COMPONENTS OF VARIABILITY IN BITUMINOUS CONCRETE PAVEMENT CONSTRUCTION

Volume 1: Summary of Current State Practices

Final Report

by

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Prepared for

OKLAHOMA DEPARTMENT OF TRANSPORTATION
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16. ABSTRACT

The Oklahoma Department of Transportation (ODOT) turned to quality assurance specifications in 1989 after several years of careful study and consideration. The objective of *phase-I* of this research project was to evaluate the ODOT's Quality Assurance Specifications (QAS) for bituminous concrete pavements in comparison with those developed by other states.

To meet the objectives of this phase, a survey of practice was conducted in Fall 1990. A letter was mailed to state DOTs asking whether the agency is using statistically-based QAS for bituminous concrete pavement construction, and if so, the letter requested copies of the specifications. Of the 30 state DOTs which responded to the survey, 70% had statistically-based QAS, 17% reported the use of combination of method specifications and QAS, and 13% were in the process of developing QAS or planning to develop one. High levels of satisfaction with, and confidence in, QAS were expressed by many of the agencies which used them.

Results of the survey indicated that there was a wide variation among specifying agencies in the quality attributes used for acceptance purposes, definition of lot and sublot of bituminous pavement, decision rule for acceptance, allowable tolerances for acceptable construction, and the basis for payment. For acceptance purposes, the three most often used quality attributes were aggregate gradation, asphalt content, and in-place density. The two most common decision rules for acceptance were the percent within limits method and the average deviation method. The methods used to determine the payment for a lot of construction material varied significantly among the different agencies.

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EXECUTIVE SUMMARY

Faced with significant expansion in the highway construction program and increasing concerns about the quality of highway and bridge construction, the Oklahoma Department of Transportation (ODOT) turned to quality assurance specifications in 1989 after several years of careful study and consideration. The primary reason for the change was to improve construction quality by assigning the responsibility for quality control to the party that has actual control over the construction process -- the contractor or material supplier.

This report summarizes the findings of *phase-I* of ODOT research project 2179 -- *Evaluation of Components of Variability in Bituminous Concrete Pavement Construction.* The overall objective of this project was to develop a better understanding of the sources and relative magnitudes of variation in the measured properties of what is considered *acceptable* bituminous concrete pavement materials and construction in Oklahoma. The specific objective of *phase-I* was to evaluate the ODOT's Quality Assurance Specifications (QAS) for bituminous concrete pavements in comparison with those developed by other states in terms of the quality attributes used for acceptance, allowable deviations for 100% pay, reported values of the standard deviation of acceptable construction, and forms of the overall pay factor.

To meet the objectives of this phase, a survey of practice was conducted in Fall 1990. A letter was mailed to state DOTs asking whether the agency is using statistically-based QAS for bituminous concrete pavement construction, and if so, the letter requested copies of the specifications. In addition, the letter inquired about any relevant studies that were performed to determine the components of variability due to materials, sampling, and testing. Thirty state DOTs responded to the letter. Wherever necessary, follow-up communications were made to clarify responses.

Of the 30 state DOTs which responded to the survey, 70% had statistically-based QAS, 17% reported the use of combination of method specifications and QAS, and 13% were in the process of developing QAS or planning to develop one. High levels of satisfaction with, and confidence in, QAS were expressed by many of the agencies which used them. From the results of the survey, the following conclusions were made:

- There was a wide variation among specifying agencies in the quality attributes used for acceptance purposes, definition of lot and sublot of bituminous pavement, decision rule for acceptance, allowable tolerances for acceptable construction, and the basis for payment.

- For acceptance purposes, the three most often used quality attributes were aggregate gradation, asphalt content, and in-place density.

- The two most common decision rules for acceptance were the percent within limits method and the average deviation method.

- The methods used to determine the payment for a lot of construction material varied significantly among the different agencies.

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CHAPTER 1

INTRODUCTION

Materials and construction (M&C) variables which affect pavement performance and can be controlled by the contractor are central to any construction specification. The oldest type of specifications that has been traditionally used by state departments of transportation (DOTs) is the *method specifications.* With this type of specification, the contractor is required to follow step-by-step procedures using materials and equipment specified by the user agency which places itself in a compromising position by assuming responsibility for both quality control and acceptance. One shortcoming of method specifications is that they eliminate the incentive to improve quality; contractors are responsible for what they are instructed to do, not for doing it better. Another deficiency is that penalties for contractor's nonconformance are based solely on the judgement of the inspector.

Intuitively-based end result specifications that require a prescribed level of some attribute of a product have been used in lieu of or in combination with method specifications for years. Typically, the limits for these specifications are derived intuitively based on what the specification writer feels is achievable. Responsibility for process control is assigned to the contractor. One of the most publicized uses of this type of specification is the AASHO Road Test which was conducted in the early 1960's to evaluate highway design, specifications, and construction practices. Results of the road test indicated that many of the specification limits used were very restrictive and unrealistic.

To help overcome the problem of end-result specifications being too tight and often lacking definition, the FHWA prompted studies in the 1960's to determine what process average and variability should reasonably be expected based on the historical performance of the construction industry. These studies led to the development of what is now known as *statistically-based quality assurance specifications* (QAS). Over the past two decades, an increasing number of state DOTs have moved from method specifications to QAS. Unlike method specifications, the contractor is responsible for quality control and has sufficient latitude to choose construction materials and methods that will enhance quality. Acceptance sampling and testing may be performed by the user agency or the contractor, as desired by the user agency. Pay adjustments are based on quality attributes that reflect the level of contractor's control of construction materials and methods. Statistically-based QAS have several distinct advantages that have been recognized by both the construction industry and state DOTs [2].

Another type of construction specifications that has recently emerged is the *performance-related specifications* (PRS). In basic intent, PRS are similar to QAS with the primary difference being that payment under PRS is dependent on the predicted loss in product life or performance. A recently completed NCHRP research project outlines the conceptual framework for the development of PRS [1]. Nevertheless, the state-of-the-art is not s fficient to develop fully functional PRS at the present time.

PROBLEM STATEMENT

Faced with significant expansion in the highway construction program and increasing concerns about the quality of highway and bridge construction, the Oklahoma Department of Transportation (ODOT) turned to quality assurance specifications in 1989 after several years of careful study and consideration. The primary reason for the change was to improve construction quality by assigning the responsibility for quality control to the party that has actual control over the construction process -- the contractor or material supplier.

As anticipated, the development of quality assurance specifications is an evolutionary process which takes a number of years. Unlike dealing with products on assembly lines where the sources of variability can be substantially controlled, modern highway construction is a complex process. It involves a wide variety of types of materials and construction methods whose characteristics vary over a wide range. In addition, the procedures used in sampling and testing of the component materials are themselves subject to variation.

The ODOT recognizes that reliable data on the sources and amounts of variability that exist in the measured properties of acceptable construction products are needed for the development of realistic quality assurance specifications. This information is required to establish the allowable deviations from specified standards and the associated pay factors. To help address these needs, the ODOT sponsored this research project to determine the statistical parameters of bituminous concrete pavement construction. The information produced by this study should help validate or modify the ODOT's acceptance criteria.

OBJECTIVES AND SCOPE

This report summarizes the findings of *Phase-I* of ODOT research project 2179 -- *"Evaluation of Components of Variability in Bituminous Concrete Pavement Construction"* which was initiated in Fall, 1990. The overall objective of this project was to develop a better understanding of the sources and relative magnitudes of variation in the measured properties of what is considered acceptable bituminous concrete pavement materials and construction in Oklahoma. The specific objectives of the research were as follows:

- Evaluate the ODOT's quality assurance specifications in comparison with those developed by other states in terms of the quality attributes used for acceptance, allowable deviations for 100% pay, reported values of the standard deviation of acceptable construction, and forms of the overall pay factor.

- Determine the components of the total variability (due to inherent variation in materials and processes, due to testing, and due to sampling) in the measured quality attributes of acceptable bituminous concrete pavements.

- Assess the ODOT's specification tolerances for bituminous concrete pavement construction and determine the 2-sigma and 3-sigma limits through a statistically-based field sampling and laboratory testing program.

- Evaluate the accuracy of the nuclear density gauge and calibrate the relationship between nuclear density measurements and core density measurements, and

- Correlate the results of the nuclear test method for asphalt content determination with those obtained using the solvent extraction method.

RESEARCH APPROACH

To meet the objectives of this project, a research plan consisting of two phases was adopted. In *phase-I*, the following tasks were addressed:

Task 1. Literature Review - Review and document national and local experiences with determining the statistical parameters of acceptable construction materials and products.

Task 2. Evaluation of Existing Data on Variability - Using available data from the ODOT's Materials Division, determine the overall variability in the quality attributes of selected bituminous concrete pavement projects which were constructed in the past.

Task 3. Survey of Quality Assurance Specifications of Other States - Evaluate the ODOT's quality assurance specifications in comparison with the specifications developed by other states DOTs.

Phase-II tasks include the following:

Task 4. Planning and Executing Field Sampling Program - The objective of this task was to conduct a field sampling program to obtain measurements of the quality attributes of acceptable bituminous concrete pavement construction. Sampling was based on the principles of random sampling and statistical experimental design.

Sampling was conducted both at the production plant and the roadway independent of acceptance sampling and job control sampling. Fifty sample units were obtained from a lot of 4,000 tons of bituminous concrete production. The lot was divided into 25 equal sublots, and two sample-units were obtained from each sublot at random. Sample-units of the aggregate were obtained from the cold feed conveyor belt. In addition, sample-units of the fresh bituminous mix were taken from delivery trucks at the plant. Nuclear density gauge measurements were made at randomly selected points on the finished pavement; two density measurements per sublot. At the conclusion of the nuclear gauge test, two cores were drilled at each sampling location.

Task 5. Field and Laboratory Testing - The sample-units obtained in Task 4 were forwarded to the materials laboratories in the different ODOT Divisions for testing. All sample-units were tested in duplicate by dividing each sample-unit into two test specimens using approved splitting and quartering methods. Preparation of test specimens and testing met ods were in accordance with the ODOT standard test methods.

Task 6. Analysis of Test results - Analysis of variance (ANOVA) procedures were applied to the test results obtained in Task 5 to determine the components of the overall variation in the measured quality attributes. The percent of measurements within the JMF tolerances, QA/QC Specification tolerances, and the 2-sigma and 3-sigma limits were computed. Results of the nuclear gauge test methods for asphalt content and in-place density were analyzed.

The results of Phase-I (Tasks 1, 2, and 3) were assembled in this interim report. Beyond describing the state of practice, the focus of this report has been on the identification of the quality attributes used for acceptance, the forms of the decision rules used in determining the level of contractor conformance and the associated pay deductions and/or incentives, and the allowable variations in

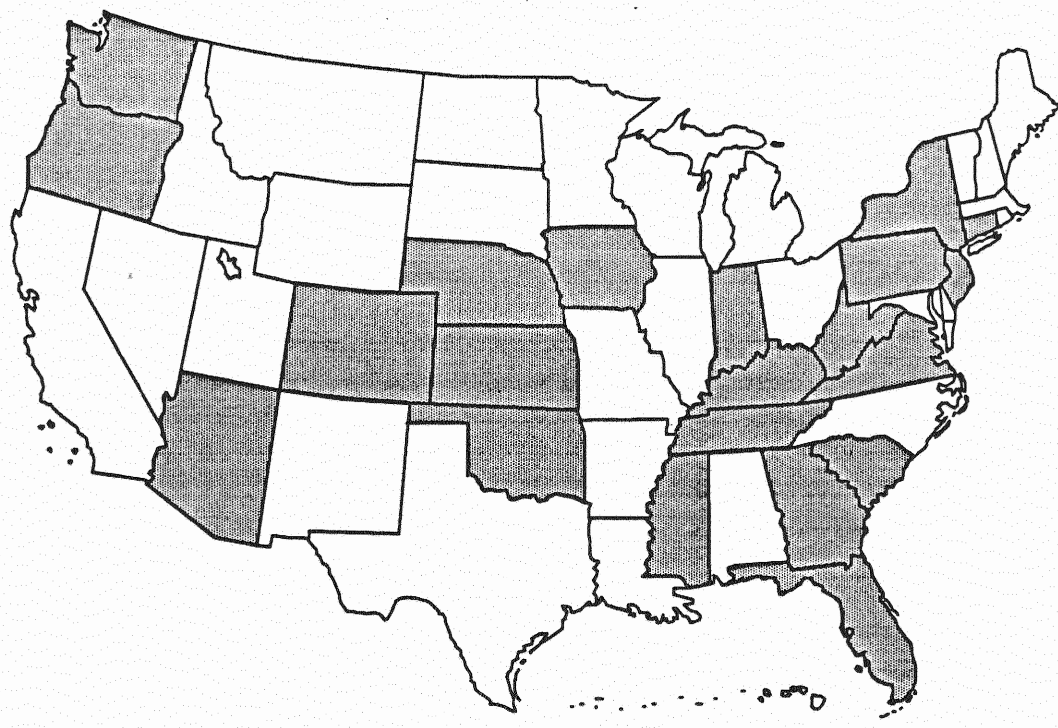

Figure 1. States Responded to Letter and Use Statistically-Based QAS

M&C VARIABLES USED IN ACCEPTANCE

Ideally, the quality attributes used in acceptance must be related to pavement performance, can be controlled by the contractor, and are independent variables that do not lead to a double jeopardy condition. Based on the survey of practice, acceptance variables used by state DOTs include one or more of the following:

- Asphalt cement content
- Aggregate gradation
- Air voids
- Stability
- In-place density
- Fineness modulus

Figure 2 illustrates the percent of agencies using each of the above variables. Aggregate gradation, asphalt cement content, and in-place density are the three most commonly used variables. Of the 21 states with statistically-based acceptance procedures, air voids is used by three agencies (Arizona, New Jersey, and Oklahoma), stability is used by two agencies (Arizona and Oklahoma), and fineness modulus is used by one agency (Kentucky).

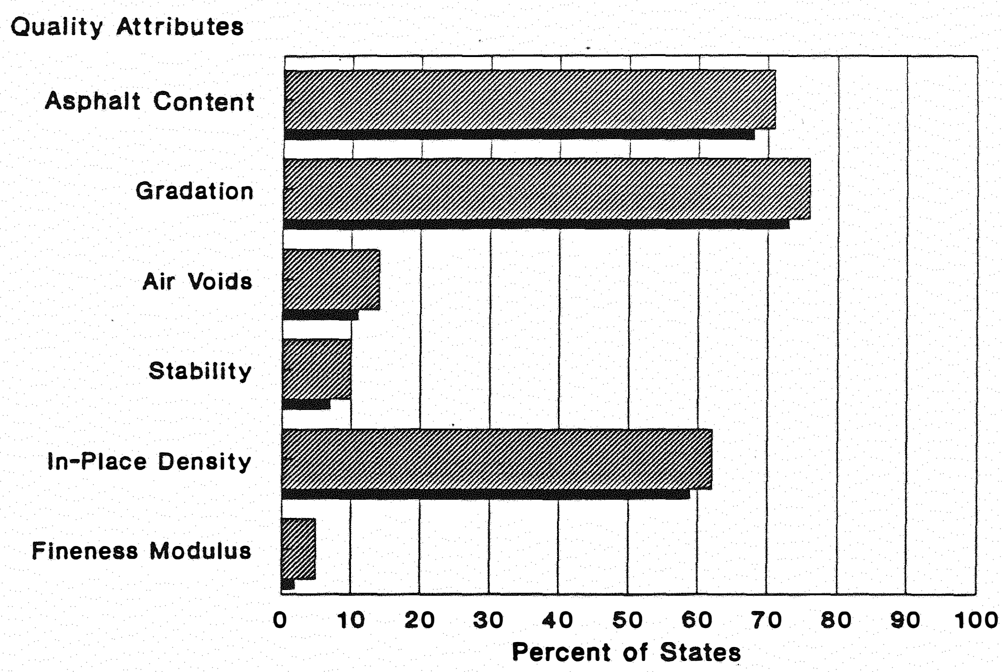

Figure 2. Quality Attributes Used in Acceptance

The distribution of the number of variables used in acceptance is shown in Figure 3. Thirty percent of the agencies use one variable, 50% use two or less variables, 85% use three or less variables, and 90% use four or less variables.

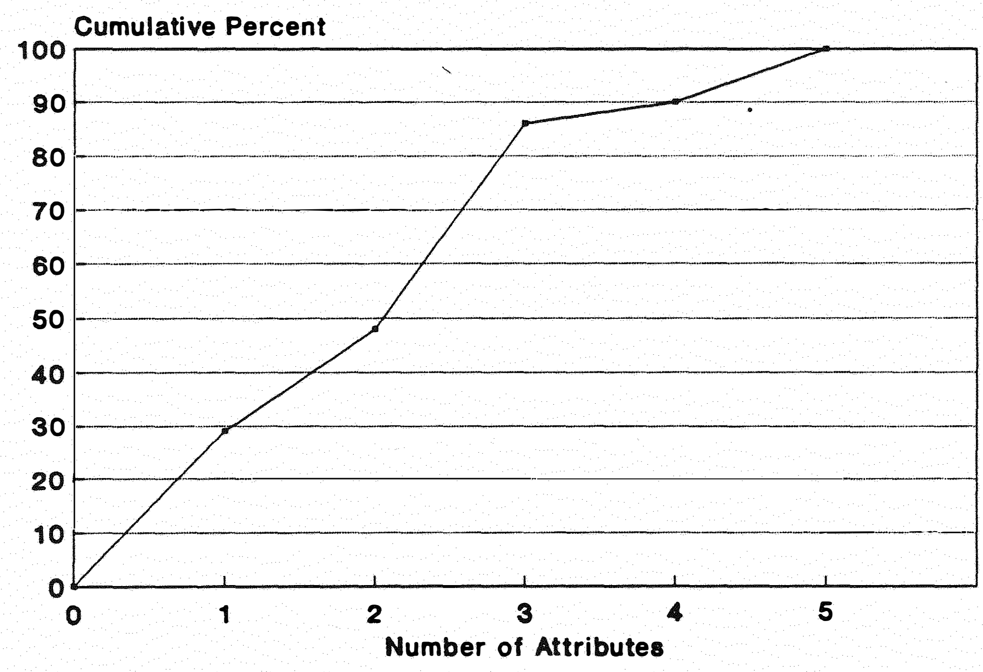

Figure 3. Number of Attributes Used in Acceptance

LOT AND SUBLOT DEFINITIONS

Statistically-based QAS require the use of random sampling methods to evaluate the characteristics of a lot of material or finished pavement. Random sampling ensures that the test specimens or test locations are selected without bias. To prevent clustering of test specimens, most agencies employ stratified random sampling for acceptance purposes. In this method, the lot is divided into equal sublots and each of these sublots is then sampled at random.

The definition of lot size varies among agencies. As shown in Figure 4, 38% of the states define a lot of bituminous concrete pavement based on *tonnage and/or square yards*. Examples of states using this definition include Florida, Indiana, Kansas, Nebraska, New Jersey, Oklahoma, Pennsylvania and Virginia. A second common definition of lot size which is used by another 38% of the states is *one day's production.* Other lot definitions include *quantity of material produced per JMF*, *material produced by same process through continuous production*, *one production shift*, and *quantity represented by the average of four test results.* Some agencies employ two lot definitions; one at the production plant and a second at the roadway. Examples of such agencies are Florida, Washington, and West Virginia.

Sublot size definitions also vary among agencies. Three states do not specify a sublot size and the number of tests is related to the lot definition. Table A-1 (Appendix A) contains greater detail on lot and sublot definitions.

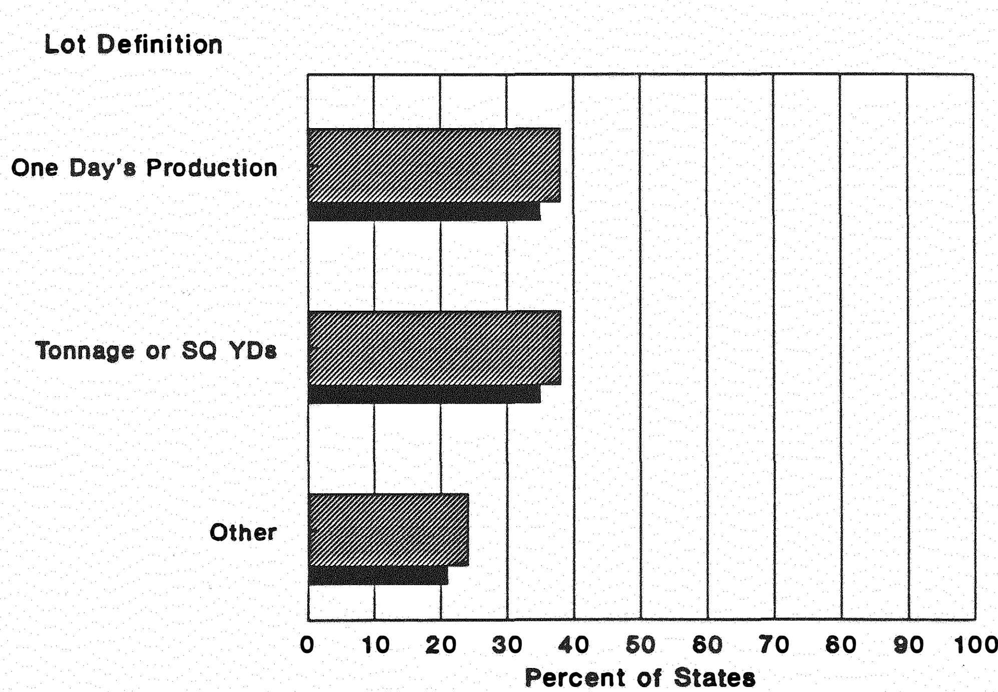

Figure 4. Lot Definition

NUMBER OF ACCEPTANCE TESTS

Typically, the number of acceptance tests is specified per sublot. This approach is used by 76% of the states. One test per sublot is the most frequently used number. Some agencies specify that the average of two or more tests of a particular quality attribute be treated as one test in determining the pay factor. Examples of states using this method include Indiana, Oklahoma and Oregon. Further details on the number of acceptance tests are included in Table A-1 (Appendix A).

DECISION RULES FOR ACCEPTANCE

Materials and construction variables are stochastic in nature and should be treated as such in any rationale acceptance plan. Both the mean and a measure of dispersion are necessary in order to characterize the statistical distributions of these variables. Dispersion is most often measured by the standard deviation which can be either known or unknown. In the former case, the standard deviation is estimated from historical data on process variability, whereas in the latter case, it is determined from acceptance test results. Some agencies employ the range of test results as a measure of dispersion.

Appendix A includes a summary of the decision rules for acceptance as obtained from the survey of practice. The two most common decision rules are the *percent within limits (PWL)* method and the *average deviation* method. As depicted in Figure 5, the PWL method is used by 38% of the agencies which responded to the survey including Arizona, Colorado, New Jersey, New York, Oregon, Pennsylvania, Washington, and West Virginia. The average deviation method is used by another 38% of the agencies including Florida, Georgia, Kentucky, Nebraska, Oklahoma, South Carolina, Tennessee, and Virginia.

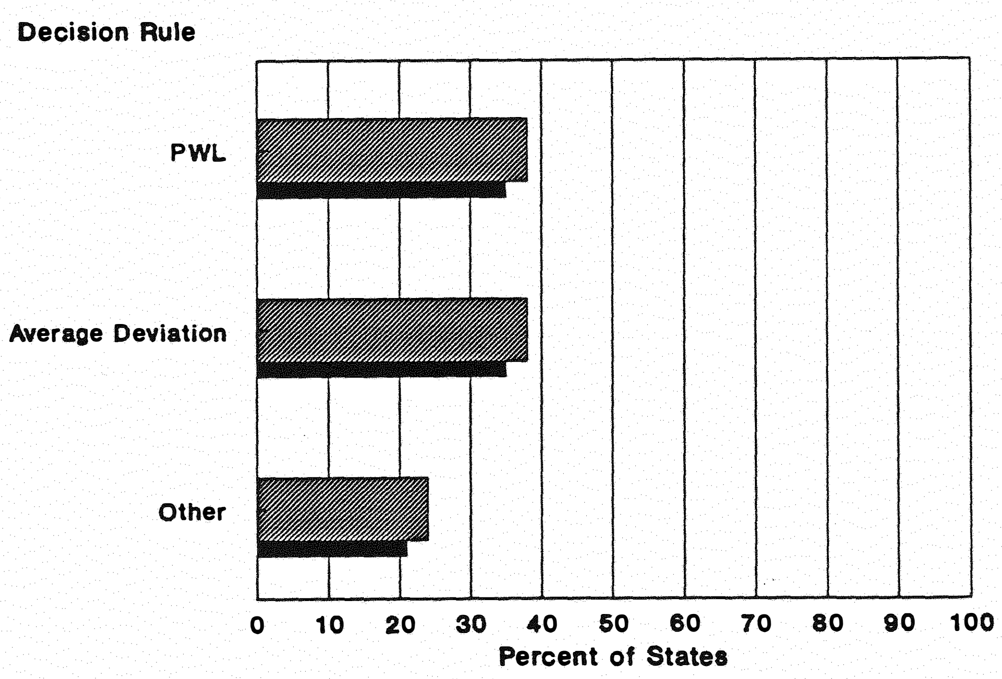

Figure 5. Decision Rules for Acceptance

Percent Within Limits Method - The PWL, or its complement -- the percent defective, is a statistical procedure for estimating the percent compliance to a specification. It is sometimes referred to as "quality level analysis". Application of this method requires computing the average x and standard deviation s of the lot acceptance test results.

Analysis of each quality attribute is typically based on an acceptable quality level (AQL) of 95% and a producer's risk of 5%. The AQL may be viewed as the lowest percent of a quality attribute that is acceptable as a process average. Producer's risk is the probability that when a contractor is producing material at exactly the AQL, the material will be paid for at less than 100%.

The computational steps for determining the PWL are as follows:

a) Compute the upper quality index: $Q_U = (USL - \bar{X}) / s$
where *USL* is the upper specification limit or target value plus allowable deviation.

b) Compute the lower quality index: $Q_L = (\bar{X} - LSL) / s$
where *LSL* is the lower specification limit or target value minus allowable deviation.

c) Determine P_U (the percent within the upper specification limit which corresponds to a given Q_U from a table similar to Table 2. If an *USL* is not specified, P_U will be 100%.

d) Determine P_L (the percent within the lower specification limit which corresponds to a given Q_L from a table similar to Table 2. If a *LSL* is not specified, P_L will be 100%.

e) Determine the *PWL* as: $PWL = (P_U + P_L) - 100$

f) Using the *PWL* from step (e), determine the lot pay factor based on the quality attribute under consideration from a table that relates PWL, sample size, and pay factor. Table 3 is an example.

To help demonstrate, consider a lot of bituminous concrete pavement that is submitted for acceptance based on density. The average $\bar{x}$ and the standard deviation s of four test results are 97.5% and 1.05%, respectively. For a lower specification limit of 96.7%, the value of Q_L is (97.6 - 96.7)/1.05 = 0.857. From Table 2, the value of P_L is 79% and the *PWL* is (100 + 79) - 79 = 79%.

Average Deviation Method - In this method, the variability in the quality attribute under consideration is assumed to be known based on historical performance data. The average of the deviations of acceptance test results from a prescribed standard value θ is computed as follows:

$$Average\ Deviation = [\sum_{i=1}^{n} (\theta - x_i)] / n$$

When the prescribed standard is a target value, as in asphalt content, the sign of the individual deviations is often ignored because both positive as well as negative deviations are critical to pavement performance. For those attributes where the prescribed standard is a maximum or minimum value, the signs of the individual deviations are often considered in computing the average deviation. The allowable deviations used for acceptance by state DOTs are reproduced in Appendix C.

TABLE 2. PERCENT WITHIN LIMITS ANALYSIS, VALUES OF P_U & P_L *

Upper Quality Index Q_U or Lower Quality Index Q_L

P_U or P_L	Sample Size (n)										
	3	4	5	6	7	8	9	10-11	12-14	15-18	19-25
100	1.16	1.50	1.79	2.03	2.23	2.39	2.53	2.65	2.83	3.03	3.20
99		1.47	1.67	1.80	1.89	1.95	2.00	2.04	2.09	2.14	2.18
98	1.15	1.44	1.60	1.70	1.76	1.81	1.84	1.86	1.91	1.93	1.96
97		1.41	1.54	1.62	1.67	1.70	1.72	1.74	1.77	1.79	1.81
96	1.14	1.38	1.49	1.55	1.59	1.61	1.63	1.65	1.67	1.68	1.70
95		1.35	1.44	1.49	1.52	1.54	1.55	1.56	1.58	1.59	1.61
94	1.13	1.32	1.39	1.43	1.46	1.47	1.48	1.49	1.50	1.51	1.52
93		1.29	1.35	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45
92	1.12	1.26	1.31	1.33	1.35	1.36	1.36	1.37	1.37	1.38	1.39
91	1.11	1.23	1.27	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.33
90	1.10	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.27	1.27
89	1.09	1.17	1.19	1.20	1.20	1.21	1.21	1.21	1.21	1.22	1.22
88	1.07	1.14	1.15	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17
87	1.06	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
86	1.04	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
84	1.01	1.02	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96
82	0.97	0.96	0.95	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.92
81	0.96	0.93	0.91	0.90	0.90	0.89	0.89	0.89	0.89	0.88	0.88
80	0.93	0.90	0.88	0.87	0.86	0.86	0.86	0.85	0.85	0.85	0.85
79	0.91	0.87	0.85	0.84	0.83	0.82	0.82	0.82	0.82	0.81	0.81
78	0.89	0.84	0.82	0.80	0.80	0.79	0.79	0.79	0.78	0.78	0.78
77	0.87	0.81	0.78	0.77	0.76	0.76	0.76	0.75	0.75	0.75	0.75
76	0.84	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.71	0.71
75	0.82	0.75	0.72	0.71	0.70	0.70	0.69	0.69	0.69	0.68	0.68
74	0.79	0.72	0.69	0.68	0.67	0.66	0.66	0.66	0.66	0.65	0.65
73	0.76	0.69	0.66	0.65	0.64	0.63	0.63	0.63	0.62	0.62	0.62
72	0.74	0.66	0.63	0.62	0.61	0.60	0.60	0.60	0.59	0.59	0.59
71	0.71	0.63	0.60	0.59	0.58	0.57	0.57	0.57	0.57	0.56	0.56
70	0.68	0.60	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.53	0.53
69	0.65	0.57	0.54	0.53	0.52	0.52	0.51	0.51	0.51	0.50	0.50
68	0.62	0.54	0.51	0.50	0.49	0.49	0.48	0.48	0.48	0.48	0.47

TABLE 2 (continued). PERCENT WITHIN LIMITS ANALYSIS, VALUES OF P_U & P_L [a]

Upper Quality Index Q_U or Lower Quality Index Q_L

P_U or P_L	Sample Size (n)									
	3	4	5	6	7	8	9	10-11	12-14	15-18	19-25
67	0.59	0.51	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.45
66	0.56	0.48	0.45	0.44	0.44	0.43	0.43	0.43	0.42	0.42	0.42
65	0.52	0.45	0.43	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.39
64	0.49	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37	0.36
63	0.46	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34	0.34
62	0.43	0.36	0.34	0.33	0.32	0.32	0.32	0.32	0.31	0.31	0.31
61	0.39	0.33	0.31	0.30	0.30	0.29	0.29	0.29	0.29	0.29	0.28
60	0.36	0.30	0.28	0.27	0.27	0.27	0.26	0.26	0.26	0.26	0.26
59	0.32	0.27	0.25	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.23
58	0.29	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.20
57	0.25	0.21	0.20	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18
56	0.22	0.18	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15
55	0.18	0.15	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10
53	0.11	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

a For negative values of Q_U or Q_L, the value of P_U or P_L is equal to 100 minus the tabulated value of P_U or P_L. If the value of Q_U or Q_L does not correspond exactly to a figure in the table, use the next higher figure.

TABLE 3. PERCENT WITHIN LIMITS ANALYSIS, PAY FACTORS [a]

Pay Factor	Percent Within Limits										
	Sample Size (n)										
	3	4	5	6	7	8	9	10-11	12-14	15-18	19-25
1.05	100	100	100	100	100	100	100	100	100	100	100
1.04	90	91	92	93	93	93	94	94	95	95	96
1.03	80	85	87	88	89	90	91	91	92	93	93
1.02	75	80	83	85	86	87	88	88	89	90	91
1.01	71	77	80	82	84	85	85	86	87	88	89
1.00	68	74	78	80	81	82	83	84	85	86	87
0.99	66	72	75	77	79	80	81	82	83	85	86
0.98	64	70	73	75	77	78	79	80	81	83	84
0.97	62	68	71	74	75	77	78	78	80	81	83
0.96	60	66	69	72	73	75	76	77	78	80	81
0.95	59	64	68	70	72	73	74	75	77	78	80
0.94	57	63	66	68	70	72	73	74	75	77	78
0.93	56	61	65	67	69	70	71	73	74	75	77
0.92	55	60	63	65	67	69	70	71	72	74	75
0.91	53	58	62	64	66	67	68	69	71	73	74
0.90	52	57	60	63	64	66	67	68	70	71	73
0.89	51	55	59	61	63	64	66	67	68	70	72
0.88	50	54	57	60	62	63	64	65	67	69	70
0.87	48	53	56	58	60	62	63	64	66	67	69
0.86	47	51	55	57	59	60	62	63	64	66	68
0.85	46	50	53	56	58	59	60	61	63	65	67
0.84	45	40	52	55	56	58	59	60	62	64	65
0.83	44	48	51	53	55	57	58	59	61	63	64
0.82	42	46	50	52	54	55	57	58	60	61	63
0.81	41	45	48	51	53	54	56	57	58	60	62
0.80	40	44	47	50	52	53	54	55	57	59	61
0.79	38	43	46	48	50	52	53	54	56	58	60
0.78	37	41	45	47	49	51	52	53	55	57	59
0.77	36	40	43	46	48	50	51	52	54	56	57
0.76	34	39	42	45	47	48	50	51	53	55	56
0.75	33	38	41	44	46	47	49	50	51	53	55
Reject	Quality Levels Less Than Those Specified for a 0.75 Pay Factor										

a To obtain a given pay factor, the computed PWL shall equal to or exceed the value in the table. Delete the rows associated with pay factor greater than 1.00 where quality incentives are not allowed.

BASIS FOR PAYMENT

A wide variation exists among state DOTs in determining the payment for a lot of bituminous concrete pavement. The following methods are rank ordered based on the frequency of their use:

1. Payment for material in a lot is made at a price determined by multiplying the contract unit bid price by a composite pay factor (CPF) which is a weighted average of the individual pay factors (PFs) for the applicable quality attributes. The composite pay factor is computed as follows:

$$CPF = (\sum_{i=1}^{k} w_i \times PF_i) / (\sum_{i=1}^{k} w_i)$$

   where w_i is the weight assigned to the *ith* attribute. Examples of agencies using this method include Nebraska, Oklahoma, Oregon, Pennsylvania, and Washington. Table 4 lists the weighing factors used by these agencies.

2. Payment for material in a lot is made at a price determined by multiplying the contract unit bid price by the lowest of the individual pay factors established for the applicable quality attributes. Examples of agencies using this method include Georgia DOT and Kentucky DOT.

3. Payment for material in a lot is made at a price determined by multiplying the contract unit bid price by the product of the individual pay factors established for the applicable quality attributes. Examples of agencies using this method include South Carolina DOT and West Virginia DOT.

4. Payment for material in a lot is made at a price determined by subtracting the sum of pay deduction factors for the applicable quality attributes from the contract unit bid price. Examples of agencies using this method include Florida DOT and Tennessee DOT.

5. Payment for material in a lot is made at a price determined by multiplying the contract unit bid price by the average of the individual pay factors established for the applicable quality attributes. Examples of agencies using this method include Colorado DOT.

6. Payment for material in a lot is made at a price determined by multiplying the contract unit bid price by the sum of the individual pay factors established for the applicable quality attributes. Examples of agencies using this method include Arizona DOT.

ALLOWABLE TOLERANCES

Table 5 presents a summary of the allowable tolerances for acceptable bituminous concrete pavement construction based on one test result and 100% pay factor. These tolerances were reproduced from the QAS of some selected agencies. When acceptance is based on the average of n test results, the acceptance limits (allowable deviations) are determined by dividing the values in Table 5 by the square root of the number of tests.

Direct comparison of the allowable tolerances prescribed by different agencies is somewhat meaningless because some agencies base their tolerances on 3-sigma (three standard deviation) limits, while other agencies employ 2-sigma (two standard deviation) limits.

TABLE 4. WEIGHTS USED IN COMPUTING COMPOSITE PAY FACTOR

Quality Attribute	Weighing Factors				
	Oklahoma [a]	Oregon	Pennsylvania	Washington	WASHTO
Gradation					
3/8 inch and Larger	1	1	---	2	6
1/4 inch	1	5	---	6	---
No. 4	1	---	---	---	---
No. 8	---	---	---	---	10
No. 10	1	5	---	10	---
No. 40	---	3	---	6	6
No. 200	1	10	1	20	20
Moisture Content	---	8	---	---	---
Asphalt Cement Content	3	26	1	52	50
Air Voids	3	---	---	---	50
In-Place Density	3	40	2	---	50
Hveem Stability	1	---	---	---	---
Surface Smoothness [b]	1	---	---	---	---

a Only the smallest of the gradation pay factors shall be used in determining the composite pay factor for a lot.

b Applies to surface courses only.

TABLE 5. ALLOWABLE TOLERANCES FOR ACCEPTABLE BITUMINOUS CONCRETE PAVEMENT CONSTRUCTION [a]

Agency	JMF Tolerances for Gradation (Percent)												Fineness Modulus
	3/4"	1/2"	3/8"	1/4"	No. 4	No. 8	No. 10	No. 30	No. 40	No. 50	No. 100	No. 200	
Arizona	± 6.0					± 5.5			± 4.0			± 2.0	
Florida					± 7.0		± 5.5		± 4.5			± 2.0	
Georgia													
Surface Course			± 9.0		± 9.0	± 7.0							
Subsurface Course		± 12.9	± 10.0		± 10.0	± 8.0							
Indiana													
Surface Course		± 8.0			± 8.0			± 4.0				± 1.0	
Subsurface Course		± 10.0			± 10.0			± 6.0				± 2.0	
Kansas													
Surface Course			± 5.0		± 5.0	± 5.0		± 4.0		± 3.0	± 3.0	± 2.2	
Subsurface Course			± 6.0		± 6.0	± 6.0		± 5.0		± 4.0	± 4.0	± 2.2	
Kentucky			± 9.0		± 8.0	± 8.0				± 6.0	± 3.0	± 2.0	± 0.3
Oklahoma		± 8.0	± 8.0		± 8.0		± 6.5	± 6.5	± 6.5	± 6.5	± 6.5	± 3.0	
South Carolina													
Surface Course			± 7.0		± 7.0	± 7.0		± 6.3			± 4.2	± 2.3	
Subsurface Course			± 10.5		± 8.2	± 8.2		± 6.3			± 4.2	± 2.3	
Tennessee			± 9.0		± 7.0	± 6.0		± 6.0		± 6.0	± 2.5	± 2.5	
Virginia	± 8.0	± 8.0	± 8.0		± 8.0	± 8.0		± 6.0		± 5.0		± 2.0	
Washington				± 6.0			± 5.0		± 4.0			± 2.0	
WASHTO			± 6.0			± 6.0			± 4.0			± 2.0	

a Based on one test, Pay factor = 100%.

TABLE 5 (continued). ALLOWABLE TOLERANCES FOR ACCEPTABLE BITUMINOUS CONCRETE PAVEMENT CONSTRUCTION [a]

Agency	Asphalt Cement Content (percent)		Air Voids (percent)	In-Place Density (percent)	Stability	Thickness (inch)
	Extraction	Digital Printout				
Arizona	± 0.50		+ 1 and - 2			
Florida	± 0.55	± 0.15				
Georgia						
Surface Course	± 0.70	± 0.30				
Subsurface Course	± 0.80	± 0.30				
Indiana						
Surface Course	± 0.70					
Subsurface Course	± 0.70					
Kansas						
Surface Course						
Subsurface Course						
Kentucky	± 0.50					
Oklahoma	± 0.70	± 0.30	± 2.5	+ 4 and - 2	- 2	
South Carolina						
Surface Course	± 0.47					
Binder Course	± 0.58					
Base Course	± 0.63					
Tennessee	± 0.55					
Virginia	± 0.60					
Washington	± 0.50					
WASHTO	± 0.50		± 1.5	± 3		0.25

a Based on one test, Pay factor = 100%.

REFERENCES

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2. Gendell, D. S. "Ensuring Better Pavements Through Quality Assurance Programs", *Hot Mix Technology*, pp. 10-15 (Fall, 1987).

3. McMahon, T. F., et al. "Quality Assurance in Highway Construction", *Public Roads*, Vol. 35, Nos. 6-11 (1969).

4. WASHTO QA Task Force. *Model Quality Assu ance Specifications for WASHTO States.* WASHTO, (1990).

APPENDIX A

STATISTICALLY-BASED ACCEPTANCE CRITERIA

TABLE A-1. SUMMARY OF STATISTICALLY-BASED ACCEPTANCE CRITERIA

Agency	Quality Attributes	Standard Lot Size	Sublot Size	Number of Tests
Arizona	AC Content Gradation Air Voids Stability Inplace Density	One production shift.	N/A	Four per lot.
Colorado	AC Content Gradation Relative Compaction	Material produced by same process through continuous production.	N/A	Five per lot, but a lot may include as few as 3 or as many as 7 tests).
Connecticut	Inplace Density	One day's production (300 tons minimum).	Ten sublots per lot.	One per sublot.
Florida	AC Content Gradation Inplace Density	At production plant: Lot = 4,000 tons. At roadway: Density lot = 5,000 ft of pass made by paving train regardless of pass width.	At production plant: 1,000 tons. At roadway: 1,000 ft.	One per sublot.
Georgia	AC Content Gradation Inplace Density	One day's production.	First sublot: 250 tons; Following sublots: 500 tons each.	One per sublot.
Indiana	AC Content Gradation Crushed Particle Content Inplace Density	4,000 tons for base and binder course; and 2,500 tons for surface mixtures.	Five sublots per lot. Density sublot = 2,000 sq. yds.	One per sublot. Average of five tests per sublot is considered as one test for inplace density.
Iowa	Density	One day's production	Seven sublots per lot.	One per sublot.
Kansas	Gradation	2,000 tons (may be increased to 3,000 tons if certain conditions are met).	Four sublots per lot.	One per sublot.
Kentucky	AC Content Gradation Fineness Modulus	One day's production	Three sublots per lot.	One per sublot.
Mississippi	Density	One day's production	Five sublots per lot.	One per sublot.

TABLE A-1 (continued). SUMMARY OF STATISTICALLY-BASED ACCEPTANCE CRITERIA

Agency	Quality Attributes	Standard Lot Size	Sublot Size	Number of Tests
Nebraska	AC Content Gradation	First lot = 1,000 tons; Each following lot = 2,500 tons	Five sublots per lot.	One per sublot.
New Jersey	Air Voids	5,000 Sq. Yds. (uniform thickness); 10,000 Sq. Yds. (variable thickness).	Five sublots per lot.	One per sublot.
New York	Density	One day's production (minimum 4,000 lane-feet or 400 tons, whichever is less).	Four sublots per lot.	One per sublot.
Oklahoma	AC Content Gradation Air Voids Stability Inplace Density	4,000 tons	Four sublots per lot.	One per sublot. For stability, voids, and density, average of three randomly selected sample units per sublot is considered as one test.
Oregon	AC Content Gradation Density	Quantity of material produced per JMF	500 tons.	One per sublot. For density, average of five randomly selected sample units per sublot considered as one test.
Pennsylvania	AC Content Gradation Density	Wearing Course:		One per sublot.
		330 tons (4,000 sq. yds.) but less than 440 tons (5,400 sq. yds.)	3 sublots per lot	
		440 tons (5,400 sq. yds.) but less than 550 tons (6,700 sq. yds.)	4 sublots per lot	
		550 tons (6,700 sq. yds.) but less than 660 tons (8,000 sq. yds.)	5 sublots per lot	
		Binder Course:		
		330 tons (3,000 sq. yds.) but less than 440 tons (4,000 sq. yds.)	3 sublots per lot	
		440 tons (4,000 sq. yds.) but less than 550 tons (5,100 sq. yds.)	4 sublots per lot	
		550 tons (5,100 sq. yds.) but less than 660 tons (6,000 sq. yds.)	5 sublots per lot	

TABLE A-1 (continued). SUMMARY OF STATISTICALLY-BASED ACCEPTANCE CRITERIA

Agency	Quality Attributes	Standard Lot Size	Sublot Size	Number of Tests
South Carolina	AC Content Gradation	One day's production	N/A	Four per lot.
Tennessee	AC Content Gradation	One day's production	Lot Size — # Sublots 3001-4000 tons — 4 2001-3000 tons — 3 1001-2000 tons — 2 Less than 1001 tons — 1	One per sublot.
Virginia	AC Content Gradation	At production plant: 2,000 tons (4,000 tons may be used when daily production exceeds 2,000 tons).	At production plant: four sublots per lot.	At production plant: one test per sublot.
Washington	AC Content Gradation Inplace Density	At production plant: quantity of material produced per JMF At roadway: density lot = one day's production or 400 tons whichever is less	At production plant: sublot size varies depending on JMF tonnage. At roadway: sublot is not defined.	At production plant: one test per sublot. At roadway: five density tests per lot.
West Virginia	AC Content Gradation Inplace Density	At production plant: quantity represented by the average of four consecutive test results. At roadway: density lot = 1,000 ft of paving lane of each layer or one day's production whichever is less.	At production plant: quantity of material represented by one test result At roadway: five sublots per lot.	At plant: four, three, and two tests during 1st, 2nd, and 3rd day of production, respectively. One test during 4th and subsequent days. At roadway: one density test per sublot.

APPENDIX B

STATISTICALLY-BASED PAYMENT CRITERIA

TABLE B-1. SUMMARY OF STATISTICALLY-BASED PAYMENT CRITERIA

Agency	Decision Rule For Acceptance	Payment Factors (PFs)	Adjustment of Contract Price	Bonus Pay
Arizona	Percent within limits, PWL, based on average and standard deviation of acceptance test results.	1. For each quality attribute, a PF is determined based on PWL (see Tables B-1 & B-2, Appendix B). 2. If any PF is negative, the Pay Adjustment is the sum of all negative PFs (maximum of -\$5/ton). 3. If all PFs are positive, the Pay Adjustment is the sum of the PFs subject to certain stipulations.	$ACP = CP + Pay\ Adjustment$ $LP = ACP \times LQ$	Yes
Colorado	Percent within limits, PWL, based on average and standard deviation of acceptance test results.	1. For each quality attribute, a PWL is determined. 2. The average of PWLs for the different attributes is then used to determine the Lot Pay Factor (see Table B-3, Appendix B).	$ACP = CP \times PF$ $LP = ACP \times LQ$	Yes
Connecticut	Average lot density.	Table B-4 (Appendix B) relating average lot density to PF.	$ACP = CP \times PF$ $LP = ACP \times LQ$	No
Florida	Average of absolute deviations of acceptance test results from JMF.	1. PFs are determined from Tables B-7 & B-8, Appendix B. 2. For each quality attribute, a pay deduction is computed as: contract price × (1 - PF).	$ACP = CP - \sum Pay\ Deductions$ $LP = ACP \times LQ$	No
Georgia	Average of absolute deviations of acceptance test results from JMF.	PFs are determined from Tables B-9, B-10 and B-11 (Appendix B).	$ACP = CP \times Lowest\ PF$ $LP = ACP \times LQ$	No
Indiana	1. Deviation of average of acceptance test results from prescribed tolerances; and 2. Deviation of range of acceptance test results from prescribed tolerances.	1. Adjustment points are determined from Tables B-13, B-14, B-15, and B-16 (Appendix B). 2. A Quantity Adjustment Factor is computed as 100% minus the total number of adjustment points accumulated for the lot.	$LP = CP \times LQ \times QAF$	No

TABLE B-1 (continued). SUMMARY OF STATISTICALLY-BASED PAYMENT CRITERIA

Agency	Decision Rule For Acceptance	Payment Factors (PFs)	Adjustment of Contract Price	Bonus Pay
Iowa	Deviation of the average of acceptance test results from target value divided by standard deviation of test results.	PF is determined from Table C-17 (Appendix C).	$ACP = CP \times PF$ $LP = ACP \times LQ$	No
Kansas	Accumulated absolute deviations of acceptance test results from JMF.	PF is determined from Table C-19 (Appendix C).	$ACP = CP \times PF$ $LP = ACP \times LQ$	No
Kentucky	Average of absolute deviations of acceptance test results from JMF.	1. PFs are determined from Table C-20 (Appendix C). 2. The lowest PF is used in adjusting the lot price.	$ACP = CP \times Lowest\ PF$ $LP = ACP \times LQ$	No
Mississippi	Average lot density.	PF is determined from Table C-21 (Appendix C).	$ACP = CP \times PF$ $LP = ACP \times LQ$	No
Nebraska	Absolute deviation of the mean of acceptance test results from JMF.	1. PFs are determined from Tables C-22 & C-23 (Appendix C). 2. Combined Pay Factor (CPF) is weighted average of individual PFs.	$ACP = CP \times CPF$ $LP = ACP \times LQ$	No
New Jersey	Percent defective based on average and standard deviation of acceptance test results.	1. Percent of material falling outside specification limits (PD) is determined from Table C-23 (Appendix C). 2. Percent Pay Adjustment (PPA) is computed as: PPA = 1.0 - 0.1 x PD.	$ACP = CP \times PPA$ $LP = ACP \times LQ$	Yes
New York	Percent within limits (PWL) based on average and standard deviation of acceptance test results.	Quantity Adjustment Factor (QAF) is determined from Table C-25 (Appendix C).	$LP = CP \times LQ \times QAF$	No

TABLE B-1 (continued). SUMMARY OF STATISTICALLY-BASED PAYMENT CRITERIA

Agency	Decision Rule For Acceptance	Payment Factors (PFs)	Adjustment of Contract Price	Bonus Pay
Oklahoma	Average deviation of acceptance test results from prescribed standard. For AC Content, Gradation and Air Voids, the absolute values of deviations are used; whereas for Stability, Density and Smoothness, the signs are considered.	1. PFs are determined from Table C-26 (Appendix C). 2. Combined Pay Factor (CPF) is weighted average of individual PFs.	$ACP = CP \times CPF$ $LP = ACP \times LQ$	Yes
Oregon	Percent within limits (PWL) based on average and standard deviation of acceptance test results.	1. PFs are determined from Table C-27 (Appendix C). 2. Combined Pay Factor (CPF) is weighted average of individual PFs.	When CPF > 1.0 (Bonus): $LP = [1 + \frac{(CPF-1)}{2}] \times CP \times LQ$ When CPF < 1.0 (Penalty): $LP = CPF \times CP \times LQ$	Yes
Pennsylvania	1. Percent within limits based on average and standard deviation of acceptance test results; and 2. A system of bonus and penalty points depending on deviation of individual test results as well as lot average from prescribed tolerances.	1. PFs are determined from Table C-29 (Appendix C). 2. Combined Pay Factor (CPF) is weighted average of individual PFs.	$ACP = CP \times CPF$ $LP = ACP \times LQ$	Yes
South Carolina	Absolute deviation of the mean of acceptance test results from JMF.	1. PFs are determined from Table C-30 (Appendix C). 2. Combined Pay Factor (CPF) is the product of individual PFs.	$ACP = CP \times CPF$ $LP = ACP \times LQ$	No
Tennessee	Average deviation of acceptance test results from JMF.	1. PFs are determined from Table C-31 (Appendix C). 2. For each quality attribute, a Pay Deduction is computed as: PD = Contract Price x (1 - PF).	$ACP = CP - \sum Pay\ Deductions$ $LP = ACP \times LQ$	No

TABLE B-1 (continued). SUMMARY OF STATISTICALLY-BASED PAYMENT CRITERIA

Agency	Decision Rule For Acceptance	Payment Factors (PFs)	Adjustment of Contract Price	Bonus Pay
Virginia	A system of adjustment points based on: 1. Deviation of the mean of acceptance test results from prescribed process tolerance limits; and 2. Standard deviation of acceptance test results.	Adjustment points are determined from Tables C-33 and C-34 (Appendix C).	The contract price is reduced by 1% and 0.5% for each adjustment point attributed to the average and the standard deviation of test results, respectively. $LP = ACP \times LQ$	No
Washington	Percent within limits (PWL) based on average and standard deviation of acceptance test results.	1. PFs are determined from Table B-37 (Appendix C). 2. Combined Pay Factor (CPF) is weighted average of individual PFs.	$ACP = CP \times CPF$ $LP = ACP \times LQ$	Yes
West Virginia	Percent within limits (PWL) based on average and range of acceptance test results.	1. PFs are determined from Tables C-38, C-40 and C-41 (Appendix C). 2. Combined Pay Factor (CPF) is the product of individual PFs.	$ACP = CP \times CPF$ $LP = ACP \times LQ$	No

ACP = Adjusted Contract Price   CP = Contract Price   CPF = Combined Pay Factor
PF = Pay Factor   LP = Lot Payment   LQ = Lot Quantity

APPENDIX C

PAY FACTOR TABLES

TABLE C-1. ARIZONA DOT, UPPER & LOWER LIMITS OF ACCEPTABLE AC PAVEMENT CONSTRUCTION

Measured Characteristic	Lower Limit	Upper Limit
Gradation		
3/8-inch sieve	TV - 6.0	TV + 6.0
No. 8 sieve	TV - 5.5	TV + 5.5
No. 40 sieve	TV - 4.0	TV + 4.0
No. 200 sieve	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.5	TV + 0.5
Effective Voids	TV - 2.0	TV + 1.0

TABLE C-2. ARIZONA DOT, PAY FACTORS

Percent Within Limits	Pay Factor (Dollars/Ton)
> 99	+1.50
95 - 99	+1.00
90 - 94	+0.60
85 - 89	0.00
80 - 84	-0.25
75 - 79	-0.55
70 - 74	-0.90
65 - 69	-1.30
60 - 64	-1.75
55 - 59	-2.25
50 - 54	-2.80

TABLE C-3. COLORADO DOT, PAY FACTORS

Pay Factor	Percent Within Limits										
	Sample Size (n)										
	3	4	5	6	7	8	9	10-11	12-14	15-18	19-25
1.05	100	100	100	100	100	100	100	100	100	100	100
1.04	90	91	92	93	93	93	94	94	95	95	96
1.03	80	85	87	88	89	90	91	91	92	93	93
1.02	75	80	83	85	86	87	88	88	89	90	91
1.01	71	77	80	82	84	85	85	86	87	88	89
1.00	68	74	78	80	81	82	83	84	85	86	87
0.99	66	72	75	77	79	80	81	82	83	85	86
0.98	64	70	73	75	77	78	79	80	81	83	84
0.97	62	68	71	74	75	77	78	78	80	81	83
0.96	60	66	69	72	73	75	76	77	78	80	81
0.95	59	64	68	70	72	73	74	75	77	78	80
0.94	57	63	66	68	70	72	73	74	75	77	78
0.93	56	61	65	67	69	70	71	73	74	75	77
0.92	55	60	63	65	67	69	70	71	72	74	75
0.91	53	58	62	64	66	67	68	69	71	73	74
0.90	52	57	60	63	64	66	67	68	70	71	73
0.89	51	55	59	61	63	64	66	67	68	70	72
0.88	50	54	57	60	62	63	64	65	67	69	70
0.87	48	53	56	58	60	62	63	64	66	67	69
0.86	47	51	55	57	59	60	62	63	64	66	68
0.85	46	50	53	56	58	59	60	61	63	65	67
0.84	45	40	52	55	56	58	59	60	62	64	65
0.83	44	48	51	53	55	57	58	59	61	63	64
0.82	42	46	50	52	54	55	57	58	60	61	63
0.81	41	45	48	51	53	54	56	57	58	60	62
0.80	40	44	47	50	52	53	54	55	57	59	61
0.79	38	43	46	48	50	52	53	54	56	58	60
0.78	37	41	45	47	49	51	52	53	55	57	59
0.77	36	40	43	46	48	50	51	52	54	56	57
0.76	34	39	42	45	47	48	50	51	53	55	56
0.75	33	38	41	44	46	47	49	50	51	53	55
Reject	Quality Levels Less Than Those Specified for a 0.75 Pay Factor										

TABLE C-4. CONNECTICUT DOT, PAY FACTORS FOR IN-PLACE DENSITY

Average Percent Density of Ten Sublots		Percent Payment
Class 1 & 2		
	100 - 98	85
	97 - 92	100
	91 - 90	85
	89 - 88	75
	87 - 86	50 or Rejection
Class 4		
	Greater than 99	85
	98 - 90	100
	89 - 88	85
	87 - 86	75
	85 or Less	50 or Rejection
Class 114		
	100 - 95	85
	95 - 88	100
	87 - 86	85
	85 - 84	75
	83 or Less	50 or Rejection

TABLE C-5. CONNECTICUT DOT, MAXIMUM ALLOWABLE DEVIATION FROM JMF (SINGLE TEST)

Attribute	M. A. D.	% Payment
Bitumen Content	0.4	90
No. 200 Sieve	2.0	90
No. 50 Sieve	4.0	90
No. 30 Sieve	5.0	90
No. 8 Sieve	6.0	90
No. 4 Sieve	7.0	90
3/8", 1/2" & 3/4" Sieves	8.0	90

TABLE C-6. FLORIDA DOT, TOLERANCES FOR ACCEPTANCE TESTS

Characteristic	Tolerance[a]
Asphalt Content (extraction)	± 0.55%
Asphalt Content (printout)	± 0.15%
Passing No. 4 Sieve	± 7.00%
Passing No. 10 Sieve	± 5.50%
Passing No. 40 Sieve	± 4.50%
Passing No. 200 Sieve	± 2.00%

a Tolerances for sample size of n = 1.

TABLE C-7. FLORIDA DOT, PAYMENT SCHEDULE FOR DENSITY

Percent of Control Strip Density	Percent of Payment
98.0 and above	100
97.0 to less than 98.0	95
96.0 to less than 97.0	90
Less than 96.0	75

TABLE C-8. FLORIDA DOT, PAYMENT SCHEDULE FOR AC CONTENT AND GRADATION

Quality Attributes	Pay Factor	Average Absolute Deviation of Acceptance Tests from JMF					
		1 Test	2 Test	3 Test	4 Test	5 Test	6 Test
AC Content (Extraction)	1.00	0.00-0.55	0.00-0.43	0.00-0.38	0.00-0.35	0.00-0.33	0.00-0.31
	0.95	0.56-0.65	0.44-0.50	0.39-0.44	0.36-0.40	0.34-0.37	0.32-0.35
	0.90	0.66-0.75	0.51-0.57	0.45-0.50	0.41-0.45	0.38-0.42	0.36-0.39
	0.80[a]	over 0.75	over 0.50	over 0.50	over 0.45	over 0.42	over 0.39
AC Content (Printout)	1.00	0.00-0.15	0.00-0.15	0.00-0.15	0.00-0.15	0.00-0.15	0.00-0.15
	0.95	0.16-0.25	0.16-0.25	0.16-0.25	0.16-0.25	0.16-0.25	0.16-0.25
	0.90	0.26-0.35	0.26-0.35	0.26-0.35	0.26-0.35	0.26-0.35	0.26-0.35
	0.80[a]	over 0.35	over 0.35	over 0.35	over 0.35	over 0.35	over 0.35
No. 4 Sieve[b]	1.00	0.00-7.00	0.00-5.24	0.00-4.46	0.00-4.00	0.00-3.68	0.00-3.45
	0.98	7.01-8.00	5.25-5.95	4.47-5.04	4.01-4.50	3.69-4.13	3.46-3.86
	0.95	8.01-9.00	5.96-6.66	5.05-5.62	4.51-5.00	4.14-4.58	3.87-4.27
	0.90	9.01-10.0	6.67-7.36	5.63-6.20	5.01-5.50	4.59-5.02	4.28-4.67
	0.80[a]	over 10.0	over 7.36	over 6.20	over 5.50	over 5.02	over 4.67
No. 10 Sieve[b]	1.00	0.00-5.50	0.00-4.33	0.00-3.81	0.00-3.50	0.00-3.29	0.00-3.13
	0.98	5.51-6.50	4.34-5.04	3.82-4.39	3.51-4.00	3.30-3.74	3.14-3.54
	0.95	6.51-7.50	5.05-5.74	4.40-4.96	4.01-4.50	3.75-4.18	3.55-3.95
	0.90	7.51-8.50	5.75-6.45	4.97-5.54	4.51-5.00	4.19-4.63	3.96-4.36
	0.80[a]	over 8.50	over 6.45	over 5.54	over 5.00	over 4.63	over 4.36
No. 40 Sieve[b]	1.00	0.00-4.50	0.00-3.91	0.00-3.65	0.00-3.50	1.00-3.39	0.00-3.32
	0.98	4.51-5.50	3.92-4.62	3.66-4.23	3.51-4.00	3.40-3.84	3.33-3.72
	0.95	5.51-6.50	4.63-5.33	4.24-4.81	4.01-4.50	3.85-4.29	3.73-4.13
	0.90	6.51-7.50	5.34-6.04	4.82-5.39	4.51-5.00	4.30-4.74	4.14-4.54
	0.80[a]	over 7.50	over 6.04	over 5.39	over 5.00	over 4.74	over 4.54
No. 200 Sieve[b]	1.00	0.00-2.00	0.00-1.71	0.00-1.58	0.00-1.50	0.00-1.45	0.00-1.41
	0.95	2.01-2.40	1.72-1.99	1.59-1.81	1.51-1.70	1.46-1.63	1.42-1.57
	0.90	2.41-2.80	2.00-2.27	1.82-2.04	1.71-1.90	1.64-1.80	1.58-1.73
	0.80[a]	over 2.80	over 2.27	over 2.04	over 1.90	over 1.80	over 1.73

a If approved by the District Construction Engineer, based on an engineering determination that the material is acceptable to remain in place, the Contractor may accept the indicated partial pay. Otherwise, the Department will require removal and replacement at no cost. The Contractor has the option to remove and replace at no cost to the Department at any time.

b When there are two or more reduced payments for these items in one LOT of material, only the greatest reduction in payment will be applied. The No. 40 sieve applies only to Type S-I, S-II, S-III, FC-1 and FC-4.

TABLE C-9. GEORGIA DOT, PAYMENT SCHEDULE FOR AC CONTENT AND GRADATION (SURFACE COURSE)

Mixture Characteristic	Pay Factor	Mean Absolute Deviation from JMF							
		1 Test	2 Tests	3 Tests	4 Tests	5 Tests	6 Tests	7 Tests	8 Tests
	1.00	0.00-0.70	0.00-0.54	0.00-0.46	0.00-0.41	0.00-0.38	0.00-0.35	0.00-0.32	0.00-0.30
	0.95	0.71-0.80	0.55-0.61	0.47-0.52	0.45-0.46	0.39-0.43	0.36-0.39	0.33-0.36	0.31-0.34
Asphalt Cement Content	0.90	0.81-0.90	0.62-0.68	0.53-0.58	0.47-0.51	0.44-0.47	0.40-0.43	0.37-0.40	0.35-0.37
(Extraction)	0.80	0.91-1.00	0.69-0.75	0.59-0.64	0.52-0.56	0.48-0.52	0.44-0.47	0.41-0.44	0.38-0.41
	0.70	1.01-1.19	0.76-0.82	0.65-0.69	0.57-0.61	0.53-0.56	0.48-0.51	0.45-0.47	0.42-0.44
	0.50	1.20-1.40	0.83-0.85	0.70-0.72	0.62-0.64	0.57-0.59	0.52-0.55	0.48-0.51	0.45-0.48
	1.00	0.00-0.30	0.00-0.26	0.00-0.22	0.00-0.18	0.00-0.16	0.00-0.14	0.00-0.13	0.00-0.13
	0.95	0.31-0.34	0.27-0.29	0.23-0.25	0.19-0.20	0.17-0.18	0.15-0.16	0.14-0.15	0.14-0.15
Asphalt Cement Content	0.90	0.35-0.38	0.30-0.33	0.26-0.28	0.21-0.23	0.19-0.21	0.17-0.19	0.16-0.18	0.16-0.17
(Digital Printout)	0.80	0.39-0.42	0.34-0.36	0.29-0.31	0.24-0.25	0.22-0.23	0.20-0.21	0.19-0.20	0.18-0.19
	0.70	0.43-0.46	0.37-0.40	0.32-0.34	0.26-0.28	0.24-0.26	0.22-0.24	0.21-0.22	0.20-0.21
	0.50	0.47-0.50	0.41-0.46	0.35-0.40	0.29-0.34	0.27-0.31	0.25-0.28	0.23-0.25	0.22-0.23
	1.00	0.0- 9.0	0.0- 6.6	0.0-5.6	0.0-5.0	0.0-4.6	0.0-4.2	0.0-3.9	0.0-3.6
	0.98	9.1-10.0	6.7- 7.5	5.7-6.3	5.1-5.6	4.7-5.2	4.3-4.7	4.0-4.4	3.7-4.1
3/8-inch Sieve	0.95	10.1-11.9	7.6- 8.4	6.4-7.0	5.7-6.3	5.3-5.8	4.8-5.3	4.5-5.0	4.2-4.6
(B-Modified & E Mixes)	0.90	12.0-13.0	8.5- 9.3	7.1-7.7	6.4-6.9	5.9-6.3	5.4-5.8	5.1-5.4	4.7-5.0
	0.85	13.1-14.0	9.4-10.2	7.8-8.6	7.0-7.6	6.4-6.9	5.9-6.3	5.5-5.9	5.1-5.5
	0.80	14.1-14.5	10.3-10.5	8.7-8.9	7.7-8.0	7.0-7.5	6.4-6.8	6.0-6.4	5.6-6.0
	1.00	0.0- 9.0	0.0- 6.7	0.0-5.7	0.0-5.2	0.0-4.8	0.0-4.4	0.0-4.1	0.0-3.8
	0.98	9.1-10.0	6.8- 7.6	5.8-6.3	5.3-5.8	4.9-5.4	4.5-4.9	4.2-4.6	3.9-4.3
No. 4 Sieve	0.95	10.1-11.9	7.7- 8.5	6.4-6.9	5.9-6.4	5.3-5.9	5.0-5.4	4.7-5.0	4.4-4.7
(D , F, & H Mixes)	0.90	12.0-13.0	8.6- 9.4	7.0-7.5	6.5-7.0	6.0-6.5	5.5-5.9	5.1-5.5	4.8-5.1
	0.85	13.1-14.0	9.5-10.2	7.6-8.0	7.1-7.6	6.6-7.0	6.0-6.4	5.6-5.9	5.2-5.5
	0.80	14.1-14.5	10.3-10.5	8.1-8.3	7.7-8.0	7.1-7.5	6.5-6.9	6.0-6.4	5.6-5.9
	1.00	0.0- 7.0	0.0-5.6	0.0-4.8	0.0-4.3	0.0-4.0	0.0-3.6	0.0-3.4	0.0-3.2
	0.98	7.1- 8.0	5.7-6.3	4.9-5.4	4.4-4.8	4.1-4.5	3.7-4.1	3.5-3.8	3.3-3.6
No. 8 Sieve	0.95	8.1- 9.0	6.4-7.0	5.5-6.0	4.9-5.3	4.6-4.9	4.2-4.5	3.9-4.2	3.7-3.9
(All Mixes except D)[a]	0.90	9.1-10.9	7.1-7.7	6.1-6.6	5.4-5.8	5.0-5.4	4.6-4.9	4.3-4.6	4.0-4.3
	0.85	11.0-12.0	7.8-8.5	6.7-7.2	5.9-6.4	5.5-5.8	5.0-5.3	4.7-5.0	4.4-4.6
	0.75	12.1-12.5	8.6-8.8	7.3-7.5	6.5-6.8	5.9-6.3	5.4-5.7	5.1-5.3	4.7-4.9

a No. 8 Sieve for D-Mix: When the mean of the deviation from JMF for a particular lot exceeds the tolerance for a 1.00 pay factor in the appropriate column, the lot will be paid for at 0.50 of the contract price.

TABLE C-10. GEORGIA DOT, PAYMENT SCHEDULE FOR AC CONTENT AND GRADATION (SUBSURFACE MIXES)

Mixture Characteristic	Pay Factor	Mean Absolute Deviation from JMF							
		1 Test	2 Tests	3 Tests	4 Tests	5 Tests	6 Tests	7 Tests	8 Tests
	1.00	0.00-0.80	0.00-0.61	0.00-0.52	0.00-0.46	0.00-0.43	0.00-0.39	0.00-0.36	0.00-0.34
	0.95	0.81-0.90	0.62-0.68	0.53-0.58	0.47-0.51	0.44-0.47	0.40-0.43	0.37-0.40	0.35-0.37
Asphalt Cement Content	0.90	0.91-1.00	0.69-0.75	0.59-0.64	0.52-0.56	0.45-0.52	0.44-0.47	0.41-0.44	0.38-0.41
(Extraction)	0.80	1.01-1.19	0.76-0.82	0.65-0.67	0.57-0.61	0.53-0.56	0.48-0.51	0.45-0.47	0.42-0.44
	0.70	1.20-1.40	0.83-0.85	0.70-0.72	0.62-0.64	0.57-0.59	0.52-0.55	0.48-0.51	0.45-0.48
	0.50	1.41-1.60	0.86-0.88	0.73-0.75	0.65-0.67	0.60-0.63	0.56-0.60	0.52-0.56	0.49-0.52
	1.00	0.00-0.30	0.00-0.26	0.00-0.22	0.00-0.18	0.00-0.17	0.00-0.16	0.00-0.15	0.00-0.15
Asphalt Cement Content	0.95	0.31-0.34	0.27-0.29	0.23-0.25	0.19-0.20	0.18-0.19	0.17-0.19	0.16-0.18	0.16-0.17
(Digital Printout)	0.90	0.35-0.38	0.30-0.33	0.26-0.28	0.21-0.23	0.20-0.21	0.20-0.21	0.19-0.20	0.18-0.19
	0.80	0.39-0.42	0.34-0.36	0.29-0.31	0.24-0.25	0.23-0.24	0.22-0.24	0.21-0.22	0.20-0.21
	0.70	0.43-0.46	0.37-0.40	0.32-0.34	0.26-0.28	0.25-0.27	0.25-0.27	0.23-0.25	0.22-0.23
	0.50	0.47-0.50	0.41-0.44	0.35-0.37	0.29-0.31	0.28-0.31	0.28-0.30	0.26-0.28	0.24-0.26
	1.00	0.0-12.9	0.0- 8.1	0.0-6.9	0.0-6.1	0.0-5.5	0.0-5.0	0.0-4.7	0.0-4.4
	0.98	13.0-14.0	8.2- 9.1	7.0-7.7	6.2-6.8	5.6-6.1	5.1-5.6	4.8-5.2	4.5-4.9
1/2" Sieve	0.95	14.1-15.0	9.2-10.1	7.8-8.5	6.9-7.5	6.2-6.7	5.7-6.1	5.3-5.7	5.0-5.4
(Base)	0.90	15.1-16.0	10.2-11.1	8.6-9.3	7.6-8.2	6.8-7.4	6.2-6.7	5.8-6.3	5.5-5.9
	0.85	16.1-17.0	11.2-11.5	9.4-9.6	8.3-8.6	7.5-7.8	6.8-7.0	6.4-6.5	6.0-6.1
	0.80	17.1-18.0	11.6-11.9	9.7-9.9	8.7-9.0	7.9-8.1	7.1-7.3	6.6-6.8	6.2-6.4
	1.00	0.0-10.0	0.0- 7.5	0.0-6.3	0.0-5.6	0.0-5.2	0.0-4.7	0.0-4.4	0.0-4.1
	0.98	10.1-11.9	7.6- 8.4	6.4-7.0	5.7-6.3	5.2-5.8	4.8-5.3	4.5-5.0	4.2-4.6
3/8" Sieve	0.95	12.0-13.0	8.5- 9.3	7.1-7.7	6.4-6.9	5.9-6.3	5.4-5.8	5.1-5.4	4.7-5.0
(C, B, B-Modified & E Mixes)	0.90	13.1-14.0	9.4-10.2	7.8-8.6	7.0-7.6	6.4-6.9	5.9-6.3	5.5-5.9	5.1-5.5
	0.85	14.1-14.5	10.3-10.5	8.7-8.9	7.7-8.0	7.0-7.5	6.4-6.8	6.0-6.4	5.6-6.0
	0.80	14.6-15.0	10.6-10.8	9.0-9.2	8.1-8.4	7.6-7.8	6.9-7.3	6.5-6.8	6.1-6.5
	1.00	0.0-10.0	0.0- 7.6	0.0-6.3	0.0-5.8	0.0-5.4	0.0-4.9	0.0-4.6	0.0-4.3
	0.98	10.1-11.9	7.7- 8.5	6.4-6.9	5.9-6.4	5.5-5.9	5.0-5.4	4.7-5.0	4.4-4.7
No. 4 Sieve	0.95	12.0-13.0	8.6- 9.4	7.0-7.5	6.5-7.0	6.0-6.5	5.5-5.9	5.1-5.5	4.8-5.1
(F & H Mixes)	0.90	13.1-14.0	9.5-10.2	7.6-8.0	7.1-7.6	6.6-7.0	6.0-6.4	5.6-5.9	5.2-5.5
	0.85	14.1-14.5	10.3-10.5	8.1-8.3	7.7-8.0	7.1-7.5	6.5-6.9	6.0-6.4	5.6-5.9
	0.80	14.6-15.0	10.6-10.8	8.4-8.6	8.1-8.4	7.6-8.0	7.0-7.4	6.5-6.8	6.0-6.3
	1.00	0.0- 8.0	0.0-6.3	0.0-5.4	0.0-4.8	0.0-4.5	0.0-4.1	0.0-3.8	0.0-3.6
	0.98	8.1- 9.0	6.4-7.0	5.5-6.0	4.9-5.3	4.6-4.9	4.2-4.5	3.9-4.2	3.7-3.9
No. 8 Sieve	0.95	9.1-10.0	7.1-7.7	6.1-6.6	5.4-5.8	5.0-5.4	4.6-4.9	4.3-4.6	4.0-4.3
(All Mixes)	0.90	10.1-11.9	7.8-8.5	6.7-7.2	5.9-6.4	5.5-5.8	5.0-5.3	4.7-5.0	4.4-4.6
	0.85	12.0-13.0	8.6-8.8	7.3-7.5	6.5-6.8	5.9-6.3	5.4-5.7	5.1-5.3	4.7-4.9
	0.75	13.1-14.0	8.9-9.1	7.6-7.8	6.9-7.2	6.4-6.6	5.8-6.1	5.4-5.7	5.0-5.3

TABLE C-11. GEORGIA DOT, PAYMENT SCHEDULE FOR IN-PLACE DENSITY

PAY FACTOR	Percent of Target Density (Average of 5 Tests per Lot)	Percent of Target Density (Average of 10 tests per Lot) (for reevaluations)
1.00	97.5 & over	97.5 & over
0.97	97.0 - 97.4	97.1 - 97.4
0.95	96.5 - 96.9	96.7 - 97.0
0.90	95.5 - 96.4	96.0 - 96.6
0.80	93.4 - 95.4	94.5 - 95.9
0.70	91.5 - 93.3	93.1 - 94.4
0.50	90.0 - 91.4	92.0 - 93.0

TABLE C-12. GEORGIA DOT, QUALITY ATTRIBUTES FOR ACCEPTANCE

Mix Type	Quality Attributes
Asphaltic Concrete Base	1/2", No.8 Sieves and Asphalt Cement
Asphaltic Concrete B	3/8", No.8 Sieves and Asphalt Cement
Asphaltic Concrete B-Modified	3/8", No.8 Sieves and Asphalt Cement
Asphaltic Concrete D	No.4, No.8 Sieves and Asphalt Cement
Asphaltic Concrete E	3/8", No.8 Sieves and Asphalt Cement
Asphaltic Concrete F	No.4, No.8 Sieves and Asphalt Cement
Asphaltic Concrete H	No.4, No.8 Sieves and Asphalt Cement
Asphaltic Concrete G	No.8 Sieve and Asphalt Cement
Sand Asphalt Type 1 and 2	Asphalt Cement
Asphaltic Concrete C	3/8", No.8 Sieves and Asphalt Cement

TABLE C-13. INDIANA DOT, ALLOWABLE TOLERANCES & ADJUSTMENT POINTS FOR THE AVERAGE OF ACCEPTANCE TEST RESULTS (GRADATION)

Mixture	Number of Tests	Acceptance Tolerances (±)						
		Sieve Size						
		1 1/2"	1"	3/4"	1/2"	No. 4	No. 30	No. 200
Base	1	---	---	---	10.0	10.0	6.0	2.0
	2	---	---	---	7.0	7.0	4.2	1.4
	3	---	---	---	5.8	5.8	3.5	1.2
	4	---	---	---	5.0	5.0	3.0	1.0
	5	---	---	---	4.5	4.5	2.7	0.9
Binder	1	---	---	---	10.0	10.0	6.0	2.0
	2	---	---	---	7.0	7.0	4.2	1.4
	3	---	---	---	5.8	5.8	3.5	1.2
	4	---	---	---	5.0	5.0	3.0	1.0
	5	---	---	---	4.5	4.5	2.7	0.9
Surface	1	---	---	---	8.0	8.0	4.0	1.0
	2	---	---	---	5.7	5.7	2.8	0.7
	3	---	---	---	4.6	4.6	2.3	0.6
	4	---	---	---	4.0	4.0	2.0	0.5
	5	---	---	---	3.6	3.6	1.8	0.4
Adjustment Points								
For ≤ 1.0% out-of-tolerance [a]		0.1	0.1	0.1	0.1	0.1	0.2	0.3
For each 0.1% beyond the 1st 1% out-of-tolerance [a]		0.1	0.1	0.1	0.1	0.2	0.3	0.6

a Total adjustment points will be obtained by adding the amount of adjustment points calculated for one percent out of tolerance to the amount of adjustment points calculated for greater than one percent out of tolerance.

TABLE C-14. INDIANA DOT, ALLOWABLE TOLERANCES & ADJUSTMENT POINTS FOR THE AVERAGE OF ACCEPTANCE TEST RESULTS (AC CONTENT)

Allowable Tolerances (±)										
Base & Binder Courses					Surface Course					
Number of Tests					Number of Tests					
1	2	3	4	5	1	2	3	4	5	Adjustment Points
0.7	0.5	0.4	0.3	0.3	0.7	0.5	0.4	0.3	0.3	2 For each 0.1% out High 4 For each 0.1% out Low

TABLE C-15. INDIANA DOT, ALLOWABLE TOLERANCES & ADJUSTMENT POINTS FOR THE RANGE OF ACCEPTANCE TEST RESULTS

Attribute	Allowable Range (Percentage Points)			Adjustment Points (For each 0.1% out of range)
	Base Course	Binder Course	Surface Course	
1/2"	15.0 15.0	15.0	12.0	.1
No. 4	9.0	15.0	12.0	.1
No. 30	3.0 1.0	9.0	6.0	.1
No. 200		3.0	1.5	.1
% Bitumen		1.0	1.0	1.0

TABLE C-16. INDIANA DOT, ADJUSTMENT POINTS FOR LOT AND SUBLOT DENSITY

Percent of Target Density	Adjustment Points
Average Lot Density	
98.0 or Higher	0
97.9 to 96.0	0.5 points for each 0.1% below 98.0
95.9 to 95.0	10 points + 1 point for each 0.1% below 96.0
Sublot Density	
Below 95	0.1 points for each 0.1% below 95.0

TABLE C-17. IOWA DOT, PAY FACTORS FOR LOT DENSITY

Quality Index[a]	Percent of Full Payment
0.73	100
0.40 to 0.72	95
0.00 to 0.39	85
All negative values[b]	75 Maximum

a Based on 7 test results, only one outlier will be allowed.
b The engineer may declare the entire lot or parts of the lot defective.

TABLE C-18. KANSAS DOT, JMF TOLERANCES FOR GRADATION OF BITUMINOUS MIXES

Mix Designation[a]	JMF Tolerances for Gradation (Percent Retained)											
	1 1/2"	1"	3/4"	1/2"	3/8"	4	8	16	30	50	100	200
BM-1						± 5	± 5	± 5	± 5	± 4	± 3	± 2
BM-1A, 1B						± 5	± 4	± 4	± 3	± 3	± 3	± 2
BM-1T						± 6	± 5	± 5	± 4	± 3	± 3	± 2
BM-2A					± 5	± 5	± 5	± 5	± 5	± 4	± 4	± 2
BM-2, 2B, 2C, 2D, 3					± 6	± 6	± 6	± 5	± 5	± 4	± 4	± 2
BM-4, 5, 6[b]					± 7	± 7	± 6	± 6	± 6	± 6	± 5	± 2
BM-7					± 6	± 6	± 5		± 4		± 3	± 2

a BM-2 mixes used in base construction will be restricted to BM-2, BM-2B, or BM-2C gradation.
b Tolerances do not apply to road mix.

TABLE C-19. KANSAS DOT, SCHEDULE OF ADJUSTED PAYMENT FOR GRADATION OF BITUMINOUS MIXES

Accumulated Deviation of the Acceptance Tests from the Design JMF Single Point					
		Number of Tests			
Tolerance[a]	Pay Factor	1	2	3	4
± 7	1.00	0.00 - 7.00	0.00 - 9.00	0.00 - 12.12	0.00 - 14.00
	0.98	7.01 - 7.50	9.01 - 10.60	12.13 - 12.99	14.01 - 15.00
	0.95	7.51 - 8.00	10.61 - 11.32	13.00 - 13.86	15.01 - 16.00
	0.90[b]	8.01 - 8.50	11.33 - 12.02	13.87 - 14.73	16.01 - 17.00
	0.80[b]	over 8.50	over 12.02	over 14.73	over 17.01
± 6	1.00	0.00 - 6.00	0.00 - 8.48	0.00 - 10.38	0.00 - 12.00
	0.98	6.01 - 6.50	8.49 - 9.20	10.39 - 11.25	12.01 - 13.00
	0.95	6.51 - 7.00	9.21 - 9.90	11.26 - 12.12	13.01 - 14.00
	0.90[b]	7.01 - 7.50	9.91 - 10.60	12.13 - 12.99	14.01 - 15.00
	0.80[b]	over 7.50	over 10.60	over 12.99	over 15.00
± 5	1.00	0.00 - 5.00	0.00 - 7.08	0.00 - 8.61	0.00 - 10.00
	0.98	5.01 - 5.50	7.09 - 7.78	8.62 - 9.54	10.01 - 11.00
	0.95	5.51 - 6.00	7.79 - 8.48	9.55 - 10.38	11.01 - 12.00
	0.90[b]	6.01 - 6.50	8.49 - 9.20	10.39 - 11.25	12.01 - 13.00
	0.80[b]	over 6.50	over 9.20	over 11.25	over 13.00
± 4	1.00	0.00 - 4.00	0.00 - 5.66	0.00 - 6.93	0.00 - 8.00
	0.98	4.01 - 4.50	5.67 - 6.36	6.94 - 7.80	8.01 - 9.00
	0.95	4.51 - 5.00	6.37 - 7.08	7.81 - 8.67	9.01 - 10.00
	0.90[b]	5.01 - 5.50	7.09 - 7.78	8.68 - 9.54	10.01 - 11.00
	0.80[b]	over 5.50	over 7.78	over 9.54	over 11.00
± 3	1.00	0.00 - 3.00	0.00 - 4.24	0.00 - 5.19	0.00 - 6.00
	0.98	3.01 - 3.20	4.25 - 4.52	5.20 - 5.55	6.01 - 6.40
	0.95	3.21 - 3.40	4.53 - 4.80	5.56 - 5.97	6.41 - 6.80
	0.90[b]	3.41 - 3.80	4.81 - 5.38	5.98 - 6.57	6.81 - 7.60
	0.80[b]	over 3.80	over 5.38	over 6.57	over 7.60
± 2.5	1.00	0.00 - 2.50	0.00 - 3.54	0.00 - 4.32	0.00 - 5.00
	0.98	2.51 - 2.70	3.55 - 3.82	4.33 - 4.68	5.01 - 5.40
	0.95	2.71 - 2.90	3.83 - 4.10	4.68 - 5.01	5.41 - 5.80
	0.90[b]	2.91 - 3.30	4.11 - 4.66	5.02 - 5.73	5.81 - 6.60
	0.80[b]	over 3.30	over 4.66	over 5.73	over 6.60
± 2	1.00	0.00 - 2.20	0.00 - 3.12	0.00 - 3.81	0.00 - 4.40
	0.95	2.21 - 2.40	3.13 - 3.40	3.82 - 4.17	4.41 - 4.80
	0.90[b]	2.41 - 2.75	3.41 - 3.88	4.18 - 4.77	4.81 - 5.56
	0.80[b]	over 2.75	over 3.88	over 4.77	over 5.56

a See Table C-18

b If approved by the Department, the Contractor may accept the indicated partial pay. The Department may require removal and replacement at no additional cost. The Contractor has the option to remove and replace at no cost to the Department at any time.

TABLE C-20. KENTUCKY DOT, ACCEPTANCE SCHEDULE FOR OPEN GRADED FRICTION COURSE AND BITUMINOUS CONCRETE BASE, BINDER & SURFACE (EXCEPT CLASS S)

Average Absolute Deviation from JMF							
Quality Attribute	Pay Factor	Number of Tests					
		1	2	3	4	5	6
Asphalt Cement	1.00	0.0 - 0.5	0.00- 0.35	0.00- 0.30	0.00- 0.28	0.00- 0.26	0.00- 0.23
	0.98	0.6	0.36- 0.39	0.31- 0.34	0.29- 0.32	0.27- 0.29	0.24- 0.26
	0.95	-	0.40- 0.44	0.35- 0.38	0.33- 0.35	0.30- 0.32	0.27- 0.30
	0.90	0.7	0.45- 0.53	0.39- 0.46	0.36- 0.43	0.33- 0.40	0.31- 0.36
	0.85	0.8	0.54- 0.64	0.47- 0.55	0.44- 0.52	0.41- 0.48	0.37- 0.43
	0.75	0.9+	0.56+	0.56+	0.53+	0.49+	0.44+
1/2" or greater	1.00	0 - 9	0.0 - 7.0	0.0 - 6.0	0.0 - 5.4	0.0 - 5.0	0.0 - 4.7
	0.98	10	7.1 - 8.0	6.1 - 8.0	5.5 - 6.2	5.1 - 5.8	4.8 - 5.4
	0.95	11 - 12	8.1 - 9.1	7.0 - 7.8	6.3 - 7.0	5.9 - 6.5	5.5 - 6.1
	0.90	13 - 14	9.2 - 10.8	7.9 - 9.3	7.1 - 8.4	6.6 - 7.8	6.2 - 7.3
	0.85	15 - 16	10.9 - 12.9	9.4 -11.1	8.5 -10.0	7.9 - 9.3	7.4 - 8.7
	0.75	17+	13.0+	11.2+	10.1+	9.4+	8.8+
3/8", No. 4, No. 8, or No. 16	1.00	0 - 8	0.0 - 5.9	0.0 - 5.0	0.0 - 4.5	0.0 - 4.1	0.0 - 3.9
	0.98	9	6.0 - 6.8	5.1 - 5.8	4.6 - 5.2	4.2 - 4.7	4.0 - 4.5
	0.95	10	6.9 - 7.7	5.9 - 6.5	5.3 - 5.8	4.8 - 5.3	4.6 - 5.1
	0.90	11 - 12	7.8 - 9.1	6.6 - 7.8	5.9 - 7.0	5.4 - 6.4	5.2 - 6.0
	0.85	13 - 14	9.2 - 10.9	7.9 - 9.2	7.1 - 8.3	6.5 - 7.6	6.1 - 7.2
	0.75	15+	11.0+	9.3+	8.4+	7.7+	7.3+
No. 50	1.00	0 - 6	0.0 - 4.7	0.0 - 4.0	0.0 - 3.6	0.0 - 3.3	0.0 - 3.1
	0.98	7	4.8 - 5.4	4.1 - 4.6	3.7 - 4.2	3.4 - 3.8	3.2 - 3.6
	0.95	8	5.5 - 6.1	4.7 - 5.2	4.3 - 4.8	3.9 - 4.3	3.7 - 4.0
	0.90	9	6.2 - 7.3	5.3 - 6.2	4.9 - 5.6	4.4 - 5.1	4.1 - 4.8
	0.85	10	7.4 - 8.7	6.3 - 7.4	5.7 - 6.7	5.2 - 6.0	4.9 - 5.7
	0.75	11+	8.8+	7.5+	6.8+	6.1+	5.8+
No. 100	1.00	0 - 3	0.0 - 2.3	0.0 - 2.0	0.0 - 1.8	0.0 - 1.7	0.0 - 1.6
	0.98	-	2.4 - 2.6	2.1 - 2.3	1.9 - 2.1	1.8 - 2.0	1.7 - 1.8
	0.95	4	2.7 - 3.0	2.4 - 2.6	2.2 - 2.3	2.1 - 2.2	1.9 - 2.1
	0.90	5	3.1 - 3.6	2.7 - 3.1	2.4 - 2.8	2.3 - 2.6	2.2 - 2.5
	0.85	-	3.7 - 4.3	3.2 - 3.7	2.9 - 3.3	2.7 - 3.1	2.6 - 3.0
	0.75	6+	4.4+	3.8+	3.4+	3.2+	3.1+
No. 200	1.00	0.0 - 2.0	0.0 - 1.7	0.0 - 1.5	0.0 - 1.4	0.0 - 1.3	0.0 - 1.2
	0.98	2.5	1.8 - 2.0	1.6 - 1.7	1.5 - 1.6	1.4 - 1.5	1.3 - 1.4
	0.95	3.0	2.1 - 2.2	1.8 - 2.0	1.7 - 1.8	1.6 - 1.7	1.5 - 1.6
	0.90	-	2.3 - 2.6	2.1 - 2.3	1.9 - 2.2	1.8 - 2.0	1.7 - 1.9
	0.85	3.5	2.7 - 3.1	2.4 - 2.8	2.3 - 2.6	2.1 - 2.4	2.0 - 2.2
	0.75	4.0+	3.2+	2.9+	2.7+	2.5+	2.3+
Fineness Modulus (Sand Asphalt)	1.00	0.00- 0.30	0.00- 0.25	0.00- 0.20	0.00- 0.15	0.00- 0.10	0.00- 0.06
	0.98	0.31- 0.34	0.26- 0.29	0.21- 0.29	0.16- 0.19	0.11- 0.14	0.07- 0.09
	0.95	0.35- 0.39	0.30- 0.33	0.25- 0.28	0.20- 0.23	0.15- 0.18	0.10- 0.11
	0.90	0.40- 0.46	0.34- 0.37	0.29- 0.32	0.24- 0.27	0.19- 0.22	0.12- 0.13
	0.85	0.47- 0.55	0.38- 0.41	0.33- 0.37	0.28- 0.31	0.23- 0.26	0.14- 0.15
	0.75	0.56+	0.56+	0.38+	0.32+	0.27+	0.16+

NOTE: When a pay factor less than 1.00 is determined for the asphalt content or more than one sieve, use the lowest pay factor determined.

TABLE C-21. MISSISSIPPI DOT, PAYMENT SCHEDULE FOR COMPACTION

Pay Factor	Lot Density (% of Maximum Density)[a]
0.75	96.1 - 97.0
0.90	95.1 - 96.0
1.00	92.0 - 95.0
0.90	91.0 - 91.9
0.75	90.0 - 90.9

a Any lot, sublot or portion thereof with a density of more than 97.0 percent or less than 90.0 percent of maximum density shall be removed and replaced at the Contractor's expense.

TABLE C-22. NEBRASKA DOT, PAYMENT SCHEDULE FOR DENSITY

Average Density (Percent of Voidless Density, 5 Tests)	Pay Factor
First Lot	
90.0 or Greater	1.00
89.5 to 89.9	0.95
89.0 to 89.4	0.70
88.9 or Less	0.40 or Reject
Each Following Lot	
92.5 or Greater	1.00
92.0 to 92.4	0.95
91.5 to 91.9	0.90
91.0 to 91.4	0.85
90.5 to 90.9	0.80
90.0 to 90.4	0.70
89.9 or Less	0.40 or Reject

TABLE C-23. NEBRASKA DOT, PAYMENT SCHEDULE FOR ASPHALT CONTENT & AGGREGATE GRADATION

Mix Characteristic	Pay Factor	Deviation of the Average of Lot Acceptance Test Results from JMF		
		Number of Tests		
		3	4	5
	1.00	0.00 - 0.37	0.00 - 0.33	0.00 - 0.31
	0.95	0.38 - 0.42	0.34 - 0.39	0.32 - 0.37
Asphalt Content	0.90	0.43 - 0.46	0.40 - 0.43	0.38 - 0.41
	0.80	0.47 - 0.50	0.44 - 0.47	0.42 - 0.45
	0.70	0.51 - 0.54	0.48 - 0.51	0.46 - 0.49
	1.00	0.0 - 5.6	0.0 - 5.0	0.0 - 4.6
	0.95	5.7 - 6.3	5.1 - 5.6	4.7 - 5.2
3/8" Sieve	0.90	6.4 - 7.0	5.7 - 6.3	5.3 - 5.8
	0.80	7.1 - 7.7	6.4 - 6.9	5.9 - 6.3
	0.70	7.8 - 8.6	7.0 - 7.6	6.4 - 6.9
	1.00	0.0 - 4.8	0.0 - 4.3	0.0 - 4.0
	0.95	4.9 - 5.4	4.4 - 4.8	4.1 - 4.5
No. 4 and No. 10 Sieves	0.90	5.5 - 6.0	4.9 - 5.3	4.6 - 4.9
	0.80	6.1 - 6.6	5.4 - 5.8	5.0 - 5.4
	0.70	6.7 - 7.2	5.9 - 6.4	5.5 - 5.8
	1.00	0.0 - 3.8	0.0 - 3.4	0.0 - 3.2
	0.95	3.9 - 4.1	3.5 - 3.8	3.3 - 3.5
No. 50 Sieve	0.90	4.2 - 4.5	3.9 - 4.1	3.6 - 3.8
	0.80	4.6 - 4.9	4.2 - 4.4	3.9 - 4.1
	0.70	5.0 - 5.5	4.5 - 4.9	4.2 - 4.5
	1.00	0.0 - 2.1	0.0 - 1.9	0.0 - 1.8
	0.95	2.2 - 2.3	2.0 - 2.1	1.9 - 2.0
No. 200 Sieve	0.90	2.4 - 2.5	2.2 - 2.3	2.1 - 2.2
	0.80	2.6 - 2.8	2.4 - 2.5	2.3 - 2.4
	0.70	2.9 - 3.1	2.6 - 2.7	2.5 - 2.6

TABLE C-23. NEW JERSEY DOT, LOT PERCENT DEFECTIVE (SAMPLE SIZE = 5)

Quality Index, Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.64	49.29	48.93	48.58	48.22	47.86	47.51	47.15	46.80
0.1	46.44	46.09	45.73	45.38	45.02	44.67	44.31	43.96	43.60	43.25
0.2	42.90	42.54	42.19	41.84	41.48	41.13	40.78	40.43	40.08	39.72
0.3	39.37	39.02	38.67	38.32	37.97	37.62	37.28	36.93	36.58	36.23
0.4	35.88	35.51	35.19	34.85	34.50	34.16	33.81	33.47	33.12	32.78
0.5	32.44	32.10	31.76	31.42	31.08	30.74	30.40	30.06	29.73	29.39
0.6	29.05	28.72	28.39	28.05	27.72	27.39	27.06	26.73	26.40	26.07
0.7	25.74	25.41	25.09	24.76	24.44	24.11	23.79	23.47	23.15	22.83
0.8	22.51	22.19	21.87	21.56	21.24	20.93	20.62	20.31	20.00	19.69
0.9	19.38	19.07	18.77	18.46	18.16	17.86	17.55	17.25	16.96	16.66
1.0	16.36	16.07	15.78	15.48	15.19	14.91	14.62	14.33	14.05	13.76
1.1	13.48	13.20	12.93	12.65	12.37	12.10	11.83	11.56	11.29	11.02
1.2	10.76	10.50	10.23	9.97	9.72	9.46	9.21	8.96	8.71	8.46
1.3	8.21	7.97	7.73	7.49	7.25	7.02	6.79	6.56	6.33	6.10
1.4	5.88	5.66	5.44	5.23	5.02	4.81	4.60	4.39	4.19	3.99
1.5	3.80	3.61	3.42	3.23	3.05	2.87	2.69	2.52	2.35	2.19
1.6	2.03	1.87	1.72	1.57	1.42	1.28	1.15	1.02	0.89	0.77
1.7	0.66	0.55	0.45	0.36	0.27	0.19	0.12	0.06	0.02	0.00

Numbers in the body of the table are estimates of lot percent defective corresponding to specific values of Q, the quality index. For values of Q greater than or equal to zero, the table value must be subtracted from 100.

Example:

QL = 1.71, QU = 0.56
PDL = 0.55, PDU = 30.40
Total PD = 30.95

TABLE C-24. NEW YORK DOT, TABLE FOR ESTIMATING PERCENT OF LOT WITHIN LIMITS (STANDARD DEVIATION METHOD)

Negative Values of Q_U or Q_L (Sample Size n = 4)				Positive Values of Q_U or Q_L (Sample Size n = 4)			
PWL	Q_U or Q_L	PWL	Q_U or Q_L	PWL	Q_U or Q_L	PWL	Q_U or Q_L
25	0.7500	50	0.0000	99	1.4700	74	0.7200
24	0.7800	49	0.0300	98	1.4400	73	0.6900
23	0.8100	48	0.0600	97	1.4100	72	0.6600
22	0.8400	47	0.0900	96	1.3800	71	0.6300
21	0.8700	46	0.1200	95	1.3500	70	0.6000
20	0.9000	45	0.1500	94	1.3200	69	0.5700
19	0.9300	44	0.1800	93	1.2900	68	0.5400
18	0.9600	43	0.2100	92	1.2600	67	0.5100
17	0.9900	42	0.2400	91	1.2300	66	0.4800
16	1.0200	41	0.2700	90	1.2000	65	0.4500
15	1.0500	40	0.3000	89	1.1700	64	0.4200
14	1.0800	39	0.3300	88	1.1400	63	0.3900
13	1.1100	38	0.3600	87	1.1100	62	0.3600
12	1.1400	37	0.3900	86	1.0800	61	0.3300
11	1.1700	36	0.4200	85	1.0500	60	0.3000
10	1.2000	35	0.4500	84	1.0200	59	0.2700
9	1.2300	34	0.4800	83	0.9900	58	0.2400
8	1.2600	33	0.5100	82	0.9600	57	0.2100
7	1.2900	32	0.5400	81	0.9300	56	0.1800
6	1.3200	31	0.5700	80	0.9000	55	0.1500
5	1.3500	30	0.6000	79	0.8700	54	0.1200
4	1.3800	29	0.6300	78	0.8400	53	0.0900
3	1.4100	28	0.6600	77	0.8100	52	0.0600
2	1.4400	27	0.6900	76	0.7800	51	0.0300
1	1.4700	26	0.7200	75	0.7500	50	0.0000

TABLE C-25. NEW YORK DOT, QUANTITY ADJUSTMENT SCHEDULE

PWL	Quantity Adjustment Factor, Percent
100 - 95	100
94 - 84	95
83 - 62	90
61 - 36	80
35 - 15	70
14 - 5	60
< 5	**

** The lot shall be removed and replaced to meet specification requirements as ordered by the engineer

TABLE C-26. OKLAHOMA DOT, ACCEPTANCE SCHEDULE

Mix Characteristics	Pay Factor	Number of Tests: 1	2	3	4[a]
		Average of Deviations from Target (Without Regard to Signs)			
Asphalt Cement Content (Extraction or Nuclear)	1.00	0.00 - 0.70	0.00 - 0.50	0.00 - 0.40	0.00 - 0.35
	0.95	0.71 - 0.80	0.51 - 0.57	0.41 - 0.46	0.36 - 0.40
	0.90	0.81 - 0.90	0.58 - 0.64	0.47 - 0.52	0.41 - 0.45
	0.80	0.91 - 1.00	0.65 - 0.71	0.53 - 0.58	0.46 - 0.50
Target: JMF-Percent (%)	Unacceptable[b]	Over 1.00	Over 0.71	Over 0.58	Over 0.50
		Average of Deviations from Target (Without Regard to Signs)			
Asphalt Cement Content (Digital Print-out)	1.00	0.00 - 0.30	0.00 - 0.21	0.00 - 0.17	0.00 - 0.15
	0.95	0.31 - 0.35	0.22 - 0.25	0.18 - 0.20	0.16 - 0.18
	0.90	0.36 - 0.41	0.26 - 0.29	0.21 - 0.24	0.19 - 0.21
	0.80	0.42 - 0.46	0.30 - 0.33	0.25 - 0.27	0.22 - 0.23
Target: JMF-Percent (%)	Unacceptable[b]	Over 0.46	Over 0.33	Over 0.27	Over 0.20
		Average of Deviations from Target (Without Regard to Signs)			
Gradation: No.4 & Larger Sieves[c]	1.00	0.00 - 8.00	0.00 - 5.66	0.00 - 4.62	0.00 - 4.00
	0.98	8.01 - 9.00	5.67 - 6.36	4.63 - 5.20	4.01 - 4.50
	0.96	9.01 -10.00	6.37 - 7.07	5.21 - 5.77	4.51 - 5.00
	0.94	10.01 -11.00	7.08 - 7.78	5.78 - 6.35	5.01 - 5.50
	0.92	11.01 -12.00	7.79 - 8.49	6.36 - 6.93	5.51 - 6.00
	0.90	12.01 -13.00	8.50 - 9.19	6.94 - 7.51	6.01 - 6.50
	0.88	13.01 -14.00	9.20 - 9.90	7.52 - 8.08	6.51 - 7.00
	0.85	14.01 -15.00	9.91 -10.61	8.09 - 8.66	7.01 - 7.50
	0.82	15.01 -16.00	10.62 -11.32	8.67 - 9.24	7.51 - 8.00
	0.79	16.01 -17.00	11.33 -12.02	9.25 - 9.82	8.01 - 8.50
	0.76	17.01 -18.00	12.03 -12.73	9.83 -10.39	8.51 - 9.00
Target: JMF-Percent (%)	Unacceptable[b]	Over 18.00	Over 12.73	Over 10.39	Over 9.00
		Average of Deviations from Target (Without Regard to Signs)			
Gradation: No. 10 through 100 Sieves[c]	1.00	0.00 - 6.50	0.00 - 4.60	0.00 - 3.75	0.00 - 3.25
	0.98	6.51 - 7.50	4.61 - 5·30	3.76 - 4.33	3.26 - 3.75
	0.96	7.51 - 8.50	5.31 - 6.01	4.34 - 4.91	3.76 - 4.25
	0.93	8.51 - 9.50	6.02 - 6.72	4.92 - 5.48	4.26 - 4.75
	0.91	9.51 -10.50	6.73 - 7.43	5.49 - 6.06	4.76 - 5.25
	0.88	10.51 -11.50	7.44 - 8.13	6.07 - 6.64	5.26 - 5.75
	0.85	11.51 -12.50	8.14 - 8.84	6.65 - 7.22	5.76 - 6.25
	0.82	12.51 -13.50	8.85 - 9.55	7.23 - 7.79	6.26 - 6.75
	0.79	13.51 -14.50	9.56 -10.25	7.80 - 8.37	6.76 - 7.25
	0.76	14.51 -15.50	10.26 -10.96	8·38 - 8.95	7.26 - 7.75
Target: JMF-Percent (%)	Unacceptable[b]	Over 15.50	Over 10.96	Over 8.95	Over 7.75

TABLE C-26 (continued). OKLAHOMA DOT, ACCEPTANCE SCHEDULE

Mix Characteristics	Pay Factor	Number of Tests 1	2	3	4[a]
		Average of Deviations from Target (Without Regard to Signs)			
Gradation: No.200 Sieve[c]	1.00	0.00 - 3.00	0.00 - 2.12	0.00 - 1.73	0.00 - 1.50
	0.98	3.01 - 3.40	2.13 - 2.40	1.74 - 1.96	1.51 - 1.70
	0.96	3.41 - 3.80	2.41 - 2.69	1.97 - 2.19	1.71 - 1.90
	0.94	3.81 - 4.20	2.70 - 2.97	2.20 - 2.43	1.91 - 2.10
	0.91	4.21 - 4.60	2.98 - 3.25	2.44 - 2.66	2.11 - 2.30
	0.88	4.61 - 5.00	3.26 - 3.54	2.67 - 2.89	2.31 - 2.50
	0.85	5.01 - 5.40	3.55 - 3.82	2.90 - 3.12	2.51 - 2.70
	0.82	5.41 - 5.80	3.83 - 4.10	3.13 - 3.35	2.71 - 2.90
	0.79	5.81 - 6.20	4.11 - 4.38	3.36 - 3.58	2.91 - 3.10
	0.76	6.21 - 6.60	4.39 - 4.67	3.59 - 3.81	3.11 - 3.30
Target: JMF-Percent (%)	Unacceptable[b]	Over 6.60	Over 4.67	Over 3.81	Over 3.30
		Average of Deviations from Target (Without Regard to Signs)			
Air Voids	1.00	0.00 - 2.50	0.00 - 1.77	0.00 - 1.44	0.00 - 1.25
(Lab Molded Specimens)	0.99	2.51 - 2.58	1.78 - 1.82	1.45 - 1.49	1.26 - 1.29
	0.97	2.59 - 2.67	1.83 - 1.89	1.50 - 1.54	1.30 - 1.34
	0.94	2.68 - 2.75	1.90 - 1.94	1.55 - 1.59	1.35 - 1.38
ADT / Target	0.90	2.76 - 2.83	1.95 - 2.00	1.60 - 1.63	1.39 - 1.42
5000 or more / 5%	0.85	2.84 - 2.91	2.01 - 2.06	1.64 - 1.68	1.43 - 1.46
1000 - 5000 / 4%	0.79	2.92 - 3.00	2.07 - 2.12	1.69 - 1.73	1.47 - 1.50
1000 or less / 3%	Unacceptable[b]	Over 3.00	Over 2.12	Over 1.73	Over 1.50
		Average Deviations from Target (Considering Signs)			
Hveem Stability	1.00	(-)2	0	0	0
(Lab Molded Specimens)	0.90	(-)3	(-)2	(-)1	(-)1
	0.80	(-)4	(-)3	(-)2	(-)2
	Unacceptable[b]	Over (-)4	Over (-)3	Over (-)2	Over (-)2
Minimums:					
2500 ADT or more and					
All city streets	40				
Less than 2500 ADT	35				

TABLE C-26 (continued). OKLAHOMA DOT, ACCEPTANCE SCHEDULE

Mix Characteristics	Pay Factor	Number of Tests			
		1	2	3	4[a]
		Average of Deviations from Target (Considering Signs)			
Roadway Density[d]	1.00	(+)4.00-(-)2.00	(+)2.83-(-)1.41	(+)2.31-(-)1.15	(+)2.00-(-)1.00
(Core or Nuclear)	0.99	(-)2.01-(-)2.60	(-)1.42-(-)1.84	(-)1.16-(-)1.50	(-)1.01-(-)1.30
	0.98	(-)2.61-(-)3.20	(-)1.85-(-)2.26	(-)1.51-(-)1.85	(-)1.31-(-)1.60
	0.96	(-)3.21-(-)3.80	(-)2.27-(-)2.69	(-)1.86-(-)2.19	(-)1.61-(-)1.90
	0.93	(-)3.81-(-)4.40	(-)2.70-(-)3.11	(-)2.20-(-)2.54	(-)1.91-(-)2.20
	0.89	(-)4.41-(-)5.00	(-)3.12-(-)3.54	(-)2.55-(-)2.89	(-)2.21-(-)2.50
	0.84	(-)5.01-(-)5.60	(-)3.55-(-)3.96	(-)2.90-(-)3.23	(-)2.51-(-)2.80
	0.78	(-)5.61-(-)6.20	(-)3.97-(-)4.38	(-)3.24-(-)3.58	(-)2.81-(-)3.10
	0.70	(-)6.21-(-)6.80	(-)4.39-(-)4.81	(-)3.59-(-)3.93	(-)3.10-(-)3.40
	0.60	(-)6.81-(-)7.40	(-)4.82-(-)5.23	(-)3.94-(-)4.27	(-)3.41-(-)3.70
Target:	0.50	(-)7.41-(-)8.00	(-)5.24-(-)5.66	(-)4.28-(-)4.62	(-)3.71-(-)4.00
94.00% of Maximum	Unacceptable[b]	Over (-)8.00	Over (-)5.66	Over (-)4.62	Over (-)4.00
Theoretical Density		Over (+)4.00	Over (+)2.83	Over (+)2.31	Over (+)2.00

Mix Characteristics	Pay Factor	Average of Deviations from Maximum (Considering Signs)
Surface Smoothness	1.05	Less than 3.0
	1.03	3.0 - 3.6
	1.02	3.7 - 4.2
	1.01	4.3 - 5.4
	1.00	5.4 - 6.5
	0.99	6.6 - 7.7
	0.97	7.8 - 9.0
	0.95	9.1 -10.0
	0.90	10.1 -11.0
Maximum:	0.80	11.1 -12.0
6.0 inches per mile	Unacceptable[b]	More than 12.0

a If more than four tests are conducted, the allowable deviations will be determined by dividing the allowable deviations for one test by the square root of the number of tests actually conducted.

b Unless otherwise directed by the engineer, products testing in this range are unacceptable and shall be removed and replaced at no cost to the Department.
When the total adjustment to payment (Combined Pay Factor) is equal to or less than 0.90 the Contractor may, at his option, remove and replace the products at no additional cost to the Department or leave them in place and receive no payment for them.

c Only the smallest of the gradation pay factors shall be considered in determining adjustment in pat for each lot.

d It is the intent of this Specification that uniform compaction be obtained. In addition to average density requirements, the allowable range (difference between the highest and lowest densities in the affected lot) is limited to 4.0% on new construction and 5.0% on resurfacing. The density pay factors for lots exceeding these limits shall be limited to 0.98 or the density pay factors shown above, whichever is less.

TABLE C-27. OREGON DOT, PAY FACTORS

Required Quality Level for a Given Sample Size and a Given Pay Factor															
Pay Factor	Sample Size														
	3	4	5	6	7	8	9	10-11	12-14	15-18	19-25	26-37	38-69	70-200	> 200
1.05	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.04	90	91	92	93	93	93	94	94	95	95	96	96	97	97	99
1.03	80	85	87	88	89	90	91	91	92	93	93	94	95	96	97
1.02	75	80	83	85	86	87	88	88	89	90	91	92	93	94	95
1.01	71	77	80	82	84	85	85	86	87	88	89	90	91	93	94
1.00	68	74	78	80	81	82	83	84	85	86	87	89	90	91	93
0.99	66	72	75	77	79	80	81	82	83	85	86	87	88	90	92
0.98	64	70	73	75	77	78	79	80	81	83	84	85	87	88	90
0.97	62	68	71	74	75	77	78	78	80	81	83	84	85	87	89
0.96	60	66	69	72	73	75	76	77	48	80	81	83	84	86	88
0.95	59	64	68	70	72	73	74	75	77	78	80	81	83	85	87
0.94	57	63	66	68	70	72	73	74	75	77	78	80	81	83	86
0.93	56	61	65	67	69	70	71	72	74	75	77	78	80	82	84
0.92	55	60	63	65	67	69	70	71	72	74	75	77	79	81	83
0.91	53	58	62	64	66	67	68	69	71	73	74	76	78	80	82
0.90	52	57	60	63	64	66	67	68	70	71	73	75	76	79	81
0.89	51	55	59	61	63	64	66	67	68	70	72	73	75	77	80
0.88	50	54	57	60	62	63	64	65	67	69	70	72	74	76	79
0.87	48	53	56	58	60	62	63	64	66	67	69	71	73	75	78
0.86	47	51	55	57	59	60	62	63	64	66	68	70	72	74	77
0.85	46	50	53	56	58	59	60	61	63	65	67	69	71	73	76
0.84	45	49	52	55	56	58	59	60	62	64	65	67	69	72	75
0.83	44	48	51	53	55	57	58	59	61	63	64	66	68	71	74
0.82	42	46	50	52	54	55	57	58	60	61	63	65	67	70	72
0.81	41	45	48	51	53	54	56	57	58	60	62	64	66	69	71
0.80	40	44	47	50	52	53	54	55	57	59	61	63	65	67	70
0.79	38	43	46	48	50	52	53	54	56	58	60	62	64	66	69
0.78	37	41	45	47	49	51	52	53	55	57	59	61	63	65	68
0.77	36	40	43	46	48	50	51	52	54	56	57	60	62	64	67
0.76	34	39	42	45	47	48	50	51	53	55	56	58	61	63	66
0.75	33	38	41	44	46	47	49	50	51	53	55	57	59	62	65
Reject	Quality levels less than those specified for a 0.75 Pay factor.														

TABLE C-28. OR GON DOT, WEIGHING FACTORS USED IN COMPUTING THE COMPOSITE PAY FACTOR

Mix Constituent	Weighing Factor
All aggregate passing 1", 3/4" and 1/2" sieves	1 Each
All aggregate passing 1/4" sieve	5
All aggregate passing No. 10 sieve	5
All aggregate passing No. 40 sieve	3
All aggregate passing No. 200 sieve	10
Asphalt Content	26
Moisture content	8
Compaction (Density)	40

Maximum pay factor = 1.05, unless otherwise specified.
When the CPF is greater than 1.0000 it will be reduced as follows: Reduction in CPF = (CPF - 1) / 2

TABLE C-29. PENNSYLVANIA DOT, PAY FACTORS FOR AC CONTENT, GRADATION & DENSITY NOT WITHIN TOLERANCE

Percent within Limits	Pay Factor (%)	Percent within Limits	Pay Factor (%)
99	97	81	79
98	97	79	78
97	97	78	76
96	96	77	74
95	96	76	72
94	95	75	71
93	95	74	69
92	95	73	67
91	95	72	66
90	95	71	64
89	93	70	62
88	91	69	60
87	90	68	59
86	88	67	57
85	86	66	55
84	84	65	54
83	83	64	52
82	81	Less than 64[a]	50

a See Section 402.4(b)3

TABLE C-30. SOUTH CAROLINA DOT, PAY FACTORS FOR ASPHALT CONTENT & AGGREGATE GRADATION

Mix Characteristics	% Bid Price	Deviation of Average of Acceptance Test Results from JMF			
		1 Test	2 Tests	3 Tests	4 Tests
AC Content for Surface Course & Sand-Asphalt	100	0.00-0.47	0.00-0.33	0.00-0.27	0.00-0.24
	95	0.48-0.56	0.34-0.40	0.28-0.32	0.25-0.29
	90	0.57-0.61	0.41-0.43	0.33-0.35	0.30-0.31
Asphalt Content for Binder Course	100	0.00-0.58	0.00-0.41	0.00-0.34	0.00-0.29
	95	0.59-0.70	0.42-0.49	0.35-0.41	0.30-0.35
	90	0.50-0.53	0.50-0.53	0.42-0.44	0.36-0.38
Asphalt Content for Asphaltic Base	100	0.00-0.63	0.00-0.46	0.00-0.39	0.00-0.34
	95	0.64-0.75	0.47-0.54	0.40-0.46	0.35-0.40
	90	0.76-0.80	0.55-0.58	0.47-0.49	0.41-0.43
Gradation for Surface Courses					
No. 8 & Larger Sieves					
	100	0.0-7.0	0.0-4.9	0.0-4.0	0.0-3.5
	95	7.0-8.4	5.0-5.9	4.1-4.8	3.6-4.2
	90	8.5-9.1	6.0-6.4	4.9-5.2	4.3-4.6
No. 30 Sieve					
	100	0.0-6.3	0.0-4.4	0.0-3.6	0.0-3.2
	95	6.4-7.6	4.5-5.3	3.7-4.3	3.3-3.8
	90	7.7-8.2	5.4-5.7	4.4-4.7	3.9-4.2
No. 100 Sieve					
	100	0.0-4.2	0.0-3.0	0.0-2.4	0.0-2.1
	95	4.3-5.5	3.4-3.9	2.5-3.1	2.2-2.7
	90	5.6-6.9	4.0-5.0	3.2-4.0	2.8-3.5
No. 200 Sieve					
	100	0.00-2.33	0.00-1.64	0.00-1.35	0.00-1.17
	95	2.34-2.80	1.65-1.97	1.36-1.62	1.18-1.40
Gradation for Binder Courses	90	2.81-3.03	1.98-2.13	1.63-1.76	1.41-1.52
No. 3/8" & Larger Sieves					
	100	0.0-10.5	0.0-7.4	0.0-6.0	0.0-5.3
	95	10.6-12.6	7.5-839	6.1-7.2	5.4-6.4
Nos. 4 & 8 Sieves	90	12.7-13.7	9.0-9.6	7.3-7.8	6.5-6.9
	100	0.0- 8.2	0.0-5.8	0.0-4.8	0.0-4.1
	95	8.3- 9.8	5.9-7.0	4.9-5.8	4.2-4.9
No. 30 Sieve	90	9.9-10.7	7.1-7.5	5.9-6.2	5.0-5.3
	100	0.0-6.3	0.0-4.4	0.0-3.6	0.0-3.2
	95	6.4-7.6	4.5-5.3	3.7-4.3	3.3-3.8
No. 100 Sieve	90	7.7-8.2	5.4-5.7	4.4-4.7	3.9-4.2
	100	0.0-4.2	0.0-3.0	0.0-2.4	0.0-2.1
	95	4.3-5.5	3.1-3.9	2.5-3.1	2.2-2.7
No. 200 Sieve	90	5.6-6.9	4.0-5.0	3.2-4.0	2.8-3.5
	100	0.00-2.33	0.00-1.64	0.00-1.35	0.00-1.17
	95	2.34-2.80	1.65-1.97	1.36-1.62	1.18-1.40
	90	2.81-3.03	1.98-2.13	1.63-1.76	1.41-1.52

TABLE C-31. TENNESSEE DOT, PAY FACTORS FOR ASPHALT CONTENT & AGGREGATE GRADATION

Mix Characteristics	Average Arithmetic Deviation of Acceptance Test from the Job Mix Form				
	Pay Factor	1 Test	2 Tests	3 Tests	4 Tests
Asphalt Cement Content[c] (Extraction)	1.00	0.00- 0.55	0.00- 0.46	0.00- 0.40	0.00- 0.35
	0.95	0.56- 0.63	0.47- 0.53	0.41- 0.46	0.36- 0.40
	0.90	0.64- 0.71	0.54- 0.64	0.47- 0.52	over 0.45
Gradation 3/8" Sieve and Larger	1.00	0.00- 9.00	0.00- 7.50	0.00- 6.50	0.00- 5.70
	0.95	9.01-10.00	7.51- 8.21	6.51- 7.08	5.71- 6.20
	0.90	10.01-11.00	8.22- 8.92	7.09- 7.66	6.21- 6.69
	0.80[a]	over 11.00	over 8.92	over 7.66	over 6.69
Gradation No. 4 Sieve[b]	1.00	0.00- 7.00	0.00- 5.66	0.00- 4.62	0.00- 4.00
	0.95	7.01- 7.81	5.67- 6.36	4.63- 5.20	4.01- 4.50
	0.90	7.82- 8.62	6.37- 7.07	5.21- 5.77	4.51- 5.00
	0.80[a]	over 8.62	over 7.07	over 5.77	over 5.00
Gradation No. 8, 30, & 50 Sieves[b]	1.00	0.00- 6.00	0.00- 4.60	0.00- 3.80	0.00- 3.30
	0.95	6.01- 6.81	4.61- 5.31	3.81- 4.46	3.31- 3.91
	0.90	6.82- 7.62	5.32- 6.02	4.47- 5.12	3.92- 4.52
	0.80[a]	over 7.62	over 6.02	over 5.12	over 4.52
Gradation No. 100 & 200 Sieves[b]	1.00	0.00- 2.50	0.00- 2.10	0.00- 1.80	0.00- 1.60
	0.95	2.51- 3.00	2.11- 2.40	1.81- 2.00	1.61- 1.75
	0.90	3.01- 3.50	2.41- 2.70	2.01- 2.20	1.76- 1.90
	0.80[a]	over 3.50	over 2.70	over 2.20	over 1.90

a If approved by the Engineer, the Contractor may accept the indicated pay. The Department may require removal and replacement at no cost. Contractor has the option to remove and replace at no cost to the Department at any time.

b When there is more than one reduced payment relating to gradation, only the greatest reduction in payment will be applied. Reductions applicable for any other reason will be cumulative.

c Does not apply to 307 Grading "A", "A-S", or "A-CRL" mixes.

TABLE C-32. VIRGINIA DOT, PROCESS TOLERANCE

No. of Tests	Tolerance on Each Laboratory Sieve and Asphalt Content (Percent)										
	Top Size	1 1/2"	3/4"	1/2"	3/8"	No. 4	No. 8	No. 30	No. 50	No. 200	A.C.[a]
1	0.0	± 8.0	± 8.0	± 8.0	± 8.0	± 8.0	± 8.0	± 6.0	± 5.0	± 2.0	± 0.60
2	0.0	± 5.7	± 5.7	± 5.7	± 5.7	± 5.7	± 5.7	± 4.3	± 3.6	± 1.4	± 0.43
3	0.0	± 4.4	± 4.4	± 4.4	± 4.4	± 4.4	± 4.4	± 3.3	± 2.8	± 1.1	± 0.33
4	0.0	± 4.0	± 4.0	± 4.0	± 4.0	± 4.0	± 4.0	± 3.0	± 2.5	± 1.0	± 0.30
5	0.0	± 2.8	± 2.8	± 2.8	± 2.8	± 2.8	± 2.8	± 2.1	± 1.8	± 0.7	± 0.21

a Asphalt content will be measured as extractable asphalt.

TABLE C-33. VIRGINIA DOT, ADJUSTMENT POINTS FOR AC CONTENT & GRADATION OUTSIDE PROCESS TOLERANCE

AGGREGATE GRADATION	
Sieve Size	Adjustment Points for Each 1% that Gradation is Outside the Process Tolerance Permitted in Table B-32
2"	1
11/2"	1
1"	1
3/4"	1
1/2"	1
3/8"	1
4	1
8	1
30	2
50	2
200	3

AC CONTENT

One adjustment will be applied for each 0.1% that the material is out of the process tolerance for asphalt content.

a In the event the total adjustment points is 25 points or less and the Contractor does not elect to remove and replace the material, the unit price for the material will be reduced by 1% of the unit price bid for each adjustment point.

In the event the adjustment points are applied against three successive lots, plant adjustment shall be made prior to continuing production.

In the event the total adjustment for a lot is greater than 25 points, the failing material shall be removed from the road.

TABLE C-34. VIRGINIA DOT, ADJUSTMENT POINTS FOR PROCESS VARIABILITY

Attribute	Standard Deviation of Test Results		
	Number of Adjustment Points[a]		
	1	2	3
Aggregate Gradation:			
1/2"	3.8-4.7	4.8-5.7	5.8-6.7
3/8"	3.8-4.7	4.8-5.7	5.8-6.7
No. 4	3.8-4.7	4.8-5.7	5.8-6.7
No. 8	3.0-3.9	4.0-4.9	5.0-5.9
No. 30	2.2-3.1	3.2-4.1	4.2-5.1
No. 50	1.5-2.4	2.5-3.4	3.5-4.4
No. 200	1.1-2.0	2.1-3.0	3.1-4.0
AC Content	0.27-0.36	0.37-0.46	0.47-0.56

a The unit bid price will be reduced by 0.5% for each adjustment point applied for standard deviation. The disposition of material having standard deviation larger than those shown will be determined by the engineer.

TABLE C-35. WASHINGTON STATE DOT, ALLOWABLE JMF TOLERANCE LIMITS & WEIGHTING FACTORS USED IN COMPUTING COMPOSITE PAY FACTOR

Constituent of Mixture	Tolerance Limits	Weighing Factor "f"
Aggregate passing 1", 3/4", 5/8", 1/2" & 3/8" sieves	Broad band specification limits of Table B-36	2
Aggregate passing 1/4" sieve	± 6%	6
Aggregate passing No.10 sieve	± 5%	10
Aggregate passing No.40 sieve	± 4%	6
Aggregate passing No.200 sieve	± 2.0% (see Note 1)	20
Asphalt cement	± 0.5% (see Note 2)	52

Note 1: 2.0% if less than 50% RAP, 2.5% for 50% RAP or more.
Note 2: 0.5% if less than 20% RAP, 0.7% if over 20% but less than 50% RAP, 1.0% if 50% or greater RAP.

TABLE C-36. WASHINGTON STATE DOT, AGGREGATE GRADATION REQUIREMENTS

Sieve Size	Percent Passing by Weight				
	Class B	Class D	Class E	Class F	Class G
1 1/4" square	---	---	100	---	---
1" square	---	---	90 - 100	---	---
3/4" square	---	---	---	100	---
5/8" square	100	---	67 - 86	---	---
1/2" square	90 - 100	100	60 - 80	80 - 100	100
3/8" square	75 - 90	97 - 100	---	---	97 - 100
1/4" square	55 - 75	---	40 - 62	45 - 78	60 - 88
U.S. No. 4	---	30 - 50	---	---	---
U.S. No. 8	---	5 - 15	---	---	---
U.S. No. 10	32 - 48	---	25 - 40	30 - 50	32 - 53
U.S. No. 40	11 - 24	---	10 - 23	---	11 - 24
U.S. No. 200[a]	3.0 - 7.0	2.0 - 5.0	2.0 - 9.0	2.0 - 8.0	3.0 - 7.0

a For asphalt concrete classes B, E, F, and G produced using recycled asphalt materials and placed in areas other than the wearing course of the traveled lane, the gradation for the U.S. No. 200 sieve is revised as follows: 8.0% for 50% to 60% recycled material, and 9.0% for 61% to 70% recycled material.

TABLE C-37. WASHINGTON STATE DOT, PAY FACTORS

Pay Factor	Required Quality Level for a Given Sample Size and a Given Pay Factor														
	Sample Size														
	3	4	5	6	7	8	9	10-11	12-14	15-18	19-25	26-37	38-69	70-200	> 200
1.05	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.04	90	91	92	93	93	93	94	94	95	95	96	96	97	97	99
1.03	80	85	87	88	89	90	91	91	92	93	93	94	95	96	97
1.02	75	80	83	85	86	87	88	88	89	90	91	92	93	94	95
1.01	71	77	80	82	84	85	85	86	87	88	89	90	91	93	94
1.00	68	74	78	80	81	82	83	84	85	86	87	89	90	91	93
0.99	66	72	75	77	79	80	81	82	83	85	86	87	88	90	92
0.98	64	70	73	75	77	78	79	80	81	83	84	85	87	88	90
0.97	62	68	71	74	75	77	78	78	80	81	83	84	85	87	89
0.96	60	66	69	72	73	75	76	77	48	80	81	83	84	86	88
0.95	59	64	68	70	72	73	74	75	77	78	80	81	83	85	87
0.94	57	63	66	68	70	72	73	74	75	77	78	80	81	83	86
0.93	56	61	65	67	69	70	71	72	74	75	77	78	80	82	84
0.92	55	60	63	65	67	69	70	71	72	74	75	77	79	81	83
0.91	53	58	62	64	66	67	68	69	71	73	74	76	78	80	82
0.90	52	57	60	63	64	66	67	68	70	71	73	75	76	79	81
0.89	51	55	59	61	63	64	66	67	68	70	72	73	75	77	80
0.88	50	54	57	60	62	63	64	65	67	69	70	72	74	76	79
0.87	48	53	56	58	60	62	63	64	66	67	69	71	73	75	78
0.86	47	51	55	57	59	60	62	63	64	66	68	70	72	74	77
0.85	46	50	53	56	58	59	60	61	63	65	67	69	71	73	76
0.84	45	49	52	55	56	58	59	60	62	64	65	67	69	72	75
0.83	44	48	51	53	55	57	58	59	61	63	64	66	68	71	74
0.82	42	46	50	52	54	55	57	58	60	61	63	65	67	70	72
0.81	41	45	48	51	53	54	56	57	58	60	62	64	66	69	71
0.80	40	44	47	50	52	53	54	55	57	59	61	63	65	67	70
0.79	38	43	46	48	50	52	53	54	56	58	60	62	64	66	69
0.78	37	41	45	47	49	51	52	53	55	57	59	61	63	65	68
0.77	36	40	43	46	48	50	51	52	54	56	57	60	62	64	67
0.76	34	39	42	45	47	48	50	51	53	55	56	58	61	63	66
0.75	33	38	41	44	46	47	49	50	51	53	55	57	59	62	65
Reject	Quality levels less than those specified for a 0.75 Pay factor.														

TABLE C-38. WEST VIRGINIA DOT, ADJUSTMENT OF CONTRACT PRICE FOR PAVEMENT DENSITY NOT WITHIN TOLERANCE

Percent of Lot Within Tolerance	Percent of Contract Price to be Paid
85 to 100	100
80 to 85	98
75 to 80	97
70 to 75	93
Less than 70	See Note 1

Note 1: The Department will make a special evaluation of the material and determine the appropriate action.

TABLE C-39. WEST VIRGINIA DOT, AGGREGATE GRADATION TOLERANCE LIMITS & MULTIPLICATION FACTORS

Sieve Size	Plant Mix Tolerances	Multiplication Factor (M)
2"	---	1
1 1/2"	± 7	1
1"	---	1
3/4"	± 7	1
1/2"	± 7	1
3/8"	± 5	1
No. 4	± 5	1
No. 8	± 5	1
No. 16	± 5	1
No. 30	---	1.5
No. 40	---	1.5
No. 50	± 4	1.5
No. 100	---	2.0
No. 200	± 3	2.5

TABLE C-40. WEST VIRGINIA DOT, PRICE ADJUSTMENT FOR AGGREGATE GRADATION

Degree of Nonconformance[a]	Adjusted Unit Price
0.0 - 2.0	100
2.1 - 4.0	98
4.1 - 6.0	97
6.1 - 8.0	93
8.1 - 9.1	90
Greater than 9.1	See Note 1

a The total measure of the nonconformance is the sum of the nonconformances on the various sieves which would be written thus: $\Sigma M(L-X_4) + \Sigma M(X_4-U)$, where Σ is a symbol which means summation, L is the lower limit of the specification, U is the upper limit of the specification, X_4 is the particular average which is nonconforming and M is the multiplication factor assigned to the particular sieve on which the nonconformance occurs.

Note 1: Make special evaluation of the material and determine appropriate action.

TABLE C-41. WEST VIRGINIA DOT, PRICE ADJUSTMENT FOR AC CONTENT

QU or QL (See Note 1)	Percent Contract Price to be Paid
0.0	100
0.1	95
0.2	90
Greater than 0.2	See Note 2

Note 1: The degree of nonconformance is determined as follows:

When X_4 is greater than the PMF: $Q_U = X_4 - UL$

When X_4 is less than the PMF: $Q_L = LL - X_4$

Where:

X_4 = Moving average of four individual test results;
R_4 = Range of the last four individual test results;
UL = Upper Tole ance Limit = PMF + 0.6 - 0.45 R_4;
LL = Lower Tolerance Limit = PMF - 0.6 + 0.45 R_4;
PMF = Plant mix formula.

When the moving average falls outside of the tolerance limits as described above, then the sublot of material represented is considered to be nonconforming. When a lot of material is nonconfo ming, then the last sublot contained shall have its price reduced in accordance with the above schedule.

Note 2: Make special evaluation of the material and determine appropriate action.

APPENDIX D

NAMES AND ADDRESSES OF RESPONDENTS TO SURVEY

TABLE D-1. NAMES, ADDRESSES, AND PHONE NUMBERS OF RESPONDENTS

Agency	Respondent Name	Address	Phone No.
Arizona	August Hardt Deputy State Engineer	Arizona DOT Highway Operations Group 206 S. 17th Avenue Phoenix, AZ 85007	(602) 255-8274
Colorado	Robert Clevenger Chief Engineer	Colorado DOT 4201 E. Arkansas Ave. Denver, CO 80222	(303) 757-9011
Connecticut	Charles Dougan Director of Research & Materials	Connecticut DOT Bureau of Highways 24 Wolcott Hill Road Wethersfield, CT 06109	(203) 258-0372
Florida	Lawrence L. Smith State Materials Engineer	Florida DOT 2006 N.E. Waldo Road Gainesville, FL 32062	(904) 372-5304
Georgia	Ronald Collins Bituminous Materials Engineer	Georgia DOT 15 Kennedy Drive Forest Park, GA 30050	(404) 363-7569
Indiana	D. W. Lucas Chief Engineer	Indiana DOT State Office Bldg. 100 N. Senate Ave. Indianapolis, IN 46204	(317) 232-5523
Iowa	Roderick W. Monroe Bituminous Materials Engineer	Iowa DOT 800 Lincoln Way Ames, IA 50010	(515) 239-1003
Kansas	L. S. Ingram Chief of Materials & Research	Kansas DOT Docking State Office Bldg. Topeka, KS 66612	(913) 296-3566
Kentucky	Larry Epley Materials Engineer	Kentucky DOT Frankfort, KY 40622	(502) 564-3160
Mississippi	J. H. Cruse Assistant Materials Engineer	Mississippi State Highway Dept. P.O. Box 1850 Jackson, MS 39215	(601) 352-1174
Nebraska	Laird E. Weishahn Bituminous Materials Engineer	Nebraska DOT P.O. Box 94759 Lincoln, NE 68509	(402) 479-4675
New Jersey	Fred Lovett Materials Engineer	New Jersey DOT 1035 Parkway Ave., CN 600 Trenton, NJ 08625	(609) 292-4758
New York	William A. Snyder Materials Engineer	New York State DOT 1220 Washington Ave. Albany, NY 12232	(518)457-4582

TABLE D-1 (continued). NAMES, ADDRESSES, AND PHONE NUMBERS OF RESPONDENTS

Agency	Respondent Name	Address	Phone No.
Oregon	Kenneth E. Husby Manager, Office of Operations	Oregon DOT 2950 State Street Salem, Oregon 97301	(503) 378-6528
Pennsylvania	William R. Moyer Chief Engineer	Pennsylvania DOT Harrisburg, PA 17120	(717) 787-5610
South Carolina	Robert L. White State Highway Engineer	South Carolina DOT 955 Park Street Columbia, SC 29202	(803) 737-1350
Tennessee	Wayburn Crabpree Assistant Director for Construction	Tennessee DOT 700 James K. Polk Bldg. Nashville, TN 37219	(615) 741-2831
Virginia	William E. Winfrey Materials Engineer	Virginia DOT 1401 E. Broad Street Richmond, VA 23219	(804) 737-7731
Washington	Jim Walter Materials Engineer	Washington State DOT Transportation Bldg., KF-01 Olympia, Washington 98504	(206) 753-6005
West Virginia	Gary L. Robson Materials Engineer	West Virginia DOT State Capitol Complex, Bldg 5 Charleston, WV 25305	(304) 348-5338

APPENDIX E

SAMPLE LETTERS OF RESPONSE TO SURVEY

ARIZONA DEPARTMENT OF TRANSPORTATION

HIGHWAYS DIVISION

206 South Seventeenth Avenue Phoenix, Arizona 85007

ROSE MOFFORD
Governor

CHARLES L. MILLER
Director

THOMAS A. BRYANT II
State Engineer

July 9, 1990

RECEIVED
JUL 19 1990
ASST. DIRECTOR
OPERATIONS

Mr. S.C. Byers, P.E.
Assistant Director - Operations
Oklahoma Department of Transportation
200 N.E. 21st Street
Oklahoma City, Oklahoma 73105-3204

RE: End Product Asphaltic Concrete

Dear Mr. Byers:

Enclosed are two documents sent in response to your June 26, 1990 letter to Tom Bryant concerning Quality Control and Quality Assurance programs. The first document, Review of ADOT's Quality Assurance Asphaltic Concrete Specifications, by Jon Epps of the University of Nevada, Reno, is a study of our present specification acceptance tolerances. The study was performed on data obtained through the use of our end product asphaltic concrete specifications and indicated our existing tolerances could be tightened. The second document is a draft of our revised end product asphaltic concrete specification which is to be implemented this fall.

ADOT has used the end product asphaltic concrete specification since 1984 with extensive use starting in 1988. Presently, we have over 3 million tons of asphaltic concrete placed using the specification. Our specification is quite different from Oklahoma's in the method of determining pay factors so a direct comparison of the two specifications is very difficult. ADOT's experience with our end product asphaltic concrete specification has thus far been very positive. The vast majority of our A.C. paving is now done with this specification.

Please feel free to contact me at (602) 255-8274 to discuss this information further.

Sincerely,

AUGUST V. HARDT
Deputy State Engineer
Highway Operations Group

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JUL 19 1990
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OPERATIONS

DKC:cnh
Enclosures

HIGHWAYS • AERONAUTICS • MOTOR VEHICLE • PUBLIC TRANSIT • ADMINISTRATIVE SERVICES • TRANSPORTATION PLANNING

STATE OF COLORADO

DEPARTMENT OF HIGHWAYS

4201 East Arkansas Ave.
Denver, Colorado 80222
(303) 757-9011

July 5, 1990

Mr. S. C. Byers, P.E.
Assistant Director-Operations
Oklahoma Depart ent of Transportation
200 N.E. 21st. Street
Oklahoma City, Oklahoma 73105-3204

Dear Mr. Byers:

This letter is in response to your letter of June 26, 1990, in which you requested information regarding Colorado's experience with statistically based acceptance specifications.

Colorado adopted a statistically based acceptance specification in 1971. This specification included all of the materials items and has been used on all projects. After nineteen years of successful use, we have a high degree of confidence in this specification. (copy attached - see attachment A)

A more contemporary approach to statistically based acceptance is the Quality Level Analysis concept. Using this system, the estimated percent compliance to a specification can be calculated. We are now considering this type of specification as it has some obvious advantages over our current approach. One of the major enhancements of this specification is an incentive/disincentive provision. I have attached a copy of this specification for your information. (see attachment B)

We are also starting to require the contractor to conduct his own quality control testing. Our QC/QA specification is very complete in that it includes all of the ateria s items over which the contractor has control of the process. We have this QC/QA specification in approximately twelve projects which will be constructed this season. (copy attached - see attachment C)

If you need additional information please write or call our Materials Branch: Mr. Leo O'Connor, Phone (303) 757-9449.

Sincerely,

Robert L Clevenger

ROBERT L. CLEVENGER
Chief Engineer

attachments

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JUL 16 1990
ASST. DIRECTOR
OF ...S

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

24 WOLCOTT HILL ROAD, P.O. DRAWER A
WETHERSFIELD, CONNECTICUT 06109-0801

Phone: (203) 258-0372
OFFICE OF RESEARCH AND MATERIALS

July 13, 1990

Mr. S. C. Byers, P.E.
Assistant Director-Operations
State of Oklahoma
Department of Transportation
200 N.E. 21st Street
Oklahoma City, Oklahoma 73105-3204

Dear Mr. Byers:

Subject: Quality Control-Quality Assurance Program (QC-QA)

Your letter dated June 26, 1990, addressed to Mr. Edmund J. Mickiewicz on the subject, has been forwarded to me for a response.

Enclosed is a copy of a report titled "Implementation of Statistical Specifications for the Control of Bituminous Concrete - Report V, Final Report." This report summarized several years of experience with statistically based specifications which were employed in several experimental projects. Subsequently, these specifications were incorporated into our standard materials specifications. A copy of our current version of these specifications is enclosed also.

It is a pleasure to be of assistance, and I trust the information supplied will help you with your study. If you have any questions or require additional information, please contact Mr. Keith R. Lane, Assistant Director, Division of Materials Testing, at this Office. His telephone number is (203) 258-0321.

RECEIVED
JUL 17 1990
DIRECTOR
...RATIONS

Very truly yours,

Charles E. Dougan

Charles E. Dougan, Ph.D, P.E.
Director of Research and Materials
Bureau of Highways

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FLORIDA DEPARTMENT OF TRANSPORTATION
BOB MARTINEZ
GOVERNOR
BEN G. WATTS
SECRETARY

(904) 372-5304

State Materials Office
Post Office Box 1029
Gainesville, Florida 32602

July 10, 1990

Mr. S. C. Byers, P. E.
Assistant Director - Operations
State of Oklahoma
Department of Transportation
200 N. E. 21st. Street
Oklahoma City, OK 73105-3204

Dear Mr. Byers:

This letter is in response to your June 26, 1990 letter to Mr. V. G. Marcoux regarding Florida's Quality Assurance Program for Bituminous Concrete.

We have been under a Quality Assurance Specification since January 1978 and are very pleased with its results to date. Although we now consider our program very successful, we also had some difficulties during the early days of its implementation and we understand your concerns.

As you requested, we are sending you the following information on our Quality Assurance Program:

1. Sections 330 & 331 of our Standard Specifications for Road and Bridge Construction.

2. Two variability studies which were used to establish within-laboratory and between-laboratory variability for our Quality Assurance Program.

Hopefully this material will be of some benefit to you as you continue to refine your QC-QA Program. If you have any questions or need further information regarding this matter, please contact myself, G. C. Page or K. H. Murphy at the above number.

Sincerely,

L. L. Smith, P. E.
State Materials Engineer

LLS:mc

Enclosure

cc: V. G. Marcoux
G. C. Page
K. H. Murphy

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JUL 16 1990
ASST. DIRECTOR
OPERATIONS

Department of Transportation
State of Georgia
Office of Materials and Research
15 Kennedy Drive
Forest Park, Georgia 30050-2599

July 9, 1990

Mr. S. C. Byers, P.E.
Assistant Director - Operations
Oklahoma Department of Transportation
200 N.E. 21st Street
Oklahoma City, Oklahoma 73105-3204

Dear Mr. Byers:

Subject: **Quality Control - Quality Assurance**

Your June 26, 1990 letter to our State Highway Engineer was referred to me for a response. Thank you for the information which you provided on your new QC-QA Program for asphaltic concrete.

As you requested attached is a copy of our Research Report No. 6908 which reports on the work which was accomplished to develop our statistically based asphaltic concrete control and acceptance procedures. Also attached is a copy of our latest asphaltic concrete specifications.

If you have any questions or would like additional information, you may contact me at (404) 363-7569.

Very truly yours,

Lamar Caylor

Lamar Caylor

LC:dm

Attachment

cc: Stanley Lord

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JUL 13 1990
ASST. DIRECTOR
OPERATIONS

STATE of INDIANA

INDIANAPOLIS

TRANSPORTATION
INDIANA DEPARTMENT OF ~~HIGHWAYS~~
100 North Senate Avenue
Indianapolis, Indiana 46204-2249

Room 1101, State Office Building
317-232-5533

August 6, 1990

S. C. Byers
Assistant Director - Operations
Oklahoma Dept. of Transportation
200 N.E. 21st. Street
Oklahoma City, OK 73105-3204

Dear Mr. Byers:

In response to your inquiry concerning our Quality Control-Quality Assurance program we are enclosing our current Q.A. specifications for bituminous mixtures. Also enclosed are the standard deviations for each of our mixtures from each type of plant and fines collection system. This data was accumulated from 125 Q.A. contracts over the past three years. Our intent is to check these standard deviations each year to assure that our acceptance tolerances are reasonable.

Please call us if you need further information.

Sincerely,

L. E. Shrode

For: D. W. Lucas
Chief Engineer

DWL/RPW/rs

cc: File

Enclosure

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AUG 15 1990
ASST. DIRECTOR
OPERATIONS

STATE OF KANSAS

KANSAS DEPARTMENT OF TRANSPORTATION
Docking State Office Building
Topeka 66612-1568
(913) 296-3566

Horace B. Edwards
Secretary of Transportation

July 25, 1990

Mike Hayden
Governor of Kansas

Mr. S. C. Byers, P.E.
Assistant Director-Operations
Oklahoma DOT
200 N.E. 21st St.
Oklahoma City, Oklahoma

Dear Mr. Byers:

I have been asked to respond to the June 26th letter that you sent to Mr. Lackey, concerning your QC-QA program for asphalt concrete pavements. I have studied the special provision that accompanied the letter with a great deal of interest. We share your concerns as to what the appropriate limits are for setting pay adjustment factors on the various mixture characteristics. To date, KDOT has used QC-QA clauses only on aggregate gradation for plant mixed bituminous pavements. We are currently in the process of incorporating a ride specification for bituminous pavements.

I am attaching a copy of our gradation specification and our ride specification for your reference. The appropriate pay adjustment factors are also included.

We have tabulated the gradation pay adjustments for the various mix types produced for 1989 and for 1990 to date. We analyzed this data to determine if the gradation limits were set appropriately. The values shown below lead us to believe that generally, our gradation limits are properly established. Our BM-1B mix type has a higher non-compliance rate than the overall average of all mix types. We are reviewing this mix to determine if we need to adjust the specification limits or wait to see if the hot mix paving industry can improve their QC capabilities. You will note that the BM-1B compliance record for 1990 is significantly better than the 1989 record.

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Year	Mix Type	Total Lots (No.)	Non Complying Lots (No.)	Lots with 100% Pay (%)
89	all	764	90	88
89	BM-1B	139	38	73
90	all	554	55	90
90	BM-1B	93	18	81

We are currently collecting data to determine the variation of the asphalt cement content in our bituminous mixes. We intend to review the data to determine if we have a significant problem. We also hope to determine if establishing a pay factor for asphalt content will solve the problem and if so, what the appropriate limits are.

We have explored the possibility of specifying field density as a percent of theoretical maximum density. One problem we have encountered is determining the appropriate density limits for the wide variety of mix types we use throughout the state. We believe that separate limits will be required for dense graded and gap graded mixes.

I hope the attached information will be of some use to you. If you should have questions or comments, please contact me at your convenience. I will plan to contact you after this construction season to visit about how your special provision is working.

Sincerely,

L. S. INGRAM, P.E.
CHIEF OF MATERIALS AND RESEARCH

LSI:db

cc: W. M. Lackey (Ref. #1237)
J. D. Jones

COMMONWEALTH OF KENTUCKY
TRANSPORTATION CABINET
FRANKFORT, KENTUCKY 40622

MILO D. BRYANT
SECRETARY
AND
COMMISSIONER OF HIGHWAYS

WALLACE G. WILKINSON
GOVERNOR

August 31, 1990

Mr. S. C. Byers, P.E.
Assistant Director - Operations
State of Oklahoma Department of Transportation
200 N. E. 21st Street
Oklahoma City, OK 73105-3204

Dear Mr. Byers:

Thank you for sharing your experiences with Oklahoma's Quality Assurance program. We have been involved with QC-QA since 1978. Our first venture into QC-QA was requiring materials suppliers (aggregate and bituminous hot mix) to furnish Certified Bituminous and Aggregate Technicians. We started this program by permitting the suppliers to furnish Certified Technicians at their own discretion for one construction season. In 1979 this requirement was made mandatory for bituminous hot-mix suppliers. During 1979-1980 we also developed a pay adjustment schedule for bituminous hot-mix (Extracted Gradation and Asphalt Content). This schedule was developed using historical data and FHWA guidelines that were in effect at that time. However, we were uncomfortable at first with the schedule based on historical data and modified it to the liberal side.

Attached are copies of documents currently in effect concerning QC-QA for Kentucky highway projects. If you have any questions concerning these documents please contact John Hinton or me at 502-564-3160.

Sincerely,

Larry Epley

Larry Epley, P.E., Director
DIVISION OF MATERIALS

LE:abp
cc: John Hinton

SEP 07 [illegible]
ASST. DIRECTOR
OPERATIONS

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[illegible]
Northern District Commissioner

Wayne O. Burkes
Central District Commissioner

Ronnie Shows
Southern District Commissioner

[illegible]
Director

James D. Quin
Chief Engineer

Mississippi State Highway Department / P.O. Box 1850 / Jackson, Mississippi 39215-1850 / FAX (601) 359-2233

June 6, 1990

Mr. S. C. Byers, P. E.
Assistant Director-Operations
State of Oklahoma Department of Transportation
200 N. E. 21st Street
Oklahoma City, OK 73105-3204

Dear Mr. Byers:

In response to your letter of June 26, 1990, attached is a copy of our Hot Plant Mix Specification, Special Provision No. 907-401-49.

We have not made any material variability studies. We use the Compilation of Statistics from the AMRL Reference Sample Program to determine material and testing variability.

In the past, we had a pay schedule very similar to the one in your 411-3QA(a-j) 885. We changed to the enclosed specification with a pay schedule for density. Our current specification seems to have improved the quality of asphalt pavements.

Very truly yours,

J. H. Cruse
Assistant Testing Engineer

JHC/jp

Attachment

cc: Lab File

STATE OF NEBRASKA
DEPARTMENT OF ROADS
KAY A. ORR
GOVERNOR
G. C. STROBEL
DIRECTOR-STATE ENGINEER

July 3, 1990

S. C. Byers, Assistant Director-Operations
Department of Transportation
200 N.E. 21st Street
Oklahoma City, OK 73105-3204

Dear Mr. Byers:

Re: Quality Control - Quality Assurance Program

Enclosed are copies of our statistically based specifications as identified in our 1985 Standard Specifications.

The standard deviation values used in developing of the control charts are as follows:

1. Asphalt Content - 0.15
2. 3/8" sieve - 2.50
3. #4 & #10 sieve - 2.07
4. #50 sieve - 1.50
5. #200 sieve - 0.90

If I can be of further help, don't hesitate to contact me at (402) 479-4675.

Sincerely,

Laird E. Weishahn
Flexible Pavement Engineer

LEW/bt

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JUL 09 1990
ASST. DIRECTOR
OPERATIONS

PO BOX 94759 LINCOLN NE 68509-4759 PHONE (402) 471-4567, FAX (402) 479-4325

State of New Jersey
DEPARTMENT OF TRANSPORTATION
1035 PARKWAY AVENUE
CN 600
TRENTON, NEW JERSEY 08625

THOMAS M. DOWNS
COMMISSIONER

BUREAU OF MATERIALS

IN REPLY PLEASE REFER TO

Pay Adjustment
Specifications

July 31, 1990

S. C. Byers, P. E.
Assistant Director - Operation
Oklahoma Department of Transportation
Oklahoma City, OK 73105-3204

Dear Mr. Byers:

Your letter to Mr. Charles Edson, Assistant Commissioner, has been directed to this office for reply. I have enclosed a copy of our statistically based, pay adjustment specifications for portland cement and asphalt concretes. Your concerns regarding inherent variability on the materials and the testing, may be answered by Mr. Richard Weed of our Research Bureau. Please contact Mr. Weed at (609) 292-7223.

Sincerely,

Fred Lovett
Acting Project Engineer
Bureau of Materials

Enclosure

FL:fel

c C. T. Edson
M. B. Kjetsaa
J. R. Smith
R. Weed

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AUG 06 1990
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GOVERNOR

Department of Transportation
HIGHWAY DIVISION
Office of Operations 378-6528
2950 State Street, Salem, Oregon 97310

In Reply Refer to
File No.
FILE: MAT

July 11, 1990

S.C. Byers, Assistant Director-Operations
Oklahoma Dept. of Transportation
200 NE 21st Street
Oklahoma City, OK 73105-3204

RE: Quality Control-Quality Assurance Program in Oklahoma

Dear Sir:

Thank you for the copy of your QC-QA Special Provision for Asphalt Concrete Pavement. Your inclusion of air voids, stability and smoothness in the pay factors looks interesting.

After some early experimentation we began using statistical A.C. pavement specifications in 1985. A copy of our current Supplemental Standard Specifications are enclosed. In general, Section 402 is for projects up to 5,000 tons and Section 403 for projects over 5,000 tons. Also enclosed is a copy of a 1982 study on the "Impact of Variation in Material Properties on Asphalt Pavement Life".

We believe the uniformity of our A.C. pavements has improved due to the statistical specification. However, because of changed in mix designs, sampling and testing methods and contractor operations the actual improvement is difficult to measure. The contractors put forth a large amount of effort to achieve bonus payment and the statistical specifications have resulted in an average composite pay factor of 1.02.

We hope the enclosed information is of assistance to you and wish you good luck in the process of fine tuning your specifications.

Sincerely,

Kenneth E. Husby

Kenneth E. Husby, P.E., Manager
Office of Operations

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ASST. DIRECTOR OPERATIONS

RMS:mb
M07111.KH

Enclosures

cc: Don Forbes
Bill Anhorn

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
HARRISBURG, PENNSYLVANIA 17120

OFFICE OF
SECRETARY OF TRANSPORTATION

July 26, 1990

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AUG 01 1990
ASST. DIRECTOR
OPERATIONS

S. C. Byers, P.E.
Assistant Director-Operations
Oklahoma Department of Transportation
200 N. E. 21st Street
Oklahoma City, OK 73105-3204

Re: Statistically Based Restrictive Performance Specifications in Pennsylvania

Dear Mr. Byers:

We are forwarding the following information with reference to statistically based Restrictive Performance Specifications (RPS) that are currently in use by the Pennsylvania Department of Transportation.

Pennsylvania initiated the use of RPS in the early 1980's. A proto-type specification was created for bituminous concrete paving, for both binder (base) and wearing (surface) courses, for the 1980 construction season. This specification has been modified numerous times since then. During the mid 1980's, the Department instituted RPS specifications for Portland cement concrete roadway paving. A proto-type RPS specification for Portland cement concrete structures was tried and withdrawn in order that the specification could be modified. In addition, we also have an RPS specification for construction and maintenance aggregates. This aggregate specification has undergone several revisions since it was implemented.

Attached you will find copies of the current specification for bituminous paving, Portland cement concrete roadway paving and the aggregate specification. We have also enclosed a copy of the research which preceded the initial bituminous paving specification. This research report contains material variability studies.

During the initiation phase for all of the RPS specifications we experienced difficulties with the "newness" of the specifications and some problems with the specifications themselves. As the specifications became familiar to Department personnel, contractor and material supplier staffs, we noted that the overall quality of these materials has improved. In fact the payment penalties for bituminous concrete, statewide, have been at or under the level that theoretical statistics would indicate due to the nature of the material.

I trust that this information will assist you and the Oklahoma Department of Transportation as you continue to implement statistically based Restrictive Performance Specifications. Please feel free to contact Robert Miller at (717)787-5610 or Charles Kline at (717)787-4720, or write to them at the above address.

Sincerely,

for William R. Moyer, P.E.
Chief Engineer
Highway Administration

Enclosures

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
NASHVILLE, TENNESSEE 37243-0326

JULY 10, 1990

Mr. S. C. Byers, P.E.
Assistant Director of Operations
Oklahoma Department of Transportation
200 N.E. 21st Street
Oklahoma City, OK 73105-3204

RE: Quality Control - Quality Assurance Program

Dear Mr. Byers:

Attached are Special Provisions No. 407QA and 903QA that are currently being used on selected paving projects in the State of Tennessee.

The Department has used several different "End Result" specifications on selected asphalt paving projects over the past three years, generally with good results.

If I can be any further assistance, please advise.

Sincerely,

Allan S. Ellis
Assistant Director of Construction

ASE:jww

cc: Mr. Lewis Evans

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JUL 13 1990
ASST. DIRECTOR
OPERATIONS

COMMONWEALTH *of* VIRGINIA

DEPARTMENT OF TRANSPORTATION
1401 EAST BROAD STREET
RICHMOND, 23219

RAY D. PETHTEL
COMMISSIONER

JACK HODGE
CHIEF ENGINEER

July 13, 1990

Mr. S. C. Byers, P. E.
Assistant Director-Operations
Oklahoma Department of Transportation
200 N. E. 21st. Street
Oklahoma City, OK 73105-3204

Dear Mr. Byers:

Re: Quality Control-Quality Assurance Program

The Virginia Department of Transportation has been utilizing statistical base quality assurance specifications since 1968 for acceptance of asphalt concrete. In 1976 a task group was formed to develop our current Q. A. Program. Virginia's Q. A. Program is one where the producer performs all the sampling and testing for acceptance, and the Department performs monitor checks to verify the accuracy of the producer's results.

The Q. A. Program was offered to all producers on a volunteer basis in 1978 in the Richmond District which is one of our eight (now nine) construction districts. The materials covered under the program are asphalt concrete mixes, aggregate base, subbase, and select material type I. All central-mixed aggregate producers and most of the asphalt producers elected to participate in the pilot Q. A. Program.

The Q. A. Program was offered to all producers throughout the State on a volunteer basis in 1980, however, participation in the program increased at a disappointing pace.

Effective with projects advertised in December 1983, the Department began requiring all asphalt concrete and central-mixed aggregate to be furnished under the Quality Assurance Specifications.

We are pleased with the program because of the following advantages: (1) Improved product, (2) Reduced variability, (3) Better knowledge of product and process affecting same on the part of the producer, (4) Eliminates fragmented responsibility for quality control and acceptance, (5) Eliminates redundant testing, and (6) It reduces Department personnel.

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TRANSPORTATION FOR THE 21ST CENTURY

We do not know the actual number of the Department man-hours the program has saved or the extra cost charged by the producer for the materials purchased by the Department under the Q. A. Program. The program did eliminate one Department inspector at each active plant.

Attached is a copy of our Special Provisions for Asphalt Concrete, Mateials Memorandum, and Virginia Test Method setting forth our requirements, policies, and procedures for the Q. A. Program.

If further information is desired, please call Mr. William E. Winfrey, our State Materials Engineer, at (804) 737-7731.

Sincerely,

J. S. Hodge
Chief Engineer

Enclosure

Washington State
Department of Transportation
Transportation Building KF-01
Olympia Washington 98504-5201
(206) 753-6005

Duane Berentson
Secretary of Transportation

July 16, 1990

Mr. S. C. Byers
Assistant Director-Operations
Department of Transportation
200 N. E. 21st Street
Oklahoma City, OK 73105-3204

RE: Quality Control-Quality Assurance Programs

Dear Mr. Byers:

Enclosed, per your request, is a copy of our quality assurance specification for Asphalt Concrete Pavement. This specification was initially used in 1988 on a trial basis on 5 projects. Its success led to the implementation of this specification as a General Special Provision pending incorporation into our 1991 Standard Specifications book. The enclosure is a draft of the standard specification change.

Also enclosed is a copy of the draft Model Quality Assurance Specification which has been developed over the past year by a WASHTO Task Force set up as a regional pooled fund study. Washington is the lead state for this pooled fund which includes the states of Arizona, Colorado, South Dakota, Montana, Nevada New Mexico, and Wyoming. Copies of this draft were sent in early June to both the Construction and Materials Engineer in each of the WASHTO states with a request for comments. The task force expects to have a final draft ready for WASHTO Executive Committee review by the end of September. It is not entirely clear at this point when and how this model specification will be distributed.

In reading your letter and looking at your specification, it is apparent that our approach is somewhat different from yours with regard to the general philosophy of setting targets. Our approach is to specify to the contractor the end product and then put in a tolerance band which allows for testing variability. Materials variability is a problem that the contractor must solve with his own in-house quality assurance program.

Mr. S. C. Byers
July 12, 1990
Page 2

Our QA specification was developed in close cooperation with the Asphalt Paving Association of Washington. On the 5 trial projects mentioned previously, incentive payments were make for compaction on all 5 projects and incentive payments for asphalt content and gradation on 4 of the 5. We have noted increased contractor concern with quality and quicker corrective action when a problem is discovered. Our test results indicate that we are getting higher quality, more consistent pavements. We expect that this will results in longer lasting pavements and that the value of this longer life will more than compensate for the incentive payments paid to the contractor.

If you have any questions or would like to discuss QA in general my telephone number is (206) 753-7103.

Sincerely,

JOHN R. STRADA
Materials Engineer

JRSkwa

Enclosure

WEST VIRGINIA DEPARTMENT OF HIGHWAYS
State Capitol Complex
Building Five
Charleston, West Virginia 25305

GASTON CAPERTON
GOVERNOR

FRED VANKIRK
ACTING COMMISSIONER
STATE HIGHWAY ENGINEER

July 30, 1990

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AUG 03 1990
ASST. DIRECTOR
OPERATIONS

Mr. S. C. Byers, P.E.
Assistant Director-Operations
Oklahoma Department of Transportation
200 N.E. 21st Street
Oklahoma City, Oklahoma 73105-3204

Dear Mr. Byers:

<u>Your Letter Dated June 26, 1990</u>

The West Virginia Department of Transportation has had for quite some time now what we refer to as a quality assurance system of material acceptance as a part of its specifications.

Quality assurance seems to have many definitions, but we define it, in so many words, as a method of acceptance based on criteria developed to evaluate <u>all</u> input - with the two main subsets being quality control (process control) and acceptance testing. Included in this quality assurance system are pay adjustment provisions.

Briefly, and in this regard, in the middle to late 60's we (the WVDOT) co-sponsored with the U.S. Department of Transportation, the (then) Bureau of Public Roads , a Highway Planning and Research Project (HPRP-18). The projects primary purpose was to develop statistical parameters related to various aspects of quality control of highway materials and construction. This was accomplished by evaluating large numbers of test results on unbiased samples from controlled construction. Tolerance limits necessary to result in a satisfactory finished product were then defined.

We realized that material and processes were variable (some more than others) and for a specification to be realistic it must allow for these variations - not only the inherent variations, but those caused by sampling and testing as well.

The advantages of this type of research over using "historical" records is the controlled assemblage of data. In other words the actual extent of random variation as it really exists is not always available from past "project" data. Especially when you consider what sampling techniques may have been used, or the arbitrary discarding of sample data, etc.

Anyway, most of the tolerance limits we now use were derived from HPRP-18. We know what tolerances are necessary to make a satisfactory product (all other variables considered) and we know what does not; at least to the extent of becoming substandard. In the latter case, the Department takes the appropriate action to compensate for its increased risk and to provide the contractor with some incentive to make the item conform to the acceptable tolerance limits. The logic here is, there can be nonconformances that are minor that would not be expected to affect the performance of an item to the extent that would justify its removal from the roadway. The appropriate action, of course, is the price reduction.

The actual price reduction is based on, for aggregates as an example, what we call the degree of nonconformance. These limits (degree of nonconformance limits) are set at values that we feel are equitable considering the weight of the existing nonconformance. This will become clear when you review the attachments.

I have included with this letter several of the large construction item specifications along with some of the applicable Materials Procedures (MP's). The MP's are used to give guidance to the specification requirements.

In summary, our specification limits are based on parameters developed from controlled research. The actual pay adjustments over these limits are based on what we feel to be equitable and the engineering judgment that deficiencies of certain parameters weigh more heavily on the performance of an item then do deficiencies of another.

If you have any questions concerning our reply and/or the attachments, please let us know.

Very truly yours,

Gary L. Robson, Director
Materials Control, Soil
and Testing Division

GLR:Kp

Attachments

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