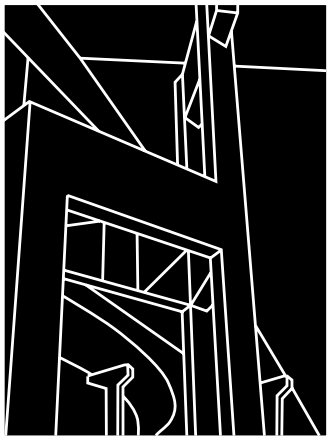
RESEARCH REPORT 1825-1

QUALIFYING ITEMS OF WORK FOR END-RESULT SPECIFICATIONS

William E. Elmore, Mansour Solaimanian, and T. Kennedy



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16. Abstract

The Texas Department of Transportation (TxDOT) is presently using a performance-based specification for hot-mix asphalt concrete pavement. There is a strong interest in determining if other construction items can be converted into this type of specification. The purpose of this report covering the initial phase of the study is to review the experiences of a large number of key states believed to be using these types of specifications, and to review the TxDOT standard specifications in order to recommend candidates for development. Of the nineteen states cooperating in the survey, the majority were willing to provide copies of their specifications to us. Nine have been received so far. Based upon the information developed from these reviews, 13 items have been recommended for consideration by the Department. Based on the action of the Department, the authors will proceed to develop draft specifications for the selected items.

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by

William E. Elmore, P.E.
Mansour Solaimanian, Ph.D.
Thomas W. Kennedy, P.E., Ph.D.

Research Report 1825-1

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Conducted for the

TEXAS DEPARTMENT OF TRANSPORTATION

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U.S. Department of Transportation
Federal Highway Administration

by the

CENTER FOR TRANSPORTATION RESEARCH
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THE UNIVERSITY OF TEXAS AT AUSTIN

July 1997

IMPLEMENTATION RECOMMENDATIONS

End-result specifications, also identified as performance-based specifications in this report, are presently being used by the Texas Department of Transportation (TxDOT) for hot-mix asphalt concrete pavements. Experience with this specification, together with the experiences of other state transportation agencies, has resulted in the Department's desire to determine the ability for expanding QC/QA type specifications to other construction items. The results of this study indicate that the standard specification items for portland cement concrete for both structures and pavements, base, aggregates, and earthwork are suitable for development and implementation as performance-based specifications.

Prepared in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.

ACKNOWLEDGMENTS

This is the first of a planned two-part report for this research project. This portion of the study was to review the activities being conducted in several key state transportation agencies, and to review current TxDOT standard specifications. Recommendations were then made to the Department for those items considered to be candidates for preparation as performance-based specifications.

The success of this project to date was made possible by the helpful input from representatives of the state highway agencies contacted. The support of the project director, Lauren Guarduno (ABL), and project coordinator Doug Dillon (WAC), together with the input from the project monitoring committee — J. Cravens (FHWA), D. Dalager (ODA), R. Hairston (WAC), M. P. Lehmann (CMD), and R. L. Walker (BWD) — have been instrumental in achieving this success.

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Thomas W. Kennedy, P.E. (Texas No. 29596)
Research Supervisor

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SUMMARY

The Texas Department of Transportation (TxDOT) is presently using a performance-based specification for hot-mix asphalt concrete pavement. There is a strong interest in determining if other construction items can be converted into this type of specification. The purpose of this report covering the initial phase of the study is to review the experiences of a large number of key states believed to be using these types of specifications, and to review the TxDOT standard specifications in order to recommend candidates for development. Of the nineteen states cooperating in the survey, the majority were willing to provide copies of their specifications to us. Nine have been received so far. Based upon the information developed from these reviews, 13 items have been recommended for consideration by the Department. Based on the action of the Department, the authors will proceed to develop draft specifications for the selected items.

CHAPTER 1. INTRODUCTION

1.1 BACKGROUND AND SIGNIFICANCE OF WORK

The terms "end result" and "QC/QA" are many times used interchangeably by specification writing agencies. In point of fact, the two are similar in many respects, but the adequacy of the final product is measured quite differently and the differences can be very significant. The pure "end-result specification" requires that the specifying agency clearly state its desired product; it then leaves it to the contracting party to deliver that product, at which time it is measured for its adequacy. The "QC/QA (quality control/quality assured) specification" is similar in that the specifying agency again states the product it requires and the contracting party proceeds to provide it. In this case, however, there is a continuing measure of the adequacy of the product by means of measurements that are carefully spelled out and accepted by both parties at the beginning of the project. Some state transportation agencies have already, with careful and long-term education and training programs, moved closer from the QC/QA specifications to the end-result type.

It is widely accepted and recognized that the quality of the construction specification is among the most important factors influencing the quality and cost of pavement construction. The move toward QC/QA specifications is motivated by the desire to control the quality of the finished product while maintaining reasonable costs. Quality is judged by accuracy and precision of selected properties of the finished product (such as gradation, asphalt content, air voids, etc., for HMAC). Accuracy is measured in terms of the proximity of the mean of measured values to target values. Precision is measured in terms of variability of measured values. The primary objective of a QC/QA specification is to communicate to the contractor in a clear and unambiguous manner exactly what is wanted. For this purpose, various statistical measures provide a practical and convenient way to describe the desired end result. The contractor should be given the principal responsibility for controlling the construction process (quality control), whereas the specifying agency should be primarily responsible for judging the acceptability of the finished product (quality assurance).

A sound QC/QA specification must define and encourage product quality and uniformity by controlling both the mean product levels and the variability of the product in a statistically efficient manner. Uniform quality, consistent within specification limits, is believed to be strongly associated with ultimate performance.

QC/QA specifications use defined target values for job mix formulas, as well as absolute (exact, fixed) or percentile (percent of target value) deviations to control both deviation and variability. Historical data and past experience have been used to identify the important properties to be controlled and to develop the tolerable deviations from target values, as well as the corresponding pay factors, as included in the current HMAC QC/QA specifications of the state. In using QC/QA specifications, the contractor is required to assume more risk than is required by the recipe approach. Accordingly, it is necessary in the

development of these types of specifications that the risks are properly balanced between agency and contractor. Logically, if maximum instructions are given to the contractor at every level, a "recipe" specification evolves. In contrast, if minimal instructions are given and performance requirements are maximized, an end-result specification evolves. This shift requires a critical review of all instructions, and the recognition that the requirements imposed on the contractor relate to performance prediction and evaluation.

At the present time TxDOT is actively moving towards QC/QA specification concepts. The Department has developed these types of specifications for asphalt pavements (HMACP), is currently exploring the development of a specification for portland cement concrete, and is interested in the development of similar specifications for other construction items. The adoption of these types of specifications implies an agency decision to move towards end-result specifications.

Responses to the survey of states discussed in Chapter 2 indicate that, in those states that have moved toward end-result specifications, the contractor has greater responsibility for the quality control and construction methods and techniques. Both the highway agencies and the contractors have for the most part been satisfied with the change.

1.2 HISTORY OF QC/QA CONSTRUCTION

The use of quality assurance in specifications for highway construction began in the late 1960s, primarily with input from the Federal Highway Administration (FHWA). A series of instructional seminars on the basic concepts and proposed benefits of this type of specification approach were conducted for the State Highway and Transportation Organizations by FHWA, based primarily on publications developed by them (1).

These were followed in the 1970s by several national in-depth studies and seminars sponsored and conducted by various organizations, such as the National Cooperative Highway Research Program (NCHRP) (2, 3), American Society for Testing and Materials (ASTM)(4), National Asphalt Pavement Association (NAPA) (5, 6), Federal Highway Administration (7), and the Associated General Contractors of America (AGC) (8). The majority of these reports were a compilation of the experiences and problems encountered in implementing a form of quality control/quality assurance specification (QC/QA) for hot-mixed asphaltic concrete (HMAC). The initial emphasis of the program nationally was in developing QC/QA specifications for HMAC. In 1987 TxDOT initiated a research study with the Center for Transportation Research (CTR), The University of Texas at Austin, to develop a true end-result specification for HMAC, RS 1168, "Development of End-result Acceptance Specifications for HMAC." This was modified to a QC/QA type specification and the results (9) became, in part, the initial basis for the later TxDOT specification Item 3007. The initial concerns about this type of specification were addressed at a September 1987 workshop, "Statistically Based End-Result Specifications" (10), conducted by the Texas Hot Mix Asphalt Pavement Association for both TxDOT and contracting personnel.

In the 1987 study for TxDOT, CTR requested and received QC/QA specifications for HMAC from sixteen state transportation departments — in Arizona, Arkansas, California, Florida, Illinois, Indiana, Kentucky, Louisiana, Maryland, Minnesota, Montana, Oregon, Pennsylvania, Virginia, Washington, and West Virginia — and from the Corps of Engineers. A few of these states, Pennsylvania, Virginia, and West Virginia, for example, had been early participants in the process of converting to this type of specification.

1.3 OBJECTIVES OF THE RESEARCH

The primary objective of this study at this point is to determine which, if any, other construction specifications are legitimate candidates, and, with the approval of the project advisory committee (PAC), to develop the draft specifications for the selected items. The objective is to be accomplished in three primary steps:

1. Survey the present status and experience of many of the original state transportation agencies to determine progress with QC/QA specifications.
2. Review existing TxDOT construction items to determine which to recommend for QC/QA specifications.
3. Recommend those selections to the TxDOT PAC.

CHAPTER 2. SURVEY AND ANALYSIS

2.1 SURVEY OF STATE TRANSPORTATION AGENCIES

Nineteen states were selected to be contacted directly by telephone. We asked contacts in these states a series of questions related to their experiences with QC/QA specifications and their planned activities in that area. These contacts were successfully completed, with most of the states agreeing to furnish copies of their specifications, nine of which have been received to date. The states contacted were:

Alabama	Michigan
Arizona	Minnesota
Arkansas	Missouri
California	New York
Colorado	Oklahoma
Georgia	Oregon
Illinois	Pennsylvania
Iowa	Virginia
Kentucky	Wisconsin
Maryland	

Questions that were asked of each state included the following:

1. What items are being controlled by QC/QA or end-result specifications?
2. What is measured?
3. What measurements are used for pay factors? Are bonuses allowed?
4. Do you require the contractor to submit a quality control plan for approval prior to commencing construction? If so, how is it enforced?
5. Who makes the measurements?
6. Are copies of your specifications available?

2.1.1 Summary of Responses by States Surveyed

Table 2.1 summarizes the construction items for which each state contacted indicated some level of use. Appendix A lists each state's response to the questions asked by telephone.

Many of the states contacted have been using performance-based specifications for many years. This finding confirmed previous findings of the earlier (1991) Center for Transportation Research study for TxDOT. It was also apparent that there is wide variety in

the level of confidence individual states have in the use of these specifications. Some have adopted their use for several construction items, while others are, for various reasons, proceeding more slowly. There is an equal variation in the specific properties each state considers important for not only quality control, but also for pay purposes. Table 2.2 summarizes the measured properties reported for hot-mix asphalt concrete, while Table 2.3 similarly summarizes those for portland cement concrete. The measured properties for concrete pavement and structures are almost identical and are combined in this table.

Table 2.1. State items using QC/QA specifications

STATE	HMAC	PCC PVMT	PCC STRUT	BASE	AGG	EARTH WORK	A/C
Alabama	x						
Arizona	x	x	x	x		x	
Arkansas	**	**	**	**	**	**	**
California	x						
Colorado	x	x					
Georgia	x						
Illinois	x	x			x		
Iowa	x	*					
Kentucky	x	*			*		
Maryland	x	x	x	x	x		
Michigan	x	x		x	x		
Minnesota	x	x			x		
Missouri	x						
New York	x		***	*			
Oklahoma	x	x	x				
Oregon	x	x	x		x		x
Pennsylvania	x	x					
Virginia	x	x	x				
Wisconsin	x	x	x		x	x	
SUMMARY	19	12	7	4	7	3	2

* Presently working on specification
** Arkansas has 100% QC/QA specifications
*** Abandoned use of QC/QA specification

Table 2.2. Number of states with measured items for HMAC

ITEM	CONTROL	PAY
VMA	11	5
ASPHALT CONTENT	17	14
GRADATION	13	11
DENSITY	14	16
AIR VOIDS	9	5
UNIFORMITY	2	

Table 2.3. Number of states with measured items for portland cement concrete

ITEM	CONTROL	PAY
COMPRESSIVE STRENGTH	7	3
SLUMP	3	
ENTRAINED AIR	4	1
GRADATION	2	1
THICKNESS	3	3
SMOOTHNESS	3	2
STEEL COVERAGE	1	

2.2 DISCUSSION OF SURVEY RESPONSES

Performance-based specifications for hot-mix asphalt concrete continue to be used by the majority of the states, even though it is apparent that some states have serious reservations concerning the quality of the product being obtained. The reservations are not necessarily expressions against this type of specification; rather, they tend to be expressions of concern regarding their success in utilizing them. Pennsylvania has a long history with the QC/QA specification program, but they have a concern that they need to review their complete operation. It is felt this is needed in order to take advantage of more modern versions that are capable of better and fairer control of their products. Maryland officials expressed a more serious concern. They have specifications for a number of items but do not believe they are getting a quality product in their use. Michigan has encountered problems with its specifications for concrete and aggregate, while New York abandoned its use of performance-based specifications for portland cement concrete after a few pilot projects. Virginia is questioning the cost effectiveness of the PCC specifications, while California has hired an outside agency to evaluate its use of these specifications (the report is not yet available).

There are a number of versions and ways to apply performance-based specifications, which probably explains the apparent wide variation in the application of and satisfaction with their use. In discussing this with one of the state material engineers, it was suggested that the terms “QC/QA” and “performance-based specifications” are defined differently in many of the states contacted.

A majority of the states interviewed indicated that the adoption and implementation of the Superpave system for HMAC has focused attention on the need for performance-based specifications.

2.3 REVIEW OF TXDOT STANDARD SPECIFICATIONS

The standard TxDOT specifications were reviewed for applicability for modification to the QC/QA-type specification. The cost effectiveness of such changes, based on input from those states contacted, is an almost indeterminate factor, given that manpower considerations have been the primary reasons for adopting the original concept in the 1960-70s. There is a definite advantage in allowing the contractor to be more involved in the success of an operation.

CHAPTER 3. RECOMMENDATIONS

Based on the responses and experiences of the states participating in this review, and on the review of the existing TxDOT standards plus the current QC/QA specification for HMAC, it is recommended that the following items be considered for modification to the QC/QA format:

Item 132:	Embankment
Item 247:	Flexible Base and other supporting items
Item (New):	Aggregates
Item 316,318:	Surface Treatments
Item 330,332:	Limestone Rock Asphalt Pavement
Item 334:	Hot-Mix, Cold-Laid Asphaltic Concrete Pavement
Item 342:	Plant Mix Seal
Item 345:	Asphalt Stabilized Base (plant mix)
Item 360:	Concrete Pavement
Item 420:	Concrete Structures
Item 421:	Portland Cement Concrete

Most of these construction items have other supporting, governing items that will need to be modified.

Input received from the other states, together with the experiences reported on the use of the TxDOT specification for HMAC, will be important factors in developing these specifications. Additionally, it is recommended that consideration be given to developing a single aggregate specification for base, ACP, portland cement concrete for pavement and structures, and earthwork.

Of equal importance in the selection of the items to rewrite is the need to be selective in the type and format of the specifications. These need to be compatible with existing and anticipated TxDOT policies so as to allow as smooth a transition as possible.

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2. "Statistically Oriented End-Result Specifications," NCHRP Synthesis of Highway Practice 38, Transportation Research Board, 1976.
3. "Quality Assurance," NCHRP Synthesis of Highway Practice 65, Transportation Research Board, October 1979.
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5. "Statistical Specifications," Charles R. Foster, National Asphalt Pavement Association, August 1976.
6. "Quality Control for Hot Mix Manufacturing Facilities and Paving Operations," National Asphalt Pavement Association Quality Improvement Series 97, December 1986.
7. "Quality Assurance Conference," Conference Proceedings, Federal Highway Administration, Region 6, Albuquerque, New Mexico, May 1976.
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10. "Statistically Based End Result Specifications," J. A. Epps, R. D. Pavlovich, and Charles W. Smoot, A Workshop at the Texas Hot Mix Association Annual Meeting, Galveston, Texas, September 26, 1987.

APPENDIX A:

RESPONSES FROM SURVEYED STATES

SURVEY QUESTIONS:

1. What items are being controlled by QC/QA or end-result specifications?
2. What is measured?
3. What measurements are used for pay factors? Are bonuses allowed?
4. Do you require the contractor to submit a quality control plan for approval prior to commencing construction? If so, how is it enforced?
5. Who takes the measurements?
6. Are copies of your specifications available?

Alabama:

1. Use this type of specification on HMAC.
2. Measure asphalt content, voids, laboratory density.
3. Same properties are measured for pay purposes and a bonus is allowed.
4. No response.
5. The contractor makes the measurements.

Arizona: Doug Forstie, 602-255-7011

1. They have approximately 10 years' experience using QC specifications with HMAC, PCC pavement and structures, base, and earthwork.
2. With HMAC, measurements are made on asphalt content, gradation (4 screens), Marshall voids, and density. For PCC, they are using a new draft that calls for measurements on compressive strengths, thickness, and ride.
3. The same properties are measured for pay factors but only HMAC provides for a bonus.
4. The contractor is not required to submit a QC plan for approval. They originally required one but dropped it as being meaningless.
5. Both the contractor and the state make the measurements.

Arkansas: Jim Gee, 501-457-4445

1. They have had 5-6 years' experience with HMAC and, with the publication of their specification book last year, they are now using this type of specification on all items.

California: Bob Doty, 916-654-6228

1. They have been using their present specification for HMAC since 1996, with five projects completed and thirty now active.
2. Asphalt content, gradation, and relative compaction based on job-mix Hveem specimens and nuclear measurements.
3. Same properties are used for pay factors and a 5% bonus is allowed based on a weighted average.
4. They require a fairly detailed QC plan prior to construction.
5. There is a strong reliance on the contractor's quality control and the state takes its own random samples; there are no split samples.

Colorado: Greg Lowrey, 303-757-9235

1. They have 4 years of experience with HMAC on projects over 5,000 tons. This type of specification has been tried on small portland cement concrete projects.
2. With HMAC they measure asphalt content, aggregate gradation, and in-place density. They are just now getting around to measuring air voids and VMA.
3. For pay factors, only HMAC allows for at present; asphalt content, gradation, and density plus voids are used. A bonus is allowed with a maximum of 6%.
4. The contractor is required to submit a quality control plan prior to starting operations.
5. The contractor makes the measurements and takes the samples but the state results are used for pay purposes.

Georgia: Don Wilson, 404-363-7521

1. Using this type specification only for HMAC. They have three Superpave sections in the state so far.
2. Measurements are made on asphalt content, gradation, in-place density, and range of values for uniformity. On the Superpave sections there have cases of raising temperatures and adding asphalt and going out of specification. They are using VMA with an effective specific gravity.
3. The same factors are used for pay factors but their state constitution prohibits the payment of a bonus.
4. Presently require a 2-year plant inspection. They are starting to require a quality control plan.
5. The contractor makes the measurements.

Illinois: James Gehler, 217-782-7200

1. They are using this type of specification for HMAC, aggregate gradation, portland cement concrete, and are investigating for base. There is a training program for technicians.
2. The properties that are measured are:
   HMAC: Running average of three for VMA, AC, dust, and air voids.
   Portland cement concrete: Slump, compressive strength, air entrainment.
   Gradation: Tight control bands, running average of 5.
3. They do not use pay factors.
4. The contractor is required to submit a quality control plan prior to the start of construction.
5. The contractor makes the measurements and the state runs duplicate test on 10%.

Iowa: Chan Pak Narotam, 515-239-1101

1. They have been using a form of QC/QA specifications for HMAC since 1992 and have had a good experience. Their goal is to have a true QC/QA specification in 2 years. In addition, they are currently developing a specification for portland cement concrete pavement.
2. In HMAC, measurements are made on VMA, voids, AC, and field density (using a quality control index); gradation is sampled at the cold feed. Their goal is to use cores for control measurements with an ignition furnace for the AC in the cores.
3. AC, density, and gradation are used for pay factors. Bonuses are not allowed.
4. The contractor is not required to submit a quality control plan for approval.
5. The contractor does all the measurements. There are random checks but no plant inspectors.
6. Copies of their specification and instructional memorandums are being sent.

Kentucky: James Stone, 502-564-3160

1. They are using QC/QA on all HMAC projects and working on specifications for concrete and aggregates.
2. All projects have lots of 4,000 tons and four cores are taken every sublot of 1,000 tons.
3. Pay factors are based on 25% air voids, 25% VMA, 10% AC, and 40% density.

4. The contractor is required to submit a quality control plan prior to construction (which also includes the aggregate). Compliance is enforced by the state.
5. Presently KDOT does all job-site testing but plans are to switch this to the contractor.
6. Their specifications are still in the development stage and not available.

Maryland: Larry Michael, 410-321-3538

1. They have QC/QA specifications for HMAC, PCC pavement and structures, base, and aggregates.
2. For HMAC, air voids, asphalt content, VMA, and gradation are measured; slump, air content, and strength are measured for PCC.
3. Pay factors for HMAC based on gradation and asphalt content. No bonus is allowed so far.
4. A QC plan is required for all items.
5. The contractor makes all QC measurements and the state verifies by nuclear device.

Michigan: Doug Coleman, 517-322-5672

1. They have been using this type of specification for HMAC for 8 years and there have problems with industry. There are similar problems with a concrete specification that they have been trying for 3 years. Now they are starting to develop specifications for aggregate and base in place.
2. HMAC: VMA, gradation, AC are measured as mix properties at the plant, cores are taken at random. Concrete pavement: Compressive strength, thickness and smoothness are measured.
   Aggregate: Density and gradation are measured in place.
3. Pay factors for HMAC are based on the consistency for voids, AC, and the No. 30 and 200 gradation sizes. They are shooting for using VMA. Concrete and aggregate use the same items measured in No. 2. A 10% bonus, with a maximum of 6% for in-place density, is allowed. They believe this is probably too broad.
4. The contractor is required to submit a quality control plan prior to construction. The state enforces this with random sampling and testing and tries to maintain inspection forces at the plant.
5. The contractor makes all the measurements.
6. Copies of their specifications will be sent.

Minnesota: Wayne Murphy, 612-779-5590

1. QC/QA specifications have been use for HMAC since 1986 and they now are using them for concrete pavement, redi-mix for concrete pavement, and quality for aggregate. MnDOT has certified plants that are sampled on a random basis.
2. In HMAC, the air voids, VMA, gradation, AC, and in-place density (the contractor does the design). For concrete pavement, the gradation and moist strength are measured and the state does the design.
3. HMAC uses the same properties measured for pay factors for pay factors. Both specifications allow a bonus and in concrete pavement the lower water/cement ration gets an incentive.
4. Requirement for an approved quality control plan is not enforced, although specification appears to require one.
5. Control is by the contractor and assurance is by the state. Sampling and testing is performed at a ratio of 3:1.
6. Copies of specifications are to be sent.

Missouri: Gerald Manchester, 573-751-3706

1. They have pilot projects with Superpave and have prepared specifications and training manuals for HMC. The contractors have been trained and testing equipment placed in their laboratories.
2. Measurements are made by the state on AC (nuclear), gradation, lab density, cores, and VMA.
3. The same properties are used for pay factors. Bonuses are allowed.
4. Unsure about requiring a quality control plan.
5. Responsibility for making the measurements is not clear.
6. Sending copies of their specifications.

New York: Wayne Bruyle, 518- 457-3240

1. They have used this type for HMAC since 1991 and also for precast concrete drainage units. Previously they have used it on PCC structures but abandoned this after a few pilot projects but may look at it again in the future, along with PCC pavements. Some work has been done developing a base specification.
2. For HMAC, air voids, asphalt content, gradation, and VMA are measured. Cores are taken from heavy-duty pavements for density and the nuclear gage is used for regular pavements.

3. For pay factor measurements, core density is used for heavy-duty pavement and nuclear gage for regular pavement. All plants are required to be automated and are depended upon. A bonus is allowed only on the heavy-duty pavements.
4. A QC plan is required for HMAC.
5. The contractor is responsible for QC with a contractor-trained technician at the plant and no resident state inspector at the plant. One day's production equals 1 lot and state takes split sample for test; contractor takes cores and state tests them.

Oklahoma: Jack Telford, 405-521-2677

1. QC/QA specifications are used on HMAC, PCC pavements and bridge decks.
2. Measurements are made: HMAC — asphalt content, gradation, laboratory density, road density, and smoothness; PCC pavement — strength, thickness, air content, gradation, and smoothness; PCC bridge decks — strength, air content, thickness, smoothness, and depth of cover over steel reinforcement.
3. Same properties are used for pay factors with a weighted average. A maximum bonus of 5% is allowed.
4. A QC plan is required; acceptance by the engineer is part of the contract.
5. It is allowable to use the contractor's measurements if the state desires but the state now is doing most of it.

Oregon: Ron Noble, 503-986-3050

1. They have had long experience with QC/QA specifications for HMAC and PCC for both pavement and structures, also 6-8 years' experience with aggregate and liquid asphalt.
2. Standard properties.
3. Same properties and a 5% bonus is allowed with HMAC.
4. No.
5. State is presently planning on going to the contractor for QC, with the state to verify.

Pennsylvania: Dean Maurer, 717-787-5229

1. They have used QC/QA specifications for HMAC since the early 1980s but believe they may need to re-evaluate these specifications for possible changes. Presently they have a specification for portland cement concrete and are working on one for aggregates.

2. For HMAC, running average measurements are made on AC, aggregate sizes -200 and #8, compacted field density using theoretical Rice's gravity and sampled behind the paver. For portland cement concrete, the slump, air, and strength are measured.
3. Only ACP has pay factors and the AC, -200, and field density measurements are used. The aim is for tight control but theoretically a bonus of up to 4% is possible.
4. The contractor is required to submit a quality control plan prior to beginning construction.
5. The contractor is directed to take the samples and the state tests them. The inspector does not have to ignore bad areas outside the sampling plan.
6. Copies of their specifications are being sent.

Virginia: Charles Hughes, 804-823-1797

1. QC/QA specifications for ACP and concrete for both structures and pavement. Only a small volume of the pavement concrete so far and they are not sure about the cost effectiveness.
2. Measurements of air voids, VMA, and AC for ACP. The state takes only about one out of three samples. The quality index for percent within limits as set forth in the AASHTO Guide Specification and QA implementation manual is used.
3. For ACP, the AC is determined by the ignition oven for % within limits, air voids, and VMA for pay factors. For the last 2 years a bonus has been allowed but the Concrete Association wants it deleted.
4. The contractor is required to submit a quality control plan but it is not spelled out clearly. There is a long-term history of using the contractor's test results. The plan is not rigidly enforced.
5. The contractor makes the measurements.
6. Copies of their "within limits" specification will be sent.

Wisconsin: Gary Whited & Curt Johnson, 608-246-5399, 608-266-3751

1. They have quality management for ACP, aggregate for base, subbase, concrete for pavement and structures, and earthwork. The program has been used for 2 years for concrete structures, but the specification for concrete pavement is just starting to be revised.
2. Measurements for ACP are made on % air voids in the compacted mix, gradation and AC by extraction. Nuclear density is in the new QC/QA specification.

3. No pay factors are presently being used but they are being drafted in the specification for concrete pavement and structures with strength, depth, and ride for pavement and strength for structures.
4. The contractor is not required to submit a quality control plan but they are looking at one for earthwork.
5. Contractor makes the measurements and there is no planned state involvement.
6. Copies of their specifications are being sent.