

INCH-POUND
MIL-G-47316A (MI)
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SUPERSEDING
MIL-G-47316 (MI)
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MILITARY SPECIFICATION

GRAPHITE, MOLDED, FOR HIGH TEMPERATURE APPLICATIONS

This specification is approved for use by the U.S. Army Missile Command, 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 defines the requirements of one type of molded graphite for high temperature applications.

1.2 Classification. The molded graphite is classified using the following styles:

- Style A - rectangular blocks
- Style B - cylindrical billets.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, U.S. Army Missile command, ATTN: AMSMI-RD-SE-TD-ST, Redstone Arsenal, AL 35898-5270 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 9390

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

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks 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).

STANDARDS

MILITARY

MIL-STD-129	-	Marking for Shipment and Storage
MIL-STD-130	-	Identification Marking of US Military Property

(Unless otherwise indicated, copies of the federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Ave., Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. 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 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).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 651	Flexural Strength of Manufactured Carbon and Graphite Articles Using Four-Point Loading at Room Temperature, Standard Test Method for
ASTM D 3951	Commercial Packaging, Standard Practice for

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

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(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 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.3) in accordance with 4.4.

3.2 Material. The material shall be graphite formed by the molding process from petroleum coke having a particle size not greater than 0.006 inch combined with coal tar pitch (see 4.7).

3.2.1 Dimensions. The dimensions of the graphite rectangular blocks and cylindrical billets shall be as specified in the contract or order (see 6.2).

3.3 Properties.

3.3.1 Apparent density. Apparent density of the graphite shall be not greater than 0.065 nor less than 0.060 ounce per 0.061 cubic inch (see 4.6.2).

3.3.2 Specific resistance. Specific resistance of the graphite shall be not greater than 13.0×10^{-4} ohm - centimeter (ohm - cm) with the grain and not greater than 17.0×10^{-4} ohm - cm across the grain (see 4.6.3).

3.3.3 Flexural strength. Flexural strength of the graphite shall be not less than 2600 pounds force per square inch (lbf/in²) with the grain and not less than 2400 lbf/in² across the grain (see 4.6.4).

3.3.4 Ash content. Ash content of the graphite shall be not greater than 0.25 percent (see 4.6.5).

3.4 Marking. Each block or billet of graphite specified herein shall be permanently marked in accordance with MIL-STD-130 with the following information:

- a. Title, number and date of this specification
- b. Part number

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- c. Supplier's name, address, and material designation.
- d. Purchase order number
- e. Lot number
- f. Weight and size of block or billet.

3.4.1 Identification. Rectangular blocks and cylindrical billets shall be color-coded red on each end. The with-grain direction shall be marked with an arrow in accordance with figure 1.

FIGURE 1. Graphite block and billet test specimens.

3.5 Workmanship. The graphite shall be manufactured to assure uniform material free from visual cracks or other defects that would prevent its use for the purpose intended.

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

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any of the inspections set forth in the 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 4.5).

4.3 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in applicable test methods documents and as specified herein.

4.3.1 Ambient conditions. Unless otherwise specified, all inspections and tests shall be conducted at room temperature between 20.9 and 31.9° Celsius (C) and at standard atmospheric pressure.

4.4 First article inspection. When specified in the contract or order (see 6.2), a first article sample consisting of ten blocks or billets shall be subjected to first article inspection as specified in table I. Subsequent units shall not be considered for acceptance until government approval of the first article sample has been obtained (see 3.1 and 4.2).

TABLE I. First article inspection.

Inspection	Requirement paragraph	Test paragraph
Apparent density	3.3.1	4.6.2
Specific resistance	3.3.2	4.6.3
Flexural strength	3.3.3	4.6.4
Ash content	3.3.4	4.6.5
Certification	3.2	4.7
Workmanship	3.4	4.6.1

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4.5 Quality conformance inspection. Quality conformance inspections shall be as specified in table II (see 4.2).

TABLE II. Quality conformance inspection.

Inspection	Requirement paragraph	Test paragraph
Workmanship	3.4	4.6.1
Apparent density	3.3.1	4.6.2

4.5.1 Lot formation. The sample selected shall consist of a random selection of 10 percent of the lot but not less than one block or billet, as specified in the contract or order (see 6.2). A lot shall consist of graphite of one shape produced by one manufacturer, in one unchanged process, using the same materials and methods and offered for acceptance at one time. The lot size shall be not greater than 100 blocks or billets.

4.5.2 Sampling. The sample selected shall represent only that quantity of units from which the sample was drawn and shall not be construed to represent any prior or subsequent quantities presented for inspection. The sample shall be subjected to inspections specified in tables II and III.

TABLE III. Sample inspection.

Inspection	Requirement paragraph	Test paragraph
Specific resistance	3.3.2	4.6.3
Flexural strength	3.3.3	4.6.4
Ash content	3.3.4	4.6.5

4.6 Methods of inspection.

4.6.1 Examination. Unless otherwise specified, samples shall be visually examined with an unaided eye to determine conformance to 3.4.

4.6.2 Apparent density. Apparent density shall be determined in accordance with the following to determine conformance to 3.3.1:

- a. Measure each dimension of the full block or billet to the nearest 0.03 inch in three or more places.
- b. Average each dimension and calculate the volume of the block or billet based on the average dimensions.
- c. Weigh the block or billet to the nearest 0.25 pound.

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- d. Calculate apparent density as follows:

$$\text{Apparent density, lbs/in}^3 = \frac{M}{V}$$

Where: M = weight of sample, pounds

V = volume of sample, cubic inches

- e. Report the apparent density of each block or billet in the lot.

4.6.3 Specific resistance. Specific resistance shall be determined in accordance with the following to determine conformance to 3.3.2:

- a. Assemble specific resistance testing apparatus as shown in figure 2.

FIGURE 2. Specific resistance test arrangement.

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- b. Balance the potentiometer according to the manufacturer's instructions.
- c. Use specimens A for with-the-grain determinations and specimens B for across-the-grain determinations (see figure 1).
- d. Place a weight of approximately five pounds on the center of the specimen to assure contact of the potential points.
- e. Determine the current passing through the test specimen.
- f. Determine the voltage drop across the potential points.
- g. Calculate specific resistance as follows:

$$\text{Specific resistance, } 10^{-4} \text{ ohm-cm} = \frac{E \times A}{I \times L}$$

Where: A = cross-sectional area, square cm

 L = length of conductor, cm

 E = potential difference, volts

 I = current, amperes

- h. Report the average of the results for specimens A (with grain) and the average for specimens B (across grain) for each block or billet.

4.6.4 Flexural strength. Flexural strength (see 3.3.3) shall be determined in accordance with ASTM C 651 and the following:

- a. Optional construction of the loading head and bed of the testing machine shall be permissible provided the distances between supports and points of load application are maintained and the application of load and directions of reactions are not affected.
- b. The contact surface of each load applying and load receiving block shall be cylindrical or have a 0.03 inch wide flat surface. (No sharp edges are permitted.)
- c. Only specimens that fracture within the middle third of the span length shall be considered valid tests.
- d. Use specimens A for with-the-grain determinations and specimens B for across-the-grain determinations.

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- e. Report the average of the results with-the-grain and the average across-the-grain for each sample block or billet.

4.6.5 Ash content. Ash content shall be determined in accordance with the following using composited pieces of test specimens from the flexural strength test to determine conformance to 3.4.4:

- a. Weigh a sample of approximately 10 g, to the nearest milligram (mg), into a tared 100 cubic centimeter (cc) platinum or porcelain crucible.
- b. Place the weighed sample in a muffle furnace and heat the sample to a temperature of 800 to 900° Celsius (C) for not less than 24 hours. To prevent ash fusion, temperature shall be not greater than 900°C.
- c. Allow the crucible and sample to cool to room temperature in a desiccator.
- d. Examine the residue for traces of carbon. If carbon is present, continue ignition until ashing is complete.
- e. Transfer the sample residue to a desiccator and allow to stand for not less than 1 hour before weighing.
- f. Weigh the residue to the nearest 0.1 mg.
- g. When there is no further visual evidence of carbon, repeat the ignition for 1 hour periods at 800 to 900° C until a constant weight is obtained.
- h. Calculate ash content as follows:

$$\text{Ash content, percent} = \frac{\text{ash weight}}{\text{sample weight}} \times 100$$

- i. Report the average of not less than two determinations for each sample block or billet.

4.7 Certification. The supplier shall certify, if specified in the contract or order (see 6.2), that the material is in conformance to 3.2.

4.8 Inspection of packaging. The sampling and inspection of the preservation, packaging, and container marking shall be in accordance with ASTM D 3951, MIL-STD-129 and MIL-STD-130 (See 3.4, 3.4.1, and section 5).

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5. PACKAGING

5.1 Preservation, packaging and packing. Preservation, packaging and packing shall be level C in accordance with ASTM D 3951.

5.2 Marking. Marking shall be in accordance with MIL-STD-129, MIL-STD-130 and conform to the requirements of 3.4 and 3.4.1.

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 graphite specified herein is intended for use in rocket motor nozzle components.

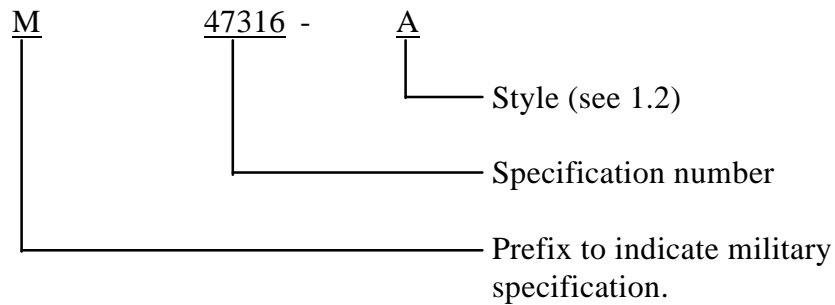
6.2 Acquisition requirements. Acquisition documents must specify the following:

- 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 2.1.1 and 2.2)
- c. When first article is required (see 3.1 and 4.4)
- d. Lot size for sample inspection (see 4.5.1)
- e. When certification of material is required (see 4.7)
- f. Dimension of blocks and billets (see 3.2.1).

6.3 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerers whether the item(s) should be a first article sample, a first production item, or a number of items to be tested as specified in 4.4. The contracting officer should 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.

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6.4 Part or identifying number (PIN). The PIN to be used for the graphite acquired to this specification is created as follows:



6.5 Metrication. Metric equivalents in accordance with FED-STD-376 are acceptable for use in this specification.

6.6 Subject term (key word) listing.

Black lead
Carbon
Lubricant
Plumbago

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

Custodian:
Army - MI

Preparing Activity:
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