

Specification for Curing Concrete

An ACI Standard

Reported by ACI Committee 308



American Concrete Institute®



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Specification for Curing Concrete

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An ACI Standard

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Note: ACI Committee 308 recognizes former committee Chair Steven H. Gebler for his significant contribution to this document prior to his passing in June 2006.

This specification is a reference specification that the Architect/Engineer can make applicable to any construction project by citing it in the Project Specification. The Architect/Engineer uses and supplements the provisions of this reference specification as needed by designating or specifying individual project requirements to which provisions of this specification apply.

This document provides requirements for alternative methods for curing concrete. These alternative methods are not necessarily equal in effectiveness, cost, effect on project schedule, or impact on other aspects of the project. To use this specification, the Architect/Engineer must not only include this document by reference in the Project Specification, but must also identify the concrete elements that are to be cured, and must choose the method to cure those elements. This specification has default settings that may or may not be applicable to a specific project. The Architect/Engineer is to use the Checklists included in this specification to customize the specification to a specific project. Checklists are provided in this document to guide the Architect/Engineer through these selection processes, and the selections must be included in the Project Specification. Alternatively, the Architect/Engineer may allow the Contractor the option of using one or more of a number of permissible curing methods, subject to review and approval. Further, the Architect/Engineer must determine whether deliberate curing efforts are to be terminated after a predetermined time has elapsed, or only after specified concrete properties have developed. When deliberate efforts to cure the concrete are to be terminated only when specified concrete properties have developed, the Architect/Engineer must also select the test method used to measure those properties.

This specification addresses curing methods applied after placement of concrete and does not apply to internal curing (use of saturated lightweight aggregate or other materials to provide supplemental water) or to accelerated curing (heat curing).

The materials, processes, quality control measures, and inspections described in this document should be tested, monitored, or performed as applicable only by individuals holding the appropriate ACI certifications or equivalent.

Keywords: cold-weather concreting; concrete construction; curing; curing films and sheets; hot-weather concreting; insulating concrete; insulation; membrane curing compounds; moist curing; moisture retention; sealers; water curing; water retention.

FOREWORD TO CHECKLISTS

F1. This foreword is included for explanatory purposes only; it does not form a part of ACI Specification 308.1.

F2. ACI Specification 308.1 may be referenced by the Specifier in the Project Specification for any building project, together with supplementary requirements for the specific project. Responsibilities for project participants must be defined in the Project Specification. ACI Specification 308.1 cannot and does not address responsibilities for any project participant other than the Contractor.

F3. Checklists do not form a part of ACI Specification 308.1. Checklists assist the Specifier in selecting and specifying project requirements in the Project Specification.

F4. The Mandatory Requirements Checklist indicates work requirements regarding specific qualities, procedures, materials, and performance criteria that are not defined in ACI Specification 308.1. The Specifier must include these requirements in the Project Specification.

F5. The Optional Requirements Checklist identifies Specifier choices and alternatives. The Checklist identifies the Sections, Parts, and Articles of the ACI Reference Specification 308.1 and the action required or available to the Specifier. The Specifier should review each of the items in the Checklist and make adjustments to the needs of a particular project by including those selected alternatives as mandatory requirements in the Project Specification.

ACI 308.1-11 supersedes 308.1-98, was adopted April 29, 2011, and was published June 2011.

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F6. The Submittals Checklist identifies information or data to be provided by the Contractor before, during, or after construction.

F7. Recommended references—Documents and publications that are referenced in the Checklists of ACI Specification 308.1 are listed. These references provide guidance to the Specifier and are not considered to be part of ACI Specification 308.1.

AASHTO M 148-05, 2005, “Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete,” AASHTO, Washington, DC.

AASHTO M 171-05, 2005, “Standard Specification for Sheet Materials for Curing Concrete,” AASHTO, Washington, DC.

AASHTO T 155-08, 2008, “Standard Method of Test for Water Retention by Liquid Membrane-Forming Curing Compounds for Concrete,” Washington, DC, 9 pp.

ACI Committee 305, 2010, “Guide to Hot Weather Concreting (305R-10),” American Concrete Institute, Farmington Hills, MI, 23 pp.

ACI Committee 306, 2010, “Guide to Cold Weather Concreting (306R-10),” American Concrete Institute, Farmington Hills, MI, 26 pp.

ACI Committee 308, 2001, “Guide to Curing (308R-01) (Reapproved 2008),” American Concrete Institute, Farmington Hills, MI, 31 pp.

ACI Committee 309, 2005, “Guide for Consolidation of Concrete (ACI 309R-05),” American Concrete Institute, Farmington Hills, MI, 35 pp.

C156-05 “Standard Test Method for Water Retention by Liquid Membrane Forming Curing Compounds for Concrete”

C171-03 “Standard Specification for Sheet Materials for Curing Concrete”

C 1315-06 “Standard Specification for Liquid Membrane Forming Compounds Having Special Properties for Curing and Sealing Concrete”

NOTES TO SPECIFIER

This Specification is incorporated by reference in the Project Specification using the wording in P3 of the Preface and including information from the Mandatory Requirements, Optional Requirements, and Submittals Checklists following the Specification.

Preface

P1. ACI Specification 308.1 is to be used by reference or incorporation in its entirety in the Project Specification. Do not copy individual Sections, Parts, Articles, or Paragraphs into the Project Specification, because taking them out of context may change their meaning.

P2. If Sections or Parts of ACI Specification 308.1 are copied into the Project Specification or any other document,

do not refer to them as an ACI Specification, because the specification has been altered.

P3. A statement such as the following will serve to make ACI Specification 308.1 a part of the Project Specification: “Work on (Project Title) shall conform to all requirements of ACI 308.1, ‘Specification for Curing Concrete,’ published by the American Concrete Institute, Farmington Hills, Michigan, except as modified by these Contract Documents.”

P4. Each technical section of ACI Specification 308.1 is written in the three-part Section format of the Construction Specifications Institute, as adapted for ACI requirements. The language is imperative and terse.

P5. ACI Specification 308.1 is written to the Contractor. When a provision of this Specification requires action by the Contractor, the verb “shall” is used. If the Contractor is allowed to exercise an option when limited alternatives are available, the phrasing “either...or...” is used. Statements provided in the Specification as information to the Contractor use the verbs “may” or “will.” Informational statements typically identify activities or options that “will be taken” or “may be taken” by the Owner or Architect/Engineer.

P6. When ACI 301, “Specifications for Structural Concrete,” is referenced in a Project Specification, this Specification shall not be referenced.

Mandatory requirements checklist

The specifier is to determine the desired results of the curing and select the appropriate section or sections to achieve those results if a particular curing method is desired. The Specifier is to use ACI 308R, “Guide to Curing Concrete,” as commentary for making decisions within the checklists. The alternative methods described in each section of this specification are not necessarily equal in effectiveness, cost, effect on project schedule, or impact on other aspects of the project. To use this specification, the Architect/Engineer must not only include this document by reference in the Project Specification, but must also review and respond to the checklists. It is imperative that the Architect/Engineer annotate this specification to meet the project requirements through the checklists. The Architect/Engineer must identify the concrete elements that are to be cured and must choose the method to cure them. Further, the Architect/Engineer must determine whether deliberate curing efforts must or may terminate after a predetermined time has elapsed, or only after particular levels of concrete properties have developed. When deliberate efforts to cure the concrete are to be terminated only when particular concrete properties have developed, the Architect/Engineer must also select the test method used to measure those properties. Checklists are provided in this document to guide the Architect/Engineer through these selection processes, and the selections must be included in the Project Specification.

MANDATORY REQUIREMENTS CHECKLIST

Section/Part/Article of ACI 308.1	Notes to Architect/Engineer
1.1.1 and 1.1.2	Describe the work that is to be cured as required by this specification, or alternately, describe the work that is not to be cured in accordance with this specification. Specify any elements for which this specification does not apply.

OPTIONAL REQUIREMENTS CHECKLIST

Section/Part/Article	Notes to Architect/Engineer
1.2	Review the referenced standards to ensure the published dates are applicable to the specified project.
2.1.1	Water loss requirements other than that required to meet ASTM C309 (AASHTO M 148) may be specified. Application rates other than required for testing by ASTM C156 (AASHTO T 155) may be specified. ASTM C1315 describes curing compounds that also function as sealers and do not interfere with adhesion of subsequent application of coatings or adhesives. If the curing membrane is to be removed after completion of the curing process, this should be specified.
2.1.3	Use black or dark-colored plastic sheeting when daily high ambient temperature is below 50°F. Use white or similarly reflective plastic sheeting when daily high ambient temperature is above 85°F. Use any color or transparent plastic sheet at temperatures between 50 and 85°F. Other types of sheeting are available, but these are not covered by specifications beyond the water retention called for in ASTM C171 (AASHTO M 171).
3.2.2.2	Specify curing compound application rate and method or allow application per manufacturers' instructions.
3.2.6	Specify surface finish if marring is acceptable.
3.3.1	Specify the minimum length of time, if other than 7 days, for the curing period under the nontested criteria.
3.3.2	Under the strength-testing criteria, specify the compressive strength that must be achieved by field-cured specimens before termination of deliberate curing efforts. The compressive strength criterion for termination of deliberate curing efforts is typically 70 percent of the specified strength as required by the Project Specification. Determine the acceptability of this value and specify a more appropriate value as necessary.
3.3.2.1.1	Unless otherwise specified, the Contractor may request use of a nondestructive test method to demonstrate adequacy of the in-place concrete for the purpose of terminating deliberate curing efforts in accordance with the specification.
3.5	Refer to ACI 306R for more information.
3.5.1	If conditions of low humidity and winds may be expected, apply initial curing methods defined in 3.1.
3.5.3	Specify acceptable strength test(s) and strength required to determine termination of curing methods. Any of these methods described for determining strength is acceptable unless otherwise specified. If strength or durability is used to determine the time for termination of curing, specify the test method and result required.
3.6	Refer to procedures in ACI 305R for guidance before and during the curing period. Use initial curing method or methods to minimize plastic shrinkage cracks.
3.6.2	Unless otherwise specified, the Contractor may apply any one or more of the curing methods within this specification. If particular methods are required, specify.

SUBMITTALS CHECKLIST

Section/Part/Article	Submittal items and notes to Specifier
1.4.2	<i>Execution</i> —Submit procedure for curing method(s) to be employed and data demonstrating that materials meet specifications.
1.4.2, 3.1, 3.2, and 3.5	<i>Cold weather</i> —Submit cold-weather curing procedures at least 1 month before cold-weather concreting.
1.4.2, 3.1, 3.2, and 3.6	<i>Hot weather</i> —Submit hot weather curing procedures at least 1 month before use and data demonstrating that proposed materials meet specification requirements. There is currently no materials specification for evaporation retardants.
1.5.2	The Contractor shall submit data on qualifications of proposed quality control testing agency for acceptance.
2.1 and 2.2	<i>Materials</i> —Submit qualification test data called for in this specification as required by the Architect/Engineer for review and acceptance.

SUBMITTALS CHECKLIST (cont.)

Section/Part/Article	Submittal items and notes to Specifier
3.1 and 3.2	Submit description of curing procedure to be used and current test data demonstrating that proposed materials meet specification requirements.
3.3.2.1.1	<i>Testing</i> —If a nondestructive test method is proposed to estimate the strength of the concrete in-place, the Contractor shall obtain the Architect/Engineer's approval for the test method and provide test data correlating strength of concrete determined by proposed nondestructive test method with the compressive strength of laboratory-cured molded cylinders or drilled cores.

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(Mandatory portion follows)

PART 1—GENERAL**1.1—Scope**

1.1.1 Work specified—This specification covers requirements for curing the cast-in-place concrete elements described in the Contract Documents. This specification includes requirements for initiating curing, protection from mechanical injury, curing for unformed and formed surfaces, and curing time.

1.1.2 Exclusions—Specialty concrete and special construction techniques, or other concrete elements that require the use of curing procedures not discussed in this specification, are not covered by this specification.

1.1.3 Units—Values in this specification are stated in inch-pound units. A companion specification in SI units is also available.

1.2—Reference standards*American Concrete Institute*

- 306.1-90(02) Standard Specification for Cold Weather Concreting
- 305.1-06 Standard Specification for Hot Weather Concreting

ASTM International

- C31/C31M-10 Standard Practice for Making and Curing Concrete Test Specimens in the Field
- C39/C39M-10 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- C156-05 Standard Test Method for Water Retention by Liquid Membrane-Forming Curing Compounds for Concrete
- C171-07 Standard Specification for Sheet Materials for Curing Concrete
- C309-07 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- C1074-10a Standard Practice for Estimating Concrete Strength by the Maturity Method
- C1077-11a Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
- C1315-08 Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
- E329-11 Standard Specification for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction

AASHTO

- M 148-05 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- M 171-05 Standard Specification for Sheet Materials for Curing Concrete
- M 182-05 Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats
- T 155-08 Standard Method of Test for Water Retention by Liquid Membrane-Forming Curing Compounds for Concrete

These publications can be obtained from the following organizations:

American Concrete Institute
P.O. Box 9094
Farmington Hills, MI 48333-9094
www.concrete.org

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
www.astm.org

AASHTO

444 North Capitol Street, N.W.
Suite #249
Washington, D.C. 20001-1512
www.aashto.org

1.3—Definitions

accepted—determined to be satisfactory by Architect/Engineer.

cold weather—a period when the average daily ambient temperature is below 40°F for more than three successive days. (Note: The average daily temperature is the average of the highest and lowest temperature during the period from midnight to midnight. When temperatures above 50°F occur during more than half of any 24-hour duration, the period shall no longer be regarded as cold weather.)

Contract Documents—a set of documents supplied by Owner to Contractor as the basis for construction. These documents contain contract forms, contract conditions, specifications, drawings, addenda, and contract changes.

curing period—time during which continuous curing procedures are employed. (Note: The curing period includes the initial and final curing stages.)

dry—having no visible liquid water.

evaporation retardant—a material applied to the surface of concrete, before set, to reduce the evaporation rate of water without interfering with finishing operations.

final curing—deliberate action taken between the final finishing and termination of curing to reduce the loss of water from the surface of the concrete and control the temperature of the concrete.

hot weather—high ambient temperature in combination with high concrete temperature, low relative humidity, high wind velocity, and solar radiation that may cause excessive evaporation.

initial curing—deliberate action taken between placement and final finishing of concrete to reduce the loss of water from the surface of the concrete.

permitted—accepted by or acceptable to Architect/Engineer, usually pertains to a request by Contractor, or when specified in Contract Documents.

required—mandatory as prescribed in Project Specifications or Contract Documents.

submit—provide to Architect/Engineer for review.

submittal—document or material provided to Architect/Engineer for review and acceptance.

testing agency—the person, firm, or entity under contract for testing.

wet—covered with visible free moisture; not dry.

1.4—Submittals

1.4.1 Curing materials—Submit qualification test data on curing materials called for in this specification as required by the Architect/Engineer for review and acceptance. Forward submittals to the Architect/Engineer a minimum of 7 days before execution of the Work unless otherwise specified. No concrete shall be placed until the Architect/Engineer has accepted the curing materials.

1.4.1.1 Fogging equipment—Submit proposed fogging equipment specifications.

1.4.1.2 Sheet material—Submit proposed sheet material specifications. Specifications shall meet the requirements of ASTM C171 or AASHTO M 171.

1.4.1.3 Liquid membrane-forming curing compound—Submit proposed liquid membrane-forming curing compound specifications. Specifications shall meet the requirements of ASTM C309 (or AASHTO M 148) or ASTM C1315.

1.4.1.4 Water—Submit proposed water source.

1.4.1.5 Dike material—Submit description of proposed dike material.

1.4.1.6 Absorbent materials—Submit description of proposed absorbent material(s).

1.4.1.7 Watering equipment—Submit proposed watering equipment specifications.

1.4.1.8 Insulation materials—Submit proposed insulation material(s) specifications.

1.4.1.9 Heating equipment—Submit proposed heating equipment specifications.

1.4.1.10 Evaporation retardant—Submit proposed liquid applied evaporation retardant specifications.

1.4.2 Curing procedures—Submit procedures for curing at least 1 month before concreting. When hot weather or cold weather is anticipated during construction, include related curing procedures.

1.5—Quality assurance

1.5.1 General—The Owner may require concrete curing materials and procedures to be tested and inspected as work progresses to verify adequacy. The Contractor may use a testing agency meeting the requirements of 1.5.2 to assure quality control of the curing process.

1.5.2 Testing agencies—Agencies that perform testing services on concrete and concrete aggregates shall meet the requirements of ASTM C1077 and be accredited. Field tests of concrete shall be made by an ACI Concrete Field Technician—Grade 1 or equivalent. Agencies that perform testing or inspection services for concrete shall meet the requirements of ASTM E329. Testing agencies that perform testing services shall be accepted by the Architect/Engineer before performing any Work. The testing agency shall report results of tests and inspections performed during the course of the work within 3 working days of testing.

1.5.3 Support—Provide an adequate area for safe storage of field-cured specimens until time of test for use by the testing agency.

PART 2—PRODUCTS**2.1—Physical protection**

2.1.1 Liquid membrane-forming curing compound—Liquid membrane-forming curing compounds shall meet the requirements of ASTM C309 (AASHTO M 148) or ASTM C1315. When the concrete to be cured is exposed to the sun, use white pigmented curing compounds unless otherwise specified or permitted by Contract Documents.

2.1.2 Evaporation retardants—Use liquid applied evaporation retardants that form a thin continuous film (monomolecular film) and prevent rapid moisture loss of water from the plastic concrete surface. Apply the evaporation retardant in accordance with manufacturer's recommendations.

2.1.3 Sheet material—Sheet material shall meet the requirements of ASTM C171 (AASHTO M 171), unless otherwise specified.

2.1.4 Temperature protection—Provide protective blankets, enclosures, and various sources of heat input, as required.

2.1.5 Wind protection—Provide wind screens as required.

2.2—Water application

Water used for curing shall be free of materials that have the potential to stain concrete or are known to cause deterioration of concrete or reinforcing steel.

2.2.1 Ponding—Use earth, clay, sand, or other acceptable material to build a dike around the area to be flooded. The temperature of the water used shall not be more than 20°F cooler than the surface temperature of the concrete at the time the water and concrete come in contact.

2.2.2 Sprinkling systems—Use soaker hoses, lawn sprinklers, or a combination thereof.

2.2.3 Fogging systems—Use Equipment that produces a fog spray from atomizing nozzles that will uniformly cover the concrete surface. The minimum rate of fog application shall not be less than 10.6 gal./h/yd² to prevent evaporation of water from the concrete surface and the accumulation of standing water on the surface. The frequency of fogging and number of nozzles operating shall be dependent upon the environmental conditions.

2.2.4 Absorbent materials—Select an absorbent material that will not adversely affect the concrete finish specified in the Contract Documents.

2.2.4.1 Earth materials shall be free of organic matter and particles larger than 1 in.

2.2.4.2 Burlap shall meet the requirements of AASHTO M 182.

PART 3—EXECUTION

3.1—Initial curing

Under conditions specified by the Contract Documents, initially cure concrete immediately after placement by 3.1.1 or 3.1.2.

3.1.1 Fogging—Set up fogging equipment to allow complete coverage of the area to be cured. Maintain the relative humidity above the slab at a level to prevent surface drying and the accumulation of standing water on the surface. Direct atomized water spray above the concrete surface to allow the fog to drift down to the concrete surface. Continue fogging as necessary to maintain the reflective appearance of the damp concrete. Keep concrete surfaces continuously damp, but do not allow accumulation of water until after final setting has occurred. Do not allow the surface to dry or to undergo cycles of drying and wetting.

3.1.2 Evaporation retardant—Entrap any bleed water on the concrete surface under a uniform film of a liquid applied

evaporation retardant. Apply the evaporation retardant after strike off and between the different floating operations

3.2—Final curing

After final finishing, cure unformed concrete by 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, or 3.2.6 until termination of curing is allowed by 3.3. Do not mar or damage the concrete with any curing procedure. Cure formed concrete after form removal by one or more of these methods until termination of curing is allowed by 3.3. When absorbent wood forms are used, keep them wet until removed.

3.2.1 Sheet material—Place sheet material on the concrete surface as soon as it is possible without marring the surface.

3.2.1.1 Cover all exposed concrete surfaces and beyond the edge of the concrete surface. Securely tape sheeting together or lap. Maintain the integrity of the material to minimize evaporation loss throughout the curing period.

3.2.1.2 Keep the concrete continuously wet under the sheeting.

3.2.2 Liquid membrane-forming curing compounds—Apply liquid membrane-forming curing compounds uniformly and at the rate recommended by the manufacturer, or at a rate not less than specified in ASTM C309 (AASHTO M 148) or ASTM C1315 as tested using ASTM C156 (AASHTO T 155).

3.2.2.1 Apply curing compounds immediately after final finishing and as soon as bleeding has essentially ceased, as evidenced by the disappearance of free water and no visible water sheen. Protect the membrane from damage for the duration of the curing period. Provide adequate ventilation during the application of the membrane.

3.2.2.2 Curing compounds shall be applied per the Contract Documents or following manufacturer's application instructions.

3.2.3 Ponding—Build a dike of earth, sand, or other material around the concrete and flood the surface with water. The entire surface is to remain covered with water for the duration of the curing period.

3.2.3.1 Start ponding on the concrete surface as soon as possible without marring the surface.

3.2.3.2 Replace water lost due to evaporation or leakage at a rate sufficient to maintain the pond. Keep concrete surfaces continuously wet. Do not allow alternate wetting and drying of the concrete surfaces.

3.2.4 Sprinkling—Perform sprinkling for final curing by using either soaker hoses or lawn sprinklers. Exercise care so the surface of the concrete is not eroded by running water.

3.2.4.1 Use soaker hoses for curing of concrete walls and columns after checking that water will not damage the surface and before form removal. Place hoses at the top of walls and columns so that water will enter between concrete and formwork.

3.2.4.2 Keep the concrete surfaces continuously wet. Do not allow alternate wetting and drying of concrete surfaces.

3.2.5 Fogging—Set up fogging equipment to allow complete coverage of the area to be cured. Maintain the relative humidity above the slab at a level to prevent surface drying and the accumulation of standing water on the surface. Keep concrete surfaces continuously wet. Do not allow alternate wetting and drying of concrete surfaces.

3.2.6 Absorbent material—After final finishing, uniformly distribute nonstaining absorbent materials on the concrete surface without marring the surface unless otherwise specified. Apply water to the materials, taking care not to displace them. Apply water during the curing period as needed to keep the concrete surfaces continuously wet. Do not allow alternate wetting and drying of concrete surfaces.

3.3—Termination of curing

Unless otherwise specified, cure the concrete for one of the following time periods.

3.3.1 When testing is not specified to terminate curing procedures, cure concrete for at least 7 days provided that the concrete surface temperature is at least 50°F. When the temperature is lower, refer to 3.5.

3.3.2 Concrete compressive strength shall meet or exceed 70 percent of design concrete compressive strength required by the Concrete Documents before termination of curing measures when curing period is based on the development of strength.

3.3.2.1 General testing requirements—Tests to determine time of termination for curing measures shall be performed by a testing agency acceptable to the Architect/Engineer.

3.3.2.1.1 Nondestructive test method—Submit the test method to the Architect/Engineer for acceptance. Provide test data correlating concrete strength determined by the proposed nondestructive test method with the compressive strength of laboratory-cured molded cylinders or drilled cores with the submittal.

3.3.2.1.2 Molded cylinder method—Mold cylinders in accordance with ASTM C31/C31M or AASHTO T 23 and test in accordance with ASTM C39/C39M or AASHTO T 22 in accordance with project requirements. Maintain curing until tests of at least two cylinders, field-cured alongside the concrete they represent, have reached the compressive strength specified for termination of curing.

3.3.2.1.3 Maturity method—Maintain curing methods until concrete attains the compressive strength specified for termination of curing, as estimated in accordance with ASTM C1074.

3.4—Protection from mechanical injury

Protect the concrete from damaging mechanical disturbances during the curing period. Protect finished surfaces from damage by construction equipment, materials or methods, application of curing procedures, or by running water.

3.5—Cold weather curing

3.5.1 General—Protection and additional curing requirements are to be implemented during cold weather. Protect the concrete from the effects of cold weather throughout the process of placing, finishing, and curing the concrete. Use curing method or methods defined in 3.5 for cold weather curing. When evaporation rates may be high during placement,

finishing, and before initial set, use the initial curing method or methods defined in 3.1.

3.5.2 Provide required materials and equipment to protect the concrete at the project site before cold weather concreting.

3.5.3 Protect the concrete against direct, uneven heating and carbonation due to the exposure to combustion heater exhaust. Do not initiate the application of water when freezing weather is to occur during the curing period. Do not expose saturated concrete to cycles of freezing and thawing until the concrete has reached the compressive strength of 3500 psi. After termination of application of water to the surface, protect the surface from freezing temperatures for at least 3 days.

3.5.4 When the concrete is to be subjected to freezing conditions, employ a water-retention sheet-curing procedure or a membrane-forming curing compound in accordance with Part 2 and add insulated material or heat the surrounding concrete environment to a temperature above freezing.

3.5.5 Maintain concrete temperature as required by ACI 306.1 during the curing period.

3.5.6 Remove protection in such a manner that the concrete will cool no faster than 5°F per hour. The maximum decrease in temperature measured at the surface of the concrete in a 24-hour period shall not exceed the following:

- 50°F for sections less than 12 in. in the least dimension.
- 40°F for sections from 12 to 36 in. in the least dimension.
- 30°F for sections from 36 to 72 in. in the least dimension.
- 20°F for sections greater than 72 in. in the least dimension.

3.6—Hot weather curing

3.6.1 General—Protection and additional curing requirements are to be implemented during hot weather. Use initial curing method or methods defined in 3.1 and in addition the requirements of ACI 305.1 shall be met when evaporation rates are expected to be high. Prepare to implement hot weather curing procedures before hot weather conditions occur. To prevent drying of the concrete before the application of the final curing methods, use an appropriate initial-curing method. When necessary to prevent rapid water loss and drying of the concrete surface, shade the formwork, reinforcing steel, and concrete from direct sunlight; erect windbreaks; or do a combination of such methods. Use liquid applied evaporation retardants, fogging, wind screens, or shade (individually or in combination) to control the rate of bleed water evaporation and subsequent drying of the concrete. When loss of moisture from the concrete cannot be controlled by the aforementioned measures, alternate curing procedures must be implemented such as placing and finishing concrete at night or postponing or delaying placement until conditions are acceptable.

3.6.2 Final curing—Final curing methods shall be employed immediately upon completion of the final finishing operation. When a specific final curing method is not specified, use any of the methods described in 3.2.



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