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AASHTO Materials Reference Laboratory

Thirty Years of Service to the Transportation Community

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The AASHTO Materials Reference Laboratory (AMRL) is a research associate program located at the National Institute of Standards and Technology (NIST) under the sponsorship of the American Association of State Highway and Transportation Officials. AMRL and the Cement and Concrete Reference Laboratory (CCRL), which is sponsored by the American Society for Testing and Materials, make up the Construction Materials Reference Laboratories at the NIST Building and Fire Research Laboratory. The primary mission of these two programs is to improve the quality of testing in laboratories that test construction materials. AMRL is involved with materials used in transportation projects, including soils, aggregates, traffic and structural paints, metals, plastic pipe, asphalt binders, and bituminous materials and mixtures. CCRL conducts programs for cements, concrete, aggregates, pozzolans, and reinforcing steel. Both laboratories are outstanding examples of how federal and state governments and the private sector can cooperate to meet a common goal: improving the quality of construction in the United States (*1,2*).

AMRL, established in 1965, operates under a memorandum of agreement between AASHTO and the National Institute of Standards and Technology. The Institute is responsible for the day-to-day management and operation of AMRL, and the AASHTO Highway Subcommittee on Materials guides the operation of the laboratory. The AMRL Council of the subcommittee maintains general oversight over the laboratory but has delegated certain responsibilities to the AMRL Administrative Task Group (ATG). This task group is responsible for conducting program reviews, making budgetary and staffing recommendations for inclusion in AASHTO's annual budget, and preparing the Association's materials standards related to the quality of laboratory testing (Figure 1).

AMRL performs four major functions: inspection of equipment, testing procedures, and quality systems at materials-testing laboratories; distribution of proficiency samples; participation in the work of standards committees; and analysis of testing problems. These functions are continually affected by innovations and changing technology.

The Cement and Concrete Reference Laboratory, which is sponsored by the American Society for Testing and Materials, promotes the quality of testing in construction materials laboratories. More than 600 laboratories in the United States, Canada, and Mexico are currently evaluated through the CCRL. In 1995 ASTM honored 29 of these organizations for maintaining an unbroken record of high-quality tests for 66 years. Thirteen of the organizations cited were the state departments of transportation in California, Florida, Idaho, Kansas, Michigan, Minnesota, Missouri, New Hampshire (Bureau of Materials and Research), New Mexico, Ohio, Oregon, Utah, and Wisconsin.

LABORATORY INSPECTION PROGRAM

The primary function of AMRL is the inspection of materials-testing laboratories. The Laboratory Inspection Program is designed to provide a formal unbiased assessment of a laboratory's test equipment, testing procedures, and quality system; and to provide an analysis and report on its testing capabilities. The evaluations are conducted by AMRL inspectors through on-site visits to laboratories (Figure 2). These services are available on a voluntary basis to any laboratory willing to pay the fees established by the Administrative Task Group.

AMRL began inspecting soil, aggregate, and liquid bituminous materials test facilities in sponsoring laboratories in January 1966. Sponsors currently include the 52 AASHTO member departments and associate members who pay

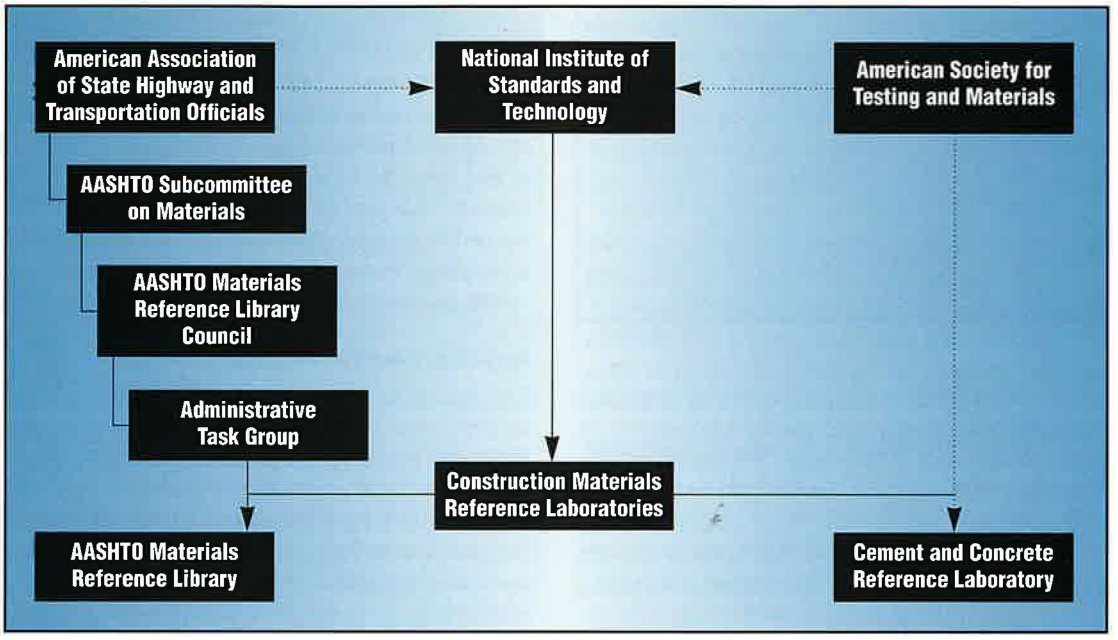


FIGURE 1
AASHTO Materials Reference Laboratory organizational relationships.

an annual assessment for these services. The inspection activities were initially limited to an evaluation of apparatus associated with 25 test methods, and testing procedures for 8 methods. The scope of the program quickly expanded to include the test methods listed in ASTM Practice E329, "Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction" (3). By 1970 the program covered the evaluation of apparatus and procedures for 55 test methods.

Until 1980, the participants in the Laboratory Inspection Program were primarily central and branch laboratories of sponsors. Then the program was made broadly available to private laboratories, which substantially increased the number of laboratories inspected. Also in 1980, the program was expanded to include an evaluation of equipment and procedures for measuring the frictional properties of pavement. Inspections for plastic pipe test laboratories and metals test laboratories were added in 1988 and 1992, respectively. Only sponsor laboratories are currently eligible for all three of these inspection services.

The most recent expansion of coverage in the program occurred in late 1992 with the addition of a quality system evaluation based on the requirements of AASHTO Practice R18, "Standard Recommended Practice for Establishing and Implementing A Quality System for Construction Materials Testing Laboratories"(4). R18 specifies procedures and records associated with staff training and evaluation, equipment calibration and verification, and quality system requirements. R18 is based on the ISO 9000 series of standards through application of criteria in International Organization of Standardization Guide 25, "General Requirements for the Competence of Calibration and Testing Laboratories" (5). Approximately one-half of the almost 300 laboratories that receive inspection services from AMRL request evaluation under R18. As an option to AASHTO R18, AMRL will also evaluate a laboratory for compliance with the requirements of ASTM Practices E329; D3666, "Standard Practice for Evaluation of Inspection and Testing Agencies for Bituminous Pavement Materials"; and D3740, "Standard Practice for Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction" (6).

AMRL inspections increased substantially during the last nine years in Tours 14 through 19 (Figure 3). A tour, generally lasting from 18

FIGURE 2
AMRL inspector observes test.

Through its Laboratory Inspection Program, AMRL reviews tests on the basis of the requirements of both AASHTO and ASTM test methods. The 102 physical tests for construction that can be inspected by AMRL are as follows:

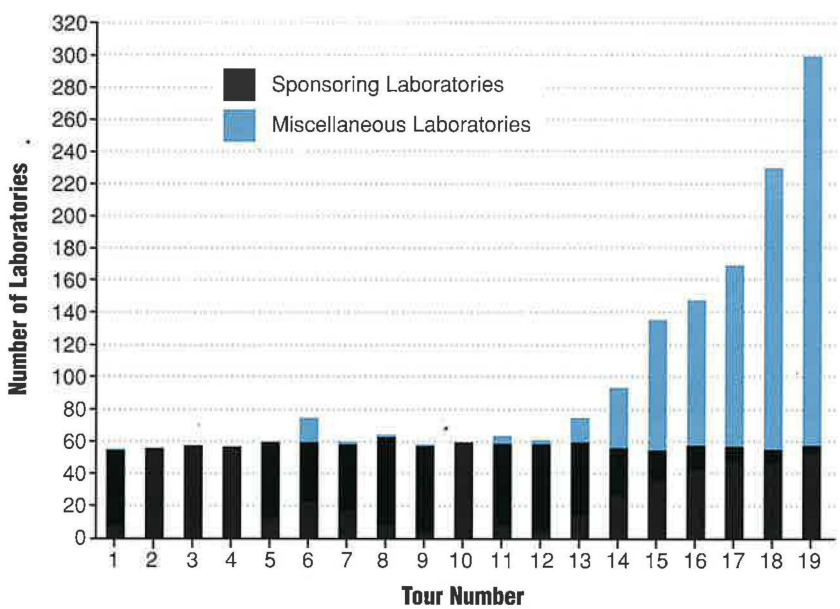
- Soil: 24
- Aggregate: 15
- Bituminous Materials: 18
- Emulsified Asphalt: 9

months to 2 years, is the time required to make a complete circuit of participating laboratories in the United States and Canada. Participation has increased in recent years for several reasons:

- AMRL inspection and R18 quality system review are required of laboratories seeking AASHTO accreditation.
- For the last 8 to 10 years, state and federal agencies have been restructuring to reduce the cost of operations. The reassignment of functional responsibilities and changes in the work force have led to a gradual move toward privatizing testing operations and assigning some of them to contractors.
- When government agencies have transferred testing responsibilities to the private sector, these commercial laboratories were required to be accredited or have their technicians certified.

Beginning in 1995 the scope of the Laboratory Inspection Program was expanded to include an evaluation of the new asphalt binder test equipment and procedures from the Strategic Highway Research Program, and the SUPERPAVE gyratory compactor and associated compaction procedures (7). SHRP was established by Congress in 1987 as a five-year, $150 million research program to improve the performance and durability of the nation's highways. Other changes will occur as the technology moves forward and as the needs of AMRL sponsors change.

FIGURE 3
Participation in AMRL Laboratory Inspection Program.



Proficiency Sample Program

The second major function of AMRL is the management and operation of a Proficiency Sample Program. This program provides participating laboratories with an opportunity to compare their test results with those from other laboratories by testing samples of the same material. Its method of operation includes obtaining and homogenizing representative material, preparing and packaging samples of the material, shipping the samples to participants with instructions for testing, conducting statistical analyses of test results, and preparing and distributing a summary report of results.

In 1966 AMRL distributed the first pair of proficiency samples, penetration-graded asphalt cements, to 53 sponsor laboratories. A pair of soil samples was distributed later that year. Six additional materials were added to the program between 1967 and 1987 (Table 1). New programs generally are restricted to sponsors' central laboratories, with expansion to their branch laboratories at a later date. Once participation is more fully developed, it is broadened to include any laboratory that wishes to participate. The records of participation for the materials included in the Proficiency Sample Program are shown in Figures 4–7.

Among the seven continuing AMRL programs that are open to all laboratories, current participation ranges from 100 laboratories in the emulsified asphalt program to almost 500 laboratories in the soil program. More than 650 laboratories located in the United States, Canada, South America, South Africa, and Denmark participate in one or more of the proficiency programs.

Data from the Proficiency Sample Program are used extensively by standards-setting committees of both AASHTO and ASTM, primarily for the preparation of precision estimates for standard test methods. AMRL staff members work closely with the standards committees of these organizations and, if requested by a committee, try to tailor a program to suit a particular data requirement. Researchers also rely on data from the Proficiency Sample Program.

Program	Initiated	Opened to all Labs
Asphalt Cement	1966	1971
Cutback Asphalt[a]	1967	1971
Soil	1967	1979
Aggregate	1968	1977
HMA (Analysis)	1974	1979
HMA (Design)	1984	1985
Asphalt Emulsion	1985	1994
Paint	1987	—

[a] Discontinued in 1994

TABLE 1
Initiation Dates of AMRL Proficiency Sample Programs

Participation in applicable parts of the AMRL Proficiency Sample Program is required by three major laboratory accrediting organizations in the United States: AASHTO Accreditation Program, American Association for Laboratory Accreditation, and the National Voluntary Laboratory Accreditation Program (*8*). AMRL provides an accrediting body or specifying agency with a copy of a laboratory's inspection report and proficiency sample test results after receiving written authorization from the laboratory.

Proficiency samples are prepared in the CMRL Materials Handling Facility located at NIST in Gaithersburg, Maryland. This federal facility was expanded in 1994 with funds provided by AMRL and CCRL (*9*).

Routine distribution of performance-graded asphalt binder samples has begun, to cover the tests specified in AASHTO Provisional Specification MP1, "Specification for Performance-Graded Asphalt Binder" (*7*). Data obtained will aid in the development of precision estimates for these new asphalt binder tests resulting from SHRP work. Proficiency samples will be distributed for the evaluation of the SHRP gyratory compactor and the compaction procedures as specified in AASHTO Test Provisional TP4, "Method for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the SHRP Gyratory Compactor" (*7*). Additional programs to support implementation of SHRP bituminous mix procedures will be initiated after the mix design equipment becomes available to the sponsors.

Standards Committee Support

A major responsibility of AMRL is to provide technical support to the AASHTO Highway Subcomittee on Materials in the development of construction materials standards. The following activities are typical of this support:

- An annual list of comments on AASHTO materials standards is prepared, based on information obtained from the Laboratory Inspection and Proficiency Sample Programs.
- In the implementation of SHRP research results, assistance is provided to the AASHTO SHRP Implementation Coordinator in drafting provisional standards for consideration by the Highway Subcommittee on Materials. AMRL is also distributing special proficiency samples for determining the precision of asphalt binder test methods, and is modifying its Laboratory Inspection and Proficiency Sample Programs to include the new provisional standards (*10*).

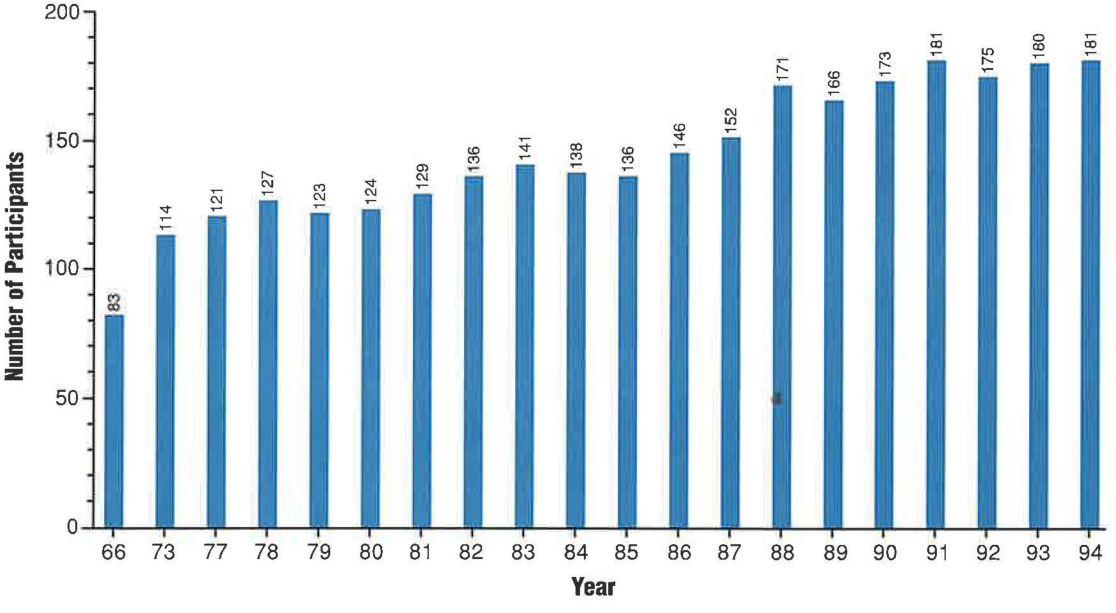


FIGURE 4
Participation in AMRL bituminous proficiency sample program.

• Guidance is provided for the metric conversion of AASHTO materials standards. Conversions to International System of Units measurements have been prepared for more than 400 standards under the jurisdiction of the Subcommittee on Materials.

• Interlaboratory test data from its Proficiency Sample Program are routinely given to the committees of AASHTO and ASTM for use in the preparation of precision statements for standard test methods.

• Standards are prepared for consideration by the AASHTO Highway Subcommittee on Materials. One example is Practice R18, initially drafted by AMRL.

AMRL staff members are active participants in the ASTM standards development process. This supports the work of the Highway Subcommittee on Materials because some AASHTO standards are based on ASTM standards. Staff members chair as well as serve on ASTM committees on laboratory evaluation, and on construction materials including soil, road-paving materials, cement, and concrete. Currently supported is an ASTM Institute of Standards Research project, which is preparing four reference soil samples and developing precision data for soil tests. This project has partial financial support from the Federal Highway Administration and several state departments of transportation.

FIGURE 5
Participation in AMRL soil proficiency sample program.

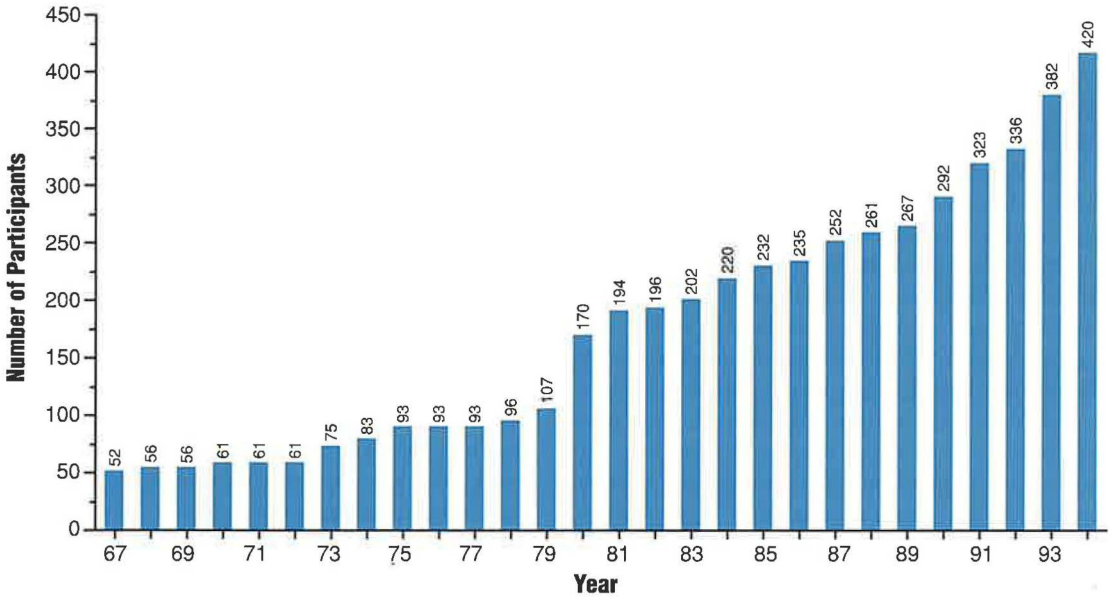
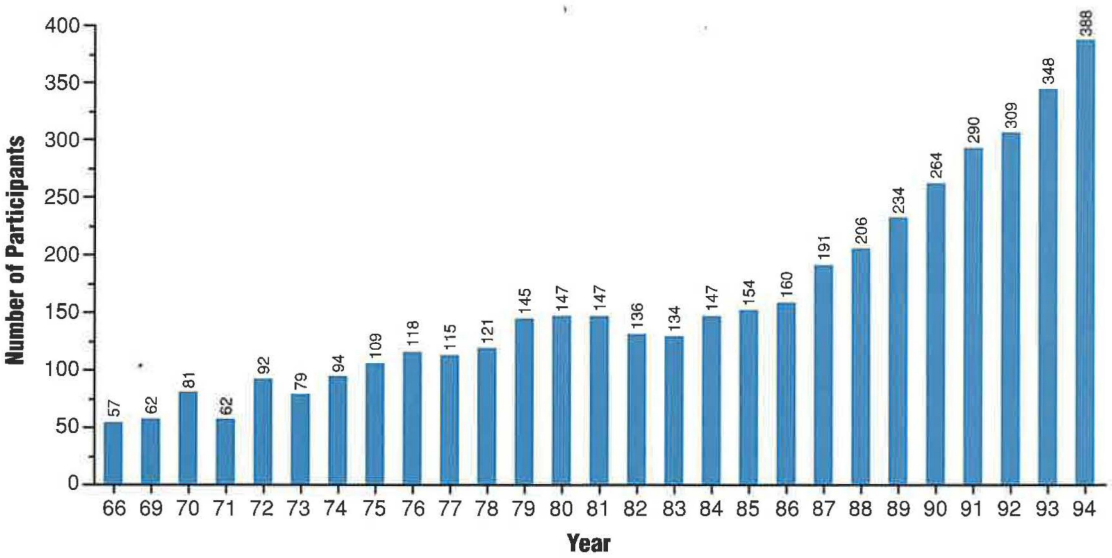


FIGURE 6
Participation in AMRL aggregate proficiency sample program.



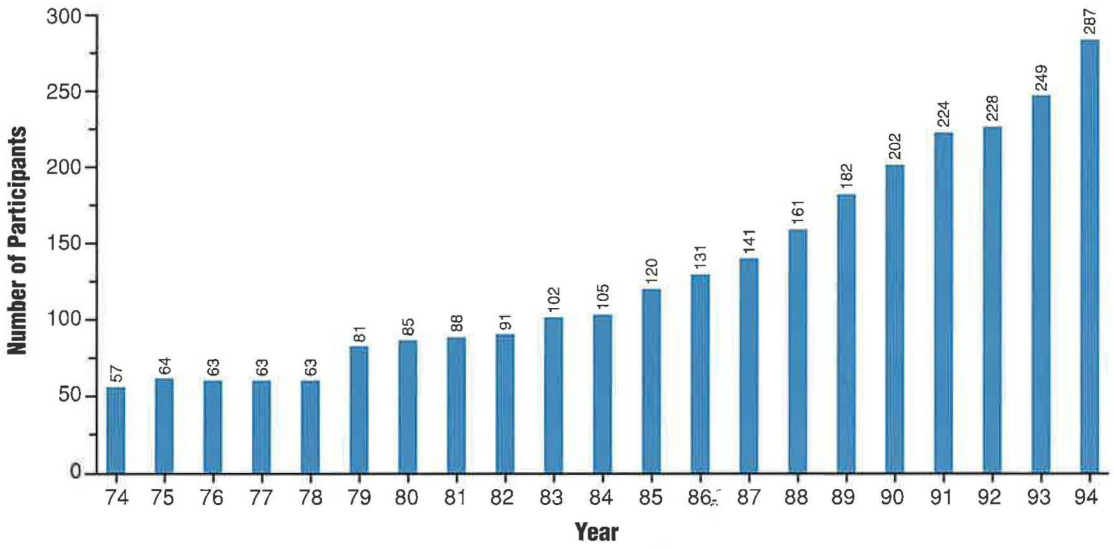


FIGURE 7
Participation in AMRL hot-mix asphalt proficiency sample program.

Study of Testing Problems

The laboratory conducts technical studies to aid in the improvement of standard methods of testing for construction materials, and to support the development of new programs. These studies are conducted by staff, cooperatively with other NIST units, or with organizations outside the Institute. An example of program development is the current work being done to incorporate the new SHRP standards into AMRL programs. As part of another project, the laboratory has collaborated with the NIST Structures Division on a project funded by FHWA to develop a calibration procedure for the Marshall Hammer used in bituminous concrete testing (*11,12*). The calibration device is undergoing field evaluation as part of the Laboratory Inspection Program. The work with the ASTM Institute of Standards Research soil project mentioned previously is an example of work with organizations outside NIST.

AASHTO Accreditation Program

The quality of laboratory testing is important to achieving safe, reliable, and cost-effective construction. In response to this need, the AASHTO Accreditation Program (AAP) was established in 1988 to provide a mechanism for formally recognizing the competency of a testing laboratory to carry out specific tests on construction materials. Laboratories may be accredited for testing of the following materials: soil, asphalt cement, emulsified asphalt, bituminous mixtures, bituminous concrete aggregates, portland cement, and portland cement concrete and aggregates. There were 218 accredited laboratories as of December 31, 1995, making the AAP the largest accreditor of laboratories testing these materials in the United States. Figure 8 shows the growth of laboratory participation since 1988.

AASHTO has assigned responsibility for monitoring and administering the operation of the AAP to the Highway Subcommittee on Materials. Accredited laboratories are required to participate in the applicable AMRL and CCRL Laboratory Inspection and Proficiency Sample Programs. The AASHTO Materials Reference Laboratory provides technical support to the subcommittee in the operation of the AAP, determines a laboratory's conformance to criteria in the AAP Procedures Manual (*13*) and Practice R18, and prepares a report of findings. The report is sent to the AMRL Council which makes decisions regarding the accreditation status of the laboratory. The AAP provides laboratories with two levels of appeal if questions about fairness arise.

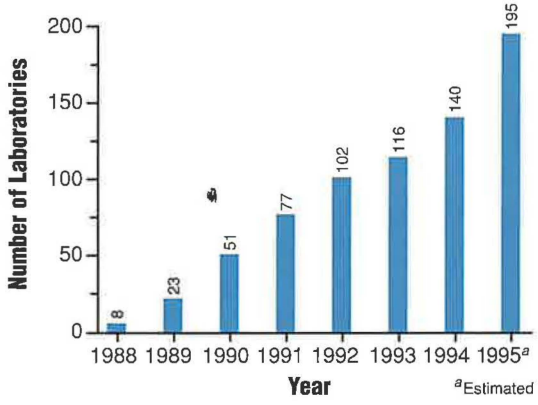


FIGURE 8
Laboratories accredited in AASHTO accreditation program.

The scope of AAP was recently expanded to include accreditation of hydraulic cement testing laboratories. CCRL Laboratory Inspection and Proficiency Sample Programs for hydraulic cement are being used to evaluate these laboratories.

Conclusions

AMRL is dedicated to improving the quality of testing in construction materials laboratories in the United States. The increasing number of participating laboratories—as well as the use of these programs by accreditors, materials producers, and governmental agencies to evaluate the competency of testing laboratories—demonstrate that AMRL is accomplishing this goal. Through its contact with industry, standards developers, and laboratories, AMRL is taking a leadership role in facilitating the implementation of new technology, for example by including the new SHRP test methods in its programs. Finally, the laboratory's programs are being broadened in scope to be more responsive to the needs of its sponsors and the transportation industry.

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