



## Standard Specification for Mortar, Refractory (High-Temperature, Air-Setting)<sup>1</sup>

This standard is issued under the fixed designation F 1097; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification covers dry air-setting refractory mortar for use in laying and bonding refractory brick in ship boiler furnaces and wet air-setting refractory mortar for use in laying refractory brick in stationary boiler furnaces, bright annealing furnaces, controlled atmosphere furnaces, and furnaces heated by electric elements.

1.2 The values stated in inch-pound units are to be regarded as standard. The SI units in parentheses are for information purposes only and may be approximate.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

C 24 Test Method for Pyrometric Cone Equivalent (PCE) of Fireclay and High Alumina Refractory Materials<sup>2</sup>

C 27 Classification of Fire Clay and High-Alumina Refractory Brick<sup>2</sup>

C 92 Test Methods for Sieve Analysis and Water Content of Refractory Materials<sup>2</sup>

C 133 Test Methods for Cold Crushing Strength and Modulus of Rupture of Refractories<sup>2</sup>

C 198 Test Method for Cold Bonding Strength of Refractory Mortar<sup>2</sup>

C 199 Test Method for Pier Test for Refractory Mortars<sup>2</sup>

2.2 *Federal Specifications<sup>3</sup>—The following documents shall apply only when one or more of the requirements of S1 are specified in the contract or purchase order (see 4.1.3):*

UU-S-48 Sacks, Shipping, Paper

PPP-B-35 Bags: Textile, Shipping, Burlap, Cotton and Waterproof Laminated

PPP-B-704 Pails: Shipping, Steel (1 through 12 gallon)

2.3 *Military Standards<sup>3</sup>—The following documents shall apply only when one or more of the requirements of S1 are specified in the contract or purchase order (see 4.1.3):*

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes

MIL-STD-129 Marking for Shipment and Storage

### 3. Classification

3.1 The refractory mortar shall be of the following types:

3.1.1 *Type 1—Dry.*

3.1.2 *Type 2—Wet.*

### 4. Ordering Information

4.1 Orders for material under this specification shall include the following information, as necessary to adequately describe the material:

4.1.1 ASTM designation and year of issue,

4.1.2 Type required (see 3.1), and

4.1.3 Optional requirements, if any (see S1).

### 5. Material

5.1 The mortar shall be composed of finely ground heat-resistant clays, minerals, or a mixture of clays and minerals in either a dry or wet condition.

5.1.1 *Type 1, Dry—Mortar shall be furnished dry and shall be ready for use as soon as mixed with water. Mortar, after being mixed with water and then dried, shall be capable of being remixed with water.*

5.1.2 *Type 2, Wet—Mortar shall be furnished ready for use at a trowelling consistency and shall be easily mixed with water to a dipping consistency.*

### 6. Performance Requirements

6.1 *Resistance to Heat Soaking—Mortar shall not soften nor show any evidence of fusion, and the shrinkage shall not be greater than hairline cracks when tested as specified in 11.2.*

6.2 *Bonding Strength—The average modulus of rupture at the brick joint when tested as specified in 11.3 shall be not less than shown in Table 1.*

6.3 *Pyrometric Cone Equivalent (PCE)—The PCE shall be not less than cone 32 (see 11.4).*

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.07 on General Requirements.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 15.01.

<sup>3</sup> Standardization Documents Order Desk, Building 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, ATTN: NPODS.

**TABLE 1 Bonding Strength of Mortar**

Temperatures, °F (°C)	Average Modulus of Rupture, psi (kPa), min
230 (110)	200 (1400)
1000 (538)	100 (700)
2000 (1093)	100 (700)

## 7. Requirements

7.1 *Fineness*—Mortar shall be ground to such fineness that not more than 5 % shall be retained on a No. 40 ASTM sieve, and not more than 0.5 % shall be held on a No. 30 ASTM sieve (see 11.1).

7.2 *Shelf Life, Type 1*—Mortar shall show no deterioration after 1 year's storage.

7.3 *Shelf Life, Type 2*—At any time within one year of shipment from the supplier, the mortar in a previously unopened container shall not have stiffened to such an extent as to interfere with its easy removal and mixing.

7.4 *Consistency*—Mortar, when tempered with water, shall be of such consistency that it will be suitable for spreading easily with a trowel or for dipping and for laying refractory brick and bonding them together upon drying and upon subsequent heating at furnace temperatures. Mortar shall retain this degree of workability for 2 h.

7.4.1 The mixed mortar shall have sufficient water retention to permit a 1/16-in. (2-mm) joint to be made with a trowelling consistency, but not allow the newly laid brick to float out of position.

## 8. Workmanship

8.1 Workmanship shall be first class in every respect. There shall be no foreign material or caked aggregate lumps in the mortar. Wet mortar shall be easily removed from the container and shall mix easily to a uniform trowelling consistency.

## 9. Sampling

9.1 An inspection lot for tests and inspections shall consist of all material manufactured at essentially the same time and of the same type offered for delivery at one time.

9.2 For the tests specified in 11.1 through 11.4, the sample unit shall be 15 lbs (7 kg) of mortar. No fewer than three sample units shall be randomly selected throughout the lot. No more than one sample shall be drawn from any one container.

9.2.1 The test sample shall be a 45-lbs (20-kg) composite of the randomly selected sample units. Two or more determinations as applicable (see Table 2) shall be performed on the composite. There shall be no evidence of failure to meet the specified unit or average requirements.

9.3 The PCE shall be determined on two cones of different samples from each lot. If both cones fail, this shall be cause for rejection without retest. If either cone fails, three additional cones shall be made, each from a different sample. If any one of the three retest cones fail, this shall be cause for rejection.

## 10. Specimen Preparation

10.1 The entire mortar sample for testing shall be thoroughly mixed to ensure uniformity before any portion is taken for tests. The selected portion of Type 1 (dry) mortar shall be mixed with water to a trowelling consistency for the tests of 11.2 and 11.3.

10.2 For the test specified in 11.3, brick-mortar joints shall be prepared in accordance with Test Method C 198, except that refractory bricks, conforming to Classification C 27, super-duty, shall be used and shall be cut in half. The two halves of each brick shall be placed in a device suitable for bringing, with a straight motion, the molded ends together with the faces parallel at all times to form a bond.

10.2.1 A small quantity of mortar shall be spread by a trowel on the upper face forming the bond to ensure intimate contact. Sufficient mortar to give a 1/8-in. (3-mm) thick layer shall be spread evenly on the lower bond forming face and the upper half shall be lowered until it is 1/16 in. (2 mm) from the lower half. The excess mortar shall be cut from the joint, flush with the sides of the brick. The unit thus formed shall be removed at once from the bond-forming machine. The bond specimens shall be allowed to air-dry for 24 h.

**TABLE 2 Testing Requirements**

Characteristic	Specification Reference		Number of Determinations per Composite	Results Reported as	
	Requirement	Test Method		Pass or Fail <sup>A</sup>	Numerically to Nearest <sup>B</sup>
Type 1 and Type 2, as applicable					
Fineness					
Retained on No. 40 ASTM sieve	7.1	11.1	2	...	0.1 %
Retained on No. 30 ASTM sieve	7.1	11.1	2	...	0.1 %
Resistance to heat soaking					
Melting	6.1	11.2	2	X	...
Shrinkage	6.1	11.2	2	X	...
Bonding strength	6.2				
After heating at					
230°F (110°C)		11.3	avg of 5	...	psi
1000°F (538°C)		11.3	avg of 5	...	psi
2000°F (1098°C)		11.3	avg of 5	...	psi
Pyrometric cone: <sup>C</sup>					
Type 1	6.3	11.4	2	...	cone number

<sup>A</sup>If failure is indicated, report description of failure or numerical point of failure as applicable.

<sup>B</sup>Test report shall include all values on which results are based.

<sup>C</sup>See 9.3.

**11. Test Methods**

11.1 *Fineness*—The fineness test shall be made in accordance with Test Methods C 92.

11.2 *Heat Soak:*

11.2.1 A pier of refractory brick, conforming to Classification C 27, super-duty, laid up with the test mortar shall be prepared and heated at 2910°F (1588°C) for 5 h in accordance with Test Method C 199.

11.2.2 The cooled pier shall be examined for evidence of shrinkage, softening, or fusion of the mortar. One or more mortar joints shall be broken and the freshly broken mortar surface shall be viewed from various angles. Any shininess or light flash at the mortar surface shall be considered an indication of excessive fusion.

11.3 *Bonding Strength:*

11.3.1 Five bond specimens (see 10.2) shall be placed in an oven operating at 230°F (110°C) for 24 h; five bond specimens shall be held at each of the other test temperatures (1000°F, 2000°F (538°C, 1093°C) for 5 h and then allowed to cool in the closed furnace for 12 to 18 h. The time required to reach test temperatures shall be 3 h. The bond shall not be broken until the specimens have reached approximately room temperature.

11.3.2 The modulus of rupture of the test specimens shall be determined in accordance with Test Methods C 133, except that the load shall be applied at the rate of 1000 lb/min (450 kg/min).

11.3.2.1 In conducting this test, bring the upper bearing edge to bear on the joint itself.

11.4 *Pyrometric Cone Equivalent*—The PCE shall be determined in accordance with Test Method C 24.

**12. Inspection**

12.1 Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may use his own facilities or any commercial laboratory acceptable to the purchaser. The purchaser reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

**13. Packaging**

13.1 Packing of the mortar shall be sufficient to afford adequate protection against deterioration and physical damage during shipment from the supply source to the first receiving activity for immediate use and may conform to the supplier’s commercial practice.

**14. Keywords**

14.1 bonding strength; mortar; refractory mortar

**SUPPLEMENTARY REQUIREMENTS**

The following supplementary requirements shall apply only when specified in the contract or purchase order (see 4.1.3.).

**S1. Special Government Requirements**

S1.1 *Quality Conformance Inspection:*

S1.1.1 Sampling for quality conformance inspection shall be performed in accordance with the provisions set forth in MIL-STD-105, except where otherwise indicated.

S1.1.2 Examination of the end item shall be made in accordance with the classification of defects, inspection levels, and quality levels specified in S1.1.2.1 through S1.1.2.3. The lot size, for the purpose of determining the sample size in accordance with MIL-STD-105, shall be expressed in units of filled containers for the examinations in S1.1.2.1 and S1.1.2.2.

S1.1.2.1 Examination of the end item container for defects in appearance, workmanship, closures, and marking (see Table S1.1). The sample unit for this examination shall be one filled container.

S1.1.2.2 Examination of end item container for defects in net contents. The sample unit for this examination shall be one filled primary container. The average net contents shall be not less than the specified or indicated quantity.

S1.1.2.3 Inspection levels for examinations. The inspection levels for determining the sample size and acceptance shall be as specified in Table S1.2.

Examine	Defect
Appearance	Not specified size or style container. Evidence of leakage or seepage. Dents, punctures, breaks or other defects affecting serviceability.
Construction	Container not as specified. Bag not waterproofed sift-proof. Bag laminations not as specified. Drum wall thickness not as specified. Exterior or interior of drum not painted or coated as specified. Bottom seam of drum not as specified.
Closures	Bag closure not as specified. Drum closure not tight. Gasket missing, does not seal properly. Lugs missing or not clamped tightly.
Markings	Exterior markings omitted, illegible, incorrect, incomplete, or not in accordance with contract requirements.
Weight	Gross or net weight exceeds specified requirements.

S1.1.2.4 Examination for workmanship. For the examination for conformance to Section 8, the sample unit shall be one bag of dry mortar or one drum of wet mortar, as applicable. The

**TABLE S1.2 Inspection Levels for Examinations**

Examination	Lot Size	Sample	Accept	Reject
S1.1.2.1	2 to 500	5	0	1
	501 to 35 000	20	1	2
	35 001 to 500 000	32	2	3
S1.1.2.2	over 500 000	50	3	4
	less than 35 000	5	0	1
	more than 35 000	20	1	2

examination may be made during selection of samples for testing or other examinations. For each lot, select a sample size of five. Reject the lot on one failure.

**S1.2 Tests:**

S1.2.1 For the tests specified in 11.1 through 11.4, the inspection level for determining sample size shall be S1 in accordance with MIL-STD-105.

**S1.3 Preparation for Delivery:**

**S1.3.1 Type 1, Dry Mortar:**

S1.3.1.1 *Levels A and B*—Type 1 mortar shall be packed in 100-lbs (45-kg) unit quantity in multiwall shipping sacks conforming to UU-S-48 or PPP-B-35.

**S1.3.2 Type 2, Wet Mortar:**

S1.3.2.1 *Levels A and B*—Type 2 mortar shall be packed in steel drums conforming to Type II of PPP-B-704, except that use of 22-gage steel drums of 12-gal (44-L) capacity is acceptable. Dropline handles shall be provided.

S1.3.3 *Marking*—In addition to any special marking required by the contract or purchase order, shipping containers shall be marked for shipment in accordance with MIL-STD-129.

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