WASHTO Model Quality Assurance Specifications

Prepared for

WASHTO Subcommittee on Materials and the
WASHTO Subcommittee on Construction
in cooperation with
United States Department of Transportation
Federal Highway Administration

August 1991

Final Report

WASHTO MODEL QUALITY ASSURANCE SPECIFICATIONS

by

WASHTO QA TASK FORCE

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PREAMBLE

Background

At the 1988 Joint WASHTO Construction/Materials committee meeting in Kalispell, Montana a decision was made to develop a model set of quality assurance specifications that would be applicable to the member states. A Task Force was organized which consisted of representatives from eight of the states, four from the Construction group and four from the Materials group. These same states indicated a willingness to support a pooled fund effort to accomplish this task.

FHWA endorsed the proposed study and a memorandum of support was signed by the Regional Administrators of Regions 6, 8, and 10 on October 11, 1988 for a regional pooled fund study. The regional pooled fund was set up and the first meeting of the Task Force was held on July 18, 1989 in Billings, Montana.

Project Objectives

The objectives of the Task Force were to collect, analyze, and summarize current applications of Quality Assurance programs and specifications in use and proposed by WASHTO States and other selected States and develop a model set of quality assurance specification that would be appropriate for implementation and use by WASHTO States.

Task Force Representation

The Task Force was made up of the following list of state representatives, and Federal Highway Administration representatives. The list also includes a representative from the Washington State Department of Transportation's Research Office which administered the pooled fund study. This person provided staff support to the Task Force.

Construction

Michael Barnes — New Mexico State Highway Department (Chairman)
Jack Bell — Wyoming State Highway Department
Gary Engel — South Dakota Department of Transportation
John Maykuth — Montana Department of Highways

Materials

Frank Abel — Colorado Department of Highways
Doug Forstie — Arizona Department of Transportation
Pete Pradere — Nevada Department of Transportation
John Strada — Washington State Department of Transportation

FHWA

Doyt Bolling — Region 8
Cliff Christianson — Region 10

Jim Erickson — Construction & Maintenance Division*
David Cox — Construction & Maintenance Division*
Donald Tuggle — Construction & Maintenance Division*

Staff Support

Keith Anderson — WSDOT Research Office

Task Force Activities

The Task Force met over a period of 15 months. The process began with an investigation of the use of QA specifications by the seventeen WASHTO states. Sample specifications were collected from each state presently using or in the process of implementing Quality Assurance Specifications. FHWA literature concerning Quality Assurance Specifications were also consulted as resource materials. These were analyzed by the Task Force for ideas that could be incorporated into the model specifications. It was found that Arizona, Colorado, Washington, Montana, Wyoming and the FHWA had QA specifications which were helpful in the development of the model specifications.

The initial investigation of the state-of-the-art in the WASHTO states was followed by discussions which developed the general outline for the model specifications. It was determined that the format would follow AASHTO Guide Specifications For Highway Construction. General information on statistical analysis, pay factors, process quality control guidelines, and acceptance guidelines would be developed separately from the sections dealing with the different materials. The seven sections of the specification are listed below:

1. Inspection and Testing of Materials (Statistical Analysis, Pay Factors and Process Quality Control Guidelines and Acceptance Guidelines)
2. Excavation and Embankment
3. Aggregate Base Course
4. Asphalt Concrete Pavement
5. Portland Cement Concrete Pavement
6. Pipe Culverts
7. Structural Concrete

Each of the seven sections were assigned to small groups of the Task Force members who were responsible developing a draft specification and presenting it at the various meetings. Drafts of the sections were reviewed within the small groups before they were sent to the entire Task Force.

At the conclusion of the fourth meeting of the Task Force a working draft of the model specifications was distributed to each of the 17 WASHTO states for their review and comments. Concurrent with this review, the Model Specifications were presented at the WASHTO 1990 Convention in Reno, Nevada and written feedback was requested. Feedback from distribution of the specifications to the states and the comments received as a result of the convention invitation were reviewed and incorporated into the final document at the final meeting of the Task Force which was held on August 22 and 23, 1990.

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* The FHWA Construction & Maintenance Division only had one representative that was reassigned twice due to job transfers.

Task Force Statement

The task force firmly believes that the Agencies who choose to use Quality Assurance (QA) specifications will benefit in some or all of the following ways:

1. The use of QA Specifications will result in a transfer of the responsibility for quality control to the Contractor.

2. The move toward QA specifications will assure acceptable quality in our present state of diminishing resources in both manpower and money.

3. The money paid out in incentives is more than offset by a more consistent product, a reduction in nonspecification work, and reduced manpower needs.

4. The use of QA specifications will result in an overall improvement in quality.

5. The Agency will be able to plan and more efficiently use its limited available manpower.

6. The use of QA specification will result in less contractor claims.

7. Agency testing costs will be minimized due to the possible elimination of field test labs and reduction of test personnel.

8. The WASHTO States that have used QA specifications and have realized some or all of these benefits include Arizona, Colorado, Montana, Utah, Wyoming, Washington, Oregon, Oklahoma, and Texas.

IMPLEMENTATION

Implementation of Quality Assurance Specifications is a major change in the way that State Highway Agencies have historically operated. As with any change there may be resistance both within and outside the organization. The Quality Assurance Specifications provided herewith are intended as a guide for State Highway Agencies to follow in developing their own specifications. Modification will be required to fit the individual agencies needs, conditions, and performance history. Modifications should be done with care to avoid inconsistent and conflicting requirements. Also, caution must be exercised so that current method type specifications are not mixed with Quality Assurance Specifications which would compromise the effectiveness of either program. Changes in one part may require changes in others. It is important that representatives of the construction industry are involved in the development of Quality Assurance Specifications. The construction industry will be able to adjust to the conceptual change if the Quality Assurance Specifications are reviewed, discussed, and in some cases, adjusted prior to implementation.

A State Highway Agency should utilize a transition period in order to implement Quality Assurance Specifications. The use of Quality Assurance Specifications necessitate that contractors/suppliers develop a Process Quality Control Program to monitor, evaluate, and control the work product(s). The development of Process Quality Control Programs should be initiated prior to the issuance and use of Quality Assurance Specifications by the Agency. The use of trial projects to evaluate and modify the specifications should prove to be beneficial to the agency in obtaining acceptance of change. In developing and letting trial projects the State Highway Agency may choose to have pre-bid conferences and require that prospective bidders attend such conferences. The use of pre-bid conferences allows the State Highway Agency to clearly state to the prospective bidders the intent of the specifications and the need to have a Process Quality Control Program. Other issues such as technician qualification, accreditation of testing laboratories, and incentives-disincentives may be discussed and fully outlined at this pre-bid meeting.

The State Highway Agency must exercise caution in the use of historical data in the development and implementation of Quality Assurance Specifications. Test result information from method specifications by nature will be biased. The State Highway Agency should consider utilizing the recommended acceptance criteria and the pay factor table included within these model Quality Assurance Specifications. The State Highway Agency will then be able to develop a data base which can be evaluated to ensure that the specification limits are appropriate.

Training is the single most important issue which an agency will address during implementation. It is imperative that appropriate training seminars are developed and utilized to assure that the Quality Assurance Specifications are understood and appropriately applied by the agency's personnel. Any specification requirements which require contractor technician qualifications will necessitate that agency technicians are similarly qualified. Training should be developed to address the qualification requirements. The Agency should work in cooperation with industry representatives to assure that the technicians responsible for the contractor's Process Quality Control receive the necessary training to assure quality work.

A quality assurance program must also be maintained by the Agency which chooses to use QA specifications. This program should include elements such as calibration of testing equipment, test methods, independent assurance testing and witnessing, correlation testing, and certification of testing personnel. Again, the importance of industry involvement in development and implementation is strongly emphasized to assure a successful program.

EVALUATION AND FEEDBACK

Permanent records should be maintained on the results of all acceptance testing. This data should be statistically analyzed annually to guarantee that upper and lower specification limits are appropriate. Desirable specification limits minimize both the "buyer's risk" and the "seller's risk" while still assuring acceptable performance. Pay factors should be reviewed to assure that "incentive-disincentive" amounts are fair and equitable to all parties involved. The analysis of test data must be accomplished by a person who is not only a qualified statistician but is also knowledgeable in highway construction practice.

Statistical data gathered during acceptance testing provides not only a means of acceptance of and payment for materials produced, but also provides a data base of "as constructed" information that can be utilized in management information systems such as pavement management, maintenance management, and highway performance monitoring systems as well as for failure analysis in the event of premature failure. The information also provides a readily available means of evaluating the production capabilities and relative performance levels of contractors.

By continually monitoring the quality of the contractor's work through acceptance testing and statistically analyzing the results of these tests on an annual basis, specification limits and pay factors can be maintained which will assure that quality work is produced and that payment made for acceptable work within specified limits is fair and equitable.

106.03 Inspection and Testing of Materials

(a) *General.* All materials are subject to inspection, sampling, and testing at any time before acceptance of the work.

A reference in the contract to a (Insert Agency) Test Method, a Federal specification, a specification or test designation of the American Association of State Highway and Transportation Officials (AASHTO), the American Society for Testing and Materials (ASTM), or any other recognized national organization, shall mean the latest revision of the specification or test designation in effect on the day the advertisement for bids for the work is dated unless otherwise designated.

Materials will be sampled and tested by a representative of the Agency unless otherwise specified in the special provisions. Copies of all test results will be furnished to the Contractor's representative at the Contractor's request. The Contractor shall not rely on results of Agency testing being available for Process Quality Control.

The Contractor may observe the Agency's sampling and testing. If a deviation from the specified sampling or testing procedures is observed, the Contractor shall describe the deviation to the Engineer's designated representative immediately and document the deviation in writing within 24 hours.

(b) *Acceptance Sampling and Testing.* Items designated for acceptance under Quality Assurance (QA) provisions will be randomly sampled and tested in accordance with the recommended acceptance guidelines (see Table 106-4). Samples may also be taken any time the material appears defective or when the Engineer determines that a change in the process or product has occurred.

Acceptance tests will govern in all cases for determination of pay factors without regard to quality control tests.

106.04 Contractor Process Quality Control. The Contractor shall provide process control adequate to produce work of acceptable quality. The Contractor shall perform process control sampling, testing, and inspection during all phases of the work at a rate sufficient to assure that the work conforms to the contract requirements (see Table 106-3).

The Engineer will not sample or test for process quality control or assist in controlling the Contractor's production operations. The Contractor shall provide personnel and testing equipment capable of providing a product which conforms to specified requirements. Continual production of nonconforming work at a reduced price, in lieu of adjustments to bring work into conformance, is not allowable.

Note: The following is a guide for use by individual Agencies who wish to require Contractor process quality control system.

(a) *Contractor Process Quality Control Plan.* The Contractor shall provide and maintain a Process Quality Control Plan, hereinafter referred to as the "Plan", including all the personnel, equipment, supplies, and facilities necessary to obtain samples, perform tests, and otherwise control the quality of the product to meet specified requirements.

The Contractor shall be prepared to present and discuss, at the pre-construction conference, quality control responsibilities for specific items as included in the contract. The Contractor shall submit the Plan for the appropriate items to the Engineer for approval a minimum of ten working days prior to the

start of related work. The Contractor shall not start work on the subject items without an approved Plan. Partial payment will not be made for materials subject to specific quality control requirements without an approved Plan. The approval process for the Contractor's Plan may include inspection of testing equipment and a sampling and testing demonstration by the Contractor's technician(s) to assure an acceptable level of performance.

The Contractor shall certify in writing to the Engineer that the testing equipment to be used is properly calibrated.

(b) *Quality Control Laboratory*. All Contractor process quality control testing under the Plan shall be performed by qualified technicians in laboratories meeting Agency requirements.

Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Engineer shall be permitted unrestricted access to inspect and review the Contractor's laboratory facility. The Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. Deficiencies shall be grounds for the Engineer to order an immediate stop to incorporating materials into the work until deficiencies are corrected.

Note: Each Agency should establish requirements for testing laboratories based on their needs and the facilities available. See Appendix A for an example.

(c) *Plan Administration and Technician Qualifications*. The Plan shall be administered by a qualified individual.

The individual administering the Plan must be a full-time employee of or a consultant engaged by the Contractor. The individual shall have full authority to institute any and all actions necessary for the successful operation of the Plan. This individual may supervise the Plan on more than one project if the job site is within one hour of the other projects.

Process Control Technicians (PCT) and Quality Control Technicians (QCT) performing the actual sampling, testing, and inspection shall be qualified.

Note: Each Agency may set minimum qualifications for the Plan Administrator and for technicians. See example in Appendix B and C.

(d) *Sampling*. The Plan shall contain a system for sampling that assures all material being produced has an equal chance of being selected for testing. The Engineer shall be provided the opportunity to witness all sampling.

When directed by the Engineer, the Contractor shall sample and test any material which appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or corrected by the Contractor. All sampling shall be in accordance with Agency, AASHTO, or ASTM procedures.

(e) *Testing*. All testing shall be performed in accordance with the acceptance test procedures applicable to the specified contract items or other methods set forth in the approved Plan. Should acceptance test procedures not be applicable to quality control tests, the Plan shall stipulate the test procedures to be utilized. The Contractor shall provide copies of all test results upon request on forms meeting the approval of the Engineer.

(f) *Records*. The Contractor shall maintain complete records of all process quality control tests and inspections. The records shall be available to the Engineer for review and copies furnished upon request.

Control Charts acceptable to the Engineer shall be maintained and kept current at a location satisfactory to the Engineer. As a minimum, the Control Charts shall identify the project number, the contract item number, the test number, each test parameter, the upper and lower specification limit applicable to each test parameter and the Contractor's test results. The Contractor shall use the Control Charts as part of a process control system for identifying production and equipment problems and for identifying pay factor reductions before they occur.

(g) *Payment.* When a contract pay item for Contractor Process Quality Control is provided, the Contractor will be paid the contract lump sum amount bid according to the following partial payment schedule.

1. Twenty-five percent of the contract lump sum bid amount or one-half percent of the original contract amount, whichever is less, when the quality control plan is approved.
2. The remaining portion of the contract lump sum bid amount will be paid on a prorated basis according to total job progress.

Payment will be full compensation for providing and maintaining the approved quality control plan and performing all sampling, testing, and inspections in conformance with requirements of the contract. Failure of the Contractor to provide properly documented test results in a timely manner will be justification for withholding progress payments or portions thereof.

106.05 Evaluation of Materials for Acceptance. Material specified to be sampled and tested on a Quality Assurance (QA) basis will be evaluated for acceptance in accordance with this Subsection. All acceptance test results for a lot as defined in Table 106-4, will be analyzed collectively and statistically by the Quality Level Analysis — Standard Deviation (Specification Conformance Analysis) Method using the procedures listed to determine the total estimated percent of the lot that is within specification limits. Quality Level Analysis (Specification Conformance Analysis) is a statistical procedure for estimating the percent compliance to a specification and is affected by shifts in the arithmetic mean (X) and by the sample standard deviation (s). Analysis of test results will be based on an Acceptable Quality Level (AQL) of 95.0 and a contractor's risk of 0.05, unless otherwise specified. AQL may be viewed as the lowest percent within the specification limits of a material that is acceptable as a process average and receive 100% pay. The contractor's risk is the probability that when the Contractor is producing material at exactly the AQL, the materials will receive less than a 1.00 pay factor.

Note: At the individual Agency's preference, the pay factor used for adjustment of contract unit prices may be either: (1) the lowest pay factor of all of the indicated properties, or (2) a composite pay factor. The assigned weights and/or incentive payments for the various properties must be determined by the individual Agency according to what they consider to be the most important material properties with regard to benefits expected, such as durability, strength, pavement life, etc. The model specifications only address the composite pay factor method. It was felt that the lowest pay factor method decreases the Contractors incentive to produce a better quality product.

As an incentive to produce quality material, a pay factor greater than 1.00 may be obtained. The maximum pay factor obtainable is 1.05.

Note: The above paragraph should be deleted by Agencies where statute or regulation prohibits incentive payment.

A lot containing non-specification material (less than 1.00 pay factor) may be accepted provided the pay factor is at least 0.75 and there are no isolated defects

identified by the Engineer. A lot may be terminated by the Engineer and the material in the shortened lot paid for at a reduced pay factor or the Engineer may order the non-specification material removed.

A lot containing non-specification material that fails to obtain at least a 0.75 pay factor will be rejected. The Contractor may submit a written request for acceptance of the material at a reduced price or approved correction. Such request shall include an engineering analysis showing expected effects on performance. The Engineer will determine whether or not the material may remain in place at the price reduction.

Note: Any lot for which at least three samples have been obtained and which meets the following criteria will receive at least a 1.00 pay factor if:

All test results are within the allowable deviations specified for the item, and

All test results are greater than or equal to a minimum specification limits, or

All test results are less than or equal to a maximum specification limit, whichever is appropriate.

This is a practical modification which may slightly reduce the Contractor's risk.

Computation of the Quality Level in these instances will determine the amount of any quality incentive.

Note: The above paragraph should be modified if quality incentive payments are not allowed.

If less than three samples have been obtained at the time a lot is terminated, the material in the shortened lot will be included as a part of an adjacent lot at the pay factor computed for that revised lot.

The Engineer may reject material which appears to be defective based on visual inspection. Such rejected material shall not be used in the work.

No payment will be made for the materials rejected by the Engineer unless the Contractor requests the material be tested. If so requested prior to disposal, three representative samples will be obtained and tested. The tests results will be statistically evaluated. If found to have a pay factor of less than 0.75 or otherwise specified, no payment will be made and the Contractor will bear the cost of the sampling, testing, and evaluation. If the pay factor is 0.75 or as otherwise specified and greater, payment will be made for the materials at the invoice cost plus __% (10% suggested).

(a) *Quality Level Analysis*. Standard deviation method procedures are as follow:

1. Test results on material not incorporated in the work will not be included in the quality level analysis.

2. Determine the arithmetic mean ($\bar{X}$) of the test results:

$$\bar{X} = \frac{\Sigma x}{n}$$

Where: Σ = summation of
x = individual test value to x^n
n = total number of test values

3. Compute the sample standard deviation(s):

$$s = \sqrt{\frac{n\Sigma (x^2) - (\Sigma x)^2}{n(n-1)}}$$

Where: Σx^2 = summation of the squares of individual test values

$(\Sigma x)^2$ = summation of the individual test values squares

4. Compute the upper quality index (Q_U):

$$Q_U = \frac{USL - \bar{X}}{s}$$

Where: USL = upper specification limit or target value (TV) plus allowable deviation.

Target Value = the single specification value which would result in an ideal product as defined by the Agency.

5. Compute the lower quality index (Q_L):

$$Q_L = \frac{\bar{X} - LSL}{s}$$

Where: LSL = lower specification limit or target value minus allowable deviation.

6. Determine P_U (percent within the upper specification limit which corresponds to a given Q_U) from Table 106-1.

Note: If a USL is not specified, P_U will be 100.

7. Determine P_L (percent within the lower specification limit which corresponds to a given Q_L) from Table 106-1.

Note: If an LSL is not specified, P_L will be 100.

8. Determine the Quality Level (the total percent within specification limits).

Quality Level = $(P_U + P_L) - 100$

9. Using the Quality Level from step 8, determine the lot pay factor (PF) from Table 106-2.

10. Determine the Composite Pay Factor (CPF) for each lot.

$$CPF = \frac{[f_1(PF_1) + f_2(PF_2) + \ldots\ldots f_j(PF_j)]}{\Sigma f = 1 \text{ to } j \quad f}$$

Where: f_j = price adjustment factor listed in the specifications for the applicable property.

PF_j = Pay Factor for the applicable property.

Σf = Sum of the "f" (price adjustment) factors.

Note: Numbers used in the above calculations shall be carried to significant figures and rounded according to AASHTO Standard Recommended Practice R-11.

APPENDIX A

Example of Requirements for Contractor Process Quality Control Laboratory

SYSTEM FOR THE EVALUATION OF TESTING LABORATORIES

SCOPE OF THE SYSTEM

The Agency will administer this system of identifying those laboratories that meet the minimum requirements as specified below. The procedure will apply to any laboratory performing testing activities for the Agency. Where so specified, this system also applies to routine Contractor quality control activities and to laboratories developing asphaltic concrete mix designs for Agency construction projects.

AGENCY SYSTEM CRITERIA

The framework for establishing the minimum level of competence is the AASHTO Accreditation Program (AAP) established in March of 1988. The Agency system will consist of the AAP with some additional requirements.

The additional requirements are as follows:

AASHTO ACCREDITATION PROGRAM — ACCREDITATION CRITERIA
Appendix A

A2.2 Personnel Qualification Requirements Are modified to add the following:

Each supervising technician shall be certified by the National Institute for the Certification of Engineering Technologies (NICET) at Level III or above for the field or fields in which he directs or meets one of the following requirements:

a) Registered as a Professional Engineer in the State of _____ with one year of applicable experience that is acceptable to the Agency.

b) Certified as an Engineer-In-Training by the State of _____ with three years of applicable experience that is acceptable to the Agency.

c) Holds a Bachelor of Science Degree in Civil Engineering or an Associate Degree in Civil Engineering Technology with three years of applicable experience that is acceptable to the Agency.

Each working technician shall meet the following requirements:

a) Construction Materials Technician certified at Level II or higher by NICET in appropriate subfield.

b) Construction Materials Technician certified at Level I by NICET if in training and under direct observation of a Level II or Level III technician certified in appropriate subfield.

A5.1 Documentation and Requirements are modified to add the following:

The laboratory shall have and maintain the latest edition of the Agency Materials Testing Manual and it shall be readily accessible to laboratory personnel.

A5.2 Testing Capability Requirements are modified to add the following:

The laboratory shall demonstrate the capability of performing tests according to the latest version of the Agency Materials Testing Manual.

A7 Quality System Requirements are modified to add the following:

Copies of AMRL and/or CCRL proficiency sample test results shall be mailed to the Agency.

Participate in the Agency proficiency sample test program for those materials for which the Agency routinely tests.

The quality system shall include written policy and procedures acceptable to the Agency to assure portable and satellite laboratory facilities are capable of providing testing services in compliance with applicable test methods. These policy and procedures should address inspection and calibration of testing equipment as well as a correlation testing program with the accredited laboratory

The laboratory shall be open for inspection by Agency personnel at any time.

Note: This example is taken from a state where accredited testing laboratories are available and where acceptance is primarily based on end product tests. It may not be appropriate for use where such facilities are not readily available.

APPENDIX B

Example of Optional Requirements for Contractor Process Quality Control Plan Administration

The Plan shall be administered by an individual meeting one of the following requirements:

a) Professional Engineer registered in the State of _____ with one year of highway experience acceptable to the Agency.

b) Engineer-In-Training certified by the State of _____ with two years of highway experience acceptable to the Agency.

c) An individual with three years of highway experience acceptable to the Agency and with a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology or Construction.

d) Construction Materials Technician certified at Level III by NICET.

e) Highway Materials Technician certified at Level III by NICET.

f) Highway Construction Technician certified at Level III by NICET.

g) A NICET certified engineering technician in Civil Engineering Technology with five years of highway experience acceptable to the Agency.

Note: The above should be modified to reflect the needs, conditions, and available personnel in a particular location.

APPENDIX C

Example of Optional Requirements for Process Control Technicians and Quality Control Technicians

The Process Control Technician (PCT) and Quality Control Technician (QCT) performing the actual sampling, testing and/or inspection shall meet one of the following criteria:

a) Construction Materials Technician certified at Level II or higher by NICET in appropriate subfield.

b) Those meeting the criteria for Plan Administrator, if they have a demonstrated proficiency in performing the appropriate test(s) or inspection functions.

c) Construction Materials Technician Trainee under direct observation of an individual listed above.

Table 106-1. Quality Level Analysis by the Standard Deviation Method

PU or PL %*	Upper Quality Index QU or Lower Quality Index QL														
	n = 3	n = 4	n = 5	n = 6	n = 7	n = 8	n = 9	n = 10 to n = 11	n = 12 to n = 14	n = 15 to n = 18	n = 19 to n = 25	n = 26 to n = 37	n = 38 to n = 69	n = 70 to n = 200	n = 201 to n = x
100	1.16	1.50	1.79	2.03	2.23	2.39	2.53	2.65	2.83	3.03	3.20	3.38	3.54	3.70	3.83
99		1.47	1.67	1.80	1.89	1.95	2.00	2.04	2.09	2.14	2.18	2.22	2.26	2.29	2.31
98	1.15	1.44	1.60	1.70	1.76	1.81	1.84	1.86	1.91	1.93	1.96	1.99	2.01	2.03	2.05
97		1.41	1.54	1.62	1.67	1.70	1.72	1.74	1.77	1.79	1.81	1.83	1.85	1.86	1.87
96	1.14	1.38	1.49	1.55	1.59	1.61	1.63	1.65	1.67	1.68	1.70	1.71	1.73	1.74	1.75
95		1.35	1.44	1.49	1.52	1.54	1.55	1.56	1.58	1.59	1.61	1.62	1.63	1.63	1.64
94	1.13	1.32	1.39	1.43	1.46	1.47	1.48	1.49	1.50	1.51	1.52	1.53	1.54	1.55	1.55
93		1.29	1.35	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.46	1.46	1.47	1.47
92	1.12	1.26	1.31	1.33	1.35	1.36	1.36	1.37	1.37	1.38	1.39	1.39	1.40	1.40	1.40
91	1.11	1.23	1.27	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.33	1.33	1.33	1.34	1.34
90	1.10	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.27	1.27	1.27	1.28	1.28	1.28
89	1.09	1.17	1.19	1.20	1.20	1.21	1.21	1.21	1.21	1.22	1.22	1.22	1.22	1.22	1.23
88	1.07	1.14	1.15	1.16	1.16	1.16	1.17	1.17	1.17	1.17	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	1.12	1.12	1.13	1.13
86	1.04	1.08	1.08	1.08	1.08	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	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	1.00	0.99	0.99	0.99
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95
82	0.97	0.96	0.95	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.92	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	0.88	0.88	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	0.84	0.84	0.84	0.84
79	0.91	0.87	0.85	0.84	0.83	0.82	0.82	0.82	0.82	0.81	0.81	0.81	0.81	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	0.78	0.77	0.77	0.77
77	0.87	0.81	0.78	0.77	0.76	0.76	0.76	0.75	0.75	0.75	0.75	0.74	0.74	0.74	0.74
76	0.84	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.71	0.71	0.71	0.71	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	0.68	0.68	0.68	0.67
74	0.79	0.72	0.69	0.68	0.67	0.66	0.66	0.66	0.66	0.65	0.65	0.65	0.65	0.64	0.64
73	0.76	0.69	0.66	0.65	0.64	0.63	0.63	0.63	0.62	0.62	0.62	0.62	0.62	0.61	0.61
72	0.74	0.66	0.63	0.62	0.61	0.60	0.60	0.60	0.59	0.59	0.59	0.59	0.59	0.58	0.58
71	0.71	0.63	0.60	0.59	0.58	0.57	0.57	0.57	0.57	0.56	0.56	0.56	0.56	0.55	0.55
70	0.68	0.60	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.53	0.53	0.53	0.53	0.53	0.52
69	0.65	0.57	0.54	0.53	0.52	0.52	0.51	0.51	0.51	0.50	0.50	0.50	0.50	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	0.47	0.47	0.47	0.47
67	0.59	0.51	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.45	0.44	0.44	0.44	0.44
66	0.56	0.48	0.45	0.44	0.44	0.43	0.43	0.43	0.42	0.42	0.42	0.42	0.41	0.41	0.41
65	0.52	0.45	0.43	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.39	0.39	0.39	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	0.36	0.39	0.36	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	0.34	0.33	0.33	0.33
62	0.43	0.36	0.34	0.33	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	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	0.28	0.28	0.28	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	0.26	0.26	0.25	0.25
59	0.32	0.27	0.25	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.23	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	0.20	0.20	0.20	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	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	0.15	0.15	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	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	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	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	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	0.03	0.03	0.03	0.02
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: For negative values of QU or QL, PU or PL is equal to 100 minus the table value for PU or PL.

If the value of QU or QL does not orrespond exatly to a figure in the table, use the next higher figure.

* Within limits for positive values of QU or QL

Table 106-2. Pay Factors

Pay Factor	Required Quality Level for a Given Sample Size(n) and Given Pay Factor														
	n = 3	n = 4	n = 5	n = 6	n = 7	n = 8	n = 9	n = 10 to n = 11	n = 12 to n = 14	n = 15 to n = 18	n = 19 to n = 25	n = 26 to n = 37	n = 38 to n = 69	n = 70 to n = 200	n = 201 to n = x
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	96	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	78	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	64	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

NOTE: To obtain a given pay factor, the computed Quality Level shall equal or exceed the value in the table.

Delete Pay Factor rows more than 1.0 where quality incentives are not allowed.

TABLE 106-3

MINIMUM PROCESS CONTROL GUIDELINES

ITEM	PROPERTY	TESTING FREQUENCY	TEST METHOD
EMBANKMENT	MOISTURE DENSITY	1 PER 1000 CU. YDS. 1 PER 1000 CU. YDS.	AASHTO T-217/265 AASHTO T-238/191
STRUT. BACKFILL	MOISTURE DENSITY	1 PER FT. OF BACKFILL PER 250 LIN.FT.	AASHTO T-217/265 AASHTO T-238/191
AGGREGATE for BASE, SUBBASE, ASPHALT CONCRETE PCCP, & STRUCTURAL CONCRETE	GRADATION FRACTURE SAND EQUIV. OR ATTERBERG LIMITS	1 PER 1000 TONS 1 PER 1000 TONS 1 PER 1000 TONS 1 PER 1000 TONS	AASHTO T-11 & 27 AGENCY AASHTO T-176 AASHTO T-89 & 90
	MOISTURE	AS NEEDED TO CONTROL OPERATIONS	AASHTO T-217/265
SUBBASE & BASE	MOISTURE DENSITY	1 PER 1000 TONS 1 PER 1000 TONS	AASHTO T-217/265 AASHTO T-238/191
	THICKNESS	AS NEEDED TO CONTROL OPERATIONS	AGENCY
ASHPALT CONCRETE	GRADATION ASHPALT CONTENT VOIDS IN MIX VOIDS IN AGG. DENSITY THICKNESS	1 PER 500 TONS 1 PER 500 TONS 1 PER 500 TONS 1 PER 500 TONS 1 PER 500 TONS AS NEEDED TO CONTROL OPERATIONS	AASHTO T-11 & 27 AASHTO T-164 OR ASTM D4125 AASHTO T-209/269 TAI MS-2 AASHTO T-230 AGENCY
PORTLAND CEMENT CONCRETE PAVEMENT (PCCP)	SLUMP AIR CONTENT	FIRST 3 LOADS PER POUR THEN AS NEEDED TO CONTROL OPERATIONS	AASHTO T-119 AASHTO T-152
	STRENGTH THICKNESS SMOOTHNESS	AS NEEDED TO CONTROL OPERATIONS	AASHTO T-22 & 23 AASHTO T-24 & 148 CALIFORNIA CA-526
STRUCTURAL CONCRETE	SLUMP AIR CONTENT	FIRST 3 LOADS PER POUR PER CLASS OF MIX, THEN AS NEEDED TO CONTROL OPERATIONS	AASHTO T-119 AASHTO T-152
	STRENGTH	AS NEEDED TO CONTROL OPERATIONS	AASHTO T-22 & 23

TABLE 106-4

ACCEPTANCE GUIDELINES

ITEM	PROPERTY	POINT OF ACCEPTANCE	SUBLOT SIZE	LOT SIZE	TEST METHOD
EMBANKMENT	MOISTURE DENSITY	ROADBED ROADBED	2000 CU YD 2000 CU YD	10000 CU YD 10000 CU YD	AASHTO T-217/265 AASHTO T-238/191
EMBANKMENT AT BRIDGE APPROACH (100 FT)	MOISTURE DENSITY	ROADBED ROADBED	500 CU YD	EACH APPROACH	AASHTO T-217/265 AASHTO T-238/191
SUBBASE & BASE	GRADATION FRACTURE S.E. OR ATTERBERG LIMITS	ROADWAY BEFORE COMPACTION	2000 TONS 2000 TONS 2000 TONS	10000 TONS 10000 TONS 10000 TONS	AASHTO T-11& 27 AGENCY AASHTO T-176 AASHTO T-89 & 90
	DENSITY THICKNESS	ROADBED AFTER COMPACTION	2000 TONS 2000 TONS	10000 TONS 10000 TONS	AASHTO T-238/191 AGENCY
ASPHALT CONCRETE	GRADATION ASPHALT CONTENT VOIDS-MIX VOIDS-AGG. DENSITY	ROADWAY BEFORE COMPACTION ROADWAY	1500 TONS 1500 TONS 1500 TONS 1500 TONS 1500 TONS 500 TONS	LOT = MIX DESIGN PER PROJECT	AASHTO T-11&27 AASHTO T-164 or ASTM D4125 AASHTO T-209/269 TAI MS-2 AASHTO T-230
PORTLAND CEMENT CONCRETE PAVEMENT	AIR CONTENT STRENGTH THICKNESS SMOOTH-NESS	AT POINT OF DISCHARGE ON GRADE	4000 SQ YD 4000 SQ YD 4000 SQ YD WHEEL-PATHS EACH LANE	LOT = DAYS PROD. OR 20,000 SQ YDS DAYS PROD.	AASHTO T-152 AASHTO T-22 & 23 AASHTO T-24 & 148 CALIFORNIA CA-526
STRUCTURAL CONCRETE	SLUMP AIR CONTENT STRENGTH	AT POINT OF PLACEMENT	50 CU YDS 50 CU YDS 50 CU YDS	LOT = MIX DESIGN PER STRUCTURE	AASHTO T-119 AASHTO T-152 AASHTO T-22 &23
PIPE CULVERT	MOISTURE DENSITY	AT POINT OF PLACEMENT	EACH LIFT	EACH PLACEMENT	AASHTO T-217/265 AASHTO T-238/191

SECTION 203 - EXCAVATION AND EMBANKMENT

203.01 Description. This work consists of excavation, hauling, disposal, placement, and compaction of all materials necessary for the construction of the roadway.

203.02 Construction Requirements

(a) *Contractor Process Quality Control.*

1. General Requirements. The Contractor shall administer a Process Quality Control Plan sufficient to assure a product meeting the contract requirements. The Plan shall meet the requirements of Subsection 106.04.
2. Elements of the Plan. The Plan shall address all elements which affect the quality of the earthwork including, but not limited to the following:
   a) Moisture
   b) Compaction
   c) Construction of embankments
   d) Conformance to plan profile and cross-section.
3. Personnel Requirements. The Plan shall include the following technician(s):

   Quality Control Technician(s) (QCT) shall utilize test results and other quality control practices to assure that embankments meet the contract requirements. The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation.

   The QCT shall periodically inspect all equipment utilized in the placement, compaction and finishing of embankments to assure it is operating properly and that all earthwork conforms with the contract requirements. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one QCT is required. The Plan shall include the criteria utilized by the QCT to correct or reject unsatisfactory earthwork.

(b) *Other Requirements.* Refer to Agency requirements.

203.03 Acceptance. Earthwork will be sampled on a statistically random basis, tested, and evaluated in accordance with Subsection 106.05(a), Quality Level Analysis, using steps 1 thru 7 only. Table 106-2, Pay Factors, does not apply. See Table 106-4 for acceptance guidelines. Acceptance will be at an 85% quality level with all material below that level reworked. Evaluation of materials will be made using the following limits:

Measured Characteristic	LSL	USL
Moisture	Optimum - 2%	Optimum + 2%
Density	95% Max. Density (AASHTO T-99)	None
Surface Tolerance	TV - .05 ft.	TV + .05 ft.

Note: The ±2% target value (TV) for moisture is for fine grain soils only.

203.04 **Method of Measurement.** Refer to Agency methods.

203.05 **Basis of Payment.** Refer to Agency methods.

SECTION 304 - AGGREGATE BASE COURSE

304.01 Description. This work consists of constructing an aggregate base course on a prepared foundation.

304.02 Materials. Materials shall conform to the requirements specified in the following Subsections.

Aggregate	703.06
Water	714.01
Calcium Chloride	714.02
Sodium Chloride	714.04

Note: Agencies may substitute their own materials requirements.

304.03 Construction Requirements

(a) *Contractor Process Quality Control.*

1. General Requirements. The Contractor shall administer a Process Quality Control Plan sufficient to assure a product meeting the contract requirements. The Plan shall meet the requirements of Subsection 106.04.
2. Elements of the Plan. The Plan shall address all elements which affect the quality of the aggregate bases including, but not limited to the following:
   a) Aggregate Production
   b) Quality of Components
   c) Stockpile Management
   d) Proportioning
   e) Mixing and Processing
   f) Transporting
   g) Placing and Spreading
   h) Compaction
   i) Finishing
3. Personnel Requirements. The Plan shall include the following technicians:
   a) Process Control Technician(s) (PCT) shall utilize test results and other quality control practices to assure the quality of each aggregate material source utilized and adjust and control crushing and/or mixing proportioning to meet the specified material requirements. The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation.

      The PCT shall periodically inspect all equipment utilized in aggregate base production to assure it is operating properly and that all aggregate base produced meet the contract requirements. The Plan shall detail how these duties and responsibilities will be accomplished and documented. The Plan shall include the criteria utilized by the PCT to correct or reject unsatisfactory materials.
   b) Quality Control Technician(s) (QCT) shall perform and utilize quality control tests at the job site to assure that the delivered materials meet the contract requirements. The QCT shall inspect all equipment utilized in mixing, processing, transporting, placing, spreading, compacting, and finishing to assure it is operating properly and that the installation of the aggregate materials conforms with the contract requirements. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one QCT is required. The Plan

shall include the criteria utilized by the QCT to correct or reject unsatisfactory materials.

c) The plan shall detail the coordination of the activities of the PCT and QCT.

(b) *Other Requirements.* Refer to Agency requirements.

304.04 Acceptance. Aggregate base course will be sampled on a statistically random basis, tested, and evaluated in accordance with Subsection 106.05(a), Quality Level Analysis, using steps 1 thru 7 only. Table 106-2, Pay Factors, does not apply. See Table 106-4 for acceptance guidelines. Acceptance will be at an 85% quality level with all material below that level reworked. Evaluation of materials will be made using the following limits:

Measured Characteristic	LSL	USL
Gradation	TV-(Specified by Agency)	TV+(Specified by Agency)
Density	Minimum 95% AASHTO T 180(D)	None
Surface Tolerance	TV - 0.05 ft.	TV + 0.05 ft.

Note: Agencies should establish LSL and USL for the gradations of the various aggregate bases used.

304.05 Method of Measurement. Refer to Agency methods.

304.06 Basis of Payment. Refer to Agency methods.

Note: If pay is to be adjusted in accordance with 106.05, the Agency must establish the factors "f" for gradations of various aggregate bases used. See Subsection 401.06 for an example of the use of these factors.

SECTION 401 - ASPHALT CONCRETE PAVEMENTS

401.01 Description. This work consists of constructing one or more courses of asphalt concrete pavement on a prepared subgrade or base course.

401.02 Materials. Materials shall meet the requirements of the following Sections or Subsections:

Portland Cement	701.01
Asphalt	702.00
Aggregate	703.00
Mineral Filler	703.12
Hydrated Lime	714.03
Fly Ash	714.11
Asphalt Additives	--------

Note: Agencies may substitute their own materials requirements.

(a) *Composition of Mixtures.*

Option 1. Contractor Provided Mix Design. A job-mix formula shall be developed by the Contractor utilizing guidelines provided by the Agency. The job-mix formula shall be developed utilizing aggregate which has been crushed, processed, separated and stockpiled for the project. The mix design gradation shall be within the gradation ranges for the designated grading.

The mix design shall be prepared under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing.

The mix design shall contain as a minimum:

1. The name and address of the testing organization and the person responsible for the mix design testing.
2. The specific location(s) of the source(s) of aggregate.
3. The supplier, refinery, and type of asphalt, and the source and type of portland cement, mineral filler, hydrated line, fly ash, and/or asphalt additive, and the percentages of each to be used.
4. The anticipated aggregate gradation in each stockpile.
5. Mix design gradation.
6. The results of all testing required by the Agency.

The mix design shall be submitted on a laboratory bituminous mixture design form in Agency format and signed by a person authorized to act on the Contractor's behalf.

The Engineer will review and approve or reject the mix design and notify the Contractor in writing within _____ days.

If the Contractor elects to change the source of material(s), or revise the mix design, the Engineer shall be furnished with a new mix design.

Option 2. Agency Provided Mix Design. It is the Contractor's responsibility to ensure that the produced material will provide an asphalt concrete mixture that conforms to the applicable Agency design parameters.

At least_____ days prior to the production of asphalt concrete the proposed job-mix formula shall be submitted to the Engineer for approval and shall include the following:

1. Aggregate samples representing each stockpile.
2. The proposed percentage of each stockpile to be used, the average gradation of each stockpile, and the proposed target value for each sieve size. The target values and the combined average gradation of all the stockpiles when combined in accordance with the Contractor's recommendation shall be within the gradation ranges for the designated grading.
3. Samples of the asphalt proposed for use in the mixture.
4. A temperature-viscosity curve for the asphalt.
5. When applicable, a sample of the portland cement, mineral filler, hydrated lime, fly ash, and/or the asphalt additive proposed.

The Agency will, at no cost to the Contractor, evaluate the proposed job-mix formula and suitability of the materials. If acceptable, a mix design will be developed within Agency requirements.

Should combinations of the Contractor's stockpiles or source of materials change, a new mix design will be required prior to production. Development of the new mix design will require a minimum of _____ days.

Note: The Agency can utilize Option 1 or Option 2.

401.03 Construction Requirements

(a) *Contractor Process Quality Control.*

1. General Requirements. The Contractor shall administer a Process Quality Control Plan sufficient to assure a product meeting the contract requirements. The Plan shall meet the requirements of Subsection 106.04.
2. Elements of the Plan. The Plan shall address all elements which effect the quality of the asphalt concrete including, but not limited to the following:
   a) Mix Design(s)
   b) Aggregate Production
   c) Quality of Components
   d) Stockpile Management
   e) Proportioning
   f) Mixing, including temperature, addition of portland cement,mineral filler, hydrated lime, fly ash, and/or asphalt additive, if required.
   g) Transporting
   h) Placing and Finishing
   i) Joints
   j) Compaction, including Temperature
   k) Smoothness
   l) Thickness, when required.
3. Personnel Requirements. The Plan shall include the following technicians:
   a) Process Control Technician(s) (PCT) shall utilize test results and other quality control practices to assure the quality of aggregates and other mix components and adjust and control mix proportioning to meet the mix design(s). The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation.

      The PCT shall periodically inspect all equipment utilized in proportioning and mixing to assure it is operating properly and that proportioning and mixing is in conformance with the mix design and other contract requirements. The Plan shall detail how these duties and responsibilities will be accomplished and documented. The Plan shall include the criteria utilized by the PCT to reject or correct unsatisfactory materials.

b) Quality Control Technician(s) (QCT) shall perform and utilize quality control tests at the job site to assure that the delivered materials meet the contract requirements. The QCT shall inspect all equipment utilized in transporting, placing, finishing and compacting to assure it is operating properly and that placing, finishing, joint construction, compaction, and thickness, when required, conforms with the contract requirements. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one QCT is required. The Plan shall include the criteria utilized by the QCT to reject or correct unsatisfactory materials.

c) The Plan shall set forth the coordination of the activities of the PCT and QCT.

(b) *Other Requirements*. Refer to Agency requirements.

401.04 Acceptance. Asphalt concrete pavement will be sampled on a statistically random basis, tested, and evaluated in accordance with Subsection 106.05. See Table 106-4 for acceptance guidelines. Evaluation of materials will be made using the following limits:

Measured Characteristic	LSL	USL
Gradation		
3/8 inch sieve	TV - 6.0%	TV + 6.0%
No. 8 sieve	TV - 6.0%	TV + 6.0%
No. 40 sieve	TV - 4.0%	TV + 4.0%
No. 200 sieve	TV - 2.0%	TV + 2.0%
Asphalt Content	TV - 0.50%	TV + 0.50%
Voids (optional)	TV - 1.5%	TV + 1.5%
Compaction	TV - 3.0%	TV + 3.0%
Thickness, when required	Plan - 0.25 in.	Plan + 0.25 in.

Note: Agencies should establish LSL and USL for the gradations of the various asphalt concrete pavement mixes used.

401.05 Method of Measurement. Refer to Agency methods.

401.06 Basis of Payment. Refer to Agency methods and as noted below:

The asphalt concrete pavement contract unit bid price will be adjusted in accordance with Subsection 106.05. Payment for material in a lot will be made at a price determined by multiplying the contract unit bid price by the Composite Pay Factor (CPF). See Section 501, Appendix E, for an example of the calculations involved when composite pay factors are used. The following table will be utilized to calculate the Composite Pay Factor:

Measured Characteristic	Factor "f"
Gradation	
3/8 inch sieve	6
No. 8 sieve	10
No. 40 sieve	6
No. 200 sieve	20

Asphalt Content	50
Voids (optional)	50
Compaction	50

Note: **Agencies should establish the factors "f" for gradations of various asphalt concrete pavement mixes used.**

SECTION 501 — PORTLAND CEMENT CONCRETE PAVEMENT

501.01 Description. This work consists of constructing a Portland cement concrete pavement on a prepared subgrade or base course.

501.02 Materials. Materials shall meet the requirements of the following Subsections:

Fine aggregate	703.01
Coarse aggregate	703.02
Portland cement	701.01
Water	712.01(a)
Air-entraining admixtures	711.02
Calcium Chloride	712.02
Joint filler	705.01
Curing materials	711.01
Reinforcing steel	709.01
Chemical admixtures	711.03
Fly ash	712.04

Note: The Agency may substitute their own materials requirements.

501.03 Construction Requirements

(a) *Contractor Process Quality Control.*

1. General Requirements. The Contractor shall administer a Process Quality Control Plan sufficient to assure a product meeting the contract requirements. The Plan shall meet the requirements of Subsection 106.04.
2. Elements of the Plan. The Plan shall address all elements which affect the quality of the Portland cement concrete including, but not limited to the following:
   a) Mix Design(s)
   b) Aggregate Production
   c) Stockpile Management
   d) Quality of Components
   e) Proportioning, including Added Water
   f) Mixing and Transportation, including Time From Batching to Completion of Delivery
   g) Initial Mix Properties, including Temperature, Air Content, and Consistency
   h) Slump
   i) Placement and Consolidation
   j) Compressive or Flexural Strength
   k) Finishing and Curing
   l) Documentation and control charts
   m) Smoothness

Note: If the concrete mix design and/or aggregate sources are supplied or designated for use by the Agency, then certain elements of the plan should be adjusted accordingly.

3. Personnel Requirements. The Plan shall include the following technicians:
   a) Process Control Technician(s) (PCT) shall utilize test results and other quality control practices to assure the quality of aggregates and other mix

components, and control and adjust mix proportioning to meet the mix design(s). The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation.

The PCT shall periodically inspect all equipment utilized in proportioning and mixing to assure it is operating properly and that proportioning and mixing is in conformance with the mix design and other contract requirements. The Plan shall detail how these duties and responsibilities are to be accomplished and documented and whether more than one PCT is required. The Plan shall include the criteria utilized by the PCT to correct or reject unsatisfactory materials.

b) Quality Control Technician(s) (QCT) shall perform and utilize quality control tests at the job site to assure that delivered materials meet the contract requirements and the mix design, including temperature, slump and air content. The QCT shall inspect all equipment utilized in transporting, placing, consolidating, joint construction, and finishing to assure it is operating properly and that placing, consolidation, joint construction, and finishing conforms with the contract requirements. The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one QCT is required. The Plan shall include the criteria utilized by the QCT to reject unsatisfactory materials.

c) The Plan shall set forth the coordination of the activities of the PCT and the QCT.

(b) *Other Requirements.* The Contractor shall provide a Certificate of Compliance for each truckload of concrete. The Certificate of Compliance shall include:

Manufacturer's Plant (Batching Facility)
Contract No.
Name of Contractor (Prime Contractor)
Date
Time Batched/Time Discharged
Truck No.
Initial/Final Revolution Counter Reading
Quantity (Quantity Batched This Load)
Type of Concrete by Class or Producer Design Mix No.
Cement Brand, Type, and Shipment Certification No.
Approved Aggregate Gradation Designation
Target Weights Per Cubic Yard and Actual Batched Weights for:

1. Cement
2. Fly ash (if used)
3. Coarse concrete aggregate (each size)
4. Fine concrete aggregate
5. Water (including free moisture in aggregates)
6. Temperature of mixing/discharge
7. Admixtures brand and quantity per 100 wt.
   - Air-entraining admixture
   - Water reducing admixture
   - Other admixtures
8. Combined monthly total of all concrete of all classes delivered to all Agency projects.

Note: Each Agency should modify this list to their own requirements. See AASHTO M 157.

The Certificate of Compliance shall be signed by a responsible representative of the concrete producer, other than the driver, affirming the accuracy of the information provided. In lieu of providing a machine produced record containing all of the above information, the concrete producer may use printed forms approved by the Agency.

501.04 Acceptance. Portland cement concrete pavement will be sampled on a statistically random basis, tested, and evaluated in accordance with Subsection 106.05, and as noted below. See Table 106-4 for acceptance guidelines. Evaluation of materials will be made using the following limits:

Measured Characteristic	LSL	USL
Air Content	TV - 1.5%	TV + 1.5%
Strength	Design	None
Thickness	Plan	None
Smoothness	None	7 in./mile

(a) *Concrete With Non-Conforming Strength.* Concrete produced in accordance with a Contractor-provided mix design which fails to meet the specified compressive strength at 28 days will be evaluated by comparison of the compressive test strength (fc) with the specified compressive strength (f'c) as follows:

1. If the (f'c - fc) value is less than 60 psi, the concrete will be accepted as being in conformance and no pay adjustment shall apply.
2. If the (f'c - fc) value is between 60 and 500 psi, the Engineer may:
   a) Require corrective action at no additional expense to the Agency; or
   b) Accept the concrete with a calculated pay adjustment as calculated below.
3. If the (f'c - fc) value is greater than 500 psi, the Engineer will:
   a) Require the complete removal and replacement with concrete meeting the contract requirements at no additional expense to the Agency; or
   b) Require corrective action at no additional expense to the Agency; or
   c) Accept the concrete where the finished product is found to be acceptable for the intended purpose, with a payment adjustment as determined in Subsection 501.06(a).

Note: Each sublot will be analyzed separately for strength.

(b) *Thickness.* Acceptance samples for thickness of the pavement will be taken after completion of any corrective work.

(c) *Pavement Smoothness Surface Test.* The Contractor shall furnish paving equipment and employ methods that produce a riding surface having an average initial profile index of 7 inches per mile or less when tested with a California type profilograph using test method CA-526 (or substitute Agency method).

Note: Additional specifications for the operation of the profilograph, corrective grinding requirements, start-up paving procedures, and how the initial profile indexes will be taken, should be inserted here. A sample specification is shown in Appendix D.

501.05 Method of Measurement. Refer to Agency methods.

501.06 Basis of Payment. Refer to Agency methods and as noted below:

(a) *Concrete With Non-Conforming Strength.* The quantity of concrete represented by an acceptance test that fails to meet the specified compressive strength will be subject to the following pay adjustment:

Pay Adjustment = 0.0005 (f'c - fc) U.P.

where f'c = specified compressive strength at 28 days

fc = compressive strength at 28 days.

U.P. = unit contract price per square yard for the concrete pavement involved. Where payment for the item is on a lump sum basis, the unit price of concrete payment shall be taken as $70.00 per square yard for concrete pavement.

Note: Strength is analyzed for pay adjustment only and is not eligible for bonus payment.

(b) *Smoothness.* When the average initial profile index for the lot is greater than 7 inches per mile, the Contractor will take corrective grinding action to bring the defective sections equal to or below the 7 inches per mile criteria. When the average initial profile index is less 7 inches per mile, the Contractor is entitled to an incentive payment. Contract unit price adjustment will be made in accordance with the following schedule. The maximum bonus payment for smoothness is 3 percent.

Initial Profile Index	Pay Adjustment Factor
Inches per mile per 0.1-mile section	Percent of pavement unit bid price
> 2.0	103.00
2.0 to 2.9	102.50
3.0 to 3.9	102.00
4.0 to 4.9	101.50
5.0 to 5.9	101.00
6.0 to 6.9	100.50
7.0	100.00

Pay adjustments will be based on the average initial profile index for the lot prior to any corrective work.

(c) *Composite Pay Factor (CPF).* The Portland Cement Concrete Pavement contract unit bid price will be adjusted in accordance with Subsection 106.05. Payment for material in a lot will be made at a price determined by multiplying the contract unit bid price by the composite pay factor. The maximum bonus for air content and thickness is 2 percent. See Appendix E for an example of the calculations involved when composite pay factors are used. The following table will be utilized to calculate the Composite Pay Factor:

Measured Characteristic	Factor "f"
Air Content	50
Thickness	50

APPENDIX D

SAMPLE SPECIFICATIONS FOR AGENCY INFORMATION

The profile index will be determined using a California type profilograph, furnished and operated by the Agency. The profilograph records on a scale of 1 inch equals 1 inch vertically, and 1 inch equals 25 feet horizontally. Motive power may be manual or by propulsion unit attached to the assembly. The profilograph will be moved longitudinally along the pavement at a speed no greater than 3 MPH.

Pavement profiles will be taken 3 feet from and parallel to each edge of the pavement for pavement placed at a 12-foot width or less. When pavement is placed at a greater width than 12 feet, the profile will be taken 3 feet from and parallel to each edge and from the approximate location of each planned longitudinal joint. The profile will terminate 15 feet from each bridge approach slab or from existing pavement that is joined by the new pavement. All profiles taken for each segment will be averaged to determine the rating of the segment. Additional profiles may be taken only to define the limits of an out-of-tolerance surface variation.

During the initial paving operations, either when starting up or after a long shutdown period, the pavement surface will be tested with the profilograph as soon as the concrete is cured sufficiently to allow testing. Membrane curing damaged during the testing operation shall be repaired by the Contractor as directed by the Engineer. Initial testing will be used to aid the Contractor and the Engineer to evaluate the paving methods and equipment.

If the initial pavement smoothness is within specification limits, and paving methods, and paving equipment are acceptable to the Engineer, the Contractor may proceed with the paving operation.

A daily average profile index will be determined for each day's paving. A day's paving is defined as a minimum of 0.1 mile of full-width pavement placed in a day. If less than 0.1 mile is paved, the day's production will be grouped with the next day's production. If an average initial profile index of 7 inches per mile is exceeded in any daily paving operation, the paving operation will be suspended and will not be allowed to resume until corrective action is taken by the Contractor.

In the event that paving operations are suspended as a result of the average initial profile index exceeding 7 inches per mile, subsequent paving operations will be tested in accordance with the initial testing procedures.

For determining pavement sections where corrective work or pay adjustments will be necessary, the pavement will be evaluated in 0.1 mile sections using the profilograph. Within each 0.1 mile section, all areas represented by high points having deviations in excess of 0.3 inch in 25 feet or less shall be corrected by the Contractor.

After correcting individual deviations in excess of 0.3 inch in 25 feet, additional corrective action may be necessary to reduce the average profile index for the 0.1 mile segment to 7 inches per mile or less. Any 0.1 mile section having an initial profile index in excess of 7 inches per mile shall be corrected to reduce the profile index to 7 inches per mile or less.

On those sections where corrections are made, the pavement will be tested to verify that corrections have produced a profile index of 7 inches per mile or less.

Corrections shall be made using an approved profiling device or by removing and replacing the pavement as directed by the Engineer. Bush hammers or other impact devices will not be permitted. Corrective work shall be done at the Contractor's expense.

Where corrections are made, the Contractor shall reestablish the surface texture to provide a uniform texture equal in friction to the surrounding uncorrected pavement and repair all affected joints. This work shall be at the Contractor's expense.

Corrective work shall be completed prior to determining pavement thickness.

APPENDIX E

EXAMPLE CALCULATIONS FOR PAY ADJUSTMENT

STEP 1 — STATEMENT OF CONDITIONS AND FIELD TEST RESULTS:

(A) Unit bid price of PCCP is $65.00 per sq. yd. (not including Portland cement, fly ash, or other additives).

(B) All samples taken on a statistically random basis with lot sizes based approximately on those values listed in Table 106-4, and adjusted as required to meet field situations.

(C) PCCP laid in one 38 foot wide path as follows:

DATE	LOCATION (STA. TO STA.)	LENGTH (FT)	AREA (SQ YD)
Aug 17-90	0+00 to 42+50	4,250	17,944.4
Aug 20-90	42+50 to 87+00	4,450	18,788.9
Aug 21-90	87+00 to 135+54	4,854	20,494.7
	Totals	13,554	57,228.0

(D) Cylinder design strength is 4000 psi. Lot #2 has only four sublots due to loader backing over one cylinder in field. However, Lot #2 still represents 20,000 sq yd. Lot #3 represents 17,228 sq yd because Lot #3 includes the remaining yardage of PCCP on the project.

LOT NUMBER	LOT SIZE (SQ YD)	SUBLOT NUMBER	SUBLOT SIZE (SQ YD)	CYLINDER STRENGTH (PSI)
1	20,000	1A	4,000	3,940
		1B	4,000	3,980
		1C	4,000	3,985
		1D	4,000	3,967
		1E	4,000	3,990
2	20,000	2A	5,000	4,300
		2B	5,000	4,255
		2C	5,000	4,152
		2D	5,000	4,090
3	17,228	3A	3,450	3,935
		3B	3,450	3,900
		3C	3,450	3,876
		3D	3,450	3,500
		3E	3,428	3,650

(E) Plan thickness is 10 inches. Lot #3 has only four sublots due to breakdown of core drilling machine.

LOT NUMBER	LOT SIZE (SQ YD)	SUBLOT NUMBER	SUBLOT SIZE (SQ YD)	ACTUAL THICKNESS (INCHES)	ACTUAL THICKNESS (INCHES)
1	20,000	1A	4,000.0	10 1/8	10.125
		1B	4,000.0	10	10.000
		1C	4,000.0	10 1/4	10.250
		1D	4,000.0	10	10.000
		1E	4,000.0	10 1/8	10.125
2	20,000	2A	4,000.0	9 7/8	9.875
		2B	4,000.0	10	10.000
		2C	4,000.0	10	10.000
		2D	4,000.0	10 1/8	10.125
		2E	4,000.0	10 1/8	10.125
3	17,228	3A	4,300.0	10 1/8	10.125
		3B	4,300.0	9 7/8	9.875
		3C	4,300.0	10	10.000
		3D	4,328.0	10	10.000

(F) Smoothness indexes taken in each wheelpath on each day's run, then averaged to determine the initial profile index for the lot as per Table 106.4. Smoothness results taken with the profilograph are as follows:

LOT NUMBER	LOCATION (STA. TO STA.)	LOT SIZE (SQ YD)	INITIAL AVERAGE INDEX (IN/ MILE)
1	0+00 TO 42+50	17,944.4	8.5
2	42+50 TO 87+00	18,788.9	6.3
3	87+00 TO 135+54	20,494.7	3.2

(G) Mix design air content is 5%.

LOT NUMBER	LOT SIZE (SQ YD)	SUBLOT NUMBER	SUBLOT SIZE (SQ YD)	AIR CONTENT (%)
1	20,000	1A	4,000.0	5.5
		1B	4,000.0	5.0
		1C	4,000.0	6.2
		1D	4,000.0	6.0
		1E	4,000.0	5.8
2	20,000	2A	4,000.0	6.1
		2B	4,000.0	6.0
		2C	4,000.0	6.6
		2D	4,000.0	6.4
		2E	4,000.0	6.5
3	17,228	3A	4,300.0	3.4
		3B	4,300.0	5.2
		3C	4,300.0	5.4
		3D	4,328.0	5.3

STEP 2 — CALCULATION OF PAY ADJUSTMENT

(A) STRENGTH PAY ADJUSTMENTS:

LOT NO.	LOT SIZE (SQ YD)	SUBLOT NUMBER	SUBLOT SIZE (SQ YD)	CYLINDER STRENGTH (PSI)	DESIGN STRENGTH (PSI)	UNIT BID PRICE ($)	PAY ADJUST FACTOR ($/SQ YD)	SUBLOT PAY ADJUST ($)	CUMULATIVE ADJUST ($)
	20,000	1A	4000.00	3940.00	4000.00	65.00	0.00	0.00	0.00
		1B	4000.00	3980.00	4000.00	65.00	0.00	0.00	0.00
		1C	4000.00	3985.00	4000.00	65.00	0.00	0.00	0.00
		1D	4000.00	3967.00	4000.00	65.00	0.00	0.00	0.00
		1E	4000.00	3990.00	4000.00	65.00	0.00	0.00	0.00
2	20,000	2A	5000.00	4300.00	4000.00	65.00	0.00	0.00	0.00
		2B	5000.00	4255.00	4000.00	65.00	0.00	0.00	0.00
		2C	5000.00	4152.00	4000.00	65.00	0.00	0.00	0.00
		2D	5000.00	4090.00	4000.00	65.00	0.00	0.00	0.00
3	17,228	3A	3450.00	3935.00	4000.00	65.00	-2.11	-7,279.50	-7,279.50
		3B	3450.00	3900.00	4000.00	65.00	-3.25	-11,212.50	-18,492.00
		3C	3450.00	3876.00	4000.00	65.00	-4.03	-13,903.50	-32,395.50
		3D	3450.00	3500.00	4000.00	65.00	-16.25	-56,062.50	-88,458.00
		3E	3428.00	3650.00	4000.00	65.00	-11.38	-39,010.64	-127,468.64

COMMENTS:

As per Subsection 501.04(a), test results for any sublot that are within minus 60 psi of, or higher than, the design strength will not be pay adjusted, but will be paid at 100% of the contract unit bid price. All concrete sublots with strengths of more than 500 psi below the mix design strength will be rejected by the Engineer.

Note that all values in Lot #1 are within the -60 psi limit, all values in Lot #2 are higher than the mix design strength, and all values in Lot #3 are between the -60 and -500 psi limit.

Note that strength is analyzed for pay adjustment only, and is not eligible for bonus payment.

(B) SMOOTHNESS PAY ADJUSTMENT:

LOT NO.	LOCATION (STA. TO STA.)	LOT SIZE	INITIAL AVERAGE INDEX (IN/MILE)	CONTRACT UNIT BID PRICE ($)	PAY ADJUSTMENT FACTOR (FROM CHART 501.06(b) (%)	NET PAY ADJUST. FACTOR (%)	TOTAL LOT PAY ADJUST. ($)	CUMULATIVE PAY ADJUSTMENT
1	0+00 TO 42+50	17,944.4	8.5	65.00	100.00	0.00	0.00	0.00
2	42+50 TO 87+00	18,788.9	6.3	65.00	100.00	0.00	0.00	0.00
3	87+00 TO 135+54	20,494.7	3.2	65.00	101.80	1.80	23,978.80	23,978.80

COMMENTS:

Note that Lot #1 has an initial profile index of above the maximum 7 inches per mile allowed as per Subsection 501.06 (b). This Lot must be ground to within 7 inches/mile criteria at the Contractor's expense. The Lot will be paid at 100% of the contract unit bid price after completion of the grinding work. Also note that any subsequent profile index taken to verify that the grinding work is acceptable, regardless of its value, will have no bearing on the pay adjustment factor for the Lot since the factor is based only on the initial average profile index taken.

(C) AIR CONTENT PAY FACTOR DETERMINATION:

LOT NUMBER	LOT SIZE	UPPER SPEC. LIMIT (USL) (%)	LOWER SPEC. LIMIT (LSL) (%)	TEST #1 (%)	TEST #2 (%)	TEST #3 (%)	TEST #4 (%)	TEST #5 (%)	TEST AVERAGE (X)
1	20,000	6.5	3.5	5.5	5.0	6.2	6.0	5.8	5.7
2	20,000	6.5	3.5	6.1	6.0	6.6	6.4	6.5	6.3
3	17,288	6.5	3.5	3.4	5.2	5.4	5.3		4.8

LOT NUMBER	STANDARD DEVIATION (s)	UPPER QUALITY INDEX (QU)	LOWER QUALITY INDEX (QL)	% WITHIN UPPER LIMITES (FROM TABLE 106-1) (PU)	% WITHIN LOWER LIMITS (FROM TABLE 106-1) (PL)	QUALITY LEVEL	PAY FACTOR (FROM TABLE 106-1)
1	0.47	1.70	4.68	100.0	100.0	100	1.05
2	0.26	0.77	10.77	77.0	100.0	77	0.99
3	0.95	1.79	1.37	100.0	97.0	97	1.05

(D) THICKNESS PAY FACTOR DETERMINATION:

LOT NUMBER	UPPER SPEC. LIMIT (USL) (%)	LOWER SPEC. LIMIT (LSL) (%)	TEST #1 (%)	TEST #2 (%)	TEST #3 (%)	TEST #4 (%)	TEST #5 (%)	TEST AVERAGE (X)
1	NONE	10.0	10.125	10.000	10.250	10.000	10.125	10.100
2	NONE	10.0	9.875	10.000	10.000	10.125	10.125	10.025
3	NONE	10.0	10.125	9.875	10.000	10.000		10.000

STANDARD DEVIATION (s)	UPPER QUALITY INDEX (QU)	LOWER QUALITY INDEX (QL)	% WITHIN UPPER LIMITS (FROM TABLE 106-1) (PU)	% WITHIN LOWER LIMITS (FROM TABLE 106-1) (PL)	QUALITY LEVEL	PAY FACTOR (FROM TABLE 106-1)
0.10	N.A.	0.96	100.0	83.0	83	1.02
0.10	N.A.	0.25	100.0	59.0	59	0.89
0.10	N.A.	0.00	100.0	50.0	50	0.85

(E) COMPOSITE PAY FACTOR DETERMINATION FOR AIR CONTENT AND THICKNESS:

LOT NO.	AIR CONTENT PAY FACTOR (PF-1)	AIR CONTENT WEIGHT FACTOR [(FROM SEC 501.06 (c)] (f-1)	MULTIPLY AIR CONTENT (PF x F)	THICKNESS PAY FACTOR (PF-2)	THICKNESS WEIGHT FACTOR [FROM SEC 501.06 (c)] (f-2)	MULTIPLY THICKNESS (PF x F)	SUM MULTIPLES	SUM WEIGHTS
1	1.05	50	52.50	1.02	50	51.00	103.50	100
2	0.99	50	49.50	0.89	50	44.50	94.00	100
3	1.05	50	52.50	0.85	50	42.50	95.00	100

LOT NO.	COMPOSITE PAY FACTOR	CONTRACT UNIT BID PRICE ($)	NET PAY ADJUST ($/SQ YD)	LOT SIZE (SQ YD)	TOTAL LOT PAY ADJUST ($)	CUMULATIVE PAY ADJUSTMENT
1	1.02	65.00	1.30	20,000	26,000.00	26,000.00
2	0.94	65.00	-3.90	20,000	-78,000.00	-52,000.00
3	0.95	65.00	-3.25	17,228	-55,991.00	-107,991.00

COMMENTS:

Note that lots must be of the same size for all characteristics included in the composite pay factor in order to calculate the pay factor. However, all other characteristics, not included in the composite pay factor, may have differing lot sizes as shown in these examples with the smoothness characteristic.

Note that all composite pay factor calculation may be adapted to include as many characteristics as the Agency may want to include.

Note that the composite pay factor for lot #1 calculates to be 1.04. However, the maximum allowable bonus payment that can be made in the composite factor is 2%, and therefore the factor has been changed to 1.02.

STEP 3 - MONTHLY PROGRESS PAYMENT DETERMINATION:

ITEM	UNIT	TOTAL PREVIOUS ESTIMATE	TOTAL THIS ESTIMATE	TOTAL TO DATE
PCCP	SQ YD	0.00	57,228.00	57,228.00
PORTLAND CEMENT	TON	0.00	4,292.10	4,292.10
FLY ASH	TON	0.00	1,430.70	1,430.70
PAY ADJUSTMENT-STRENGTH	$$$	$0.00	($127,468.64)	($127,468.64)
PAY ADJUSTMENT-SMOOTHNESS	$$$	$0.00	($23,978.00)	($23,978.00)
PAY ADJUSTMENT-AIR CONTENT & THICKNESS	$$$	$0.00	($107,991.00)	($107,991.00)

COMMENTS:

If items are set up for each type of pay adjustment and if the adjustments are made in dollars, then the quantities of each item do not have to be adjusted. If separate items are included for each type of adjustment, then a history and audit trail will be established. This will greatly simplify the bookkeeping process.

Simple forms can be developed to record pertinent test data, lot sizes, locations, test locations, etc. These forms can be formatted to include blanks for calculation of pay factors and monetary adjustment of bonus payments. The calculations and forms can also be written into a simple computer program that can also perform uniform number rounding, as well as track the restrictions and limits contained in the specifications. The calculations shown in this example have been shown in great detail to make it easier to understand. Many of the steps can be combined or shortened once familiarity is gained with the process.

SECTION 603 — PIPE CULVERTS

603.01 Description. This work consists of furnishing and installing concrete and metal culverts, storm drains, and cattle passes.

603.02 Materials. Refer to Agency requirements.

603.03 Construction Requirements

(a) *Contractor Quality Control.*

1. General Requirements. The Contractor shall administer a Process Quality Control Plan sufficient to assure a product meeting the contract requirements. The Plan shall meet the requirements of Subsection 106.04.
2. Elements of the Plan. The Plan shall address all elements which affect the quality of the pipe culvert installation, including, but not limited to, the following:
   a) Moisture
   b) Compaction
   c) Bedding
3. Personnel Requirements. The Plan shall include the following technician(s).

   Quality Control Technician(s) (QCT) shall perform and utilize quality control tests at the job site to assure that the installation of pipe culverts meets the contract requirements. The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation.

   The QCT shall periodically inspect all equipment utilized in the placement of the pipe culvert to assure it is operating properly and that the placement of the pipe culvert conforms to the contract requirements. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one individual is required. The Plan shall include the criteria utilized by the QCT to reject unsatisfactory pipe culvert installations.

(b) *Other Requirements.* Refer to Agency requirements.

603.04 Acceptance. Pipe culvert installations will be sampled on a statistically random basis, tested, and evaluated in accordance with Subsection 106.05(a), Quality Level Analysis, using steps 1 thru 7 only. Table 106-2, Pay Factors, does not apply. See Table 106-4 for acceptance guidelines. Acceptance will be at an 85% quality level with all material below that level reworked. Evaluation of materials will be made using the following limits:

Measured Characteristic	LSL	USL
Moisture	TV - 2%	TV + 2%
Density	95% Max. Density	None
Gradation	TV - (Specified by Agency)	TV + (Specified by Agency)

Note: Agencies should establish LSL and USL for the gradations of the various backfill materials used.

603.05 Method of Measurement. Refer to Agency methods.

603.06 Basis of Payment. Refer to Agency methods.

Note: If pay is to be adjusted in accordance with 106.05, the Agency must establish the factors "f" for gradations of various backfill materials used. See Subsection 401.06 for an example of the use of these factors.

SECTION 621 - STRUCTURAL CONCRETE

621.01 Description. This work consists of furnishing, placing, and curing structural concrete for use in bridges, culverts and other structures.

621.02 Materials. Materials shall meet the requirements of the following Subsections:

Portland cement	701.01
Fine aggregate	703.01
Coarse aggregate	703.02
Lightweight aggregate	703.16
Curing materials	713.01
Air-entraining admixture	713.02
Chemical admixtures	713.03
Water	714.01
Fly ash	714.11

Note: Agencies may substitute their own materials specifications.

621.03 Construction Requirements

(a) *Contractor Process Quality Control.*

1. General Requirements. The Contractor shall administer a Process Quality Control Plan sufficient to assure a product meeting the contract requirements. The Plan shall meet the requirements of Subsection 106.04.
2. Elements of the Plan. The Plan shall address all elements which affect the quality of the structural concrete including, but not limited to the following:
   a) Mix Design(s)
   b) Aggregate Production
   c) Quality of Components
   d) Stockpile Management
   e) Proportioning, including Added Water
   f) Mixing and Transportation, including Time from Batching to Completion of Delivery
   g) Initial Mix Properties, including Temperature, Air Content, and Consistency
   h) Placement and Consolidation
   i) Compressive Strength
   j) Finishing and Curing
3. Personnel Requirements. The Plan shall include the following technicians:
   a) Process Control Technician(s) (PCT) shall utilize test results and other quality control practices to assure the quality of aggregates and other mix components and control proportioning to meet the mix design(s). The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation. The PCT shall periodically inspect all equipment utilized in proportioning and mixing to assure it is operating properly and that proportioning and mixing conforms with the mix design(s) and other contract requirements. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one PCT is required. The Plan shall include the criteria utilized by the PCT to correct or reject unsatisfactory materials.

b) Quality Control Technician(s) (QCT) shall perform and utilize quality control tests at the job site to assure that delivered materials meet the requirements of the mix design(s), including temperature, slump, air content and strength. The QCT shall inspect all equipment utilized in transporting, placing, consolidating, finishing and curing to assure it is operating properly and that placement, consolidation, finishing and curing conform with the contract requirements. The Plan shall detail frequency of sampling and testing, corrective actions to be taken, and documentation. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one QCT is required. The Plan shall include the criteria utilized by the QCT to reject unsatisfactory materials.

c) The Plan shall detail the coordination of the activities of the PCT and the QCT.

(b) *Other Requirements.* The Contractor shall provide a Certificate of Compliance for each truckload of concrete. The Certificate of Compliance shall include:

Manufactured Plant (Batching Facility)
Contract No.
Name of Contractor (Prime Contractor)
Date
Time Batched/Time Discharged
Truck No.
Initial/Final Revolution Counter Reading
Quantity (quantity batched this load)
Type of Concrete by Class or Producer Design Mix No.
Cement Brand or Type, and Shipment Certification No.
Approved Aggregate Gradation Designation
Target Weights Per Cubic Yard and Actual Batched Weights for:

1. Cement
2. Fly Ash
3. Coarse Concrete Aggregate
4. Fine Concrete Aggregate
5. Water (including free moisture in aggregates)
6. Temperature of Mixing/Discharge
7. Admixtures Brand and Quantity per 100 wt.
   - Air-Entraining Admixture
   - Water Reducing Admixture
   - Other Admixtures
8. Combined Monthly Total of All Concrete of All Classes Delivered to All Agency Projects.

Note: Each Agency should modify this list to their own requirements. See AASHTO M 157.

The Certificate of Compliance shall be signed by a responsible representative of the concrete producer, other than the driver, affirming the accuracy of the information provided. In lieu of providing a machine produced record containing all of the above information, the concrete producer may use printed forms approved by the Agency.

621.04 Acceptance. Structural concrete will be sampled on a statistically random basis, tested, and evaluated in accordance with Subsection 106.05 and as noted below. See Table 106-4 for acceptance guidelines. Evaluation of materials will be made using the following limits:

Measured Characteristic	LSL	USL
Slump	TV - 1.0 in.	TV + 1.0 in.
Air	TV - 1.0%	TV + 1.0%
Strength	Design	None

(a) *Additional Samples.* The first load of concrete placed will be sampled, tested, and evaluated for quality determination. Concrete will also be tested whenever there is a change shown on the Certificate of Compliance or visual change in the mix. Concrete properties shall be determined from concrete delivered to the project and certified by the Contractor for quality testing prior to placement.

(b) *Corrective Action.* Concrete placement operations shall be suspended when the pay factor as determined in accordance with Subsection 106.05 for a lot:

1. Drops below 1.0000 and the Contractor is taking no corrective action, or
2. Is less than 0.9000.

The placement operations shall not resume until the Engineer determines that material meeting the contract requirements can be produced.

Any lot with a pay factor of less than 0.9000 will be rejected.

(c) *Concrete With Non-Conforming Strength.* Concrete produced in accordance with a Contractor-provided mix design which fails to meet the specified compressive strength at 28 days will be evaluated by comparison of the compressive test strength (fc) with the specified compressive strength (f'c) as follows:

1. If (f'c - fc) is less than 60 psi, the concrete will be accepted as being in conformance and no pay adjustment shall apply.
2. If the (f'c - fc) value is between 60 and 500 psi the Engineer may:
   a) Require corrective action at no additional expense to the Agency; or
   b) Accept the concrete with a calculated pay adjustment as calculated below.
3. If the (f'c - fc) value is greater than 500 psi, the Engineer will:
   a) Require the complete removal and replacement with concrete meeting the contract requirements at no additional expense to the Agency; or
   b) Require corrective action at no additional expense to the Agency; or
   c) Accept the concrete where the finished product is found to be acceptable for the intended purpose, with a pay adjustment as determined in Subsection 621.07(a).

Note: Each sublot will be analyzed separately for strength.

621.06 Method of Measurement. Refer to Agency methods.

621.07 Basis of Payment. Refer to Agency methods and as noted below:

(a) *Concrete With Non-Conforming Strength.* The quantity of concrete represented by an acceptance test that fails to meet the specified compressive strength will be subject to the following pay adjustment.

Pay Adjustment = 0.0005 (f'c - fc) U.P.

where f'c = specified compressive strength at 28 days
fc = compressive strength at 28 days
U.P. = unit contract price per cubic yard for the class of concrete involved. Where payment for the item is on a lump sum basis, the unit price of concrete shall be taken as $300.00 per cubic yard for concrete Class ___, ___, and ___. For concrete Class ___ the unit price for concrete shall be $150.00 per cubic yard.

(b) *Composite Pay Factor (CPF).* The Portland Cement Concrete Pavement contract unit bid price will be adjusted in accordance with Subsection 106.05. Payment for material in a lot will be made at a price determined by multiplying the contract unit bid price by the composite pay factor. See Section 501, Appendix E, for an example of the calculations involved when composite pay factors are used. The following table will be utilized to calculate the Composite Pay Factor:

Measured Characteristic	Factor "f"
Slump	40
Air Content	60