

INCH-POUND

MIL-DTL-15606J

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SUPERSEDING

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DETAIL SPECIFICATION

BRICKS, REFRACTORY, AND BURNER TILE,
NAVAL BOILER FURNACE LINING QUALITY

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

1. SCOPE

1.1 Scope. This specification covers refractory brick and burner tile and lining for Naval boiler furnaces.

1.2 Classification. Refractory brick will be of the following grades, as specified (see 6.2). Applicable ASTM C27 Group Classification is shown in parenthesis.

1.2.1 Grades.

Grade AA – 65 to 90 percent Alumina (High Alumina)

Grade A – Alumina (60 percent High-Alumina)

Grade B – Super Duty (Fireclay Brick)

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 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 of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Other Government documents, drawings, and publications. The following other Government drawings form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

NAVSHIPS 810-1385708 - Burner Tile, Refractory, for Marine Boilers

NAVSHIPS S5102-1385784 - Brick, Refractory, for Marine Boilers

(Copies of these documents are available from the applicable repositories listed in NAVSEA S0005-AE-PRO-010/EDM. Copies of NAVSEA S0005-AE-PRO-010/EDM are available from the Naval Logistics Library, 5450 Carlisle Pike, Mechanicsburg, PA 17055 or online at <https://nll.ahf.nmci.navy.mil>.)

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.

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2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/ASQ Z1.4 - Sampling Procedures and Tables for Inspection by Attributes

(Copies of this document are available from the American National Standards Institute, 25 W. 43rd St, 4th Floor, New York, NY 10036 or online at <http://webstore.ansi.org/>.)

ASTM INTERNATIONAL

ASTM C24 - Standard Test Method for Pyrometric Cone Equivalent (PCE) of Fireclay and High Alumina Refractory Materials

ASTM C27 - Standard Classification of Fireclay and High Alumina Refractory Brick

ASTM C113 - Standard Test Method for Reheat Change of Refractory Brick

ASTM C133 - Standard Test Methods for Cold Crushing Strength and Modulus of Rupture of Refractories

ASTM C134 - Standard Test Methods for Size, Dimensional Measurements, and Bulk Density of Refractory Brick and Insulating Firebrick

(Copies of these documents are available from ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 or online at www.astm.org.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 12677 - Chemical Analysis of Refractory Products by X-ray Fluorescence (XRF) - Fused Cast-bead Method

ISO 21587-1 - Chemical Analysis of Aluminosilicate Refractory Products (Alternative to the X-ray Fluorescence Method) - Part 1: Apparatus, Reagents, Dissolution and Gravimetric Silica

ISO 21587-2 - Chemical Analysis of Aluminosilicate Refractory Products (Alternative to the X-ray Fluorescence Method) - Part 2: Wet Chemical Analysis

ISO 21587-3 - Chemical Analysis of Aluminosilicate Refractory Products (Alternative to the X-ray Fluorescence Method) - Part 3: Inductively Coupled Plasma and Atomic Absorption Spectrometry Methods

(Copies of these documents are available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56 CH-1211 Geneva 20, Switzerland or online at www.iso.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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 in accordance with 4.1.

3.2 Composition. The brick or tile shall be composed of heat-resistant clays or processed aluminum silicate minerals which have been burned or fired to produce the desired properties. Group classification based on composition is in accordance with ASTM C27.

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3.3 Dimensions. Refractory brick (henceforth known as brick) shall be furnished in the dimensions specified (see 6.2), and shall conform to S5102-1385784 for shapes shown thereon. Burner tile shall be furnished in dimensions specified (see 6.2), and shall conform to 810-1385708 for shapes shown thereon. Brick (including those with anchor bolt recesses) are described as standard shapes (see 3.4.1, 4.5.1, and 6.2). Other brick and burner tile are described as special shapes (see 3.4.2, 3.4.3, and 6.2).

3.4 Tolerances.

3.4.1 Standard shape brick. Length, width, and thickness of standard rectangular refractory brick (including those recessed for anchor bolts), as shown on S5102-1385784, shall be within the limits specified in [table I](#) (see 4.5.4.1 and 6.2).

TABLE I. Allowable dimensions of standard shape brick.

Nominal dimensions (inches)	Minimum (inches)	Maximum (inches)
Length		
13 ⁹ / ₁₆	13.36	13.77
9	8.86	9.14
Width		
6 ³ / ₄	6.62	6.88
4 ¹ / ₂	4.41	4.59
2 ¹ / ₄	2.20	2.30
Thickness		
2 ¹ / ₂	2.44	2.57
1 ¹ / ₄	1.19	1.31
2	1.94	2.06

3.4.2 Special shape brick. Special shape brick shall not deviate from specified dimensions more than ± 2 percent on dimensions of 4 inches or greater, or ± 3 percent on dimensions less than 4 inches (see 4.5.4.2 and 6.2).

3.4.3 Burner tile. Burner tile shall conform to the dimensions and tolerances shown on 810-1385708. Non-parallelism of abutting tile faces, arranged as shown on [figure 1](#), shall not exceed $\frac{1}{8}$ inch (see 4.5.4.3 and 6.2).

3.5 Warpage.

3.5.1 Standard shape brick. Any gap between adjacent, stacked standard shape brick shall not exceed $\frac{3}{32}$ inch (see 4.5.5.1).

3.5.2 Special shape brick. Special shape brick shall be free of swells, warps, and distortions that would prevent ready and accurate laying up with a maximum joint gap of $\frac{1}{8}$ inch (see 4.5.5.2).

3.5.3 Burner tile. Burner tile shall be free of swells, warps, and distortions that would prevent ready and accurate laying with a maximum joint thickness of $\frac{1}{8}$ inch between abutting surfaces. A straight edge laid along the longest dimension on the working face of the tile shall not reveal warpage greater than $\frac{1}{8}$ inch (see 4.5.5.3).

3.6 Marking. The grade designation, "AA", "A", or "B", and the brand (or such name or symbol as will serve to identify the manufacturer) shall be molded into each brick or tile (see 4.5.2 and 6.2). As an alternate method (for grade designations only), the grade designations may be stamped with permanent ink on each brick.

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3.7 Grade AA, 65 to 90 percent alumina.

3.7.1 Modulus of rupture. The modulus of rupture shall average not less than 600 pounds per square inch (lb/in²) and no single specimen shall be less than 300 lb/in² (see 4.6.4).

3.7.2 Dimensional stability. The stability value shall not exceed 0.75 percent. Expansion, if any, in the length dimension shall not exceed 1 percent. Shrinkage, if any, in the length dimension shall not exceed 0.75 percent (see 4.6.5).

3.8 Grade A, alumina.

3.8.1 Alumina. The alumina content shall be not less than 57.5 percent (see 4.6.1).

3.8.2 Pyrometric cone equivalent (PCE). The PCE shall be not less than cone number 35 (3245 °F) (see 4.6.2). Grade A PCE testing is only required for the initial first article testing of a manufacturer's brand performed in accordance with MIL-DTL-15606.

3.8.3 Permanent volume change. The permanent volume change after reheating at 2910±10 °F for 5 hours shall be not greater than +3 nor less than -1 percent after the first reheat. The brick shall not expand nor shrink more than an additional 1 percent by volume between the first and third reheat (see 4.6.3).

3.8.4 Modulus of rupture. The modulus of rupture shall average not less than 500 lb/in² for bricks only and no single specimen shall be less than 250 lb/in² (see 4.6.4).

3.9 Grade B, super duty.

3.9.1 Pyrometric cone equivalent. The PCE shall not be less than cone number 33 (3170 °F) (see 4.6.2).

3.9.2 Permanent volume change. The permanent volume change after reheating at 2910±10 °F for 5 hours shall be not greater than +3 nor less than -1 percent (see 4.6.3).

3.9.3 Modulus of rupture. The modulus of rupture shall average not less than 600 lb/in² and no single specimen shall be less than 250 lb/in² (see 4.6.4).

3.10 Burner tile. Burner tile shall be of the same quality material and processing as Grade A brick.

3.10.1 Permanent linear change. The permanent linear change after reheating at 2910±10 °F for 5 hours shall be not more than 1 percent after the first reheat. The sample shall not shrink more than an additional 1 percent in linear dimension between the first and third reheat (see 4.6.6).

3.11 Workmanship.

3.11.1 Brick. The bricks shall be compact, homogenous in structure, and free from voids, soft centers, and cracks greater than 1 inch or 10 percent of the brick length (whichever is greater) and that are greater than 0.01 inch in width. No crack depth shall exceed ¼ inch. Crack-like defects that appear to jeopardize the structural integrity of the brick are not acceptable. Cracks shall not extend beyond one brick surface (extend around corners). The following are not considered cracks: crazing (surface cracking), blemishes less than ⅜ inch length that do not meet crack depth of ¼ inch, discontinuous grain boundaries, and any feature so small (less than ⅜ inch deep) or indistinct to the naked eye that it cannot clearly meet crack criteria. Crumbling or chipping at corners and edges shall not exceed ⅜ inch (see [figure 2](#)). Corners and edges shall be sufficiently solid and strong to prevent more than ⅜ inch crumbling or chipping when thumb pressure is applied (see 4.5.3). Defects on the working surface itself shall not exceed ½ inch in depth by 1 inch in length. Buried surfaces of brick shall have the same criteria for crumbling or chipping at corners as shown for the working surface. Defects on the buried surfaces shall not exceed ¼ inch in depth by 1 inch in length.

3.11.2 Burner tile. The burner tiles shall be compact, homogenous in structure, and free from voids, soft centers, and cracks as described in 3.11.1.

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3.11.2.1 Working surfaces. Crumbling or chipping at corners and edges of working surfaces shall not exceed ¼ inch (see [figure 3](#)). Corners and edges shall be sufficiently solid and strong to prevent more than ¼ inch crumbling or chipping when thumb pressure is applied. At feather edges where anchor bolt holes are close to the burner throat, crumbling or broken out areas are allowable to a maximum of ½ inch in depth (see 4.5.3).

3.11.2.2 Buried surfaces. At buried surfaces (see 6.11.1 and [figure 3](#)), crumbling or chipping of edges and corners shall not exceed ½ inch in depth. Defects on the surface itself shall not exceed ¼ inch in depth by 1 inch in length.

3.11.3 Branding. The indented or formed symbol or lettering denoting the manufacturer shall be legible.

3.12 Spall resistance. Products provided under this specification shall be spall resistance in accordance with best industry practices for the intended use (see 4.8). As guidance, a range of physical properties is shown in 6.1

3.13 Toxicity. When evaluated in accordance with 4.7, the brick and tile shall have no adverse effect on the health of personnel when used for their intended purpose and shall not cause any environmental problems during waste disposal (see 4.7 and 6.8).

4. VERIFICATION

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

- a. First article (see 4.3).
- b. Conformance inspection (see 4.4).

4.2 Sample size. Sampling for first article and conformance inspection shall be performed in accordance with ANSI/ACQ Z1.4 and table II. For purposes of sampling, an inspection lot for examinations and tests shall consist of all material of the same grade, size, and shape offered for delivery at one time. Unless otherwise specified (see 6.2), the unit of sample shall be one brick or one tile.

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TABLE II. Sampling for first article and conformance inspection.

Inspection	Test paragraph	Inspection level
Workmanship	4.5.3	S-1
Dimension		
Standard shape brick	4.5.4.1	S-3
Special shape brick	4.5.4.2	S-3
Burner tile	4.5.4.3	^{1/}
Warpage		
Standard brick	4.5.5.1	^{1/}
Special shape brick	4.5.5.2	^{1/}
Burner tile	4.5.5.3	^{1/}
Chemical analysis	4.6.1	^{1/}
Pyrometric cone equivalent	4.6.2	^{1/}
Permanent volume change	4.6.3	^{1/}
Modulus of rupture	4.6.4	^{1/}
Stability	4.6.5	^{1/}
Permanent linear change	4.6.6	^{1/}
NOTE:		
^{1/} Sample size and accept or reject criteria as specified in test paragraph and contract.		

4.3 First article inspection. First article inspection shall include the examinations of 4.5 and the tests of 4.6, as specified in [table III](#) (see 3.1 and 6.2).

TABLE III. First article inspection.

Test	Test paragraph	Requirement paragraph
Visual Examination	4.5.3	3.3 to 3.6 and 3.11
Chemical analysis	4.6.1	3.8.1 or 3.10
Pyrometric cone equivalent	4.6.2	3.8.2 ^{1/} or 3.9.1
Permanent volume change	4.6.3	3.8.3 or 3.9.2
Modulus of rupture	4.6.4	3.7.2 or 3.8.4 or 3.9.3
Stability	4.6.5	3.7.2
Permanent linear change	4.6.6	3.10.1
NOTE:		
^{1/} The PCE test for Grade A brick (or tile) is required for the initial first article test in accordance with 3.8.		

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4.4 Conformance inspection. Conformance inspections shall include the tests of 4.6, as specified in [table IV](#).

TABLE IV. Conformance inspection.

Test	Test paragraph	Requirement paragraph
Chemical analysis	4.6.1	3.8.1
Pyrometric cone equivalent	4.6.2	3.9.1
Permanent volume change	4.6.3	3.8.3 or 3.9.2
Modulus of rupture	4.6.4	3.7.1 or 3.8.4 or 3.9.3
Stability	4.6.5	3.7.2
Permanent linear change	4.6.6	3.10.1

4.5 Visual examinations.

4.5.1 Shape. Shape of the brick or tile shall be visually examined to conform to 3.3.

4.5.2 Marking. Marking of brick or tile identification shall be visually examined to determine that the marking is legible and correct and conforms to 3.6.

4.5.3 Workmanship. Workmanship shall be examined visually and shall conform to 3.11.

4.5.3.1 Multiple defects. Any individual brick or burner tile with a defect exceeding 3.11.1 and 3.11.2 limits shall be cause for rejection. Any brick or burner tile with three or more of the 3.11.1 and 3.11.2 type defects readily apparent and approaching those limits (within $\frac{2}{3}$ of the stated corner and edge loss) shall be cause for rejection; when those defects occur on the working surface of brick or burner tile, two defects shall be cause for rejection.

4.5.3.2 Branding defects. If brand inserts are used in die plates, there shall be no raised surface on the pressed piece nor shall they be depressed into the brick or tile more than $\frac{1}{16}$ inch, or it shall be cause for rejection.

4.5.4 Dimensions.

4.5.4.1 Standard shape brick. Standard shape brick shall be verified in accordance with the applicable drawing using C134 methods, and shall be within the limits as specified in [table I](#) (see 3.4.1 and 6.2).

4.5.4.2 Special shape brick. Special shape brick dimensions shall be within the limits using C134 methods as specified (see 3.4.2 and 6.2).

4.5.4.3 Burner tile. On a flat surface, a sufficient number of tiles shall be assembled to form a simulated burner assembly, with a $\frac{1}{16}$ -inch spacer at each tile-to-tile joint. Dimensions A through E shall be measured as specified (see [figure 1](#)), at three or more positions for each dimensions on the assembly in accordance with corresponding dimensions as specified on 810-1385708. See 810-1385708 for additional dimensional guidance (see 3.4.3 and 6.2).

4.5.5 Warpage.

4.5.5.1 Standard shape brick. Ten bricks shall be placed on a plane surface with the thickness dimension vertical. The bricks shall be stacked such that the branded surface is alternated. That is, counting up the ten brick stack, the odd number bricks shall have the branded surface up; the even number bricks the branded surface down. If the gap between any two adjacent bricks exceeds $\frac{3}{32}$ inch, then a second stack of 10 bricks erected in the same manner shall be inspected. A gap between any two adjacent bricks that exceeds $\frac{3}{32}$ inch on any four sides shall be cause for rejection of the lot (see 3.5.1).

4.5.5.2 Special shape brick. When surfaces of two special shape bricks are laid together (as they would be in a furnace application) non-parallelism of the two surfaces that exceeds $\frac{1}{8}$ inch (see 3.5.2) shall be cause for rejection of the lot.

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4.5.5.3 Burner tile. Abutting tile faces shall be inspected for non-parallelism greater than $\frac{1}{8}$ inch (see [figure 1](#)). A straight edge laid along the longest dimension on the working face of the tile shall not reveal warpage greater than $\frac{1}{8}$ inch (see 3.5.3 and refer to ASTM C134 test method for Procedure and Apparatus for measuring warpage of refractory brick). Warpage greater than $\frac{1}{8}$ inch shall be cause for rejection of the lot.

4.6 Tests.

4.6.1 Chemical analysis. Alumina content of 57.5 percent for Grade A brick or tile shall be determined for two bricks or tiles in accordance with ISO 12677 or ISO 21587 (see 3.8.1). If both bricks or tiles fail, the lot shall be rejected without retest. If either fails, three additional bricks or tiles shall be tested. If any one of the three retest bricks or tiles fails, this shall be cause for rejection of the lot.

4.6.1.1 Chemical certification. Certification of chemical analysis may be presented in lieu of chemical analysis for those lots presented within 3 years of the previous acceptable analysis.

4.6.2 Pyrometric cone equivalent (grade A or B). Two test cones shall be made from two Grade A or Grade B bricks or two tiles and tested in accordance with ASTM C24. If both cones fail, the lot shall be rejected without retest. If either fails, three additional cones shall be made and tested, one from each of the additional bricks. If any one of the three retest cones fails, this shall be cause for rejection of the lot (see 3.8.2 or 3.9.1).

4.6.3 Permanent volume change (grades A and B only). Three test bricks measured to the nearest 0.01 inch shall be placed in a gas-fired furnace and the temperature gradually raised to 2910 ± 10 °F. This temperature shall be maintained for 5 hours, after which the furnace shall be allowed to cool to room temperature. The bricks shall be again measured and the change computed. Grade A brick shall be given three cycles of this heat treatment and Grade B one cycle. If three samples are not in accordance with 3.8.3 or 3.9.2, as applicable, a retest shall be made on six additional bricks of the sample. Unless otherwise specified (see 6.2), if any sample fails to conform to this specification, this shall be cause for rejection of the lot.

4.6.4 Modulus of rupture. Modulus of rupture shall be determined on five sample bricks in accordance with ASTM C133. If these samples are less than specified in 3.7.1, 3.8.4, or 3.9.3, as applicable, a retest shall be made on five additional bricks. Unless otherwise specified (see 6.2), if any sample fails to conform to this specification, this shall be cause for rejection of the lot.

4.6.5 Stability (grade AA only). Three test bricks shall be measured in length and width to the nearest 0.01 inch. The length dimension, if greater than 9 inches, shall be cut to 9 inches for this test. The brick shall be placed, lying on a $4\frac{1}{2}$ by $2\frac{1}{2}$ -inch end, in a gas-fired furnace and the temperature gradually raised to 3000 ± 10 °F. The temperature shall be maintained for 5 hours, after which the furnace shall be allowed to cool to room temperature. The brick shall be measured, and the changes in length and width dimension shall be calculated as percent to the original dimensions. The stability value is calculated by subtracting the percent change in length from the percent change in width, except that negative width changes (indicating shrinkage) shall be adjusted to zero before calculating stability value. If these three samples are not in accordance with 3.7.2, a retest shall be made on each of six additional bricks of the sample. Unless otherwise specified (see 6.2), if bricks fail to conform to this specification, this shall be cause for rejection of the lot.

4.6.6 Permanent linear change, burner tile only. Permanent linear change shall be determined in accordance with ASTM C133, or as specified below. If three samples are not in accordance with 3.10.1, a retest shall be made on each of six additional tiles of the sample. Unless otherwise specified (see 6.2), if the tiles fail to conform to this specification, this shall be cause for rejection of the lot.

a. Cut three sample tiles using a masonry saw so as to provide, from each, a specimen having parallel ends approximately 9 inches apart (or as near 9 inches as possible) and perpendicular to a flat surface.

b. Measure the lengths of the three specimens before and after heating. Measurements shall be to the nearest 0.01 inch using a vernier caliper or dial gage device. Specimens shall be heated at 2910 ± 10 °F according to schedule C of ASTM C113. Calculate the percentage linear change based on the original length of each specimen.

c. Each specimen shall be given three cycles of this heat treatment (see 3.10.1).

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4.7 Toxicity. The brick and tile shall be evaluated by the Navy and Marine Corps Public Health Center (NMCPHC) using the administrative Health Hazard Assessment (HHA). Sufficient data to permit an HHA of the product shall be provided by the manufacturer/distributor to the NMCPHC. To obtain current technical information requirements specified by the NMCPHC, see 6.9.

4.8 Spalling. Although there are no test requirements for resistance to spalling, the same level of spalling resistance is required as for previously supplied products. Where previously supplied products have historically proven acceptable with regard to spalling resistance, similar grain size, apparent porosity, density, additives, and formulations of the brick, shall be supplied, provided the brick otherwise conforms to current specification requirements.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. 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. Refractory bricks and burner tile covered by this specification are intended for use in industrial and naval main propulsion boilers. Brickwork in naval main propulsion boilers is subjected to rapid change in temperature during frequent light-off and securing cycles that will cause thermal spalling. The purpose of the refractory bricks and burner tile is to provide structural stability and protection of back-up insulation from maximum temperatures, flame erosion, slag attack, and rapid temperature changes. Grade A firebrick is more heat resistant than Grade B. However, Grade A will not be superior to Grade B in all applications. Factors adversely affecting Grade A are slightly greater thermal expansion and thermal conductivity, and less spall resistance. The major advantage of Grade B is that under slag attack a gradual wearing away results, as opposed to significant sudden losses of up to ½ inch that can occur using Grade A or AA brick. The use of distillate fuels has eliminated this advantage of Grade B. Grade AA is intended as an upgrade for Grade A when high furnace temperatures require better refractory (heat resistant) properties than Grade A. NAVSEA approved refractory arrangement drawings should be used to determine firebrick grades for various boiler locations. The physical properties of the brick grades covered by this specification are shown in [table V](#).

TABLE V. Physical properties of brick grades.

Grades	Apparent porosity (%)	Density (lb/ft ³)
Grade AA	18 to 26	152 to 190
Grade A	15 to 29	149 to 181
Grade B	14.5 to 19	134 to 167

6.2 Acquisition requirements. Acquisition documents should specify the following:

- Title, number, and date of this specification.
- Grade, as applicable to be furnished (see 1.2).
- When a sample should be subjected to first article inspection (see 3.1). First article testing can be waived if previously performed by the manufacturer within a 3-year period when there has been no change in manufacturing location, fabrication procedures, or source of basic fire brick raw materials since the earlier test.

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- d. When the Acceptance Quality Levels (AQL) of 2.5 can be used for workmanship (see 4.5.4), inspection level S-1, and AQL 2.5 can be used for dimensional verification tests (see 4.5.4.1 and 4.5.4.2), inspection level S-3.
- e. When 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.
- f. Dimensions and shape of brick and burner tile as specified on applicable drawings; special shapes of burner tile as specified (see 3.3 and 4.5.1).
- g. Tolerance of brick as specified on the applicable drawing (see 3.4.1 and 4.5.4.1).
- h. Special shape brick and dimensions as specified (see 3.4.2 and 4.5.4.2).
- i. Dimensions and tolerance of burner tile as specified on the applicable drawings (see 3.4.3 and 4.5.4.3).
- j. Special marking and palletization if required (see 3.6, 4.5.2, and 6.8).
- k. When the unit of sample is other than one brick or one tile (see 4.2).
- l. When the average of nine samples during the permanent volume change test is permitted to determine rejection of the lot (see 4.6.3).
- m. When the average of ten samples during the modulus of rupture test is permitted to determine rejection of the lot (see 4.6.4).
- n. When the average of nine bricks during the stability test is permitted to determine rejection of the lot (see 4.6.5).
- o. When the average of nine tiles during the permanent linear change test is permitted to determine rejection of the lot (see 4.6.6).
- p. Sample shipping containers as specified (see 6.7.1 and 6.7.2).
- q. Level of packing required, including method of waterproofing pallets if required (see 6.8.2).
- r. If palletization is required for Level A (see 6.8.2.1).
- s. Additional requirements for Certificates of Compliance (see 6.5 and 6.10), Reference to Navy Data Item Description DI-MISC-81356 or similar data requirement for content and format.

6.3 Applicable documents.

6.3.1 General. The documents listed in this section are specified in section 6 only of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples.

6.3.2 Government documents.

6.3.2.1 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 cited in the solicitation or contract.

FEDERAL SPECIFICATIONS

NN-P-71 - Pallets, Material Handling, Wood, Stringer Construction, 2-Way and 4-Way (Partial)

FEDERAL STANDARDS

FED-STD-313 - Material Safety Data, Transportation Data, and Disposal Data for Hazardous Materials Furnished to Government Activities

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-129 - Military Marking for Shipment and Storage

MIL-STD-147 - Palletized Unit Loads

MIL-STD-2073-1 - Standard Practice for Military Packaging

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(Copies of these documents are available online at <https://assist.dla.mil/quicksearch/> or <https://assist.dla.mil/>.)

6.3.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

- ASTM D1974/D1974M - Standard Practice for Methods of Closing, Sealing, and Reinforcing Fiberboard Boxes
- ASTM D3953 - Standard Specification for Strapping, Flat Steel and Seals
- ASTM D4727/D4727M - Standard Specification for Corrugated and Solid Fiberboard Sheet Stock (Container Grade) and Cut Shapes
- ASTM D5118/D5118M - Standard Practice for Fabrication of Fiberboard Shipping Boxes
- ASTM D6880/D6880M - Standard Specification for Wood Boxes

(Copies of these documents are available from ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 or online at www.astm.org.)

6.4 Material safety data sheets. When required, contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets (MSDS) prepared in accordance with FED-STD-313. The pertinent government mailing addresses for submission of data are listed in FED-STD-313. In order to obtain the MSDS, FAR clause 52.223-3 will be in the contract.

6.5 Certification. Consideration should be given to including certificates of compliance with each shipment of brick or tile. Certificates should indicate successful completion of the individual tests of the verification inspections as described in 6.10.

6.6 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.7 Preservation, packing, and marking inspections.

6.7.1 Shipping containers. A sample shipping container should be inspected for preservation, packing, marking, count, and weight. The sample shipping container should be fully packed and selected prior to closing and sealing, and fully prepared for delivery (see 6.2).

6.7.2 Palletized unit loads. A sample palletized unit load should be inspected for packing, markings, and count. The sample pallet should be fully packed and prepared for delivery (see 6.2).

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6.8 Delivery instructions. The preparation for delivery instructions specified herein apply only for direct Government acquisition. For the extent of applicability of the preparation for delivery requirements of reference documents listed in section 2, see 6.2.

6.8.1 Preservation. Brick should be preserved in accordance with MIL-STD-2073-1 level A in accordance with the methods shown herein. Packs should contain brick of one size, shape, and grade only. Methods that follow are for physical protection of the items. When special circumstances require waterproof protection for storage or shipment, it should be specified in the 6.2 acquisition requirements.

6.8.1.1 Straights. Straights of 9 inches should be protected in unit packs of 10 bricks. Each pack should contain five courses of two bricks each, stacked in a crisscross formation (see [figure 4](#)). Each course of brick should be separated by a sheet of solid or corrugated fiberboard and corners of each pack should be protected by means of scored fiberboard sheet, extending the height of the pack and a minimum of 1½ inches along each face (see [figure 4](#), protector and separator sheet data). The top and bottom of each unit pack should be provided with fiberboard caps as specified on [figure 4](#). Separator sheets, fiber caps, and corner protectors should be in accordance with W5c and W5s of ASTM D4727/D4727M. Each pack should be tension tied with a minimum of three uniformly spaced flat steel straps, ⅜ by 0.020 inch, in accordance with Type I, Finish B, Grade 2 of ASTM D3953 as specified on [figure 4](#).

6.8.1.1.1 Alternate unit pack. Straights of 9 inches should be protected: 10 bricks for each pack, in close fitting fiberboard boxes conforming to ASTM D5118/D5118M style RSC/0201 or FOL/0203. The fiberboard should be weather-resistant (WR), V3s or V3c, of ASTM D4727/D4727M. Bricks should be separated from each other by fiberboard sheets conforming to W5c or W5s of ASTM D4727/D4727M. Style RSC/0201 boxes, when used, should also have top and bottom pads of fiberboard of the same material as the separate sheets. Boxes should be closed in accordance with ASTM D1974/D1974M methods 2B2 or 4B5 as applicable. Boxes should be reinforced with a minimum of 2½-inch wide pressure-sensitive filament tapes applied girthwise on the container.

6.8.1.2 Splits. Splits should be protected as specified in 6.8.1.1 or 6.8.1.1.1 except that each unit pack should consist of 20 bricks. When packed as specified in 6.7.1, splits should be arranged in ten courses of two bricks each.

6.8.1.3 Anchor. Anchor bricks of nominal dimensions 9 by 6¾ by 2½ inches or 13⅞ by 4½ by 2½ inches should be packed as specified in 6.8.1.1 except that each unit pack should consist of six bricks arranged in a single stack and the single girthwise tension strap should not be used. Anchor bricks of nominal dimensions 9 by 4½ by 2½ inches should be packed as specified in 6.8.1.1. Courses for anchor brick should be so load that notches should be outside and visible.

6.8.1.4 Special shape brick and burner tile. Special shape brick and burner tile should be packed in snug-fitting fiberboard boxes conforming to ASTM D5118/D5118M, style RSC/0201 or FOL/0203. Fiberboard should conform to ASTM D4727/D4727M grade V3s or V3c. Boxes should have full height liners and partitions for brick separation and protection. RSC/0201 style boxes, when used, should also include full size top and bottom fiberboard as specified for separator partitions and pads should be of corrugated fiberboard as specified for separator sheets in 6.8.1.1. Large voids within the box should be filled with fiberboard as specified herein, or equivalent cushion pads in such a manner so as to provide support to the box cover and prevent movement of the contained brick(s). Small special shapes may be wrapped with cushioning media; however, this wrapping will not eliminate the requirements for liners and partitions. Boxes should be closed in accordance with ASTM D1974/D1974M methods 2B2 or 4B5 as applicable, and reinforced with two girthwise ½-inch wide filament tapes. The gross weight of boxes, including contents, should not exceed 50 pounds except when the individual brick or tile exceeds 50 pounds.

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6.8.2 Packing. Packing should be level A or B, as specified (see 6.2).

6.8.2.1 Level A. Unless otherwise specified (see 6.2), pallets and shipping containers should contain brick of one size, shape, or grade only.

6.8.2.1.1 Straights, splits, and anchor. Straights, splits, and anchor brick preserved as specified in 6.8.1 should be packed as follows:

a. Brick of nominal dimensions 9 by 4½ inches by 2½ inches should be packed in unit loads on 40- by 48-inch pallets conforming to Type 2 of NN-P-71. Unit load should consist of 40 packs arranged 20 packs for each course and two courses for each load. Load strapping should conform to MIL-STD-147. Weight limitation of MIL-STD-147 does not apply.

b. Bricks of nominal dimensions 9 by 6¾ by 2½ inches or 13⅞ by 4½ by 2½ inches should be packed as specified in (a) above, except that unit loads should consist of 52 packs arranged 26 packs for each course and two courses for each load.

c. Standard shape brick acquired in quantities not constituting a full pallet load should be packed in nailed wood boxes conforming to ASTM D6880/D6880M, Class 2, Style 2, or in fiberboard boxes conforming to ASTM D5118/D5118M, class weather-resistant (WR). Unit packs should be separated from each other by fiberboard sheets conforming to W5c or W5s of ASTM D4727/D4727M. Gross weight of wood boxes should not exceed 500 pounds and the boxes should be modified by the addition of skids in accordance with ASTM D6880/D6880M. Gross weight of fiberboard boxes should not exceed the weight limitation of ASTM D5118/D5118M. Fiberboard or equivalent material should be used to fill all voids within the box to prevent damage. Wood boxes should be closed and strapped in accordance with the applicable box specification. Methods 2B2 or 4B5, as applicable, of ASTM D1974/D1974M, closure and reinforcement with non-metallic banding or pressure-sensitive filament reinforced tape, should apply for ASTM D5118/D5118M boxes.

6.8.2.1.2 Special shape brick and burner tile. Special shape brick and burner tile acquired in quantities not constituting a full pallet load (3000 pounds) will require no further packing. When pallet load quantities are acquired, pallets should be in accordance with MIL-STD-147, Type III. Fiberboard or wood strips should be used as filler material to have the load fit the edges of the pallet.

6.8.2.2 Level B. Packing for MIL-STD-2073-1 Level B should be as specified for Level A except that boxes referred to in 6.8.2.1.1.c should conform to ASTM D6880/D6880M, Class 1, Style 2, or ASTM D4727/D4727M Class domestic (D).

6.8.3 Marking. In addition to any special markings specified (see 6.2), unit packs, shipping containers, and palletized unit loads should be marked in accordance with MIL-STD-129.

6.8.3.1 Special marking. Each individual unit container for special shape brick and burner tile (see 6.8.1.4) should have handling markings, arrow, and “up”, in addition to either fragile, or precautionary legend (see [figure 5](#)).

6.9 Toxicity evaluation. The Navy and Marine Corps Public Health Center (NMCPHC) requires sufficient information to permit an HHA of the product. Any questions concerning toxicity and requests for HHA should be addressed to the Commanding Officer, Navy and Marine Corps Public Health Center (NMCPHC), ATTN: Industrial Hygiene Department, Acquisition Technical Support Division, 620 John Paul Jones Circle, Suite 1100, Portsmouth, VA 23708-2103. Upon receipt of the HHA, a copy should be provided to the Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Ave., SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to commandstandards@navy.mil.

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6.10 Certificates of compliance. The certificates of compliance should include the results of verification testing for each requirement in 3.7, 3.8, 3.9, or 3.10, as applicable. This will include the found test results, the specified requirements, and the conclusion that each result passed. For example, the Modulus of Rupture results for Grade A alumina brick would be reported as 772 lb/in² (if that is the found test result) with the 3.8.4 requirement of a 500 lb/in² (min) shown and the conclusion of "Passed" indicated. Additional requirements of the certificates of compliance content or format may be specified in the 6.2 requirements. A copy of each certificate should be provided to Commanding Officer, Naval Surface Warfare Center, Carderock Division, Ship Systems Engineering Station, Attn: NSWCCD-SSES Code 922, 5001 South Broad St., Philadelphia PA 19112, in addition to other reporting requirements of the contract.

6.11 Definition.

6.11.1 Buried surfaces. Buried surface is defined as any other surface other than working surface (see 3.11.2.2 and 4.5.3).

6.12 Subject term (key words).

Alumina

Anchor brick

Apparent porosity

Fireclay

Furnace

Modulus of rupture

Permanent linear change

Permanent volume change

Pyrometric cone equivalent

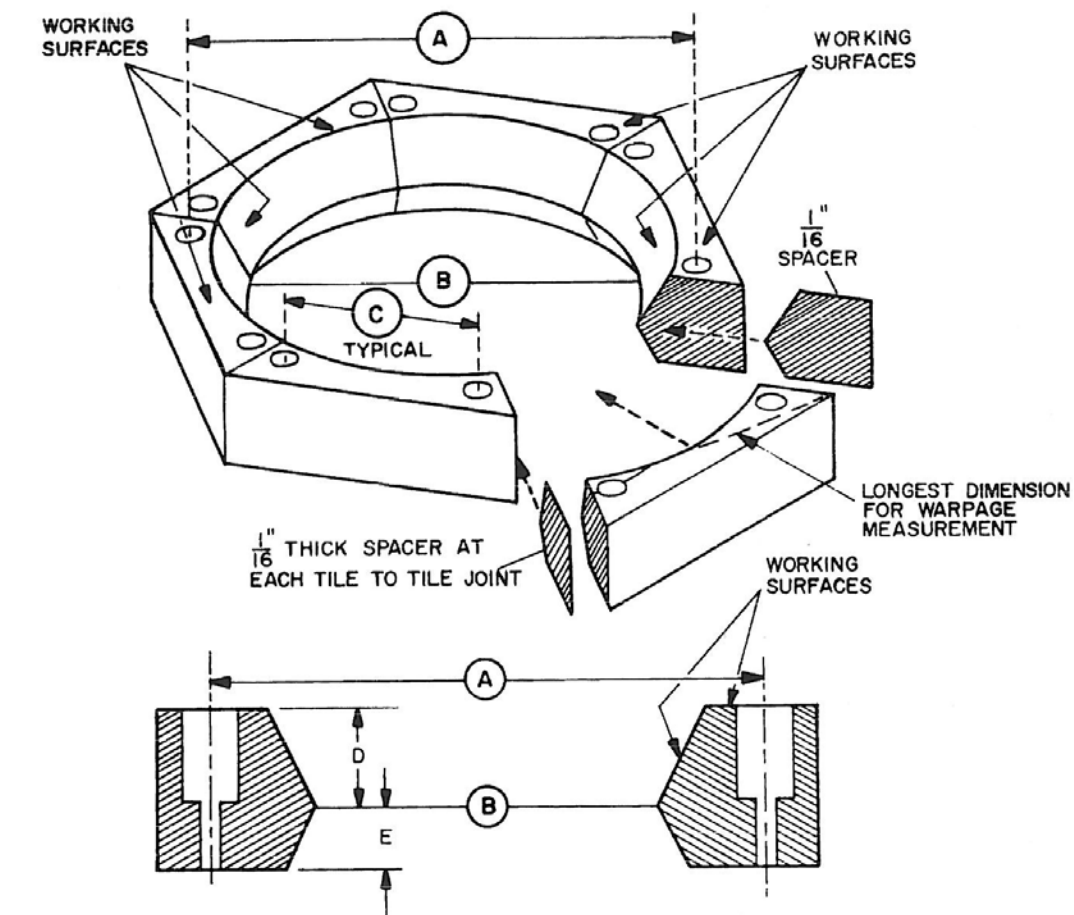
Reheat

Spalling

Super duty

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

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FIGURE 1. Typical burner tile arrangement.

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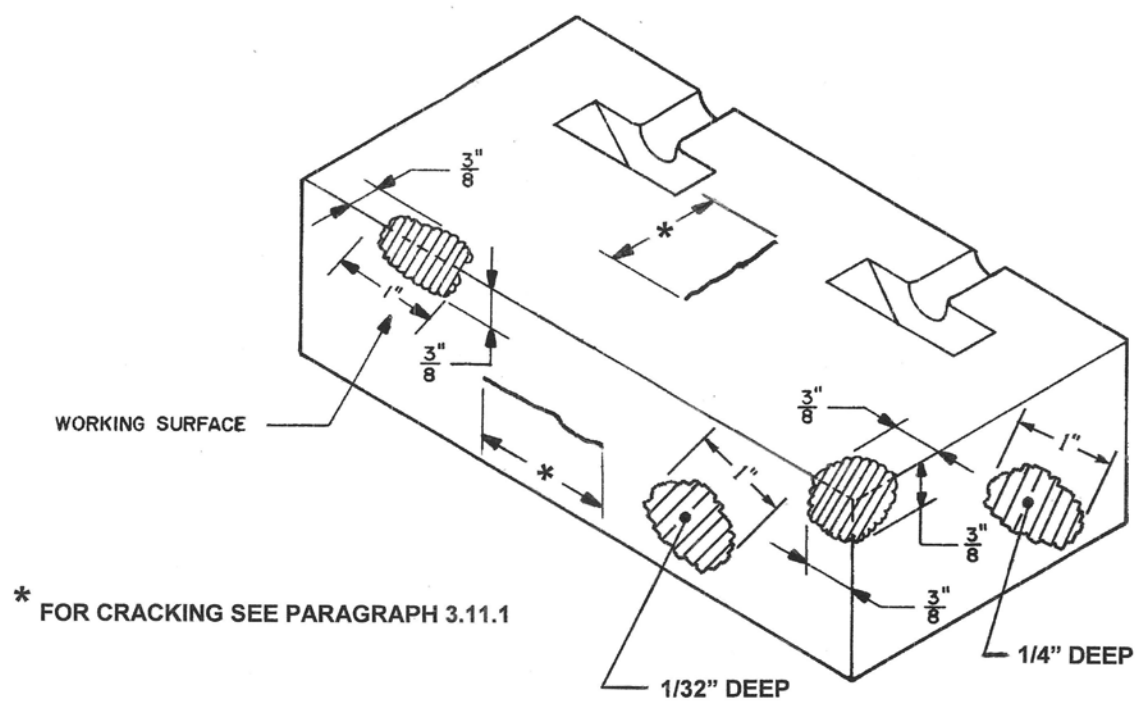


FIGURE 2. Maximum allowable dimensions of cracks and corner or edge crumbling or chipping in brick.

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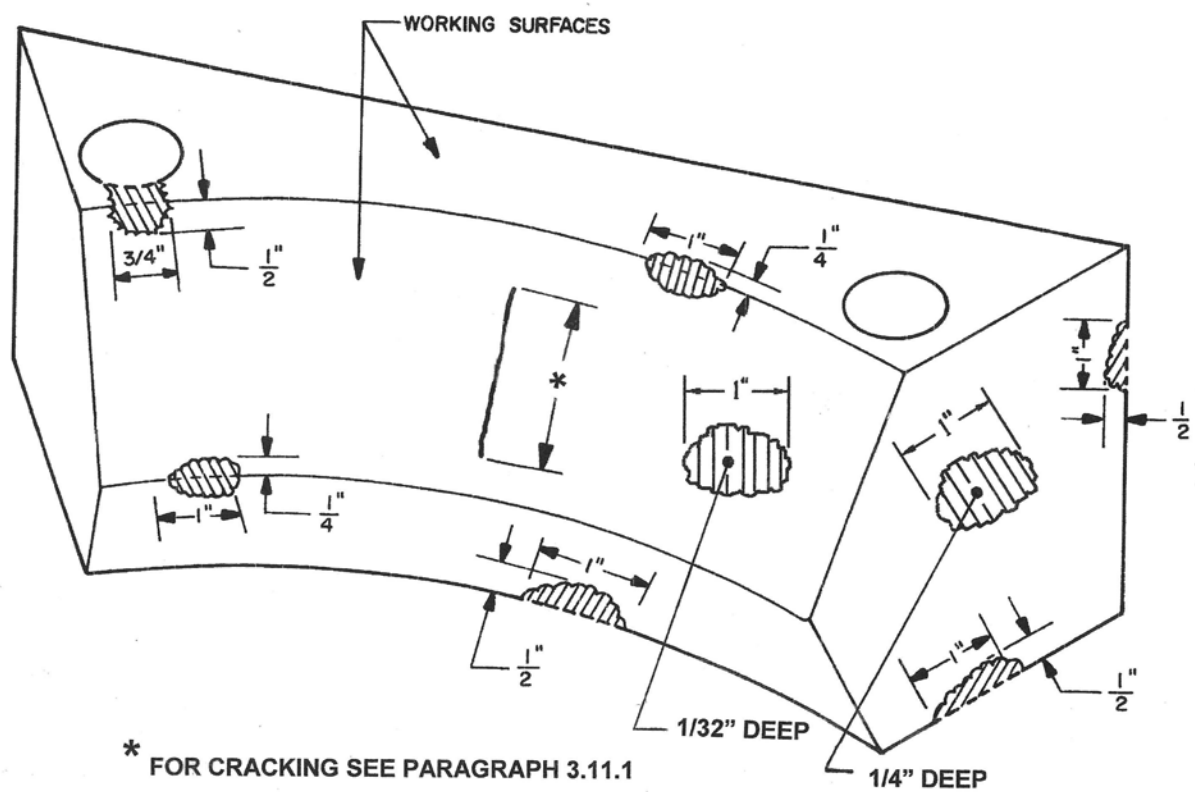
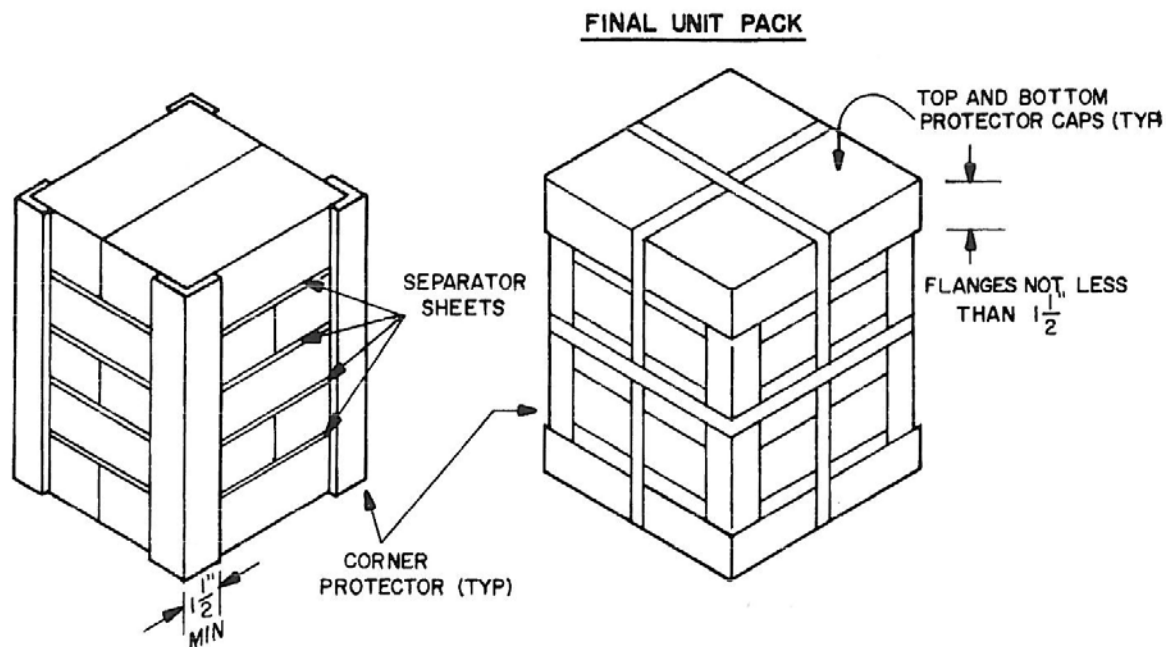


FIGURE 3. Maximum allowable dimensions of cracks and corner or edge crumbling or chipping in burner tile.

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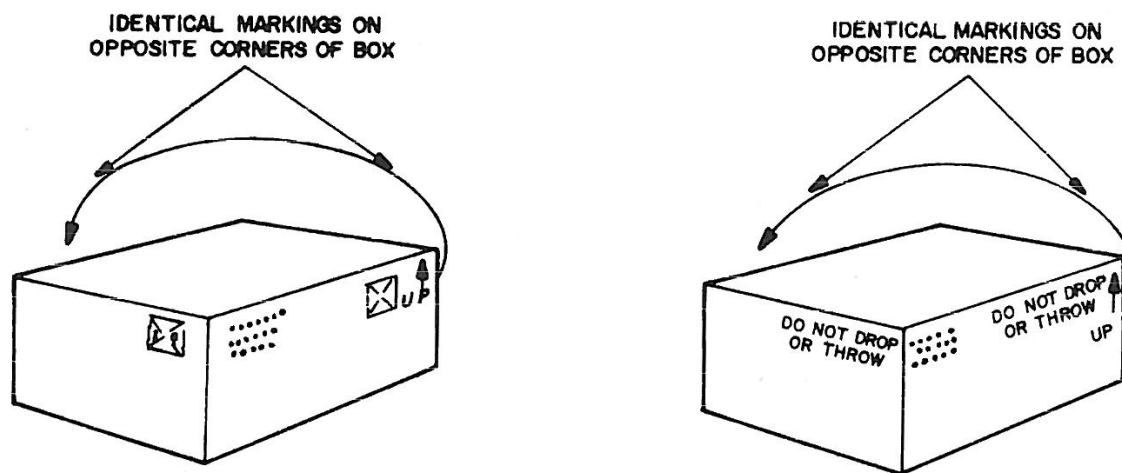


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PROTECTOR AND SEPARATOR SHEET DATA	UNIT PACK DATA
W5s or W5c fiberboard sheets.	For Level A Packing (6.8.2.1.1)
Protector sheets must fit snugly over bricks.	1. Unit package of 10 9-inch straights in 5 courses as shown.
	2. Unit packages split to contain 20 bricks each.
	3. Unit package to consist of only one size, grade, and shape of brick.

FIGURE 4. Detail of unit pack and protector sheet.

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WITH FRAGILE LABELS AND UP

WITH PRECAUTIONARY LEGEND AND UP

NOTE:

1. Refer to MIL-STD-129 for special handling, including arrows and FRAGILE/DELICATE markings.

FIGURE 5. Marking for unit packs of special shapes.

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Custodians:

Navy – SH
AF – 99

Preparing Activity:

Navy – SH
(Project 9350-2011-002)

Review Activities:

DLA – IS
Navy – MC

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.dla.mil>.