



Designation: C 1017/C 1017M – 03

Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete¹

This standard is issued under the fixed designation C 1017/C 1017M; 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 (ϵ) indicates an editorial change since the last revision or reapproval.

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

1. Scope

1.1 This specification covers two types of chemical admixtures to be added to hydraulic cement concrete mixtures for the purpose of producing flowing concrete. The types are as follows:

1.1.1 *Type I*—Plasticizing, and

1.1.2 *Type II*—Plasticizing and retarding.

1.2 This specification stipulates tests of a chemical admixture with reference concreting materials or with concrete-making materials proposed for specific work. Unless otherwise specified by the purchaser, the tests shall be made using reference concreting materials.

1.3 If a chemical admixture has been tested and found to comply with the provisions of this specification using reference materials, and is being considered for use with other materials for specific work, additional tests for such use are allowed if agreed upon between the purchaser and the supplier and are allowed to consist of a portion of the tests described herein.

1.4 This specification provides for three levels of testing.

1.4.1 *Level 1*—During the initial approval stage, proof of compliance with the performance requirements defined in Table 1 demonstrates that the admixture meets the requirements of this specification. Uniformity and equivalence tests of the section on Lot Uniformity and Equivalence shall be carried out to provide results against which later comparisons can be made.

1.4.2 *Level 2*—Limited retesting described in the section relating to general requirements may be requested at intervals by the purchaser. Proof of compliance with the requirements of Table 1 demonstrates continued conformity of the admixture with the requirements of the specification.

1.4.3 *Level 3*—For acceptance of a lot or for measuring uniformity within or between lots, when specified by the

purchaser, the uniformity and equivalence tests of the section on Lot Uniformity and Equivalence shall be used.

1.5 The values stated in SI units are to be regarded as standard. The values in inch-pound units shown in parentheses are provided for information purposes only.

NOTE 1—It is recommended that, whenever practicable, tests be made using the concrete-making materials (cement, pozzolan, slag, aggregates, air-entraining admixture), the mixture proportions, and the batching sequence and other physical conditions proposed for the specific work. The specific effects produced by chemical admixtures may vary with the properties and proportions of the other ingredients of the concrete.

NOTE 2—Temperature has a pronounced effect on time of setting of concrete. This may be exaggerated by the use of admixture Types I and II. If concrete temperatures to be expected on a particular job differ significantly from the conditions set forth in this specification, further testing may be desirable.

NOTE 3—An unusually rapid loss of workability with time, sometimes termed “slump loss”, can be experienced with these admixtures. The rate of slump loss will vary with the particular concreting materials and proportions, mixing equipment and procedures, and temperatures experienced on any particular job. At elevated temperatures, the slump may be retained for a longer period if a Type II admixture is used.

NOTE 4—Admixtures that contain relatively large amounts of chloride may accelerate corrosion of prestressing steel. Compliance with the requirements of this specification does not constitute assurance of acceptability of the admixture for use in prestressed concrete (see ACI 318).

NOTE 5—Admixtures that contain relatively large amounts of alkali ($\text{Na}_2\text{O} + 0.658 \text{K}_2\text{O}$) may contribute to reaction with some aggregates. Compliance with the requirements of this specification does not assure acceptability when used with alkali-reactive aggregates and some cements.

1.6 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.

1.7 The following precautionary caveat pertains only to the test method sections 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*

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.

Current edition approved Dec. 1, 2003. Published January 2004. Originally approved in 1985. Last previous edition approved in 1998 as C 1017 – 98.

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:²

- C 33 Specification for Concrete Aggregates
 - C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - C 78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
 - C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - C 138/C 138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
 - C 143 Test Method for Slump of Hydraulic Cement Concrete
 - C 150 Specification for Portland Cement
 - C 157 Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete
 - C 173 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
 - C 183 Practice for Sampling and the Amount of Testing of Hydraulic Cement
 - C 192 Practice for Making and Curing Concrete Test Specimens in the Laboratory
 - C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 - C 260 Specification for Air-Entraining Admixtures for Concrete
 - C 403 Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
 - C 666 Test Method for Resistance of Concrete to Rapid Freezing and Thawing
 - C 778 Specification for Standard Sand
 - D 75 Practice for Sampling Aggregates
 - D 1193 Specification for Reagent Water
 - E 100 Specification for ASTM Hydrometers
 - Manual of Aggregate and Concrete Testing
- ### 2.2 American Concrete Institute Standard:³
- ACI 211.1-81 Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete
 - ACI 318-83 Building Code Requirements for Reinforced Concrete

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *flowing concrete*—concrete that is characterized by a slump greater than 7½ in. (190 mm) while maintaining a cohesive nature, and which otherwise meets the requirements of Table 1.

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.

³ Available from the American Concrete Institute, 38800 Country Club Drive, Farmington Hills, MI 48331.

TABLE 1 Physical Requirements^A

	Type I Plasticizing	Type II Plasticizing and Retarding
Time of setting, allowable deviation from Reference, h		
Initial: at least not more than	... 1 earlier nor 1½ later	1 later 3½ later
Final: at least not more than	... 1 earlier nor 1½ later	... 3½ later
Increase in slump, min.	90 mm (3.5 in.)	90 mm (3.5 in.)
Compressive strength, min., % of reference		
3 days	90	90
7 days	90	90
28 days	90	90
6 months	90	90
1 year	90	90
Flexural strength, min., % of reference		
3 days	90	90
7 days	90	90
28 days	90	90
Length change after 14 days drying, max. shrinkage (alternative requirements): ^B		
% of reference	135	135
Increase over reference, in.	0.010	0.010
Relative durability factor, min. ^C	80	80

^AThe values in the table include allowance for normal variation in the test results. The object of the 90 % strength requirements is to require a level of performance comparable to that of the reference concrete.

^B*Alternative Requirements*—Percent of reference limit applies when length change of reference is 0.030 % or greater; increase over reference limit applies when length change of reference is less than 0.030 %.

^CThe requirement is applicable only when the admixture is to be used in air-entrained concrete which may be exposed to freezing and thawing while wet.

3.1.2 *plasticizing admixture*—a chemical admixture which, when added to concrete, produces flowing concrete without further addition of water and does not retard the setting of the concrete.

3.1.3 *plasticizing and retarding admixture*—a chemical admixture which, when added to concrete, produces flowing concrete without further addition of water and retards the setting of concrete.

3.1.4 *reference concrete*—concrete which contains the same amounts of cement, aggregates, water, and other concreting materials, but no plasticizing admixture.

3.1.5 *test concrete*—concrete which has a plasticizing admixture added.

4. Ordering Information

4.1 When the purchaser specifies flowing concrete, he shall also specify the type of chemical admixture desired. If not specified, the requirements of Type I will apply.

5. General Requirements

5.1 For initial compliance with this specification, test concrete in which each type of admixture shown in 1.1 is used 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 will cover 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 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.

NOTE 6—Additional performance tests currently in this standard may be required by users having special requirements.

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

5.4 At the request of the purchaser, when the chemical admixture is to be used in prestressed concrete, the manufacturer shall state in writing the chloride content of the admixture and whether or not chloride has been added during its manufacture.

5.5 Tests for uniformity and equivalence 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 supplied for use in the work.

6. Lot Uniformity and Equivalence

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

6.1.1 *Infrared Analysis*—The absorption spectra of the initial sample and the test sample, obtained as specified, shall be essentially similar.

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

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

6.1.4 *Specific Gravity (Liquid Admixtures)*—When tested as specified, the specific gravity of subsequent test samples shall not differ from the specific gravity of the initial sample by more than 10 % of the difference between the specific gravity of the initial sample and that of reagent water at the same temperature. If 10 % of the difference between the 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 D 1193, Types III or IV, and prepared by distillation, ion exchange, reverse osmosis, electro dialysis, or a combination of these procedures is adequate.

6.2 When 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. Sampling and Inspection

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

7.2 Samples shall be either grab or composite samples, as specified or required 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.

7.3 Samples will be taken for two reasons:

7.3.1 *Quality Tests*—A sample taken for the purpose of evaluating the quality of a source or lot of admixture will be required to meet all the applicable requirements of this specification. Samples used to determine conformance with the requirements of this specification shall be composites of grab samples taken from sufficient locations to ensure that the composite sample will be representative of the lot.

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

7.4 *Liquid Admixtures*—Liquid admixtures shall be agitated thoroughly immediately prior to sampling. Grab samples taken for quality or uniformity tests shall represent not more than 2500 gal (9500 L) of admixture and shall have a volume of at least 1 qt (1 L). A minimum of three grab samples shall be taken. Composite samples shall be prepared by thoroughly mixing the grab samples selected and the resultant mixture sampled to provide at least 1 gal (4 L) for quality tests. Grab samples shall be taken from different locations well distributed throughout the quantity to be represented.

7.4.1 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.

7.4.2 Samples shall be packaged in impermeable, airtight containers which are resistant to corrosion.

7.5 *Nonliquid Admixtures*—Grab samples taken for quality or uniformity tests shall represent not more than 2 tons (1800 kg) of admixture and shall weigh at least 2 lb (1 kg). A minimum of four grab samples shall be taken. Composite samples shall be prepared by thoroughly mixing the grab samples selected and the resultant mixture sampled to provide at least 5 lb (2.3 kg) for the composite sample. Grab samples shall be taken from different locations well distributed throughout the quantity to be represented.

7.5.1 Samples of packaged admixtures shall be obtained by means of a tube sampler as described in Practice C 183.

7.5.2 Samples shall be packaged in moisture-proof, airtight containers.

7.6 Samples shall be thoroughly mixed before testing to ensure uniformity. When recommended by the manufacturer,

the entire sample of a nonliquid admixture shall be dissolved in water prior to testing.

TEST METHODS

8. Scope

8.1 These test methods are based on arbitrary stipulations which make possible highly standardized testing in the laboratory and are not intended to simulate actual job conditions.

9. Apparatus

9.1 *Infrared Spectrophotometer.*

9.2 *Hydrometers*, Nos. 112H through 117H in accordance with Specification E 100.

9.3 *Water Bath*, capable of maintaining $25 \pm 1^\circ\text{C}$.

10. Reagents and Materials

10.1 *Reagents:*

10.1.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water as defined by Types III or IV of Specification D 1193.

10.1.2 *Potassium Bromide*, of a grade suitable for infrared analysis.

10.2 *Materials:*

10.2.1 *Cement*—The cement used in any series of tests shall be either the cement proposed for specific work or a cement conforming to the requirements of Specification C 150, Type I or Type II. If, when using a cement other than that proposed for specific work, the air content of the concrete made without admixture is more than 3.0 %, select a different cement so that the air content of the concrete will be 3.0 % or less.

10.2.2 *Aggregates*—Except when tests are made using the aggregates proposed for specific work, the fine and coarse aggregates used in any series of tests shall come from single lots of well-graded, sound materials that conform to the requirements of Specification C 33, except that the grading of the aggregates shall conform to the following requirements:

10.2.3 *Fine Aggregate*—The fine aggregate grading shall be as follows:

Sieve	Weight Percent Passing
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

10.2.4 *Coarse Aggregate*—The coarse aggregate shall meet the requirements for size number 57 of Specification C 33. Take care in loading and delivery to avoid segregation.

10.2.4.1 The coarse aggregate used for each set of reference concrete and comparable test admixture-treated concrete shall be essentially the same. Therefore, a set of test concrete consists of one reference concrete and as many test admixture-containing concretes as are intended to be compared to that one reference. Thus, coarse aggregate for one set shall consist of enough material for one reference concrete, the test admixture-containing concrete to be compared with that reference and the sample for grading analysis testing.

10.2.4.2 Prepare coarse aggregate for a set, comprising a sample large enough for concrete trials, as follows: Fill tared containers, one each for a sample, a batch of reference concrete

and one or more test concretes to the required mass from the aggregate stockpile. Accomplish this by starting with a scoopful into the first container and progress with a scoopful into each succeeding container and repeat this procedure until all containers have their required mass. Repeat the process for each of the three or more sets needed. One or more spare sets may be needed. See Appendix of Practice D 75, Sampling from Stockpiles, and the Manual of Aggregate and Concrete Testing for guidance for conditions and procedures.

10.2.4.3 Coarse aggregate samples representing each set shall be tested by Test Method C 136 requirements for the sieves shown below. Any set for which the sample does not comply with size 57 shall be discarded. Test results for samples which comply with size 57 shall be averaged for each sieve size. Any set for which the sample deviates from this average by more than the amount shown in column 3 shall be discarded. The process of preparation, testing and averaging shall be continued until sufficient sets of aggregate within tolerance are obtained.

Sieve	Specification C 33, No. 57 Percent Passing	Maximum variation from average/passing
37.5-mm (1.5 in.)	100	0.0
25.0-mm (1.0 in.)	95 to 100	1.0
12.5-mm (0.5 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

NOTE 7—All of the results required for demonstrating compliance under this specification are dependent on the uniformity of the aggregate samples prepared and used. Careful, skilled and well-supervised work is essential.

10.2.5 *20-30 Sand*—As specified in Specification C 778.

10.2.6 *Air-Entraining Admixture*—Except when tests are made using the air-entraining admixture proposed for specific work, the air-entraining admixture used, if needed in the concrete mixtures, shall be a material which when used to entrain the specified amount of air in the reference concrete mixture will give concrete of satisfactory resistance to freezing and thawing. The material to be so used will be designated by the person, or agency, for whom the testing is to be performed. If no material is designated, neutralized Vinsol resin⁴ shall be used.

NOTE 8—If unneutralized Vinsol resin is purchased, neutralization may be accomplished by treating 100 parts of Vinsol resin with 9 to 15 parts of NaOH by mass. In an aqueous solution, the ratio of water to the resinate should not exceed 12 to 1 by mass.

10.2.7 *Materials for Tests for Specific Uses*—To test a chemical admixture for use in specific work, the concreting materials used shall be representative of those proposed for use in the work. Add the chemical admixture 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 mixtures to have the cement content specified for use in the work. If the maximum size of coarse aggregate is greater than 25.0 mm (1 in.), screen the concrete over a 25.0-mm (1-in.) sieve prior to fabricating the test specimens.

10.2.7.1 *Other Use Conditions*—At times, other conditions affect the overall suitability of the concrete mixture for specific

⁴ Vinsol resin is manufactured by Hercules, Inc., Wilmington, DE.