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Laboratory Accreditation and the Quality of Testing of Construction Materials Used in Transportation Systems[1]

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Abstract

An important contribution to the quality of a constructed facility is accurate testing of materials which go into the project. In recognition of this fact, laboratory accreditation programs are being used to a greater extent in the United States to ensure that materials used in highways and other transportation projects are being tested in conformance with appropriate standards and specifications. The largest of these programs in the United States is the AASHTO Accreditation Program (AAP) which was established by the American Association of State Highway and Transportation Officials (AASHTO) in 1988. It provides a mechanism for formally recognizing the competency of testing laboratories to perform specific tests on asphalt binders, hot-mix asphalt, aggregates, hydraulic cement, and portland cement concrete. AAP utilizes the laboratory inspection and proficiency sample programs of the AASHTO Materials Reference Laboratory (AMRL) and the Cement and Concrete Reference Laboratory (CCRL) to accredit laboratories. The Federal Highway Administration (FHWA) is requiring that certain state and private laboratories which test materials used in Federal transportation projects be accredited by AAP. This paper provides an overview of AMRL and CCRL programs, and discusses how the approach to laboratory accreditation used by AAP assists FHWA in promoting the quality of laboratory testing of highway construction materials.

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Introduction

The accurate testing of construction materials is important for ensuring the quality of built structures. Such testing is needed so that building officials, contractors, material's producers, owners, architectural and engineering firms, and others involved with the construction process have confidence that the materials going into the structure comply with contract specifications. The key to competent testing in a laboratory is an effective and comprehensive quality system with sufficient checks to ensure that it is operating effectively. This issue is becoming increasingly important in the United States with adoption of ISO quality standards by the construction community [Pielert, 1994].

This paper will overview AMRL and CCRL programs, and discuss how the approach to laboratory accreditation used by the AASHTO Accreditation Program is being utilized by FHWA to promote the quality of laboratory testing of highway construction materials.

Program Elements of the Construction Materials Reference Laboratories

The Construction Materials Reference Laboratories (CMRL) located at the National Institute of Standards and Technology (NIST) consist of the Cement and Concrete Reference Laboratory (CCRL) and the AASHTO Materials Reference laboratory (AMRL). The primary mission of the CMRL is to improve the quality of testing in laboratories that test construction materials [Pielert, 1989].

CCRL and AMRL are Research Associate Programs managed by NIST under Memoranda of Agreement between the sponsoring agencies and NIST. CCRL was established at NIST in 1929 under sponsorship of the American Society for Testing and Materials (ASTM), and AMRL was established at NIST in 1965 under sponsorship of the American Association of State Highway and Transportation Officials (AASHTO). AMRL conducts programs to evaluate laboratories' abilities to test materials used in transportation projects including soils, aggregates, traffic and structural paints, metals, plastic pipe, asphalt binders, and bituminous materials and mixtures [Steele; Pielert, 1996]. CCRL conducts programs for evaluating laboratories which test cements, concrete, concrete aggregates, pozzolans, and reinforcing steel [PCA, 1993]. These organizations are outstanding examples of how federal and state government, and the private sector can cooperate to meet the common goal of improving the quality of construction in the United States.

CMRL promotes the quality of laboratory testing through four major functions: (1) inspecting laboratories to determine conformance with national standards; (2)

conducting proficiency sample programs; (3) participating in the work of technical committees of organizations who prepare test standards; and (4) conducting technical studies related to materials testing. Most of these programs are available on a voluntary basis to any laboratory willing to pay fees established by the sponsors.

The CMRL Laboratory Inspection Programs are designed to provide a formal independent and unbiased assessment of a laboratory's test equipment, testing procedures, and quality system; and to provide an analysis and report on its testing capabilities. Each participating laboratory is visited with specialized equipment to evaluate its capability to carry out testing in accordance with standardized procedures. A "hands-on" approach is used, with detailed work sheets based on ASTM and AASHTO standards, to evaluate equipment and a technician performing the tests as shown in Figure 1.

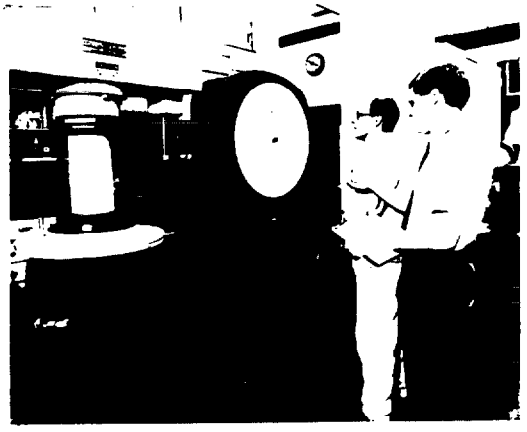

Figure 1. Inspection of a Testing Laboratory by a CCRL Laboratory Inspector

Any deviation from the prescribed procedure is noted, and if necessary, the correct technique is demonstrated. At the completion of the visit, a face to face discussion is held with the laboratory's technical manager outlining findings including a preliminary written report. A final written report is subsequently sent to the laboratory. It is treated as strictly confidential, but may be distributed to other parties if the laboratory provides a written request.

AMRL and CCRL inspect laboratories in North America on a sequential basis at intervals (inspection tours) of 2 to 2½ years. CCRL inspected 659 laboratories and AMRL 384 laboratories in their most recently completed tours.

The Proficiency Sample Programs provide comparisons of results within or among various laboratories with the objective of recognizing and correcting deficiencies. Uniform samples are prepared at a facility at NIST from lots of a given material and sent to participating laboratories with instructions for performing tests based on ASTM or AASHTO standards. Each laboratory returns the results to CCRL and AMRL for review and analysis. A final report with statistical information is provided to all participating laboratories who are alerted to possible problems with their testing. Compilations of these proficiency sample test data and statistics are provided to standards committees who use them in the development of standards such as to prepare statements of precision [ASTM, 1980; Pielert, 1995]. Table 1 shows participation levels in the proficiency sample programs vary between 38 in a new CCRL concrete masonry unit program to almost 500 laboratories in the AMRL soil program.

Table 1 - Laboratory Participation in CMRL Proficiency Sample Program

Organization	Program	Number of Laboratories
CCRL	Portland Cement	265
	Portland Cement Concrete	496
	Pozzolans	78
	Blended Cement	90
	Masonry Cement	86
	Masonry Mortar	48
	Concrete Masonry Units	38
AMRL	Asphalt Binders	190
	Bituminous Concrete	404
	Soils	497
	Aggregates	533

CCRL and AMRL staff provide technical support to the standards committees of ASTM and AASHTO. Data from the laboratory and proficiency sample programs are used by standards committees in assessing the adequacy of current test methods, in determining the impact of revisions to standards, and in developing precision statements. Support to standards committees has proven to be of significant benefit to the

construction industry since it provides a liaison between the authors and users of ASTM and AASHTO standards covered by the programs.

Technical studies are conducted by CMRL to aid in improvement of standard methods of test for materials included in its programs, and to support development of new programs. A study may be initiated by a request from a standards committee or other interested party, or a program requiring study may be identified while conducting the laboratory inspection or proficiency programs. An example of a technical study is a special inter-laboratory study to evaluate changes in a standard test method requested by a committee.

CMRL programs are referenced in ASTM and AASHTO standards and are used by specifying and accrediting bodies as part of their programs to evaluate the competency of testing laboratories. It is to be noted that participation in AMRL and CCRL programs does not represent certification or accreditation of a laboratory.

Laboratory Accreditation

While the evaluation of laboratory competence is probably as old as the industrial revolution, the idea of a national "third party" to meet the needs of users of laboratory services was developed in Australia following World War II [Gilmour]. While this activity was first called *laboratory registration*, the expression *laboratory accreditation* came into general usage in the early 1970's.

The current definition of laboratory accreditation given in ISO Guide 2, General Terms and Their Definitions Concerning Standardization and Related Activities, is "a formal recognition that a laboratory is competent to perform specific tests or a specific type of test" [ISO, 1996]. ISO (the International Organization for Standardization) has been quite active in preparing additional documents for laboratory accreditation systems, many of which have been adopted by ASTM Committee E36 on Conformity Assessment.

ISO Guide 25 - General Requirements for the Organization of Calibration and Testing Laboratories [ISO, 1990]

This guide was prepared by ISO Committee on Conformity Assessment (CASCO). It sets out general requirements a laboratory has to meet if it is to be recognized for being competent to carry out tests or calibrations. It can be used by laboratories in developing quality, administrative and technical systems that govern their operations. ISO Guide 25 is the basis for ASTM E548 Standard Guide for General Criteria Used for Evaluating Laboratory

Competence [ASTM, 1996].

ISO Guide 58 - Calibration and Testing Laboratory Accreditation Systems - General Requirements for Operation and Recognition [ISO, 1993]

> This guide sets out general requirements for operation of a system for accreditation of calibration or testing laboratories. It provides guidance for setting up and operating an accreditation system and assists in facilitating agreements on mutual recognition of accreditation of laboratories between accreditation bodies. ISO Guide 58 is the basis for ASTM E994, Standard Guide for General Criteria Used for Evaluating Laboratory Competence [ASTM, 1996].

There are three major national programs in the United States for accrediting construction materials testing laboratories: AASHTO Accreditation Program (AAP), the American Association for Laboratory Accreditation (A2LA), and the National Voluntary Laboratory Accreditation Program (NVLAP). These programs use some or all of the CMRL programs as discussed below [Pielert, 1988].

A2LA was formed in 1978 as a nonprofit, scientific, membership organization dedicated to the formal recognition of testing organizations that have been shown to be competent [Locke]. A2LA grants accreditation in the following fields of testing: biology, chemistry, construction materials, geotechnical, electrical, mechanical, nondestructive testing, and thermal. A2LA requires laboratories to participate in applicable proficiency sample programs of AMRL and CCRL as part of its accreditation requirements.

NVLAP, which is administered by NIST, accredits public and private testing laboratories in broad fields of testing [Gladhill]. NVLAP accreditation in construction testing services is available for selected methods of test for concrete, aggregates, cement, admixtures, geotextiles, soil and rock, bituminous materials, and steel. Participation in the laboratory inspection and proficiency sample programs of CCRL and AMRL may be used by laboratories to meet NVLAP requirements.

Unlike the laboratory accreditation systems in other countries, especially in Europe, the system in the United States is fragmented and often requires laboratories to receive multiple accreditations. A study is underway to attempt to remedy the situation, and a National Council on Laboratory Accreditation (NACLA) is being formed to bring some sense to the situation [NIST]. NACLA is proposed as a cooperative partnership between the public and private sectors that will provide a uniform approach for accrediting organizations and accrediting laboratories to meet international standards.

The planned infrastructure will provide for national and international recognition of a laboratory's competence and eliminate the need for multiple, often duplicate accreditations required by organizations in government and the private sector.

AASHTO Accreditation Program

The AASHTO Accreditation Program (AAP) was established by AASHTO in 1988 to provide a mechanism for formally recognizing the competency of testing laboratories to perform specific tests on construction materials [Spellerberg]. AASHTO has assigned responsibility for monitoring and administering the operation of the AAP to its Highway Subcommittee on Materials. Laboratories may be accredited for testing of soil, asphalt binders, emulsified asphalt, hot-mixed asphalt mixes and aggregates used in these mixes, portland cement, and portland cement concrete and aggregates. Accreditation is provided for specific tests of these materials and for compliance to the requirements of ASTM Standard Practices C1077, C1222, D3666, D3740 and E329; and to ISO Guide 25. For initial accreditation, a laboratory must satisfy the quality system requirements specified in AASHTO Practice R18, Standard Recommended Practice for Establishing and Implementing a Quality System for Construction Materials Testing Laboratories, and receive on-site inspections from AMRL and/or CCRL for test methods for which accreditation is being sought [AASHTO]. In addition, the laboratory must be enrolled in applicable AMRL and CCRL proficiency sample programs. AASHTO accreditation is available to all laboratories including independent laboratories, manufacturers' in-house laboratories, university laboratories, and governmental laboratories.

There were 272 laboratories accredited by AAP as of March 31, 1997, making it the largest accreditor of laboratories testing these materials in the United States. Figure 2 shows the growth of laboratory participation since 1988.

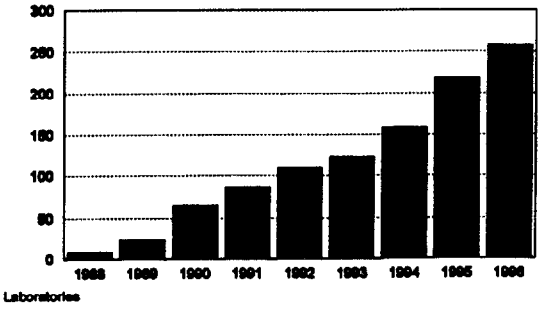

Figure 2. Growth of AASHTO Accreditation Program Since Inception in 1988

AAP accreditation is being used by various governmental organizations to qualify laboratories for doing work under their jurisdiction. The use of AAP for this purpose by the Federal Highway Administration (FHWA) is discussed next.

FHWA Requirements and Laboratory Accreditation

Federal Regulation 23 CFR 637 "Quality Assurance Procedures for Construction" published June 29, 1995 requires that, for federal aid projects, each State Highway Administration (SHA) develop a quality assurance (QA) program, approved by the FHWA to ensure the quality of the product from which acceptance decisions are made. The QA program must consist of an acceptance program and an independent assurance (IA) testing program. These regulations require the following:

- Each SHA shall have its central laboratory accredited by the AAP by June 30, 1997.
- All contractor, vendor, and SHA testing used in the acceptance decision shall be performed by qualified personnel by June 29, 2000.
- Any non-SHA designated laboratory that is used in dispute resolution sampling and testing shall be accredited in the testing to be performed by the AAP or a comparable laboratory accreditation program approved by the FHWA by June 29, 2000.
- Any non-SHA designated laboratory which performs IA sampling and testing shall be accredited in the testing to be performed by the AAP or a comparable laboratory accreditation program approved by the FHWA by June 29, 2000.
- All sampling and testing data to be used in the acceptance decisions or the IA program shall be executed by qualified sampling personnel by June 29, 2000
- Any qualified non-SHA laboratory shall perform only one type of testing (verification, quality control, IA or dispute resolution) on the same project.

Conclusions

High-quality laboratory testing services are important to achieving safe, efficient, and cost-effective structures. The programs discussed in this paper are available to evaluate the quality of laboratory testing and to ensure that the testing in participating laboratories remains at the highest level.

References

AASHTO, Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part I: Specifications, 17th ed., AASHTO, Washington, D.C., 1995.

ASTM, "Use of CCRL Reference Sample Results for Precision Statements," Cement, Concrete and Aggregates, Vol. 2, No.1, Philadelphia, PA, Summer 1980, pp. 50-52.

ASTM, Annual Book of Standards, Volume 14.02, Philadelphia, PA., 1996

Gilmour, J.A., "The Practice of Laboratory Accreditation," Proceedings of the International RILEM/ILAC Symposium on Test Quality for Construction Materials and Structures, RILEM Proceedings 9, Chapman and Hall, London, 1990, pp. 249-257.

Gladhill, R.L., "Impact of Accreditation on Laboratory Quality Assurance," Proceedings, Symposium on Test Quality for Construction, Materials and Structures, RILEM, Paris, France, October 1990, pp. 283-289.

ISO, ISO Guide 25, "General Requirements for the Competence of Calibration and Testing Laboratories," International Organization of Standardization, Geneva, Switzerland, 1990.

ISO, ISO Guide 58, " Calibration and Testing Laboratory Accreditation Systems - General Requirements for Operation and Recognition," International Organization of Standardization, Geneva, Switzerland, 1993.

ISO, ISO Guide 2, "General Terms and Their Definitions Concerning Standardization and Related Activities," International Organization of Standardization, Geneva, Switzerland, 1996.

Locke, J.W., "Quality Assurance in the Construction Materials Laboratory," Proceeding, Workshop on Evaluation of Cement and Concrete Laboratory Performance, Special Publication 788, National Institute of Standards and Technology, Gaithersburg, MD, 1990.

NIST, "Open Forum – The National Council for Laboratory Accreditation," Standards and Conformity Assessment, Newsletter of Office of Standards Services, National Institute of Standards and Technology, Gaithersburg, MD, Winter 1996-1997.

PCA, "Promoting Quality in Laboratory Testing, Concrete Technology Today," Portland Cement Association, Skokie, Illinois, Volume 14/Number 2, 1993, pp. 3-4.

Pielert, J.H., "Activities of the Construction Materials Reference Laboratories Related to Laboratory Accreditation," ASTM STP 1057, ASTM, Philadelphia, PA, 1988, pp. 30-36.

Pielert, J.H., "Construction Materials Reference Laboratories at NIST - Promoting Quality in Laboratory Testing," Standardization News, ASTM, Philadelphia, PA, 1989, pp. 40-44.

Pielert, J.H., "The Role of Cement and Concrete Testing Laboratories," STP 169C, ASTM, Philadelphia, PA, 1994, pp. 38-41.

Pielert, J., Haverfield, J., and Spellerberg, P., "Application of CCRL Data in the Formulation of Precision Statements for Selected Cement Standards, "Cement, Concrete and Aggregates, Vol.7, No. 1, ASTM, Philadelphia, PA, Summer 1995, pp. 37-42.

Pielert, J.H. and Spellerberg, P.A., "AASHTO Materials Reference Laboratory - Thirty Years of Service to the Transportation Community," TR News, Transportation Research Board, Washington, D.C., March-April 1996, pp. 22-28.

Spellerberg, P.A., W.L. Trimm and J.H. Pielert, 'Development and Application of a Quality System Standard for Construction Materials Testing Laboratories," Journal of Testing and Evaluation, Vol. 24, No. 1, ASTM, Philadelphia, PA, 1996, pp. 49-55.

Steele, G.W., "Quality Assurance of Our Highways - The AASHTO Materials Reference Laboratory (AMRL), Fifteen Years of Service," AASHTO Quarterly, American Association of State Highway and Transportation Officials, Washington, D.C., January 1981, pp. 35-38.