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Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation[1]

This standard is issued under the fixed designation C1077; 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.

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

1. Scope*

1.1 This practice identifies and defines the duties, responsibilities, and minimum technical requirements of testing laboratory personnel and the minimum technical requirements for laboratory equipment utilized in testing concrete and concrete aggregates for use in construction.

1.2 This practice provides criteria for the evaluation of the capability of a testing laboratory to perform designated ASTM test methods on concrete and concrete aggregates. It can be used by an evaluation authority in the inspection or accreditation of a laboratory or by other parties to determine if the laboratory is qualified to conduct the specified tests.

NOTE 1—Specification E329 provides criteria for the evaluation of laboratories that perform the inspection of concrete during placement.

~~1.3If the laboratory requires external technical services to conduct tests, the external agency shall be subject to separate evaluation.~~

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1.3 This practice provides criteria for Inspection Bodies and Accreditation Bodies that provide services for evaluation of testing laboratories in accordance with this practice.

1.4 If the laboratory requires external technical services to conduct tests, the external agency shall be subject to separate evaluation.

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 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
C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
C40 Test Method for Organic Impurities in Fine Aggregates for Concrete
C117 Test Method for Materials Finer than 75-m (No. 200) Sieve in Mineral Aggregates by Washing
C125 Terminology Relating to Concrete and Concrete Aggregates
C127 Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
C128 Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
C138/C138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
C143/C143M Test Method for Slump of Hydraulic-Cement Concrete
C172 Practice for Sampling Freshly Mixed Concrete
C173/C173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C617 Practice for Capping Cylindrical Concrete Specimens

[1] This practice is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.98 on Evaluation of Laboratories.

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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.**

C802 Practice for Conducting an Interlaboratory Test Program to Determine the Precision of Test Methods for Construction Materials
C1064/C1064M Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
C1231/C1231M Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders
D75 Practice for Sampling Aggregates
D2419 Test Method for Sand Equivalent Value of Soils and Fine Aggregate
E4 Practices for Force Verification of Testing Machines
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
E329 Specification for Agencies Engaged in Construction Inspection and/or Testing
E1301 Guide for Proficiency Testing by Interlaboratory Comparisons

2.2 *ACI Standards:*

ACI 214-77 Recommended Practice for Evaluation of Strength Test Results of Concrete[3]

2.3 *ISO Standards:*

ISO 17011 Conformity Assessment—General Requirements For Accreditation Bodies Accrediting Conformity Assessment Bodies[4]

3. Terminology

3.1 *Definitions*:

3.1.1 For definitions of terms used in this practice, refer to Terminology C125.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *evaluation authority*, *n*—an independent entity, apart from the testing laboratory being evaluated, that has the capability to provide an unbiased evaluation of the professional and technical activities of concrete and concrete aggregates testing laboratories.

3.2.1.1 *Discussion*—Two acceptable methods of evaluation are inspection and accreditation, and these evaluations are offered by many evaluation authorities. An inspection is an evaluation of equipment and procedures based on the Test Methods and Procedures section, along with a review of the quality system. An inspection report is the final step in the process for an inspection agency. The testing laboratory being evaluated performs corrective actions for any deficiencies noted, and these corrections are to be placed with the other inspection documentation as part of the permanent record of the inspection. An accreditation agency uses the results of the inspection report or the results of their own onsite assessment as one phase of the accreditation process. As a separate phase, the accreditation agency also reviews the testing laboratory's corrective actions for the deficiencies noted and issues a certificate of accreditation once all of the deficiencies have been corrected. There is no universally accepted evaluation authority in the construction materials testing field; therefore, testing laboratories should give careful consideration when selecting an evaluation authority to gain the most benefit from the evaluation. In most cases, a testing laboratory will select an evaluation authority as a result of requirements in a project specification, or contract, or in response to local codes, or other industry requirements. In those circumstances, the requirements will stipulate the acceptable evaluation authorities. If there are no specific requirements and the evaluation is in anticipation of future work or to compete with other local testing laboratories, then the laboratory should contact the organization(s) most likely to use their services for a list of acceptable evaluation authorities. A list of evaluation authorities is provided in the Qualification of Personnel and Laboratory Evaluation section of the Manual of Aggregate and Concrete Testing.[5] The list is merely a collection of organizations willing to provide this service and is not an endorsement of any particular organization. Other organizations may also be available to provide this service.

3.2.2 *external technical services*, *n*—those services required by a testing laboratory that are provided by another organization.

3.2.3 *field technician*, *n*—an employee of the laboratory who is assigned to perform sampling and testing functions outside the laboratory.

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

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

3.2.6 *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 required testing services.

4. Significance and Use

4.1 The testing and inspection of concrete and concrete aggregates are important elements in obtaining quality construction. A

[3] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.aci-int.org.
[4] Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards* , Vol 04.02.
[4] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.
[5] Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards* , Vol 04.02.

testing laboratory providing these services 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. The testing laboratory services shall be provided under the technical direction of a registered professional engineer.

4.3 This practice establishes essential characteristics pertaining to the organization, personnel, facilities, and quality systems of the laboratory. This practice may be supplemented by more specific criteria and requirements for particular projects.

5. Organization

5.1 The following information shall be readily available for review:

5.1.1 Description of the organization, including:

5.1.1.1 Complete legal name and address of the main office and each laboratory location,

5.1.1.2 Names and positions of the principal officers and the responsible, registered professional engineer in charge, and

5.1.1.3 Description of the organization management structure.

5.1.2 Listing of the relevant technical services offered, and

5.1.3 All external technical services normally utilized.

5.2 The laboratory shall designate an individual with access to management who has the responsibility of seeing that procedures required in this document are being carried out.

6. Personnel Qualifications

6.1 Information shall be made available to substantiate personnel qualifications as follows:

6.1.1 All relevant testing services are provided under the full-time technical direction of a registered professional engineer with at least 5 years experience in construction materials testing.

6.1.2 Supervising laboratory technicians shall possess a minimum of 3 years relevant experience and current technician certification. The technician certification program must include a written examination and performance examination of relevant tests. Relevant tests that must be covered by the certification program are: Practice C31/C31M, Test Methods C39/C39M, C40, C117, C127, C128, C136, C138/C138M, C143/C143M, Practice C172, Test Methods C173/C173M, C231, and Test Method C1064/C1064M. In cases where the supervising laboratory technician is supervising technicians who only test concrete, the applicable relevant tests are the concrete tests listed in the group. Where the supervising laboratory technician is supervising technicians who only test aggregates, the applicable relevant tests are the aggregate tests listed in the group.

6.1.3 Supervising field technicians shall possess a minimum of 3 years relevant experience and current technician certification. The technician certification program must include a written examination and performance examination of relevant tests. Relevant tests that must be covered by the certification program are: Practice C31/C31M, Test Methods C138/C138M, C143/C143M, Practice C172, Test Methods C173/C173M, C231, and C1064/C1064M.

6.1.4 Concrete laboratory technicians shall possess current technician certification. The technician program must include a written examination and performance examination of relevant tests. Relevant tests that must be covered by the certification program are: Test Method C39/C39M and Practice C617 or C1231/C1231M.

6.1.5 Aggregate laboratory technicians shall possess current technician certification. The technician certification program must include a written examination and performance examination of relevant tests. Relevant tests that must be covered by the certification program are: Test Methods C40, C117, C127, C128, and C136.

6.1.6 Concrete field technicians shall possess current technician certification. The technician certification program must include a written examination and performance examination of relevant tests. Relevant tests that must be covered by the certification program are: Practice C31/C31M, Test Methods C138/C138M, C143/C143M, Practice C172, Test Methods C173/C173M, C231, and C1064/C1064M.

6.1.7 The technician certification program shall meet the following criteria:

6.1.7.1 The written examination shall be of sufficient length and detail to cover the entire test method,

6.1.7.2 The performance examination shall adequately cover procedures of the test method, and

6.1.7.3 The written and performance examinations shall include all relevant test methods that are listed in the section above for the type of technician being certified.

NOTE 2—A list of technician certification programs is provided in the Qualification of Personnel and Laboratory Evaluation section of the Manual of Aggregate and Concrete Testing.[5]The list is merely a collection of certification programs and is not an endorsement of any particular program. Other programs may also be available.

7. Test Methods and Procedures

7.1 The testing laboratory shall be capable of performing the required ASTM test methods, guides, or practices in 7.2 and may request additional evaluation for the optional methods in 7.3 to the extent that those services are provided by the laboratory.

7.2 *Required Test Methods and Practices*:

7.2.1 *For Laboratories Testing Concrete*:

7.2.1.1 *Sampling*, Practice C172,

7.2.1.2 *Slump*, Test Method C143/C143M,

7.2.1.3 *Unit Weight, Yield, and Air Content*, Test Method C138/C138M,
7.2.1.4 *Air Content*, Test Method C173/C173M (volumetric method), or Test Method C231 (pressure method), or both.
7.2.1.5 *Temperature*, Test Method C1064/C1064M,
7.2.1.6 *Making and Curing Test Specimens*, Practice C31/C31M,
7.2.1.7 *Compressive Strength*, Test Method C39/C39M,
7.2.2 *For Laboratories Testing Concrete Aggregates*:
7.2.2.1 *Sieve Analysis*, Test Method C136,
7.2.2.2 *Material Finer Than 75-μm (No. 200) Sieve*, Test Method C117,
7.2.2.3 *Specific Gravity and Absorption*, Test Method C127 (Coarse Aggregate) and Test Method C128 (Fine Aggregate), and
7.2.2.4 *Organic Impurities in Fine Aggregate*, Test Method C40.
7.3 *Optional Test Methods or Practices*:
7.3.1 Some laboratories conduct other tests on concrete and concrete aggregates in addition to those listed in The *Required Test Methods and Practices* Section. These optional test methods and practices could include any of the test methods or practices developed by Committee C09 and contained in volume 04.02, as well as other related standards such as Practice D75 and Test Method D2419. The laboratory shall have evidence of proper facilities, equipment, and trained personnel to comply with the applicable test method or practice, if it is included in the scope of services as defined by the laboratory. The laboratory and the evaluation authority will mutually agree upon which optional test methods or practices will be included in the laboratory's evaluation. The evaluation authority shall then select which of the optional test methods or practices offered by the laboratory need to be demonstrated by the personnel.
7.4 The laboratory shall use the latest version of each referenced method within one year of its publication unless an earlier version of the standard is required by the client.
7.5 Laboratory personnel shall have convenient access to applicable standards.

8. Facilities, Equipment, and Supplemental Procedures

8.1 *General*—The laboratory shall have facilities and equipment conforming to the requirements of the applicable test method. This section contains equipment requirements and procedures that clarify certain provisions of the test methods.
8.2 *Procedures Related to Required Test Methods*—In addition to standard test method requirements, the conditions listed in 8.3 and 8.4 must be met.
8.3 *For Laboratories Testing Concrete*:
8.3.1 *Compressive Strength Testing Machines*, shall conform to the applicable requirements of Test Method C39/C39M and have a capacity, loading range, and the appropriate heads for specimens to be tested. Testing machines shall be verified at least annually in accordance with Practices E4 and a report giving details of the verification shall be readily available.
8.4 *For Laboratories Testing Concrete Aggregates*:
8.4.1 *Sieve Accuracy*—Verification of sieve accuracy shall be performed at least annually on each sieve used in the test for sieve analysis (Test Methods C117 and C136). Any one of the following three methods of verification is acceptable. Each method of sieve verification shall include an inspection of the sieve cloth for punctures or obvious defects.
8.4.1.1 Verification of each sieve used according to the procedures prescribed in the Annex of Specification E11.
8.4.1.2 A comparison of the results of a split sample sieved on different sieve sets. Results shall be verified for single operator precision to be within the acceptable range of two results stated in the test method.
8.4.1.3 Participation in the sieve analysis test in an aggregate proficiency sample program, as described in the Quality Systems section. Results shall be verified for multilaboratory precision to be within the acceptable range of two results stated in the test method.
8.4.2 *Mechanical Sieve Shaker*—When mechanical sieving devices are used, the period of mechanical agitation shall be checked at least annually for adequacy of sieving as described in Test Method C136. Mechanical agitation periods must be established for each different type of aggregate tested.

NOTE 3—Different types of aggregate refer to shape and composition, not supplier. For example, agitation periods for elongated materials may need to be extended, while softer materials that break down easily may require a shorter period to minimize alteration of the particle size distribution.

8.4.3 *Relative Density (Specific Gravity) and Absorption Tests*—When performing the procedures of Test Methods C127 and C128, duplicate tests shall be made at least once every 6 months. Results shall be verified for single operator precision within the tolerance stated in the respective test method. Participation in a proficiency sample program with relative density (specific gravity) and absorption testing is an acceptable alternative.
8.4.4 Balances or scales for all concrete and aggregate tests shall be calibrated annually.
8.5 *Procedures Related to Optional Test Methods*:
8.5.1 If the applicable test method requires equipment calibration and does not specify a frequency, then the laboratory shall establish a frequency in its quality assurance program and conform thereto.
8.5.2 In the event that the laboratory borrows or rents equipment to perform an optional test method, the laboratory must be able to document that it obtained the appropriate equipment and that the equipment was calibrated, standardized, or verified.
8.6 All equipment listed in this section shall be calibrated or verified before being placed in service. Equipment not in operating

condition or out of tolerance shall be marked as such and taken out of service until corrected.

9. Laboratory Records and Reports

9.1 The laboratory shall maintain a system of records that permits verification of any issued report.

9.2 The records of the laboratory shall contain the following information:

9.2.1 Standard operating procedures for the following:

9.2.1.1 Identification of the test sample,

9.2.1.2 Transfer of the sample from the field to the laboratory, and

9.2.1.3 Recording of test results.

9.2.2 Calibrations or verifications of equipment required by the test method for all of the tests offered in the scope of the laboratory's services. The records shall include:

9.2.2.1 The identification of the specific piece of equipment,

9.2.2.2 The identification of the equipment used to perform the calibration or verification,

9.2.2.3 The name of the individual who performed the calibration or verification,

9.2.2.4 The date the calibration or verification was performed,

9.2.2.5 The quantity measured by the equipment (such as length, force, or mass), and

9.2.2.6 The associated accuracy of the measurement or a comparison of the measured quantity with the associated allowable tolerances, as necessary to verify that the equipment complies with the requirements in the relevant standards. Where additional calibration or verification requirements have been listed in the *Facilities, Equipment, and Supplemental Procedures* Section, this information shall also be included in the records.

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

9.2.4 Audits and inspections by outside agencies and all reports or certifications, with applicable dates, of any evaluation or accreditations issued by any evaluating authorities,

9.2.5 The laboratory shall retain results of participation in proficiency sample programs, including data sheets, summary reports and, if low proficiency sample ratings are received, a record of the laboratory's investigation into the reason for the low ratings and corrective action taken.

9.2.6 Current standard test methods and other pertinent reference material in a library,

9.2.7 Identification of the person performing the field tests, and

9.2.8 Documents that establish the traceability to an acceptable reference standard or a national standard for load cells, proving rings, thermometers, test weights, and test equipment used for verification or calibration of laboratory equipment.

9.3 Laboratory test reports shall accurately and clearly present the specified test results and all pertinent data.

9.4 Test reports shall include the following information:

9.4.1 Name and address of the laboratory,

9.4.2 Identification of the report and the date issued,

9.4.3 Name of the client,

9.4.4 Project identification,

9.4.5 Sample identification,

9.4.6 Identification of the standard test method used, a notation of all known deviations from the test method, and all requirements of the test method that were not performed by the laboratory (Note 5),

9.4.7 Test results and other pertinent data required by the standard,

9.4.8 Name of the registered professional engineer or his designee, and

9.4.9 Identification of results obtained from tests performed by other laboratories.

9.5 Corrections or additions to reports shall clearly reference the report being amended.

9.6 All records required by this standard shall be stored safely for at least 3 years, unless otherwise required by law or governing specifications. Those records that are confidential in nature, including test reports and other records generated as required by contract with the client, shall be stored safely in confidence to the client, unless otherwise required by law, governing specification, or client requirements.

NOTE 4—There are circumstances when a longer retention period may be advantageous to the laboratory. Records concerning the calibration, verification, and standardization of equipment are an example. Records of this type are often held throughout the useful life of the equipment.

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

10. Quality Systems

10.1 The laboratory shall maintain a quality manual of written procedures for ensuring the quality of the services offered (Note 8). In addition to the following information, each page in the manual shall contain a preparation or revision date to ensure the latest procedure is being followed.

10.1.1 Internal quality assurance program, including:

10.1.1.1 Personnel evaluation including the method of evaluation, the frequency of the review, the criteria used, and the title or name of the individual responsible for administering the evaluations; and technician training including a description of the levels

of training, the testing used to determine when a level has been reached and the title or name of the individual responsible for administering the training,

10.1.1.2 Equipment calibration and maintenance,

10.1.1.3 A current library including all relevant test methods, and

10.1.1.4 Inventory of all test equipment requiring both an initial and a subsequent periodic calibration or verification that is used by the laboratory to perform the test methods covered by this standard and within the laboratory's scope of services. The inventory shall include the equipment description, identification number, and next date of calibration or verification.

NOTE 6—The inventory should include equipment such as scales, compression machines, and slump cones. Equipment such as tamping rods and expendable supplies such as single-use cylinder molds need not be included on the inventory.

10.1.1.5 Participation in proficiency sample programs (PSP). The laboratory shall participate in concrete or aggregate proficiency sample programs or both if the laboratory performs testing in both areas. The PSP used must meet the following criteria: (1) include a minimum of 10 participants, (2) issue a report that includes the laboratory's results, the average of all results, the standard deviation of the results, and rating(s) based on the number of standard deviations that the laboratory's results vary from the grand average for the test method(s) covered, (3a) include at least one of the following methods if the laboratory tests concrete: C39/C39M, C138/C138M, C143/C143M, C173/C173M, or C231; and, (3b) include at least one of the following methods if the laboratory tests concrete aggregates: C136, C127, or C128, (4) be independent of the participating laboratories, (5) distribute samples at least once annually, and (6) maintain a record of all sample test results from participants for at least 3 years.

NOTE 7—For additional guidance in selecting a proficiency sample program the laboratory may wish to consult Guide E1301.

10.1.2 The laboratory shall establish procedures for responding to low proficiency sample program ratings. Ratings are considered to be low if the laboratory's result is beyond two standard deviations from the grand average on the final report.

10.1.3 The laboratory shall establish procedures for handling technical complaints from clients that includes the title or name of the individual responsible for handling the complaint, the review system in the laboratory and the type of reply to be issued.

10.1.4 The laboratory shall establish procedures for ensuring the quality of external technical services, such as: calibration services used by the laboratory, equipment and materials procured by the laboratory from vendors, and subcontractors (that is, a laboratory contracted to perform a standard test method or part of a test method). The laboratory should be able to demonstrate that the subcontractor is competent and is in compliance with the requirements of the test methods. The laboratory should maintain records of the subcontractor and vendor evaluations. The selection and evaluation criteria for the subcontractor should include a review of external audits, inspections, certifications, and laboratory accreditations held by the laboratory.

NOTE 8—Other recommended quality programs for a laboratory include: (*1*) Conducting within-laboratory statistical computations on concrete tests. Randomly selecting 10 tests per month and determining the within-test standard deviation (see ACI 214-77 and Practice C802 for statistical methods); (*2*) Participation in an interlaboratory proficiency program on concrete tests. A quarterly exchange of samples between laboratories in accordance with Practice C802 will provide excellent quality assurance data.

11. Laboratory Evaluation

11.1 The testing laboratory shall have its facilities, equipment, personnel, and procedures evaluated at intervals of approximately 24 months by an evaluation authority to confirm its ability to perform the required tests. The personnel and equipment used by the laboratory during the evaluation shall be representative of the personnel and equipment available during the period between evaluations. Temporary acquisition of personnel or equipment to enhance the results of the evaluation shall not be permitted.

~~11.2Deficiencies noted in the final report provided to the laboratory by the evaluation authority shall be corrected within 30 days of receipt of the report.~~

~~11.3 The laboratory shall (*1*) report deficiency corrections to the accrediting body who will issue a certificate of accreditation when their requirements are satisfied, or (*2*) if an inspection service is used, supplement copies of the final report with a statement of corrective actions taken signed by the laboratory's professional engineer.~~

11.2 Two methods of evaluation, either inspection or accreditation, are acceptable.

11.2.1 Responsibilities and duties of evaluation authorities conducting assessments (identified as Inspection Bodies) shall be in accordance with Annex A1.

11.2.2 Responsibilities and duties of evaluation authorities conducting assessments as part of an accreditation process (identified as Accreditation Bodies) shall be in accordance with Annex A2.

11.3 The personnel and equipment used by the laboratory during the evaluation shall be representative of the personnel and equipment available during the period between evaluations. Temporary acquisition of personnel or equipment to enhance the results of the evaluation shall not be permitted.

11.4 Deficiencies noted in the final report provided to the laboratory by the evaluation authority shall be corrected within 30 days of receipt of the report.

11.4.1 If an inspection service is used, the laboratory shall supplement the final report with a statement of corrective actions taken, which is signed by the laboratory's professional engineer.

11.4.2 If an accreditation service is used, the laboratory shall report deficiency corrections to the Accreditation Body who will issue a certificate of accreditation when its requirements are satisfied.