



Designation: C401 – 12 (Reapproved 2018)

## Standard Classification of Alumina and Alumina-Silicate Castable Refractories<sup>1</sup>

This standard is issued under the fixed designation C401; 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 reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

### 1. Scope

1.1 This classification covers alumina and alumina-silicate castable refractories that, when tempered with water, will develop structural strength by chemical action.

1.2 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

- C113 Test Method for Reheat Change of Refractory Brick
- C133 Test Methods for Cold Crushing Strength and Modulus of Rupture of Refractories
- C134 Test Methods for Size, Dimensional Measurements, and Bulk Density of Refractory Brick and Insulating Firebrick
- C862 Practice for Preparing Refractory Concrete Specimens by Casting
- C865 Practice for Firing Refractory Concrete Specimens

### 3. Significance and Use

3.1 Alumina and alumina-silicate castable refractories are produced to yield property characteristics commensurate with different end-use properties. Volume stability, modulus of

rupture, bulk density, and lime content have become useful measures to distinguish various alumina and alumina-silicate castable formulations for initial fitness for service. This classification is considered useful for purchase specifications and for quality control.

### 4. Basis of Classification

4.1 Alumina and alumina silicate castable refractories that contain a hydraulic setting cement and have a density of greater than 105 lb/ft<sup>3</sup> (1.68 g/cm<sup>3</sup>) may be classified by the lime (CaO) content as contributed by the cement. The classifications are shown in Table 1. While this standard only uses the lime content as contributed by cement, other sources of lime may be present in the mix and may affect the performance of a material.

4.2 Refractory castables classified as conventional castable refractories having a modulus of rupture after drying of at least 300 psi (2.07 MPa) are normal strength, and those having at least 600 psi (4.14 MPa) modulus of rupture are high-strength types. They are further classified on the basis of volume stability of cast test brick when fired at the temperatures prescribed in Table 2.

4.3 *Insulating Refractory Castables*—This class includes insulating castable refractories which are classified on the basis of bulk density of dried cast test brick and volume stability of such test brick when fired at the temperatures prescribed in Table 3.

### 5. Test Methods

5.1 The properties enumerated in this classification shall be determined in accordance with the following ASTM methods:

5.1.1 *Modulus of Rupture*—Test Methods C133 on test brick with Practice C862, and after oven drying in accordance with the Curing of Test Specimens section of Practice C862. Specimens should be fired as given in heating schedule of Practice C865.

5.1.2 *Permanent Linear Change*—Test Method C113 on specimens prepared in accordance with Practice C862 and fired as given in heating schedule of Practice C865.

5.1.3 *Bulk Density*—Test Methods C134 on test brick prepared and oven dried in accordance with Practice C862 and fired as given in heating schedule of Practice C865.

<sup>1</sup> This classification is under the jurisdiction of ASTM Committee C08 on Refractories and is the direct responsibility of Subcommittee C08.92 The Joseph E. Kopanda Subcommittee for Editorial, Terminology, and Classification.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

**TABLE 1 Classification of Dense Castable Refractories**

Classification	Lime (CaO) as contributed by cement
No Cement Castable (NCC)	≤0.2 %
Ultra-Low Cement Castable (ULCC)	>0.2 % and ≤1.0 %
Low Cement Castables (LCC)	>1.0 % and ≤2.5 %
Conventional Castables	>2.5 %

**TABLE 2 Conventional Castable Refractories**

Test Requirements	Classes of Alumina-Silica Base Castable Refractories						
	Class A	Class B	Class C	Class D	Class E	Class F	Class G
Permanent linear change, not more than 1.5 % when fired for 5 h at:	2000 °F (1095 °C)	2300 °F (1260 °C)	2500 °F (1370 °C)	2700 °F (1480 °C)	2900 °F (1595 °C)	3100 °F (1705 °C)	3200 °F (1760 °C)

**TABLE 3 Insulating Castable Refractories**

Test Requirements	Classes of Insulating Castable Refractories				
	Class N	Class O	Class P	Class Q	Class R
Permanent linear change, not more than 1.5 % when fired for 5 h at:	1700 °F (925 °C)	1900 °F (1040 °C)	2100 °F (1150 °C)	2300 °F (1260 °C)	2500 °F (1370 °C)
Maximum bulk density, lb/ft <sup>3</sup> (g/cm <sup>3</sup> ) after drying at 220 to 230 °F (105 to 110 °C)	55 (0.88)	65 (1.04)	75 (1.20)	90 (1.44)	95 (1.52)
Test Requirements	Class S	Class T	Class U	Class V	
	2700 °F (1480 °C)	2900 °F (1595 °C)	3000 °F (1650 °C)	3200 °F (1760 °C)	
Maximum bulk density, lb/ft <sup>3</sup> (g/cm <sup>3</sup> ) after drying at 220 to 230 °F (105 to 110 °C)	95 (1.52)	100 (1.60)	105 (1.68)	105 (1.68)	

## 6. Retests

6.1 Because of variables resulting from sampling and the lack of satisfactory reproducibility in tests conducted by different laboratories, the material may be resampled and retested when requested by either the manufacturer or the purchaser. This may apply in instances when the first test results do not conform to the requirements prescribed in this classification. The final results to be used shall be the average

of at least two sets of results, each of which has been obtained by following in detail the specified testing procedures.

## 7. Keywords

7.1 alumina; alumina-silicate; castable refractories; insulating castable refractories; low-cement castable refractories; no-cement castable refractories; regular castable refractories; ultra-low cement castable refractories

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