same equipment as will be used to load the production charges. PPD is determined by pouring the propellant charge in the same manner as it will be loaded, i.e., from a height of approximately one and a half meters above the case mouth, through a tube only slightly larger than the case. The PPD must be determined for each lot of propellant by pouring three charges (the propellant for which has been preconditioned for a minimum of four days at 21°C $\pm$ 2°C) at each of three charge levels covering the range expected to be used in acceptance tests of the lot of propellant. A curve shall be fitted through the means of the data. The PPD associated with the charge weight assessed by the proving ground shall meet the requirements of 3.8 or the lot will be rejected.

4.6.7 Ballistic Testing

4.6.7.1 Warming or Conditioning Rounds. Warming or conditioning rounds shall be fired to stabilize gun temperature and to eliminate the biasing effects of firing the propellant at various charge levels or temperatures. The first round fired in a gun during a test is the warming round. The first round fired as part of a temperature conditioning group or charge level group wherein the velocity is expected to differ from the previous group by approximately 30 m/s or more is a conditioning round. Warming and conditioning rounds may have unusual ballistics and therefore the results are disregarded. These rounds are in addition to those specified in subsequent paragraphs.

4.6.7.2 Gun Performance Tests. All ballistic testing shall be conducted using fleet-released 5-inch, 62-caliber gun barrels which have met the acceptance criteria during proofing and which have a velocity loss of 15 m/s or less. The Mark 45 gun system shall be used. The non-test components (e.g.; case, primer, etc.) of the complete round of ammunition shall be from one acceptable lot per component and the cartridge shall be assembled in accordance with the applicable Naval Sea Systems Command drawing # 53711-x7263177, "Charge, Propelling, CARGO, Extended Range, Ex-175 Mod 0" (see 2.1). Deviations in propelling charge assembly shall consist of adjustment of charge weight/production packing depth (PPD) to vary ballistics. The projectiles shall be inert loaded and their weight shall be 31.75 ± 0.23kg. The ballistic test shall be performed on the preproduction and production lot except that:

a. For the preproduction sample, the test of 6.4 herein is mandatory.

b. For the production lot, the test of 6.4 herein shall be performed at the discretion of the government when the government deems the test necessary.

4.6.7.3 Charge Assessment. Charge assessment shall be accomplished by conducting the firing programs described below. Only one gun shall be fired each day and the velocities shall be corrected to the muzzle. The cases, primers and propellant for all propelling charges shall be preconditioned at 21°C ± 2°C for a minimum of fours days immediately prior to assembly and shall be fired at 21°C ± 2°C. Charges shall be loaded to yield the packing depth within 1 cm of that determined in 4.6.6 for the charge weight to be fired. For the verification firing program the cartridges shall be reconditioned after assembly for a minimum of 48 hours at 21°C ± 2°C prior to firing. For all tests, the cartridges shall be fired within five (5) minutes of removal from temperature conditioning.

4.6.7.3.1 Charge Weight Probe. A probing round firing program shall be conducted in an instrumented test mount to determine the estimated charge weight of the test propellant (TP) needed to match the required velocity. The test shall consist of firing a series of TP rounds wherein the TP charge is adjusted to vary the velocity. Sufficient rounds should be fired to obtain at least two rounds below and two rounds at or above the required velocity. An estimate shall be made from the TP velocity-charge data of the TP charge weight required to match the required velocity (C1). If the estimated pressure for the estimated TP charge, as determined from the pressure-charge data, exceeds the maximum service pressure limit of 3.9.2 by more than 11 MPa, the probing round program shall be repeated. If the estimated TP charge again has an estimated pressure which exceeds the maximum chamber pressure by 11 MPa, the lot of propellant shall be rejected without further testing.

4.6.7.3.2 Powder Proof Firings. A firing program shall be conducted in each of four gun barrels in the automatic Mk 45 gun system to determine the charge of the TP required to match the required velocity. Three TP charges at each of four charge levels shall be fired in each gun. The first TP charge (C_1) shall be that which was determined during the probing round test to match the required velocity. The second charge (C_2) shall be approximately 0.25 kg less than C_1 and third charge (C_3) shall be approximately 0.25 kg greater than C_1. The fourth charge or matching charge (MC) is that charge of the TP which is predicted to match the required velocity on that day in that gun.

4.6.7.3.3 Data Reduction. A linear, least squares equation shall be calculated for the velocity-charge data for each gun. The MC is determined by substituting the required velocity in the equation and solving for the charge weight.

4.6.7.3.4 Assessed Charges. The assessed charge (AC) shall be determined by using the formula:

$$AC = \frac{\sum_{i=1}^{4} (MC_i/?_i^2)}{\sum_{i=1}^{4} (1/?_i)^2}$$

where: MC = charge of the test propellant estimated to match the required velocity in the i^{th} gun.

$?_i$ = difference between the mean muzzle velocity obtained with the matching charge in the i^{th} gun and the required velocity. (If $?_i$ is zero, replace the zero with 1.) The velocity shall meet the requirements of 3.9.1

4.6.7.3.5 Charge Weight Validity. The validity of the assessed charge shall be determined by a firing program in any of the gun barrels used in the assessment firing from the test mount with cases instrumented with piezoelectric gauges for breech pressure measurement. The program shall consist of 10 TP rounds which have been assembled and preconditioned as noted above. Velocity measured in this test is for information only. This mean pressure determined in this program is considered to be the mean pressure of the charge. The mean pressure and pressure standard deviations shall meet the requirements of 3.9.2 and 3.9.4 respectively or the lot shall be rejected.

4.6.7.4 Velocity uniformity. The velocity standard deviation shall be determined from the matching charge data from each gun barrel. The velocity standard deviation shall meet the requirements of 3.9.3 or the lot shall be rejected. To calculate the velocity standard deviation, perform the calculations described in a through d.

a. Calculate the sum of the squares of the deviations from the mean for each gun.

b. Sum across the guns.

c. Divide by the quantity of the sum of the total number of rounds minus the number of guns.

d. Take square root to nearest unit of acceptance criteria.

4.6.8 Examination of Preparation for Delivery. Each unit of packaging shall be visually examined to ensure that containers are properly closed, labeled and free of major dents or breaks.

4.6.9 Relative quickness. Relative quickness of the propellant shall be conducted in a closed bomb as specified in MIL-STD-286, Method 801.1.2. The reference propellant shall be representative of the nominal composition of the propellant type to be tested. The "hot-wire" method of ignition may be used as an alternative to the "squib" method. This test is done for information only.

4.6.10 Interface tests. The procedure is described in the notes (see 6.4). For the preproduction lot the test is mandatory. For the production lot, the test shall be performed at the discretion of the Government.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be specified in the contract or order (see 6.2, 6.7). When actual packaging of material is to be performed by DOD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military's Department's System

Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

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 propellant covered by this specification is intended for use in the 5-inch, 62-caliber gun system. The charge is the Extended Range Propelling Charge for firing the CARGO Discarding Rotating Banded Projectile. This propellant is military unique because it is used in Navy ship's gun ammunition only and has no commercial application. This is a detail specification because it deals with an explosive material for which safety considerations are paramount. Development and qualification of the explosive required years of testing and evaluation to ensure that the material's sensitivity to handling stimuli is not overly high, that the material exhibits adequate stability and sufficient safe life and that it is chemically compatible with the other components of the propelling charge with which it may come in contact. Deviations from this specification, especially in the ingredients and composition, could incur severe explosive hazards.

6.2 Approved POP Packages. The currently approved POP packages for this material are the Mk 7 Powder Can, Drawing 138439 and the leverpak, Drawing 5755.

6.3 Ordering Data. Procurement documents should specify the following:

a. Title, number, and date of this specification

b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.1.2)

c. If preproduction is required and, if so, sample size (See 3.1 and 4.4.1)

d. Lot size if other than 4.5.1

e. Activity to conduct gun performance tests, generally Dahlgren Division, Naval Surface Warfare Center (see 4.7.7.2)

f. Packaging and marking considerations (see 5.1, 6.7)

g. Data required (see 6.4)

h. Activity to receive surveillance sample, generally Naval Surface Warfare Center, Indian Head Division (see 4.5.2.3)

6.3 Description Sheets and Test Reports

6.3.1 Propellant Description Sheets. The propellant manufacturer should furnish a propellant description sheet in accordance with MIL-STD-1171 giving a complete history of the manufacture of each propellant lot and the results of all tests performed on it. Unless otherwise specified, copies of each description sheet should be submitted to each of the following: The Navy's gun ammunition propelling charge design agent, Indian Head Division, Naval Surface Warfare Center (Code 621C), 101 Strauss Ave, Indian Head, MD 20640-5035; Crane Division, Naval Surface Warfare Center (Code 4025), Crane, IN 47522-5050; and to the activity designated to perform the gun performance tests (generally Dahlgren Division, Naval Surface Warfare Center, Code G61).

6.3.2 Gun Performance Test Reports. The activity which conducts the gun performance tests (4.7.6.2) should furnish a complete test report, including all test, gun, projectile, and cartridge components data. Unless otherwise specified, two copies of each test report should be submitted to the following: Crane Division, NSWC, Code 4025, Crane, IN 47522-5050; Indian Head Division, NSWC, Code 621, 101 Strauss Avenue, Indian Head, MD 20640-5053.

6.4 Propellant Interface Test. A test firing program should be conducted in an instrumented mount (instrumentation location to be as specified in NSWC, Dahlgren Laboratory - TOE Drawing 1002) on the preproduction lot to verify that there is no adverse primer-propellant relationship which could cause problems in the fleet. The test would consist of twelve data rounds utilizing the assessed charge weight from 4.6.7.8. Three rounds would be preconditioned for a minimum of 72 hours and fired at each of four temperatures: -7° $\pm$ 2° C, 10° $\pm$ 2° C, and 49° $\pm$ 2°C. In addition, a minimum of one data round per temperature of the applicable master propellant would be fired for comparison. The non-test components (e.g., case, primer, etc.) of the propelling charge and the propelled mass of 50.0 $\pm$ 0.1 kilograms would be from the same acceptable lots used for the ballistic tests (see 4.6.7.3). All rounds would be assembled in accordance with the applicable Naval Surface Warfare Center, Indian Head Division Propelling Charge Assembly drawing (see 2.1) except for the required instrumentation gauges. The analyses of the pressure-time plots would be performed by the Navy's gun ammunition propelling charge design agent, Code 621C, Indian Head Division, NSWC, Indian Head, Maryland. Subsequently, upon completion of analyses, the design agent would advise the Naval Surface Warfare Center, Crane Division in writing, of the results of these analyses.

6.5 Advisory. The average relative quickness value should be within 3.0 percent of the reference lot when measured in a closed bomb in order to be certain of meeting the required ballistics (see 4.7.9)

6.6 Safety Precautions. Safety precaution requirements of DOD 4145.26 M are applicable. Note: When this specification is used as part of work to be accomplished by a Government activity, the safety precaution requirements of OP 5 are applicable. For Army activities, the safety precautions of AMCR-385-100 are applicable.

6.7 Packaging

6.7.1 Packing. Packing should be level A. The propellant should be packed in accordance with the packing requirements of 49 CFR Part 171-178, which states that containers must be approved according to United Nations Performance Oriented Packaging (POP). (See 6.2)

6.7.2 Marking. In addition to any special marking required by the contract or order, shipping containers should be marked in accordance with the requirements of 49 CFR Part 171-178. Proper shipping name and serial number in accordance with CFR 49 is "PROPELLANT, SOLID, UN 0499". The appropriate United Nations Performance Oriented Packaging marking should be applied on side of container opposite the identification marking with letters .50 inches minimum height. Encirclement of U/N symbol should be sufficiently large to provide a minimum clear spacing around letters. (**) insert year packed.

6.8 Subject term (key word) listing.

Propelling Charge
5-inch
62 Caliber
Extended Range
CARGO

Preparing Activity:
Navy – OS
(Project 1376-0064)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	**1. DOCUMENT NUMBER** MIL-DTL-32040(OS)	**2. DOCUMENT DATE (YYMMDD)** 990319

PROPELLANT, GUN, HIGH ENERGY NITRAMINE

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON *(if applicable)*	**7.DATE SUBMITTED** (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE *Include Area Code)*
COMMANDER, INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER	(1) Commercial (301) 744-4700 (2) AUTOVON 354-4700
STANDARDIZATION TEAM (CODE 840M) 101 STRAUSS AVENUE INDIAN HEAD, MD 20640-5035	Defense Quality and Standardization Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533 Fort Belvoir, Virginia 22060-6221 (703) 767-6888 DSN: 427-6888