



Designation: **C151/C151M—18** **C151/C151M – 23**

Standard Test Method for Autoclave Expansion of Hydraulic Cement¹

This standard is issued under the fixed designation C151/C151M; 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 (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This test method covers determination of the expansion of a hardened cement paste when exposed to the autoclave conditions in this method.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific precaution statements, see the section on Safety Precautions.

1.4 *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:*²

- [C187 Test Method for Amount of Water Required for Normal Consistency of Hydraulic Cement Paste](#)
- [C219 Terminology Relating to Hydraulic and Other Inorganic Cements](#)
- [C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency](#)
- [C490/C490M Practice for Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete](#)
- [C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes](#)
- [C856 Practice for Petrographic Examination of Hardened Concrete](#)
- [C1005 Specification for Reference Masses and Devices for Determining Mass and Volume for Use in Physical Testing of Hydraulic Cements](#)
- [C1157/C1157M Performance Specification for Hydraulic Cement](#)

3. Terminology

3.1 Definitions:

3.1.1 For definitions pertinent to this test method, see Terminology [C219](#).

¹ This test method is under the jurisdiction of ASTM Committee [C01](#) on Cement and is the direct responsibility of Subcommittee [C01.31](#) on Volume Change. Current edition approved April 1, 2018/Dec. 1, 2023. Published April 2018/December 2023. Originally approved in 1940. Last previous edition approved in 2016/2018 as [C151/C151M – 16](#)/[C151/C151M – 18](#). DOI: [10.1520/C0151-C0151M-18](#)/[10.1520/C0151-C0151M-23](#).

² 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.

*A Summary of Changes section appears at the end of this standard



4. Significance and Use

4.1 The autoclave expansion test provides an index of potential delayed expansion caused by the hydration of CaO or MgO, or both, when present in hydraulic cement.³

5. Interferences

5.1 Pozzolans containing fine-grained quartz have been reported to cause excessive expansion under autoclave test conditions due to alkali-silica reaction that will not occur under normal service conditions.⁴ When excessive expansion of paste containing pozzolans occurs, it is recommended that the specimens be examined (see Practice C856) for evidence of alkali-silica reaction (Note 1).

NOTE 1—If the excessive expansion has resulted from alkali-silica reaction under autoclave conditions, the pozzolan can be evaluated for alkali reactivity using the procedure described in Performance Specification C1157/C1157M.

6. Apparatus

6.1 *Weighing Devices and Weights*, for determining the mass of materials conforming to the requirements of Specification C1005.

6.2 *Glass Graduates*, ~~200 or 250 mL~~ 200 mL or 250 mL capacity, and conforming to the requirements of Practice C490/C490M.

6.3 *Molds*, conforming to the requirements of Practice C490/C490M for test specimens used in the determination of length change of cement paste.

6.4 *Flat Trowel*, conforming to the requirements of Test Method C187.

6.5 *Autoclave*, consisting of a high-pressure steam vessel provided with a thermometer well. The autoclave shall be equipped with automatic controls and either a rupture disk with a bursting pressure of 2.4 MPa [350 psi] \pm 5 % or a safety valve that actuates at this pressure. In addition, the autoclave shall be equipped with a vent valve to allow the escape of air during the early part of the heating period and to release any steam pressure remaining at the end of the cooling period. The pressure gauge shall have a nominal capacity of 4.0 MPa [600 psi], a dial with a nominal diameter of 115 mm [4½ in.] and shall be graduated from ~~0~~ 0 MPa to 4.0 MPa [~~0 psi to 600 psi~~] with scale divisions not exceeding 0.03 MPa [5 psi]. The error in the gauge shall not exceed \pm ~~0.02 MPa~~ \pm 0.02 MPa [\pm 3 psi] at the operating pressure of 2 MPa [295 psi]. The capacity of the heating unit shall be such that with maximum load (water plus specimens) the pressure of the saturated steam in the autoclave may be raised to a gauge pressure of 2 MPa [295 psi] in 45 to 75 min from the time the heat is turned on. The automatic control shall be capable of maintaining the gauge pressure at ~~2.2 MPa~~ \pm 0.07 MPa [~~295 \pm 10 psi~~] [~~295 psi \pm 10 psi~~] for at least 3 h. A gauge pressure of ~~2.2 MPa~~ \pm 0.07 MPa [~~295 \pm 10 psi~~] [~~295 psi \pm 10 psi~~] corresponds to a temperature of ~~216 \pm 2°C~~ [~~420 \pm 3°F~~], 216 °C \pm 2 °C [420 °F \pm 3 °F]. The autoclave shall be designed to permit the gauge pressure to drop from ~~2 MPa~~ 2 MPa to less than 0.07 MPa [~~295 psi to less than 10 psi~~] 10 psi in 1½ ~~h~~ h after the heat supply has been shut off.

6.5.1 *Rupture Disk*—The rupture disk shall be made of a material having a tensile strength that is relatively insensitive to temperature in the range ~~20 to 216°C~~ [~~68 to 420°F~~] 20 °C to 216 °C [68 °F to 420 °F] and that is electrochemically compatible with the pipe leading to it and to its holder.

6.6 *Length Comparator*—The comparator used for measuring length change of specimens shall conform to the requirements of Practice C490/C490M.

7. Temperature and Humidity

7.1 *Molding Room*—Maintain the temperature of the molding room, dry materials and mixing water, and the relative humidity of the molding room within the limits of Practice C490/C490M.

³ Gonnerman, H. F., Lerch, W. and Whiteside, T. M., "Investigations of the Hydration Expansion Characteristics of Portland Cements," *Portland Cement Association Research Department Bulletin 45*, pp. 1–168, 1953.

⁴ Wang, H., "Autoclave Soundness Test Mischaracterizes Cement-Fly Ash Blends by Introducing Alkali-Quartz Reaction," *Cement, Concrete, and Aggregates*, Vol 24, No. 2, pp. 68–72, 2002.