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Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete¹

This standard is issued under the fixed designation C1602/C1602M; 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 specification covers the compositional and performance requirements for water used as mixing water in hydraulic cement concrete. It defines sources of water and provides requirements and testing frequencies for qualifying individual or combined water sources. In any case where the requirements of the purchaser differ from these in this specification, the purchaser's specification shall govern.

1.2 This specification does not purport to cover methods of storage, transportation, or blending of water, or to address the development and maintenance of quality control programs sponsored or managed by the manufacturer.

1.3 The values stated in either SI units, shown in brackets, 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.

1.4 The text of this specification references 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.

1.5 *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 to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

C31/C31M [Practice for Making and Curing Concrete Test Specimens in the Field](#)

C33/C33M [Specification for Concrete Aggregates](#)

C39/C39M [Test Method for Compressive Strength of Cylindrical Concrete Specimens](#)

C94/C94M [Specification for Ready-Mixed Concrete](#)

C109/C109M [Test Method for Compressive Strength of Hydraulic Cement Mortars \(Using 2-in. or \[50-mm\] Cube Specimens\)](#)

C114 [Test Methods for Chemical Analysis of Hydraulic Cement](#)

C125 [Terminology Relating to Concrete and Concrete Aggregates](#)

C192/C192M [Practice for Making and Curing Concrete Test Specimens in the Laboratory](#)

C305 [Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency](#)

C403/C403M [Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance](#)

C494/C494M [Specification for Chemical Admixtures for Concrete](#)

C1603 [Test Method for Measurement of Solids in Water](#)

2.2 ACI Documents:³

ACI 318 [Building Code Requirements for Structural Concrete and Commentary](#)

3. Terminology

3.1 *Definitions:* For definitions of terms used in this specification, refer to Terminology C125

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *combined water* **combined water, n** —a mixture of two or more sources of water blended together, before or during introduction into the mixture, for use as mixing water in the production of concrete.

¹ This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.40 on Ready-Mixed Concrete.

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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 American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333.

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

3.2.2 *hydration stabilizing admixtures*—extended set retarding admixtures that control the hydration of cement in applications of managing returned concrete and water from concrete production hydration stabilizing admixtures, *n*—set retarding admixtures, conforming to Specification C494/C494M Type B or D, that can predictably reduce the hydration rate of cement for applications requiring the management of time of setting of returned concrete, reducing the hydration rate of cement fines in water from concrete production, or for applications requiring extended delivery time of ready mixed concrete.

3.2.3 *non-potable* non-potable, *adj*—water sources that are not fit for human consumption, or if it contains quantities of substances that discolor it or make it smell or have objectionable taste but does not contain water from concrete production operations.

3.2.4 *potable water* potable water, *n*—water suitable for human consumption

3.2.5 *water from concrete production operations*, *n*—water recovered from processes of hydraulic cement concrete production that includes wash water from mixers or that was a part of a concrete mixture; water collected in a basin as a result of storm water runoff at a concrete production facility; or water that contains quantities of concrete ingredients.

4. Requirements for Use

4.1 Mixing water shall consist of:

4.1.1 Batch water (water weighed or metered through the batch plant),

4.1.2 Ice,

4.1.3 Water added by truck operator,

4.1.4 Free moisture on the aggregates, and

4.1.5 Water introduced in the form of admixtures when this water increases the water-cementitious materials ratio by more than 0.01.

4.2 Potable water is permitted to be used as mixing water in concrete without testing for conformance with the requirements of this specification.

4.3 Mixing water that is wholly or partially composed of sources of water that are non-potable or from concrete production operations are permitted to be used in any proportions to the limits qualified to meet the requirements of Table 1. At the option of the purchaser and when appropriate for the construction, any of the optional limits found within Table 2 shall be specified at the time of concrete ordering according to the section on *Ordering Information* of Specification C94/C94M.

4.3.1 Non-potable sources of water shall be qualified for use in accordance with 5.1. When required by the purchaser, requirements of 5.4 shall also apply. When the non-potable water source is blended with a potable source, the qualification of the mixing water shall be at the highest percentage of the non-potable source in the combined mixing water anticipated during production.

4.3.2 Combined water blended from two or more sources, where one of the sources includes that from concrete production, shall be qualified for use in accordance with 5.2. When required by the purchaser, requirements of 5.4 shall also apply. The combined water shall be qualified at the highest solids content in the total mixing water anticipated during production. Mixing water containing total solids equal to or less than the level qualified by testing shall be permitted.

5. Testing and Requirements

5.1 For sources of non-potable mixing water (as defined in 3.2.3) proposed for use as total mixing water or in the combined mixing water (as defined in 3.2.1), the following shall apply to the total combined mixing water:

TABLE 1 Concrete Performance Requirements for Mixing Water

	Limits Test Methods
	Limits
Compressive strength, min % control at 7 days ^{A,B}	90 C31/C31M, C39/C39M
Compressive strength, min % control at 7 days ^A	90
Time of set, deviation from control, h: min ^A	From 1:00 early to 1:30 later C403/ C403M
Time of setting, deviation from control, h: min ^A	From 1:00 earlier to 1:30 later

^A Comparisons shall be based on fixed proportions for a concrete or mix design representative of the construction. The water supply and a control mixture shall be made with 100 % potable or distilled water or di. The test mixture shall be made with the mixing water that is being evaluated. (See Annex A1).

^B Compressive strength results shall be based on at least two standard test specimens made from a composite sample.

TABLE 2 Optional Chemical Limits for Combined Mixing Water^A

	Limits	Test Method
Maximum concentration in combined mixing water, ppm ^B		
A. Chloride as Cl ⁻ , ppm		
1 1 in prestressed concrete, bridge decks, or otherwise designated	500^C 500 ^C	C114 C114 ^D
2 2 other reinforced concrete in moist environments or containing aluminum embedments or dissimilar metals or with stay-in-place galvanized metal forms	1000^C 1000 ^C	C114 C114 ^D
B. Sulfate as SO ₄ ⁻² , ppm		
1 1 in prestressed concrete, bridge decks, or otherwise designated	3000 3000	C114 C114 ^D
2 2 other reinforced concrete in moist environments or containing aluminum embedments or dissimilar metals or with stay-in-place galvanized metal forms	600 600	C114 C114 ^D
C. Alkalies as (Na ₂ O + 0.658 K ₂ O), ppm		
1 1 in prestressed concrete, bridge decks, or otherwise designated	600 600	C114 C114 ^D
2 2 other reinforced concrete in moist environments or containing aluminum embedments or dissimilar metals or with stay-in-place galvanized metal forms	50 000 50 000	C1603 C1603

^ASpecification limits from this table are not prohibited from being specified as individual items or as a whole per ~~p~~ in accordance with the section on Ordering Information of Specification C94/C94M.

^Bppm is the abbreviation for parts per million

^CThe requirements for concrete in ACI 318 shall govern when the manufacturer can demonstrate that these limits for mixing water can be exceeded. For conditions allowing the use of calcium chloride (CaCl₂) accelerator as an admixture, the chloride limitation is permitted to be waived by the purchaser.

^DTest Methods C114 includes reference and alternative test methods to measure the concentration of chlorides, sulfates, and alkalis in solutions prepared from dissolving cementitious materials. Use the applicable test methods in Test Methods C114 to measure these constituents. The laboratory performing these tests is not required to conform to the method qualification requirements of Test Methods C114. Alternative instrumental and wet chemistry methods not listed in Test Methods C114 that measure the concentration of these chemical species in solution are permitted. When alternative methods are used, the test method used shall be included in the report.

5.1.1 Water shall be tested for compliance with Table 1 before first use and thereafter every three months or more often when there is reason to believe that a change has occurred in the characteristics of the source. Testing is permitted to be at a lower frequency, but not less than annually when results from four consecutive tests indicate compliance with Table 1. Testing shall be in accordance with 5.3.

~~5.1.2 The manufacturer shall maintain documented evidence that the characteristics of the combined mixing water are in compliance with Table 2. These tests shall be conducted before first use and thereafter every 6 months or more often when there is reason to believe that a change has occurred in the characteristics of the source. These records shall be provided to the purchaser on request.~~

5.2 For sources of water from concrete production operations (as defined in 3.2.5) proposed for use as the total mixing water or in the combined mixing water (as defined in 3.2.1), the following shall apply to the total combined mixing water:

5.2.1 The density of the ~~source of water from ready mixed concrete~~ concrete production operations shall be tested at least on a daily basis in accordance with Test Method C1603 or monitored with a hydrometer that has been verified in accordance with Test Method C1603. Manufacturers that use automated devices shall maintain at the production facility documentation on the procedures and calibration of systems, as needed (See Note 1).

NOTE 1—Blending proportions of water sources can be determined in accordance with Appendix A1 of Test Method C1603 for achieving a target solids content.

5.2.2 Combined water shall be tested for compliance with the requirements of Table 1, in accordance with 5.3, at the highest solids content anticipated to be used during production in accordance with the following testing frequencies:

5.2.2.1 When the density of the combined water is less than 1.01 g/mL, the water shall be tested before first use and thereafter once every six months. Testing frequency is permitted to be reduced to once every 12 months when the results of two consecutive tests indicate compliance with the requirements of Table 1 (See Note 2).

NOTE 2—This condition is intended to cover the use of clarified wash water that has been passed through a settling pond system.

5.2.2.2 When the density of the combined water is between 1.01 and 1.03, the water shall be tested before first use and thereafter monthly. Testing frequency is permitted to be reduced to once every three months when the results of 4 consecutive tests indicate compliance with the requirements of Table 1 (See Note 3).

NOTE 3—Water density of 1.03 approximately represents a total solids content of 50,000 ppm.

5.2.2.3 When the density of the combined water exceeds 1.03, the water shall be tested weekly or more often when there is reason to believe that there is a change in the water characteristics for compliance with the requirements of Table 1. Testing frequency is permitted to be reduced to once every month when the results of two months of consecutive tests indicate compliance with the requirements of Table 1.

5.2.2.4 Testing for water with density exceeding 1.05 shall be the same as that of 5.2.2.3 whether the water includes or does not include a set/hydration stabilizing admixture (See Note 4).

NOTE 4—Water density exceeding approximately 1.05, where the solids are essentially composed of cementitious materials, may require the use of hydration stabilizing admixtures to maintain compliance with the requirements of Table 1. The producer should have a documented process in place to verify the effectiveness of the admixtures and dosages employed.