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Standard Practice for Evaluation of Laboratories Testing Hydraulic Cement¹

This standard is issued under the fixed designation C 1222; 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 practice covers the technical training and experience of laboratory testing personnel and identifies the minimum technical requirements for laboratory equipment used in testing of hydraulic cement as prescribed by ASTM.

1.2 This practice provides minimum criteria for evaluating the capability of a laboratory to perform chemical or physical tests listed in the various specifications on hydraulic cement (see Note 1).

NOTE 1—Relevant hydraulic cement specifications are Specifications C 91, C 150, C 595, C 845, and Performance Specification C 1157.

1.3 The SI units are to be regarded as the standard.

1.4 *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.*

¹ This practice is under the jurisdiction of ASTM Committee C-1 C01 on Cement and is the direct responsibility of Subcommittee C01.95 on Coordination of Standards. Current edition approved July 10, 1999; Nov. 1, 2003. Published September 1999; December 2003. Originally published approved as P 227 in 1991. Last previous edition approved in 1999 as C 1222 – 979.

2. Referenced Documents

2.1 *ASTM Standards:*²

- C 91 Specification for Masonry Cement
- C 109/C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
- C 114 Test Methods for Chemical Analysis of Hydraulic Cement
- C 115 Test Method for Fineness of Portland Cement by the Turbidimeter
- C 125 Terminology Relating to Concrete and Concrete Aggregates
- C 150 Specification for Portland Cement
- C 151 Test Method for Autoclave Expansion of Portland Cement
- C 185 Test Method for Air Content of Hydraulic Cement Mortar
- C 187 Test Method for Normal Consistency of Hydraulic Cement
- C 191 Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
- C 204 Test Method for Fineness of Hydraulic Cement by Air Permeability Apparatus
- C 219 Terminology Relating to Hydraulic Cement
- C 230 Specification for Flow Table for Use in Tests of Hydraulic Cement
- C 266 Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles
- C 305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
- C 451 Test Method for Early Stiffening of Portland Cement (Paste Method)
- C 595 Specification for Blended Hydraulic Cements
- C 778 Specification for Standard Sand
- C 845 Specification for Expansive Hydraulic Cement
- C 1005 Specification for ~~Weights Reference Masses and Weighing~~ Devices for Determining Mass and Volume for Use in the Physical Testing of Hydraulic Cements
- C 1157 Performance Specification for Blended Hydraulic Cement
- E 4 Practices for Force Verification of Testing Machines

2.2 *Other Documents:*

- ACI 116R Cement and Concrete Terminology
- ~~ASTM Manual of Cement Testing~~²⁻³

3. Terminology

3.1 *Definitions:*

3.1.1 *inspection, n*—a process of measuring, examining, testing, gaging, or using other procedures to ascertain the quality or state, detect errors or defects, or otherwise appraise materials, products, services, systems, or environments when compared to preestablished criteria.

3.1.2 Additional definitions may be found in Terminologies C 125 and C 219, Practices E 4, and ACI 116R.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *evaluation authority, n*—an independent entity, apart from the organization being evaluated, that can provide an unbiased evaluation of the organization and shall have the capability to assess the technical activities of testing laboratories (see Discussion).

3.2.1.1 *Discussion*—One such evaluation authority is the Cement and Concrete Reference Laboratory (CCRL).⁴ Laboratory inspection is broadened into accreditation programs by such independent authorities as the National Voluntary Laboratory Accreditation Program (NVLAP),⁵ American Association for Laboratory Accreditation (A2LA)⁶ AASHTO Accreditation Program (AAP),⁷ and others established.

3.2.2 *laboratory technician, n*—an employee of the laboratory who is assigned to perform the actual testing operations primarily conducted in the laboratory.

3.2.3 *quality systems, n*—those internal procedures and practices that a laboratory utilizes to ensure continued compliance with applicable testing standards.

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*, Vol 04.01, volume information, refer to the standard's Document Summary page on the ASTM website.

Annual Book of ASTM Standards, Vol 04.02:

³ Available from American Concrete Institute, P.O. Box 19150, Detroit, MI 48219.

Annual Book

⁴ CCRL, National Institute of Standards and Technology, Bldg. 226, Rm. A365, Gaithersburg, MD 20899.

⁵ Available from American Concrete Institute, P.O. Box 19150, Detroit, MI 48219.

⁵ NVLAP, National Institute of Standards and Technology, Building 411, Room A124, Gaithersburg, MD 20899.

⁶ CCRL, National Institute of Standards and Technology, Bldg. 226, Rm. A365,

⁶ American Association for Laboratory Accreditation, Quince Orchard, Gaithersburg, MD 20899; 20878.

⁷ NVLAP, National Institute

⁷ American Association of Standards State Highway and Technology, Building 411, Room A124, Gaithersburg, MD 20899; Transportation Officials (AASHTO), 444 N. Capital St., NW, Suite 225, Washington, DC 20001.

- 3.2.4 *subcontracting, n*—employing another organization to provide testing services that the laboratory contracted to provide.
- 3.2.5 *testing laboratory, n*—an organization that measures, examines, performs tests, or otherwise determines the characteristics or performance of materials or products. This may include organizations that offer commercial testing services, an in-house quality control function, an academic institution, or any other organization providing the specified testing services.

4. Significance and Use

- 4.1 The testing of hydraulic cement is an important element in obtaining quality construction. A testing laboratory must be selected with care.
- 4.2 A testing laboratory shall be deemed qualified to perform and report the results of its tests if the laboratory meets the requirements of this practice.
- 4.3 This practice provides guidance for evaluating the organization, personnel, facilities, and quality systems of the laboratory. This practice may be supplemented by criteria and requirements for particular projects.

5. Documentation of Organization

- 5.1 The following information shall be readily available for review:
- 5.1.1 A description of the organization, including the complete legal name and address of the main office and each laboratory location, names and positions of the principal officers and the individual in charge of the laboratory,
- 5.1.2 A description of the organization management structure, and
- 5.1.3 A listing of the range of services offered.

6. Human Resources

- 6.1 The manager of the laboratory shall be a chemist, materials analyst, or an engineer and a full-time employee of the organization having at least three years supervisory experience in the testing of hydraulic cement; however, a person with equivalent science-oriented education or experience having satisfactorily directed testing of hydraulic cement is acceptable.

7. Testing and Additional Requirements

- 7.1 *Testing Requirements*—The organization shall have the capability of performing tests associated with its range of services (see Note 2). The laboratory shall have the facilities and equipment required for preparing, storing, conditioning, and testing specimens.

NOTE 2—The range of services of a testing laboratory may involve either chemical testing or physical testing, or both. The laboratory need not perform all tests listed in the applicable ASTM specification, but rather have the required equipment and demonstrate the ability to perform the procedures within its reported range of services.

- 7.1.1 The laboratory shall use the latest version of each referenced ASTM standard within one year of its publication in the *Annual Book of ASTM Standards* except where an earlier version is specifically required.

7.1.2 Laboratory personnel shall have convenient access to applicable standards.

- 7.2 *Additional Requirements*—The following requirements apply to only those tests performed by the laboratory. They are intended to supplement certain provisions of the standard test methods.

~~7.2.1 Water storage recording thermometers shall be checked for accuracy at least every six months by comparing their output with that of a mercury in glass thermometer, graduated in 0.5°C divisions, placed in the water adjacent to the probe of the recording thermometer. Adjustments shall be made if differences in the observed readings exceed 1°C.~~

~~7.2.2 General purpose~~

~~7.2.1 General purpose~~ weighing devices and weights shall be checked at least annually and shall conform to the requirements of Specification C 1005.

~~7.2.32~~ Analytical balances and reference masses shall be checked at least annually and shall conform to the requirements of Test Methods C 114.

~~7.2.4 The 45-µm (No. 325) sieve fineness nozzles shall be checked at least every six months using the flow rate test procedure described in the *ASTM Manual of Cement Testing*.~~

~~7.2.5 Flow~~

~~7.2.3 Flow~~ tables shall be checked at least every 2½ years using the calibration material described in Specification C 230.

~~7.2.64~~ Compression machines shall be verified, in accordance with Practices E 4 at least annually to determine if indicated loads, with and without the maximum load indicator (when so equipped), are accurate to ±1.0 %.

~~7.2.75~~ Compression machine bearing blocks shall be checked for planeness in accordance with the requirements of Test Method C 109/C 109M at least annually using a straightedge and feeler stock and shall be refinished if found to be out of tolerance.

~~7.2.86~~ Air content measures (400 mL) shall be calibrated at least every 2½ years following the procedures described in Test Method C 185.

~~7.2.97~~ Wagner turbidimeter apparatus shall be calibrated at least every six months using the procedures described in Test Method C 115.

~~7.2.108~~ Each lot of standard sand shall be checked upon receipt to determine if it conforms to the requirements of Specification C 778.

7.2.119 Autoclave apparatus shall be maintained and tested in accordance with Test Method C 151.

7.2.120 Cube molds and tampers shall be checked for conformance to the design and dimensional requirements of Test Method C 109/C 109M at least every 2½ years.

7.2.131 Vicat apparatus and vicat ring shall be inspected and checked for conformance to Test Methods C 187, C 191, and C 451 at least every 2½ years.

7.2.142 Gillmore test apparatus shall be inspected and checked for conformance to the requirements of Test Method C 266 at least every 2½ years.

7.2.153 Mechanical mixing apparatus shall be inspected and checked for conformance to the requirements of Practice C 305 at least every 2½ years.

7.2.164 Air-permeability apparatus and related accessory equipment shall be calibrated and checked for conformance to Test Method C 204 at least every 2½ years.

7.2.164.1 Check determinations shall be made against standard or secondary standard reference samples every six months. If the results exceed the precision of the test method, the apparatus shall be recalibrated.

7.2.175 Water-retention apparatus and related equipment shall be checked for conformance to Specification C 91 at least every 2½ years.

8. Subcontracting

8.1 Subcontracting for the performance of part or all of a test method is permitted. When subcontracting is used the quality of the work provided must be ensured. The requirements for evaluation differ depending on the permanence of the subcontracting.

8.2 *Permanent Subcontracting* —When all or a portion of a test method is subcontracted on a permanent basis then the subcontracted organization must be subjected to separate evaluation according to this practice for the methods subcontracted. The laboratory shall retain a copy of this evaluation for review by the evaluation authority.

8.3 *Temporary Subcontracting* —When all or a portion of a test method is subcontracted on a temporary basis then the laboratory shall ensure the quality of the subcontracted work. The level and type of assurance will depend on the extent of the subcontracting (see Note 3). The laboratory shall retain records of this assurance for review by the evaluation authority.

NOTE 3—Some examples of assurance for different levels of temporary subcontracting are: (1) a review of calibrations records when the use of a piece of equipment is subcontracted; and (2) a satisfactory rating on a proficiency sample when a method is subcontracted. Other means of assurance are test results from a standard reference material or, in the case of chemical testing records of qualification testing.

9. Quality System

9.1 *Quality System Requirements*—The laboratory shall establish a quality system for ensuring the quality of services offered.

9.1.1 The laboratory shall maintain written documentation for the following:

9.1.1.1 Procedures for sampling, handling, and testing the hydraulic cement,

9.1.1.2 Procedures for training and evaluating laboratory personnel,

9.1.1.3 Procedures for calibrating and maintaining test equipment, and

9.1.1.4 Procedures for handling technical complaints from clients about results, procedures, or methods used.

9.1.2 The laboratory shall maintain current standard test methods and other pertinent reference material.

9.1.3 The laboratory shall participate in the appropriate CCRL Cement Proficiency Sample Program (see Note 4).

NOTE 4—The CCRL offers proficiency sample programs for physical and chemical testing of portland and blended cements and physical testing of masonry cement. The laboratory should participate in the program compatible with its scope.

10. Laboratory Records and Reports

10.1 *Quality System Records*—The laboratory shall maintain records indicating compliance with the procedures described in their quality system documentation. Records shall be maintained for at least five years. The records shall include at least the following:

10.1.1 Results of all calibrations and verifications performed in the laboratory,

10.1.2 Traceability or accuracy of any in-house calibration or verification equipment used,

10.1.3 An inventory and description of all required test equipment,

10.1.4 Records on laboratory personnel that document work experience, education, on-the-job training, and action taken to ensure continued competence in performing the required test methods,

10.1.5 Records of audits and inspections by outside agencies and all reports or certifications, with applicable dates, of any evaluations or accreditations issued by an evaluating authority, and

10.1.6 Records of participation in the appropriate CCRL Cement Proficiency Sample Program.

10.2 *Test Report Records*—The laboratory shall maintain a system of records that permits verification of any test report issued. Each test report and related records shall be retained for at least three years. Corrections or additions to reports shall clearly reference the report being amended. Include in the test report or the records the following information:

10.2.1 Name and address of the laboratory,

10.2.2 Identification of the report and the date issued,

10.2.3 Name of the client, if applicable,

- 10.2.4 Project identification, if applicable,
- 10.2.5 Sample identification,
- 10.2.6 Date of receipt of test samples,
- 10.2.7 Date(s) of test performance,
- 10.2.8 Identification of the standard test method used, and a notation of all known deviations from the test method observed during the testing of the sample being reported (see Note 5).

NOTE 5—Deviation from standard test methods may adversely affect results.

- 10.2.9 Identification of any standard test methods subcontracted and name of the organization that provided such services,
- 10.2.10 Test results and other pertinent data required by this practice,
- 10.2.11 Identification of the person performing the tests, and
- 10.2.12 Name of the person in charge of the laboratory or their designee.

11. Laboratory Evaluation

11.1 *Laboratory Evaluation*—The laboratory shall have its facilities, personnel, equipment, and procedures inspected at intervals of approximately two years by an evaluation authority (see Discussion in 3.2.1) to confirm its ability to perform the required tests.

11.2 The evaluation authority, who performs the inspection of the laboratory, shall report to the manager of the laboratory on all applicable requirements of this practice including deficiencies that existed during the inspection. The laboratory manager is responsible for the correction of any deficiencies.

11.3 The manager of the laboratory shall report corrective actions taken on all inspection deficiencies when required by the evaluating authority for accreditation.

11.4 The evaluation authority providing the accreditation shall provide to the laboratory a statement of conformance when the laboratory evaluation report, including satisfactory correction of the deficiencies, has been accepted. The statement of conformance shall be evidence of the ability of the laboratory to conduct tests on cements in accordance with relevant standards. The report and statement of conformance shall be in such form that they may be used for public disclosure at the discretion of the laboratory.

12. Keywords

- 12.1 hydraulic cement; laboratory evaluation

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