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Standard Specification for Cold-Weather Admixture Systems[1]

This standard is issued under the fixed designation C1622/C1622M; 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.

ε[1] NOTE—Editorially corrected ASTM designation references in October 2016.

1. Scope*

1.1 This specification covers cold-weather admixture systems to be added to hydraulic-cement concrete when the temperature of the concrete immediately after placement will be as low as -5.0 °C [23.0 °F] prior to the time of initial set.

1.2 This specification stipulates tests of the cold-weather admixture system with suitable materials as described in 11.1 – 11.3 or with materials proposed for specific work (See 11.5). Unless otherwise requested by the purchaser, tests shall be made using suitable concreting materials as described in 11.1 – 11.3.

NOTE 1—Whenever practicable, tests should be made using the concreting materials, the mixture proportions, and batching sequence proposed for the specific work (See 11.5) because the time of setting, compressive strength gain, and other properties may vary.

1.3 This specification provides 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 cold-weather admixture system meets the requirements of this specification. Uniformity and equivalence tests (See Section 6) shall be carried out to provide results against which later comparisons can be made.

1.3.2 *Level 2*—Limited retesting is described in 5.2, 5.2.1, and 5.2.2. Proof of compliance with the requirements of Table 1 demonstrates conformity of the admixture system with the requirements of this specification.

1.3.3 *Level 3*—For acceptance of a lot or for measuring uniformity within or between lots, when specified by the purchaser, uniformity and equivalence tests (See 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. Within the text, the inch-pound units are shown in brackets. 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.

1.5 The text of this standard references notes and footnotes, which 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 to the test methods portion, 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 and health practices and determine the applicability of regulatory limitations prior to use.* **WARNING**—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.[2]

2. Referenced Documents

2.1 *ASTM Standards:*[3]

C33/C33M Specification for Concrete Aggregates

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C125 Terminology Relating to Concrete and Concrete Aggregates

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

[1] This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.23 on Chemical Admixtures.

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[2] Section on Safety Precautions, Manual of Aggregates and Concrete Testing, Annual Book of ASTM Standards Vol. 04.02.

[3] 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**

TABLE 1 Performance Requirements for Cold-Weather Admixture[A]

Time of Initial Setting, maximum % of control[B]	200
Compressive Strength. minimum % of control[C]	
7 days[D]	40
28 days	80
90 days	90
Length Change, Maximum Shrinkage (alternative requirements)[E]	
Percent of Control[B]	135
Increase over control, percentage points	0.010
Relative Durability Factor, Minimum % of control[F]	80

[A]The values in the table include allowance for normal variation in test results

[B]As an example, in the case of initial time of setting, if the control mixture has a set time of 4.0 hrs, the test specimens can have a set time up to 8.0 hrs. For length change, if the control specimen shrinks X units, the test specimen is allowed to shrink up to 1.35X.

[C]The compressive strength of the concrete containing the cold-weather admixture shall not be less than 90 % of that attained at the previous test age. The objective of this limit is to require that the compressive strength of the cold-weather admixture concrete shall not decrease with age.

[D]Because the test specimens will be cool and damp for the 7d compressive test, it will be necessary to use unbonded caps as described in Practice C1231/C1231M.

[E]Alternative requirements, see 17.1.2: Percent of control applies when shrinkage of control concrete is 0.030 % or greater; the increase over control limit applies when shrinkage of control concrete is 0.030 % or less.

[F]This requirement is applicable only when the cold-weather admixture is to be used in air-entrained concrete that may be exposed to freezing and thawing while wet.

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

C403/C403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

C494/C494M Specification for Chemical Admixtures for Concrete

C666/C666M Test Method for Resistance of Concrete to Rapid Freezing and Thawing

C1064/C1064M Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

C1231/C1231M Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Cylindrical Concrete Specimens

D1193 Specification for Reagent Water

2.2 *American Concrete Institute Standard:*[4]

ACI 211.1 Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

3. Terminology

3.1 *Definitions:*

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cold-weather admixture system, n*—an admixture or group of admixtures that depresses the freezing point of mixing water and increases the hydration rate of cement in concrete.

3.2.2 *control concrete mixture, n*—a concrete mixture without the cold-weather admixture system.

3.2.3 *dummy concrete specimen, n*—additional concrete specimen instrumented with a temperature sensing device to estimate the temperature of test concrete specimens.

3.2.4 *replicate concrete specimen, n*—additional time-of-setting specimen exposed to the same temperature regimen as the test concrete specimen.

3.2.5 *test concrete mixture, n*—a concrete mixture with the cold weather admixture system.

4. Apparatus

4.1 *Low Temperature Environment*—A chamber of sufficient size to subject the test specimens to the specified low temperature and that allows access for laboratory personnel to conduct appropriate tests. The chamber or chambers shall be capable of cooling numerous specimens from their initial temperature to -5.0 ± 1 °C [23.0 ± 2.0 °F] within the specified elapsed time and maintain them at that temperature for the specified time period.

4.2 *Temperature Measuring Equipment*—The temperature measuring equipment shall be capable of measuring and recording the temperature at the center of the dummy specimens to ± 1.0 °C [± 2.0 °F] at least every ½ h for 7 days.

4.3 *Tools*—Molds and tools for preparing test specimens as described in Practice C192/C192M. Molds shall have lids to provide for sealed conditions.

5. General Requirements

5.1 For initial compliance with this specification, the concrete shall be tested with the cold-weather admixture system for conformance with the requirements in Table 1.

5.2 The purchaser is permitted to require limited retesting to confirm current compliance of the admixture system to specification requirements. The limited retesting includes measurements of physical and performance properties of the admixture system as described in 5.2.1 and 5.2.2.

5.2.1 The physical properties retesting consists of uniformity and equivalence tests of the admixture system for infrared absorption spectrum and relative density.

5.2.2 The performance properties retesting consists of time of initial setting and compressive strength of concrete at 7 and 28 days. Purchasers having special requirements are permitted to require additional tests.

5.3 At the request of the purchaser, the manufacturer shall state in writing that the admixture system supplied for use in the work is equivalent in all essential respects, including concentration, to the admixture system tested under this specification.

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

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

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 samples taken elsewhere within the lot or subsequent lots of admixture supplied to the work.

6. Uniformity and Equivalence Tests

6.1 When specified by the purchaser, the uniformity of a lot, or equivalence of multiple lots from the same source shall be established by the following requirements:

6.1.1 *Infrared Analysis*—The absorption spectra of the initial sample and the test sample, obtained as specified in Section 18, shall exhibit the same pattern of absorption bands in terms of frequency and intensity.

6.1.2 *Relative Density* (Liquid Admixture)—When tested as specified in Section 18, the relative density (specific gravity) of subsequent test samples shall not differ from the relative density of the initial sample by more than 10 % of the difference between the relative density of the initial sample and reagent water at the same temperature. Reagent water conforming to Specification D1193, Type III or IV, and prepared by distillation, ion exchange, reverse osmosis, or a combination of these procedures, is acceptable (See Note 2).

6.2 When the nature of the admixture system or analytical capability of the purchaser make 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.

NOTE 2—Oven drying methods are not appropriate for measuring the oven-dried residue content for cold-weather admixture system because water, present in the form of bound water of hydration, is released slowly upon drying, and can often lead to highly variable results. Relative density is an acceptable indication of lot-to-lot uniformity.

7. Packaging and Marking

7.1 When the cold-weather admixture system is delivered in packages or containers, the proprietary name of the individual admixtures in the system, the designation of this specification, and the net mass or volume shall be plainly marked thereon. Similar information shall be provided in the shipping information accompanying packages or bulk shipments of admixture.

8. Storage

8.1 Store the cold-weather admixture system to permit easy access for proper inspection and identification of each shipment, and in a suitable building that will protect the admixture from moisture absorption if it is a dry admixture or from freezing if it is a liquid admixture.

9. Sampling and Testing

9.1 Every facility shall be provided to the purchaser for sampling and inspection, either at the point of manufacture or at the site of the work, as specified by the purchaser.

9.2 Samples shall be either "grab" or "composite" samples as specified by this specification. A grab sample is one obtained in a single operation. A composite sample is one obtained by combining three or more grab samples.

9.3 For the purpose of this specification, it is recognized that samples will be taken for two reasons:

9.3.1 *Compliance Tests*—A sample taken for evaluating compliance of a source or lot of cold-weather admixture system shall meet the applicable requirements of this specification. Samples used to determine conformance with this specification shall be composites of grab samples taken from different locations so that the composite sample will be representative of the lot.

9.3.2 *Uniformity and Equivalence Tests*—When specified by the purchaser, a sample taken for evaluating the uniformity of a single lot or equivalence of multiple lots from one source shall be tested as provided in Section 6. When uniformity of a single lot is being determined, grab samples shall be used. When uniformity of multiple lots from the same source is being determined, composite samples from individual lots shall be used.

9.4 *Liquid Admixtures*—Liquid admixtures shall be agitated immediately prior to sampling. Grab samples taken for quality or uniformity tests shall represent a unit shipment or a single production lot. Each grab sample shall be at least 1 L [1 qt]. At least three grab samples of equal portions shall be taken. Composite samples shall be prepared by mixing the grab samples and the resultant mixture shall provide at least 3 L [3 qt] for compliance tests. Grab samples shall be taken from different locations distributed throughout the quantity to be represented.

9.4.1 Admixtures in bulk storage tanks shall be sampled equally from the upper, intermediate, and lower levels by means of drain cocks in the sides of the tanks or a weighted sampling bottle fitted with a stopper that can be removed after the bottle is lowered to the desired depth.

9.4.2 Samples shall be stored in impermeable containers that are resistant to attack by the admixture.

9.5 *Nonliquid Admixtures*—Grab samples taken for compliance or uniformity tests shall be at least 1kg [2 lb]. At least four grab samples of equal portions shall be taken from not more than 2 Mg [2 tons] of admixture. Prepare composite samples by mixing the grab samples and sampling the resultant mixture to provide at least 2.5 kg [5 lb] for the composite sample. Take grab samples from different locations distributed throughout the quantity to be represented.

9.5.1 Obtain samples of packaged admixtures by means of a sampler as described in Practice C183/C183M.

9.5.2 Samples shall be stored in moisture-proof, airtight containers.

9.6 Mix samples before testing to ensure uniformity. When recommended by the manufacturer, dissolve the entire sample of non-liquid admixture in water prior to testing.

10. Rejection

10.1 For initial compliance testing, the purchaser is permitted to reject the cold-weather admixture system if it fails to meet any of the requirements of this specification.

10.2 For the initial retesting, the purchaser is permitted to reject the admixture if it fails to meet any of the requirements of Section 6 and applicable parts of Table 1, as defined in 5.2.2.

10.3 If, after completion of tests, an admixture has been stored at the point of manufacture for more than 6 months prior to shipment, or an admixture has been in local storage in the hands of a vendor for more than 6 months, it shall be retested before use when requested by the purchaser and is permitted to be rejected if it fails to conform to this specification.

10.4 Packages and containers varying more than 5 % from the specified mass or volume are permitted to be rejected. If the average mass or volume of 50 packages taken at random is less than that specified, the entire shipment is permitted to be rejected.

10.5 When the admixture is for a specific use in non-air-entrained concrete, it is permitted to be rejected if the test concrete containing it has an air content greater than 3.5 % at the dosage used to meet this specification. When the admixture is to be used in air-entrained concrete, it is permitted to be rejected if the test concrete containing it has an air content greater than 7.5 % at the dosage used to meet this specification.

11. Materials

11.1 *Concrete Not for Specific Use*—The materials in 11.2 – 11.4 are for compliance testing using a concrete mixture not for a specific use.

11.2 *Cementitious Materials*—The cementitious materials shall be a Type I or Type II portland cement conforming to Specification C150/C150M, or a blend of two or more of these cements from different sources.

11.3 *Aggregates*—Except when tests are made in accordance with 11.4 using the aggregates for a specific use, the fine and coarse aggregates used in any series of tests shall come from single lots of materials that conform to the requirement of Specification C33/C33M, except that the grading shall conform to the following requirements:

11.3.1 *Fine Aggregate Grading:*

Sieve	Percent Passing by Mass
4.75 mm (No. 4)	100
1.18 mm (No. 16)	65 to 75
300 µm (No. 50)	12 to 20
150 µm (No. 100)	2 to 5

11.3.2 *Coarse Aggregate Grading*—The coarse aggregate grading shall meet the Size 57 grading requirements of Specification C33/C33M. Take care in loading and delivery to avoid segregation.

11.3.3 Coarse aggregate used for control concrete and test concrete shall be essentially the same. Provide sufficient coarse aggregate for the control concrete, the test concrete, and for grading analysis.

11.3.3.1 Prepare required quantities of coarse aggregate (See Note 3) as follows: Fill tared containers, one for sieve analysis, one for a batch of control concrete, and one for a batch of test concrete, to the required mass from the aggregate stockpile. Accomplish this by placing equal quantities into each container, successively, and repeat the procedure until all the containers have their required mass.

NOTE 3—Refer to the section on Sampling Aggregates in the Manual of Aggregate and Concrete Testing for guidance on sampling from stockpiles.

11.3.4 Perform sieve analyses on the coarse aggregate prepared in 11.3.3.1 by Test Method C136/C136M. Discard any prepared quantity of aggregate that deviates from the specified percent passing by more than the amount shown in column 3 below.

Sieve	Specification C33/C33M, No. 57 Percent Passing by Mass	Maximum Variation from Percent Passing
37.5 mm (1 ½ in.)	100	0.0
25.0 mm (1 in.)	95 to 100	1.0
12.5 mm (½ in.)	25 to 60	4.0
4.75 mm (No. 4)	0 to 10	4.0
2.36 mm (No. 8)	0 to 5	1.0

11.4 *Air-Entraining Admixture*—Except when tests are made in accordance with 11.5 using an air-entraining admixture proposed for specific work, the air-entraining admixture used in the concrete mixtures specified in Section 12 shall be a material such that, when used to entrain the specified amount of air in the concrete mixture, will give concrete of satisfactory resistance to freezing and thawing. The air-entraining admixture shall conform to Specification C260/C260M.

11.5 *Concrete for Specific Use*—The materials in this section are for specific use, such as for testing the cold-weather admixture system in simulated job concrete mixtures. To test the cold-weather admixture system for use in specific work, the cementitious materials, aggregates (See 11.3), other chemical admixtures, and air-entraining admixture used shall be representative of those used in the work. Add the cold-weather admixture system in the same manner and at the same time during the batching and mixing sequence as it will be added on the job. Proportion the concrete mixture to be similar to that used in the work. If the maximum size of coarse aggregate in the job concrete is greater than 25.0 mm [1 in.], screen the fresh concrete over a 25.0 mm (1 in.) sieve prior to fabricating the specimens to be tested.

12. Proportioning Concrete Mixtures

12.1 *Preparation and Batching*—Prepare all materials and make all weighing as prescribed in Practice C192/C192M. Prepare all materials so that the test concrete temperature, at the time of specimen casting, shall be 14 ± 2 °C [57 ± 3 °F]. Prepare all control concrete materials according to 14.6.2.

12.2 *Proportions*—Concrete mixtures not for specific uses shall be proportioned using ACI 211.1 (See Note 4). After evaluation of trial mixtures, aggregate proportions shall be adjusted as needed to obtain workable, cohesive mixtures with the correct yield. Unless otherwise specified, the cold-weather admixture system shall be added with the second increment of mixing water added to the mixer.

12.2.1 The cementitious materials content shall be 357 ± 3 kg/m^3 [600 ± 5 lb/yd^3].

12.2.2 For the first trial mixture, refer to the table on volume of coarse aggregate in ACI 211.1 for guidance on amount of coarse aggregate to use for the fineness modulus of the fine aggregate being used.

NOTE 4—Values in the referenced table of ACI 211.1 are intended to ensure workable mixtures with the least favorable combinations of aggregates used. It is suggested, therefore, that for a closer approximation