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Standard Specification for Chemical Admixtures for Concrete¹

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

1. Scope*

1.1 This specification covers materials for use as chemical admixtures to be added to hydraulic-cement concrete mixtures for the purpose or purposes indicated for the eight types as follows:

- 1.1.1 *Type A*—Water-reducing admixtures,
- 1.1.2 *Type B*—Retarding admixtures,
- 1.1.3 *Type C*—Accelerating admixtures,
- 1.1.4 *Type D*—Water-reducing and retarding admixtures,
- 1.1.5 *Type E*—Water-reducing and accelerating admixtures,
- 1.1.6 *Type F*—Water-reducing, high range admixtures,
- 1.1.7 *Type G*—Water-reducing, high range, and retarding admixtures, and
- 1.1.8 *Type S*—Specific performance admixtures.

1.2 Unless specified otherwise by the purchaser, test specimens for qualifying an admixture shall be made using concreting materials as described in 11.1 – 11.3.

NOTE 1—As discussed in Appendix X2, it is recommended that, whenever practicable, supplementary tests be made by the purchaser using the cement, pozzolan, aggregates, air-entraining admixture, and the mixture proportions, batching sequence, and other physical conditions proposed for the specific work because the specific effects produced by chemical admixtures may vary with the properties and proportions of the other ingredients of the concrete. For example, Types F and G admixtures may exhibit much higher water reduction in concrete mixtures having higher cement contents than that listed in 12.1.1.

NOTE 2—The purchaser should verify that the admixture supplied for use in the work is equivalent in composition to the admixture subjected to test under this specification (see Section 6, Uniformity and Equivalence).

NOTE 3—Admixtures that contain sufficient amounts of chloride may accelerate corrosion of steel reinforcement. Compliance with the requirements of this specification does not constitute assurance of acceptability of the admixture for use in reinforced concrete.

1.3 This specification provides for three levels of testing.

1.3.1 *Level 1*—During the initial approval stage, proof of compliance with the performance requirements defined in Table 1 demonstrates that the admixture meets the require-

ments of this specification. Proof of compliance shall be based on comparisons of the average test results from the batches of test concrete and the average test results from the batches of reference concrete. Admixtures (except for Types B, C, E, and S) shall qualify for provisional compliance if the time of setting, length change, and durability factor meet the physical requirements and any of the alternative compressive strength requirements shown in parentheses in Table 1 are met through the date of provisional acceptance (see Note 4). If subsequent test results at six months or one year fail to meet the requirement of at least 100 % of reference strength, the provisional compliance of the admixture to this standard is withdrawn and all users of the admixture shall be notified immediately. Uniformity and equivalence tests of Section 6 shall be carried out to provide results against which later comparisons shall be made.

NOTE 4—Allowing for provisional compliance while retaining longer term compressive strength requirements promotes more rapid qualification of new materials, but also provides assurance that new admixture technologies will not exhibit unexpected longer term performance. The alternative compressive strength requirements in Table 1 are based on statistical analysis of 103 Specification C494/C494M evaluation tests. The alternative requirements shown in parentheses correspond to a 99 % probability of passing strength requirements at subsequent test ages,² if any one of the requirements is met. There is no requirement that all be met.

1.3.2 *Level 2*—Limited retesting is described in 5.2 – 5.2.2. Proof of compliance with the requirements of Table 1 demonstrates continued conformity of the admixture with the requirements of the specification.

1.3.3 *Level 3*—For acceptance of a lot or for measuring uniformity within or between lots, if specified by the purchaser, the uniformity and equivalence tests of Section 6 shall be used.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two

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² Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:C09-1030. Contact ASTM Customer Service at service@astm.org.

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

systems shall not be combined. Some values have only SI units because the inch-pound equivalents are not used in practice.

1.5 The text of this standard refers to notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.6 The following precautionary caveat pertains only to test method Sections 11 – 18 of this Specification: *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. (Warning—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to exposed skin and tissue upon prolonged exposure.³)*

1.7 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:⁴

- C33/C33M Specification for Concrete Aggregates
- C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
- C78/C78M Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
- C125 Terminology Relating to Concrete and Concrete Aggregates
- C127/C127M Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
- C128/C128M Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate
- C136/C136M Test Method for Sieve Analysis of Fine and Coarse Aggregates
- C138/C138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- C143/C143M Test Method for Slump of Hydraulic-Cement Concrete
- C150/C150M Specification for Portland Cement
- C157/C157M Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
- C183/C183M Practice for Sampling and the Amount of Testing of Hydraulic Cement
- C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory
- C231/C231M Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- C260/C260M Specification for Air-Entraining Admixtures for Concrete

³ See Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol. 04.02.

⁴ 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.

- C403/C403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
- C666/C666M Test Method for Resistance of Concrete to Rapid Freezing and Thawing
- C1753/C1753M Practice for Evaluating Early Hydration of Hydraulic Cementitious Mixtures Using Thermal Measurements
- D75/D75M Practice for Sampling Aggregates
- D891 Test Methods for Specific Gravity, Apparent, of Liquid Industrial Chemicals
- D1193 Specification for Reagent Water
- E100 Specification for ASTM Hydrometers
- E178 Practice for Dealing With Outlying Observations
- E1252 Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis
- Manual of Aggregate and Concrete Testing

2.2 American Concrete Institute Standard:

- ACI 211.1–91 (2009) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete⁵

3. Terminology

3.1 For definitions of terms used in this specification, refer to Terminology C125.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *accelerating admixture*, *n*—an admixture that increases the rate of reaction of cementitious materials thus reducing time of setting and increasing the rate of early-age strength development of concrete.

3.2.2 *reference concrete*, *n*—concrete made without the admixture being evaluated and used as the basis for evaluating the performance of the admixture.

3.2.3 *retarding admixture*, *n*—an admixture that decreases the rate of reaction of cementitious materials thus increasing time of setting of concrete.

3.2.4 *test concrete*, *n*—concrete containing the admixture being evaluated.

3.2.4.1 *Discussion*—In the text of this specification, the wording “category of concrete” refers to whether the concrete mixture is the reference concrete or the test concrete.

3.2.5 *water-reducing admixture*, *n*—an admixture that either increases the slump of freshly mixed concrete without increasing the water content or that maintains the slump with a reduced amount of water due to factors other than air entrainment.

3.2.6 *water-reducing admixture, high range*, *n*—an admixture that reduces the quantity of mixing water required to produce concrete of a given slump by 12 % or greater.

3.2.7 *water-reducing and accelerating admixture*, *n*—an admixture that reduces the quantity of mixing water required to produce concrete of a given slump, reduces the time of setting, and increases the rate of early-age strength development.

⁵ Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, <http://www.aci-int.org>.

3.2.8 *water-reducing and retarding admixture, n*—an admixture that reduces the quantity of mixing water required to produce concrete of a given slump and increases the time of setting of concrete.

3.2.9 *water-reducing, high-range, and retarding admixture, n*—an admixture that reduces the quantity of mixing water required to produce concrete of a given slump by 12 % or greater and increases the time of setting of concrete.

3.2.10 *specific performance admixture, n*—an admixture that provides a desired performance characteristic(s) other than reducing water content, or changing the time of setting of concrete, or both, without any adverse effects on fresh, hardened and durability properties of concrete as specified herein, excluding admixtures that are used primarily in the manufacture of dry-cast concrete products.

3.2.10.1 *Discussion*—Other specific performance characteristics include, but are not limited to, shrinkage reduction, mitigation of alkali-silica reaction, and viscosity modification. Admixtures used for the purposes of reducing water content or changing the time of setting of concrete are classified within the Type A through Type G grouping. Plasticizing, water-repellent, and efflorescence-controlling admixtures are examples of admixtures that are used in the manufacture of dry-cast concrete products.

4. Ordering Information

4.1 The purchaser shall specify the type of chemical admixture desired, and in the case of a Type S admixture the specific performance characteristic(s) required.

5. General Requirements

5.1 For initial compliance with this specification, test concrete made with one of the admixtures shown in 1.1 shall conform to the respective requirements prescribed in Table 1.

5.2 The purchaser is allowed to require a limited retesting to confirm current compliance of the admixture to specification requirements. The limited retesting covers physical properties and performance of the admixture.

5.2.1 The physical properties retesting shall consist of uniformity and equivalence tests for infrared analysis, residue by oven drying, and relative density (specific gravity).

5.2.2 The performance property retesting shall consist of water content of fresh concrete, setting time, and compressive strength at 3, 7, and 28 days.

5.3 At the request of the purchaser, the manufacturer shall state in writing the chloride content of the admixture.

5.4 At the request of the purchaser, the manufacturer shall provide data to substantiate the specific performance characteristic(s) stated by the manufacturer for a Type S admixture.

5.5 Tests for uniformity and equivalence, as indicated in Section 6, shall be made on the initial sample and the results retained for reference and comparison with the results of tests of samples taken from elsewhere within the lot or subsequent lots of admixture.

5.6 At the request of the purchaser, the manufacturer shall state in writing that the infrared analysis spectrum, residue by

oven drying, and relative density (specific gravity) of the supplied admixture are within the limits in Section 6 when compared with the initial sample tested under Level 1 of this specification.

6. Uniformity and Equivalence

6.1 If specified by the purchaser, the uniformity of a lot, or the equivalence of different lots from the same source shall be established by complying with the following requirements:

6.1.1 *Infrared Analysis*—The infrared absorption spectra of the initial sample and the test sample, obtained as specified in 18.1, shall be equivalent. Two infrared absorption spectra are considered equivalent if the same infrared absorption frequencies at the same relative intensities are present in both spectra. Refer to Appendix X3 for additional guidance.

6.1.2 *Residue by Oven Drying (Liquid Admixtures)*—When dried as specified in 18.2, the oven-dried residues of the initial sample and of subsequent samples shall be within ± 12 % of the mid-point of the manufacturer's stated range, but not exceeding the manufacturer's stated limits.

NOTE 5—As an example, for an admixture produced with a residue range from 27 to 35 %, the manufacturer would provide maximum acceptable limits of 27.3 to 34.7 %, representing ± 12 % of the mid-point of the limits, where the mid-point is 31.0 %.

6.1.3 *Residue by Oven Drying (Nonliquid Admixtures)*—When dried as specified in 18.3, the oven-dried residues of the initial sample and of the subsequent samples shall be within a range of variation not greater than ± 4 percentage points.

6.1.4 *Relative Density (Specific Gravity) (Liquid Admixtures)*—When tested as specified in 18.4, the relative density (specific gravity) of the initial sample and subsequent test samples shall not differ from the mid-point of the manufacturer's stated range by more than 10 % of the difference between the mid-point of the manufacturer's stated range and that of reagent water. If 10 % of the difference between the relative density (specific gravity) of the initial sample and water is less than 0.01, use the value 0.01 as the maximum allowable difference. Reagent water conforming to Specification D1193, Types III or IV, and prepared by distillation ion exchange, reverse osmosis, electrodialysis, or a combination of these procedures is adequate.

6.2 If the nature of the admixture or the analytical capability of the purchaser make some or all of these procedures unsuitable, other requirements for uniformity and equivalence from lot to lot or within a lot shall be established by agreement between the purchaser and the manufacturer.

7. Packaging and Marking

7.1 If the admixture is delivered in packages or containers, the proprietary name of the admixture, the type under this specification, and the net mass or volume shall be plainly marked thereon. Similar information shall be provided in the shipping advices accompanying packaged or bulk shipments of admixtures.

8. Storage

8.1 The admixture shall be stored in such a manner as to permit access for inspection and identification of each