



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

This standard is issued under the fixed designation C 1602/C 1602M; 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 reappraisal. A superscript epsilon (ε) indicates an editorial change since the last revision or reappraisal.

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

C 31/C 31M Practice for Making and Curing Concrete Test Specimens in the Field

C 39/C 39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C 94/C 94M Specification for Ready-Mixed Concrete

C 114 Test Methods for Chemical Analysis of Hydraulic Cement

C 125 Terminology Relating to Concrete and Concrete Aggregates

C 192/C 192M Practice for Making and Curing Concrete Test Specimens in the Laboratory

C 403/C 403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

C 1603 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 **C 125**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *combined water*—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.

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

3.2.3 *non-potable*—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*—water suitable for human consumption

3.2.5 *water from concrete production operations*—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:

³ Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333.

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.

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

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 **C 94/C 94M**.

4.3.1 Non-potable sources of water shall be qualified for use in accordance with **5.1**. 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**. 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:

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**.

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 shall be tested at least on a daily basis in accordance with Test Method **C 1603** or monitored with a hydrometer that has been verified in accordance with Test Method **C 1603**. 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 **C 1603** for achieving a target solids content.

5.2.2 Combined water shall be tested for compliance with the requirements of **Table 1** 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 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.

5.2.3 The manufacturer shall maintain documentation on the characteristics of the water in compliance with the requirements of **Table 2**, other than the total solids requirement. These requirements shall apply to the combined water at the highest

TABLE 1 Concrete Performance Requirements for Mixing Water

	Limits	Test Methods
Compressive strength, min % control at 7 days ^{A,B}	90	C 31/C 31M, C 39/C 39M
Time of set, deviation from control, h: min ^A	From 1:00 early to 1:30 later	C 403/C 403M

^A Comparisons shall be based on fixed proportions for a concrete mix design representative of questionable water supply and a control mix using 100 % potable water or distilled water. (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 in prestressed concrete, bridge decks, or otherwise designated	500 ^C	C 114
2 other reinforced concrete in moist environments or containing aluminum embedments or dissimilar metals or with stay-in-place galvanized metal forms	1000 ^C	C 114
B. Sulfate as SO ₄ , ppm	3000	C 114
C. Alkalies as (Na ₂ O + 0.658 K ₂ O), ppm	600	C 114
D. Total solids by mass, ppm	50 000	C 1603

^ASpecification limits from this table are not prohibited from being specified as individual items or as a whole per paragraph 4.1.6 of Specification C 94/C 94M.

^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.

solids content anticipated for use. These tests shall be conducted before first use and thereafter once every 6 months. These records shall be provided to the purchaser on request (See Note 5).

5.3 Concrete testing to verify compliance with the requirements of Table 1 shall be conducted on concrete samples obtained from production batches or in laboratory batches in accordance with Practice C 192/C 192M (See Note 5).

NOTE 5—The sampling of total combined water in its final form from

either the batch plant or transportation unit is impractical. Therefore, for the purposes of testing for compliance to the requirements of Table 1 and Table 2, it is acceptable to sample, proportion, and combine the individual sources of water to produce a test sample that is representative of the actual combined mixing water used in production.

6. Keywords

6.1 combined water; density; hydration stabilizing admixture; mixing water; recycled water

ANNEX

(Mandatory Information)

A1. GUIDE FOR THE COMPARISON BETWEEN TWO CONCRETE MIXTURES NECESSARY FOR COMPLIANCE WITH Table 1

INTRODUCTION

To comply with the performance requirements in Table 1, comparison between two concrete mixtures is required: one as a control batch using a potable water source, and a second as a test batch using the water source(s) proposed for use. The following shall apply:

A1.1 Water for the test batch as defined in 3.2 with a density greater than 1.01 g/mL, or as close in approximation to density as used during actual production.

A1.2 Water for the test batch as defined in 3.2 shall be as close as possible to the actual age of water used during actual production.

A1.3 Air entraining and water reducing admixtures are permitted in test and control batches. The air-entraining admixture shall be adjusted to produce the target air content with a tolerance of $\pm 1.5\%$. The dosage of water reducing admixture shall be the same in both batches.

A1.4 Hydration stabilizing admixtures are permitted for use in the mixing water for the test batch. No other set controlling admixtures are permitted.

A1.5 Mixing water content of the test batch shall not be less than the mixing water content of the control batch.

A1.6 Mixture proportions shall be made available upon request.

A1.7 Each batch for concrete comparison purposes to determine compliance with Table 1 shall be within $\pm 1\text{ }^{\circ}\text{C}$ at the time of mixing and shall be conditioned the same for the duration of the test.

APPENDIX
(Nonmandatory Information)
X1. GUIDE FOR TESTING FREQUENCY AS RELATED TO WATER SOURCE USED IN MIXING WATER.

Water Sources	Combined Water Density (g/mL)	Testing Frequency		
		Density, C 1603	Table 1	Table 2
Potable	N/A	N/A	N/A	N/A
Non-Potable ^A	N/A	N/A	3 months; after 4 tests annually (5.1.1)	6 months (5.1.2)
Concrete	<1.01	Daily (5.2.1)	6 months; annually after 2 tests (5.2.2.1)	6 months (5.2.3)
Production ^A	1.01 – 1.03		Monthly; 3 months after 4 tests (5.2.2.2)	
	> 1.03		Weekly; monthly after 8 tests (5.2.2.3)	

^ATesting frequencies apply to the combined mixing water when it is wholly or partially composed of the listed source as defined in Section 3.

SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this specification since the last issue, C 1602/C 1602M – 05, that may impact the use of this specification. (Approved February 15, 2006)

(I) Added new footnote A in **Table 2**.

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