ENGINEERING POLICY BALLOT

Effective: July 1, 2019

Level 2

Level two revisions require the approval of the **Assistant Chief Engineer** and the **Federal Highway Administration** only. The **Senior Management Team** is encouraged to review the content and provide comment to the appropriate director. For all other parties, these revisions are posted for information only.

ENGINEERING POLICY BALLOT

Effective: July 1, 2019

Issue 1: Incorporate the QC/QA JSP into Section 100

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Michael R. Meyerhoff - CM

Summary: This revision incorporates the QC/QA JSP into the specifications and brings the specifications up to date with practices in the field.

Publication: Secs 105, 106, 107, 108, 109, EPG 106

Issue 2: Revise Fixed Unit Price for Class C Excavation

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Dennis Brucks - CM

Summary: The existing fixed unit prices for Class C excavation are outdated and the price can vary significantly depending on the hardness of the rock and the frequency. AGC and MoDOT have mutually agreed to limit the risk to both parties by capping the fixed price at $75 for 500 CY or less.

Publication: Sec 109

Issue 3: Post-Award Value Engineering (PAVE)

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Sarah Kleinschmit – DE
Kenny Voss - DE

Summary: This revision provides guidance on Post-Award Value Engineering (PAVE) processes and project selections, now that the pilot program has been completed.

Publication: EPG 130

Issue 4: Prioritization of Guardrail and Guard Cable Repairs

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Julie Stotlemeyer – DE
Sarah Kleinschmit – DE

Summary: This new guidance will assist primarily guardrail and guard cable JOC administrators with identifying high priority repairs, repair consistency across the districts, and will align the repairs better with MoDOT's incident response plan.

Publication: EPG 147

Issue 5: Incorporate the QC/QA JSP into Section 200

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Michael R. Meyerhoff - CM

Summary: This revision incorporates the QC/QA JSP into the specifications and brings the specifications up to date with practices in the field.

Publication: Secs 203, 209, 214, EPG 202, 203, 205

Issue 6: Clarifications and Documentation Regarding Clear Zone Strategies

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: James Smith - DE

Summary: This revision was previously submitted in the April 2019 Ballot, but after the comment period, it was determined the proposed revision needed additional clarifications, thus it is being resubmitted.

The proposed revision incorporates additional Roadside Design Guide language, updates RDG tables, and recommends a safety analysis as a means of documenting decisions for safety strategies.

Publication: EPG 231

Issue 7: ADA Transition Plan and Other Construction Requirements

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Mendy Sundermeyer - DE

Summary: This revision updates EPG 264.4.4 to reflect the recent interim guidance for determining responsibilities for the ADA transition plan and other construction requirements.

Publication: EPG 236

Issue 8: Incorporate the QC/QA JSP into Section 300

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Michael R. Meyerhoff - CM

Summary: This revision incorporates the QC/QA JSP into the specifications and brings the specifications up to date with practices in the field.

Publication: Secs 302, 304, 310, EPG 302, 304

Issue 9: Incorporate the QC/QA JSP into Section 400

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Michael R. Meyerhoff – CM
Daniel Oesch - CM

Summary: This revision incorporates the QC/QA JSP into the specifications and brings the specifications up to date with practices in the field.

This revision also increases the lower spec requirement for each UBAWS type and eliminates the requirement of staying within the master range during production for asphalt content and increases the emulsion membrane application rate. The revision also allows for the option of using PG70-28 binder.

Publication: Secs 401, 402, 403, 404, 409, 413, 490

Issue 10: Changes to Area of Localized Roughness (ALRs) Limit and Profiling Exception

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: John Donahue - CM

Summary: This revision was requested by industry due to the inability to meet smoothness specifications with regards to areas of localized roughness (ALRs). This provision increases the maximum ALR limit for multi-lift overlays, less than or equal to 3 inches, from 125 to 175 in/mile. It will also expand the profiling exception of 50' on either side of intersections to those with no special grade transition.

Publication: Sec 610

Issue 11: Temporary Traffic Control Sheeting and Pilot Car Updates

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Nickolas Voltenburg – TS
Dan Smith - TS

Summary: Standard Plan 616.10 is being revised to update the sign sheeting material requirement and to introduce additional pilot car signs. Standard Plan 617.20 also updates the sheeting material requirements. The Standard Specification revisions are also related to the sheeting material requirements and brings the specifications up to date with practices in the field.

Publication: Secs 1042, 1063, 1065, Std. 616.10, 617.20, 903.03

Issue 12: Shoulder Widening Projects

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Sarah Kleinschmit - CM

Summary: This guidance will standardize the construction of shoulder widening projects across all districts. This revision also establishes that Type A2 and Type A3 shoulders are used only in conjunction with the construction of new pavement.

Publication: EPG 231

105.18.4.10 F-10. Date, Time, and Place of Hearing. Not revised.

105.18.4.11 F-11. The Hearing. Not revised.

105.18.4.12 F-12. Time Standards. Not revised.

105.18.4.13 F-13. Time of Award. Not revised.

105.18.4.14 F-14. Neutral Arbitrator's Compensation. Not revised.

105.18.5 Form of Award – Shall be added as follows:

The arbitrator shall provide a concise, written breakdown of the basis of the award and a written explanation and justification for the awarded amount.

105.19 Electronic Signatures. The contractor may utilize a verifiable electronic signature to sign contract documents. The electronic signature shall be verified by a recognized independent third party or the Construction and Materials Divisions.

105.20 Contractor Quality Control. The contractor shall perform Quality Control (QC) in accordance with the contract and specifications. Contractor QC responsibilities shall include all specified QC material testing and general quality control monitoring of all construction activities to ensure all materials and workmanship meet requirements. The engineer or designee shall perform Quality Assurance (QA) testing and monitoring except as specified otherwise in the contract or specifications.

105.21 Project Safety. The contractor shall develop and implement a plan for project safety as specified in Sec 107.

for PAL material, the action taken to correct those deficiencies, and written concurrence from Construction and Materials that the problem has been suitably addressed and that the agent is approved as an intermediate agent of PAL material.

106.12.10.2 An intermediate agent will be allowed to request PAL inclusion for a product manufactured by a separate company that does not have substantial business interest in applying for PAL or for a product that is only used in small quantities. If PAL inclusion is granted, the intermediate agent shall be responsible for any material provided that does not meet the applicable specifications. The intermediate agent shall assume all penalties for non-compliant material, including removal from a PAL in accordance with Sec 106.12.5.

106.12.11 Contractor PAL Use. The source for PAL material shall be listed on the PAL at the time the material is incorporated into the project. The contractor bears the risk that material on the PAL at the time of bidding is no longer on the PAL at the time of incorporation. The contractor may obtain a list of PAL material by contacting Construction and Materials or from MoDOT's website. Use of PAL material shall not relieve the contractor or supplier of any responsibility to provide an inspected and approved material meeting all requirements of the contract documents.

106.12.12 Testing of Material. Test results from any sample will be considered representative of the material, and a final determination of specification compliance will be made on the basis of that sample.

106.12.13 Responsibility for Material Failure. When material has been incorporated into the project and fails any specified tests, Sec 106.7 will apply. The use of this material on all other projects shall be suspended until notified otherwise by Construction and Materials.

106.13 Quality Control/Quality Assurance (QC/QA). For material or work governed by QC/QA specifications, quality control performed by the contractor following an approved QC plan will determine acceptance of the material when test results are confirmed by the engineer's QA sampling, testing, and assessment. When the engineer's sampling, testing, or assessment do not support the contractor's results, work ~~shall~~ may be suspended and any material in place will be subject to rejection following a review by the engineer. Final acceptance of the material, work or process will be based on the engineer's sampling, testing and assessment.

106.13.1 Quality Control Plan. The contractor shall submit a Quality Control Plan (QCP) to the engineer for approval prior to beginning work. Separate QC plans for each type of work are permissible. The QCP shall include the following elements:

(a) The name and contact information of the person in responsible charge of the QC testing.

(b) A list of the QC technicians who will perform testing on the project, including the fields in which they are certified to perform testing.

(c) A proposed independent third party testing firm for dispute resolution, including all contact information.

(d) The list of standard holdpoints, or an adjusted list as approved by the engineer.

(e) When applicable, lot and sublot sizes and how they will be designated.

(f) The test methods to be used.

106.13.2 QC Testing and Reporting. QC testing shall be performed per the test method and frequency specified and when applicable by personnel who are certified in the MoDOT Technician Certification Program for each test being performed. For areas of testing and inspection not covered by the Technician Certification Program, QC shall coordinate with QA to ensure testing is accurate and follows industry standards. The contractor may utilize sub-contractors, producers or consultants to perform QC testing under the general direction of the contractor. The engineer shall be allowed to witness contractor QC testing at any time.

106.13.2.1 Checklists are available on MoDOT's website to assist QC staff with general quality control monitoring of the work. Submittal of completed checklists is not required, except as specified herein.

106.13.2.1.1 Monitoring and testing of the production of concrete shall be the responsibility of QC. Submittal of a completed 501 Concrete Plant checklist is required for each day of production.

106.13.2.2 All QC reports shall be submitted to the engineer as soon as practical, but no later than the day following the test. QC data shall be immediately provided to the engineer upon request at any time, including prior to the submission of the QC report. No payment will be made for the work performed until acceptable QC results have been received by the engineer and confirmed by QA test results.

106.13.2.3 QC results shall be reported on electronic forms where provided by MoDOT. Forms and the Contractor Reporting Excel2Oracle (CRE2O) worksheets can be found on MoDOT's website. All required forms, reports, supporting information, and materials certifications shall be uploaded to MoDOT's Microsoft Sharepoint® site and organized in the file structure established by MoDOT.

106.13.3 Non-Conformance Reporting. A Non-Conformance Report (NCR) shall be submitted by the contractor when the contractor proposes to incorporate material into the work that does not meet the testing requirements or for any work that does not comply with the contact terms or specifications. NCRs may be initiated by the engineer when QA finds material to be non-compliant.

106.13.3.1 Non-Conformance Reports shall be submitted electronically. After uploading, the contractor shall notify the engineer by email.

106.13.3.2 The contractor shall propose a resolution to the non-conforming material or work. The proposed resolution must be accepted by the engineer and successfully completed before the NCR is closed and the material or work is accepted for payment.

106.13.4 Hold Points. Hold points are events that require QA approval prior to continuation of work. A list of typical hold points is found on MoDOT's website.

The engineer will provide the contractor a project specific hold point list in advance of the work. The engineer may alter the project-specific hold point list at any time.

106.13.4.1 Prior to all hold point inspections, the contractor shall verify the work has been completed in accordance with the contract and specifications. When QA identifies any corrective actions needed during a hold point inspection, the corrections shall be completed prior to continuing work. The engineer may schedule a new hold point as part of any corrective actions. Re-scheduling a hold point requires a minimum of 24 hours of advance notice from the contractor, unless otherwise allowed by the engineer.

106.13.5 Dispute Resolution. When there are significant discrepancies between the engineer's and the contractor's test results, MoDOT's dispute resolution procedures will be used.

106.13.5.1 Cease Work. The contractor's operations may cease until the dispute is resolved, if any test results indicate the material or completed work is subject to failure and/or would impact subsequent operations.

106.13.5.2 Resolution of Differences. The first step in dispute resolution is to identify differences in procedures, and correcting inappropriate procedures, before moving to third party dispute resolution. If this step does not resolve the dispute, either the contractor or the engineer may request a previously approved third party to test the material. The test results of the approved third party shall be binding on both the engineer and contractor.

106.13.5.3 Third Party. The third party shall be independent of the contractor, MoDOT consultants and all project subcontractors or suppliers on each specific project. All testing of material for dispute resolution shall be performed by a laboratory accredited by AASHTO in the areas of the material being tested or otherwise approved by the engineer.

106.13.5.4 Third Party Payment. The contractor shall be responsible for the cost associated with the third party testing and dispute resolution if the final test result indicates the engineer's test results were correct. Likewise the Commission will be responsible for the cost associated with the third party testing and dispute resolution when the final test result indicates the contractor's results were correct.

106.13.5.5 Other Adjustments. The contractor shall not be entitled to any additional payment for costs incurred due to use of the dispute resolution procedures including, but not limited to, those for delay, cessation of operations, and/or costs to subcontractors. The engineer may consider adjusting working days, if warranted.

106.13.6 Outliers. No test result shall be discarded, except individual test results, on a lot basis, may be checked for an outlier in accordance with the statistic T in ASTM E 178, at a significance level of 5 percent. If an outlier is found, material from the retained QA sample may be tested, in the presence of the engineer, to determine a replacement test value. The replacement test value shall be used in the PWL determination.

106.14. Quality Level Analysis (QLA). Where indicated, material or work governed by QC/QA shall be subject to statistical analysis by the engineer. The resulting analysis may be used to determine pay adjustment.

106.14.1. PWL will be based on the mean, standard deviation and quality index of each lot's test results. The upper PWL (PWL_{UPPER}) and lower PWL (PWL_{LOWER}) is determined from the table in Sec 106.14.2 of these specifications.

Total percent within limits, PWL_{TOTAL}, is: $PWL_{TOTAL} = (PWL_{UPPER} + PWL_{LOWER}) - 100$.

The mean is: $x_a = (\sum x_i) / n$

Where: x_a = Average of the individual values being considered

$\sum x_i$ = The sum of all the individual values being considered

n = The number of individual values under consideration

The Standard Deviation is: $s = (\sum 2(x_i - x_a) / (n - 1))^{1/2}$

The Upper Quality Index is: $Q_{UPPER} = (USL - x_a) / s$

The Lower Quality Index is: $Q_{LOWER} = (x_a - LSL) / s$

Where: Q_{UPPER} = Upper Quality Index

Q_{LOWER} = Lower Quality Index

USL = Pay Factor Item Upper Spec Limit

LSL = Pay Factor Item Lower Spec Limit

106.14.2 PWL Determination Table. Values in Table I are estimates of the PWL corresponding to specific values of the Quality Index (Q). For Q values less than zero, the table shall be subtracted from 100.

TABLE I
Variability-Unknown Procedure
Standard-Deviation Method

Quality Index	PWL For Selected Sample Sizes							
(Q_U or Q_L)	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
0.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
0.01	50.28	50.33	50.36	50.37	50.37	50.38	50.38	50.38
0.02	50.55	50.67	50.71	50.74	50.75	50.76	50.76	50.77
0.03	50.83	51.00	51.07	51.10	51.12	51.13	51.15	51.15
0.04	51.10	51.34	51.42	51.47	51.50	51.51	51.53	51.54
0.05	51.38	51.67	51.78	51.84	51.87	51.89	51.91	51.92
0.06	51.66	52.00	52.14	52.21	52.24	52.27	52.29	52.30
0.07	51.93	52.33	52.49	52.57	52.62	52.65	52.67	52.69
0.08	52.21	52.67	52.85	52.94	52.99	53.02	53.06	53.07
0.09	52.48	53.00	53.20	53.30	53.37	53.40	53.44	53.46
0.10	52.76	53.33	53.56	53.67	53.74	53.78	53.82	53.84

0.11	53.04	53.66	53.91	54.04	54.11	54.16	54.20	54.22
0.12	53.32	54.00	54.27	54.40	54.48	54.54	54.58	54.60
0.13	53.59	54.33	54.62	54.77	54.86	54.91	54.95	54.99
0.14	53.87	54.67	54.98	55.13	55.23	55.29	55.33	55.37
0.15	54.15	55.00	55.33	55.50	55.60	55.67	55.71	55.75
0.16	54.43	55.33	55.68	55.86	55.97	56.04	56.09	56.13
0.17	54.71	55.67	56.04	56.23	56.34	56.42	56.47	56.51
0.18	54.98	56.00	56.39	56.59	56.72	56.79	56.84	56.89
0.19	55.26	56.34	56.75	56.96	57.09	57.17	57.22	57.27
0.20	55.54	56.67	57.10	57.32	57.46	57.54	57.60	57.65
0.21	55.82	57.00	57.45	57.68	57.83	57.91	57.98	58.03
0.22	56.10	57.33	57.81	58.05	58.20	58.29	58.35	58.40
0.23	56.39	57.67	58.16	58.41	58.56	58.66	58.73	58.78
0.24	56.67	58.00	58.52	58.78	58.93	59.04	59.10	59.15
0.25	56.95	58.33	58.87	59.14	59.30	59.41	59.48	59.53
0.26	57.23	58.66	59.22	59.50	59.67	59.78	59.85	59.90
0.27	57.52	59.00	59.57	59.86	60.03	60.15	60.22	60.28
0.28	57.80	59.33	59.93	60.22	60.40	60.51	60.60	60.65
0.29	58.09	59.67	60.28	60.58	60.76	60.88	60.97	61.03
0.30	58.37	60.00	60.63	60.94	61.13	61.25	61.34	61.40
0.31	58.66	60.33	60.98	61.30	61.49	61.62	61.71	61.77
0.32	58.94	60.67	61.33	61.66	61.85	61.98	62.08	62.14
0.33	59.23	61.00	61.68	62.01	62.22	62.35	62.44	62.51
0.34	59.51	61.34	62.03	62.37	62.58	62.71	62.81	62.88
0.35	59.80	61.67	62.38	62.73	62.94	63.08	63.18	63.25
0.36	60.09	62.00	62.73	63.09	63.30	63.44	63.54	63.61
0.37	60.38	62.33	63.08	63.44	63.66	63.80	63.91	63.98
0.38	60.68	62.67	63.42	63.80	64.02	64.17	64.27	64.34
0.39	60.97	63.00	63.77	64.15	64.38	64.53	64.64	64.71
0.40	61.26	63.33	64.12	64.51	64.74	64.89	65.00	65.07
0.41	61.56	63.66	64.46	64.86	65.09	65.25	65.36	65.43
0.42	61.85	64.00	64.81	65.21	65.45	65.60	65.72	65.79
0.43	62.15	64.33	65.15	65.57	65.80	65.96	66.07	66.15
0.44	62.44	64.67	65.50	65.92	66.16	66.31	66.43	66.51
0.45	62.74	65.00	65.84	66.27	66.51	66.67	66.79	66.87
0.46	63.04	65.33	66.18	66.62	66.86	67.02	67.14	67.22
0.47	63.34	65.67	66.53	66.96	67.21	67.37	67.49	67.57
0.48	63.65	66.00	66.87	67.31	67.56	67.73	67.85	67.93
0.49	63.95	66.34	67.22	67.65	67.91	68.08	68.20	68.28
0.50	64.25	66.67	67.56	68.00	68.26	68.43	68.55	68.63
0.51	64.56	67.00	67.90	68.34	68.61	68.78	68.90	68.98

0.52	64.87	67.33	68.24	68.69	68.95	69.12	69.24	69.32
0.53	65.18	67.67	68.58	69.03	69.30	69.47	69.59	69.67
0.54	65.49	68.00	68.92	69.38	69.64	69.81	69.93	70.01
0.55	65.80	68.33	69.26	69.72	69.99	70.16	70.28	70.36
0.56	66.12	68.66	69.60	70.06	70.33	70.50	70.62	70.70
0.57	66.44	69.00	69.94	70.40	70.67	70.84	70.96	71.04
0.58	66.75	69.33	70.27	70.73	71.00	71.17	71.29	71.38
0.59	67.07	69.67	70.61	71.07	71.34	71.51	71.63	71.72
0.60	67.39	70.00	70.95	71.41	71.68	71.85	71.97	72.06
0.61	67.72	70.33	71.28	71.74	72.01	72.11	72.30	72.39
0.62	68.05	70.67	71.61	72.08	72.34	72.37	72.63	72.72
0.63	68.37	71.00	71.95	72.41	72.68	72.63	72.97	73.06
0.64	68.70	71.34	72.28	72.75	73.01	72.89	73.30	73.39
0.65	69.03	71.67	72.61	73.08	73.34	73.15	73.63	73.72
0.66	69.37	72.00	72.94	73.41	73.67	73.55	73.95	74.04
0.67	69.71	72.33	73.27	73.73	73.99	73.95	74.28	74.36
0.68	70.05	72.67	73.60	74.06	74.32	74.35	74.60	74.69
0.69	70.39	73.00	73.93	74.38	74.64	74.75	74.93	75.01
0.70	70.73	73.33	74.26	74.71	74.97	75.15	75.25	75.33
0.71	71.08	73.66	74.59	75.03	75.29	75.46	75.57	75.64
0.72	71.44	74.00	74.91	75.35	75.61	75.78	75.88	75.96
0.73	71.79	74.33	75.24	75.68	75.92	76.09	76.20	76.27
0.74	72.15	74.67	75.56	76.00	76.24	76.41	76.51	76.59
0.75	72.50	75.00	75.89	76.32	76.56	76.72	76.83	76.90
0.76	72.87	75.33	76.21	76.63	76.87	77.03	77.14	77.21
0.77	73.24	75.67	76.53	76.95	77.18	77.34	77.44	77.51
0.78	73.62	76.00	76.85	77.26	77.50	77.64	77.75	77.82
0.79	73.99	76.34	77.17	77.58	77.81	77.95	78.05	78.12
0.80	74.36	76.67	77.49	77.89	78.12	78.26	78.36	78.43
0.81	74.75	77.00	77.81	78.20	78.42	78.56	78.66	78.72
0.82	75.15	77.33	78.12	78.51	78.72	78.86	78.95	79.02
0.83	75.54	77.67	78.44	78.81	79.03	79.16	79.25	79.31
0.84	75.94	78.00	78.75	79.12	79.33	79.46	79.54	79.61
0.85	76.33	78.33	79.07	79.43	79.63	79.76	79.84	79.90
0.86	76.75	78.66	79.38	79.73	79.92	80.05	80.13	80.19
0.87	77.18	79.00	79.69	80.03	80.22	80.34	80.42	80.47
0.88	77.60	79.33	80.00	80.33	80.51	80.63	80.70	80.76
0.89	78.03	79.67	80.31	80.63	80.81	80.92	80.99	81.04
0.90	78.45	80.00	80.62	80.93	81.10	81.21	81.28	81.33
0.91	78.91	80.33	80.92	81.22	81.38	81.49	81.56	81.61
0.92	79.37	80.67	81.23	81.51	81.67	81.77	81.84	81.88

0.93	79.83	81.00	81.53	81.81	81.95	82.05	82.11	82.16
0.94	80.29	81.34	81.84	82.10	82.24	82.33	82.39	82.43
0.95	80.75	81.67	82.14	82.39	82.52	82.61	82.67	82.71
0.96	81.27	82.00	82.44	82.67	82.80	82.88	82.94	82.97
0.97	81.78	82.33	82.74	82.95	83.07	83.15	83.20	83.24
0.98	82.30	82.67	83.04	83.24	83.35	83.42	83.47	83.50
0.99	82.81	83.00	83.34	83.52	83.62	83.69	83.73	83.77
1.00	83.33	83.33	83.64	83.80	83.90	83.96	84.00	84.03
1.01	83.93	83.66	83.93	84.08	84.17	84.22	84.26	84.28
1.02	84.53	84.00	84.22	84.35	84.43	84.48	84.51	84.53
1.03	85.14	84.33	84.51	84.63	84.70	84.74	84.77	84.79
1.04	85.74	84.67	84.80	84.90	84.96	85.00	85.02	85.04
1.05	86.34	85.00	85.09	85.18	85.23	85.26	85.28	85.29
1.06	87.10	85.33	85.38	85.44	85.49	85.51	85.53	85.53
1.07	87.87	85.67	85.66	85.71	85.74	85.76	85.77	85.77
1.08	88.63	86.00	85.95	85.97	86.00	86.01	86.02	86.02
1.09	89.40	86.34	86.23	86.24	86.25	86.26	86.26	86.26
1.10	90.16	86.67	86.52	86.50	86.51	86.51	86.51	86.50
1.11	91.55	87.00	86.80	86.76	86.75	86.75	86.74	86.73
1.12	92.95	87.33	87.07	87.01	87.00	86.99	86.98	86.96
1.13	94.34	87.67	87.35	87.27	87.24	87.22	87.21	87.20
1.14	95.74	88.00	87.62	87.52	87.49	87.46	87.45	87.43
1.15	97.13	88.33	87.90	87.78	87.73	87.70	87.68	87.66
1.16	100.00	88.66	88.17	88.03	87.96	87.93	87.90	87.88
1.17	100.00	89.00	88.44	88.27	88.20	88.15	88.12	88.10
1.18	100.00	89.33	88.70	88.52	88.43	88.38	88.35	88.32
1.19	100.00	89.67	88.97	88.76	88.67	88.60	88.57	88.54
1.20	100.00	90.00	89.24	89.01	88.90	88.83	88.79	88.76
1.21	100.00	90.33	89.50	89.25	89.12	89.05	89.00	88.97
1.22	100.00	90.67	89.76	89.48	89.35	89.26	89.21	89.17
1.23	100.00	91.00	90.02	89.72	89.57	89.48	89.43	89.38
1.24	100.00	91.34	90.28	89.95	89.80	89.69	89.64	89.58
1.25	100.00	91.67	90.54	90.19	90.02	89.91	89.85	89.79
1.26	100.00	92.00	90.79	90.41	90.23	90.12	90.05	89.99
1.27	100.00	92.33	91.04	90.64	90.44	90.32	90.25	90.19
1.28	100.00	92.67	91.29	90.86	90.65	90.53	90.44	90.38
1.29	100.00	93.00	91.54	91.09	90.86	90.73	90.64	90.58
1.30	100.00	93.33	91.79	91.31	91.07	90.94	90.84	90.78
1.31	100.00	93.66	92.03	91.52	91.27	91.13	91.03	90.96
1.32	100.00	94.00	92.27	91.73	91.47	91.32	91.22	91.15
1.33	100.00	94.33	92.50	91.95	91.68	91.52	91.40	91.33

1.34	100.00	94.67	92.74	92.16	91.88	91.71	91.59	91.52
1.35	100.00	95.00	92.98	92.37	92.08	91.90	91.78	91.70
1.36	100.00	95.33	93.21	92.57	92.27	92.08	91.96	91.87
1.37	100.00	95.67	93.44	92.77	92.46	92.26	92.14	92.04
1.38	100.00	96.00	93.66	92.97	92.64	92.45	92.31	92.22
1.39	100.00	96.34	93.89	93.17	92.83	92.63	92.49	92.39
1.40	100.00	96.67	94.12	93.37	93.02	92.81	92.67	92.56
1.41	100.00	97.00	94.33	93.56	93.20	92.98	92.83	92.72
1.42	100.00	97.33	94.55	93.75	93.37	93.15	93.00	92.88
1.43	100.00	97.67	94.76	93.94	93.55	93.31	93.16	93.05
1.44	100.00	98.00	94.98	94.13	93.72	93.48	93.33	93.21
1.45	100.00	98.33	95.19	94.32	93.90	93.65	93.49	93.37
1.46	100.00	98.66	95.39	94.49	94.06	93.81	93.64	93.52
1.47	100.00	99.00	95.59	94.67	94.23	93.97	93.80	93.67
1.48	100.00	99.33	95.80	94.84	94.39	94.12	93.95	93.83
1.49	100.00	99.67	96.00	95.02	94.56	94.28	94.11	93.98
1.50	100.00	100.00	96.20	95.19	94.72	94.44	94.26	94.13
1.51	100.00	100.00	96.39	95.35	94.87	94.59	94.40	94.27
1.52	100.00	100.00	96.57	95.51	95.02	94.73	94.54	94.41
1.53	100.00	100.00	96.76	95.68	95.18	94.88	94.69	94.54
1.54	100.00	100.00	96.94	95.84	95.33	95.02	94.83	94.68
1.55	100.00	100.00	97.13	96.00	95.48	95.17	94.97	94.82
1.56	100.00	100.00	97.30	96.15	95.62	95.30	95.10	94.95
1.57	100.00	100.00	97.47	96.30	95.76	95.44	95.23	95.08
1.58	100.00	100.00	97.63	96.45	95.89	95.57	95.36	95.20
1.59	100.00	100.00	97.80	96.60	96.03	95.71	95.49	95.33
1.60	100.00	100.00	97.97	96.75	96.17	95.84	95.62	95.46
1.61	100.00	100.00	98.12	96.88	96.30	95.96	95.74	95.58
1.62	100.00	100.00	98.27	97.02	96.43	96.08	95.86	95.70
1.63	100.00	100.00	98.42	97.15	96.55	96.21	95.98	95.81
1.64	100.00	100.00	98.57	97.29	96.68	96.33	96.10	95.93
1.65	100.00	100.00	98.72	97.42	96.81	96.45	96.22	96.05
1.66	100.00	100.00	98.84	97.54	96.92	96.56	96.33	96.16
1.67	100.00	100.00	98.97	97.66	97.04	96.67	96.44	96.27
1.68	100.00	100.00	99.09	97.78	97.15	96.79	96.54	96.37
1.69	100.00	100.00	99.22	97.90	97.27	96.90	96.65	96.48
1.70	100.00	100.00	99.34	98.02	97.38	97.01	96.76	96.59
1.71	100.00	100.00	99.43	98.13	97.48	97.11	96.86	96.69
1.72	100.00	100.00	99.53	98.23	97.58	97.21	96.96	96.78
1.73	100.00	100.00	99.62	98.34	97.69	97.31	97.05	96.88
1.74	100.00	100.00	99.72	98.44	97.79	97.41	97.15	96.97

1.75	100.00	100.00	99.81	98.55	97.89	97.51	97.25	97.07
1.76	100.00	100.00	99.86	98.64	97.98	97.60	97.34	97.16
1.77	100.00	100.00	99.91	98.73	98.07	97.69	97.43	97.25
1.78	100.00	100.00	99.95	98.81	98.17	97.78	97.52	97.33
1.79	100.00	100.00	100.00	98.90	98.26	97.87	97.61	97.42
1.80	100.00	100.00	100.00	98.99	98.35	97.96	97.70	97.51
1.81	100.00	100.00	100.00	99.06	98.43	98.04	97.78	97.59
1.82	100.00	100.00	100.00	99.14	98.51	98.12	97.86	97.67
1.83	100.00	100.00	100.00	99.21	98.58	98.19	97.93	97.75
1.84	100.00	100.00	100.00	99.29	98.66	98.27	98.01	97.83
1.85	100.00	100.00	100.00	99.36	98.74	98.35	98.09	97.91
1.86	100.00	100.00	100.00	99.42	98.81	98.42	98.16	97.98
1.87	100.00	100.00	100.00	99.48	98.87	98.49	98.23	98.05
1.88	100.00	100.00	100.00	99.53	98.94	98.55	98.30	98.11
1.89	100.00	100.00	100.00	99.59	99.00	98.62	98.37	98.18
1.90	100.00	100.00	100.00	99.65	99.07	98.69	98.44	98.25
1.91	100.00	100.00	100.00	99.69	99.13	98.75	98.50	98.31
1.92	100.00	100.00	100.00	99.73	99.18	98.81	98.56	98.37
1.93	100.00	100.00	100.00	99.77	99.24	98.87	98.62	98.44
1.94	100.00	100.00	100.00	99.81	99.29	98.93	98.68	98.50
1.95	100.00	100.00	100.00	99.85	99.35	98.99	98.74	98.56
1.96	100.00	100.00	100.00	99.87	99.39	99.04	98.79	98.61
1.97	100.00	100.00	100.00	99.90	99.44	99.09	98.84	98.67
1.98	100.00	100.00	100.00	99.92	99.48	99.14	98.90	98.72
1.99	100.00	100.00	100.00	99.95	99.53	99.19	98.95	98.78
2.00	100.00	100.00	100.00	99.97	99.57	99.24	99.00	98.83
2.01	100.00	100.00	100.00	99.98	99.60	99.28	99.05	98.88
2.02	100.00	100.00	100.00	99.98	99.64	99.32	99.09	98.92
2.03	100.00	100.00	100.00	99.99	99.67	99.37	99.14	98.97
2.04	100.00	100.00	100.00	99.99	99.71	99.41	99.18	99.01
2.05	100.00	100.00	100.00	100.00	99.74	99.45	99.23	99.06
2.06	100.00	100.00	100.00	100.00	99.76	99.48	99.27	99.10
2.07	100.00	100.00	100.00	100.00	99.79	99.51	99.30	99.14
2.08	100.00	100.00	100.00	100.00	99.81	99.55	99.34	99.18
2.09	100.00	100.00	100.00	100.00	99.84	99.58	99.37	99.22
2.10	100.00	100.00	100.00	100.00	99.86	99.61	99.41	99.26
2.11	100.00	100.00	100.00	100.00	99.88	99.64	99.44	99.29
2.12	100.00	100.00	100.00	100.00	99.89	99.66	99.47	99.32
2.13	100.00	100.00	100.00	100.00	99.91	99.69	99.51	99.36
2.14	100.00	100.00	100.00	100.00	99.92	99.71	99.54	99.39
2.15	100.00	100.00	100.00	100.00	99.94	99.74	99.57	99.42

2.16	100.00	100.00	100.00	100.00	99.95	99.76	99.59	99.45
2.17	100.00	100.00	100.00	100.00	99.96	99.78	99.62	99.48
2.18	100.00	100.00	100.00	100.00	99.97	99.80	99.64	99.50
2.19	100.00	100.00	100.00	100.00	99.98	99.82	99.67	99.53
2.20	100.00	100.00	100.00	100.00	99.99	99.84	99.69	99.56
2.21	100.00	100.00	100.00	100.00	99.99	99.85	99.71	99.58
2.22	100.00	100.00	100.00	100.00	99.99	99.87	99.73	99.61
2.23	100.00	100.00	100.00	100.00	100.00	99.88	99.75	99.63
2.24	100.00	100.00	100.00	100.00	100.00	99.90	99.77	99.66
2.25	100.00	100.00	100.00	100.00	100.00	99.91	99.79	99.68
2.26	100.00	100.00	100.00	100.00	100.00	99.92	99.80	99.70
2.27	100.00	100.00	100.00	100.00	100.00	99.93	99.82	99.72
2.28	100.00	100.00	100.00	100.00	100.00	99.94	99.83	99.73
2.29	100.00	100.00	100.00	100.00	100.00	99.95	99.85	99.75
2.30	100.00	100.00	100.00	100.00	100.00	99.96	99.86	99.77
2.31	100.00	100.00	100.00	100.00	100.00	99.96	99.87	99.78
2.32	100.00	100.00	100.00	100.00	100.00	99.97	99.88	99.80
2.33	100.00	100.00	100.00	100.00	100.00	99.97	99.90	99.81
2.34	100.00	100.00	100.00	100.00	100.00	99.98	99.91	99.83
2.35	100.00	100.00	100.00	100.00	100.00	99.98	99.92	99.84
2.36	100.00	100.00	100.00	100.00	100.00	99.98	99.93	99.85
2.37	100.00	100.00	100.00	100.00	100.00	99.99	99.93	99.86
2.38	100.00	100.00	100.00	100.00	100.00	99.99	99.94	99.87
2.39	100.00	100.00	100.00	100.00	100.00	100.00	99.94	99.88
2.40	100.00	100.00	100.00	100.00	100.00	100.00	99.95	99.89
2.41	100.00	100.00	100.00	100.00	100.00	100.00	99.96	99.90
2.42	100.00	100.00	100.00	100.00	100.00	100.00	99.96	99.91
2.43	100.00	100.00	100.00	100.00	100.00	100.00	99.97	99.91
2.44	100.00	100.00	100.00	100.00	100.00	100.00	99.97	99.92
2.45	100.00	100.00	100.00	100.00	100.00	100.00	99.98	99.93
2.46	100.00	100.00	100.00	100.00	100.00	100.00	99.98	99.94
2.47	100.00	100.00	100.00	100.00	100.00	100.00	99.98	99.94
2.48	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.95
2.49	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.95
2.50	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.96
2.51	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.96
2.52	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.97
2.53	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.97
2.54	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.98
2.55	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.98
2.56	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.98

2.57	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.98
2.58	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
2.59	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
2.60	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
2.61	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
2.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
2.63	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2.64	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2.65	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

~~**106.13.1 Access to Contractor QC Testing.** The engineer shall be allowed to witness contractor QC testing at any time.~~

106.145 Proprietary Items. In the event a proprietary item included in a contract becomes unavailable during the term of the contract, the contractor shall promptly provide documentation to the engineer substantiating that the proprietary item is unavailable. Price or credit terms demanded of the contractor by the supplier will not constitute sufficient reason to substitute for the specified proprietary item. As part of the documentation, the contractor shall propose an alternative source or item that meets the performance requirements of the original proprietary item included in the contract. Any adjustment in the contract unit price shall be made in accordance with Sec 109.4. If an acceptable alternative item cannot be located, the proprietary item and any associated work may be underrun from the contract.

copyright, service or trademark, the contractor shall arrange and provide for such use by suitable agreement with the patentee or owner, and a copy of the agreement may be required by the Commission. The contractor and surety shall indemnify and save harmless the State, the Commission, the Commission's agents, employees and assigns from any suits, claims or damages arising from the infringement upon or use of any patented, copyrighted or registered design, device, material, process or mark.

107.4 Safety and Sanitary Provisions The contractor shall at all times take necessary precautions to protect the life and health of all persons employed on the project or, who at the direction of the contractor are present on the right of way. The contractor shall be familiar with the latest accepted accident prevention methods and shall provide necessary safety devices and safeguards accordingly. The Commission will refuse to provide inspection services at plants or work sites where adequate safety measures are not provided and maintained.

107.4.1 Apparel. All workers within highway right of way shall wear approved ANSI/ISEA 107 Performance Class 2 or 3 safety apparel and more specifically as follows:

107.4.1.1 During daytime activities, flaggers shall wear a high visibility hard hat, safety glasses, a Performance Class 3 top OR a Performance Class 2 top, and safety footwear. Hard hats other than high visibility orange or green shall be covered with a high visibility covering.

107.4.1.2 During daytime activities, workers shall wear a hard hat, safety glasses, a Performance Class 3 top OR a Performance Class 2 top, and safety footwear.

107.4.1.3 During nighttime activities, flaggers shall wear a high visibility/reflective hard hat, safety glasses, a Performance Class 3 top AND Class E bottoms, OR Performance Class 2 top AND Class E bottoms, and safety footwear. Hard hats shall be reflective or covered with a high visibility covering.

107.4.1.4 During nighttime activities, workers shall wear a hard hat, safety glasses, a Performance Class 3 top OR Performance Class 2 top AND Class E bottoms, and safety footwear.

107.4.2 The contractor shall provide and maintain in a neat and sanitary condition, such accommodations for the use of employees as may be necessary to comply with the requirements and regulations of any agency having jurisdiction over public health and sanitation. The contractor shall permit no public or private nuisance.

107.4.3 All sanitary facilities and safety devices shall be furnished free to employees and no direct payment will be made for such facilities or devices.

107.4.4 Safety Plan.

107.4.4.1 Description. The contractor shall submit to the engineer a project Safety Plan (SP) for all work performed by the contractor and all subcontractors. The purpose of the SP is to encourage and enable all work to be performed in the safest possible manner and that all parties involved are aware of their individual responsibility for safety on the jobsite.

107.4.4.1.1 The SP shall be completed by the contractor and provided to the engineer prior to the beginning of any construction activity or phase on the project.

107.4.4.1.2 The contractor shall designate a person to serve as Project Safety Manager (PSM). The PSM shall be responsible for implementing and overseeing the SP. The PSM is not

required to be present on the project at all times, but must be available to address safety issues and needs.

107.4.4.1.3 The PSM shall make revisions to the SP as necessary. Any new project activities or phases shall be included in the SP prior to work beginning on that activity or phase.

107.4.4.1.4 An example Safety Plan is available at: www.modot.org/safety-plan

107.4.4.2 Emergency Preparedness. The SP shall outline and detail for all workers, the specific procedures and actions necessary to respond to a jobsite emergency and the measures taken to communicate these requirements to all workers.

107.4.4.2.1 The SP shall include a list of local emergency contacts including phone numbers. A copy of the emergency contact list shall be accessible to all workers.

107.4.4.2.2 In the case where there is no cellular or land line phone service at the jobsite, the SP shall identify how to reach the nearest available phone service.

107.4.4.3 Project Safety Analysis. The SP should contain a basic Project Safety Analysis (PSA) that outlines the actions necessary to complete each activity or phase of the project safely. The PSA shall include a general description of the primary activities or steps required to safely complete the project.

107.4.4.3.1 Each activity should also include a general description of the work involved along with the known risks associated with the activity. In addition the PSA should outline the controls for those risks, including any Personal Protection Equipment (PPE) requirements for that activity or phase, and whether or not the activity or phase requires a specific safety meeting prior to beginning the activity or phase.

107.4.4.3.2 Submittal of the PSA for all activities or phases is not required with the initial submittal of the SP; however, a PSA should be completed for each activity or phase prior to the beginning of that activity or phase.

107.4.4.4 Safety Meetings. The SP shall include the types of safety meetings that will be required of and conducted by the contractor.

107.4.4.5 Safety Training. The SP shall identify the required safety training provided to the contractor's personnel. The contractor shall require that the appropriate safety training for the contractor's personnel is completed prior to the beginning of work on each activity or phase.

107.4.4.5.1 The SP shall identify the recommended safety training needs and PPE for MoDOT employees who will be exposed to the work activities. MoDOT will provide safety training and PPE to MoDOT employees based on MoDOT safety policies.

107.5 Public Convenience and Safety The contractor shall conduct the work in a manner that will ensure, as far as practical, the least obstruction to traffic and shall provide for the convenience and safety of the general public and residents along and adjacent to the highway in an adequate and satisfactory manner.

107.5.1 Obstructions Prohibited Fire hydrants on and adjacent to the highway shall be kept accessible to fire fighting apparatus at all times, and no obstruction shall be placed within15 feet of any such hydrant. Footways, gutters, sewers, outlets, inlets and portions of highways adjoining the work under construction shall not be obstructed. Pavements over which hauling is performed shall be kept clean of spilled or tracked-on material at all times when in use by traffic.

shall be fully responsible for the prosecution and coordination of all work being performed under the contract.

108.3.2 The work in progress shall receive the personal attention either of the contractor or of a competent and reliable representative of the contractor who shall have full and final authority to act for the contractor. If authority is delegated to a representative of the contractor, the contractor shall notify the engineer in writing, stating the name of the person authorized to act as the contractor's representative, and stating the name or names of persons authorized to sign the various documents such as weekly reports, change orders, force account statements, labor payrolls and any other documents that may be required during the progress of the work. If progress at any time is not adequate to meet the contractor's schedule and the contract completion time, the contractor shall take all steps necessary to complete the work in the time and manner specified in the contract.

108.3.3 Prior to beginning any work on contracts involving a joint venture, the joint venturers shall appoint and maintain a single representative having full and final authority to act for the joint venture. The engineer shall be notified in writing of the name of this representative and of any replacements.

108.3.4 Weekly Meeting. When work is active, the contractor shall hold a weekly project meeting with the engineer to review the planned activities for the following week and to resolve any outstanding issues. Attendees shall include the engineer, the contractor superintendent or project manager and any foreman leading major activities. This meeting may be waived when, in the opinion of the engineer, a meeting is not necessary.

108.3.5 Pre-Activity Meeting. A pre-activity meeting is required in advance of the start of each new activity, except when waived by the engineer. The purpose of this meeting is to review construction details of the new activity. At a minimum, the discussion topics shall include: safety precautions, QC testing, traffic impacts, and any required hold points. Attendees shall include the engineer, the contractor superintendent and the foreman who will be leading the new activity. Pre-activity meetings may be held in conjunction with the weekly project meeting.

108.4 Progress Schedules. The contractor shall submit a progress schedule to the engineer for review prior to or at the pre-construction conference. The progress schedule shall be used to establish construction operations and to monitor the progress of the work, although the engineer's determination of the then major operation or controlling item of work will always prevail. The progress schedule shall be in the form specified in Sec 108.4.1, unless the contract contains different requirements. The progress schedule shall be based on the number of working days, calendar days or other increments as set forth in the contract that the contractor expects to require in completing the project, recognizing the capabilities of labor, equipment, arrangements for material, mobilization, shop drawing preparation and approvals, and other relevant items. If an electronic computer software program is used to generate the schedule, the contractor shall also provide copies of the native files of the initial and any revised schedules using MoDOT's Sharepoint® site.~~shall be accompanied by a disk containing the schedule files in the native format of the software program used to create the schedule. The disk shall be labeled with the contract ID, route, county, date of revision, and the name of the software program used. The contractor will not be required to provide any copies of the software program.~~

108.4.1 Form and Contents of Progress Schedule. The progress schedule shall contain an activities schedule bar chart and may, at the contractor's option, include a written narrative that breaks down into detail the time in working days, calendar days or completion date involved in performing all construction activities for the duration of the project, and which is in a

suitable scale as to indicate the percentage of work scheduled for completion at any time. The schedule shall indicate all interdependencies between activities. The progress schedule shall also clearly outline the intended maintenance of traffic, work phasing provided by the contract and such other information, as required by the contract.

108.4.2 Preparation of Initial Schedule. The contractor shall complete development of a progress schedule and present a copy to the engineer prior to or at the pre-construction conference.

108.4.2.1 The construction time, as indicated by the progress schedule, for the entire project or any milestone, shall not exceed the specified contract time. If any milestone date or contract completion date is exceeded in the schedule, time estimates on the progress schedule shall be revised. The controlling activity shall be clearly shown for each day of the schedule. A controlling activity will be defined as that part of a progress-controlling item or items that must be performed before the next progress-controlling item of work can be started. Following a review of the progress schedule by the engineer, the engineer and contractor will meet for a joint review, correction and adjustment of the schedule, if necessary.

108.4.2.2 If necessary this process will be repeated. However, the schedule shall be finalized by the contractor within seven days after request for correction and adjustment to the schedule.

108.4.3 Cost and Intent of Progress Schedules. The review by the engineer of any progress schedule will not constitute a determination that the schedule is reasonable, that following the schedule will result in timely completion, or that deviation will result in a delayed completion. The progress schedule, and any updates provided, is not a part of the contract. If the schedule reflects a completion date different than that specified in the contract, that does not void the completion date or working days specified in the contract. If any schedule reflects a completion time earlier than that specified in the contract, the contractor specifically understands that no claim for additional contract time or compensation will lie against the Commission if the work is not completed by the earlier time shown on the schedule. It will be the contractor's responsibility to determine the most feasible order of work consistent with the requirements of the contract.

108.4.3.1 No direct payment will be made for furnishing progress schedules or revisions.

108.4.3.2 If the contractor fails to comply with the requirement to supply an initial or any revised progress schedule, the engineer may withhold progress payments until a schedule has been submitted and reviewed.

108.4.4 Revised Progress Schedules. The contractor shall provide a revised progress schedule, which will then become the current progress schedule:

(a) When departure from the existing progress schedule makes it apparent to the engineer or the contractor that the project will not be completed in the time provided in the contract.

(b) When the engineer or the contractor determines that the progress schedule requires revisions for any reason.

108.4.5 Two-Week Schedule. For each week that construction is active on the project, the contractor shall submit to the engineer a two-week schedule that outlines the planned project activities for the following two-week period. At a minimum, the two-week schedule shall detail all planned work activities, traffic control events, and requested inspection hold points.

will be calculated in accordance with Sec 109.15.1 Asphalt Cement Price Index, except as defined herein.

109.15.4.1 Basis of Payment. To determine the adjustment for any material specified in this provision the following formula will be used.

A = B X (0.9/2000) x (D – E)

Where: A = adjustment for membrane placed during the index period
B = square yards of membrane placed during the index period
D = average index price at the beginning of the period
E = average index price at time of bid

109.15.4.2 Optional. This provision is optional. If the bidder wishes to be bound by the provision, the bidder shall execute the acceptance form in the Bid for Polymer Modified Emulsion Membrane (UBAWS). Failure by the bidder to execute the acceptance form will be interpreted to mean election not to participate in the Polymer Modified Emulsion Membrane Price Index (UBAWS).

109.16 Fixed Cost Items. The following fixed prices shall be used when referenced in the specifications:

Sec	Item No.	Item of Work	Unit	Fixed Price
201.4.3	201-30.00	Clearing and Grubbing	Acre	$3,500.00
203.9.4	**≤500 cy**			
	203-20.00	Class C Excavation	cy	$25.00
	>500 cy but < 2000 cy			
	203-20.00	Class C Excavation	cy	$20.00
	≥ 2000 cy)			
	203-20.00	Class C Excavation	cy	$8.00
206.6.2	206-36.00	Supplemental Foundation Test Holes	ft	$6.00
206.6.3.1	206-10.03	Class 1 Excavation in Rock	cy	$120.00
206.6.3.2	206-20.03	Class 2 Excavation in Rock	cy	$170.00
206.6.3.3	206-31.00	Class 3 Excavation in Rock	cy	$85.00
206.6.3.4	206-34.00	Class 4 Excavation in Rock	cy	$85.00
214.5.1.2	214-20.00	Furnishing Rock Fill	cy	$15.00
303.5.1.2	303-06.00	Furnishing Rock Base Material	sy	$10.00
401.14	401-05.00	Sample of Compacted Plant Mix Bituminous Pavement	Each	$75.00
403.23.2	403-05.00	Sample of Compacted Asphaltic Concrete Pavement	Each	$75.00
611.30.5.1	611-30.10	Furnishing Type 1 Rock Blanket	cy	$24.00
	611-30.20	Furnishing Type 2 Rock Blanket	cy	$25.00
701.7.7	701-15.00	Concrete Coring	lf	$100.00
703.5.1	**Concrete Fill > 2 cy**			
	703-20.02	Class B Concrete (Misc)	cy	$500.00
703.5.1	**Concrete Fill < 2 cy**			
	703-20.02	Class B Concrete (Misc)	cy	$750.00
704.6	706-10.00	Reinforcing Steel	lb	$2.00

109.17. Vehicle Scales. Vehicle scales shall be approved by the engineer and shall be in accordance with the requirements specified herein.

109.17.1 Basis of Acceptance. Scale acceptance will be based on one of the following:

(a) A valid certification or seal of approval by the Missouri Department of Agriculture, Division of Weights and Measures.

(b) A valid certification or seal of approval by a State of Missouri duly appointed Sealer of Weights and Measures in cities or counties of 75,000 population or more.

(c) Certification of calibration from a commercial scale service company showing that the scale meets the requirements of these specifications. The contractor shall furnish the certification of calibration to the engineer.

(d) Calibration from zero weight through the maximum load to be applied by the application of standard weights in the presence of the engineer by the contractor's personnel. In lieu of starting the calibration at zero weight, standard weights may be applied to an unloaded truck, the weight of which has been determined on a certified scale and the calibration continued through the maximum load to be applied.

Regardless of the form of acceptance, the calibration shall be within the accuracy requirements specified in Sec 109.16, and the scales shall meet all requirements of these specifications.

109.17.2 Scale Calibration. Scales shall have been calibrated within the 12-month period immediately prior to any material being delivered or any time the engineer has cause to question the accuracy of the scale. Scales shall be accurate to within 0.4 percent of the net load applied, regardless of the location of the load on the platform. The value of the smallest unit of graduation on a scale shall be no greater than 20 pounds. Sensitivity requirements of scales not equipped with balance indicators shall be twice the value of the minimum graduated interval on the weigh beam or 0.2 percent of the nominal capacity of the scale, whichever is less. For scales equipped with balance indicators, the sensitivity requirement shall be the value of the minimum graduated interval on the weigh beam.

109.17.3 Verification. Verification of a vehicle scale may be required by the engineer at any time. Weighing a hauling unit on another recently calibrated and certified scale is an acceptable method of verification.

109.17.4 Long Vehicles. If equipment to be weighed is of such length that all axles cannot be weighed simultaneously, a level area of concrete or bituminous pavement shall be provided permitting those axles not on the scale platform to be on the pavement during the weighing operation. The approach shall be at least as wide as the platform and of sufficient length to ensure the level positioning of vehicles during weight determinations. The weighing shall be performed with all brakes released. If equipment to be weighed is equipped with an air bag suspension unit on any axle, the equipment, including semi-trailers or pup trailers, shall be determined on vehicle scales of sufficient size to weigh all axles of the combination simultaneously.

109.17.5 Certification. All costs incurred in obtaining certification of calibration or verification shall be at the contractor’s expense.

106.13 Contract Quality Control/Quality Assurance

Sec 106.13 provides information for how the Quality Control/Quality Assurance (QC/QA) shall be administered on projects where acceptance of material or work is governed by QC/QA. Some jobs deemed more complex or with a larger scale are governed by Quality Management as described in the related JSP and EPG 150 Quality Management.

For QC/QA work, QC testing is performed by the contractor and QA testing is performed by MoDOT. Consultant inspection may be hired by either side to represent them. Specification requirements and deviation limits for testing of materials are located or are referenced within the material's respective Standard Specification.

MoDOT specifications have included QC/QA for over a decade in certain areas. Recently this approach has been standardized and expanded to include all specifications. Be aware that during the implementation of this new approach, not all work item sections may be been updated and as a result some jobs include a JSP to applied QC/QA to those sections.

The standardized format contains these sections related to the QC/QA program:

1) QC. This section houses all the specific instructions for QC responsibilities and details about the individual tests required.
2) QA. This section includes QA responsibilities, QCs responsibilities for cooperation with QA, and has comparison limits for QA's independent and split samples.
3) QC/QA Frequency Table. A table of the applicable tests and their corresponding testing frequencies. Note that this table may have different frequencies for small quantities or specific types of construction work as needed.

Quality Control Plan (QCP). QCP as discussed in Sec 106.3 are required for most work items, but do not have to be customized for each project so long as it covers the specifications and expected situations found on that particular project. When a QCP is found to not cover a particular situation, the contractor and RE office should work together to resolve the issue. A work stoppage may be appropriate in some situations where the potential for unacceptable quality justifies it.

A subcontractor's QCP plan may be submitted by the contractor and in such case both are bound by its provisions. MoDOT should only accept a subcontractor's QCP when submitted by or acknowledged by the prime contractor.

Quality Level Analysis (QLA). Some specifications include a Quality Level Analysis (QLA) that is associated with a payfactor based pay adjustment. This statistical system described in Sec 106.14 is designed to promote uniformity and quality. Detail on how an individual QLA, payfactor, and pay adjustment are made can be found in the measurement and/or payment sections of each specification.

will be calculated in accordance with Sec 109.15.1 Asphalt Cement Price Index, except as defined herein.

109.15.4.1 Basis of Payment. To determine the adjustment for any material specified in this provision the following formula will be used.

A = B X (0.9/2000) x (D – E)

Where: A = adjustment for membrane placed during the index period
B = square yards of membrane placed during the index period
D = average index price at the beginning of the period
E = average index price at time of bid

109.15.4.2 Optional. This provision is optional. If the bidder wishes to be bound by the provision, the bidder shall execute the acceptance form in the Bid for Polymer Modified Emulsion Membrane (UBAWS). Failure by the bidder to execute the acceptance form will be interpreted to mean election not to participate in the Polymer Modified Emulsion Membrane Price Index (UBAWS).

109.16 Fixed Cost Items. The following fixed prices shall be used when referenced in the specifications:

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203.9.4	~~≤500 cy~~ **Class C Excavation ≤ 500 cy**		cy	$75.00
	~~203-20.00~~	~~Class C Excavation~~	~~cy~~	~~$25.00~~
	~~**>500 cy but < 2000 cy**~~			
	~~203-20.00~~	~~Class C Excavation~~	~~cy~~	~~$20.00~~
	~~**≥ 2000 cy)**~~			
	~~203-20.00~~	~~Class C Excavation~~	~~cy~~	~~$8.00~~
206.6.2	206-36.00	Supplemental Foundation Test Holes	ft	$6.00
206.6.3.1	206-10.03	Class 1 Excavation in Rock	cy	$120.00
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701.7.7	701-15.00	Concrete Coring	lf	$100.00
703.5.1	**Concrete Fill > 2 cy**			
	703-20.02	Class B Concrete (Misc)	cy	$500.00
703.5.1	**Concrete Fill < 2 cy**			
	703-20.02	Class B Concrete (Misc)	cy	$750.00
704.6	706-10.00	Reinforcing Steel	lb	$2.00

203.9 Basis of Payment. Roadway and drainage excavation will be paid for at the contract unit price per cubic yard and will be considered full compensation for the following:

(a) Excavating.

(b) Hauling any distance.

(c) Placing and forming embankments.

(d) Preparation of subgrade.

(e) Shouldering, rounding slopes, obliterating existing roadbeds or temporary construction, finishing of graded earth roadway, picking up and disposing of field stone and other rock.

(f) Disposal of excess excavation.

(g) Any work noted on the plans to be included in the contract unit price for excavation.

203.9.1 No payment will be made for any material used for purposes other than those designated, except as approved by the engineer.

203.9.2 Payment will be made at the contract unit price per cubic yard for the applicable item of Class A Excavation or Unclassified Excavation for each handling of stockpiled excavation approved by the engineer.

203.9.3 No payment will be made for rock overbreak or for backfilling overbreak areas below the undergrading limits. Payment for the material for backfilling required undergraded areas will be made under an applicable excavation item. No direct payment will be made for backfilling around structures, the excavation for which has been paid for as roadway excavation.

203.9.4 If the contract does not contain a contract unit price for Class C Excavation and such material is encountered during construction, unless the project is let on an unclassified excavation basis, payment will be made per cubic yard at the fixed contract unit price specified in Sec 109, except that payment will be determined in accordance with Sec 109.4 when the quantity exceeds 500 cubic yards.

203.9.5 No direct payment will be made for water required in compaction work. Any costs involved in reducing the moisture content in soils will be at the contractor's expense.

203.9.6 Payment for finishing a graded earth roadway will be considered completely covered by the contract unit price for the various classes of excavation except as otherwise specifically noted under Sec 104.11.2 in regard to material excavated in cleaning channels and culverts used in place.

203.9.7 When removal of unsuitable material is directed by the engineer, the contractor will be reimbursed for excavation of the unsuitable material and the excavation of the suitable replacement material. Payment will be made for each operation at the contract unit price of Class A Excavation or Unclassified Excavation. Payment for placement of the suitable material will be paid for at the contract unit price of Compacting Embankment.

Category:130 Value Engineering

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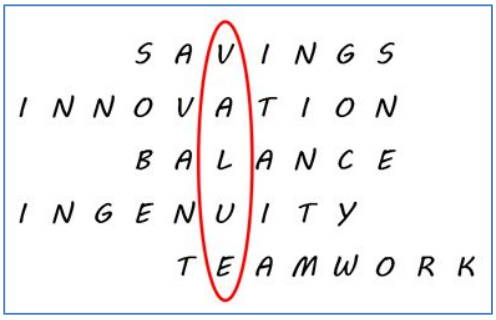

Continually Searching for Value

Contents

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130.1 Discussion

Value Engineering (VE) is a systematic method of examining performance to improve the value of projects or processes. Value is defined as the ratio of performance to cost and thus capable of being increased by either lowering the cost or improving the performance. MoDOT's values and tangible results place increased importance on value-based, practical design. While VE, in the classic sense, tends to be somewhat more structured, VE and Practical Design are are intended to

achieve the same goal. The goal of VE is to build the right project at the right time, achieving delivery of project purpose and need with proper project scope.

Practical Design

Summary 2007

See also: Innovation Library

MoDOT uses VE to ensure that the public receives full value for every tax dollar invested in Missouri's transportation system. VE techniques are used to improve productivity in nearly every aspect of MoDOT's operation, including practices, processes, and procedures. In highway construction, VE encourages contractors to submit proposals for modifying the plans, specifications or other requirements of the contract to deliver improved projects of the best possible value.

MoDOT's goal is to have some form of Value Analysis on every project.

Additional Information

District Value Engineering Coordinator's Responsibilities

Project Manager's Guide

Value Engineering Team Leader Guide

VE Training Evaluation Form

Construction Value Engineering Change Proposal (C-104)

Evaluation Procedures for Construction Value Engineering Change Proposals

MoDOT Value Engineering Contacts

130.1.1 Study Timing

VE studies are performed to add value to a project, not to simply reduce costs. VE studies should challenge project scoped that exceed the minimum necessary to deliver the project's purpose and need. As stated in the law, VE studies are conducted "to provide suggestions for reducing the total cost of the project and providing a project of equal or better quality."

Although only a single study during preliminary design is generally required for a project, VE studies can be performed any time prior to letting and even multiple times on an individual project. A study can be conducted at any stage during the design life of the project; however, priority is given to performing the study as early as feasible to maximize the opportunity to implement developed alternatives. During the study, all aspects of the project may be considered including, but not limited to, location, geometrics, final vertical and horizontal alignments, drainage, construction staging, traffic control, and signalization, pavement and structure details. In addition, studies in the later phase should consider what additional flexibility can be added and what adjustments can be made to "fine tune" the project prior to letting.

Additional VE analysis should be considered if, during a project's design, the scope of work is changed significantly from that which was studied previously. In addition, consideration should be given to an additional study if the previous study will have been conducted more than 10 years prior to the projects letting.

130.1.2 VE Organization

Value Engineering is a critical program and requires statewide participation in order to accomplish the program goals. The Policy and Innovations Engineer manages the overall

operation of MoDOT's VE program. The Policy and Innovations Engineer is responsible for tracking the VE program and reporting its progress to both management and the FHWA. The Policy and Innovations Engineer leads studies and may assist with the initial selection of teams for district VE studies, and provides training guidelines and facilitation.

Each District Engineer selects a district value engineering coordinator (DVEC) to coordinate VE activities in that district. The DVEC is responsible for the district's VE program. The DVEC should be at a level consistent with the supervision and management responsibilities of the VE effort. The DVEC is responsible for scheduling the study and making appropriate accommodations for the participants. The DVEC serves as a team member on the VE study to become familiar with the process and leads VE studies, as required, to meet the demands of the program. The DVEC is also responsible for tracking the district led value engineering studies and ensuring the study results are forwarded to the Policy and Innovations Engineer and entered into the SIMS database for each studi~~u~~ed project.

In any case, the facilitator of the study compiles recommendations from the VE study and submits them in a VE report, for approval as follows:

- The lowest level decision maker within the project hierarchy can approve and implement VE recommendations that do not change policy, standards, or scope of the original project.~~For any study conducted, the facilitator of the study compiles recommendations from the VE study and submits them for approval in form of a VE report, as follows: y, standards or the scope of the original project.~~ A copy of the VE study and the Project Manager's, District Design Engineer or District Engineers approval is retained by the district and the Policy and Innovations Engineer. The Policy and Innovations Engineer notifies the team members of the study results and tracks results of each study.

- The approval of a District Engineer or division engineer is required to approve and implement VE recommendations that change the scope of the original project. A copy of the VE study and the District Engineer or division engineers' approval is retained by the district and the Policy and Innovations Engineer. The Policy and Innovations Engineer tracks results of each study.

- The approval of the Chief Engineer, or his representative, is required to approve and implement VE recommendations that affect more than one division/district or ~~that~~ change policy or standards. The Policy and Innovations Engineer notifies affected divisions, districts and the team members and tracks results of each study.

Approved recommendations are incorporated in the project design. If an approved recommendation cannot be included, the Project Manager must document the justification for eliminating the recommendation. This documentation should be submitted with the PS&E and a copy is sent to the Policy and Innovations Engineer.

130.1.3 Design Phase Project Selection and VE Workplan~~/Project Selection~~

Each year, a value engineering work plan for the federally required Value Engineering Studies is completed after approval of the MoDOT highway right of way and construction program.

The federal requirements are:

- Projects on the National Highway System (NHS) receiving federal assistance with an estimated total cost of $50,000,000 or more.
- Bridge project on the NHS receiving federal assistance with an estimated total cost of $40,000,000 or more. (A bridge project is defined as any project where the primary purpose is to construct, reconstruct, rehabilitate, resurface or restore a bridge).
- Any other project designated by the Secretary of Transportation.
- Design/Build projects do not require a VE study.

Please note, total cost is defined as the cost of all phases of a project including environmental, design, right of way, utilities and construction. ~~Also, projects delivered by the Design/Build method are not required to have a value engineering study.~~

Projects ~~which~~ meeting the minimum ~~criteria for~~ federal requirements are identified and submitted to FHWA for their concurrence in the form of a VE work plan. The VE work plan will identify all of the projects requiring a study and the anticipated date of those studies (if known). In addition, the work plan will identify each of projects for which a VE study is required for which value analysis has already been conducted along with the date of that study. The DVECs will assist the Policy and Innovations Engineer in identifying the appropriate projects.

A district value engineering workplan will be created by each DVEC to identify the district's projects which will be the priority on which to conduct a V~~alue~~ E~~ngineering~~ effort. The DVEC may use the VE project selection criteria to aid in determining~~e~~ which projects have the greatest potential for study. The DVEC sends the district's annual study schedule to the Policy and Innovations Engineer for retention and to supplement the MoDOT VE work plan.

Divisions or districts may also request VE studies at any point throughout the year. These design phase~~project~~ VE studies are generally done at the district level. VE studies on procedures, processes, specifications, standard plans and details of statewide impact are generally done at the division level.

The VE study report and recommendations are conveyed to the appropriate staff upon completion of the study. Affected districts and divisions will receive copies of the study as soon as practical after its completion. The DVEC works with project managers to evaluate the recommendations of the VE team. The project managers submit responses to the study recommendations to the Policy and Innovations Engineer.

130.1.4 Design Phase VE Study Process

The formal VE process entails a systematic process of review and analysis of a project during its design/project development phase, resulting in recommendations to improve value while

addressing the project's purpose and need. The study consists of the following, which is also known as the job plan:

- **Pre-Study Phase:** The Policy and Innovations Engineer works with the project manager~~TPM~~ and DVEC to set up the study (see the Project Manager's Guide for additional information).

- **Study Phase:** A multidisciplinary team not directly involved in the planning or design of the project, conducts the VE review by: investigating and analyzing the planning, design, and constructability of a project.

    - Informative Phase - identifying project functions and costs and worth;
    - Creative Phase - creatively speculating on alternate ways to perform the various functions;
    - Evaluation Phase - evaluating the best and/or least life-cycle alternatives;
    - Development Phase - developing acceptable alternatives into supported recommendations; and
    - Presentation Phase - presenting the team's recommendations to the appropriate staff.

Related Information Video

Life Cycle of a Highway

- **Post Study Phase (or Resolution Phase):** Approval and implementation of VE recommendations and finalizing the VE Report. The VE Report should consist of:

    - The names and contact information for the participants
    - A description of the project
    - A summary of the functional determination or consideration given for the project.
    - A listing of the generated alternative solutions
    - The anticipated savings costs associated with each alternative
    - A copy of the district's or division's response indicating accepted alternatives and anticipated savings.
    - Any additional pertinent information associated with the study.

In addition, required VE studies for bridge projects should include the following:

- A review of the bridge substructure and superstructure requirements with consideration for alternative construction materials.
- An engineering and economic assessment with consideration of acceptable designs.
- A life-cycle cost analysis and consideration of construction duration.

130.1.5 Design Phase VE Study Types

There are several types of studies:

130.1.5.1 Traditional VE Studies

A traditional study is typically used on required studies, however as each project is unique, each phase of the study can be scaled to meet the needs of the individual project.

- **Concept Stage VE (CSVE).** The focus is on coming up with many alternates, the goal being to choose the best alternate to accomplish project P&N. It works best for the CSVE to be conducted prior to signing DEIS or before conceptual submittal if a CE. (3- to 5-day study). A full VE report is prepared.

- **Preliminary Stage VE (PSVE).** The traditional VE study conducted prior to preliminary plan submittal. The focus here is usually on improving the existing design, often, by this stage, the footprint is usually set and it may be too late for major functional enhancements. (3- to 5-day study). A full VE report is prepared.

- **Final Design Stage VE (FDVE).** A traditional VE study conducted near the end of the design process. The focus here is on improving the design, providing flexibility and considering alternatives that meet the purpose and need. This is likely the least effective phase to conduct the study as most of design features will have been committed to and significant changes may be required to implement new alternatives, however project improvement is still possible. A full VE report is prepared.

130.1.5.2 Non-Traditional Studies

A non-traditional study is typically used on projects that do not formally require a VE study. Although these are not the formal, traditional study, there should still be an emphasis on the Job Plan and giving consideration to each phase of the process, even if some of the phases are truncated or eliminated as appropriate.

- **Compressed Value Engineering Study.** An abbreviated, yet thorough, analysis which follows the standard VE Job Plan but is conducted in a compressed time frame using techniques designed to reduce the required time frame to fully consider the project and alternatives. It may take anywhere from 4 hours to 3 days and is commensurate with the complexity of the project. The study may be conducted at any stage from conceptual to final plans.

    - Use technology to maximize time for functional analysis and solution development.
    - May use a Pre-Develop functional analysis, which is expanded in study to meet any unique project features.
    - After ranking, the alternative solutions are developed just far enough to validate and generate costs. Additional design effort necessary to address acceptance and implementation decisions questions or concerns and the full design is accomplished by the project design staff.

- **Alternative Value Analysis (AVA).** An abbreviated, yet thorough, analysis conducted quickly (anywhere from 2 hours to 3 days, commensurate with the complexity of the project) at any stage from conceptual to final plans, which is led by the PM, the Design Liaison Engineer or the DVEC. An abbreviated VE report is prepared. The report should contain at a minimum, the participants, all identified alternatives, the accepted alternatives and an estimate of any cost savings associated with the alternatives.

    - Team composition- Consists of Central Office and district staff. Teams may be small, only 3 to 5 persons, or large, mirroring project core teams.
    - May follow either the traditional or compressed Value Engineering study process. Findings may be reported in a simple letter format.
    - A pre-established workbook is available for a district-led Accelerated Value Analysis – Practical Review. This workbook is intended to lead the review team through the process by identifying typical opportunities for alternative approaches on routine work elements.

- **Combined Project Type Value Studies.**

    - Multiple projects of the similar scope and size are grouped together for the study. A composite analysis is conducted with unique features of each project discussed and considered accordingly, however the focus should remain on the individual project traits and not on the program guidelines.

    - The compressed study process may also be used.

- **Constructability Review.** This type of study concentrates on constructability, traffic management, "bidability", innovative contracting, etc. It can be done at any stage from conceptual to final plans. The study length can be anywhere from 2 hours to 5 days.

    - It generally consists of or coincides with a meeting of MoDOT personnel and interested contractors to discuss their perspective on construction aspects associated with the draft plans.

    - If a meeting with the industry is conducted during this process, the preliminary plans should be posted with the meeting notice at least one week prior to provide opportunity to schedule attendance and review the proposed plans.

    - The meeting should not be mandatory, to avoid unnecessary impacts to the bidding environment for the project.

- **Value Focused Risk Assessment.** Risk assessments approached from the perspective of identifying opportunities to improve the value of the project are an acceptable form of value analysis. After determining the functions of the project, the project risks are considered and documented in accordance with EPG 149.5 Risk Assessment. When developing strategies to avoid, minimize or mitigate the project risks, consideration should be given to alternative approaches which will meet the functions of the project

while decreasing or eliminating areas of risk. A risk assessment report should be generated and properly documented.

- **Programmatic Value Studies.** This programmatic study type is used when studying entire programs for consideration of process and program value improvement. The functional perspective and associated alternatives are considered in the development or review of the guidelines in order to have projects within the program that are of the greatest value. The emphasis is placed on the improving the guidance that will be subsequently used for project development. The high level study should focus on the function of the program more than the individual projects. The study could be conducted in a traditional manner or based upon the compressed study type. The study length will likely be less than 1 day.

- **Process Value Analysis.** This type of study concentrates on process improvement. The goal is to take an innovative and practical look at any process. Subjects could include anything, for example, maintenance operations, construction standards or purchasing specifications. The study length can be 2 to 5 days.

Because of the value of minimizing unnecessary design work there is a benefit to conducting Concept Stage VE studies in order to develop multiple alternates when trying to identify the right solution. However this is not always possible nor is it always the right time for a specific project. The later staged VE study or the non-traditional studies can often be the the correct approach to help build consensus through collaboration and to ensure that the most practical solution is found. The later stage VE studies can also help reduce last minute scrutiny of the project. Project managers can use VE as a proven problem-solving system and can realize secondary benefits including better project scope definition and increased value by optimizing the ratio of project performance and project cost.

130.1.6 NEPA Considerations

Given the potential for impacts to resources outside the NEPA study area or changes to previously approved designs, the environmental and historic preservation sections will have a stake in most VE studies; however, decisions and/or agreements from environmental studies and public hearings can be questioned. Members from one or both sections can provide the team with needed information to help in the process.

When VE studies are conducted post-NEPA, caution **must** be exercised to ensure when VE decisions contradict any commitments that are made in a standing, approved NEPA document. This would also apply to assumptions made for post-NEPA approvals, such as Section 404 permits, approvals from the U.S. Fish and Wildlife Service, as well as others. Although VE decisions may negatively impact environmental or public hearing agreements, these decisions may be made provided the time, cost and effort for the supplemental studies or hearings should be considered. All valid suggestions should be included in the study report for management's consideration.

130.1.7 Documenting Value Analyses in SIMS

In order to properly track all value analysis efforts, each study, review or other VE undertaking must be recorded in the Bike/Ped VE Project Data Entry Area of SIMS.

130.1.7.1 Value Analyses Numbering Convention

A numbering convention for tracking both Central Office and District Value Analysis efforts is provided to aid in tracking all VE efforts. Please note in this area, a VE Number is automatically entered by SIMS upon a user entering data. This is not an officially VE number but is instead an individual number key used by the SIMS database. It does not replace the District or Central Office generated numbering convention and should be ignored for these purposes.

130.1.7.1.1 District Value Analysis Efforts

The DVEC shall ensure that each value analysis effort performed by the district is properly documented under the appropriate VE number. The district value engineering number will consist of the District Designation followed by the year followed by the study number to three digits, starting with one. For example, Central District's first district led value engineering effort of 2012 would be numbered CD 2012-001.

130.1.7.1.2 Central Office Value Analysis Efforts

The Policy and Innovations Engineer shall ensure that each value analysis effort performed by the Central Office is properly documented under the appropriate VE number. The Central Office value engineering number will consist of the year followed by the study number to three digits, starting with one. For example, the first Central Office-led value engineering effort of 2012 would be numbered VE-2012-001.

130.1.8 Additional Information

When consideration is given to using a consultant for conducting a VE Study, the Policy and Innovations Engineer should be contacted. If the State Design Engineer approves the use of consultant services for a~~n~~ VE study, the Policy and Innovations Engineer will work with the district to ensure that the selected consultant is qualified and has no conflict of interest for the proposed work.

The FHWA's *Value Engineering for Highways* provides further details on the VE technique and its applicability to highway projects and functions. Copies may be obtained from the FHWA VE coordinator. in addition, AASHTO's *Guidelines for Value Engineering, 2nd Edition* provides an excellent description of VE and the process steps.

MoDOT's Value Engineering Team Leader Guide and Project Manager's Guide offer specific, in-depth information for those involved in these respective capacities.

130.2 Post-Award Value Engineering (PAVE) ~~Change Proposals~~

Post-award value engineering (PAVE) workshops are conducted during the construction phase of a project. Typically the one day workshop is held 1-3 weeks after the contract is awarded but before the contract notice to proceed. The PAVE facilitator (Policy and Innovations Engineer or consultant), District Design and Construction staff, and the contractor will participate in the PAVE workshop. Design consultants may also be invited to the PAVE workshop. Value Engineering Change Proposals (VECPs) and Practical Design Value Engineering Change Proposals (PDVECPs) are submitted by the contractor and approved or rejected by the Engineer in accordance with Sec 104.6 of the Missouri Standard Specifications for Highway Construction. When approved, contractors will receive 50 percent of VECP savings and 25 percent PDVECP savings. The process used to evaluate value engineering change proposals is presented in EPG 104.13.

130.2.1 Project Selection and PAVE Workplan

There is no federal requirement for identifying projects for PAVE workshops. Each district should identify projects for PAVE workshops early in the design process based on the following criteria:

- Projects estimated over $20 Million
- Interchange projects
- Projects with stage construction
- Projects with potential construction risks
- Major bridge projects
- Projects identified by the District Engineer or Chief Engineer
- PAVEs are not conducted on Design/Build projects

When a project has been identified for a PAVE workshop, the job special provision Post-Award Value Engineering Change Proposal Workshop (JSP-16-01) shall be included in the contract documents.

A project may still be identified by District leadership, Division Engineers, or Chief Engineer for a PAVE workshop after the contract has been let or the job special provision was not in the contract documents. The Policy and Innovations Engineer will work with District staff and the contractor to select dates and locations for the PAVE.

The PAVE workshop report and recommendations are conveyed to the appropriate staff upon completion of the workshop. All routine internal costs incurred by MoDOT to review and implement approved VECPs and PDVECPs will be at the Commission's expense. Major redesign costs, and design/review costs of any amount charged by a consultant to the Commission, will be deducted from the gross savings. Approved and rejected VECPs and PDVECPs are tracked by Construction and Materials Division.

~~Value Engineering Change Proposals~~ (VECPs) ~~and Practical Design Value Engineering Change Proposals (PDVECPs) are handled in accordance with~~ Sec 104.6 ~~of the Missouri Standard~~

Specifications for Highway Construction. The process used to evaluate the change proposal is presented in EPG 104.13 Construction Inspection Guidance for Sec 104.

VECPs provide a product of equal or improved quality by reducing the project's total cost, improving the project's safety, or decreasing the time required to complete the project. This proposal is submitted using the VE Change Proposal and allows the contractor to receive up to 50% of the savings associated with the proposal should it be approved by MoDOT.

A PDVECP may provide a product of lesser value; use an existing item in place or underrun contract items. The PDVECP shall not adversely affect safety or function of the final product. These proposals are submitted using the VE change proposal, allowing the contractor to receive up to 25% of the savings associated with the proposal should it be approved by MoDOT.

All reasonable documented engineering costs incurred by the contractor to design and develop a value engineering proposal shall be reimbursed and subtracted from the savings of the construction costs. All costs incurred by MoDOT to review and implement the VECP will be at the Commission's expense.

For example, a contractor submits a VECP with a reduction in construction costs of $100,000. The documented engineering costs for the proposal total $20,000. The actual net savings are determined by subtracting the engineering costs ($20,000) from the reduced construction cost ($100,000). In this example, the net savings is $80,000 that is split between MoDOT and the contractor using either the 50/50 or 75/25 ratio dependent upon the type of VE approved.

It should be noted that a VECP or PDVECP to accelerate construction may not be considered. The proposal to accelerate construction will not be considered a VECP and will not be eligible for Federal-aid highway program funding participation.

Examples of Value Engineering Proposals can be found on the Value Engineering Web Page.

147.3.4.1 Prioritization of Repairs for Guardrail and Guard Cable

In accordance with MoDOT's Incident Response Plan, guardrail and guard cable damage is classified as either a Priority 2 or Priority 3 repair. The repair time limits established in the job order contract is consistent with a Priority 2 response. The timeline includes a brief collaboration period with the contractor on the repair work needed, three (3) working days for "notice to proceed", which allows time for marking of utilities, and seven (7) calendar days for the contractor to perform the repair,.

Priority 2 - Response should be accomplished as soon as practical during normal working hours, suspending other lower priority work if necessary. Either the condition represents a potential safety concern or the feature is not performing as intended. Examples include guardrail that has been severed or displaced, non-functional end terminals, guard cable down, etc.

Priority 3 - Response should be accomplished with higher urgency than routine maintenance. Examples include guardrail that is bowed or slightly deformed but still intact, end terminals with minor alignment damage but the head is intact, guard cable or posts with minor damage but somewhat functional.

The above prioritization is for the repair work only and is separate from the initial emergency response that is sometimes necessary. If an initial Priority 1 response is required in order to remove debris from the roadway and possibly delineate the damaged area, that response is performed by MoDOT forces or other first responders. The contractor is not responsible for this initial response.

The administrator of the guardrail/guard cable job order contract will normally issue job orders chronologically as they are received and processed, However, when multiple job orders are pending, it may be necessary to prioritize the repairs for the contractor, including job orders that may have already been issued. For example, if a Priority 2 repair is received immediately following issuance of one or more Priority 3 repairs, the administrator may request the contractor respond to the Priority 2 repair first. This reprioritization may require granting additional time to compensate for the delay to the already scheduled Priority 3 repair. Further prioritization of Priority 2 repairs may also be necessary. For example, a Priority 2 repair on an interstate or other high volume route may warrant higher priority than a low volume route. Lateral distance to the hazard should also be considered. For example, a damaged end terminal on the median side (typically a 4' shoulder) could be a higher priority than one that has a reasonable buffer zone, such as a 10'shoulder. Crash frequency at the location might also be a factor.

High Priority Repair

If needed, a Priority 2 repair can be elevated to a high priority repair if the engineer determines the safety of the public is unduly compromised by the damaged facility. A

high priority job order is typically negotiated and issued within 48 hours. The contractor is required to begin the repair within 24 hours of issuance of the job order. A one-time high priority repair payment is made for the accelerated response and repair, unless the contractor fails to comply. The adjustment factor does not apply to the high priority payment.

The high priority repair is expected to be infrequent. For general bidding purposes, the contract proposal advises bidders to anticipate approximately five (5) high priority repairs per year.

Engineering judgment should be used when elevating a Priority 2 repair to high priority status. Generally, a high priority repair should only be used for extreme hazards, such as exposure to a blunt end (ex. bridge abutment) or if there is an exposed guardrail end that is at normal height and facing traffic (i.e. the end terminal is completely removed or there is a complete rupture of the rail). Guard cable damage should be designated as a routine Priority 2 repair and generally does not require high priority repair.

too large to permit placing in a 24-inch layer shall be reduced in size as necessary to permit this placement. Rock shall not be dumped in place, but shall be distributed by blading or dozing in a manner to ensure proper placement in final position in the embankment. Construction equipment shall be routed uniformly over the entire surface of each layer. The spalls and smaller stone fragments shall be left on the surface of each layer as formed.

203.4.18 Rigid or Flexible Pavements. If the specified or proposed surfacing consists of a rigid or flexible-type pavement, the top consolidated rock layer for the full width between roadbed slopes shall be finished to the same limits as shown on the plans for undergrading in rock cuts. If rigid pavement is to be constructed without an aggregate base, the material requirements of Sec 203.4.4.2.1 (a) or (b) shall govern the construction of the area between the bottom of the pavement and the top of the top consolidated rock layer. Any embankment necessary outside the limits of the pavement shall be constructed of suitable earth or as otherwise specified in the contract.

203.5 Compaction of Embankment and Treatment of Cut Areas with Moisture and Density Control. ~~AASHTO T 99, Method C, replacing any material retained on a 3/4-inch sieve, as provided therein, or MoDOT Test Method TM 40 will be used as the Standard Compaction Test for determining the moisture density relations of soils.~~ The optimum moisture as determined by the Standard Compaction t~~T~~est defined in Sec 203.8.3 shall ~~may~~ be used as a guide in determining the proper moisture content at which each soil type should be compacted. Water shall be added or removed as necessary to permit obtaining the required density and moisture control. ~~The field density of the embankment after compaction will be determined in accordance with AASHTO T 191 or T 205, using the total material or T 310, for wet density. The volume of the test hole may be reduced as necessary to accommodate available testing equipment. If nuclear density methods are used, moisture content will be determined in accordance with AASHTO T 239, except that a moisture correction factor will be determined for each soil in accordance with MoDOT Test Method TM 35.~~ The calculated density obtained in a lift~~field~~ density test will be compared with the maximum density as directed by the Standard Compaction Test to determine the percent of compaction attained.

203.5.1 Maximum Density Compaction Requirements. If payment of Compacting Embankment or Embankment in Place is specified as a contract pay item, compaction to at least 90 percent of maximum density, as determined by the Standard Compaction Test, will be required in the following areas:

(a) All roadway embankments except as otherwise provided in the following sections: Secs 203.4.14, 203.4.15, 203.4.16.2, 203.5.3, 203.5.4, 203.5.5 and 203.5.7

(b) All backfilled undergraded cuts, except as modified by Sec 203.5.3.

(c) Certain portions of the roadbed in cuts specified in Sec 203.5.8, except as modified in Sec 203.5.3.

203.5.2 Moisture Control. The moisture content of the soil at the time of compaction shall be as specified herein.

203.5.2.1 When necessary to eliminate a rubbery condition of the embankment, it may be required that some soils have a moisture content below the optimum during compacting work, except that Class A material having a liquid limit of 40 or more, where placed in embankments within 5 feet of the top of the finished subgrade or where encountered in areas of cut compaction, shall be compacted at no less than the optimum moisture content. ~~The liquid limit determination will be in accordance with AASHTO T 89.~~ Some Class A material, including heavy clays and material commonly known as shales and fireclays, shall require breaking down such that the moisture can be uniformly distributed.

203.5.2.2 Loessial soils shall have moisture controlled so as not to exceed optimum plus 3 percentage points when placed in embankments less than 30 feet high. When placed in embankments 30 feet high or more, such soils shall have moisture controlled such that the optimum moisture is not exceeded. If wet foundation conditions contribute to the embankment moisture while compacting, the engineer may waive this specified moisture content for a height not to exceed 3 feet above the embankment foundation. In the event of conflict of provisions of this section with provisions in Sec 203.5.2.1, Sec 203.5.2.1 shall govern.

203.5.3 Top Lift Thicknesses. The upper 18 inches of the earth subgrade extending the full width between roadbed slopes shall be compacted to at least 95 percent of maximum density.

203.5.4 Structure Approach. Roadway embankment within 100 feet of each end of a structure on which the top slab or deck is to be used as the riding surface and the spill fill under such a structure shall be compacted to no less than 95 percent of maximum density.

203.5.5 Rocky Fill. Density requirements will not apply to portions of embankments constructed of material so rocky that the embankment cannot be satisfactorily tested. ~~in accordance with AASHTO T 191 or T 205. Material of a gradation having more than approximately 20 percent retained on a 3/4-inch sieve will generally be considered too rocky for satisfactory density testing.~~ In lieu thereof, the compactive effort on rocky material shall consist of making four complete passes on each layer with a tamping-type roller or two complete passes on each layer with a vibratory roller. The tamping-type roller shall have tampers or feet protruding no less than 6 inches from the surface of the drum and shall have a minimum load on each tamper of 250 psi of tamping area. The vibratory roller shall have a manufacturer's rating of 16 to 20 tons compacting power. During compaction, each layer shall have the moisture content controlled such that, in the judgment of the engineer, any silt and clay fraction is in a plastic state. Simple diagnostic tests to establish such a plastic state will include ability to indent with a thumb or heel or to roll a short thread of soil between the hands. Material that crumbles under pressure will be considered too dry.

203.5.6 Lift Consistency. Each layer shall be wetted or dried as necessary, and shall be compacted to the required density. Regardless of the type of equipment used, the roadway shall be compacted uniformly and the surface kept reasonably smooth at all times. If large pieces of heavy clay are encountered, the material shall be broken down by suitable manipulation to permit satisfactory embankment construction. If shale is encountered, the shale shall be broken down as much as practical and compacted at or above optimum moisture.

203.5.7 Deep Fills. Compaction to at least 95 percent of maximum density will be required for that portion of any embankment below an elevation 50 feet below the top of the finished subgrade. If, because of embankment foundation conditions, the 95 percent maximum density cannot be obtained after reasonable compactive effort has been expended, the engineer may waive the 95 percent requirement for a height not exceeding 3 feet above the embankment foundation.

203.5.8 Compacting in Cut. Cut compaction shall be performed in all Class A material areas and in all unclassified material areas that meet the requirements of Sec 203.2.2 after removal of the roadway excavation material to the required section. A surface parallel to the pavement slope, 12 inches below the bottom of the pavement or lowest base course, shall be temporarily exposed for the full width between roadway inslopes. The exposed material shall be manipulated and compacted to no less than the required density to a depth of 6 inches . The material above this compacted plane shall be spread in layers not exceeding 8-inch loose thickness, each layer being wetted or dried as necessary and compacted to the specified

density. The entire volume of material so handled and compacted, including the 6-inch layer compacted in place, will be considered as Compacting in Cut. All Class A material having a liquid limit of 40 or more, including the 6-inch layer compacted in place, shall be compacted at no less than the optimum moisture content.

203.5.8.1 Cut compaction shall be performed to an additional depth of 12 inches for 50 feet on each side of the intersection of the natural ground and the top of the subgrade, then uniformly graded for 30 feet to meet the depth requirements of Sec 203.5.8 and, if necessary, Sec 203.5.8.2.

203.5.8.2 The existing ground for the full width between roadway slopes under embankments less than 18 inches high shall be treated in accordance with Sec 203.5.8 to only such depth as to ensure having 18 inches of material of the required density and moisture below the top of the finished subgrade.

203.5.9 Field Laboratory. When authorized by the engineer, the contractor shall provide a Type 2 field laboratory in accordance with Sec 601.

203.6 Compaction of Embankment not Constructed with Density or Moisture and Density Control. If compaction of embankment is a requirement of the contract but has not been specified as a pay item, the compactive effort on each layer shall consist of distributing all equipment movements over the entire embankment area and of at least three complete passes with a tamping-type roller over the entire area to be compacted. The tamping-type roller shall have tampers or feet projecting no less than 6 inches from the surface of the drum and shall have a minimum load on each tamper of 250 psi of tamping area. Compactive efforts shall be continued, if necessary, until the tamping feet penetrate no more than 2 inches into the layer of material being compacted. Continuous leveling and manipulating will be required during compacting operations and the moisture content shall be adjusted as necessary, in the judgment of the engineer, to permit proper consolidation.

203.6.1 Dumping and rolling areas shall be kept separate, and no lift shall be covered by another until compaction complying with these requirements has been attained. Unstable areas in the embankment shall be removed and replaced with suitable material at the contractor's expense.

203.6.2 Each layer of embankment constructed of rock or rocky material shall also be compacted by three complete passes of the tamping-type roller. A vibratory roller may be used if approved by the engineer.

203.7 Compaction of Embankment Without Specified Compaction Results or Specified Compaction Equipment. If compaction of embankment is not designated by the contract, compaction will not be required other than that attained by distributing equipment movements over the entire embankment area.

203.8 Quality Control (QC). The contractor shall control and monitor the quality of the work.

203.8.1 Sample Location. The location of pre-construction samples shall be determined by the contractor to ensure they reasonably represent the material being tested. Testing locations of lifts being constructed shall be determined by the contractor either by a random number system or by a uniform method so as not to bias the results. The method of determining test locations shall be described in the quality control plan.

203.8.1.1 In locations where the existing subgrade varies significantly the contractor shall coordinate with the engineer to determine sample locations or other necessary alterations to the quality control procedures to ensure a quality product.

203.8.2 Failing Test. All failing tests shall be recorded even if additional work or rework is made before a passing result is obtained.

203.8.3 Standard Compaction. Prior to construction, QC shall determine the moisture density relationship for all materials expected to be part of the work. AASHTO T 99, Method C including annex A or MoDOT Test Method TM 40 shall be used as the Standard Compaction test.

203.8.4 Moisture Correction Factor. When nuclear methods are used for determining density and moisture, a moisture correction factor shall be determined for each soil in accordance with MoDOT Test Method TM 35.

203.8.5 Plasticity Index. When required, prior to construction AASHTO T90 shall be used to determine the Plasticity Index (PI) of each material and the results used to determine suitability.

203.8.6 Liquid Limit. When required, prior to construction AASHTO T89 shall be used to determine the Liquid Limit (LL) of each material and the results used to determine suitability.

203.8.7 Lift Thickness. The contractor shall monitor the placement thickness of all material. Acceptable lift thicknesses are determined by the type and location of the lift being constructed. Every lift thickness measurement shall indicate whether it is a compacted or uncompacted measurement.

203.8.8 Lift Moisture. AASHTO T310 or AASHTO T265 shall be used to determine the moisture content of soils during construction. When nuclear methods are used, the moisture correction factor shall be included in the final calculation.

203.8.9 Lift Density. AASHTO T310 or AASHTO T191 shall be used to determine the density of lifts being constructed where required. The density or percent compaction required for acceptance is determined by the type and location of the lift being constructed. The volume of the test hole may be reduced as necessary to accommodate available testing equipment. Material of a gradation having more than approximately 20 percent retained on a 3/4-inch sieve will generally be considered too rocky for satisfactory density testing.

203.8.10 Placement Temperature. The contractor shall monitor the temperature of both the material to be placed and the area upon which it is being placed. Acceptable temperatures are defined in Sec 203.4.10.2. Temperature monitoring is waived whenever the temperature has been above 40 F degrees for the previous 48 hours, The frequency of temperature checks shall be increased when the temperature is falling and expected to go below freezing so as to ensure production halts once the temperature requirements are no longer met.

203.9 Quality Assurance (QA). The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor. Results of QA testing will be furnished to the contractor within 24 hours of testing being completed.

203.9.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when independent QA samples meet the same specification criteria as QC. A favorable comparison with the QC standard compaction test shall be obtained when the QA result is within 3.0 pounds.

203.9.2 Split QA Samples. No split samples are called for in Sec 203.

203.10 QC/QA Frequency Table.

Tested Property	QC Frequency	QA Frequency	
		Independent Samples	Split Samples
Standard Compaction	1 per Material	1 per Project	-
Moisture Correction Factor			
Plasticity Index			
Liquid Limit			
Lift Thickness	1 per lift, per 500 Feet	1 per Day	
Lift Moisture			
Lift Density			
Placement Temperatures	1 per Day	-	

203.~~8~~11 Method Of Measurement.

203.~~8~~11.1 Contract Quantity Payment. The quantities of excavation , compacting embankment, and embankment in place for which payment will be made will be those shown in the contract for the various items, provided the project is constructed essentially to the lines and grades shown on the plans. A partial check of existing ground elevations will be made at the time slope stakes are set, and of the finished work for deviations in the grade, width or slope from the authorized grade or typical section.

203.~~8~~11.1.1 Final measurement will not be made of Class A Excavation, Unclassified Excavation , Compacting Embankment, and Embankment in Place except when:

(a) Appreciable errors are found in the original computations.

(b) An original cross section is found to have an average deviation from the true elevation in excess of one foot.

(c) An authorized change in grade, slope or typical section is made.

(d) Unauthorized deviations decrease the quantities on the plans.

(e) Class C excavation is encountered, unless the contract calls for unclassified excavation. If this condition is encountered, corrections or revisions will be computed and added to or deducted from the contract quantity.

(f) Quantities are determined by measurement as specified in Sec 203.8.2.

203.~~8~~11.1.2 If the plans have been altered or when disagreement exists between the contractor and the engineer as to the accuracy of the plan quantities of any balance, or the entire project, either party has the right to request a recomputation of contract quantities of excavation within any area by written notice to the other party. The written notice will contain evidence that an error exists in the original groundline elevation or in the original computations that will materially affect the final payment quantity. If such final measurement will be required, measurement will be made from the latest available ground surface and the design section.

203.~~8~~11.2 Measured Quantities. If payment of excavation is to be made on a measured quantity basis, volumes of authorized excavation will be computed from cross section measurements by the average end area method. When not attributable to carelessness of the contractor, slides in Class A Excavation and in Unclassified Excavation will be included in such measurements. Authorized excavation of rock, shale, muck or other unsuitable material will also be included.

203.~~8~~11.2.1 Authorized excavation of rock, shale, muck or other unsuitable material below grade shall consist of that excavation necessary to provide the designated depth of undergrading. No measurement or payment will be made of any material removed and replaced below the design limits of undergrading. No measurement will be made for overbreak or for the disposal of the same if such material is obtained from outside the neat lines of the proposed backslopes in rock excavation, except that such overbreak will be measured as Class A Excavation or Unclassified Excavation, as applicable, when all suitable authorized excavation has been used and the overbreak material will be required for completion of the embankment. A maximum tolerance of one foot will be permitted for rock protruding or extending within the neat lines of the proposed backslopes.

203.~~8~~11.2.2 While work involving classified excavation is in progress, the engineer will fix points of elevation and stationing as required to establish the lines of demarcation between material of different classification. These top points will be determined before any Class C, sandstone or igneous rock excavation is removed, and the contractor shall notify the engineer before removing any such material. Any excavation removed before the engineer has been notified and given 24 hours to establish lines of demarcation will be included in the measurement of Class A Excavation only.

203.~~8~~11.2.3 Excavation may be encountered in which lines of demarcation between material of different classifications are impractical to establish. The quantity of material classified as other than Class A Excavation may be determined by the engineer on a percentage basis as the work progresses after the limits of determinate classification material have been established. Where vertical or near vertical excavation limits are indicated by the plans, all Class A Excavation material encountered within the actual Class C vertical excavation limits will be included with Class C Excavation quantities.

203.~~8~~11.2.4 Measured quantities of excavation will be used where the ground elevations shown on the plans are found to be erroneous. No revision of contract quantities will be made if the actual ground elevations are considered to agree generally with the ground line shown on the plans. Where the engineer authorizes a change in grade, slope or typical section affecting the volume of excavation allowed for payment in that particular balance or area, the revised volume will be determined by the average end area method on the basis of the revised

grade, slope or typical section. Where unauthorized deviations result in a decrease in the contract quantities, the deviations will be measured and deducted from the contract quantity.

203.~~8~~11.2.5 The quantity of Class C Excavation will be computed on a measured quantity basis. The volume of Class A Excavation allowed for payment in roadway balances involving rock excavation will be determined by one of the following methods, whichever in the judgment of the engineer is more applicable:

(a) Measuring and computing both the Class A Excavation and the Class C Excavation within the limits affected or as defined by Sec 203.8.2.3.

(b) Deducting the volume of Class C, sandstone or igneous rock excavation from the total adjusted volume of roadway excavation, regardless of classification, within the limits affected or as defined by Sec 203.8.2.3.

203.~~8~~11.2.6 Measurement will be made for unsuitable material actually excavated and removed to permit proper compaction in cut sections and in foundations for embankment sections. No measurement will be made of the suitable material temporarily removed and replaced to facilitate compaction in cuts or under shallow embankments.

203.~~8~~11.2.7 Borrow quantities will be determined by measuring the borrow area before and after excavating.

203.~~8~~11.2.8 Excavated material stockpiled in accordance with Sec 203.4.9 will be measured in the stockpile by the average end area method.

203.~~8~~11.2.9 Only that material placed in accordance with Sec 203.5 will be included in the measurement of Compacting Embankment and Embankment in Place. If an error has been found in the original computations or ground elevations, or if there has been an authorized change in grade, slope or typical section, the plan quantity for Compacting Embankment and Embankment in Place for those areas or balances affected will be adjusted for final payment. All required compaction above the original ground line and all compacting of material placed in undergraded cut sections will be considered as Compacting Embankment and Embankment in Place.

203.~~8~~11.2.10 Compacting in cuts will be measured to the nearest 1/10 station along the centerline of each roadbed regardless of width, and will include any required compaction of the original ground under shallow embankments. For the purpose of measurement, a divided highway will be considered as having two roadbeds. Measurement of ramps will be made from or to the ramp's gore point. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

203.~~8~~11.2.11 Measurement of roadway and drainage excavation, compacting embankments and embankments in place will be made to the nearest cubic yard .

203.~~9~~12 Basis of Payment. Roadway and drainage excavation will be paid for at the contract unit price per cubic yard and will be considered full compensation for the following:

(a) Excavating.

(b) Hauling any distance.

(c) Placing and forming embankments.

(d) Preparation of subgrade.

(e) Shouldering, rounding slopes, obliterating existing roadbeds or temporary construction, finishing of graded earth roadway, picking up and disposing of field stone and other rock.

(f) Disposal of excess excavation.

(g) Any work noted on the plans to be included in the contract unit price for excavation.

203.~~9~~12.1 No payment will be made for any material used for purposes other than those designated, except as approved by the engineer.

203.~~9~~12.2 Payment will be made at the contract unit price per cubic yard for the applicable item of Class A Excavation or Unclassified Excavation for each handling of stockpiled excavation approved by the engineer.

203.~~9~~12.3 No payment will be made for rock overbreak or for backfilling overbreak areas below the undergrading limits. Payment for the material for backfilling required undergraded areas will be made under an applicable excavation item. No direct payment will be made for backfilling around structures, the excavation for which has been paid for as roadway excavation.

203.~~9~~12.4 If the contract does not contain a contract unit price for Class C Excavation and such material is encountered during construction, unless the project is let on an unclassified excavation basis, payment will be made per cubic yard at the fixed contract unit price specified in Sec 109.

203.~~9~~12.5 No direct payment will be made for water required in compaction work. Any costs involved in reducing the moisture content in soils will be at the contractor's expense.

203.~~9~~12.6 Payment for finishing a graded earth roadway will be considered completely covered by the contract unit price for the various classes of excavation except as otherwise specifically noted under Sec 104.11.2 in regard to material excavated in cleaning channels and culverts used in place.

203.~~9~~12.7 When removal of unsuitable material is directed by the engineer, the contractor will be reimbursed for excavation of the unsuitable material and the excavation of the suitable replacement material. Payment will be made for each operation at the contract unit price of Class A Excavation or Unclassified Excavation. Payment for placement of the suitable material will be paid for at the contract unit price of Compacting Embankment.

203.~~9~~12.8 Embankment in Place will be paid for at the contract unit price per cubic yard , and will be considered full compensation for:

(a) Furnishing and transporting material from stockpile sites or from a contractor-provided source.

(b) Placing and forming embankments.

(c) Compacting embankment or for adding or reducing the water content of the embankment.

(d) Any excavation required to provide the embankment material included under the item of embankment in place, including mulching and seeding a borrow site.

(e) Any work noted on the plans to be included in the contract unit price for embankment in place.

203.~~9~~12.9 Payment will be made at the contract unit price for each of the pay items included in the contract.

SECTION 209

SUBGRADE PREPARATION

209.1 Description. This work shall consist of preparing the subgrade upon which a base course is to be constructed or a surfacing placed as shown on the plans or as directed by the engineer. After a base course has been constructed, the top of the completed base course will be considered the subgrade for the next operation. In surfacing contracts involving only incidental grading, the contractor shall complete subgrade compaction in accordance with Sec 210 before proceeding with this work.

209.2 Construction Requirements. The subgrade shall be substantially uniform in density throughout the entire width of the subgrade. The subgrade shall be constructed to drain surface water to the side ditches and all ditches shall be kept open by the contractor. Where hauling results in ruts or other objectionable irregularities, the contractor shall reshape and reroll the subgrade before the base or surfacing is placed. If an old roadway comprises any part of the roadbed, the contractor shall loosen the compacted portions to a depth of at least 6 inches and shall reshape the roadbed.

209.2.1 All subgrade shall be rolled. The subgrades shall be checked after rolling and, if not at the proper elevation at all points, sufficient material shall be removed or added and compacted to bring all portions of the subgrade to the required elevation and density. The moisture content of the top 6 inches of the finished subgrade at the time the base is placed, or at the time pavement is placed if no base is provided under the pavement, shall be no less than ~~than the minimum specified for compacting in Sec 203.5.3~~ 95 percent of maximum density. If the moisture content has not been maintained, the subgrade shall be scarified, wet to the required moisture content and compacted. A maximum deviation of 1/2 inch, plus or minus, from the required elevation will be permitted on the surface of the finished subgrade.

209.2.2 Soft spots shall be removed to a maximum depth of 24 inches and backfilled with approved stable material. Unsuitable material shall be removed and backfilled in accordance with Sec 203.4.5.

209.2.3 The subgrade shall be compacted and brought to true shape. Any material added shall be satisfactorily incorporated and compacted. Care shall be taken in forming the crown and shaping the subgrade to ensure that the specified thickness of pavement will be attained. The finished concrete pavement subgrade at the time of paving shall be moist, but sufficiently firm to resist rutting or deforming under construction traffic.

209.3 Quality Control (QC). The contractor shall control and monitor the quality of the work as outlined in this specification and Sec 203.8

209.4 Quality Assurance (QA). The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor. Results of QA testing will be furnished to the contractor within 24 hours of testing being completed.

209.4.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when independent QA samples meet the same specification criteria as QC.

209.4.2 Split QA Samples. No split samples are called for in Sec 209.

209.5 QC/QA Frequency Table. The frequency of testing shall be as found in Sec 203.10

209.~~3~~6 Basis of Payment. No direct payment will be made for subgrade preparation.

SECTION 214

ROCK FILL

214.1 Description. This work shall consist of constructing fill of rock or broken concrete for protection of embankment.

214.2 Material. The material for rock fill shall be durable stone or broken concrete. ~~containing a combined total of no more than 10 percent of earth, sand, shale and non-durable rock.~~ The material shall be similar to quarry-run stone graded from coarse to fine with a minimum of voids. The coarse stone shall be as large as can be conveniently handled, but at least 25 percent of the material shall be of pieces having a volume of one cubic foot or more. ~~Acceptance of quality and size of material may be made by visual inspection at the job site.~~

214.3 Construction Requirements. Successive horizontal layers of stone or broken concrete not exceeding 24 inches thick shall be spread over the area of the rock fill. The larger pieces shall be well distributed and the voids filled with smaller pieces. Each layer shall be spread in accordance with Sec 203.4.16. Where rock fill is placed as a portion of embankment with controlled density, the material shall be compacted in accordance with Sec 203.3.5. The fill shall conform to the elevations and dimensions shown on the plans, and the slopes shall present a dense, finished appearance free from segregation with a proportionate quantity of the large pieces exposed.

214.4 Quality Control (QC). The contractor shall control and monitor the quality of the work. No QC plan is required for rock fill work.

214.4.1 Fill Cleanliness. The contractor shall visually inspect all material for rock fill as it is unloaded or placed to ensure it is clean material with no more than 10 percent of earth, sand, shale and non-durable rock. If the cleanliness is considered borderline by visual judgment, the engineer shall be notified.

214.4.2 Gradation. The contractor shall visually inspect all material for rock fill as it is unloaded or placed to determine if it meets the graduation requirements. Acceptable material will meet the requirements in Sec 214.2. If the gradation is considered borderline by visual judgment, the engineer shall be notified.

214.5 Quality Assurance (QA). The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor.

214.5.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when independent QA samples meet the same specification criteria as QC.

214.5.2 Split QA Samples. No split samples are required in Sec 214.

214.6 QC/QA Frequency Table.

Tested Property	QC Frequency	QA Frequency	
		Independent Samples	Split Samples
Fill Cleanliness Gradation	As needed	1 per project	-

214.74 Method of Measurement. Measurement will be made to the nearest cubic yard of material in place in the completed fill.

214.85 Basis of Payment.

214.851 Commission Furnished Rock Fill. If shown on the plans that the material for rock fill is to be obtained from the right of way or other source furnished by the Commission, the excavating, including all breaking, loading and hauling, regardless of haul distance, will be paid for and considered completely covered under the contract items of Class A Excavation, Class C Excavation, Unclassified Excavation, Excavation for Structures or other applicable items. If payment is made under these conditions, separate payment for furnishing rock fill will not be made.

214.851.1 If the rock fill from the right of way or other sources furnished by the Commission is made unsuitable or unattainable by the contractor's operations, the contractor shall provide suitable material and dispose of any surplus material at the contractor's expense.

214.851.2 If all or part of the required quantity of acceptable material is not actually available and was not made unacceptable by the contractor's operations, payment will be made per cubic yard at the fixed unit price specified in Sec 109 for such additional rock fill material that the contractor is required to furnish and haul.

214.852 Contractor Furnished Rock Fill. If the plans do not provide for a source of material, the contractor shall provide the material and all costs of securing the source, quarrying, excavating, breaking and hauling the material to the site will be paid for at the contract unit price per cubic yard for furnishing rock fill.

214.853 Placing Rock Fill. Payment for placing rock fill will be made at the contract unit price per cubic yard.

EPG 202.5.1 Remove- program no longer exists.

EPG 203.1 Remove and replace this paragraph.

Contractor Grading Schedule

The inspector should obtain the contractor's grading plan of operation and quality control plan. ~~The inspector should then immediately run enough standard compaction tests covering materials in the area where work will start to replace those furnished by the district soils and geology technologist. The inspector should also determine moisture content of the soil in its natural state throughout the area where the contractor plans to start grading.~~ It is the contractor's QC responsibility to determine the compaction standard and other soil properties prior to construction. MoDOT should provide QA and expertise as possible to ensure that the soil samples represent the material to be worked. Ideally both parties would be present in obtaining of both QC and QA samples so that any concerns can be addressed immediately.

EPG 205.2.2.3.7 Remove and replace.

The QC and QA tests and frequencies for these materials are covered in ~~the table below:~~ Sec 203. Depending on the type of stabilization used, the contractor may propose other tests or frequencies in their quality control plan.

~~Type of Construction or Material~~	~~Tests to be Made (if specified)~~	~~Sampled~~	~~Minimum Number of Tests~~
~~**Modified subgrade** (sand-soil base, soil-cement base or soil-lime base)~~	~~Graduation SAA002WA~~	~~Before compactions~~	~~One per 5,000 tons (5,000 megagrams) or fraction thereof per specified graduation source. None required if less than 1,000 tons (1,000 megagrams) of a specified graduation.~~
	~~Liquid Limit included with gradation~~	~~Before compactions~~	~~One per project per specified graduation, per source. None required if less than 1,000 tons (1,000 megagrams).~~

	~~PI included with gradation~~	~~Before compactions~~	~~One per project per specified graduation, per source. None required if less than 1,000 tons (1,000 megagrams).~~

231.2 Clear Zones

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231.2.1 Introduction

The clear zone concept is the road design principle of providing an unobstructed, traversable area beyond the edge of the ~~through~~ traveled way for the recovery of errant vehicles. The clear zone is located adjacent to and measured from the edge of the traveled way. The clear zone includes shoulders, bike lanes, and auxiliary lane, except those auxiliary lanes that function like through lanes (>2 miles in length). The concept was developed in the 1960s and later incorporated into the *Roadside Design Guide* (RDG). The ~~RDG suggests~~ clear zone distances should be location specific and based on traffic volumes, ~~and~~ design speed~~s~~, roadside slopes, existing features, reasonable driver expectations, and other roadway features. These distances are neither absolute nor precise and, in some cases, it may be reasonable to leave a fixed object or non-traversable terrain within the clear zone area. ~~Roadside design strategies involve the following:~~The RDG Clear Zone distances are based on limited empirical data. The distances obtained from the RDG Table 3-1 should suggest only the approximate center of a range to be considered and not a

precise distance to be held as absolute. For roadways with low traffic volumes, it may not be practical to apply even the minimum values found in RDG Table 3-1. Refer to RDG Chapter 12 for additional considerations for low-volume roadways and RDG Chapter 10 for additional guidance for urban applications.

Roadway design strategies for providing clear zone are as follows, in order of preference:

1. Remove the obstacle
2. Redesign the obstacle for safe traversal
3. Relocate the obstacle further from the roadway (or move the roadway further from obstacle)
4. Reduce obstacle severity (make it breakaway)
5. Shield the obstacle
6. Delineate the obstacle ~~(~~when ~~we must~~ it is determined to leave the obstacle~~)~~

~~The clear zone concept guidelines in the RDG may be most applicable to new construction and reconstruction/rehabilitation projects. Fixed objects and non-traversable terrain features may also be addressed on existing roads as part of resurfacing (1R) or resurfacing and restoration (2R) projects (see EPG 128.2 Preventive Maintenance Projects (1R and 2R)). Every roadside should be made as safe as practical. On existing roads, primarily those of an older or lower-order nature, a clear area may be established through maintenance activities. While this practice is strongly encouraged, these areas should not be construed as providing the same safety benefit as clear zones.~~

~~Clear zones are reviewed and/or selected based on the RDG guidelines after consulting the location study report.~~

Figures

Roadway Typical Sections

RDG Table 3-1 "Suggested Clear-Zone Distances from Edge of Through Traveled Lane"

RDG Table 3-2 "Horizontal Curve Adjustment Factor"

RDG Figure 3-2 "Clear Zone for Non-Recoverable Parallel Foreslope"

RDG Figure 3-6 "Preferred Cross Sections for Channels with Abrupt Slope Changes"

Clear zone concepts provide safety benefits to drivers on all types of roadway projects but are primarily applicable to new construction and/or major reconstruction projects where the roadway designer has the opportunity and economy of scale to modify design elements to minimize the proximity of roadside obstacles, high fills and non-traversable terrain. Reconstructing existing roadways to create clear zone widths suggested by RDG Table 5-2 (Barrier Guidelines for Non-Traversable Terrain and Roadside Obstacles) of the RDG may not be feasible or practicable given site conditions and limited resources.

Clear zone~~s~~ guidelines should be used ~~are designed into a project~~ when the ~~anticipated posted~~ design speed of the roadway is 45 mph or more. When the ~~anticipated posted~~ design speed is less than 45 mph, clear zones are still beneficial, but they ~~are to~~ should be ~~considered~~used ~~only~~ if

economically feasible. Non-traversable slopes or fixed objects are to be removed, redesigned, relocated, delineated, or shielded by a barrier if they are within the indicated minimum clear zone width and it is cost effective to do so.

Where resources and safety benefits justify the use of clear zones, clear zone concepts may be applied to existing roads to address roadside obstacles and non-traversable terrain. Clear zones are reviewed and/or selected based on the RDG guidelines during the preparation of the location/conceptual study report.

The clear zone conceptwidth is to be should be applied with goodengineering judgment including a safety analysis (Highway Safety Manual or HSM) and should be balanced with project costs. Limited right of way or high construction costs may lead to the installation of a barrier or possibly no protection at all if justified through a safety analysis. The designer should consider site specific characteristics of the roadway at issue including, if appropriate, the location of the object or area in relation to the roadway, road width, lane width, traffic volume, design speed, roadway geometry, and the crash history (including severity) involving the roadside object or area when analyzing whether or not to install a barrier. Documentation of decisions regarding clear zone strategies should be included in the project conceptual study report, project core team minutes, or design exception forms, and should be filed in eProjects.

Maintenance staff may remove trees, boulders, or other obstacles on existing roads where right-of-way is available. This cleared area shall not be assumed a designed clear zone as used in the EPG. If a safety concern is identified during a roadway safety audit or a project core team meeting, then the safety concern should be considered and discussed with the core team in the context of project budget and scope.

231.2.2 Roadside ObstaclesClear Zone Perception Issues

Roadside obstacles may be either man-made or natural. Barrier recommendations for roadside obstacles are a function of the nature of the obstacle itself and the likelihood that it will be hit. However, a barrier should be installed only if it is clear that the result of a vehicle striking the barrier will be less severe than the crash resulting from hitting the unshielded obstacle.

Roadside obstacles that are normally shielded are listed in Table 5-2 of the RDG. While roadside obstacles immediately adjacent to the traveled way are normally removed, relocated, modified, delineated or shielded, the optimal solution becomes less evident as the distance between the obstruction and the traveled way increases. Table 3-1 of the RDG, Suggested Clear-Zone Distances, is intended as a guide to aid the designer in determining whether the obstruction constitutes an obstacle to an errant motorist.

~~In most cases, the use of the clear zone concept is preferable to the use of a shielding barrier. There is, however, a notable exception.~~

~~Occasionally the public will poorly perceive the clear zone concept. In areas of very high fills, particularly those on the outside of a horizontal curve, the clear zone alone may give the impression of an unsafe situation. Even though the design may be completely safe within the guidance of the RDG the public will inevitably request the area be shielded, most often with guardrail.~~

~~In these cases, the best practice is to initially specify shielding. By doing so, MoDOT can avoid the needless expense of eventually using both treatments in the same location.~~

231.2.3 For Bridges and Culverts

~~Clear zones, when used, shall extend full-width to bridge ends.~~ Where the existing roadway is to be incorporated into ~~the completed~~ a newly construted facility as part of the main roadway, the use of clear zones will be considered on individual projects. For "spot improvements" such as bridge replacements, the designer may determine to use less than the prescribed clear zone for new construction. This decision should be based on engineering judgment, giving consideration to accident history, roadway characteristics, access issues, project scope, and budget.

The use of clear zone typical sections is not applicable to small culvert replacement projects where the intent is to continue the service of the road without upgrading it. In such cases, the typical sections used in the original construction are to be used except that the roadbed width is not to be more narrow than 24 feet.

The use of clear zone typical sections is not applicable to small culvert replacement projects where the intent is to continue the service of the road without upgrading it. In such cases, the typical sections in the original construction are to be used except the roadway width is not to be narrower than the template of the roadway approaching the improvement.

In shallow fills and in cuts where box or pipe culvert normally require a headwall to be located in the clear zone, the ~~structure should be extended to place~~location of the headwall ~~at the outside of the clear zone~~will be determined after an appropriate ~~or a~~ safety analysis is conducted~~appurtenance (guardrail or barrier) should be provided~~. The culvert extension, shielding, audible warnings (rumble strips), delineation and the like (or combination of these) should be considered within the scope and budget of the project~~The slope of the clear zone will then require modification over the entire surface~~.

231.2.4 ~~On~~ Ramps

Clear zones should be considered on ramps when applicable. Shielding may also be applicable with engineering judgment at these locations. Special consideration should be given at ramp termini where stop conditions exist. It may be acceptable to leave a non-traversable slope unshielded when operating speeds that approach zero are to be expected, especially when barriers in those areas become obstacles and receive continual damage from low speed, turning, commercial vehicle traffic.

~~Flattened slopes or clear zones are to be used on ramps to eliminate the use of guardrail. Use guardrail only to protect bridge ends within the interchange area.~~

231.2.5 ~~In~~ Unusual Conditions

~~When a standard clear zone width and slope will not properly terminate on the existing ground surface because of hilly conditions,~~In areas where topography and right of way limits preclude the construction of the full clear zone, additional grading or the acceptance of steeper slopes ~~must~~ may be used. In ~~this~~ these cases, the clear zone may be omitted and guardrail used at the shoulder line to shield a non-recoverable slope. Refer to EPG606.1 (Guardrail – Length of Need) as well as RDG 5.6.4 (Length of Need). For long fill sections through a levee or reservoir project and/or other unusual circumstances, shielding may be preferred in lieu of construction of traversable slopes. This practice may also be necessary in areas where the right of way outside the traveled way is controlled by another entity and the construction of traversable roadway slopes is a competing interest to the function of the levee/reservoir/etc. ~~The desirable minimum length for the elimination of clear zone is 500 ft. but in no case less than 250 feet.~~

~~For long fill sections through a reservoir project, clear zones can be eliminated and guardrail used at the shoulder lines.~~

~~Speed change~~Auxiliary lanes adjacent to the traveled way~~main roadway~~ are to be placed within the main roadway's clear zone with no widening of clear zone. The clear zone is ~~always~~ located adjacent to and measured from the normal edge of the traveled way~~pavement of the main roadway including climbing or continuous auxiliary lanes~~. See RDG 3.3.6 for additional information on clear zones for auxiliary lanes and freeway ramps.

231.2.6 ~~Maintenance~~Clear Zone Perception Issues

In most cases, the use of the clear zone concept is preferable to the use of a shielding barrier.

At some locations, such as very high fills, bodies of water, steep cliffs, etc., particularly those on the outside of a horizontal curve, the clear zone alone may not provide the public with a sense of security. In these circumstances, the design may be completely safe within the guidance of the RDG, but drivers may still request the area be shielded, most often with guardrail, possibly with guard cable.

At these locations, engineering judgment, which may include a safety analysis (HSM) comparing various alternatives (clear zone widths, guardrail in-lieu of clear zone, and/or a combination of

clear zone and shielding) may be employed to determine if there is an effective solution. Additional guidance can be found in the RDG, paragraphs 5.2 Barrier Recommendations and 5.2.1 Roadside Geometry and Terrain Features.

~~District personnel shall be responsible for maintaining clear zones on highways~~.

236.4.4 Title ~~Datum,~~and ADA Responsibility ~~and Allied Services~~

236.4.4.1 Purpose

The ADA Transition Plan was developed in 1992 to fulfill the requirements of the Federal ADA Act of 1990. The plan identified a list of all ADA structures on a statewide basis that required improvement as outlined in the federal law. Part of the process is determining the ownership information and ADA improvement responsibility. The majority of state routes came into the departments system through federal and state laws followed by the Highway Commission acceptance beginning in 1913. Many of the roads were expanded over the years and acquired by deeds. Maintenance Agreements came into existence which defined maintenance responsibility for certain segments, which can include ADA structures.

Specific documents are required when determining responsibility for ADA improvements. The process ~~checklist~~ included in this section as well as EPG 642, will serve as tools for the districts to verify they have performed the necessary due diligence. Detailed history and overall guidance can be found in the Interim ADA Transition Plan Guidance and chronology of MoDOT history.

236.4.4.2 Ownership Information

The following document~~step~~s can be reviewed to determine ~~should be taken to address~~ ownership or ADA responsibility:

- ~~Thorough search of~~ MoDOT deed definings ~~for~~ actual ownership. ~~can date back to 1913 when the highway departments were created by federal law.~~
- Title Opinion: Research by district and approved by counsel, or it is also acceptable to ~~C~~contract a title company to provide opinion on ownership.~~.~~
- Executed maintenance agreement/urban agreements/county agreements, outlined who maintains the roadway and/or future ownership of roadway which can include sidewalks. ~~Thorough search of ownership deeds and assessor records at the county courthouse.~~
- Search for dedicated plats retained in courthouse and/or city hall.

If the above information does not define ownership~~responsibility~~, the district right of way staff will summarize the compiled information and present the "Request for ADA Responsibility Determination" memo to the D~~d~~istrict E~~e~~ngineer for a recommendation on addressing the ADA improvement. (Follow specific drafters notes in the memo.) Once the recommendation has been noted by the D~~d~~istrict E~~e~~ngineer or designated representative, the memo, support documentation, and aerial map with location identified submitted to C~~c~~entral O~~o~~ffice R~~r~~ight of W~~w~~ay for removal of the subject segment from the transition plan.

It is the district's responsibility to ~~,~~

~~R~~retain all support documents in The ADA Transition Database in TMS~~district file~~ for future reference.

236.4.4.3 ADA Responsibility Determination

Step 1: Determine Responsibility

- District Right of Way staff will follow guidelines in EPG 236.4.4 to determine responsibility of the roadway and pedestrian facility.
- MoDOT's responsibility is governed by laws that have added roadways to the state system as listed below:
    - 1917 Hawes Road Law specifies a minimum standard width for hard-surfaced roadways to be at least 40 feet in width on the centerline (20 feet each side of the centerline) for grading, bridges, culverts and other drainage features.
    - 1921 Centennial Law gave the state highway system the power to construct all roads, culverts, and bridges. The improvements were required to be distributed uniformly across the state in coordination with the county and/or civil subdivision.
    - 1921 Federal Aid Law enacted funding for all roadway development and maintenance. Where MoDOT has upgraded or improved roadways outside of the documented width for 10 years or more, the area is considered in the state system and the responsibility of the department.
    - 1927 McCawley-Painter Act governed laying out several 100 mile systems across the nation. As a result of this act, Missouri began taking over these roadway sections into the state system through MHTC action.

The definition for major and minor routes as outlined below coincides with STIP, Asset Management, and roadway maintenance references.

- MoDOT will determine responsibility based on the following documentation. The width of responsibility is controlled by the priority of documents listed in order below (i.e. Deeds take precedent over maintenance agreements. ~~and~~ ~~p~~Prescriptive easements can overlap with all options):
    - 1) Deeds - defined as conveyances entered into by the Commission.
    - 2) Maintenance or municipal agreements – defined as documents outlining maintenance responsibilities for the section or roadway. May include ditches, signals, signs and sidewalks.
    - 3) Dedicated plats - defined as dedicated recorded plats that have been accepted in writing or by act and identified as "for public use".
    - 4) Prescriptive easement rights – A Public Agency is responsible for any areas (drainage, signal, signs, site distance, shoulders, sidewalks, etc.) of the right of way~~oadway~~ that has~~ve~~ been improved or maintained by ~~such~~ an agency for a period of 10 years or longer. The public agency can be MoDOT or another local public agency, however~~but in~~ either case requires~~there must be~~ documented evidence (letter, email, invoice) of the use and maintenance of the facility to determine the responsibility.

- 5) When no other documentation is available the following applies: (note: prescriptive easement can apply in both situations)
  - For **major routes**, MoDOT is responsible for the stated 40' width mandated by 1917 Hawes Road law.
  - For **minor routes**, MoDOT is responsible for, at a minimum, the hard surface travelway.
  - If items 1-4 above state a wider width, then the documented width is MoDOTs responsibility.

-
- Responsibility does not imply ownership.

- **Maintenance agreements** are not a determination of ownership but can be used as a supporting document for determining responsibility. If the agreement states the local entity is responsible for the maintenance of the sidewalks, the agreement can qualify as a responsibility determination. Maintenance specifications included in Cost Share Agreements cease once a project is completed and no longer apply to responsibility.
- Upon District Right of Way staff completing the documentation compilation for responsibility determination, the District Engineer will be presented the supporting documentation as outlined in EPG 236.4.4 to assist in making the final decision for improvement or removal from the transition plan.
- If supporting documents are not available, see Step 2 below. Updating of current agreements or the execution of a new agreement defining responsibility for upgrades and maintenance to the pedestrian facility will be completed.
- If it is determined MoDOT is not responsible for the pedestrian facility, the District Engineer will submit an executed memo (236.4.4) to Central Office Right of Way for the removal of the segment identified within the ADA Transition Plan database. This determination does not immediately result in the facility being removed from the ADA Transition Plan. Additional considerations are required in Step 2.
- Once determination of responsibility is complete, there may be additional items to add to the ADA Transition Plan. These additional items will be completed at the time of the project or delayed. See Step 2 below regarding delaying improvements or upgrades.
- This guidance does not cover all situations. For example, some major routes function more like a minor route. If it is determined a project has unique circumstances that does not fit this guidance, the District Engineer will request a variance from the Chief Engineer. Additional guidance can be found in EPG 642 Pedestrian Facilities.
- ~~Major routes: MoDOT will be responsible for the area defined in a deed, maintenance agreement, or dedicated plat. If no other document is available to define the area, the standard 40-foot width (specified in the 1917 Hawes Road Law) will be used.~~
- ~~Business routes created by bypasses will be considered major routes for determination of responsibility.~~

- ~~Minor routes: MoDOT will be responsible for the area defined by deed, maintenance agreement, dedicated plat, or at a minimum the hard surface travelway.~~
- ~~For all routes: MoDOT is responsible for areas maintained or improved in the past 10 years (prescriptive easement) which can include drainage, signals, site distance, shoulders, sidewalks, etc. and considered MoDOT's responsibility.~~

236.4.4.4 ~~Plan development based on n~~Non-MoDOT ADA ~~facility and title, ownership or ADA r~~ Responsibility

- Once the review ~~checklist has been addressed, the research has been~~ is completed and the determination made by the D~~d~~istrict E~~e~~ngineer. A copy of the ~~of property ownership and ADA responsibility has been made, a~~ memo from the R~~r~~ight of W~~w~~ay M~~m~~anager to the ~~D~~Dd~~d~~istrict ~~Right of Way Manager~~ E~~e~~ngineer will be sent to ~~the~~ C~~C~~entral O~~o~~~~O~~ffice R~~r~~~~R~~ight of W~~w~~~~W~~ay ~~Liaison~~ summarizing the efforts that ha~~ves~~ taken place~~,~~; the property ownership status outlining the ADA responsibility~~,~~ and a recommendation request on behalf of the district to update the transition plan.~~.~~
- In the event the ~~D~~determination is made that MoDOT is not responsible for the ADA facility~~,~~ ~~:~~ the district must document the research and retain copies for record retention in the ADA Transition database. Central O~~o~~ffice R~~r~~ight of W~~w~~ay~~ROW Liaison~~ will update the ADA Transition database to reflect the recommendation~~sponsibility determination~~. (~~-~~This determination does not immediately result in the project being removed from the ADA Transition Plan.)
- When MoDOT determines it is not responsible for the ADA facility~~:~~, the district is required to partner with the responsible entity to assist in facility improvement plan. At a minimum MoDOT is responsible for curb cuts.

~~Note that any reference to title companies in the following sections pertains to both title and abstract companies unless noted otherwise.~~

~~236.4.4.2 Title Information – Phase I~~

~~Prior to the development of preliminary plans, ownership information and legal descriptions of properties abutting the proposed project will be provided to district design by district right of way. The title information does not necessarily recite the entire ownership area but will, in each case, quote that portion lying within or adjacent to the proposed highway project. Required title information at this phase of a project may be secured by a qualified member of the right of way staff or purchased from a title company doing business in the county. Title information at this stage shall be provided by photocopy of last deed of record, or typewritten form showing the grantee and legal description of the property. Current county assessor's maps may also be useful. This phase of title work should be charged to the P.E. job number.~~

~~236.4.4.3 Title Information – Phase II~~

As the detail design plans near completion, it is then necessary to obtain more comprehensive title information. At this phase, district design is in need of owners' names and total area of contiguous lands comprising the ownership. Also, district right of way will, within a short period of time, require information regarding mortgages, special assessments, liens, taxes, etc., to enable its staff to prepare the necessary documents for title transfer. This phase of title work may be charged to the P.E. job number, or to the R job number as provided by a limited "A" date or acquisition authority.

At the phase II stage, when it is possible, commitments for title insurance are to be obtained from qualified title agencies. Representatives for the title company shall set out in the commitment any conditions which must be satisfied for the issuance of title insurance. In the event commitments for title insurance cannot be obtained, or the cost thereof is prohibitive, the district shall obtain abstracts from which its regional counsel can determine the conditions of titles. Each abstract will cover a minimum period of 30 years in all instances except where it reasonably appears that an apparent indicated ownership of the fee title of more than 30 years duration exists, in which case, such additional conveyances shall be abstracted as necessary to indicate the record owner. No less than four conveyances will be included in the submission herein above described in every instance, together with such conveyances of easements, mineral rights, or other interests, obviously less than fee title which appear of record.

The abstracts will reflect the nature of each document affecting title and if special provisions appear therein (such as retention of any estate less than fee, covenants running with the land, a deviation from the usual form of warranty or quitclaim conveyance) a copy of the document will be attached. All unsatisfied mortgages, special assessments, liens, taxes, etc., will be indicated.

When temporary rights are the only rights being acquired, it is permissible to determine ownership by use of "phase I title information." However, since a title commitment or abstract will often contain other information that is needed, it is recommended that commitments or abstracts be purchased when available. The right of way manager shall decide which type of information will be obtained before ordering "phase II title information" for a project.

236.4.4.4 Title Information - Phase III

This phase of title information will be performed immediately prior to closing a transaction, or immediately prior to filing the condemnation petition, on all tracts. Due to a decentralized operation, it requires approximately 1 to 2 weeks from the date a conveyance is signed until the date the payment is made. During the interim period, numerous acts may occur that affect marketable title for the proposed acquisition area. To assure the Commission that clear marketable title is passing, it is necessary to execute phase III of the title search program. Phase III consists of extending to date the title commitment, or abstract immediately prior to closing or immediately prior to condemnation. Phase III may be performed by the title company or qualified staff personnel. This phase must be documented by letter or memo, signed by the person doing the final check.

236.4.4.5 Agreements Between Commission and Abstractor or Title Companies

The document referred to as Contract Services Agreement (Form RW44) (Form RW44 is accessible in eAgreements) shall be employed when obtaining commitments for title services during phase II of the title work. Any special or additional agreement with the title company must be approved by the Right of Way Section and then made part of the appropriate contract.

Form RW44 may be executed on behalf of the Missouri Highways and Transportation Commission as specified in the Execution of Documents Policy. Any changes to the above-referenced exhibits must be reviewed by CCO for approval as to form.

236.4.4.6 Escrow Services

It is the policy of MoDOT to escrow **all transactions, except** partial acquisitions that do not include major improvements when neither a title company nor an abstract company is available to perform the duties of an escrow agent and there is no disbursement of the funds to parties other than the fee owner. It is not required to escrow payments for temporary rights unless circumstances warrant it.

The above exception is not intended to prohibit the use of an escrow agent on all transactions. When an acquisition comes under the exception, it is at the discretion of the right of way manager to place the payment in escrow.

In cases where escrow services are unavailable from title companies, it is the policy to employ a local bank having F.D.I.C. membership to act as escrow agent. Should there be some reason why a local F.D.I.C. bank would not act as escrow agent, another firm or party may be selected to act as agent, provided prior approval is secured from the Right of Way Section. In all cases where a party other than a title or abstract company is used as an escrow agent, qualified right of way personnel will perform phase III title work prior to the escrow agent releasing any funds.

Fees for escrow services in this situation shall be established by negotiations. Right of way managers are authorized to employ escrow agents for a fee not to exceed $100 per parcel. Escrow fees in excess of $100 per parcel must be submitted to the Right of Way Section for prior approval. A letter of understanding, setting forth the escrow fee, if any, and duties to be performed by escrow agents, shall be executed by the escrow agent and retained in the project file.

236.4.4.7 Procedure for Obtaining Title Services

All contracts for title services shall comply with statutory, MoDOT and E-Verify requirements when applicable. Please refer to EPG 236.3.11 Contracting with MoDOT and E-Verify Requirements for more information.

All contractual title services shall be, when advantageous to the department, awarded on a competitive bid basis. It is not required that bid forms be sent to companies that have provided inadequate or unsatisfactory service in the past. Reasons for excluding a company from bidding must be noted in the file.

It is a requirement that all abstractors or title companies doing business with the department execute the appropriate agreement as mentioned in EPG 236.4.4.5. The only exception to this policy is set out in 236.4.4.7(b) below.

(a) Securing Title and Escrow Services

Invitations to bid will then be sent out by certified mail to all **qualified** title companies doing business in the counties for which services are needed and no contract currently exists.

Title companies that are not adequately staffed or equipped to perform the needed service, have been delinquent in performing past services or have not performed past work in a satisfactory manner are deemed unqualified to bid; contract file must contain documentation as to why a company was not requested to submit a proposal. Title companies must have a title plant in the county for which bids are being taken unless one of the following conditions exist:

1. There is not a title plant in the county;

2. The company that does have the title plant in the county refuses to furnish the service at a reasonable charge;

3. The person writing the title insurance for the company is an attorney.

The invitation to bid, as shown on Form RW44 (Form RW44 is accessible in eAgreements), must be amended to satisfy the calendar period needed. Agreements are not to exceed three years. The invitation to bid must be accompanied with three copies of the appropriate Proposal for Title Work, three copies of the Escrow Agreement, and three copies of the Certificate of Disbursement of Funds. All bids received shall be tabulated to determine if it is advantageous for the department to accept the bid, etc. If the bid is accepted, the acceptance thereof will be noted by the execution of the proposal as specified by the Execution of Documents Policy. One copy of the executed contract is to be forwarded to the Controller's Office for the payment of any future invoices submitted by the title company.

All contractual title services shall be awarded to the lowest bidder, however, MoDOT is not obligated to accept the lowest bid for title services if such bid is from a company considered unqualified as defined above. In the event the district does not wish to accept the services of the lowest bidder, documentation must be in the file to state the objections and explain reasoning for same. The district should be careful not to solicit a bid from a company and then request that the company not be accepted as the low bidder.

Once the bid has been accepted, district right of way will prepare the agreement and forward it to the successful bidder for execution. After the contractor has executed the agreement, the agreement is to be executed on behalf of the Commission as specified in the Execution of Documents Policy.

(b) Securing Title Work When Competition is Unavailable

Only one title company is available in certain counties so consequently competition cannot be had. Under these circumstances, a district right of way representative shall negotiate the most reasonable fee possible and the proposal for title work completed in the usual manner.

Should the abstractor refuse to agree upon fees or for other reasons refuse to sign an agreement, qualified district personnel, if available, should be utilized to complete the

necessary title work. If qualified district personnel are not available, contact the division office for guidance.

236.4.4.8 Obtaining Title Insurance and Title Commitments

It is the policy of the department to purchase title insurance or an abstract on acquisitions when permanent rights are purchased. When temporary rights are the only rights acquired, the Commission will not purchase title insurance unless unusual circumstances warrant it.

It is necessary to obtain title commitments on the properties being condemned.

Interim ADA Transition Plan Guidance (3/21/2019)

MoDOT values the needs of all transportation users, including pedestrians. The citizens of Missouri have identified as part of our Long Range Transportation plan they want better transportation choices and they want MoDOT to keep travelers safe, no matter the mode of transportation. Our engineering guidance and decision making should also align with the expectations of our users. Due to the diversity of our state, the expectations of our users differ in each community so it is important to engage stakeholders in the decision making process.

One challenge with implementing the ADA Transition Plan is the determination of MoDOT responsibility. The following is intended to provide guidance on how to determine MoDOT's responsibility and obligations for addressing ADA improvements.

Step 1: Determine Responsibility

- District Right of Way staff will follow guidelines in EPG 236.4.4 to determine responsibility of the roadway and pedestrian facility.
- MoDOT's responsibility is governed by laws that have added roadways to the state system as listed below:
    - 1917 Hawes Road Law specifies a minimum standard width for hard-surfaced roadways to be at least 40 feet in width on the centerline (20 feet each side of the centerline) for grading, bridges, culverts and other drainage features.
    - 1921 Centennial Law gave the state highway system the power to construct all roads, culverts, and bridges. The improvements were required to be distributed uniformly across the state in coordination with the county and/or civil subdivision.
    - 1921 Federal Aid Law enacted funding for all roadway development and maintenance. Where MoDOT has upgraded or improved roadways outside of the documented width for 10 years or more, the area is considered in the state system and the responsibility of the department.
    - 1927 McCawley-Painter Act governed laying out several 100 mile systems across the nation. As a result of this act, Missouri began taking over these roadway sections into the state system through MHTC action.

The definition for major and minor routes as outlined below coincides with STIP, Asset Management, and roadway maintenance references.

- MoDOT will determine responsibility based on the following documentation. The width of responsibility is controlled by the priority of documents listed in order below (i.e. Deeds take precedent over maintenance agreements and prescriptive easement can overlap with all options):
    - 1) Deeds - defined as conveyances entered into by the Commission.
    - 2) Maintenance or municipal agreements – defined as documents outlining maintenance responsibilities for the section or roadway. May include ditches, signals, signs and sidewalks.

- 3) Dedicated plats - defined as dedicated recorded plats that have been accepted in writing or by act and identified as “for public use”.
- 4) Prescriptive easement rights – A Public Agency is responsible for any areas (drainage, signal, signs, site distance, shoulders, sidewalks, etc.) of the roadway that have been improved or maintained by such agency for a period of 10 years or longer. The public agency can be MoDOT or another local public agency, but in either case there must be documented evidence of the use and maintenance of the facility to determine responsibility.
- 5) When no other documentation is available the following applies:
  - For **major routes**, MoDOT is responsible for the stated 40’ width mandated by 1917 Hawes Road law.
  - For **minor routes**, MoDOT is responsible for, at a minimum, the hard surface travelway.
  - If items 1-4 above state a wider width, then the documented width is MoDOTs responsibility.

- Responsibility does not imply ownership.

- **Maintenance agreements** are not a determination of ownership but can be used as a supporting document for determining responsibility. If the agreement states the local entity is responsible for the maintenance of the sidewalks, the agreement can qualify as a responsibility determination.
- Upon District Right of Way staff completing the documentation compilation for responsibility determination, the District Engineer will be presented the supporting documentation as outlined in EPG guidance 236.4.4 to assist in making the final decision for improvement or removal from the transition plan.
- If supporting documents are not available, see Step 2 belowUpdating of current agreements or the execution of a new agreement defining responsibility for upgrades and maintenance to the pedestrian facility will be completed.
- If it is determined MoDOT is not responsible for the pedestrian facility, the District Engineer will submit an executed memo (236.4.4) to Central Office Right of Way for the removal of the segment identified within the ADA Transition Plan database. This determination does not immediately result in the facility being removed from the ADA Transition Plan. Additional considerations are required in Step 2.
- Once determination of responsibility is complete, there may be additional items to add to the ADA Transition Plan. These additional items will be completed at the time of the project or delayed. See Step 2 below regarding delaying improvements or upgrades.
- This guidance does not cover all situations. For example, some major routes function more like a minor route. If it is determined a project has unique circumstances that do not fit this guidance, the District Engineer will request a variance from the Chief Engineer.

Step 2: Determine ADA Improvements

- If MoDOT determines it is not responsible for the pedestrian facilities, the district must first contact the owner to discuss if there is an opportunity for participation in the improvement.
- If there is not an opportunity to partner on the improvement, the district must determine the practical functionality of the pedestrian facility to decide if curb cut improvements (curb ramps) to the facility should be provided with the current alteration (resurfacing). Considerations of practical functionality should include the following:
    - Existing use of the facility – does it provide public access to the community
    - Condition of existing facility
    - Connectivity to other pedestrian facilities
    - Likelihood owner will maintain the facility
- If it is determined facility improvements or access should be provided, the district will make necessary curb cut improvements to the facility and acquire any needed property rights.
- If it is determined access should be delayed, the district will document why the pedestrian facility was determined to not be practically functioning. This documentation should include any correspondence with the owner of the facility regarding responsibility and indicate the curb cuts are being delayed until the facility is upgraded by the owner. Facility improvement delays must be approved by the District Engineer.
- Sidewalks may also be removed if determined they are no longer needed to provide access because businesses have closed, relocated, function has changed, etc. Removal of sidewalks must be approved by the District Engineer and within existing right of way.
- Municipal Agreements will continue to be used as required.

Summary

This interim guidance requires the district to determine if a pedestrian facility is the responsibility of MoDOT and whether the pedestrian facility is practically functioning as originally intended. The transportation intent of the Americans with Disabilities Act (ADA) is to provide a service and ensure ADA facilities are safe and accessible. Providing access to facilities that have deteriorated beyond use or are no longer functional does not comply with the intent of the law. Therefore, there must be conversations and decisions that take into account the overall condition and sustainability of the pedestrian facilities. These decisions should be made with the entire program delivery and operations team and in collaboration with the local entity to address all interests and concerns.

SECTION 302

STABILIZED PERMEABLE BASE

302.1 Description. This work shall consist of furnishing and placing a stabilized permeable base material. The mixture shall be placed, spread and compacted as shown on the plans or as directed by the engineer.

302.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Aggregate for Drainage	1009
Asphalt Binder ~~(PG 64-22, PG 70-22, PG 76-22)~~	1015
Portland Cement	1019
Water	1070

302.2.1 General. Stabilized permeable base shall be either asphalt binder stabilized or Portland cement stabilized at the option of the contractor. All stabilized permeable base shall use Grade 4 drainage aggregate in accordance with Sec 1009.

302.2.2 Asphalt Stabilized Permeable Base. Mixtures shall be composed of the base aggregate and 2.5 percent asphalt binder by weight of the total mixture. PG 64-22, PG 70-22 or PG 76-22 asphalt binder shall be used. All proportioning, mixing and transporting shall be in accordance with Sec 401.

302.2.3 Cement Stabilized Permeable Base. Cement stabilized base mixtures shall be composed of the base aggregate with a cement factor of ~~2.5 sacks~~235 pounds per cubic yard. All proportioning, mixing and transporting shall be in accordance with Sec 501. Fly ash and ground granulated blast furnace slag shall not be used.

302.3 Construction Requirements.

302.3.1 Contamination. Contamination of the finished base material that affects the drainage capability of the product will not be permitted. Any areas determined to be contaminated shall be completely removed without disturbing the adjacent or underlying material and replaced at contractor's expense.

302.3.2 Displacement. Rutting or other displacement of the permeable base or the underlying base will not be permitted. If displacement occurs, which could result in ponding or a non-uniform, non-draining thickness of permeable base, the material shall be completely removed without disturbing the adjacent or underlying material and shall be replaced at the contractor's expense.

302.3.3 Asphalt Stabilized Permeable Base. Applicable portions of Sec 401 will apply, except as noted herein. The final mixture, when discharged from the pugmill or drum, shall be 250-300 F. A minimum of three passes of a 5 to 10 ton steel wheel roller shall be made, compacting the material until no further displacement is noted. Compaction shall begin as soon after spreading the mixture as the mixture is able to bear the weight of the roller without undue displacement and shall be completed before the temperature of the mixture drops below 100 F. The approximate compacted thickness of a single lift shall be a maximum of 4 inches .

302.3.4 Cement Stabilized Permeable Base. Applicable portions of Sec 502 will apply, except as noted herein. Segregation of the mixture shall be minimized. Normal concrete pavement consolidation equipment such as vibrators or vibrating pans will be considered adequate, provided the mixture can be satisfactorily compacted. Burlap curing shall be used and kept moist ~~The mixture shall be cured for~~ a minimum of 48 hours ~~in accordance with Sec 502.6, except that white pigmented membrane or straw shall not be used. A fine water mist may be applied several times each day for the 48 hour period as needed to maintain moisture.~~ . The water application shall not be heavy enough to wash away the cementitious material or mortar.

302.4 Quality Control (QC). The contractor shall control and monitor the quality of the work. A QC Plan will not be required.

302.4.1 Gradation. The contractor shall sample and determine the gradation of all aggregate used to ensure its meets the requirements in Sec 1009.

302.4.2 Deleterious. The contractor shall sample and determine the deleterious content of all aggregate to ensure it does not exceed the limits referenced in Sec 1009.

302.5 Quality Assurance (QA). The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor. Results of QA testing will be furnished to the contractor within 24 hours of obtaining the sample.

302.5.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when independent QA samples meet the same specification criteria as QC.

302.5.2 Split QA Samples. No QA split samples are required for Sec. 302 work.

302.6 QC/QA Frequency Table.

Tested Property	QC Frequency	QA Frequency	
		Independent Samples	Split Samples
Gradation Deleterious	1 per 2000 Tons	1 per Project	-

302.47 Method of Measurement. Final measurement of the completed permeable base will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, measurement of permeable base, complete in place, will be made to the nearest square yard-. The revision or correction will be computed and added to or deducted from the contract quantity.

302.58 Basis of Payment. The accepted quantities of permeable base of the thickness specified will be paid for at the contract unit price for each of the pay items included in the contract. Payment will be considered full compensation for all labor, equipment and material, including the stabilizing agent, to complete the described work.

SECTION 304

AGGREGATE BASE COURSE

304.1 –Description. This work shall consist of furnishing and placing one or more courses of aggregate on a prepared subgrade in accordance with these specifications, and as shown on the plans or as directed by the engineer. The type of aggregate to be used will be specified in the contract.

304.2 -Material. Material for Type 1, 5 and 7 aggregate bases shall be crushed stone or reclaimed asphalt or concrete which meet the requirements of Sec 1007.

304.2.1 Temporary Recycled Material. ~~If available, t~~The contractor may substitute bituminous pavement cold millings or crushed recycled concrete in lieu of aggregate base for any temporary surface, regardless of the type or thickness of aggregate shown on the plans. If this option is exercised, the contractor shall notify the engineer at least two weeks prior to using the millings or recycled concrete, and shall identify the location from where the millings or concrete will be removed.

304.3 -Construction Requirements.

304.3.1- Field Laboratory. When authorized by the engineer, the contractor shall provide a Type 2 field laboratory in accordance with Sec 601. Payment for the laboratory will be made in accordance with Sec 601.

304.3.2 -Subgrade. All work on that portion of subgrade on which the base is to be constructed shall be completed in accordance with Sec 209.2.1 prior to placing any base material on that portion. Aggregate base shall not be placed on frozen subgrade.

304.3.3 -Placing.

304.3.3.1 –The contractor shall place base material on the roadbed as shown in the contract documents. The maximum compacted thickness of any one layer shall not exceed 6 inches. If the specified compacted depth of the base course exceeds 6 inches, the base shall be constructed in two or more layers of approximately equal thickness. The compacted depth of a single layer of the base course may be increased to 8 inches for shoulders.

304.3.3.2 -Types 1 and 5 aggregate base used for shoulders adjacent to rigid or flexible type pavement, including pavement resurfacing, shall be simultaneously deposited and spread on the subgrade. Aggregate shall not be deposited on the pavement and bladed or dozed into place.

304.3.4 –Shaping and Compacting. Each layer shall be compacted to the specified density or dynamic cone penetration index value before another layer is placed.

304.3.4.1 —Segregated surface areas constructed of Type 1 aggregate base may be corrected by adding and compacting limestone screenings of such gradation and quantity as required to fill the surface voids, and firmly bind the loose material in place. Screenings used in correcting segregated surface areas will be measured and paid for as base material. Type 5 and Type 7 aggregate bases are intended to provide some drainage and shall not be segregated. Trimmed Type 5 and 7 aggregate base may not be reused until the material is verified as meeting the required specifications. Base material contaminated to the extent that the material no longer complies with the specifications shall be removed and replaced with satisfactory material at the contractor's expense.

304.3.4.2 ~~Type 1 aggregate base used for shoulders shall be compacted to a minimum 95 percent of standard maximum density. Type 1 aggregate base used on other than shoulders shall be compacted to no less than standard maximum density. Type 5 aggregate base under both roadway and shoulders shall be compacted to a minimum 95 percent of standard maximum density. The Standard Compaction Test will be conducted in accordance with AASHTO T 99, Method C, replacing any material retained on the 3/4-inch sieve, as provided therein. Field density will be determined in accordance with AASHTO T 191 or AASHTO T 310, Direct Transmission, for wet density. The volume of the test hole may be reduced as necessary to~~

~~accommodate available testing equipment.~~ ~~If nuclear density test methods are used, moisture content will be determined in accordance with AASHTO T 310except a moisture correction factor will be determined for each aggregate in accordance with MoDOT Test Method TM 35.~~ Aggregate base shall be compacted to meet the quality control requirements found in this specification. In lieu of the density requirements for Type 1 aggregate base used for shoulders with thicknesses less than 4 inches, the aggregate shall be compacted by a minimum of three complete coverages with a 5 ton roller. Rolling shall be continued until there is no visible evidence of further consolidation.

~~**304.3.4.3** Type 7 aggregate base under both roadway and shoulders shall be compacted to achieve an average dynamic cone penetration index value through the base lift thickness less than or equal to 0.4 inches per blow, as determined by a standard dynamic cone penetrometer (DCP) device with a 17.6 lb hammer meeting the requirements of ASTM D6951.~~

304.3.4.3~~.1~~ Water shall be applied to the Type 7 base material during the mixing and spreading operations so that at the time of compaction the moisture content is not less than 5 percent of the dry weight.

~~**304.3.4.3.2** Type 7 base shall be tested with the DCP within 24 hours of placement and final compaction.~~

304.3.4.4 If at any time the compacted aggregate base or subgrade ruts, pumps, or otherwise becomes unstable, the contractor, at the contractor's expense, shall restore the earth subgrade and the aggregate base to the required grade, cross section and density.

304.3.~~5~~ 4.5 ~~**Substitutions for Aggregate Base.** If available, the contractor may substitute bituminous pavement cold millings or crushed recycled concrete in lieu of aggregate base for any temporary surface, regardless of the type or thickness of aggregate shown on the plans. If this option is exercised, the contractor shall notify the engineer at least two weeks prior to using the millings or recycled concrete, and shall identify the location from where the millings or concrete will be removed. The m~~Millings or recycled concrete shall be installed to the same dimensions shown on the plans for the aggregate base. Millings or recycled concrete shall be placed in maximum 4-inch lifts, and each lift shall be compacted by a minimum of three passes with a 10-ton roller.

304.3.5~~6~~ **Maintenance.** The contractor shall maintain, at the contractor's expense, the required density and surface condition of any portion of the completed aggregate base until either the prime coat or a succeeding course or pavement is placed.

304.3.6 Prime Coat. If a prime coat is specified in the contract, the contractor will be required to apply the prime coat on any completed portion of the aggregate base as soon as practical, or as otherwise specified. The contractor will not be permitted to apply prime if the moisture in the top 2 inches of the Type 1 or 5 aggregate base exceeds the higher of either (1) the average of the optimum moisture as determined by the Standard Compaction Test and the absorption of the plus No. 4 fraction, or (2) two-thirds of the optimum moisture as determined by the Standard Compaction Test.

304.4 ~~**Quality Control (QC)/Quality Assurance (QC/QA).**~~

~~**304.4.1 Quality Control.**~~ The contractor shall control operations to ensure the aggregate base, in place, meets the specified requirements ~~for density, thickness, gradation, deleterious, and plasticity index~~. Tests shall be taken at random locations designated by the engineer. ~~at the following frequency:~~

~~[a]Sampled at point of delivery, prior to rolling.~~

304.4.1~~.3~~ **Deficiency Limits Determination.** When density or ~~DCP~~ dynamic cone penetrometer index value tests are less than specified or when thickness measurements indicate the thickness is deficient by more than 1/2 inch from the plan thickness, additional measurements will be taken at 100-foot intervals parallel to centerline ahead and behind the tested location until the extent of the deficiency has been determined. Each measurement will be assumed as representative of the ~~base thickness~~full width for a distance extending one-half the distance to the next measurement, measured along centerline, or in the case of a beginning or ending measurement, the distance will extend to the end of the base section. Any deficient areas shall be corrected by reworking or adding material within the limits of the deficiency.

304.4.2~~1.4~~ Rejected Material. When two consecutive tests for gradation, deleterious material, or plasticity index do not meet the specification limits, the material shall be removed beginning at the point where the first test was conducted.

304.4.~~1.5~~3 Retained Samples. The contractor shall retain and clearly identify the untested portion of aggregate samples ~~of the plasticity index, gradation and deleterious sample~~ for the engineer's use. The amount retained shall be at least as large as necessary to perform the ~~QA~~quality assurance plasticity index, gradation and deleterious testing. The contractor shall retain the samples for 7 days after testing has been completed and the results accepted by the engineer.

304.4.4 % Density. Field density for Type 1 and Type 5 aggregate base ~~will~~shall be determined in accordance with AASHTO T 191 or AASHTO T 310, Direct Transmission, for wet density. For sand cone method, t~~T~~he volume of the test hole may be reduced as necessary to accommodate available testing equipment. If nuclear density test methods are used, moisture content will be determined in accordance with AASHTO T 310 and a moisture correction factor applied. Type 1 aggregate base used for shoulders shall be compacted to a minimum 95 percent of standard maximum density. Type 1 aggregate base used on other than shoulders shall be compacted to no less than standard maximum density. Type 5 aggregate base under both roadway and shoulders shall be compacted to a minimum 95 percent of standard maximum density.

304.4.5 Dynamic Cone Penetrometer Index. Type 7 aggregate base under both roadway and shoulders shall be compacted to achieve an average dynamic cone penetration (DCP) index value through the base lift thickness less than or equal to 0.4 inches per blow, as determined by a standard DCP device with a 17.6 lb hammer meeting the requirements of ASTM D6951. DCP testing shall occur within 24 hours of placement and final compaction.

304.4.6 Thickness The thickness of the placed material shall be monitored using an applicable method meeting engineer's approval.

304.4.7 Gradation – AASHTO T 11 and AASHTO T 27 shall be utilized to monitor gradation compliance with Sec 1007. Samples shall be taken at point of delivery, prior to rolling.

304.4.7.1 When production for a week is anticipated to be 1,000 tons or less, the contractor may test the material at a frequency of 1 per 250 tons with a minimum of 1 test per week in lieu of the frequency found in the QC/QA frequency table.

304.4.8 Deleterious – Using MoDOT TM 71, QC shall determine the deleterious content compliance with Sec 1007. Samples shall be taken at point of delivery, prior to rolling. Small quantities shall follow Sec 304.4.7.1

304.4.9 Plasticity Index – Using AASHTO T 89 and AASHTO T 90, QC shall determine the PI compliance with Sec 1007. Samples shall be taken at point of delivery, prior to rolling. Small quantities shall follow Sec 304.4.7.1

304.4.10 Standard Compaction The contractor shall determine the standard maximum dry density and the optimum moisture content for Type 1 and 5 base materials and supply all test data to the engineer prior to the beginning of work. The s~~S~~tandard c~~C~~ompaction t~~T~~est will be conducted in accordance with AASHTO T 99, Method C, replacing any material retained on the 3/4-inch sieve, as provided therein. A new standard compaction test shall be performed by QC when there is evidence of changes to the material or as directed by the engineer.

304.4.11 Dry Weight The contractor shall determine the dry weight for Type 7 base materials and supply all test data to the engineer prior to the beginning of work.

304.4.12 Nuclear Moisture Correction Factor. Whenever nuclear gauges are used for field density, a moisture correction factor will be determined for each aggregate in accordance with MoDOT TM 35. The contractor shall supply the correction factor and all test data to the engineer prior to the beginning of work.

304.~~4.2~~5 Quality Assurance (QA). ~~The contractor's QC test results and the engineer's QA test results shall meet the specifications and the following. For Type 1 and 5 base the contractor's compaction standard tests shall compare within 3.0 pounds of the maximum density of the MoDOT determined compaction standard. For Type 7~~

~~base the contractor's average DCP penetration index shall compare within 0.1 inches per blow of the MoDOT determined average penetration index.~~

304.5.1 Independent QA Samples. ~~The contractor's QC test results and the engineer's QA test results shall meet the specifications~~ Unless otherwise stated, a favorable comparison shall be obtained when independent QA samples meet the same specification criteria as QC. ~~and the following.~~ For Type 1 and 5 base a favorable comparison with the ~~contractor's~~ QC ~~compaction~~ standard compaction tests shall be obtained when the QA result is ~~compare~~ within 3.0 pounds ~~of the maximum density of the MoDOT determined compaction standard~~. For Type 7 base the ~~contractor's~~QC average DCP penetration index shall compare within 0.1 inches per blow of the ~~MoDOT~~QA ~~determined average penetration index.~~

304.5.2 Split QA Samples.

For retained samples, the ~~contractor's~~ QC test results and ~~the engineer's~~ QA test results shall compare within the following limits.~~:~~

~~(a)~~ The total deleterious material shall be within 2.0 percentage points.

~~(b)~~ The plasticity index shall be within 2.

~~(c)~~ The gradation test results shall compare within the following limits:

Sieve	Tolerance (%)
~~1 1/2 inch~~	~~± 5.0~~
~~1 inch~~	~~± 5.0~~
~~3/4 inch~~	~~± 5.0~~
1/2-inch and larger	± 5.0
No. 4	± 4.0
No. 8	± 4.0
No. 10	± 3.0
No. 30	± 3.0
No. 40	± 2.0
No. 100	± 2.0
No. 200	± 1.0

304.6 QC/QA Frequency Table

Tested Property	QC Frequency	QA Frequency	
		Independent Samples	Split Samples
% Density	1 per 1,000 Tons, Min of 1 per Day	1 per 4,000 Tons	-
DCP Index			
Thickness			
Gradation Material	1 per 2,000 Tons, Min of 1 per Day	-	1 per 8,000 Tons
Deleterious			
Plasticity Index	1 per 10,000 Tons		1 per 40,000 Tons
Standard Compaction	1 per Material	1 per Project	-
Dry Weight		-	
Nuclear Moisture Correction Factor			

304.~~5~~ 7 Method of Measurement. Final measurement of the completed aggregate base course will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Measurement will include aggregate course placed under curb and gutter. Where required, measurement of

aggregate base course, complete in place, will be made to the nearest square yard. Where the aggregate base course extends to the inslope of the shoulder, the pay limit of the aggregate base course will be measured from the mid-point of the sloped portion. The revision or correction will be computed and added to or deducted from the contract quantity.

304.~~6~~ 8 Basis of Payment. The accepted quantities of aggregate base course of the thickness and type specified will be paid for at the contract unit price for each of the pay items included in the contract. Payment will be considered full compensation for water used in performing this work. When bituminous pavement cold millings or recycled crushed concrete are substituted for aggregate base, payment will be made for the aggregate base quantity provided in the plans, regardless of whether millings, recycled crushed concrete or the aggregate base is used. Payment will be considered full compensation for hauling of millings, cold milling operations, and all other material or labor necessary to substitute bituminous pavement millings for aggregate base.

SECTION 310

AGGREGATE SURFACE

310.1 Description. This work shall consist of furnishing and placing chat, gravel or crushed stone surfacing in the quantity shown in the contract document or as directed by the engineer.

310.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically Sec 1006. The type and gradation of the surfacing material to be used will be specified in the contract.

310.3 Construction Requirements.

310.3.1 General. The contractor shall furnish, haul and spread surfacing material on the subgrade at the designated rate. The rate of application may be varied at the discretion of the engineer, depending on the nature of the soil encountered in the subgrade. The contractor shall uniformly unload and distribute the required quantity of material throughout each station. The subgrade shall be prepared as specified in Sec 209, and any work done in reshaping the subgrade before placing surfacing material shall be at the contractor's expense. When it is determined by the engineer to be to the Commission's advantage, hauling may be done over surfacing material previously spread, otherwise, all hauling shall be over the subgrade.

310.3.2 Surface Requirements. Material shall be spread to a uniform thickness over the subgrade and shaped as shown on the plans until the surface is free from ruts and waves. The surface shall be compacted under traffic. Maintenance of the surface shall continue until final project acceptance is made.

310.3.3 Stockpiles. Material shall be stockpiled at locations approved by the engineer, and in the approximate quantity shown on the contract.

310.3.4 Salvage. Designated areas shall be scarified to the full depth of the existing surfacing and such material pulverized to a maximum size of approximately 2 inches. Uncontaminated material shall be removed from the roadbed and placed in stockpiles or spread at locations approved by the engineer. Salvaged surfacing material shall be maintained as free as practical of dirt, vegetation or other objectionable material. Salvaging shall not be performed unless approved by the engineer.

310.4 Quality Control. The contractor shall control and monitor the quality of the work. No QC plan shall be required for aggregate surfacing work. QC for quantity less than 500 tons shall be governed by Sec 1006.

310.4.1 Gradation. The gradation shall be determined and meet the requirements of Sec 1006.

310.4.2 Deleterious. The deleterious content of the material shall be determined and meet the requirements of Sec 1006.

310.4.3 Durability. The durability of the material shall be determined and meet the requirements of Sec 1006.

310.5 Quality Assurance. The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor. Results of QA testing will be furnished to the contractor within 24 hours of testing be completed.

310.5.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when independent QA samples meet the same specification criteria as QC.

310.5.2 Split QA Samples. No split samples are called for in Sec 310.

310.6 QC/QA Frequency Table.

Tested Property	QC Frequency	QA Frequency	
		Independent Samples	Split Samples
Gradation	1 per 2000 Tons	1 per Project	-
Deleterious			
Durability	1 per Material	-	

~~**310.4. Vehicle Scales.** Vehicle scales shall be approved by the engineer and shall be in accordance with the requirements specified herein.~~

~~**310.4.1 Basis of Acceptance.** Scale acceptance will be based on one of the following:~~

~~(a) A valid certification or seal of approval by the Missouri Department of Agriculture, Division of Weights and Measures.~~

~~(b) A valid certification or seal of approval by a State of Missouri duly appointed Sealer of Weights and Measures in cities or counties of 75,000 population or more.~~

~~(c) Certification of calibration from a commercial scale service company showing that the scale meets the requirements of these specifications. The contractor shall furnish the certification of calibration to the engineer.~~

~~(d) Calibration from zero weight through the maximum load to be applied by the application of standard weights in the presence of the engineer by the contractor's personnel. In lieu of starting the calibration at zero weight, standard weights may be applied to an unloaded truck, the weight of which has been determined on a certified scale and the calibration continued through the maximum load to be applied. Regardless of the form of acceptance, the calibration shall be within the accuracy requirements specified in Sec 310.4.2, and the scales shall meet all requirements of these specifications.~~

~~**310.4.2 Scale Calibration.** Scales shall have been calibrated within the 12 month period immediately prior to any material being delivered or any time the engineer has cause to question the accuracy of the scale. Scales shall be accurate to within 0.4 percent of the net load applied, regardless of the location of the load on the platform. The value of the smallest unit of graduation on a scale shall be no greater than 20 pounds. Sensitivity requirements of scales not equipped with balance indicators shall be twice the value of the minimum graduated interval on the weigh beam or 0.2 percent of the nominal capacity of the scale, whichever is less. For~~

~~scales equipped with balance indicators, the sensitivity requirement shall be the value of the minimum graduated interval on the weigh beam.~~

~~**310.4.3 Verification.** Verification of a vehicle scale may be required by weighing a hauling unit on another recently calibrated and certified scale.~~

~~**310.4.4 Long Vehicles.** If equipment to be weighed is of such length that all axles cannot be weighed simultaneously, a level area of concrete or bituminous pavement shall be provided permitting those axles not on the scale platform to be on the pavement during the weighing operation. The approach shall be at least as wide as the platform and of sufficient length to ensure the level positioning of vehicles during weight determinations. The weighing shall be performed with all brakes released. If equipment to be weighed is equipped with an air bag suspension unit on any axle, the equipment, including semi-trailers or pup trailers, shall be determined on vehicle scales of sufficient size to weigh all axles of the combination simultaneously.~~

~~**310.4.5 Certification.** All costs incurred in obtaining certification of calibration or verification shall be at the contractor's expense.~~

310.7~~5~~ Method of Measurement.

310.7~~5~~.1 Measurement by Volume. Stockpiles of salvaged surfacing material may be measured by the average end area method.

310.7~~5~~.2 Measurement of Aggregate Surfacing by Area. Final measurement of the completed aggregate surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of aggregate surface, complete in place, will be made to the nearest square yard. The revision or correction will be computed and added to or deducted from the contract quantity.

310.7~~5~~.3 Measurement by Weight. Measurement will be made by weighing each truck load on scales in accordance with Sec 310.4. Deductions will be made for any moisture in excess of 2.0 percent of the dry weight of the material. After deduction for excess moisture has been made, measurement will be made to the nearest ton for the total tonnage of material accepted.

310.8~~6~~ Basis of Payment. The accepted quantities of aggregate surface will be paid for at the contract unit price

EPG 302 Remove and replace 302.2.1.1 as shown

302.2.1 Procedure

The QC/QA tests and frequencies for these materials are covered in the ~~table below~~specification.

~~Type of Construction or Material~~	~~Tests to be Made (if specified)~~	~~Sampled~~	~~Minimum Number of Tests~~
~~Stabilized Permeable Base~~	~~Graduation SAA002UB~~	~~Before compactions~~	~~One per 5,000 tons (5,000 megagrams) or fraction thereof per specified graduation source. None required if less than 1,000 tons (1,000 megagrams) of a specified graduation.~~

Remove and Replace these various sections as shown:

304.1.2 Material (Sec 304.2)

Qaulity Control is the responsibility of the Contractor. District Construction personnel are responsible for QA inspection of material when it arrives on the project and laying operations begin. Refer to Quality Control/Quality Assurance (QC/QA) in regard to QA testing requirements. There will be times during base laying operations when Materials inspectors will be on the project to take samples of base. If difficulties are encountered with material degrading, or varying appreciably in plastic index or gradation, the project inspector should not hesitate to ask the DistrictMaterials inspector assistance or advice.

304.1.3 Construction Requirements (Sec 304.3)

Compaction and rolling requirements will be in accordance with Sec 304.3~~.5~~. Review the general requirements in Construction Inspection for Bases and Aggregate Surfaces.

304.1.4.2 Quality Assurance (Sec 304.4.2)

A vital element in acceptance of aggregate base is the quality assurance. Material properties are to be tested at the frequency stated in Sec 304.~~4~~6. Density, gradation, presence of deleterious material and the PI are to be checked and documented by the engineer. Observe the compacting operation to ensure the material forms a firm, stable base. Measure and record the random thickness and template of the finished aggregate base for conformance with specifications, in addition to any inspections performed on items that are not otherwise part of a permanent record.

304.2.3.5 Testing

Tests are to be run in accordance with the applicable test methods at the frequency listed in Sec 304.~~4.1~~6. Please note that the frequencies listed are minimums. If material is approaching specification limits or if problems are encountered the inspector should increase the testing frequency.

~~Inspectors shall test one of the contractor's retained QC samples at the following frequencies:~~

~~Test~~	~~Frequency~~
~~Gradation and Deleterious~~	~~1 per project with a minimum of 1 per week and at least 1 per 16,000 tons~~
~~PI~~	~~1 per project with a minimum of 1 per week and at least 1 per 80,000 tons~~

Delete the following

~~***304.2.3.6 Failing Tests***~~

~~Procedures for failing test results are outlined in Sec 304.4.~~

SECTION 401
PLANT MIX BITUMINOUS BASE AND PAVEMENT

401.1 Description. This work shall consist of a bituminous mixture placed, spread and compacted as shown on the plans or as directed by the engineer.

401.2 Material.

~~**401.2.1**~~ The grade of asphalt binder will be specified in the contract. ~~When the plasticity index on individual aggregate fractions with 10 percent or more passing the No. 30 sieve exceeds 3, a moisture susceptibility test shall be required in accordance with Sec 401.4.5 during the mix design process. If the plasticity index exceeds that of the material approved for the mix design, additional testing may be required.~~ All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Bituminous Asphalt Mixes	490
Coarse Aggregate	1004.2
Fine Aggregate	1002.3
Mineral Filler	1002.4
Hydrated Lime	1002.5
Asphalt Binder, Asphalt Emulsion~~, Performance Graded (PG)~~	1015

~~**401.2.2 Reclaimed Asphalt.** Reclaimed Asphalt may be obtained from Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS). The asphalt binder content of recycled asphalt materials shall be determined in accordance with AASHTO T 164, ASTM D 2172 or other approved method of solvent extraction. A correction factor for use during production may be determined for binder ignition by burning a sample in accordance with AASHTO T 308 and subtracting from the binder content determined by extraction.~~

~~The use of reclaimed asphalt shall be limited to one of the following options with the exception of bituminous base. For bituminous base the limits specified may be increased according to the recycled materials used as follows; 10% for RAP only, 5% for RAS only and 10% for the appropriate RAP and RAS combination.~~

~~Binder~~	~~Percent Effective Virgin Binder Replacement~~		
	~~RAP~~	~~RAS~~	~~RAP and RAS combination~~
~~Contract Grade Virgin Binder shall be used~~	~~0 – 20~~	~~0 – 10~~	~~RAP + (2*RAS) ≤ 20~~
~~Virgin Binder shall be Softened One Grade[a]~~	~~21 – 40~~	~~11 – 20~~	~~20 < RAP + (2*RAS) ≤ 40~~
~~Blend Chart[b]~~	~~0 – 100~~	~~N/A~~	~~N/A~~
~~Extraction and Grading of Binder from final Mixture[c]~~	~~0 – 100~~		

~~[a]The virgin binder shall have a low temperature grade 6 degrees lower than the binder grade specified in the contract. Lowering the high temperature of the virgin binder is not required; however, if lowered, the virgin binder shall have a high temperature grade no lower than 6 degrees below the binder grade specified in the contract. (Ex. Contract grade PG 64-22; virgin binder could be either PG 58-28 or PG 64-28). The Pressure Aging Vessel (PAV) test temperature (AASHTO M320) shall be tested at 19° C, regardless of the high temperature grade of the selected virgin binder~~

~~[b]Testing in accordance with AASHTO M323 including raw data shall be included with the mix design which demonstrates that the grade of the combine mixture meets the contract requirements.~~

~~[c]Testing in accordance with either AASHTO T319, or AASHTO T164 and R59 along with grading in accordance with AASHTO M320 including raw data shall be included with the mixt design which demonstrates that the grade of the combine mixture and rejuvenator, if applicable, meets the contract requirements.~~

401.2.2.1 Reclaimed Asphalt Pavement. Reclaimed Asphalt Pavement (RAP) may be used in any Sec 401, Plant Mix Bituminous Base and Pavement. All RAP material, except as noted below, shall be tested in accordance with AASHTO T 327, Method of Resistance of Coarse Aggregate Degradation by Abrasion in the Micro-Deval Apparatus. Aggregate shall have the asphalt coating removed either by extraction or binder ignition during production. The material shall be tested in the Micro-Deval apparatus at a frequency of once per 1500 tons. The percent loss shall not exceed the Micro-Deval loss of the combined virgin material by more than five percent. Micro-Deval testing will be waived for RAP material obtained from MoDOT roadways. All RAP material shall be in accordance with Sec 1002 for deleterious and other foreign material. The aggregate specific gravity shall be determined by performing AASHTO T 209 in accordance with Sec 403.19.3.1.2 and calculating the G_{se} to which a 0.98 correction factor will be applied in order to determine G_{sb} as follows:

$$G_{se} = \frac{100 - Pb}{\frac{100}{G_{mm}} - \frac{Pb}{G_b}}$$

RAP G_{sb} = RAP G_{se} X 0.98

See Sec 401.4.4.1 for mixes containing more than 40% effective binder replacement from reclaimed asphalt.

401.2.2.2 Reclaimed Asphalt Shingles. Reclaimed Asphalt Shingles (RAS) may be used in any mixture specified to use PG 64-22 in accordance with AASHTO PP 53. In addition, shingles shall be ground to 3/8 inch minus. Waste, manufacturer or new, shingles shall be essential free of deleterious materials. Post-consumer RAS shall not contain more than 1.5 percent wood by weight or more than 3.0 percent total deleterious by weight. Post-consumer RAS shall be certified to contain less than the maximum allowable amount of asbestos as defined by national or local standards. The bulk specific gravity of RAS used in the job mix formula shall be 2.600.

RAS G_{sb} = 2.600

See Sec 401.4.4.1 for mixes containing more than 40% effective binder replacement from reclaimed asphalt.

The gradation of the aggregate may be determined by solvent extraction of the binder or using the following as a standard gradation:

Shingle Aggregate Gradation	
Sieve Size	**Percent Passing by Weight**
3/8 in.	100
No. 4	95
No. 8	85
No. 16	70
No. 30	50
No. 50	45
No. 100	35
No. 200	25

401.2.2.3 Rejuvenators. Rejuvenators may be used in any asphalt mixture containing recycled material. When a rejuvenator is used for the purpose of softening the binder grade, the requirements for the Extraction and Grading of Binder from Final Mixture option in Sec 401.2.2 must be satisfied.

401.3 Composition of Mixtures. Aggregate sources shall be from the specific ledge or combination of ledges within a quarry, or processed aggregate from a particular product, as submitted in the mix design. The total aggregate prior to mixing with asphalt binder shall be in accordance with the following gradation requirements:

Sieve Size	**Percent Passing by Weight**			
	Base	**BP-1**	**BP-2**	**BP-3**
1 inch	100	100	100	100
3/4 inch	85-100	100	100	100
1/2 inch	60-90	85-100	95-100	100
3/8 inch	—	—	—	100
No. 4	35-65	50-70	60-90	90-100

No. 8	25-50	30-55	40-70	—
No. 16	—	—	—	30-60
No. 30	10-35	10-30	15-35	—
No. 200	4-12	5-12	5-12	7-12

401.4 2.1 Job Mix Formula (JMF). Mix designs meeting the Sec 490 requirement shall be submitted at least seven days prior to placement. At least 30 days prior to placing any mixture on the project, the contractor shall submit a mix design for verification and approval by Construction and Materials. Bituminous Base (BB) and Bituminous Pavement (BP-1, BP-2, or BP-3) mixtures as designated by the plans are used for Section 401 pay items. The mixture shall be designed in accordance with Asphalt Institute Publication MS-2, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types. The mixture shall be compacted and tested at a minimum of three asphalt contents separated by a maximum of 0.5 percent in accordance with AASHTO T 245, except as herein noted. The test method shall be modified by short-term aging the specimens in accordance with AASHTO R 30. A detailed description of the mix design process shall be included with the job mix formula. Representative samples of each ingredient for the mixture shall be submitted with the mix design. Aggregate fractions shall be in accordance with the same proportions as the proposed job mix formula. A minimum of 150 pounds will be required for any individual fraction. The amount of each ingredient submitted shall be as follows for each mix design to be verified:

Ingredient	Minimum Amount
Aggregate	300 lbs
Hydrated Lime, Mineral Filler and/or Baghouse Fines	20 lbs
Asphalt Binder	10 gal.

401.4.1 Mixture Design. Laboratories that participate and achieve a score of 3 or greater in the AASHTO proficiency sample program for T 11, T 27, T 84, T 85, T 166, T 209, T 308 and T 245 or T 312 will have the mixture verification process waived. The mix design shall be submitted to Construction and Materials for approval at least seven days prior to mixture production.

401.4.2 Required Information. The mix design shall include raw data from the design process and shall contain the following information:

(a) All possible sources intended for use, and grade and specific gravity of asphalt binder.

(b) Source, type (formation, etc.), ledge number(s) if applicable, gradation, and percent chert of each aggregate fraction.

(c) Plasticity index of each aggregate fraction which has 10 percent or more passing the No. 30 sieve.

(d) Bulk and apparent specific gravities and absorption of each aggregate fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate, including all raw data, or in accordance with TM 81.

(e) Specific gravity of hydrated lime, mineral filler or baghouse fines, if used, in accordance with AASHTO T 100.

(f) Percentage of each aggregate component.

(g) Combined gradation of the job mix.

(h) Percent of asphalt binder, by weight, based on the total mixture.

(i) Bulk specific gravity (G_{mb}) by AASHTO T 166, Method A of a laboratory compacted mixture.

(j) Percent air voids (V_a) of the laboratory compacted specimen.

(k) Voids in the mineral aggregate (VMA) and voids in the mineral aggregate filled with asphalt binder (VFA).

(l) Theoretical maximum specific gravity (G_{mm}) as determined by AASHTO T 209 in accordance with Sec 403.19.3 after the sample has been short-term aged in accordance with AASHTO R 30.

(m) Mixing temperature and molding temperature.

~~(n) Bulk specific gravity (G_{mb}) of the combined aggregate.~~

~~(o) Percent deleterious content of the combine aggregate.~~

~~(p) Baghouse fines added for design. Provide the combine gradation with and without the baghouse percentage.~~

401.~~4.3~~2.1.1 Mixture Approval. No mixture will be accepted for use until the job mix formula for the project is approved by Construction and Materials. The job mix formula approved for each mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results or other conditions occur, or should a source of material be changed, a new job mix formula may be required. ~~In lieu of a new laboratory design, mixtures requiring adjustment beyond the limits allowed in Sec 401.8.2 may be designed in the field based on characteristics of plant produced mixture in accordance with Sec 401 and verified by Construction and Materials, which may require new aggregate characteristics.~~

401.2.1.2 Mixture Adjustments. In producing mixtures for the project, the plant shall be operated such that no intentional deviations from the job-mix formula are made except as follows. Aggregate only bin changes are allowable so long as the original gradation tolerances, non-carbonate requirements, and binder replacement requirements of Sec 490 are met.
The contractor shall provide a record of the time and tonnage of all mixture adjustments as well as all verification calculations or testing to the engineer.

401.2.2 Substitutions. At the option of the contractor and at no cost to the Commission, the contractor may use a Sec 401 mixture with a smaller nominal maximum size aggregate or an approved Sec 403 mixture, design level C, E, or F with the same or smaller nominal maximum size aggregate in lieu of any Sec 401 mixture. When a Sec 403 mixture is substituted, all Sec 401 requirements including QC/QA requirements shall remain except the layer thickness requirements of Sec 403 shall apply.

401.~~5.3~~2.3 Commercial Mixture. A mixture other than those approved following Sec. 490 may be used ~~I~~if specified in the contract as~~that a~~n ~~approved~~ commercial mixture or for temporary construction that is to be maintained at the contractor's expense and removed prior to completion of the contract. The plant requirements of Sec 404 will not be required. A field laboratory will not be required. ~~may be used, the contractor shall, at least seven days prior to the desired time of use, furnish a statement setting out the source and characteristics of the mixture proposed to be furnished. The statement shall include:~~

~~(a) The types and sources of aggregate, percentage range of each, and range of combined gradation.~~

~~(b) The percent and grade of asphalt binder.~~

~~(c) The mixing time and range of mixture temperature.~~

The ~~plant shall be designed and operated~~ mixture shall be ~~to~~ produced, transported, and placed accordance with Sec 401.5 ~~to be a~~ uniform, thoroughly mixed, and ~~material~~ free from segregation. ~~It will not be necessary for the plant to meet the requirements of Sec 404. A field laboratory will not be required. If the proposed mixture and plant are approved by the engineer, the component material and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish with the first truckload of each day's production, a certification that the material and mixture delivered are in conformance with the approved mixture.~~ Upon completion of the work, the contractor shall supply ~~a plant~~a certification ~~shall be furnished by the supplier~~ for the total quantity ~~delivered~~detailing the components and proportions used. Acceptance of commercial mixture will be by visual inspection. ~~The mixture shall be transported, placed and compacted in accordance with Sec 401.7. Without specific contract designation, an approved commercial mixture may be used in lieu of plant mix bituminous pavement or base course mixtures for work that is considered temporary construction and is to be maintained at the contractor's expense. Temporary construction will be defined as work that is to be removed prior to completion of the contract.~~

~~**401.4.4 Mixture Characteristics.**~~

~~**401.4.4.1** Base, BP-1, BP-2 and BP-3 mixtures shall have the following properties, when tested in accordance with AASHTO T 245 or AASHTO T 312. The number of blows with the compaction hammer shall be 35 or the number of gyrations shall be 35 with the gyratory compactor. BP-1 and BP-2 mixtures shall have between 60 and 80 percent of the VMA filled with asphalt binder and dust to effective binder ratio of 0.8 to 1.6. BP-3 mixtures shall be compacted with the gyratory compactor to 35 gyrations and shall have a minimum 75 percent of the VMA filled with asphalt binder and dust to effective binder ratio of 0.9 to 2.0.~~

~~Mix Type~~	~~Percent Air Voids~~	~~AASHTO T 245 Stability lb~~	~~Voids in Mineral Aggregate (VMA)[b]~~
~~BB~~	~~3.5~~	~~750~~	~~13.0[a]~~
~~BP-1~~	~~3.5~~	~~750~~	~~13.5~~

BP-2	3.5	750	14.0
BP-3	3.5	750	15.0

[a]Bituminous base mixtures that would require 12.0 percent VMA following Asphalt Institute MS-2 will have a minimum 12.0 percent requirement.
[b]If the effective virgin binder replacement from any combination of RAP and RAS is greater than 40 percent; then the minimum VMA required shall be increased by 0.5.

401.4.4.2 When specified in the contract as BP-3NC, BP-3 mixtures containing limestone aggregate shall contain a minimum amount of non-carbonate aggregate as shown in the table below, or the aggregate blend shall have an acid-insoluble residue (A.I.R.), MoDOT Test Method TM-76, meeting the criteria of crushed non-carbonate material. The A.I.R. shall be determined on the minus No. 4 sieve. Non-carbonate aggregate shall have an A.I.R. of at least 85 percent insoluble residue.

Aggregate	Minimum Non-Carbonate by Volume
Limestone	20% Minus No. 4
Dolomite	No Requirement

401.4.5 Moisture Susceptibility. Moisture susceptibility may be tested in accordance with AASHTO T 283. A minimum retained strength of 70 percent shall be obtained when tested for moisture susceptibility. An approved anti-strip additive may be added to increase retained strength to a passing level. When testing is required by Sec 401.2.1 or Sec 401.9, the mixture shall be testing during production in accordance with Sec 403.19.

401.4.6 Time Limit. A mix design may be transferred to other projects for a period of three years from the original approval date provided satisfactory results are obtained during production and placement.

401.5 Gradation and Deleterious Content Control. In producing mixtures for the project, the plant shall be operated such that no intentional deviations from the job-mix formula are made without prior approval from the engineer. The contractor shall determine the mixture gradation at the frequency stated in Sec 401.8.1. The mixture gradation may be determined directly by using residual aggregate from the binder ignition process or by mathematical combination of the cold feed and recycled materials gradations. When the mathematical combination method is used, the RAS gradation shall be from the JMF and RAP gradation from the ignition or extraction residual aggregate. Mixtures as produced shall be subject to the following tolerances and controls:

(a) The maximum variations from the approved job-mix formula shall be within the tolerances as shown in the table below:

Sieve Size	Percent Passing by Weight	
	Tolerance	Action Limit
No. 8[a]	± 5.0	± 10.0
No. 200	± 2.0	± 4.0

[a]Use No. 16 sieve for BP-3

(b) The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in Sec 1004.2.

(c) The quantity of asphalt binder introduced into the mixer shall be the quantity specified in the job-mix formula. No changes shall be made to the quantity of asphalt binder without written approval from the engineer. The quantity of asphalt binder determined by tests on the final mixture shall not vary by more than – 0.3 to + 0.5 percent from the job-mix formula.

401.5.1 Sample Location. The gradations of the total aggregate will be determined from samples taken from the hot bins on batch-type plants or continuous mixing plants or from the composite cold feed belt on drum-mix plants. The deleterious content of the total aggregate shall be determined from samples taken from the composite cold feed belt. When required, samples for plasticity index shall be taken from the stockpile. The RAP shall be sampled from the RAP feeding system on the asphalt plant. Samples for asphalt content determination may be taken at the plant.

401.5.2 Substitutions. At the option of the contractor and at no cost to the Commission, the contractor may use a Sec 401 mixture with a smaller nominal maximum size aggregate or an approved Sec 403 mixture, design level C, E, or F with the same or smaller nominal maximum size aggregate in lieu of any Sec 401 mixture. When a Sec 403 mixture is substituted, the layer thickness requirements of Sec 403 will apply. The gradation, asphalt content, deleterious, and density acceptance of the substituted mixture during production will be in accordance with Sec 401.

~~**401.5.3 Commercial Mixture.** If specified in the contract that an approved commercial mixture may be used, the contractor shall, at least seven days prior to the desired time of use, furnish a statement setting out the source and characteristics of the mixture proposed to be furnished. The statement shall include:~~

~~(a) The types and sources of aggregate, percentage range of each, and range of combined gradation.~~

~~(b) The percent and grade of asphalt binder.~~

~~(c) The mixing time and range of mixture temperature.~~

~~The plant shall be designed and operated to produce a uniform, thoroughly mixed material free from segregation. It will not be necessary for the plant to meet the requirements of Sec 404. A field laboratory will not be required. If the proposed mixture and plant are approved by the engineer, the component material and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish with the first truckload of each day's production, a certification that the material and mixture delivered are in conformance with the approved mixture. Upon completion of the work, a plant certification shall be furnished by the supplier for the total quantity delivered. The mixture shall be transported, placed and compacted in accordance with Sec 401.7. Without specific contract designation, an approved commercial mixture may be used in lieu of plant mix bituminous pavement or base course mixtures for work that is considered temporary construction and is to be maintained at the contractor's expense. Temporary construction will be defined as work that is to be removed prior to completion of the contract.~~

~~**401.5.4 Moisture Content.** The bituminous mixture, when sampled and tested in accordance with AASHTO T 329, shall contain no more than 0.5 percent moisture by weight of the mixture.~~

401.~~.5.5~~ 2.4 Contamination. The bituminous mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue or any other material not inherent in the job mix formula.

401.3 Mixing Plants and Hauling Equipment. Bituminous mixing plants, trucks used for hauling bituminous mixtures, and preparation of material and mixtures shall be in accordance with Sec 404.

401.~~.6~~ 4 Field Laboratory. The contractor shall provide a Type 3 field laboratory in accordance with Sec 601. The contractor shall furnish the bituminous mixture equipment to perform all required test methods for QC and QA work. A field laboratory shall not be required for small quantity work.
~~The contractor may use the equipment provided in the Type 3 laboratory as long as adequate space is provided for the engineer's work.~~

401.5~~7~~ Construction Requirements.

401.5~~7~~.1 Weather Limitations. Bituminous mixtures shall not be placed on any wet surface or frozen pavement. ~~Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.~~

~~**401.7.2 Bituminous Mixing Plants.** Bituminous mixing plants and preparation of material and mixtures shall be in accordance with Sec 404.~~

401.5~~7.3~~ 2 Subgrade or Surface Preparation. The subgrade upon which the bituminous mixture is to be placed shall be prepared in accordance with Sec 209 and primed as specified in the contract in accordance with Sec 408, as applicable. All material requirements of a tacked surface shall be in accordance with Sec 407.

401.5~~7.3~~2.1 Base Widening. For base widening work, the bottom of the trench shall be compacted until further consolidation is not visually evident, by use of a trench roller having a weight of no less than 300 psi of width of rear roller, or by mechanical tampers or other methods approved by the engineer. Suitable excavated material may be used in shouldering operations. On the outside of curves, the design depth of trench at the beginning of the superelevation transition shall be varied gradually to the minimum depth at the end of the superelevation transition. Slight transitioning of the width of the base widening will be necessary to permit the indicated angle of repose or shear angle outside of the ultimate edge of surface. The bottom of the trench shall in no case be less than 3 inches below the surface of the existing pavement. All surplus excavated material shall be disposed of by the contractor in areas to be secured by the contractor beyond the right of way limits. An acceptable written agreement with the property owner on whose property the material is placed shall be submitted to the engineer.

401.5~~7.3~~2.2 Application of Prime or Tack. Application of prime or tack shall be in accordance with Sec ~~403.12~~403.11.2.

~~**401.7.4 Hauling Equipment.** Trucks used for hauling bituminous mixtures shall be in accordance with Sec 404.~~

401.5~~7.5~~ 3 Spreading. The base course, tacked or primed surface, or preceding course or layer shall be cleaned of all dirt, packed soil or any other foreign matter prior to spreading the bituminous mixture. The mixture shall be spread in the number of layers and in the quantity required to obtain the compacted thickness and cross section shown on the plans. When placing multiple layers with varying thicknesses, the thicker layer shall be placed first.

401.5~~7.5~~3.1~~.1~~ Segregation. No segregation will be permitted in handling the mixture at the plant, from the truck or during spreading operations on the roadbed. Mixture production shall immediately cease if either criteria of the segregation test fail. Segregated mixture shall be removed and replaced to the limits determined by the engineer.~~**Irregularities.** The mixture shall be spread without tearing the surface and struck off such that the surface is smooth and true to cross section, free from all irregularities, and of uniform density throughout. Care shall be used in handling the mixture to avoid segregation. Areas of segregated mixture shall be removed and replaced with a suitable mixture at the contractor's expense. The outside edge alignment shall be uniform. Irregularities shall be corrected by adding or removing mixture before compacting. In situations where there is a dispute in the existence of segregation, the area in question will be tested in accordance with MoDOT Test Method TM 75. Mixture production shall immediately cease if either criteria of MoDOT Test Method TM 75 fail. Segregated mixtures shall be removed and replaced to the limits determined by the engineer.~~

~~**401.11 Defective Mixture.** Any mixture showing an excess of bituminous material or that becomes loose and broken, mixed with dirt, or is in any way defective, shall be removed and replaced with a satisfactory mixture, which shall be immediately compacted to conform to the surrounding area.~~

401.~~7~~5.~~5~~3.2~~.2~~ Leveling Course. If required by the contract, a leveling course consisting of a layer or layers of variable thickness shall be spread to the desired grade and cross section to eliminate irregularities in the existing surface. ~~Spot leveling operations over small areas, with feather edging at high points and ends of spot areas, may be required prior to placing the leveling course. Rigid control of the placement thickness of the leveling course will be required. The mixture shall be practically free from segregation.~~

401.~~7~~5.~~5~~3.3 Base Widening. The specified total thickness of base widening shall be completed to the adjacent traveled way elevation as shown on the plans. Additional thickness of base widening may be placed as required prior to coldmilling, at the contractor's expense, and shall subsequently be coldmilled to the same elevation as the traveled way, if conducive to expedite operations. On base-widening work, a succeeding layer of bituminous mixture may be placed the same day as the previous layer, if it can be shown that the desired results are being obtained. On small areas, and on areas that are inaccessible to mechanical spreading and finishing equipment, the mixture may be spread and finished by hand methods if permitted by the engineer. At least one lane of the existing pavement and the adjacent shoulder shall be kept open to traffic at all times during construction, except for short intervals when the movement of the contractor's equipment will seriously hinder the flow of traffic. Intervals during which the contractor will be allowed to halt traffic shall be as designated by the engineer. The contractor shall not open more trenches ahead of the first layer of the base widening than is necessary for placing that layer in one half a day's operations. The first layer of the base widening shall not be placed for a greater distance ahead of the second layer than is necessary for placing the second layer in one half a day's operations. The second layer shall not be placed for a greater distance ahead of the final layer than is necessary for placing the final layer in one day's operation. Any changes in these lengths shall be made only with written permission from the engineer.

401.5.4 Defective Mixture. Any mixture showing an excess of bituminous material or that becomes loose and broken, mixed with dirt, or is in any way defective, shall be removed and replaced with a satisfactory mixture, which shall be immediately compacted to conform to the surrounding area.

~~**401.7.5.4 Edge Differential.** For roadways constructed under traffic, no pavement edge differential shall be left in place for more than seven days, unless approved by the engineer.~~

401.~~7~~5.~~6~~ 5 Longitudinal Joints. The longitudinal joints in one layer shall offset those in the layer immediately below by approximately 6 inches. The joints in the final surface layer shall be at the lane lines of the traveled way, except that the placement width shall be adjusted such that pavement marking shall not fall on a longitudinal joint. Each side of the joint shall be flush and along true lines.~~The minimum density of all traveled way pavement within 8 inches of a longitudinal joint, shall be no less than 2.0 percent below the specified density. The cores taken to evaluate this area shall be centered 6 inches from the longitudinal joint. If no deficient cores are found in the first 25 percent of production, the established rolling procedure may be used, at the direction of the engineer, in lieu of density tests provided no changes in the material, typical location or temperatures are made. Pay adjustments due to longitudinal joint density shall apply to the full width of the lane paved. Adjustments due to joint density shall apply to the day's production from which the cores are obtained. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the layer. When a transverse vertical edge is to be left in place and opened to traffic, a temporary depth transition shall be constructed as approved by the engineer. The longitudinal joints in one layer shall offset those in the layer immediately below by approximately 6 inches. The joints in the final surface layer shall be at the lane~~

~~lines of the traveled way, except that the placement width shall be adjusted such that pavement marking shall not fall on a longitudinal joint. Each side of the joint shall be flush and along true lines.~~

401.5.6 Transverse Joints. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the layer. When a transverse vertical edge is to be left in place and opened to traffic, a temporary depth transition shall be constructed as approved by the engineer.

401.~~7~~5.7 Surfaced Approaches. At locations designated in the contract or as specified by the engineer, approaches shall be primed or tacked in accordance with Sec 408 and surfaced with a plant mix bituminous mixture. The bituminous surface shall be placed as shown on the plans or as directed by the engineer. Approaches shall not be surfaced before the surface course adjacent to the entrance is completed. No direct payment will be made for any work required to condition and prepare the subgrade on the approaches.

401.~~7~~5.8 Alternate Compaction Method. ~~The compacted mixture shall have a minimum density of 92 percent of the theoretical maximum specific gravity. Density will be determined by the direct transmission nuclear method in accordance with MoDOT Test Method TM 41 or by a specific gravity method. When the contractor elects to place a lift of mixture greater than six times the nominal maximum aggregate size, cores shall be cut in half and the density of each half determined separately.~~ In lieu of density requirements, mixtures used for wedging, transitions, shoulders, temporary bypasses to be maintained at the expense of the contractor, and areas where a commercial mixture is used shall be thoroughly compacted by at least three complete coverage's over the entire area with either a pneumatic tire roller weighing no less than 10 tons, a tandem-type steel wheel roller weighing no less than 10 tons or an approved vibratory roller. Rolling shall be performed at proper time intervals on each layer and shall be continued until there is no visible evidence of further consolidation.

401.~~12~~5.9 Pavement Marking. If the contractor's work has obliterated existing pavement marking on resurfacing projects open to through traffic, the pavement marking shall be replaced at the contractor's expense in accordance with Sec 620.

401.5.10 Surface Smoothness. The finish of the pavement surface shall be substantially free from waves or irregularities and shall be true to the established crown and grade. The pavement shall be thoroughly tested for smoothness by profiling or straightedging in accordance with Sec 610.

401.5.11 Pavement Edge Treatment. For roadways constructed under traffic, pavement edge treatments as described in Standard Plan 619.10 shall be required. No pavement edge treatments shall be left in place for more than seven days, unless approved by the engineer.

401.5.12 Coring. The contractor shall restore the surface from which samples have been taken immediately with the mixture under production or with a cold patch mixture acceptable to the engineer.

401.~~8~~ 6 Quality Control. The contractor shall control and monitor the quality of the work. At the engineer's discretion, testing may be waived when production does not exceed 200 tons per day. ~~The contractor shall certify the proper proportions of a previously proven mixture were used. The contractor shall maintain equipment and qualified personnel to perform QC field inspection, sampling and testing in accordance with applicable portions of Sec 403. A QC Plan will not be required. A proposed third party for dispute resolution shall be included with the mix design submittal.~~ Mixture suppliers shall have either a standard quality control plan on file with the Construction & Materials division for the applicable plant or be included in the contractor's quality control plan.

~~**401.5.1 Sample Location.** The gradations of the total aggregate will be determined from samples taken from the hot bins on batch type plants or continuous mixing plants or from the composite cold feed belt on drum mix plants. The deleterious content of the total aggregate shall be determined from samples taken from the composite cold feed belt. When required, samples for plasticity index shall be taken from the stockpile. The RAP shall be sampled from the RAP feeding system on the asphalt plant. Samples for asphalt content determination may be taken at the plant.~~

~~**401.8.1 Mixture Testing.** The contractor shall randomly test the mixture within the following frequencies. The gradation and the asphalt content shall be determined at least once every 1,000 tons of production or a minimum of once per day. Deleterious content shall be determined once per 5,000 tons unless quality concerns dictate more frequent testing as directed by the engineer. Gradation and asphalt content of RAP shall be determined once every 10,000 tons of production. If RAP is used and AASHTO T 308 is used to determine the asphalt content, the binder ignition oven shall be calibrated in accordance with MoDOT Test Method TM 77. At the engineer's discretion, testing may be waived when production does not exceed 200 tons per day. The contractor shall certify the proper proportions of a previously proven mixture were used.~~

~~**401.8.2 Failing Test.** If a, deleterious content, or asphalt content test result falls outside of the specification tolerances, a review or adjustment of the plant settings and production shall be made and another sample shall be immediately taken. If the second test falls outside of the specification tolerances, production shall be immediately ceased until the mixture can be brought back into specification. If a gradation test falls between the Tolerance and Action Limits, adjustments to plant shall be made and another gradation shall be taken immediately. Plant production for the following day shall not resume until the mixture is brought back into specification when the final gradation for the day is not within tolerance. If a gradation test falls outside the Action Limit, production shall cease until the mixture is brought back into specification.~~

401.~~8~~6.~~3~~ 1 Retained Samples. One half of the contractor's sample for mixture gradation, aggregate deleterious content, ~~and~~ and mixture asphalt content as well as ~~and~~ all cores shall be retained for the engineer. The contractor shall retain the samples for ~~7~~ 14 production days after testing has been completed unless otherwise notified ~~and the results accepted~~ by the engineer.

401.6.2 Temperature of Air and Base. The contractor shall monitor the environmental conditions that affect asphalt production and laydown operations. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

401.6.3 Mixture Temperature. The contractor shall periodically record temperature of mix before it leaves the plant.

401.5~~6~~.4 Mixture Gradation ~~and Deleterious Content Control.~~ ~~In producing mixtures for the project, the plant shall be operated such that no intentional deviations from the job-mix formula are made without prior approval from the engineer. The contractor shall determine the mixture gradation~~ The gradations of the total aggregate will be determined from samples taken from the hot bins on batch-type plants or continuous mixing plants or from the composite cold feed belt on drum mix plants. ~~at the frequency stated in .~~ The mixture gradation may be determined directly by using residual aggregate from the binder ignition process or by mathematical combination of the cold feed and recycled materials gradations. When the mathematical combination method is used, the RAS gradation shall be from the JMF and RAP or RAS gradation from the ignition or extraction residual aggregate. Mixtures as produced shall be subject to the maximum variations from the approved JMF in the table below. If a gradation test falls between the Tolerance and Action Limits, mixture adjustments per Sec 401.2.1.2 shall be made and another gradation shall be taken immediately. Plant production for the following day shall not resume until the gradation tolerances are met or the mixture adjustment is successfully verified. If a gradation test falls outside the Action Limit, production shall cease until the mixture is brought back into specification.~~Mixtures as produced shall be subject to the following tolerances and controls:~~

~~(a) The maximum variations from the approved job-mix formula shall be within the tolerances as shown in the table below:~~

Mix Type	Sieve Size	Percent Passing by Weight	
		Tolerance	Action Limit
BP-1, BP-2, BB	No. 8[a]	± 5.0	± 10.0
BP-3	No 16		
All	No. 200	± 2.0	± 4.0

~~[a] Use No. 16 sieve for BP-3~~

~~(b) The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in Sec 1004.2.~~

~~(c) The quantity of asphalt binder introduced into the mixer shall be the quantity specified in the job-mix formula. No changes shall be made to the quantity of asphalt binder without written approval from the engineer. The quantity of asphalt binder determined by tests on the final mixture shall not vary by more than – 0.3 to + 0.5 percent from the job-mix formula.~~

401.6.5 Mixture Asphalt Content. Samples for asphalt content determination may be taken at the plant. The quantity of asphalt binder determined by tests on the final mixture shall not vary by more than – 0.3 to + 0.5 percent from the job-mix formula.
If an asphalt content test result falls outside of the specification tolerances, a review or mixture adjustment per Sec 401.2.1.2 shall be made and another sample shall be immediately taken. If the second test falls outside of the specification tolerances, production shall be immediately ceased until the mixture can be brought back into specification.

~~**of Air and Base**The contractor shall monitor the environmental conditions that affect asphalt production and laydown operations. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.~~

401.6.6 Mixture Moisture Content. The bituminous mixture, when sampled and tested in accordance with AASHTO T 329, shall contain no more than 0.5 percent moisture by weight of the mixture

401.6.7 Moisture Susceptibility. QC and QA TSR testing shall be waived when not required per Sec 490. QC TSR testing shall be waived when independent QA plasticity index tests compare favorably. TSR results shall be 70 percent or above.

401.6.8 RAP Gradation. The contractor shall test the residual aggregate from the RAP asphalt content testing to determine its gradation.

401.6.9 RAP Asphalt Content. RAP shall be sampled from the RAP feeding system on the asphalt plant or a representative stockpile sample. Solvent extraction or binder ignition methods shall be used to determine RAP asphalt contents. If AASHTO T 308 is used to determine the asphalt content, the binder ignition oven shall be calibrated in accordance with MoDOT Test Method TM 77.

401.6.10 RAP Durability. All RAP material not from a MoDOT roadway shall be tested in accordance with AASHTO T 327, Method of Resistance of Coarse Aggregate Degradation by Abrasion in the Micro-Deval Apparatus. Samples of RAP for this test shall have the asphalt coating removed either by extraction or binder ignition. The percent loss of RAP shall not exceed the loss of the combined loss of the virgin material by more than five percent.

401.6.11 Aggregate Deleterious. The deleterious content of the total aggregate shall be determined from samples taken per Sec 401.6.3. The deleterious content of the material retained on the No. 4 sieve for the combined virgin aggregates shall not exceed the limits specified in Sec 1004.2.

401.6.12 Aggregate Plasticity Index. QC plasticity index testing shall be waived when independent QA plasticity index tests compare favorably. Applicable individual aggregate fractions shall be tested for plasticity. Samples for plasticity index shall be taken from the stockpile. The plasticity index shall be within two of the Job Mix Formula.

401.6.13 Surface Smoothness. See Sec 610 for additional details.

401.6.14 Lift Thickness. The thickness of the layer to be tested shall be measured on all density and joint cores.

401.6.15 Pavement Density. The compacted mixture shall have a minimum density of 92 percent of the theoretical maximum specific gravity shown on the JMF. The cores from each days production shall be averaged to determine acceptance. Density will be determined by the direct transmission nuclear method in accordance with MoDOT TM 41 or by a specific gravity method. Density of the pavement shall be determined by one core obtained by the contractor at each random location selected by the engineer. Minimum 4-inch diameter cores, shall be taken the full depth of the layer to be tested. Cores tested by AASHTO T 166 shall be in accordance with Sec 490.8. When the contractor elects to place a lift of mixture greater than six times the nominal maximum aggregate size, cores shall be cut in half and the density of each half determined separately.

401.6.16 Longitudinal Joint Density. Core sampling and testing shall be in accordance Sec 401.6.15 except as modified herein. The minimum density of all traveled way pavement within 8 inches of a longitudinal joint, shall be no less than 90%. One longitudinal joint density core shall be taken from the same transverse cross section as each pavement density core. The longitudinal joint density core shall alternate sides of the paved layer. The cores shall be centered 6 inches from the longitudinal joint. Once the contractor's procedures have demonstrated to provide the required density, the engineer may waive or reduce the frequency of longitudinal joint density testing.

~~**401.5.4 Moisture Content.** The bituminous mixture, when sampled and tested in accordance with AASHTO T 329, shall contain no more than 0.5 percent moisture by weight of the mixture.~~

~~During construction, the engineer will designate as many tests as necessary to ensure that the course is being constructed of proper thickness, composition and density.~~

~~**401.8.4 Pavement Testing.** During construction, the engineer will designate as many tests as necessary to ensure that the course is being constructed of proper thickness, composition and density. Density of the roadway shall be determined by one core obtained by the contractor at a random location selected by the engineer for every 500 tons of production. A joint density core shall be taken from the same transverse cross section as the mat core and alternate sides. The maximum theoretical density shown on the job mix formula shall be used for this determination. Minimum 4 inch diameter cores, shall be taken the full depth of the layer to be tested. Cores tested by AASHTO T 166 shall be in accordance with Sec 403.19.3.1.3. The contractor shall restore the surface from which samples have been taken immediately with the mixture under production or with a cold patch mixture acceptable to the engineer.~~

~~**401.8.5 Density Adjustment.** Payment for mixture placed at or below the required minimum density will be adjusted as follows:~~

~~Field Density Percent of Maximum Theoretical Density~~	~~Percent of Contract Unit Price[a]~~
~~91.5 or above~~	~~100%~~
~~91.0 to 91.4, inclusive~~	~~97%~~
~~90.5 to 90.9, inclusive~~	~~94%~~
~~90.0 to 90.4, inclusive~~	~~90%~~
~~89.5 to 89.9, inclusive~~	~~80%~~

Below 89.5	Remove and Replace

401.6.17 Segregation. Areas in question will be tested in accordance with MoDOT Test Method TM 75. QC shall ensure MoDOT has the opportunity to witness TM 75 being performed. In situations where there is a dispute in the existence of segregation, the area in question will be tested in accordance with MoDOT Test Method TM 75.Mixture production shall immediately cease if either criteria of MoDOT Test Method TM 75 fail.

401.6.18 Binder Quality. The contractor shall ensure the binder is handled and stored in a manner that does not affect its quality. When the contractor is modifying the binder after delivery, additional quality control requirements apply. QC shall either assist QA in taking samples or obtain the QA sample in the inspector's absence.

[a]When adjustments are necessary, the lower percent of the contract unit price of either the pavement or joint density adjustment will apply.

401.9 7 Quality Assurance. The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor. Acceptance tests for gradation, deleterious content and asphalt content will be performed by the engineer at a minimum rate of one independent sample per 4 QC samples. A favorable comparison will be considered when a QA test is within the specification tolerances. An acceptance test for plasticity index will be performed by the engineer on an independent sample during the first day's production. When the plasticity index on aggregate passing the No. 30 sieve exceeds 3, moisture susceptibility testing shall be required in accordance with Sec 401.4.5. At least once for every five days of production, a split of the contractor's sample will be tested. If the results of the split sample are not within five percent on all sieves above the No. 200, two percent on the No. 200, within the specification ranges on the deleterious content, and within 0.5 percent on the asphalt content from the contractor's results, another split sample will be taken jointly with the contractor and tested. If the second test results do not compare within the specification tolerances, production shall cease until the discrepancy is resolved. If the second test results compare within the above tolerances, production may continue. Results of QA testing will be furnished to the contractor within 24 hours of obtaining the sample.

401.10 Surface Smoothness. The finish of the pavement surface shall be substantially free from waves or irregularities and shall be true to the established crown and grade. The pavement shall be thoroughly tested for smoothness by profiling or straightedging in accordance with Sec 610.

401.7.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when independent QA samples **401.11 Defective Mixture.** Any mixture showing an excess of bituminous material or that becomes loose and broken, mixed with dirt, or is in any way defective, shall be removed and replaced with a satisfactory mixture, which shall be immediately compacted to conform to the surrounding area.meet the same specification requirements as QC. QA asphalt content testing shall be within ± 5.0 of QCs results. A QA test for plasticity index will be performed by the engineer on an independent sample during the first day's production and results furnished to the contractor within 24 hours of obtaining the sample. When the plasticity index on aggregate passing the No. 30 sieve exceeds 3, moisture susceptibility QA test will be required. The engineer may waive independent QA pavement density samples and instead utilize a existing QC core as a QA split sample.

401.7.2 Split QA Samples. A favorable mixture gradation comparison shall be obtained when QA is within 5% of QC on all sieves and within 2% of QC on the #200 sieve. A favorable mixture asphalt content comparison shall be obtained when QA is within 0.5% of QC. A favorable comparison for deleterious content shall be obtained when QA is within one half of the requirements found in Sec 1004.2 of the QC results. If the results of a split sample do not compare, another split sample will be taken jointly and tested by both QC and QA. If the second test results do not compare, production shall cease until the testing discrepancy is resolved.

401.8 QC/QA Frequency Table.

Tested Property	QC Frequency	QA Frequency		QC Small Quantity Frequency
		Independent Samples	Split Samples	
Temperature of Base and Air	As Needed	As Needed	-	As Needed
Mixture Temperature	4 per Day	1 per Project		4 per Day
Mixture Gradation	1 per 1000 Tons, Min of 1 per Day	1 per 4 QC, Min 1 per Week	1 per 5 Days	1 per Project
Mixture Asphalt Content				
-Mixture Moisture	1 per Week	1 per Project	-	-
Moisture Susceptibility*	1 per Mix			

RAP Gradation RAP Asphalt Content	1 per 10000 Tons			
RAP Durability*	1 per 5000 Tons	-		
Aggregate Deleterious	1 per 7500 Tons	1 per 4 QC	1 per 5 Days	
Aggregate Plasticity Index	1 per Mix	1 per Mix	-	
Surface Smoothness	Per Section 610~~–~~			
Lift Thickness Pavement Density	1 per 500 Tons	1 per Week	-~~–~~	
Longitudinal Joint Density*		-		
Segregation	As Needed	As Needed		As Needed
Binder Quality	-	1 per Day		-

* Testing of this property is conditional based on other specification requirements.

~~**401.12 Pavement Marking.** If the contractor's work has obliterated existing pavement marking on resurfacing projects open to through traffic, the pavement marking shall be replaced at the contractor's expense in accordance with Sec 620.~~

401.~~13~~ 9 Method of Measurement. Measurement will be in accordance with Sec 403.

401.~~14~~ 10 Basis of Payment. The accepted quantities of plant mix bituminous pavement and base course will be paid for at the contract unit price for each of the pay items included in the contract. Payment for obtaining and delivering samples of compacted mixture from the base and replacement of the surface will be made per sample at the fixed contract unit price specified in Sec 109. No direct payment will be made for QC ~~cores~~testing, excavating the trench for base widening, or for hauling and disposing of excess excavation material.

401.10.1 Density Adjustment. The contract unit price shall be adjusted by whichever is lower of the pavement density pay factor or the longitudinal joint density pay factor. Pay adjustments due to longitudinal joint density pay factor shall apply to the full width of the lane paved. When a core is cut in half due to lift thickness, the lower of the two densities results will be used to determine the pay factor. Pay factors in the table below shall be applied to material represented by each density sample.

Pavement Density	Longitudinal Joint Density Pay Factor	Percent of Contract Unit Price Pay Factor
91.5 or above	89.5 or above	100%
91.0 to 91.4	89.0 to 89.4	97%
90.5 to 90.9	88.5 to 88.9	94%
90.0 to 90.4	88.0 to 88.4	90%
89.5 to 89.9	87.5 to 87.9	80%
Below 89.5	Below 87.5	Remove and Replace

401.10.2 Surface Smoothness Adjustment. Payment for mixture placed shall be adjusted per Sec 610 when applicable.

~~**401.4.4 Mixture Characteristics.**~~

~~**401.4.4.1** Base, BP-1, BP-2 and BP-3 mixtures shall have the following properties, when tested in accordance with AASHTO T 245 or AASHTO T 312. The number of blows with the compaction hammer shall be 35 or the number of gyrations shall be 35 with the gyratory compactor. BP-1 and BP-2 mixtures shall have between 60 and 80 percent of the VMA filled with asphalt binder and dust to effective binder ratio of 0.8 to 1.6. BP-3 mixtures shall be compacted with the gyratory compactor to 35 gyrations and shall have a minimum 75 percent of the VMA filled with asphalt binder and dust to effective binder ratio of 0.9 to 2.0.~~

~~Mix Type~~	~~Percent~~	~~AASHTO T 245~~	~~Voids in Mineral~~

	Air Voids	Stability lb	Aggregate (VMA)[b]
BB	3.5	750	13.0[a]
BP-1	3.5	750	13.5
BP-2	3.5	750	14.0
BP-3	3.5	750	15.0

[a]Bituminous base mixtures that would require 12.0 percent VMA following Asphalt Institute MS-2 will have a minimum 12.0 percent requirement.
[b]If the effective virgin binder replacement from any combination of RAP and RAS is greater than 40 percent; then the minimum VMA required shall be increased by 0.5.

401.4.4.2 When specified in the contract as BP-3NC, BP-3 mixtures containing limestone aggregate shall contain a minimum amount of non-carbonate aggregate as shown in the table below, or the aggregate blend shall have an acid insoluble residue (A.I.R.), MoDOT Test Method TM-76, meeting the criteria of crushed non-carbonate material. The A.I.R. shall be determined on the minus No. 4 sieve. Non-carbonate aggregate shall have an A.I.R. of at least 85 percent insoluble residue.

Aggregate	Minimum Non-Carbonate by Volume
Limestone	20% Minus No. 4
Dolomite	No Requirement

401.4.5 Moisture Susceptibility. Moisture susceptibility may be tested in accordance with AASHTO T 283. A minimum retained strength of 70 percent shall be obtained when tested for moisture susceptibility. An approved anti-strip additive may be added to increase retained strength to a passing level. When testing is required by Sec 401.2.1 or Sec 401.9, the mixture shall be testing during production in accordance with Sec 403.19.

401.4.6 Time Limit. A mix design may be transferred to other projects for a period of three years from the original approval date provided satisfactory results are obtained during production and placement.

SECTION 402
PLANT MIX BITUMINOUS SURFACE LEVELING

402.1 Description. This work shall consist of placing, spreading and compaacting a bituminous mixture as shown on the plans or as directed by the engineer. Spot wedging will not be required.

402.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Bituminous Asphalt Mixes	490
Coarse Aggregate	1004.2
Fine Aggregate	1002.3
Mineral Filler	1002.4
Asphalt Binder, Asphalt Emulsions Performance Graded (PG)	1015.3
Asphalt Mixes	490

402.2.1 Asphalt Binder. The grade of asphalt binder will be specified in the contract.

402.2.2 Wet Bottom Boiler Slag. The contractor may furnish wet bottom boiler slag of approved quality in lieu of coarse aggregate specified in Sec 402.2. If wet bottom boiler slag is used, the slag shall meet the requirements for coarse aggregate, except that the percentage of wear specified in Sec 1004.2.1 will not apply.

402.2.3 Reclaimed Asphalt. The asphalt binder content of recycled asphalt materials shall be determined in accordance with AASHTO T 164, ASTM D 2172 or other approved method of solvent extraction. A correction factor for use during production may be determined for binder ignition by burning a sample in accordance with AASHTO T 308 and subtracting from the binder content determined by extraction.

402.2.3.1 Reclaimed Asphalt Pavement. Reclaimed Asphalt Pavement (RAP) may be used in any mixture, except SMA mixtures. Mixtures may be used with more than 30 percent virgin effective binder replacement provided testing according to AASHTO M 323 is included with the job mix formula that ensures the combined binder meets the grade specified in the contract. All RAP material, except as noted below, shall be tested in accordance with AASHTO T 327, *Method of Resistance of Coarse Aggregate Degradation by Abrasion in the Micro-Deval Apparatus*. Aggregate shall have the asphalt coating removed either by extraction or binder ignition during production. The material shall be tested in the Micro-Deval apparatus at a frequency of once per 1500 tons. The percent loss shall not exceed the Micro-Deval loss of the combined virgin material by more than five percent. Micro-Deval testing will be waived for RAP material obtained from MoDOT roadways. All RAP material shall be in accordance with Sec 1002 for deleterious and other foreign material. The aggregate specific gravity shall be determined by performing AASHTO T 209 in accordance with Sec 403.19.3.1.2 and calculating the G_{se} to which a 0.98 correction factor will be applied in order to determine G_{sb} as follows:

$$G_{se} = \frac{100 - Pb}{\frac{100}{G_{mm}} - \frac{Pb}{G_b}}$$

$$\text{RAP } G_{sb} = \text{RAP } G_{se} \times 0.98$$

402.2.3.2 Reclaimed Asphalt Shingles. Reclaimed Asphalt Shingles (RAS) may be used in any mixture specified to use PG 64-22 in accordance with AASHTO PP 53 except as follows:

For mixtures containing RAS or a combination of RAS and RAP, the RAS contribution shall not exceed 20 percent effective virgin binder replacement. Mixtures containing a combination of RAS and RAP may have a maximum 30 percent effective virgin binder replacement with no virgin binder grade change. Mixtures containing a combination of RAS and RAP may have a 30 to 40 percent effective virgin binder replacement under the following conditions: (1) with a virgin binder grade change from a PG64-22 to a PG 58-28 or (2) with a combination of a PG64-22 binder and a rejuvenator provided testing demonstrates that a PG58-28, meeting the requirements of AASHTO M320, is achieved. Shingles shall be ground to 100 percent passing the 3/8 inch sieve. Waste, manufacturer or new, shingles shall be essential free of deleterious materials. Post consumer RAS shall not contain more than 1.5 percent wood by weight or more than 3.0 percent total deleterious by weight. Post consumer RAS shall be certified to contain less than the maximum allowable amount of asbestos as defined by national or local standards. The bulk specific gravity of RAS used in the job mix formula shall be 2.600.

~~RAS G_{sb} = 2.600~~

~~The gradation of the aggregate may be determined by solvent extraction of the binder or using the following as a standard gradation:~~

~~Shingle Aggregate Gradation~~	
~~Sieve Size~~	~~Percent Passing by Weight~~
~~3/8 inch~~	~~100~~
~~No. 4~~	~~95~~
~~No. 8~~	~~85~~
~~No. 16~~	~~70~~
~~No. 30~~	~~50~~
~~No. 50~~	~~45~~
~~No. 100~~	~~35~~
~~No. 200~~	~~25~~

~~**402.3 Composition of Mixture.** Aggregate sources shall be from the specific ledge combination of ledges within a quarry, or processed aggregate from a particular product, as submitted in the mix design. The total aggregate prior to mixing with asphalt binder shall be in accordance with the following gradation requirements:~~

~~Plant Mix Bituminous Surface Leveling~~	
~~Sieve Size~~	~~Percent Passing by Weight~~
~~3/4 inch~~	~~100~~
~~1/2 inch~~	~~99-100~~
~~3/8 inch~~	~~90-100~~
~~No. 4~~	~~60-90~~
~~No. 8~~	~~40-70~~
~~No. 30~~	~~15-35~~
~~No. 200~~	~~5-12~~

~~BP-3 in accordance with Sec 401.3 is an allowable substitution.~~

~~**402.3.1 Mixture Characteristics.** Bituminous surface leveling mixture shall have the following properties, when tested in accordance with AASHTO T 245 or AASHTO T 312. The number of blows with the compaction hammer shall be 35 or the number of gyrations shall be 35 with the gyratory compactor. The mixture shall have a minimum voids filled with asphalt (VFA) of 75 percent. The dust to effective binder ratio shall be 0.8 to 1.6.~~

~~Percent Air Voids~~	~~AASHTO T 245 Stability lb~~	~~Voids in Mineral Aggregate (VMA)~~
~~3.5~~	~~750~~	~~14.5~~

402.2.14 Job Mix Formula (JMF). Mix designs meeting the Sec 490 requirement shall be submitted for each project at least seven days prior to placement. ~~The mixture shall be~~At least 30 days prior to placing any mixture on the project, the contractor ~~shall submit a mix design~~ in accordance with Sec 401.4490 for approval by Construction and Materials. Surface Leveling (SL) mixtures as designated by the plans are used for Section 402 pay items.

~~**402.2.2 Substitutions.** At the option of the contractor and at no cost to the Commission, the contractor may use a BP-3 mixture as an allowable substitution for 402 mixtures.~~

402.2.1.13 Mixture Approval. No mixture will be accepted for use until the job mix formula for the project is approved by Construction and Materials. The job mix formula approved for each mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results or other conditions occur, or should a source of a material be changed, a new job mix formula may be required. In lieu of a new laboratory design, mixtures requiring adjustment beyond the limits allowed in Sec

401.6.1 may be designed in the field based on characteristics of plant-produced mixture in accordance with Sec 401 and verified by Construction and Materials, which may require new aggregate characteristics.

402.2.1.2 Mixture Adjustments. In producing mixtures for the project, the plant shall be operated such that no intentional deviations from the job-mix formula are made except as follows. Aggregate only bin changes are allowable so long as the original gradation tolerances are met. Anytime the gradation tolerances are exceeded or there is a change to binder providing components, the contractor shall verify the mix still meets the Sec 490 requirements for recycle contribution, VMA and VFA with the adjusted Gsb, and D/B ratio. The contractor shall provide a record of the time and tonnage of all mixture adjustments as well as all verification calculations or testing to the engineer. No changes may be made to the quantity of asphalt binder specified in the job mix formula without written approval from the engineer.

402.2.2 Substitutions. At the option of the contractor and at no cost to the Commission, the contractor may use a BP-3 mixture as an allowable substitution for Section 402 mixtures.

402.52.64 ~~Mixture~~ Contamination. The bituminous mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue or any other material not inherent in the job mix formula.

~~**402.7 Moisture Content.** The bituminous mixture, when sampled and tested in accordance with AASHTO T 329, shall contain no more than 0.5 percent moisture by weight of the mixture.~~

~~**402.8 Contamination.** The bituminous mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue or any other material not inherent in the job mix formula.~~**402.3 Mixing Plants and Hauling Equipment.** Bituminous mixing plants, hauling equipment, and preparation of material and mixtures shall be in accordance with Sec 404.

402.4 Field Laboratory. The contractor shall provide a Type 3 field laboratory in accordance with Sec 601. The contractor shall furnish the bituminous mixture equipment to perform all required test methods for QC and QA work. A field laboratory shall not be required for small quantity work.

~~**402.5 Gradation and Deleterious Content Control.** In producing mixture for the project, the plant shall be operated such that no deviations from the job mix formula are made. The contractor shall determine on a daily basis, at a minimum, the gradation on the aggregate reclaimed from the RAP by either extraction or binder ignition. The gradation results shall be used to determine the daily specification compliance for the combined gradation. Mixture as produced will be subject to the following tolerances and control:~~

~~(a) The total aggregate gradations shall be within the master range specified in Sec 402.3.~~

~~(b) Material passing the No. 200 sieve shall not vary from the job mix formula by more than ± 2.0 percentage points.~~

~~(c) The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in Sec 1004.2.~~

~~(d) If the plasticity index of any fraction exceeds that of the material approved for the mix design, additional testing may be required.~~

~~(e) The quantity of asphalt binder introduced into the mixer shall be that quantity specified in the job mix formula. No changes may be made to the quantity of asphalt binder specified in the job mix formula without written approval from the engineer. The quantity of asphalt binder determined by calculation or tests on the final mixture shall not vary more than ± 0.3 percent from the job mix formula.~~

~~**402.6 Sample Location.** The gradations of the total aggregate will be determined from samples taken from the hot bins on the batch type plants, or from hot bins or combined hot aggregate flow on continuous mixing plants, or from the combined cold feed on dryer drum plants. The deleterious content of the total aggregate will be determined from the samples taken from the combined cold feed belt. Samples for plasticity index will be taken from the stockpile. The RAP shall be sampled from the RAP feeding system on the asphalt plant.~~

~~**402.7 Moisture Content.** The bituminous mixture, when sampled and tested in accordance with AASHTO T 329, shall contain no more than 0.5 percent moisture by weight of the mixture.~~

402.8 Contamination. The bituminous mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue or any other material not inherent in the job mix formula.

402.9 Field Laboratory. The contractor shall provide a Type 3 field laboratory in accordance with Sec 601.

402.510 Construction Requirements.

402.510.1 Weather Limitations. Bituminous mixtures shall not be placed (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 50° F or (2) on any wet surface or frozen pavement. when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 50 F. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

402.10.2 Bituminous Mixing Plants. Bituminous mixing plants and preparation of material and mixtures shall be in accordance with Sec 404.

402.510.23 Application of Prime or Tack. On the first day of production, the contractor shall demonstrate proper application of tack coat in the presence of the engineer. Application of prime or tack coat shall be in accordance with Sec 408 or Sec 407, respectively. When the engineer is not present to witness the application of tack coat, the contractor shall document the tack application by taking a minimum of two high-resolution date/time stamped photographs of the tacked surface per one-mile segment. Pictures should be taken just in front of the paver in order to account for the loss of tack from truck tires. The contractor shall also monitor and document the application rate. The contractor shall take distributor readings at the beginning and ending of each shift and document the quantity used. Application of prime or tack coat shall be in accordance with .

402.10.4 Hauling Equipment. Trucks used for hauling bituminous mixtures shall be in accordance with Sec 404.

402.510.35 Spreading and Rolling. Prior to spreading and rolling the bituminous mixture, theThe existing surface shall be cleaned of all dirt, packed soil or any other foreign material prior to spreading the bituminous mixture. On the first day of production, the contractor shall demonstrate successful spreading and compaction of the mixture, including proper rolling patterns, in the presence of the engineer. The mixture shall be spread in the quantity required to obtain the compacted thickness and cross section shown on the plans. On small areas and on areas that are inaccessible to mechanical spreading and finishing equipment, the mixture may be spread and finished by hand methods when permitted by the engineer.

The contractor shall monitor all roadway production procedures and document them daily. The use of approved Intelligent Compaction technology is an allowable substitute for daily documentation. The paver shall be operated at a speed that will give the best results. The rate of delivery of the mixture to the paver shall be coordinated to provide, where practical, a uniform rate of placement without intermittent operation of the paver. On small areas and on areas that are inaccessible to mechanical spreading and finishing equipment, the mixture may be spread and finished by hand methods when permitted by the engineer.

402.5.410.5.1 Roadway Irregularities. When provided for in the plans, aAdditional tons of mixture will be provided for irregularities in the existing roadway surface. The tonnage specified for irregularities is an estimated quantity and shall only be placed at locations where it is necessary to fill ruts and other low points. Prior to placing the mixture, the contractor and engineer shall evaluate the entire route and develop a plan that best utilizes the tonnage needed for irregularities. Any excess quantity of irregularities shall not be placed. The outside edge alignment shall be uniform and any irregularities shall be corrected by adding or removing mixture before compacting.

402.5.5 Segregation. No segregation will be permitted in handling the mixture at the plant, from the truck or during spreading operations on the roadbed. Mixture production shall immediately cease if either criteria of MoDOT Test Method TM 75 fail. Segregated mixture shall be removed and replaced to the limits determined by the engineer.**Mixture Irregularities.** The mixture shall be spread without tearing the surface and struck off such that the surface is smooth and true to cross section, free from all irregularities and of uniform density throughout. Care shall be used in handling the mixture to avoid segregation. Areas of segregated mixture shall be removed and replaced with suitable mixture. The outside edge alignment shall be uniform and any irregularities shall be corrected by adding or removing mixture before compacting.

402.5.6 Mixture Contamination. The bituminous mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue or any other material not inherent in the job mix formula.

402.5.7 6 10.5.2 Pavement Edge DifferentialTreatment. No pavement edge differential shall be left in place for more than seven days, without written approval from the engineer. For roadways constructed under traffic, pavement edge treatments as described in Standard Plan 619.10 shall be required. No pavement edge treatments shall be left in place for more than seven days, unless approved by the engineer.

402.5.87 10.6 Joints. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the layer. When a transverse vertical edge is to be left and opened to traffic, a temporary depth transition shall be built as approved by the

engineer. The longitudinal joint shall be at the lane lines of the traveled way except that the placement width of bituminous surface may be adjusted such that temporary raised pavement markers will not fall on a longitudinal joint. Each side of the joint shall be flush and along true lines.

402.5.9810.7 Compaction. The mixture shall be thoroughly compacted by at least three complete ~~coverages~~ passes over the entire area with either a pneumatic tire roller or a tandem-type steel wheel roller each weighing no less than 10 tons. All rollers used shall be in satisfactory condition, capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers. Rollers shall have a system for moistening each roll or wheel. Rolling shall begin as soon after spreading the mixture as the new surface will bear the weight of the roller without undue displacement. Final rolling shall be done by the steel wheel roller. Rolling shall be performed at proper time intervals and shall be continued until there is no visible evidence of further consolidation and until all roller marks are eliminated.

402.5.10910.8 Surface Condition. The surface of the mixture after compaction shall be smooth and uniform. Any mixture showing an excess of asphalt binder or that becomes loose and broken, mixed with dirt or is in any way defective shall be removed and replaced at the contractor's expense with a satisfactory mixture, which shall be immediately compacted to conform to the surrounding area.

402.5.11010.9 Hauling Over Completed Surface. Hauling of ~~plant mix bituminous~~ mixture over any completed portion of the project will not be permitted ~~unless allowed by special provision~~.

402.6 Quality Control. The contractor shall control and monitor the quality of the work. At the engineer's discretion, testing may be waived when production does not exceed 200 tons per day. Mixture suppliers shall have either a standard quality control plan on file with the Construction & Materials division for the applicable plant or be included in the contractor's quality control plan.

402.6.1 Retained Samples. One half of the contractor's sample for mixture gradation, aggregate deleterious content, and mixture asphalt content as well as all cores shall be retained for the engineer. The contractor shall retain the samples for 14 production days after testing has been completed unless otherwise notified by the engineer.
~~The contractor shall control and monitor the quality of work as specified in Sec 106.13.~~

~~**402.6.1 Sample Location.** The gradations of the total aggregate will be determined from samples taken from the hot bins on the batch-type plants, or from hot bins or combined hot aggregate flow on continuous mixing plants, or from the combined cold feed on dryer drum plants. The deleterious content of the total aggregate will be determined from the samples taken from the combined cold feed belt. Samples for plasticity index will be taken from the stockpile. The RAP shall be sampled from the RAP feeding system on the asphalt plant.~~
402.6.2 Temperature of Air and Base. The contractor shall monitor the environmental conditions that affect asphalt production and laydown operations. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

402.6.3 Mixture Temperature. The contractor shall periodically record the temperature of mix before it leaves the plant.

402.6.4 Mixture Moisture Content. The bituminous mixture, when sampled and tested in accordance with AASHTO T 329, shall contain no more than 0.5 percent moisture by weight of the mixture.

402.6.255 Mixture Gradation~~, and Deleterious Content Control.~~ ~~In producing mixture for the project, the plant shall be operated such that no deviations from the job mix formula are made. The contractor shall determine on a daily basis, at a minimum, the gradation on the aggregate reclaimed from the RAP by either extraction or binder ignition.~~ The gradations of the total aggregate will be determined from samples taken from the hot bins on batch-type plants or continuous mixing plants or from the composite cold feed belt on drum mix plants. The mixture gradation may be determined directly by using residual aggregate from the binder ignition process or by mathematical combination of the cold feed and recycled materials gradations. When the mathematical combination method is used, the RAS gradation shall be from the JMF and RAP gradation from the ignition or extraction residual aggregate. ~~The gradation results shall be used to determine the daily specification compliance for the combined gradation. Mixture as produced will be subject to the following tolerances and control:~~

~~(a)~~ The total aggregate gradations shall be within the master range specified in Sec 490 for Surface Level mixtures. ~~Sec 402.3.~~

~~(b)~~ Material passing the No. 200 sieve shall not vary from the job mix formula by more than ± 2.0 percentage points.

402.6.6 Mixture Asphalt Content. The quantity of asphalt binder determined by calculation or tests on the final mixture shall not vary more than ± 0.3 percent from the job-mix formula.

401~~1~~2.6.~~3~~7 Aggregate Deleterious. The deleterious content of the total aggregate shall be determined from samples taken per Sec 401.6.3. The deleterious content of the material retained on the No. 4 sieve for the combined virgin aggregates shall not exceed the limits specified in Sec 1004.2. ~~Quality concerns may dictate more frequent testing as directed by the engineer.~~
~~(c) The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in Sec 1004.2.~~

402.6.8 Aggregate Plasticity Index. QC plasticity index testing shall be waived when independent QA plasticity index tests compare favorably. Applicable individual aggregate fractions shall be tested for plasticity. Samples for plasticity index shall be taken from the stockpile. The plasticity index shall be within two of the Job Mix Formula.
~~**402.6.4 Mixture Asphalt Content.** The quantity of asphalt binder determined by calculation or tests on the final mixture shall not vary more than ± 0.3 percent from the job mix formula. No changes may be made to the quantity of asphalt binder specified in the job mix formula without written approval from the engineer. The quantity of asphalt binder introduced into the mixer shall be the quantity required by the contract and must be monitored by the contractor and reported to the engineer.~~

402.6.~~5~~ 9 Binder Monitoring. Original asphalt binder delivery tickets shall accompany the report submitted to the engineer. The contractor shall take a daily QC sample of asphalt binder which will be collected by the engineer and shipped to the MoDOT Central Lab for random testing.

~~**402.6.6 Mixture Temperature.** The contractor shall periodically record temperature of mix before it leaves the plant.~~

~~**402.6.7 Mixture Moisture Content.** The bituminous mixture, when sampled and tested in accordance with AASHTO T329, shall contain no more than 0.5 percent moisture by weight of the mixture.~~

402.6.1~~8~~0 RAP Gradation. The contractor shall test the residual aggregate from the RAP asphalt content testing to determine its gradation. ~~The contractor shall determine the gradation on the aggregate reclaimed from the RAP by either extraction or binder ignition.~~

402.6.~~9~~ 11 RAP ~~% AC~~Asphalt Content. RAP shall be sampled from the RAP feeding system on the asphalt plant. Solvent extraction or binder ignition methods shall be used to determine RAP percent asphalt contents. If AASHTO T 308 is used to determine the asphalt content, the binder ignition oven shall be calibrated in accordance with MoDOT Test Method TM 77.

402.6.~~10~~ 12 RAP Durability. All RAP material not from a MoDOT roadway shall be tested in accordance with AASHTO T 327, Method of Resistance of Coarse Aggregate Degradation by Abrasion in the Micro-Deval Apparatus. Samples of RAP for this test shall have the asphalt coating removed either by extraction or binder ignition. The RAP percent loss shall not exceed the loss of the combined virgin material by more than five percent.

402.6.13 Tack Uniformity. When the engineer is not present to witness the application of tack coat, the contractor shall document the tack application uniformity by taking a minimum of two high-resolution date/time stamped photographs of the tacked surface per one-mile segment. Pictures should be taken just in front of the paver in order to account for the loss of tack from truck tires.

402.6.14 Tack Usage. The contractor shall take distributor readings at the beginning and ending of each shift and document the quantity used. The contractor shall monitor and document the application rate.

~~**402.6.11 Aggregate Plasticity Index.** If the plasticity index of any fraction exceeds that of the material approved for the mix design, additional testing may be required.~~

~~(d) If the plasticity index of any fraction exceeds that of the material approved for the mix design, additional testing may be required.~~

~~(e) The quantity of asphalt binder introduced into the mixer shall be that quantity specified in the job mix formula. No changes may be made to the quantity of asphalt binder specified in the job mix formula without written approval from the engineer. The quantity of asphalt binder determined by calculation or tests on the final mixture shall not vary more than ± 0.3 percent from the job mix formula.~~

402.6.15 Segregation Limits. Areas in question will be tested in accordance with MoDOT Test Method TM 75. QC shall ensure MoDOT has the opportunity to witness TM 75 being performed.

402.6.16 Binder Quality. The contractor shall ensure the binder is handled and stored in a manner that does not affect its quality. When the contractor is modifying the binder after delivery, additional quality control requirements apply. QC shall either assist QA in taking samples or obtain the QA sample directly in the inspector's absence.

402.6.17 Roadway Compaction. The contractor shall monitor all roadway production procedures and document them daily. The use of approved Intelligent Compaction technology is an allowable substitute for daily documentation of compaction.

402.7 Quality Assurance. The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor.

402.7.1 Independent QA Samples. ~~The engineer will take a minimum of one binder sample per project from the binder line. The engineer sample will be shipped to the Central Lab for testing along with the contractor daily samples.~~ Unless otherwise stated, a favorable comparison shall be obtained when independent QA samples meet the same specification criteria as QC. A QA test for plasticity index will be performed by the engineer on an independent sample during the first day's production and results furnished to the contractor within 24 hours of obtaining the sample.

402.7.2 Split QC/QA Samples. Split samples shall be clearly labeled and stored by the contractor in a manner that prevents contamination. Uncollected split samples shall be retained by the contractor until the engineer authorizes disposal or until the Final Inspection, whichever occurs earlier. A favorable mixture gradation comparison shall be obtained when QA is within 5% of QC on all sieves and within 2% of QC on the No. 200. A favorable mixture ~~%AC~~asphalt content comparison shall be obtained when QA is within 0.5% of QC. A favorable comparison for deleterious content shall be obtained when QA is within one half the Sec 1004.2 requirements of the QC results. If the results of a split sample do not compare, another split sample will be taken jointly and tested by both QC and QA. If the second test results do not compare, production shall cease until the testing discrepancy is resolved.

402.8 QC/QA Frequency Table.

<table>
<tr><th rowspan="2">Tested Property</th><th rowspan="2">QC Frequency</th><th colspan="2">QA Frequency</th><th rowspan="2">QC Small Quantity Frequency</th></tr>
<tr><th>Independent Samples</th><th>Split Samples</th></tr>
<tr><td>Temperature of Base and Air</td><td>As Needed</td><td>As Needed</td><td rowspan="3">-</td><td>As Needed</td></tr>
<tr><td>Mixture Temperature</td><td>4 per Day</td><td>1 per Project</td><td>4 per Day</td></tr>
<tr><td>Mixture Moisture</td><td rowspan="3">1 per Day~~1 per day~~</td><td>1 per Week</td><td>-</td></tr>
<tr><td>Mixture Gradation</td><td rowspan="2">1 per 10,000 ~~t~~Tons</td><td rowspan="2">1 per 10,000 ~~t~~Tons</td><td rowspan="2">1 per ~~p~~Project</td></tr>
<tr><td>Mixture Asphalt Content ~~Aggregate Deleterious~~</td></tr>
<tr><td>Aggregate Deleterious ~~Mixture %AC~~</td><td>1 per 5000 Tons</td></tr>
<tr><td>~~Binder Monitoring~~</td><td>~~1 per day~~</td><td>~~1 per project~~</td><td>-</td><td>-</td></tr>
<tr><td>~~Mixture Temperature~~</td><td>~~4 per day~~</td><td>~~1 per project~~</td><td>-</td><td>~~4 per day~~</td></tr>
<tr><td>~~Mixture Moisture~~</td><td>~~1 per day~~</td><td>~~1 per week~~</td><td>-</td><td>-</td></tr>
<tr><td>Aggregate Plasticity Index</td><td>1 per Mix</td><td>1 per Mix</td><td rowspan="11">-
-
-
-
-</td><td rowspan="7">-
-
-
-</td></tr>
<tr><td>Binder Monitoring</td><td>1 per ~~d~~Day~~ay~~</td><td>1 per Project</td></tr>
<tr><td>RAP Gradation</td><td rowspan="3">1 per 10000 Tons</td><td rowspan="6">-
-</td></tr>
<tr><td>RAP ~~%AC~~Asphalt Content</td></tr>
<tr><td>RAP Deleterious</td></tr>
<tr><td>RAP Durability*</td><td>1 per ~~1500~~5000 ~~t~~Tons</td></tr>
<tr><td>Tack Uniformity</td><td>2 per Mile</td><td>2 per Day</td></tr>
<tr><td>Tack Usage</td><td>1 per Day</td><td>1 per Day</td></tr>
<tr><td>Segregation Limits</td><td>As Needed</td><td>As Needed</td><td rowspan="3">-</td></tr>
<tr><td>Binder Quality</td><td>-</td><td>As Needed</td></tr>
<tr><td>Roadway Compaction</td><td>Daily</td><td>-</td><td>Daily</td></tr>
<tr><td>~~Aggregate Plasticity Index~~</td><td>~~1 per mix~~</td><td colspan="2">~~1 per mix~~ -</td><td>-</td></tr>
</table>

* Testing of this property is conditional based on other specification requirements.

402.~~11~~9 M~~ethod of Measurement~~onitoring Quantity. ~~The weight of the mixture will be determined from the batch weights if a batch type plant is used. If other types of plants are used, the weight of the mixture will be determined by weighing each truck load on scales in accordance with Sec 310. Measurement will be made to the nearest 0.1 ton for the total tonnage of material accepted.~~The contractor shall monitor the quantity of Surface Level mix placed and report that information to the engineer and production staff as specified herein.

a) The contractor shall verify that the quantity of mixture in the contract for each route is sufficient to cover the roadway as shown on the typical sections, including any surface irregularities. Any discrepancies shall be brought to the engineer's attention in writing prior to the pre-construction conference. Plan quantity shall be defined as the total tons computed to cover the surface area according to the typical sections, plus any amount pre-approved by the engineer for pavement irregularities.

b) The contractor shall provide temporary log mile reference points at no less than ½ mile intervals along each route to monitor the tons of Surface Leveling mix laid in relation to plan quantity. Entrances, shoulders, or other irregular areas will be monitored as directed by the engineer.

c) During production, the contractor shall document the total tons placed in each one-mile segment, along with the plan quantity and the percent over/under for that segment. The cumulative quantity and percent over/under for the route should also be documented. After each one-mile segment, the contractor shall provide a status report to the production manager and the engineer. When the engineer is not present on the project the contractor shall send an electronic status report to the engineer. The engineer will monitor the status reports and will advise the contractor on how to proceed when there is an excessive variance, exceeding 2%, from the plan quantity. The engineer may decrease the frequency of electronic status reports when the variances are consistently low.

d) The contractor shall collect asphalt tickets from the delivery trucks and group them per each one-mile segment. The contractor shall submit to the engineer a daily summary report that includes all of the information specified in Sec 402.9-c. The contractor shall sign the summary report confirming that the information is accurate and that the attached tickets represent the asphalt material placed.

e) The contractor shall be equipped with contractor-furnished cellular device capable of providing and maintaining a reliable means of immediate communication with the engineer when the engineer is not present on the project.

402.9.1 Excessive Quantity. If the contractor places Surface Level mixture on any one-mile segment, or any other isolated areas, in excess of plan quantity by 5% or more, without prior approval from the engineer, further investigation may be required to determine if the excess was warranted. If directed by the engineer, the contractor shall core the pavement at locations established by the engineer to determine the amount that was excessive, if any. No payment will be made for the cost to core the pavement or for the tons of mixture that the engineer determines to be excessive. If the amount of mixture is determined to be justified, payment will be made for the mix, and for the cost of coring at the fixed price established in Sec 109. Placement of asphalt in excess of plan quantity for two consecutive segments without prior approval from the engineer may result in issuance of an Order Record to stop work.

402.10 Method of Measurement. The weight of the mixture will be determined from the batch weights if a batch-type plant is used. If other types of plants are used, the weight of the mixture will be determined by weighing each truck load on scales in accordance with Sec ~~310~~109. Measurement will be made to the nearest 0.1 ton for the total tonnage of material accepted

402.1~~2~~1 Basis of Payment. The accepted quantities of plant mix bituminous surface leveling will be paid for at the contract unit price for each of the pay items included in the contract.

SECTION 403
ASPHALTIC CONCRETE PAVEMENT

403.1 Description. This work shall consist of providing a bituminous mixture to be placed in one or more courses on a prepared base or underlying course as shown on the plans or as directed by the engineer. ~~The contractor shall be responsible for QC of the bituminous mixture, including the design, and control of the quality of the material incorporated into the project. The engineer will be responsible for QA, including testing, to assure the quality of the material incorporated into the project.~~

~~**403.1.1 Naming Convention.** The nomenclature of Superpave bituminous mixture names, such as SP125CLP, will be as follows. When only the aggregate size is shown, such as SP125, the specifications shall apply to all variations of that size, such as SP125B, SP125C, SP125CLP, etc. When "x" is indicated, such as SP125xLP, specifications shall apply to all variations of mixture designs. Stone Matrix Asphalt will be generally referred to as SMA and designated by SM or SMR.~~

~~Superpave Nomenclature~~	
~~SP~~	~~Superpave~~
~~048~~	~~4.75mm (No. 4) nominal aggregate size~~
~~095~~	~~9.5 mm (3/8 inch) nominal aggregate size~~
~~125~~	~~12.5 mm (1/2 inch) nominal aggregate size~~
~~190~~	~~19.0 mm (3/4 inch) nominal aggregate size~~
~~250~~	~~25.0 mm (1 inch) nominal aggregate size~~
~~x~~	~~Mixture design: B, C, E or F (as described below)~~
~~LP~~	~~Limestone porphyry (when designated)~~
~~SM~~	~~Stone Matrix Asphalt (when designated)~~
~~SMR~~	~~Stone Matrix Asphalt limestone/non-carbonate (when designated)~~

~~**403.1.2 Design Levels.** The following cumulative equivalent single axle loads (ESALs) shall be used for the specified mix design. The same size aggregate mix design at a higher design traffic may be substituted at the contractor's expense for the contract specified mixture design with the approval from the engineer. Substitutions shall be done uniformly and project mixing of various designs for the same work will not be permitted. For example, an SP125B mixture may be substituted for an SP125C mixture, or SP190C for SP190E, etc. Mixture design substitution will be limited to one design level higher than that specified in the contract.~~

~~Design Traffic (ESALs)~~	~~Design~~
~~< 300,000~~	~~F~~
~~300,000 to < 3,000,000~~	~~E~~
~~3,000,000 to < 30,000,000~~	~~C~~
~~≥ 30,000,000~~	~~B~~

403.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Bituminous Asphalt Mixtures	490
Aggregate	1002
Asphalt Binder~~, Performance Graded (PG)~~[a]	1015
Asphalt Emulsions	1015
Fiber Additive	1071
Anti-Strip Additive	1071

~~[a]The grade of asphalt binder will be specified in the contract.~~

~~**403.2.1 Fine Aggregate Angularity.** Fine aggregate angularity (FAA) shall be measured on the fine portion of the blended aggregate. When tested in accordance with AASHTO T 304 Method A, aggregate particles passing the No. 8 sieve shall meet the following criteria for the minimum percent air voids in loosely compacted fine aggregate:~~

~~Design~~	~~FAA~~

F	–
E	40
C	45
B	45

403.2.2 Coarse Aggregate Angularity. Coarse aggregate angularity (CAA) shall be measured on the coarse portion of the blended aggregate. When tested in accordance with ASTM D 5821, the coarse aggregate shall meet the following criteria. Crushed limestone, dolomite, steel slag and porphyry will be considered as having 100 percent two fractured faces unless visual observations indicate an undesirable particle shape is being produced.

Design	CAA[a]
F	55/None
E	75/None
C	95/90
B	100/100

[a]The criteria denotes the minimum allowable percentage of the coarse aggregate with "one/two" fractured faces, such as a "95/90" requirement, means that the coarse aggregate shall have a minimum of 95 percent particles by weight with one fractured face and a minimum of 90 percent particles by weight with two fractured faces.

403.2.3 Clay Content. When tested in accordance with AASHTO T 176, blended aggregate particles passing the No. 4 sieve shall meet the following minimum sand equivalent criteria:

Design	Sand Equivalent
F	40
E	40
C	45
B	50

403.2.4 Thin, Elongated Particles. For all mixtures except SMA, the blended aggregate particles retained on the No. 4 sieve shall not exceed 10 percent, based on a ratio of 5:1 when tested for flat and elongated particles in accordance with ASTM D 4791.

403.2.5 Stone Matrix Asphalt. In addition to other requirements, material for SMA mixtures shall meet the following. Coarse aggregate shall consist of crushed limestone and either porphyry or steel slag in accordance with the quality requirements of Sec 1002, except as follows. The Los Angeles (LA) abrasion, when tested in accordance with AASHTO T 96, shall not exceed 40 percent based on initial ledge approval and source approval. The percent absorption, when tested in accordance with AASHTO T 85, shall not exceed 3.5 percent based on the individual fractions. The amount of flat and elongated particles, measured on material retained on a No. 4 sieve, of the blended aggregate shall not exceed 20 percent based on a 3:1 ratio or 5 percent based on a 5:1 ratio.

403.2.5.1 Filler Restriction. Rigden void content determined in accordance with MoDOT Test Method TM-73 shall be no greater than 50 percent.

403.2.5.2 Fibers. A fiber additive shall be used as a stabilizer when required to prevent draindown during production. Fibers shall be uniformly distributed by the end of the plant mixing process. The dosage rate for fibers shall be no less than 0.3 percent by weight of the total mixture for cellulose and no less than 0.4 percent by weight for mineral fibers.

403.2.6 Reclaimed Asphalt. A maximum of 30 percent virgin effective binder replacement may be used in mixtures without changing the grade of binder. The asphalt binder content of recycled asphalt materials shall be determined in accordance with AASHTO T 164, ASTM D 2172 or other approved method of solvent extraction. A correction factor for use during production may be determined for binder ignition by burning a sample in accordance with AASHTO T 308 and subtracting from the binder content determined by extraction. The aggregate specific gravity shall be determined by performing AASHTO T 209 in accordance with Sec 403.19.3.1.2 and calculating the G_{se} to use in lieu of G_{sb} as follows:

$$G_{se} = \frac{100 - Pb}{\frac{100}{G_{mm}} - \frac{Pb}{G_b}}$$

403.2.6.1 Reclaimed Asphalt Pavement. Reclaimed Asphalt Pavement (RAP) may be used in any mixture, except SMA mixtures. Mixtures may be used with more than 30 percent virgin effective binder replacement provided testing according to AASHTO M 323 is included with the job mix formula that ensures the combined binder meets the grade specified in the contract. All RAP material, except as noted below, shall be tested in accordance with AASHTO T 327, Method of Resistance of Coarse Aggregate Degradation by Abrasion in the Micro-Deval Apparatus. Aggregate shall have the asphalt coating removed either by extraction or binder ignition during production. The material shall be tested in the Micro-Deval apparatus at a frequency of once per 1500 tons . The percent loss shall not exceed the Micro-Deval loss of the combined virgin material by more than five percent. Micro-Deval testing will be waived for RAP material obtained from MoDOT roadways. All RAP material shall be in accordance with Sec 1002 for deleterious and other foreign material.

403.2.6.2 Reclaimed Asphalt Shingles. Reclaimed Asphalt Shingles (RAS) may be used in any mixture specified to use PG 64-22 in accordance with AASHTO PP 53 except as follows: When the ratio of virgin effective binder to total binder in the mixture is between 60 and 70 percent, the grade of the virgin binder shall be PG 52-28 or PG 58-28. Shingles shall be ground to 3/8 inch minus. Waste, manufacturer or new, shingles shall be essential free of deleterious materials. Post-consumer RAS shall not contain more than 1.5 percent wood by weight or more than 3.0 percent total deleterious by weight. Post-consumer RAS shall be certified to contain less than the maximum allowable amount of asbestos as defined by national or local standards. The gradation of the aggregate may be determined by solvent extraction of the binder or using the following as a standard gradation:

Shingle Aggregate Gradation	
Sieve Size	**Percent Passing by Weight**
3/8 inch	100
No. 4	95
No. 8	85
No. 16	70
No. 30	50
No. 50	45
No. 100	35
No. 200	25

403.3 Composition of Mixtures.

403.3.1 Gradation. Prior to mixing with asphalt binder, the combined aggregate gradation, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract. A job mix formula may be approved which permits the combined aggregate gradation during mixture production to be outside the limits of the master range when the full tolerances specified in Sec 403.5 are applied.

Percent Passing by Weight							
Sieve Size	**SP250**	**SP190**	**SP125**	**SP095**	**SP048**	**SP125xSM(R)**	**SP095xSM(R)**
1 1/2 inch	100	—	—	—	—	—	—
1 inch	90 – 100	100	—	—	—	—	—
3/4 inch	90 max.	90 – 100	100	—	—	100	—
1/2 inch	—	90 max.	90 – 100	100	—	90-100	100
3/8 inch	—	—	90 max.	90-100	100	50-80	70-95
No. 4	—	—	—	90 max.	90-100	20 – 35	30-50
No. 8	19 – 45	23 – 49	28 – 58	32-67	—	16 – 24	20-30
No. 16	—	—	—	—	30-60	—	21 max.

No. 30	—	—	—	—	—	—	18 max.
No. 50	—	—	—	—	—	—	15 max.
No. 100	—	—	—	—	—	—	—
No. 200	1 – 7	2 – 8	2 – 10	2-10	7-12	8.0-11.0	8.0-12.0

403.3.2 Anti-Strip Agent. An anti-strip will be allowed by the engineer to improve resistance to stripping. Anti-strip agents and application rates shall be from a list approved in accordance with Sec 1071.

403.3.3 Porphyry Mixtures. For LP and SMA mixtures, at least 50 percent by volume of the aggregate shall be crushed porphyry retained on the following sieves: No. 30 for SP048, No. 16 for SP095 and No. 8 for SP125. Depending on the actual gradation of porphyry aggregate furnished, the amount of crushed porphyry required may vary, however at least 40 percent by weight of crushed porphyry will be required. Steel slag may be substituted for porphyry in LP and SM mixtures, except at least 45 percent by weight of crushed porphyry and/or slag will be required. The engineer may approve the use of other hard, durable aggregate in addition to porphyry and steel slag. . When an SMR mixture is designated, the mixture shall contain aggregate blends with at least 30 percent non-carbonate material in accordance with Sec 403.3.5.

403.3.4 Minimum Stone Matrix Asphalt Binder. The percent asphalt binder for SMA mixtures shall not be less than 6.0 percent unless otherwise allowed by the engineer.

403.3.5 Surface Mixtures. Design level B surface mixtures and SP048NC, except as described in Sec 403.15.3, containing limestone coarse aggregate shall contain a minimum amount of non-carbonate aggregate. The LA abrasion values, AASHTO T 96, of the limestone will determine the type and amount of non-carbonate aggregate required as shown in the table below. The LA abrasion value will be determined from the most recent source approval sample. In lieu of the above requirements, the aggregate blend shall have an acid insoluble residue (AIR), MoDOT Test Method TM 76, meeting the plus No. 4 criteria of crushed non-carbonate material. Non-carbonate aggregate shall have an AIR of at least 85 percent insoluble residue.

Coarse Aggregate (+ No. 4)	Minimum Non-Carbonate by Volume
Limestone, LA ≤ 30	30% Plus No. 4
Limestone, LA > 30	20% Minus No. 4[a]
Dolomite	No Requirement

[a] Use for all SP095 and SP048NC containing limestone.

403.4 .2.1 Job Mix Formula (JMF). Mix designs meeting the Sec 490 requirement shall be submitted for each project at least seven days prior to placement. At least 30 days prior to placing any mixture on the project, the contractor shall submit a mix design for approval to Construction and Materials. Superpave (SP) and Stone Mastic (SM) mixtures are intended for Section 403 pay items as shown on the plans. In producing mixtures for the project, the plant shall be operated such that no intentional deviations from the job mix formula are made.

403.42.2 Substitutions. At the option of the contractor and at no cost to the Commission, the contractor may substitute a smaller nominal maximum size mixture for a larger sized mixture. Specifications governing the substitute mixture shall apply. For multi-lift or single-lift construction paid for by area, the total plan pavement thickness shall be maintained.11. The contract unit price for the original mixture shall be used.

403.413.512.3 Shoulder Substitution. When a Sec 403 mixture is specified for traffic lanes, the same mixture may be used for the adjacent shoulder, subject to the density requirements in Sec 403.

The mixture shall be designed in accordance with AASHTO R 35 or R 46 and shall be tested in accordance with AASHTO T 312 except as noted herein. A detailed description of the mix design process shall be included with the job mix formula (JMF). Representative samples of each ingredient for the mixture shall be submitted with the mix design. Aggregate fractions shall be provided in the same proportions as the proposed job mix formula. A minimum of 150 pounds will be required for any individual fraction. The amount of each ingredient submitted shall be as follows for each mix design to be verified:

Ingredient	Minimum Amount
Aggregate	750 Pounds
Hydrated Lime, Mineral Filler and/or Baghouse Fines	20 Pounds
Asphalt Binder	10 Gallons

403.4.1 Proficiency Sample Program. Laboratories that participate in and achieve a score of three or greater in the AASHTO proficiency sample program for T 11, T 27, T 84, T 85, T 166, T 176, T 209, T 304 (ASTM C 1252), T 308 and T 312 will have

the mixture verification process waived. The mix design shall be submitted to Construction and Materials for approval at least seven days prior to mixture production.

403.4.2 Required Information. The mix design shall include raw data from the design process and contain the following information:

(a) All possible sources intended for use, and grade and specific gravity of asphalt binder.

(b) Source, type (formation, etc.), ledge number if applicable, gradation, and deleterious content of each aggregate fraction.

(c) Bulk and apparent specific gravities and absorption of each aggregate fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate including all raw data.

(d) Specific gravity of hydrated lime, mineral filler or baghouse fines, if used, in accordance with AASHTO T 100.

(e) Percentage of each aggregate component.

(f) Combined gradation of the job mix.

(g) Percent asphalt binder, by weight, based on the total mixture and percent asphalt binder contributed by reclaimed asphalt materials.

(h) Bulk specific gravity (G_{mb}) by AASHTO T 166 Method A of a laboratory compacted mixture compacted at N_{design} gyrations.

(i) Percent air voids (V_a) of the laboratory compacted specimen compacted to Ndesign gyrations.

(j) Voids in the mineral aggregate (VMA) and voids in the mineral aggregate filled with asphalt binder (VFA) at N_{design} gyrations.

(k) Theoretical maximum specific gravity (G_{mm}) as determined by AASHTO T 209, in accordance with Sec 403.19.3, after the sample has been short term aged in accordance with AASHTO R 30.

(l) The tensile strength ratio as determined by AASHTO T 283 including all raw data.

(m) The gyratory sample weight to produce a 115 mm minimum height specimen.

(n) Mixing temperature and gyratory molding temperature.

(o) Number of gyrations at $N_{initial}$, N_{design}, and $N_{maximum}$.

(p) Dust proportion ratio ($200/P_{be}$).

(q) Bulk specific gravity (G_{sb}) of the combined aggregate.

(r) Percent chert contained in each aggregate fraction.

(s) Percent of G_{mm} at $N_{initial}$ and $N_{maximum}$.

(t) Blended aggregate properties for clay content, angularity, and thin and elongated particles.

(u) Voids in coarse aggregate (VCA) for both the mixture and dry-rodded condition for SMA mixtures.

(v) Draindown for SMA mixtures.

(w) Baghouse fines added for design.

(i) Batch and continuous mix plants – Indicate which aggregate fraction to add baghouse percentage during production.

(ii) Drum-mix plants – Provide cold feed settings with and without baghouse percentage.

403.~~.5~~2.4~~4.3~~ Mixture Approval. No mixture will be accepted for use until the JMF for the project is approved by Construction and Materials. When test results indicate the mixture produced does not meet the specification requirements, the contractor may field adjust the job mix formula as noted herein. Field adjustments may consist of changing the percent binder as listed on the original approved job mix by no more than 0.3 percent. Additional fractions of material or new material will not be permitted as field adjustments. The engineer shall be notified immediately when any change is made in the cold feed settings, the hot bin settings or the binder content. A new Gsb shall be calculated using the new aggregate percentages. The gradation of the adjusted mixture shall meet the requirements of the mixture type specified in the contract. When the binder content is adjusted more than 0.3 percent, the mixture will be considered out of specification, and a new mix design shall be established.

403.~~6~~2.5~~11.1~~ Field Mix Redesign. When a new mix design will be required, the contractor will be permitted to establish the new mix design in the field. The mixture shall be designed in accordance with AASHTO R 35 or AASHTO R 46 and shall meet the mix design requirements, including TSR. A representative sample of the mixture shall be submitted with the new mix design to the Central Laboratory for mixture verification. The amount of mixture submitted for verification shall weigh at least 50 pounds.

~~**403.11.1 Field Mix Redesign.** When a new mix design will be required, the contractor will be permitted to establish the new mix design in the field. The mixture shall be designed in accordance with AASHTO R 35 or AASHTO R 46 and shall meet the mix design requirements, including TSR. A representative sample of the mixture shall be submitted with the new mix design to the Central Laboratory for mixture verification. The amount of mixture submitted for verification shall weigh at least 50 pounds.~~

403.2.5~~6~~.1 Redesign Approval. New mix designs established in the field shall be submitted for approval to Construction and Materials. Upon approval, Construction and Materials will assign a new mix number to the mixture.

403.~~6~~2.5.2 Resume Production. No mixture shall be placed on the project until the new field mix design is approved.

403.~~7~~2.6~~5.10~~ Contamination. The asphaltic concrete mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue or any other material not inherent to the job mix formula.

~~**403.4.4 Job Mix Formula Modification.** The JMF approved for each mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results occur or should a source of material be changed, a new JMF may be required.~~

~~**403.4.5 Design Gyrations.** The number (N) of gyrations required for gyratory compaction shall be as follows:~~

~~Design~~	~~[b] $N_{initial}$~~	~~[a] N_{design}~~	~~[a,b] $N_{maximum}$~~
~~F~~	~~--~~	~~50~~	~~--~~
~~E~~	~~7~~	~~75~~	~~115~~
~~C~~	~~8~~	~~80 or 100~~	~~160~~
~~B~~	~~9~~	~~125~~	~~205~~

~~[a] SMA mixtures shall have N_{design} equal to 100 and no $N_{maximum}$ requirement.~~

~~[b] Design Level C mixtures designed at 80 gyrations shall have no $N_{initial}$ or $N_{maximum}$ requirements.~~

~~In addition, the compaction level, as a percent of theoretical maximum specific gravity, shall be less than or equal to 91.5 percent for Design F, 90.5 percent for Design E and 89.0 percent for Designs C and B at $N_{initial}$, equal to 96.0 percent at N_{design} and less than or equal to 98.0 percent at $N_{maximum}$.~~

~~**403.4.6 Mixture Characteristics.** When compacted in accordance with AASHTO T 312, the mixture shall meet the following criteria.~~

~~**403.4.6.1** Air Voids (V_a). Design air voids for all mixtures at all traffic levels shall be 4.0.~~

403.4.6.2 Voids in the Mineral Aggregate (VMA).

Mixture	VMA Minimum (percent)
SP250	12.0
SP190	13.0
SP125 (except for SMA)	14.0
SP095 (except for SMA)	15.0
SP048	16.0
SMA	17.0

403.4.6.3 Voids Filled With Asphalt (VFA).

Design	VFA (percent)[a]
F	70 – 80
E	65 – 78
C	65 – 75[b]
B	65 – 75[b]

403.83 Mixing Plants and Hauling Equipment. Bituminous mixing plants, trucks used for hauling bituminous mixtures, and preparation of material and mixtures shall be in accordance with Sec 404.

403.94 Field Laboratory. The contractor shall provide a Type 3 field laboratory in accordance with Sec 601. The contractor shall furnish the bituminous mixture equipment to perform all required test methods for QC and QA work. A field laboratory shall not be required for small quantity work.

[a]SMA and SP048 mixtures shall have a minimum VFA of 75 percent.

[b]Maximum 76 percent for SP095 and 78 percent for SP048.

403.4.7 Dust to Binder Ratio. For all mixtures except SMA and SP048, the ratio of minus No. 200 material to effective asphalt binder (Pbe) shall be between 0.8 and 1.6. For SP048, the ratio of minus No. 200 material to effective asphalt binder (Pbe) shall be between 0.9 and 2.0.

403.4.8 Moisture Susceptibility. For all mixtures except SMA, the mixture shall have a tensile strength ratio (TSR) greater than 80 percent when compacted to 3.7 inches with 7 ±0.5 percent air voids and tested in accordance with AASHTO T 283. SMA mixtures shall have a TSR greater than 80 percent when compacted to 3.7 inches with 6±0.5 percent air voids and tested in accordance with AASHTO T 283.

403.4.9 Draindown. AASHTO T 305, Draindown Test, shall be performed on all SMA mixtures prior to job mix approval. The mixture shall be stabilized in such a way that the draindown of the asphalt binder shall not exceed 0.3 percent by weight of mixture.

403.4.10 Voids in Coarse Aggregate. The percent VCAMIX of SMA mixtures shall be less than or equal to the VCADRC as determined using AASHTO T 19. This may be calculated using the following equations:

$$VCA_{DRC} = 100 \times (G_{CA}\gamma_w - \gamma_s) / G_{CA}\gamma_w$$

$$VCA_{MIX} = 100 - (P_{bp} \times G_{mb} / G_{CA})$$

$$P_{bp} = P_s \times PA_{bp}$$

Where: G_{CA} = bulk specific gravity of the combined coarse aggregate (AASHTO T 85),
γ_s = unit weight of coarse aggregate in the dry-rodded condition (DRC) (lb/ft3) (AASHTO T 19),
γ_w = unit weight of water (62.34 lb/ft3) ,
P_{bp} = percent aggregate by total mixture weight retained on No. 4 sieve and
PA_{bp} = percent aggregate by total aggregate weight retained on No. 4 sieve*.

~~*Use No. 8 sieve for SP095xSM~~

~~**403.5 Mixture Production Specification Limits.**~~

~~**403.5.1 Gradation and Deleterious Content Control.** The gradation of the aggregate shall be determined from samples taken from the hot bins on batch type or continuous mixing plants or from the composite cold feed belt on drum mix plants. The gradation may also be obtained by sampling the mixture and testing the residual aggregate. The deleterious content of the aggregate shall be determined from samples taken from the composite cold feed belt. The RAP shall be sampled from the RAP feeding system on the asphalt plant. The contractor shall determine on a daily basis at minimum, the gradation on the aggregate reclaimed from the RAP by either extraction or binder ignition. The results shall be used to determine the daily specification compliance for the combined gradation.~~

~~**403.5.1.1 Stone Matrix Asphalt Tolerances.** In producing mixtures for the project, the plant shall be operated such that no intentional deviations from the job mix formula are made. The maximum deviation from the approved job mix formula shall be as follows for SMA mixtures:~~

~~Sieve~~	~~Max. Tolerance~~	
	~~SP095~~	~~SP125~~
~~3/4 inch~~	~~—~~	~~—~~
~~1/2 inch~~	~~—~~	~~±4~~
~~3/8 inch~~	~~±4~~	~~±4~~
~~No. 4~~	~~±3~~	~~±3~~
~~No. 8~~	~~±3~~	~~±3~~
~~No. 200~~	~~±2~~	~~±2~~

~~**403.19.1 Random Numbers.** The engineer will generate random numbers.~~**403.~~10~~5 Acceptance and Payment for Work Types.** Acceptance of bituminous mixtures will be by the QC/QA process as designated within. The applicable pay adjustments shall be based on the type of work performed.

403.~~10~~5.1 Multiple Lift Mainline Construction. For mainline traveled way work consisting of placing multiple lifts all QC/QA requirements and pay adjustments shall apply. Shoulders placed integrally with the mainline shall be included in the QC/QA lot process and adjustments for mainline.

~~**403.23.7.1.4~~~~10~~5.1.1 Roadway/Shoulder Lots.** For the purpose of ~~QLA,~~pay adjustments mixture placed on the traveled way ~~and~~or placed on the traveled way and shoulders integrally, shall be accounted for in a regular lot/sublot routine with density being included ~~on~~ in the pay factor total. Mixture placed on shoulders only shall be accounted for in a shoulder lot/sublot routine.

403.~~10~~5.2 Non-Integral Shoulders. All QC/QA requirements shall apply for mixtures used on non-integral shoulders, surfacing medians, and similar areas, except that density acceptance is as described in Sec. 403.11.11.2. All pay adjustments shall apply except for when an established roller pattern is utilized, no density related pay adjustment shall be made. No unconfined joint cores or pay factor shall apply to non-integral shoulder work.

403.~~10~~5.3 Mill and Fill. For resurfacing projects specifying a milling operation prior to mixture placement, the QC/QA requirements and pay adjustments of multiple lift construction shall apply.

403.~~10~~5.4 Single Lift or Leveling Course. For resurfacing projects without milling specifying a single lift overlay or for leveling course work all QC/QA requirements shall apply. All applicable adjustments shall be used in determining payment for acceptable work except that the density adjustment shall be used in lieu of including the pavement density in the pay factor total.

403.~~10~~5.5 Base Widening and Entrances. For base widening and entrance work, all QC/QA requirements shall apply. For base widening mixture and entrance work, compaction may be performed and accepted in accordance with Sec 403.~~16~~11.11.~~2~~2. No pay adjustments shall be made. Payment for these mixtures will be made at 100 percent of contract unit price for material that otherwise meets the specifications. ~~**403.19.3.2.2 Base Widening and Entrances.** For base widening mixture and entrance work,~~

403.~~10~~5.6 Temporary Pavement. All QC/QA requirements shall apply for mixture placed for temporary work items except that moisture susceptibility and surface smoothness testing is not required. ~~Only t~~The Superpave adjustment without the density payfactor as well as the density adjustment ~~and without the density payfactor~~ shall apply to temporary work.

~~the following will apply:~~

~~(a) All base widening shall be constructed in accordance with Sec 401.7 and subsections.~~

~~(b) The minimum density of these mixtures shall be attained as specified herein, except, compaction may be performed in accordance with Sec 403.15.3.~~

403.~~10~~5~~19.3.2.1~~.7 Small Quantities~~ty~~s. When ~~Small quantities are~~ less than 4000 tons for each separate mixture is called for it shall be considered a small quantity. This designation applies to individual projects, individual projects in combination contracts or projects with short discontinuous sections. For small quantities the contractor may elect to perform either the full QC/QA process or the modified process using the ~~The contractor has the option to use all testing frequencies in accordance with Sec 403.19.3 or the following shall apply:~~QC Small Quantity frequencies listed in the Sec 403.14 table.

~~(a) A field laboratory will not be required for monitoring mixtures. All required QC and QA testing shall be performed in an approved laboratory.~~

~~(b) QC tests required in Sec 403.19.3 shall be performed at a frequency of no less than one per day if production does not exceed 750 tons and at a frequency of no less than two per day if production exceeds 750 tons. Independent or retained sample QA tests shall be performed at least once per 1500 tons, as indicated.~~

QA frequency for small quantities will be determined by the engineer. All applicable adjustments shall be used in determining payment for acceptable work except that when the QC Small Quantity frequencies are used, the Superpave adjustment shall not apply.

403.~~10~~5.8 Certifiable Quantity. At the engineer's discretion, QC/QA requirements may be waived when production does not exceed 200 tons per day. The contractor shall certify the proper proportions of a previously proven mixture were used. No price adjustments shall be made, payment for these mixtures will be made at 100 percent of contract unit price for material that otherwise meets the specifications.

403.~~21.1~~6~~1~~ Sequence of Operations. To reduce inconvenience to the traveling public during widening or surfacing, the contractor will not be permitted to place any final surface course until the base widening, the leveling course and the binder course have been completed throughout the entire combination of sections, unless otherwise authorized by the engineer. The proper condition of the base widening, the leveling course and the binder course, at the time of placing the surface course, shall be the contractor's responsibility.

403.~~21.2~~7~~2~~ Pavement Marking. If the contractor's work has obliterated the existing pavement marking on resurfacing projects open to through traffic, the pavement marking shall be replaced in accordance with Sec 620.

403.~~21.3~~8~~3~~ Surfaced Approaches. At locations designated in the contract or as specified by the engineer, approaches shall be primed in accordance with Sec 408 and surfaced with Type SP125 asphaltic concrete. The asphaltic concrete surface shall be placed in accordance with the details shown on the plans or as specified by the engineer. Approaches shall not be surfaced until after the surface course adjacent to the entrance is completed. Any work required to condition and prepare the subgrade on the approaches will be at the contractor's expense.

403.~~21.4~~9~~4~~ Filling Drain Basins. If shown on the plans, existing drain basins shall be filled to the top of the lip with plant mix bituminous base course or asphaltic concrete from the pavement edge to the edge of the shoulder. Any difficulty or delay created by this requirement will be at the contractor's expense.

403.~~21.5~~10~~5~~ ~~Pavement Repairs (~~Blow-Ups~~).~~ A blow-up will be considered ~~that~~ area where excessive expansion has resulted in distress to the existing pavement. Blow-ups occurring prior to the application of the tack coat on the existing surface will normally be repaired by the Commission. Blow-ups occurring after the application of the tack coat shall be repaired by the contractor by removing the distressed ~~concrete~~pavement and replacing the pavement in accordance with Sec 613.

~~**403.5.1.2 Mixture Tolerance.** For all other SP mixtures, the percent passing the first sieve size smaller than the nominal maximum size shall not exceed 92.0 percent, a tolerance not to exceed 2.0 percent on the No. 8 sieve from the table in Sec 403.3.1, and within the range listed in Sec 403.3.1 for the No. 200 sieve The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in Sec 1002.2.~~

~~**403.5.2 Density.** The final, in-place density of the mixture shall be 94.5 ± 2.5 percent of the theoretical maximum specific gravity for all mixtures except SMA. SMA mixtures shall have a minimum density of 94.0 percent of the theoretical maximum specific gravity. The theoretical maximum specific gravity shall be determined from a sample representing the material being tested. Tests shall be taken not later than the day following placement of the mixture. The engineer will randomly determine test locations.~~

~~**403.5.2.1 Shoulder Density.** Density on non-integral shoulders shall be in accordance with Sec 403.15.3.~~

~~**403.5.2.2 Integral Shoulder.** When shoulders are placed integrally with the traveled way, tests shall be taken on the traveled way.~~

~~**403.5.2.3 Longitudinal Joint Density.** Density along longitudinal joints shall be in accordance with Sec 403.16.1.~~

~~**403.5.3 Asphalt Content.** The asphalt content (AC) shall be within ±0.3 percent of the approved mix design.~~

~~**403.5.4 Voids in the Mineral Aggregate.** The VMA shall be within – 0.5 and + 2.0 percent of the minimum required for each type of mixture at N_{des} gyrations.~~

~~**403.5.5 Air Voids.** Air voids shall be within ±1.0 percent of the approved mix design at N_{des} gyrations.~~

~~**403.5.6 Tensile Strength Ratio.** The TSR shall be greater than or equal to 75 percent as determined from loose mixture taken from the roadway and tested in accordance with AASHTO T 283.~~

~~**403.5.7 Aggregate Properties.** Aggregate properties from Sec 403.2 on the combined aggregate during production shall be no less than 2 percent below the minimum for FAA, no less than 5 percent below the minimum for CAA, no less than 5 percent below the minimum for clay content and no more than 2 percent above the maximum for thin, elongated particles.~~

~~**403.5.8 Fibers.** The fiber proportioning and delivery system for SMA mixtures shall have an accuracy of 10 percent by weight of the material actually being measured in any given period of time.~~

~~**403.5.9 Moisture Content.** The asphaltic concrete mixture, when sampled and tested in accordance with AASHTO T 329, shall not contain more than 0.5 percent moisture by weight of the mixture.~~

~~**403.5.10 Contamination.** The asphaltic concrete mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue or any other material not inherent to the job mix formula.~~

~~**403.6 Field Laboratory.** The contractor shall provide a Type 3 field laboratory in accordance with Sec 601. The contractor shall furnish the bituminous mixture equipment to perform all required test methods for QC and QA work. The gyratory compactor shall be evaluated in accordance with AASHTO PP 35. An approved list will be maintained by Construction and Materials. All other equipment shall be capable of performing tests in accordance with the approved test methods.~~

~~**403.7 Bituminous Mixing Plants.** Bituminous mixing plants and preparation of material and mixtures shall be in accordance with Sec 404.~~

~~**403.8 Hauling Equipment.** Trucks used for hauling bituminous mixtures shall be in accordance with Sec 404.~~

~~**403.9 Pavers.** Bituminous pavers shall be self-contained units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing asphaltic concrete in lane widths applicable to the specified typical sections and thicknesses shown on the plans.~~

403.~~10~~ 1~~6~~1 Construction Requirements.

403.~~10~~1~~6~~1.1 Weather Limitations. ~~No~~ Bituminous mixtures shall not be placed on any wet or frozen surface.

~~**403.10.2 Substitutions.** With approval from the engineer, the contractor may substitute a smaller nominal maximum size mixture for a larger sized mixture. Specifications governing the substitute mixture shall apply. Except for a single surface layer, the total pavement thickness shall be maintained when the substitute mixture layer is reduced as allowed in Sec 403.13 by increasing the thickness of other layers or courses. The contract unit price for the original mixture shall be used.~~

~~**403.11 Field Adjustments of Job Mix Formulas.** When test results indicate the mixture produced does not meet the specification requirements, the contractor may field adjust the job mix formula as noted herein. Field adjustments may consist of changing the percent binder as listed on the original approved job mix by no more than 0.3 percent. Additional fractions of material or new material will not be permitted as field adjustments. The engineer shall be notified immediately when any change is made in the cold feed settings, the hot bin settings or the binder content. A new Gsb shall be calculated using the new aggregate percentages. The gradation of the adjusted mixture shall meet the requirements of the mixture type specified in the contract. When the binder content is adjusted more than 0.3 percent, the mixture will be considered out of specification, and a new mix design shall be established.~~

~~**403.11.1 Field Mix Redesign.** When a new mix design will be required, the contractor will be permitted to establish the new mix design in the field. The mixture shall be designed in accordance with AASHTO R 35 or AASHTO R 46 and shall meet the mix design requirements, including TSR. A representative sample of the mixture shall be submitted with the new mix design to the Central Laboratory for mixture verification. The amount of mixture submitted for verification shall weigh at least 50 pounds.~~

~~**403.11.1.1 Approval.** New mix designs established in the field shall be submitted for approval to Construction and Materials. Upon approval, Construction and Materials will assign a new mix number to the mixture.~~

~~**403.11.1.2 Resume Production.** No mixture shall be placed on the project until the new field mix design is approved.~~

403.~~12~~ 1~~6~~1.2 Application of Prime or Tack. The prime coat, if specified, shall be applied in accordance with Sec 408. A tack coat ~~is~~ shall be applied ~~required~~ on all existing pavement and shoulder surfaces that will be overlaid with a bituminous mixture. A tack coat ~~is~~shall also be required between all lifts of bituminous pavements placed within the driving and turn lanes, unless otherwise specified in the contract. All construction requirements of a tacked surface shall be in accordance with Sec 407, and specified herein. The tack coat shall be applied uniformly and shall completely cover the surface upon which the bituminous mixture is to be placed. Placement of a bituminous mixture shall not be placed upon a tacked surface that is not uniformly covered or surfaces that have experienced excessive loss of tack due to tracking. Re-application of tack due to excess tracking or non-uniform coverage shall be at the contractor's expense.

403.~~13~~ 1~~6~~1.3 Spreading and Finishing. The base course, primed or tacked surface, or preceding course or layer shall be cleaned of all dirt, packed soil or any other foreign material prior to spreading the asphaltic mixture. Truck loads not free of ~~If~~ lumps ~~are present~~ or ~~a~~ crusted material shall be rejected ~~of mixture has formed, the entire load will be rejected~~. The thickness and width of each course shall conform to the typical section in the contract. The contractor may elect to construct each course in multiple layers. The minimum compacted thickness shall be 0.75 inches for SP048, 1.25 inches for SP095, 1.75 inches for SP125, 2 inches for SP190, and 3 inches for SP250.

403.~~13~~ 1~~6~~1.3.1 Transitions. All layers shall be feathered out, by hand raking if necessary, in transitioning the depth of the surface to meet present grades at bridges or ends of projects, to provide a uniform, smooth riding surface free of irregularities. Where only the top layer of the surfacing continues across a bridge, the bottom layers shall be feathered out.

403.~~13~~1~~6~~1.4~~1~~ Paving Widths. The following shall apply for roadways constructed under traffic. For pavements having a width of 16 to 24 feet, inclusive, the asphaltic concrete pavement shall be laid in lanes approximately one half the full width of the completed pavement, and the full width shall be completed as soon as practical. Unless otherwise permitted, a single lane of any course shall not be constructed to a length that cannot be completed to full width of the pavement the succeeding operating day. For pavements greater than 24 feet wide, single lane width construction shall be limited to one day's production and completion to full width shall be accomplished as soon as practical. Uneven pavement shall be left in place for no more than seven days, unless approved by the engineer. Removal of pavement to be in accordance with this specification shall be at the contractor's expense.

403.~~13~~1~~6~~1.5~~2~~ Segregation. No segregation will be permitted in handling the mixture at the plant, from the truck or during spreading operations on the roadbed. Mixture production shall immediately cease if either criteria of MoDOT Test Method TM 75 fail. Segregated mixture shall be removed and replaced to the limits determined by the engineer.

403.~~13~~1~~6~~1.3 ~~6~~ Release to Traffic. If the asphaltic concrete construction consists of more than a single layer, each layer shall be compacted as specified and allowed to cool sufficiently that further consolidation or deformation is not experienced before placing ~~to cool to the ambient temperature~~ before the next layer is placed. The contractor shall keep traffic off the asphaltic concrete until the surface of the asphaltic concrete is 140 F or below and the asphaltic concrete has cooled sufficiently to prevent flushing of the asphalt binder to the surface, marking or distorting the surface or breaking down the edges.

403.~~13~~1~~6~~1.4 ~~7~~ Draindown. Evidence of asphalt binder separation or draindown at delivery will be cause for rejection.

403.1~~6~~11.2~~8~~ Defective Mixture. Any mixture that becomes loose and broken, mixed with dirt or is in any way defective shall be removed and replaced with fresh, hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of asphalt binder shall be removed and replaced.

~~**403.13.5 Shoulder Substitution.** When a Sec 403 mixture is specified for traffic lanes, the same mixture may be used for the adjacent shoulder, subject to the density requirements in Sec 403.5.2.~~

403.~~14~~ 1~~6~~1.9 Spot Wedging and Leveling Course. The engineer will specify the locations and thickness of spot wedging and the thickness of leveling course to obtain the smoothest possible riding surface. This procedure may result in spot wedging

operations over small areas with feather-edging at high points and ends of wedge areas. Rigid control of the placement thickness of the leveling course shall be required. Leveling course, consisting of a layer of asphaltic concrete of variable thickness used to superelevate curves and eliminate irregularities in the existing base, shall be spread uniformly to the specified profile grade and cross section. The mixture shall be uniformly spread and compacted, with only minor segregation as accepted by the engineer. Type SP125 or finer mixtures, as applicable, shall be used for the spot wedging and for the leveling course.

403.~~6~~11.10 Base Widening. All base widening shall be constructed in accordance with Sec 401.5.2.1 and subsections.

403.~~16~~11.11 Compaction. After the asphaltic mixture has been spread, struck off and surface irregularities adjusted, the asphaltic mixture shall be compacted thoroughly and uniformly by rolling to obtain the required compaction while the mixture is in a workable condition. Excessive rolling, to the extent of aggregate degradation, will not be permitted. A pneumatic tire roller shall be used as the initial or intermediate roller on any course placed as a single lift, as a wedge or leveling course. Rollers shall not be used in the vibratory mode when the mixture temperature is below 225 F. When warm mix technology is used, as approved by the engineer, rollers shall not be used in the vibratory mode when the mixture temperature is below 200 F .

403.~~16~~11.11.1 **Rolling.** Any displacement occurring as a result of starting, stopping or changing direction of a roller, or from other causes, shall be avoided. Excess liquid, to prevent adhesion of the mixture to the rollers, will not be permitted. Diesel fuel, fuel oil or other detrimental products shall not be used as wetting agents. Along forms, curbs, headers, walls and other places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons or with mechanical tampers.

~~**403.15.2 Defective Mixture.** Any mixture that becomes loose and broken, mixed with dirt or is in any way defective shall be removed and replaced with fresh, hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of asphalt binder shall be removed and replaced.~~

403.~~16~~11.~~3~~11.2 ~~Non-Traffic Areas~~Alternate Compaction Method. M~~Sec 403 m~~ixtures used for non-integral shoulders, surfacing medians, and similar areas~~, shoulders adjacent to rigid or flexible pavement and shoulders adjacent to resurfaced pavement~~ shall be compacted to the specified densities for the mixture. Once an established rolling pattern has been demonstrated to provide the required density for shoulders, at the engineer's discretion, the pattern may be used in lieu of density tests provided no changes in the material, typical location or temperatures are made. Regardless of the method, density will still be required and subject to testing as deemed necessary by the engineer. ~~In lieu of roller and density requirements, temporary bypasses to be maintained at the expense of the contractor shall be thoroughly compacted. The rolling shall be performed at proper time intervals and shall be continued until there is no visible evidence of further consolidation.~~

~~**403.15.4 Density Measurement.** Measurements for determining the in-place density of the mixture shall be taken no later than the day following placement. Measurements not obtained within the prescribed time limits shall be subject to the requirements of Sec 403.22. If a core is taken, material from underlying layers that remain adhered to the core shall be removed in a manner that does not harm the integrity of the specimen. If the contractor elects to place a lift of mixture greater than six times the nominal maximum aggregate size, cores shall be cut in half and the density of each half determined separately.~~

403.~~16~~ ~~1~~6~~1~~.12 Transverse Joints. Transverse joints shall be formed by any method that will produce a dense, vertical section for use when laying is resumed. When a transverse vertical edge is to be left and opened to traffic, a temporary depth transition shall be built as approved by the engineer. The joint formed when the fresh mixture is placed shall be dense, well sealed, and the grade, line and surface texture of the succeeding surface shall conform to that of the joined surface. If directed by the engineer for properly sealing the transverse joint, a light coating of bituminous material shall be applied to the exposed edge before the joint is made. ~~. If directed by the engineer, the transverse joint shall be painted with a light coating of liquid asphalt.~~ Hand manipulation of the mixture shall be minimized to avoid unsightly surface texture.

403.~~6~~11.13~~16.1~~ Longitudinal Joints~~ Composition~~. ~~.~~The longitudinal joint in any layer shall offset that in the layer immediately below by a minimum of 6 inches; except, the joints in the completed surfacing shall be at the lane lines of the traveled way or other required placement width outside the travel lane. The placement width shall be adjusted such that pavement marking shall not fall on a longitudinal joint. Longitudinal joints shall be formed by the use of an edging plate fixed on both sides of the finishing machine. Care shall be taken to obtain a well bonded and sealed longitudinal joint by placing the hot mixture in a manner ensuring maximum compaction at this point. If directed by the engineer for properly sealing the longitudinal joint, a light coating of bituminous material shall be applied to the exposed edge before the joint is made. ~~The minimum density of all traveled way pavement within 6 inches of a longitudinal joint, including the pavement on the traveled way side of the shoulder joint, shall not be less than 2.0 percent below the specified density when unconfined. The density of the longitudinal joint when confined will be included in the evaluation of the remainder of the mat.~~ Each side of the joint shall be flush and along true lines.

403.11.14 Surface Smoothness. The finish of the pavement surface shall be substantially free from waves or irregularities and shall be true to the established crown and grade.

~~**403.16.2 Joint Offset.** The longitudinal joint in any layer shall offset that in the layer immediately below by a minimum of 6 inches; except, the joints in the completed surfacing shall be at the lane lines of the traveled way or other required placement width outside the travel lane. The placement width shall be adjusted such that pavement marking shall not fall on a longitudinal joint.~~

403.~~6~~11.15~~22.4.2 Surface Restoration~~Coring. The surface from which samples have been taken, including those for density measurements, shall be restored by the contractor with the mixture then being produced no later than the next day of plant operation, if construction is still active. If bituminous construction has been completed, the surface from which samples have been taken shall be restored within 48 hours with an approved commercial mixture or with cold patch mixtures acceptable to the engineer.

403.~~17~~ 1~~7~~2 Quality Control. The contractor shall control and monitor the quality of the work. Mixture suppliers shall have either a standard quality control plan on file with the Construction & Materials division for the applicable plant or be included in the contractor's quality control plan. ~~90~~ The contractor's test results will be used when applicable to determine the PWL, provided the contractor's QC tests and the engineer's QA tests compare favorably, and provided the engineer's inspection and monitoring activities indicate the contractor is following the approved QC Plan.

403.~~7~~12.1 Lots/Sublots. Loose mix material will be sampled from the roadway behind the paver in lots or sublots on a random basis through the use of a random number system and evaluated using a Quality Level Analysis (QLA). A QLA will determine payment based on a combination of the total PWL (PWLt) determined for each pay factor item for each lot of material produced. The lot size shall be designated in the contractor's QC Plan. Each lot shall contain no less than four sublots with a maximum sublot size of 1,000 tons. Sublots from incomplete lots shall be combined with the previous complete lot for determination of pay factors. When no previous lot exists, the mixture shall be treated as a small quantity A new lot shall begin when the asphalt content of a mixture is adjusted in accordance with Sec 403.2.5.

403.~~7~~12.2 Random Numbers. The engineer will generate random numbers for density cores and loose mix sampling locations. For the purpose of QLA, all mixture placed on the roadway shall be subject to random testing, except mixture placed within 6 inches of an unconfined longitudinal joint shall not be subject to pavement density evaluation. Random loose mix samples taken in the same day may be separated by 200 tons.

403.~~17~~12~~7~~.2.~~3~~3 Retained Samples. All samples taken by the contractor, including but not limited to tested aggregate, volumetric and density samples, shall be retained for the engineer for a minimum of 7 production days after testing has been completed unless otherwise notified by the engineer. ~~seven days after the contractor's tests are complete and accepted unless otherwise instructed.~~ These samples shall be maintained in clean covered containers, without contamination, readily accessible to the engineer. The retained sample's identification shall consist of, but is not limited to:

(a) Time and date sampled.

(b) Product specification number.

(c) Type of sample, i.e. belt, bin, stockpile.

(d) Lot and sublot designation.

(e) Sampler/Tester.

(f) Project Job Number.

403.12.4 Temperature of Base and Air. The contractor shall monitor the environmental conditions that affect asphalt production and laydown operations. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

403.~~7~~12.5 Mixture Temperature. The contractor shall periodically record the temperature of the mix before it leaves the plant.
~~**7BA** Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.~~
403.~~7~~12.6 Mixture Moisture Content. The asphaltic concrete mixture, when sampled and tested in accordance with AASHTO T 329, shall not contain more than 0.5 percent moisture by weight of the mixture. In addition to the minimum frequency listed in the table, mixture moisture content shall be taken any time the aggregate stockpiles' moisture content is significantly changed.

403.~~7~~12.7 Mixture Gradation. The gradations of the total aggregate will be determined using AASHTO T 27 from samples taken from the hot bins on batch-type plants or continuous mixing plants or from the composite cold feed belt on drum mix

plants. The mixture gradation may be determined directly by using residual aggregate from the binder ignition process or by mathematical combination of the cold feed and recycled materials gradations. When the mathematical combination method is used, the RAS gradation shall be from the JMF and RAP gradation from the ignition or extraction residual aggregate. Mixtures as produced shall be subject to the maximum tolerance in the table below.

Sieve Size	Percent Passing by Weight Tolerance						
	SP095SM	SP125SM	SP048	SP095	SP125	SP190	SP250
3/4 inch	-	-	-	-	-	-	0 - 92
1/2 inch		JMF ±4				0 - 92	
3/8 inch	JMF ±4	JMF ±4			0 - 92	-	
No. 4	JMF ±3	JMF ±3		0 - 92	-		
No. 8	JMF ±3	JMF ±3	0 - 92	30 - 69	26 - 60	21 - 51	17 - 47
N0. 16	-	-	28 - 62	-	-	-	-
No. 200	JMF ±2	JMF ±2	7 - 12	2 - 10	2 - 10	2 - 8	1 - 7

403.~~7~~12.8 Aggregate Deleterious The deleterious content of the total aggregate shall be determined using AASHTO T 11 from samples taken from the composite cold feed belt. The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in Sec 1002.2.

403.~~7~~12.9 Aggregate Consensus Properties. Aggregate properties include fine aggregate angularity (FAA), course aggregate angularity (CAA), sand equivalent, and thin, elongated particles as defined in Sec 490 on the composite cold feed belt aggregate shall be as follows:

Design	FAA Minimum %	CAA w/One Fractured Faces Minimum %	CAA w/Two Fractured Faces Minimum %	Sand Equivalent Minimum %	Thin, Elongated 5:1 Particles Maximum %
F	-	50	-	35	12
E	38	70			
C	43	90	85		
B	43	95	95		

403.~~7~~12.10 Mixture Asphalt Content. All loose mix samples for determination asphalt binder content shall be taken from the roadway at random locations designated by the engineer. The quantity of asphalt binder determined by AASHTO T 308 tests on the final mixture shall be within ±0.3 percent of the approved job-mix formula. The aggregate correction factor shall be applied to ignition oven results. The ignition oven temperature shall match the temperature used to when determining the correction factor.

403.~~7~~12.11 Volumetric Properties. All loose mix samples for determination of volumetrics shall be taken from the roadway at random locations designated by the engineer. A volumetric properties including Voids in Coarse Aggregate (VCA), Voids in the Mineral Aggregate (VMA), Air Voids (Va), Voids Filled with Asphalt (VFA), Theoretical Maximum Specific Gravity (Gmm), and Mixture Bulk Specific Gravity (Gmb) shall be determined by the contractor. ~~Two gyratory specimens shall be compacted for each sublot and the average of the two specimens will be used to calculate the volumetrics of the sublot.~~ The ~~VMA, VFA, and air voids shall be determined from the gyratory compacted specimens. The VMA and air voids for the QLA shall be those calculated using the~~ combined bulk specific gravity (Gsb) of the aggregate as listed on the approved job mix formula shall be used in calculations~~, the average bulk specific gravity of the gyratory compacted specimens and the theoretical maximum specific gravity of the mixture determined for the sublot of material.~~ If the bin percentages have been altered, a new Gsb shall be calculated and used in volumetrics calculations. The aggregate content used for ~~the~~ calculations shall be that determined from field asphalt content testing ~~for that sublot.~~

403.~~7~~12.11.1 VCA. No acceptance criteria exist.

403.~~7~~12.11.2 VMA. The VMA shall be within – 0.5 and + 2.0 percent of the minimum required for each type of mixture at N_{des} gyrations in Sec. 490.

403.~~7~~12.11.3 Va. Air voids shall be within ±1.0 percent of the approved JMF at N_{des} gyrations. Any sublot of material with air voids in the compacted specimens less than 2.5 percent shall be removed and replaced with acceptable material by the contractor.

403.~~7~~12.11.4 VFA. No acceptance criteria exist.

403.~~7~~12.11.5 Gmm. No acceptance criteria exist. Gmm shall be determined in accordance with Sec 490.9

403.~~19.3.1.1~~7~~2~~.11.6~~3~~ ~~Mixture Bulk Specific Gravity~~Gmb. ~~-~~ Two gyratory specimens shall be compacted for each sample and the average of the two specimens will be used. ~~-~~Bulk specific gravity shall be determined as specified in Sec 490.

~~When the water absorption of any aggregate fraction is greater than 2.0 percent, the test method for determining theoretical maximum specific gravity, AASHTO T 209, shall be modified as follows: After completing the procedure in accordance with Section 9.5.1 or 9.5.2, drain water from the sample. To prevent loss of fine particles, decant the water through a paper towel held over the top of the container. Spread the sample before an electric fan to remove surface moisture. Weigh at 15-minute intervals, and when the loss in mass is less than 0.05 percent for this interval, the sample may be considered to be surface dry. This procedure requires about 2 hours and shall be accompanied by intermittent stirring of the sample. Break conglomerations of mixture by hand. Take care to prevent loss of particles of mixture. Calculate the specific gravity of the sample by substituting the final surface-dry mass for A in denominator of Equations 2 or 3.~~

403.~~7~~12.12 RAP Gradation The contractor shall test the residual aggregate from the RAP %AC testing to determine its gradation..

403.~~7~~12.13 RAP Asphalt Content. RAP shall be sampled from the RAP feeding system on the asphalt plant. Solvent extraction or binder ignition methods shall be used to determine RAP asphalt contents. If AASHTO T 308 is used to determine the asphalt content, the binder ignition oven shall be calibrated in accordance with MoDOT Test Method TM 77.

~~T~~ **403.~~7~~12.14 RAP Durability.** All RAP material not from MoDOT roadway shall be tested in accordance with AASHTO T 327, Method of Resistance of Coarse Aggregate Degradation by Abrasion in the Micro-Deval Apparatus. Samples of RAP for this test shall have the asphalt coating removed either by extraction or binder ignition.. The RAP percent loss shall not exceed the loss of the combined virgin material by more than five percent.

403.~~7~~12.15 RAS Maximum Size. The contractor shall test shingle material being incorporated into the mixture to ensure that 100% passes a 3/8" sieve. The sample for this test shall be taken from the feed to the plant. The test may be performed on either raw RAS material or residual material from an extraction or ignition process.

403.~~7~~12.16 Moisture Susceptibility. Loose mix samples for determination of Tensile Strength Ratio (TSR) may be taken from the roadway or at the plant at random tonnages designated by the engineer. The TSR shall be greater than or equal to 75 percent as determined from loose mixture tested in accordance with AASHTO T 283.

403.~~7~~12.17 Surface Smoothness. ~~The finish of the pavement surface shall be substantially free from waves or irregularities and shall be true to the established crown and grade. The pavement surface shall be thoroughly tested for smoothness by profiling or straighedging in accordance with Sec 610.~~ See Sec 610 for additional details.

403.~~7~~12.~~19~~18 Lift Thickness. The finished courses shall have the nominal thickness shown on the plans. Lift thickness shall be determined by the average thickness of pavement density cores taken for each lot. The thickness of the layer to be tested shall be measured on all pavement and joint density cores.

403.~~17~~12.~~18x~~19.~~ Full Depth Thickness. When a full depth pavement is being constructed the following shall apply.
Total thickness samples for new full depth asphalt pavements shall be obtained after all bituminous construction is completed on the project. Full depth pavement cores shall be measured in accordance with AASHTO T 148. Sections of any pavement determined to be less than the thickness shown on the plans by 0.5 inches or more shall be corrected by the contractor. No payment will be made for any costs incurred by the contractor in correcting pavement deficient in thickness. Each core is representative of the pavement thickness for a distance extending one-half the distance to the next core, measured along centerline, or in the case of a beginning or ending core, the distance will extend to the end of the pavement.

403.~~17~~125.~~18~~ ~~20 Density Measurement~~Pavement Density. The contractor shall cut core samples at locations designated by the engineer. The final, in-place density shall be 94.5 ± 2.5 percent for all mixtures except SMA. SMA mixtures shall have a minimum density of 94.0 percent. Any sublot of material with a pavement density of less than 90.0 percent or greater than 98.0 percent shall be removed and replaced with acceptable material by the contractor. For SMA mixtures, any sublot of material with a pavement density of less than 92.0 percent shall be removed and replaced with acceptable material by the contractor.

403.~~7~~12.~~18~~20.1 Bulk specific gravity shall be determined as specified in Sec 490. The Gmm of production material corresponding with the core being tested shall be used to determine the percent density. All cores shall be a minimum of 4" diameter. Material from underlying layers that remain adhered to the core shall be removed in a manner that does not harm the integrity of the specimen.

403.~~7~~12.~~18~~20.2 A pavement density sample may consist of between one and three cores as stated in the QC plan. When multiple cores are used, the second and third cores shall be obtained at the same offset within one foot of the randomly selected location. The average of the cores cut shall represent the density for that sublot.

403.~~7~~12.~~18~~20.3 For lift thicknesses greater than six times the nominal maximum aggregate size, cores shall be cut in half and the density of each half determined. The lowest percent density from both halves shall count for acceptance and pay adjustments.

403.~~7~~12.~~18~~20.4 Measurements for determining the in-place density of the mixture shall be taken no later than the day following placement. ~~Measurements not obtained within the prescribed time limits shall be subject to the requirements of Sec 403.20. If a core is taken, material from underlying layers that remain adhered to the core shall be removed in a manner that does not harm the integrity of the specimen. If the contractor elects to place a lift of mixture greater than six times the nominal maximum aggregate size, cores shall be cut in half and the density of each half determined separately.~~

403.~~7~~12.~~20~~21 Unconfined Joint Density The final, in-place density ~~The minimum density~~ of all traveled way pavement within 6 inches of a longitudinal joint, including the pavement on the traveled way side of the shoulder joint when unconfined during placement, shall not be less than ~~2.0 percent below the specified density when unconfined~~88 percent for non-SMA mixtures and 90 percent for SMA mixtures. ~~The density of the longitudinal joint when confined will be included in the evaluation of the remainder of the mat.~~Testing and handling of joint cores shall be the same as pavement density cores.

403.~~17~~12.~~21~~ 22 Segregation Limits. ~~In situations where there is a dispute in the existence of segregation, the a~~Areas in question will be tested in accordance with MoDOT Test Method TM 75. QC shall ensure MoDOT has the opportunity to witness TM 75 being performed.

403.12.23 Binder Quality. The contractor shall ensure the binder is handled and stored in a manner that does not affect its quality. When the contractor is modifying the binder after delivery, additional quality control requirements apply. QC shall either assist QA in taking samples or obtain the QA sample in the inspector's absence.

403.18~~8~~3 Quality Assurance. The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor.

~~All QA field inspection, sampling and testing will be performed by a qualified MoDOT technician. The QA inspector shall have free access to any and all testing equipment used by the mixture producer and any workbooks, records or control charts maintained by the mixture producer for the QC process. The QA inspector shall also have sufficient access to the plant grounds to assure compliance with the approved QC Plan.~~

403.1~~8~~13~~8~~.1 ~~Assurance Testing~~Independent QA Samples. ~~The engineer will independently sample and test the mixture from the roadway at the frequency listed in . The~~ QA independent samples will be of sufficient size to retain half for possible disputes. Further testing of QA retained material will be under the direction of the engineer. ~~The retained portion of the QC samples for mixture properties, gradation, and deleterious content will be tested at a frequency no less than once per week.~~ The engineer's test results, including all raw data, will be made available to the contractor when completed and no later than the next working day. For volumetric properties, pavement density, and mixture asphalt content favorable comparison will be obtained when the engineer's QA test results are within two standard deviations, or one-half the specification tolerance, whichever is greater, from the mean of the QC's results for that particular lot. For all other independent QA samples, a favorable comparison will be obtained when QA samples meet the same specification criteria as QC.

403.~~8~~13.2 Split QA Samples. QA will test samples split from QC samples as follows.

~~**403.18.2 Core Chain of Custody.** QA density cores that are not in possession of the engineer for the entire time from extraction till testing shall be sealed in tamper proof bags after extraction.~~

403.18~~8~~3.2.1~~3 Aggregate~~Gradation Comparison. A favorable mixture gradation comparison shall be obtained when QA is within the below ranges of QCs result. ~~Comparison for aggregate will be considered favorable when the contractor's QC results and the engineer's QA test results of a retained sample compare within the following limits.~~

~~**403.18.3.1 Gradation.**~~

~~Sieve Size~~	~~Percentage Points~~Range
~~3/4 inch and larger~~	~~5.0~~
1/2 inch and larger	±5.0%~~5.0~~

3/8 inch	±4.0%~~4.0~~
No. 4	±4.0%~~4.0~~
No. 8	±3.0%~~3.0~~
No. 10	±3.0%~~3.0~~
No. 16	±3.0%~~3.0~~
No. 20	±3.0%~~3.0~~
No. 30	±3.0%~~3.0~~
No. 40	±2.0%~~2.0~~
No. 50	±2.0%~~2.0~~
No. 100	±2.0%~~2.0~~
No. 200	±1.0%~~1.0~~

403.~~8~~13.2.2 Mixture Asphalt Content Comparison. A favorable comparison of mixture asphalt content shall be obtained when QA is within ±0.1% of QC.

403.~~8~~13.2.3 Volumetric Properties Comparison. A favorable comparison of volumetric properties shall be obtained when QA is within ±0.005 of QC's Gmm and within ±0.010 of QC's Gmb

~~403.18138.2.3.42 Coarse Aggregate~~Aggregate Consensus. ~~Angularity~~Comparison. A favorable comparison for virgin aggregate ~~Angular particles shall~~properties shall be obtained when QA is within the range of QC's results listed in the following chart.

Property	Course Aggregate Angularity	Fine Aggregate Angularity	Sand Equivalent	Thin, Elongated Particles
Range	±5%	±5%	±8%	±1%

~~5 percentage points.~~

~~**403.18.3.3 Fine Aggregate Angularity.** Void content shall be within 2 percentage points.~~

~~**403.18.3.4 Sand Equivalent.** Sand equivalency shall be within 8 percentage points.~~

~~**403.18.3.5 Thin, Elongated Particles.** Flat, elongated particle content shall be within one percentage point.~~

403.~~18~~13.2.5~~8.3.6 Deleterious~~ Comparison. ~~The total and individual~~A favorable comparison for virgin aggregate ~~deleterious~~ content shall ~~not~~be obtained when the QA is within one half the Sec 1002.2 requirements of the QC results.

403.~~8~~13.3 Contractor Responsibility for QA Cores. QA density cores that are not in possession of the engineer for the entire time from extraction till testing shall be sealed in tamper proof bags after extraction. QA cores shall be cut and delivered to the engineer no later than the end of the next day following the laydown operation.

~~**403.18.4 Federal Highway Administration Requirements.** Performance and acceptance of QC/QA testing under these specifications shall not eliminate any FHWA requirements for acceptance of the material.~~

403.19~~9~~4.3 ~~Test and Pay Factor Items~~QC/QA Frequency Table. ~~As a minimum, the contractor and engineer shall test in accordance with the following table. Where multiple test methods are allowed, the contractor shall designate the test method to be used in the QC Plan. Final payment will be based on the indicated pay factor items.~~

Tested Property	~~Contractor~~QC Frequency	~~Engineer~~QA Frequency		QC Small Quantity Frequency
		Independent Samples	Split Samples	
~~Mixture temperature~~Temperature of Base and Air	As Needed~~1/Sublot~~	As Needed ~~1/day~~		As Needed
Mixture Temperature ~~Temperature of base and air~~	1 ~~As needed~~per Sublot	1 ~~As needed~~per Day	-	1 per Day
~~Mat Density (%~~	1 per Week~~1~~	1 per Project ~~1~~		-

of theoretical maximum density) by contractor Mixture MoistureUnconfined Joint Density	Sample[b]/Sublot	Sample/4 Sublots		
Cold feed or hot bin gradation andMixture Gradation deleterious content	1/2 Sublots1 per 2 Sublots	1/4 Sublots1 per 4 Sublots	1 per Week	1 per 750 Tons
Aggregate Deleterious				-
Aggregate Consensus Properties FAA, CAA, Clay Content and Thin, Elongated Particles from material sampled from the cold feed or hot bin	1 per /10,000 tTons with a minimum of 1/project/mix type	-1/project	1 per Project	
Mixture Asphalt contentAsphalt Content	1 per /Sublot 1/4 Sublots	1 per /4 Sublots 1/project	1 per Week	1 per 750 Tons
Volumetric PropertiesAsphalt content of RAP				
RAP Gradation	1 per 4 Sublots	1 per Project	-	-
RAP Asphalt Content				
RAP Durability	1 per 10,000 Tons			
RAS Maximum Size	1 per 10,000 Tons	1 per Project		
TSR of the in place mixtureMoisture Susceptibility	1/ per 10,000 Tons or fraction thereof	1/ per 50,000 Tons or 1/project combination		1 per Project
Surface Smoothness	Per Section 610			
Lift Thickness	1 per QC Core	1 per QA Core	-	1 per QC Core
Full Depth Thickness	1 per 1000 Feet[2]	1 per 5000'5000 Feet		1 per 1000 Feet[2]
Pavement Density	1 per Sublot	1 per 4 Sublots		1 per Day
Unconfined Joint Density	1 per Sublot	1 per 4 QC coresCores		1 per Day
Segregation Limits	As Needed	As Needed		As Needed
Binder Quality	-	1 per Day		-

[a]Based on the average of a minimum of two compacted specimens.
[b]Core samples shall consist of one core. Up to two additional cores, as stated in the QC Plan, may be obtained at the same offset within one foot of the randomly selected location. If more than one core is obtained, all cores shall be combined into one sample.
[c]Payment will be based on the table in Sec 403.23.5.
[d]Other methods may be approved by establishing correction factors for RAP from the same source.
[e]AASHTO T 331 may be substituted for AASHTO T 166.

403.17.1 Quality Control Operations. The contractor shall maintain equipment and qualified personnel to perform all QC field inspection, sampling and testing as required by this specification. All contractor personnel included in the QC operation shall be qualified by the MoDOT Technician Certification Program. Under no circumstances will unqualified personnel be allowed to perform QC sampling or testing. Personnel will be disqualified if acceptable methods and procedures are not followed.

403.17.1.1 Asphalt Test Results. The contractor shall record all test results and furnish a copy, including all raw data, to the engineer no later than the beginning of the day following the test. The contractor shall maintain all test results in an organized format and shall be available to the QA inspector at all times. Scale readings and other measurements not directly recorded by

electronic media shall be recorded in an organized format. Printouts from gyratory compactors and asphalt content devices shall be retained as part of the testing records.

403.17.2 Bituminous Quality Control Plan. Prior to approval of the trial mix design by the engineer, the contractor shall submit a QC Plan to Construction and Materials for approval. The QC Plan shall include:

(a) The contractor representative in charge of QC and the project level representative if different from the contractor representative. Contact information should be recorded for these individuals.

(b) Lot and sublot sizes and how they will be designated.

(c) The test method for determining asphalt content and number of cores to be cut for density determination.
(d) A proposed independent third party name, contact, address, and phone number for dispute resolution.

403.17.2.1 Third Party. The third party shall be independent of the contractor, MoDOT consultants and all project subcontractors or suppliers on each specific project. All testing of material for dispute resolution shall be performed by an approved laboratory. Approved laboratories shall be AASHTO Accreditation Program certified in the areas of the material being tested.

403.17.2.2 Plant Calibration. Plant calibration shall be performed by the contractor in accordance with , and records shall be made available to the engineer.

403.17.2.3 Retained Samples. All samples taken by the contractor, including but not limited to tested aggregate, volumetric and density samples, shall be retained for the engineer for a minimum of seven days after the contractor's tests are complete and accepted unless otherwise instructed. These samples shall be maintained in clean covered containers, without contamination, readily accessible to the engineer. The retained sample's identification shall consist of, but is not limited to:

(a) Time and date sampled.

(b) Product specification number.

(c) Type of sample, i.e. belt, bin, stockpile.

(d) Lot and sublot designation.

(e) Sampler/Tester.

(f) Project Job Number.

403.17.2.3.1 Gradation and Deleterious Content Samples. For each gradation and deleterious sample taken, the contractor shall retain for the engineer, the portion of the sample not tested after reducing the original sample to testing size.

403.17.2.3.2 Loose Mix Sample. All loose mix samples for determination of volumetrics, asphalt binder content and TSR shall be taken from the roadway at random locations designated by the engineer. A companion loose mix sample shall be taken, identified and retained for the engineer.

403.17.3 Quality Control Laboratory. All QC mixture testing shall be performed in an approved laboratory.

403.17.3.1 Calibration Schedule. The contractor shall calibrate or verify all significant test equipment associated with tests covered in this specification. Intervals as set by the contractor shall not exceed the following limits:

Equipment – Test Method (AASHTO)	**Requirement**	**Interval (Month)**
Gyratory Compactor - T 312	Calibrate – 1.16 ± .02° internal angle	12[a]
Gyratory Compactor – T 312	Verify	Daily
Gyratory Molds - T 312	Check Critical Dimensions	12
Thermometers - T 209, T 166, T 312	Calibrate	6
Vacuum System – T 209	Check Pressure	12
Pycnometer (Flask) - T 209	Calibrate	Daily
Binder Ignition Oven – T 308	Verify	12[b]
Nuclear Content Gauge – T 287	Drift & Stability – Manuf.	1

or MoDOT TM 54	Recommendation	
Mechanical Shakers - T 27	Check Sieving Thoroughness	12
Sieves	Check Physical Condition	6
Weighted Foot Assembly - T 176	Check Weight	12
Mechanical Shaker - T 176	Check Rate & Length of Throw	12
Liquid Limit Device - T 89	Check Wear & Critical Dimensions	12
Grooving Tool - T 89	Check Critical Dimensions	12
Ovens	Verify Temp. Settings	4
Balances	Verify	12[b]
Timers	Check Accuracy	6

[a] Calibrate and/or verify after each move.
[b] Verify after each move.

403.17.3.1.1 Inventory. An inventory of all major sampling, testing, calibration and verification equipment, including the serial number or other identifying number shall be maintained.

403.17.3.1.2 Calibration Records. Calibration and verification records shall include but are not limited to:

(a) Detailed results of the work performed (dimensions, mass, force, temperature, etc.)

(b) Description of the equipment calibrated including identifying number.

(c) Date the work was performed.

(d) Identification of the individual performing the work.

(e) Identification of the calibration or verification procedure used.

(f) The previous calibration or verification date and next due date.

(g) Identification of any in-house calibration or verification device used (including identification to establish traceability of items such as standard masses, proving rings, standard thermometers, balances, etc.).

403.17.3.2 Record Retention. Test records shall be maintained to permit verification of any test report. Records pertaining to testing, equipment calibration and verification, test reports, internal quality systems review, proficiency sample testing, test technician training and evaluation and personnel shall be retained in a secure location for a minimum of three years.

403.17.3.3 Test Method Availability. A current copy of all test methods and procedures shall be maintained in the QC laboratory at all times for reference by the technicians. Examples of report formats and procedures may be found in AASHTO R 18.

403.18 Quality Assurance. All QA field inspection, sampling and testing will be performed by a qualified MoDOT technician. The QA inspector shall have free access to any and all testing equipment used by the mixture producer and any workbooks, records or control charts maintained by the mixture producer for the QC process. The QA inspector shall also have sufficient access to the plant grounds to assure compliance with the approved QC Plan.

403.18.1 Assurance Testing. The engineer will independently sample and test the mixture from the roadway at the frequency listed in . The independent sample will be of sufficient size to retain half for possible disputes. Further testing of this sample will be under the direction of the engineer. The retained portion of the QC samples for mixture properties, gradation, and deleterious content will be tested at a frequency no less than once per week. The engineer's test results, including all raw data, will be made available to the contractor when completed and no later than the next working day.

403.18.2 Core Chain of Custody. QA density cores that are not in possession of the engineer for the entire time from extraction till testing shall be sealed in tamper proof bags after extraction.

403.18.3 Aggregate Comparison. Comparison for aggregate will be considered favorable when the contractor's QC results and the engineer's QA test results of a retained sample compare within the following limits.

403.18.3.1 Gradation.

Sieve Size	Percentage Points
3/4 inch and larger	5.0
1/2 inch	5.0
3/8 inch	4.0
No. 4	4.0
No. 8	3.0
No. 10	3.0
No. 16	3.0
No. 20	3.0
No. 30	3.0
No. 40	2.0
No. 50	2.0
No. 100	2.0
No. 200	1.0

403.18.3.2 Coarse Aggregate Angularity. Angular particles shall be within 5 percentage points.

403.18.3.3 Fine Aggregate Angularity. Void content shall be within 2 percentage points.

403.18.3.4 Sand Equivalent. Sand equivalency shall be within 8 percentage points.

403.18.3.5 Thin, Elongated Particles. Flat, elongated particle content shall be within one percentage point.

403.18.3.6 Deleterious. The total and individual deleterious content shall not exceed the specification limits.

403.18.4 Federal Highway Administration Requirements. Performance and acceptance of QC/QA testing under these specifications shall not eliminate any FHWA requirements for acceptance of the material.

403.19 Acceptance of Material. Acceptance of bituminous mixture will be based on lots. Material will be sampled from the roadway behind the paver in lots or sublots on a random basis through the use of a random number system and evaluated using a Quality Level Analysis (QLA). A QLA will determine payment based on a combination of the total PWL (PWLt) determined for each pay factor item for each lot of material produced.

403.19.1 Random Numbers. The engineer will generate random numbers.

403.19.2 Lots. The lot size shall be designated in the contractor's QC Plan. Each lot shall contain no less than four sublots with a maximum sublot size of 1,000 tons. Sublots from incomplete lots shall be combined with the previous complete lot for determination of pay factors. When no previous lot exists, the mixture shall be treated in accordance with Sec 403.23.7.4.1. A new lot shall begin when the asphalt content of a mixture is adjusted in accordance with Sec 403.11.

403.19.3 Test and Pay Factor Items. As a minimum, the contractor and engineer shall test in accordance with the following table. Where multiple test methods are allowed, the contractor shall designate the test method to be used in the QC Plan. Final payment will be based on the indicated pay factor items.

Tested Property	Pay Factor	Test Method	Contractor Frequency	Engineer Frequency
Mixture temperature	No	---	1/Sublot	1/day
Temperature of base and air	No	---	As needed	As needed
Mat Density (% of theoretical maximum density) by contractor	Yes	MoDOT Test Method TM-41 or AASHTO T 166[e]	1 Sample[b]/Sublot As needed for joints & shoulders.	1 Sample/4 Sublots
Unconfined Joint Density	No	MoDOT Test Method TM-41 or	1 Sample[b]/Sublot	1 Sample/4 Sublots

		AASHTO T 166[e]		
Cold feed or hot bin gradation and deleterious content	No	AASHTO T 27 and AASHTO T 11	1/2 Sublots	1/4 Sublots
Ground shingles	No	AASHTO T 27	1/10,000 tons with a minimum of 1/project	1/project
FAA, CAA, Clay Content and Thin, Elongated Particles from material sampled from the cold feed or hot bin	No	AASHTO T 304, ASTM D 5821, AASHTO T 176 and ASTM D 4791	1/10,000 tons with a minimum of 1/project/mix type	1/project
Asphalt content	Yes	AASHTO T 164, or MoDOT Test Method TM-54, or AASHTO T 287, or AASHTO T 308	1/Sublot	1/4 Sublots
Asphalt content of RAP	No	AASHTO T 164[d]	1/4 Sublots	1/project
VMA @ N_{des} gyrations	Yes[a]	AASHTO T 312 and R 35[e]	1/Sublot	1/4 Sublots
V_a @ N_{des} gyrations	Yes[a]	AASHTO T 312 and R 35[e]	1/Sublot	1/4 Sublots
VFA @ N_{des} gyrations	No[a]	AASHTO T 312 and R 35[e]	1/Sublot	1/4 Sublots
Theo. max SG of the mixture	No	AASHTO T 209	1/Sublot	1/4 Sublots
TSR of the in place mixture	No[c]	AASHTO T 283	1/10,000 Tons or fraction thereof	1/50,000 Tons or 1/project combination

[a]Based on the average of a minimum of two compacted specimens.
[b]Core samples shall consist of one core. Up to two additional cores, as stated in the QC Plan, may be obtained at the same offset within one foot of the randomly selected location. If more than one core is obtained, all cores shall be combined into one sample.
[c]Payment will be based on the table in Sec 403.23.5.
[d]Other methods may be approved by establishing correction factors for RAP from the same source.
[e]AASHTO T 331 may be substituted for AASHTO T 166.

403.19.3.1 Test Method Modification.

403.19.3.1.1 Binder Ignition Modification. Asphalt content determination in accordance with AASHTO T 308, Section 6.9.1 shall be modified by adding the following: If the calibration factor exceeds 1.0 percent, lower the test temperature to 800 ± 8 F and repeat test. Use the calibration factor obtained at 800 F even if it exceeds 1.0 percent. If RAP is used, the binder ignition oven shall be calibrated in accordance with MoDOT Test Method TM 77. At the engineer's discretion, testing may be waived when production does not exceed 200 tons per day. The contractor shall certify the proper proportions of a previously proven mixture were used.

403.19.3.1.2 Rice Test. When the water absorption of any aggregate fraction is greater than 2.0 percent, the test method for determining theoretical maximum specific gravity, AASHTO T 209, shall be modified as follows: After completing the procedure in accordance with Section 9.5.1 or 9.5.2, drain water from the sample. To prevent loss of fine particles, decant the water through a paper towel held over the top of the container. Spread the sample before an electric fan to remove surface moisture. Weigh at 15-minute intervals, and when the loss in mass is less than 0.05 percent for this interval, the sample may be considered to be surface dry. This procedure requires about 2 hours and shall be accompanied by intermittent stirring of the sample. Break conglomerations of mixture by hand. Take care to prevent loss of particles of mixture. Calculate the specific gravity of the sample by substituting the final surface dry mass for A in denominator of Equations 2 or 3.

403.19.3.1.3 Mixture Bulk Specific Gravity. Determining bulk specific gravity using paraffin-coated specimens, AASHTO T 275, shall not be used when required by AASHTO T 166. Alternate methods are AASHTO T 331 and ASTM D1188. The surface of specimens prepared for testing by these methods may have the surface texture removed by sawing a minimal amount. Specimens shall be securely held in a jig or other clamping device to eliminate distortion and retain a face parallel to the original surface. Measurements for lift thickness shall be made prior to sawing.

403.19.3.2 Miscellaneous Applications.

403.19.3.2.1 Small Quantities. Small quantities are less than 4000 tons for each separate mixture. This applies to individual projects, individual projects in combination contracts or projects with short discontinuous sections. The contractor has the option to use all testing frequencies in accordance with Sec 403.19.3 or the following shall apply:

(a) A field laboratory will not be required for monitoring mixtures. All required QC and QA testing shall be performed in an approved laboratory.

(b) QC tests required in Sec 403.19.3 shall be performed at a frequency of no less than one per day if production does not exceed 750 tons and at a frequency of no less than two per day if production exceeds 750 tons. Independent or retained sample QA tests shall be performed at least once per 1500 tons, as indicated.

403.19.3.2.2 Base Widening and Entrances. For base widening mixture and entrance work, the following will apply:

(a) All base widening shall be constructed in accordance with Sec 401.7 and subsections.

(b) The minimum density of these mixtures shall be attained as specified herein, except, compaction may be performed in accordance with Sec 403.15.3.

403.19.4 Dispute Resolution. When there are significant discrepancies between the engineer's and the contractor's test results, dispute resolution procedures will be used.

403.19.4.1 Cease Work. The contractor's operations may be required to cease until the dispute is resolved if the test results indicate the mixture is subject to failure.

403.19.4.2 Third Party Resolution. The first step in dispute resolution will be to identify differences in procedures and correcting inappropriate procedures before moving to third party resolution. If that does not resolve the dispute, either the contractor or the engineer may request the approved QC Plan third party involvement. The recommendations of the approved third party shall be binding on both the engineer and contractor.

403.19.4.3 Third Party Payment. The contractor shall be responsible for the cost associated with the third party testing and resolution if the final result indicates the engineer's test results were correct. Likewise the Commission will be responsible for the cost associated with the third party testing and resolution when the final result indicates the contractor's results were correct.

403.19.4.4 Other Adjustments. The contractor shall not be entitled to any additional payment for costs incurred due to use of the dispute resolution procedures such as, but not limited to, those for delay, cessation of operations, costs to subcontractors, etc. The engineer may give consideration to adjustment of working days if warranted.

403.20 Surface Smoothness. The finish of the pavement surface shall be substantially free from waves or irregularities and shall be true to the established crown and grade. The pavement surface shall be thoroughly tested for smoothness by profiling or straighedging in accordance with Sec 610.

403.21 General Requirements.

403.21.1 Sequence of Operations. To reduce inconvenience to the traveling public during widening or surfacing, the contractor will not be permitted to place any final surface course until the base widening, the leveling course and the binder course have been completed throughout the entire combination of sections, unless otherwise authorized by the engineer. The proper condition of the base widening, the leveling course and the binder course, at the time of placing the surface course, shall be the contractor's responsibility.

403.21.2 Pavement Marking. If the contractor's work has obliterated the existing pavement marking on resurfacing projects open to through traffic, the pavement marking shall be replaced in accordance with Sec 620.

403.21.3 Surfaced Approaches. At locations designated in the contract or as specified by the engineer, approaches shall be primed in accordance with Sec 408 and surfaced with Type SP125 asphaltic concrete. The asphaltic concrete surface shall be placed in accordance with the details shown on the plans or as specified by the engineer. Approaches shall not be surfaced until

~~after the surface course adjacent to the entrance is completed. Any work required to condition and prepare the subgrade on the approaches will be at the contractor's expense.~~

~~**403.21.4 Filling Drain Basins.** If shown on the plans, existing drain basins shall be filled to the top of the lip with plant mix bituminous base course or asphaltic concrete from the pavement edge to the edge of the shoulder. Any difficulty or delay created by this requirement will be at the contractor's expense.~~

~~**403.21.5 Pavement Repairs (Blow-Ups).** A blow-up will be considered that area where excessive expansion has resulted in distress to the existing pavement. Blow ups occurring prior to the application of the tack coat on the existing surface will normally be repaired by the Commission. Blow-ups occurring after the application of the tack coat shall be repaired by the contractor by removing the distressed concrete and replacing the pavement in accordance with Sec 613.~~

403.~~22 20~~14 Method of Measurement.

403.~~2220~~14.1 Weight Determination. If a batch-type plant is used, t~~T~~he weight of the mixture will be determined from the batch weights ~~if a batch type plant is used, and will be determined~~. If other types of plants are used the weight will be determined ~~-~~by weighing each truck load on scales in accordance with ~~Sec 310~~ Sec 109. ~~if other types of plants are used.~~ Measurement will be made to the nearest 0.1 ton for the total tonnage of material accepted.

403.~~2220~~14.2 Full Depth.

403.~~2220~~14.2.1 The final driving surface area, for the full depth of the pavement, will be used as the area for all underlying bituminous lifts and will not include the additional quantity needed to construct the slope or edge treatment.

403.~~2220~~14.2.2 Final measurement of the completed pavement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of the pavement complete in place will be made to the nearest 0.1 square yard. The revision or correction will be computed and added to or deducted from the contract quantity.

403.~~2220~~14.3 Alternate Overlay.

403.~~2220~~14.3.1 Field Established Quantity. When bid as an alternate to a Portland cement concrete overlay, the contractor shall establish the existing roadway profile and set the final overlay profile. The engineer may adjust the final profile as needed. The tons of hot mix asphalt required will be determined by the engineer from the set or adjusted profile. This quantity will be the field established plan quantity.

403.~~20~~1422.3.2 Overlay Measurement. Final measurement of the completed pavement will be based on the field established plan quantity except for authorized changes during construction. The revision or correction will be computed and added to or deducted from the contract quantity. Measurement of the pavement complete in place will be made to the nearest 0.1 ton.

~~**403.22.4 Pavement Testing.** The finished courses shall have the nominal thickness shown on the plans. Tests will be conducted to ensure that each course is being constructed to proper thickness, composition and density. The contractor shall cut samples from any layer of the compacted mixture at locations designated by the engineer. QA samples shall be cut and delivered to the engineer no later than the end of the next day following the laydown operation. If the samples are not cut and delivered as stated, the asphaltic laydown operation may be suspended and a deduction of 5 percent per day of the contract unit price of the representative material may be applied, until samples are cut and delivered to the engineer. Samples may be obtained by either sawing or drilling 4 inch minimum diameter cores. Each sawed sample shall consist of a single piece of the pavement of the size designated by the engineer, but no larger than 12 inches square.~~

~~**403.22.4.1 Pavement Thickness.** Lift thickness may be determined by the average thickness of cores taken for density measurements for each lot. Total thickness samples for new full depth asphalt pavements shall be obtained after all bituminous construction is completed on the project and shall be taken at locations specified by the engineer. For the purpose of determining the constructed thickness of full depth pavement, cores shall be taken at random intervals in each traffic lane at the rate of one core per 1000 feet or increment thereof, or at any other locations as may be determined by the engineer and measured in accordance with AASHTO T 148. Sections of any asphaltic concrete determined to be 0.5 inches or more, less than the thickness shown on the plans, shall be corrected by the contractor. No payment will be made for any costs incurred by the contractor in correcting pavement deficient in thickness. Each core is representative of the pavement thickness for a distance extending one-half the distance to the next core, measured along centerline, or in the case of a beginning or ending core, the distance will extend to the end of the pavement.~~

~~**403.22.4.2 Surface Restoration.** The surface from which samples have been taken, including those for density measurements, shall be restored by the contractor with the mixture then being produced no later than the next day of plant operation, if~~

~~construction is still active. If bituminous construction has been completed, the surface from which samples have been taken shall be restored within 48 hours with an approved commercial mixture or with cold patch mixtures acceptable to the engineer.~~

403.~~23~~ 15~~1~~ Basis of Payment.

403.15~~123~~.1 Aggregate Variation. Due to possible variations in the specific gravity of the aggregates, the tonnage of mixture used may vary from the proposal quantities. No adjustment in contract unit price will be made because of such variation.

403.~~23~~15~~1~~.2 ~~Compacted~~ Pavement Density Samples. Payment for obtaining and delivering QA pavement density samples ~~of compacted mixture from the pavement and replacing the surface~~ will be made per sample at the fixed price specified in Sec 109. No direct payment will be made for QC samples ~~taken for QC testing~~.
If QA cores are not cut and delivered as required, the asphaltic laydown operation may be suspended and a deduction of 5 percent of the contract unit price of the representative material may be applied, until samples are cut and delivered to the engineer.

403.~~23~~15~~1~~.3 Payment for ~~Pavement Repairs (~~Blow-ups~~).~~ Payment for repairing blow-ups will be made in accordance with Sec 104.

403.~~23~~15~~1~~.4 Surface Smoothness Adjustment. The contract unit price for all mixes, except wedge or level course, will be adjusted in accordance with Sec 610.5. The contract unit prices for asphaltic concrete pavement will be considered full compensation for all materials entering into the construction of the pavement and for the cost of the smoothness testing and correction.

403.~~23~~15~~1~~.5 ~~Tensile Strength Retained~~Moisture Susceptibility Adjustment. The contract unit price of each 10,000 tons or fraction thereof for all mixtures shall be adjusted based on ~~TSR~~ moisture susceptibility according to the following:

TSR	~~Percent of Contract Price~~ Pay Factor
90% ~~and~~ or above	103
75-89%	100
70-74%	98
65-69%	97
<65%	Remove and Replace

403.15~~1~~.6 Superpave Adjustment. Each sublot of material shall have its contract unit price adjusted based off either the pay factor total or the unconfined joint density pay factor. The unconfined joint density pay factor shall only be used for lots where it is less than 100% and it is less than the pay factor total.
~~The engineer will make the QLA no more than 24 hours after receipt of the contractor's test results, by determining the PWLt for each designated pay factor item.~~**~~403.23.6 Density Adjustment.~~** ~~Pay adjustments due to longitudinal joint density will apply to the full width of the lane paved. The average of joint cores from each lot will determine specification compliance. Adjustments will be in accordance with Sec 403.23.7.4.1(b). If payment reductions are necessary, the lower adjusted contract unit price of the PWL or unconfined joint density adjustment will apply. Adjustments due to joint density will apply to the lot from which the cores are obtained.~~

~~**403.23.7 Percent Within Limits.** PWL will be based on the mean, standard deviation and quality index of each lot's test results. The upper PWL (PWL_u) and lower PWL (PWL_l) is determined from the table in Sec 502.15.8. Total percent within limits, PWL_t, is: $PWL_t = (PWL_u + PWL_l) - 100$.~~

~~The mean is: $x_a = (\sum x_i)/n$~~
~~Where: x_a = Average of the individual values being considered~~
~~$\sum x_i$ = The summation of all the individual values being considered~~
~~n = The number of individual values under consideration~~

~~The Standard Deviation is: $s = (\sum(x_i - x_a)2/(n - 1))^{1/2}$~~
~~The Upper Quality Index is: $Qu = (USL - x_a)/s$~~
~~The Lower Quality Index is: $Q1 = (x_a - LSL)/s$~~

~~Where: Q_u = Upper Quality Index~~
~~Q_l = Lower Quality Index~~
~~USL = Pay Factor Item Upper Spec Limit~~
~~LSL = Pay Factor Item Lower Spec Limit~~

403.23.7.1 Quality Level Analysis. The engineer will make the QLA no more than 24 hours after receipt of the contractor's test results, by determining the PWLt for each designated pay factor item.

403.23.7.1.1 Acceptance. The contractor's test results will be used when applicable to determine the PWL, provided the contractor's QC tests and the engineer's QA tests compare favorably, and provided the engineer's inspection and monitoring activities indicate the contractor is following the approved QC Plan.

403.23.7.1.2 Comparison. Favorable comparison will be obtained when the engineer's QA test results on a production sample are within two standard deviations, or one-half the specification tolerance, whichever is greater, from the mean of the contractor's test results for that particular lot.

403.23.7.1.3 Outliers. No test result shall be discarded, except individual test results on a lot basis may be checked for an outlier in accordance with the statistic T in ASTM E 178, at a significance level of 5 percent. If an outlier is found, material from the retained QA sample may be tested, in the presence of the engineer, to determine a replacement test value. The replacement test value shall be used in the PWL determination.

403.23.7.1.4 Roadway/Shoulder Lots. For the purpose of QLA, mixture placed on the traveled way and placed on the traveled way and shoulders integrally, shall be accounted for in a regular lot/sublot routine. Mixture placed on shoulders only shall be accounted for in a shoulder lot/sublot routine.

403.23.7.1.5 Random Sampling. For the purpose of QLA, all mixture placed on the roadway shall be subject to random testing, except mixture placed within 6 inches of an unconfined longitudinal joint shall not be subject to evaluation. Random samples taken in the same day may be separated by 200 tons.

403.~~21~~15.6~~3.7~~.1~~2~~ Pay Factor Total. The engineer will make the QLA no more than 24 hours after receipt of the contractor's test results, by determining the PWLt for each designated pay factor item. All lots of material with a PF_T less than 50.0 shall be removed and replaced with acceptable material by the contractor. **~~Pay Factors.~~** The total pay factor (PF_T) ~~for each lot~~ will be equal to the weighted sum of the pay factors ~~(PF)~~ for each pay factor item ~~for each lot~~, and is determined as follows:

$$PF_T = + (0.25)\ PF_{\text{Mixture \%A}\sim\text{C}} + (0.25)\ PF_{\text{VMA}} + (0.25)\ PF_{\text{Va}} + (0.25)\ PF_{\text{Pavement D}\sim\text{ensity}}$$

The PF_T ~~for each lot,~~ on the shoulder or otherwise when the density PWL pay factor is not directly included, ~~will~~shall be equal to the weighted sum of the PF for each pay factor item ~~for each lot~~, and will be determined as follows:

$$PF_T = + (0.3333)\ PF_{\text{Mixture \%A}\sim\text{C}} + (0.3333)\ PF_{\text{VMA}} + (0.3333)\ PF_{\text{Va}}$$

The PF for each pay factor item ~~for each lot~~ will be based on the PWL_t of each pay factor item ~~of each lot~~ and will be determined as follows:

When PWL_t is greater than or equal to 70: $PF = 0.5\ PWL_t + 55$
When PWL_t is less than 70: $PF = 2\ PWL_t - 50$

403.23.7.2.2 Asphalt Content Pay Factor. The QLA will be performed using the asphalt content test results from each lot.

403.23.7.2.3 Voids in the Mineral Aggregate and Air Voids Pay Factor. Two gyratory specimens shall be compacted for each sublot and the average of the two specimens will be used to calculate the volumetrics of the sublot. The VMA, VFA, and air voids shall be determined from the gyratory compacted specimens. The VMA and air voids for the QLA shall be those calculated using the combined bulk specific gravity of the aggregate as listed on the approved job mix formula, the average bulk specific gravity of the gyratory compacted specimens and the theoretical maximum specific gravity of the mixture determined for the sublot of material. The aggregate content used for the calculation shall be that determined from field asphalt content testing for that sublot.

403.23.7.3 Removal of Material. ~~All lots of material with a PF_t less than 50.0 shall be removed and replaced with acceptable material by the contractor.~~ Any sublot of material with a percent of theoretical maximum density of less than 90.0 percent or greater than 98.0 percent shall be removed and replaced with acceptable material by the contractor. For SMA mixtures, any sublot of material with a percent of theoretical maximum density of less than 92.0 percent shall be removed and replaced with acceptable material by the contractor. Any sublot of material with air voids in the compacted specimens less than 2.5 percent shall be removed and replaced with acceptable material by the contractor. No additional payment will be made for such removal

~~and replacement. The replaced material will be tested at the frequencies listed in Sec 403.19. Pay for the material will be determined in accordance with the applicable portions of Sec 403.23 based on the replacement material.~~

403.15~~1~~.6.2 Unconfined Joint Density Pay Factor. The average of all unconfined joint cores from each lot will be used determine the unconfined joint density pay factor for sublots with an unconfined joint. The unconfined joint payfactor will be in accordance with the following:

For Non- SMA mixtures:		For SMA mixtures:	
Unconfined Joint Density	Pay Factor	Unconfined Joint Density	Pay Factor
98.0 or Above	Remove and Replace	92.0 or Above	100
97.6 to 97.9	80	91.5 to 91.9	90
97.1 to 97.5	90	91.0 to 91.4	85
90.0 to 97.0	100	90.5 to 90.9	80
89.5 to 89.9	90	90.0 to 90.4	75
89.0 to 89.4	85	Below 90.0	Remove and Replace
88.5 to 88.9	80	-	-
88.0 to 88.4	75		
Below 88.0	Remove and Replace		

~~**403.23.7.4 Miscellaneous Applications.**~~

403.~~21~~15.~~7.4.1~~7 ~~Small Quantities~~Density Adjustment. When QC/QA is in effect and pavement density is not included in the Superpave adjustment, the contract unit price shall be adjusted using the following density payfactor table. The density adjustment shall be applied to material represented by each pavement density sample.

~~Pay Factor (Percent of Contract Unit Price)~~			
For Non- SMA mixtures:		For SMA mixtures:	
Mixture Density	Pay Factor	Mixture Density	Pay Factor
98.0 or Above	Remove and Replace	94.0 or Above	100
97.6 to 98.0	80	93.5 to 93.9	90
97.1 to 97.5	90	93.0 to 93.4	85
92.0 to 97.0 ~~inclusive~~	100	92.5 to 92.9	80
91.5 to 91.9 ~~inclusive~~	90	92.0 to 92.4	75
91.0 to 91.4 ~~inclusive~~	85	Below 92.0	Remove and Replace
90.5 to 90.9 ~~inclusive~~	80	-	-
90.0 to 90.4 ~~inclusive~~	75		
Below 90.0	Remove and Replace		

~~>94.0~~	~~100~~
~~93.5 to 93.9 inclusive~~	~~90~~
~~93.0 to 93.4 inclusive~~	~~85~~
~~92.5 to 92.9 inclusive~~	~~80~~
~~92.0 to 92.4 inclusive~~	~~75~~
~~Below 92.0~~	~~Remove and Replace~~

403.15~~1~~.8 Removal and Replacement of Material. No additional payment will be made for removal and replacement of material when required by this specification. Replacement material will be subject to the same testing requirements as the original material. Pay for the replacement material will be determined in accordance with the applicable portions of this specification.

~~[a]Calibrate and/or verify after each move.~~

~~[b]Verify after each move.~~

~~**403.17.3.1.1 Inventory.** An inventory of all major sampling, testing, calibration and verification equipment, including the serial number or other identifying number shall be maintained.~~

~~**403.17.3.1.2 Calibration Records.** Calibration and verification records shall include but are not limited to:~~

~~(a) Detailed results of the work performed (dimensions, mass, force, temperature, etc.)~~

~~(b) Description of the equipment calibrated including identifying number.~~

~~(c) Date the work was performed.~~

~~(d) Identification of the individual performing the work.~~

~~(e) Identification of the calibration or verification procedure used.~~

~~(f) The previous calibration or verification date and next due date.~~

~~(g) Identification of any in-house calibration or verification device used (including identification to establish traceability of items such as standard masses, proving rings, standard thermometers, balances, etc.).~~

SECTION 413

SURFACE TREATMENTS

SECTION 413.10 MICRO-SURFACING.

413.10.1 Description. This work shall consist of producing and placing a mixture of cationic polymer-modified asphalt emulsions, mineral aggregate, mineral filler, water, and other additives as needed at locations shown on the plans or as directed by the engineer.

413.10.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Emulsified Asphalt	1015
Aggregate	1002

413.10.2.1 Aggregate.

413.10.2.1.1 The mineral aggregate shall be flint chat from the Joplin area, an approved crushed porphyry or an approved crushed steel slag. Blast furnace slag may be used from sources with a documented history of satisfactory use and that have been previously approved by MoDOT for use in micro-surfacing. For non-traffic areas such as shoulders, the mineral aggregate may be crushed limestone or crushed gravel in accordance with Sec 1002.2. The aggregate shall be free of cemented or conglomerated material and shall not have any coating or detrimental material. All aggregate shall be sampled, tested and approved by the engineer prior to use.

413.10.2.1.2 Blends of approved aggregate may be supplied provided:

(a) The individual aggregates are reasonably uniform in gradation and other qualities.

(b) The aggregates are uniformly blended with designated proportions into a separate stockpile prior to use. Aggregate may be blended directly into the supply truck provided the blending device has been calibrated, gate settings are unchanged, and belt samples indicate material gradation compliance.

(c) The proportion is not changed from the job mix formula during the course of placement.

413.10.2.1.3 The final aggregate, or blend of aggregates, shall be in accordance with one of the following gradations. In addition, the aggregate shall be ± 5 percent of the designated job mix gradation for all plus No. 200 material and within ± 2 percent for the minus No. 200 material.

~~Aggregate Gradation Requirements~~			
~~Type II~~		~~Type III/Type IIIR~~	
~~Sieve~~	~~Percent Passing~~	~~Sieve~~	~~Percent Passing~~
~~3/8 inch~~	~~100~~	~~3/8 inch~~	~~100~~
~~No. 4~~	~~90 - 100~~	~~No. 4~~	~~70 - 90~~
~~No. 8~~	~~65 - 90~~	~~No. 8~~	~~45 - 70~~
~~No. 16~~	~~45 - 70~~	~~No. 16~~	~~28 - 50~~
~~No. 30~~	~~30 - 50~~	~~No. 30~~	~~19 - 34~~
~~No. 50~~	~~18 - 30~~	~~No. 50~~	~~12 - 25~~
~~No. 100~~	~~10 - 21~~	~~No. 100~~	~~7 - 18~~
~~No. 200~~	~~5 - 15~~	~~No. 200~~	~~5 - 15~~

Aggregate Gradation Requirements		
Sieve	Type II	Type III Type IIIR
3/8 inch	≤ 100	≤ 100
No. 4	90 - 100	70 - 90
No. 8	65 - 90	45 - 70
No. 16	45 - 70	28 - 50
No. 30	30 - 50	19 - 34

No. 50	18 - 30	12 - 25
No. 100	10 - 21	7 - 18
No. 200	5 - 15	5 - 15

413.10.2.1.4 The final aggregate mixture shall have no oversize material when deposited at the stockpile site. If the stockpile area contains any particles exceeding the specified maximum sieve, all aggregate shall be screened again as the aggregate is loaded into the final placement machine.

413.10.2.2 Mineral Filler. Mineral filler shall be Type 1 Portland cement or hydrated lime, and shall be free of lumps or any other deleterious material. Portland cement and hydrated lime ~~may be~~ acceptance~~d for use based on~~ is by visual examination.

413.10.2.3 Water. Water shall be potable and free of harmful soluble salts.

413.10.2.4 Additives. Any other material added to the mixture or to any of the component materials to provide the required properties shall be supplied by the emulsion manufacturer.

~~**413.10.2.5. Material Acceptance.** All aggregate shall be sampled, tested and approved by the engineer prior to use. Portland cement and hydrated lime may be accepted for use based on visual examination.~~

413.10.3 Job Mix Formula. The manufacturer of the emulsion shall develop the job mix formula and shall present certified test results for the engineer's approval. The job mix formula shall be designed in accordance with the International Slurry Surfacing Association (ISSA) recommended standards by an ISSA recognized laboratory. Mix acceptance will be subject to satisfactory field performance. The job mix formula, all possible emulsion sources intended for use, all material, the methods and the proportions shall be submitted for approval prior to use. Proportions to be used shall be within the limits provided in the table below. If more than one aggregate is used, the aggregates shall be blended in designated proportions as indicated in the job mix formula, and those proportions shall be maintained throughout the placement process. If aggregate proportions are changed, a new job mix formula shall be submitted for approval.

Material	Requirement
Type II Mineral agg, lbs/yd^2 dry mass, min.	10 - 20
Type III Mineral agg, lbs/ yd^2 dry mass, min.	15 - 30
Type IIIR	As necessary
Polymer Modified Emulsion (residual), percent	5.5 to 10.5 by dry weight of aggregate
Mineral Filler, percent by mass of dry aggregate	0.0 to 3.0 by dry weight of aggregate
Additive	As required

413.10.3.1 All Types. The minimum dry mass per unit area will be based on a bulk specific gravity (BSG) of 2.65. In the event that crushed steel slag aggregate is used as a part of the blended aggregate or as the entire aggregate, the BSG of the final aggregate blend shall be determined and shown as part of the job mix formula criteria. If the BSG is different from 2.65 by more than 0.05, the above minimum masses shall be adjusted by dividing the specified unit mass by 2.65 and multiplying by the new BSG. (For example, for a slag BSG = 3.15, the new minimum would be 3.15/2.65 * 10.8 = 23.8 lbs./sy). These adjusted values shall be designated on the job mix formula and will apply in the field.

413.10.3.2 Type II. For Type II, if a specified thickness will be required, the amount of mineral aggregate per square yard shall be increased as necessary to obtain the thickness.

413.10.3.3 Type III. When specified, Type III shall be applied in two passes of approximately equal quantities, the first of which shall be to fill depressions and level the surface for the final pass.

413.10.3.4 Type IIIR. For Type IIIR mixes, there will be no minimum or maximum unit quantities. The contractor shall make the determination as to the amount necessary, except all depressed areas shall be filled level as specified. Type IIIR may be applied in more than one pass at the contractor's expense. Type IIIR shall not be added to Type II or Type III applications in the field, but shall be a separate application.

413.10.4 Equipment.

413.10.4.1 Mixing Equipment. The micro-surfacing mixture shall be mixed and laid by a self-propelled mixing machine. The mixing machine shall be able to accurately deliver and proportion the aggregate, mineral filler, water, additive and emulsion to a revolving multi-blade dual mixer and to discharge the thoroughly mixed product. The machine shall have sufficient storage capacity for all components to maintain an adequate supply to the proportioning controls.

413.10.4.1.1 Individual volume or weight controls for proportioning each item to be added to the mix shall be provided. Each material control device shall be calibrated and properly marked. The calibration shall be approved by the engineer prior to

proportion. Each device shall be accessible for ready calibration and placed such that the engineer may determine the amount of each material used at the time.

413.10.4.1.2 The mixing machine shall be equipped with a water pressure system and nozzle-type spray bar to provide a water spray to dampen the surface when required immediately ahead of and outside the spreader box as required. No free flowing water shall be present.

413.10.4.2 Spreading Equipment. The micro-surfacing mixture shall be spread uniformly by means of a mechanical-type spreader box attached to the mixer. The spreader box shall be equipped with paddles or augers to agitate and spread the material uniformly throughout the box. The paddles or augers shall be designed and operated so all the fresh mix will be agitated to prevent the mixture from setting up in the box, causing side buildup and lumps.

413.10.4.2.1 The spreader box used for surface course construction shall be equipped with flexible seals in contact with the road to prevent loss of mixture from the box. The box shall be equipped with devices to adjust the thickness or grade of the surface and shall have a squeegee strike-off rear plate.

413.10.4.2.2 A secondary strike-off shall be provided to improve surface texture. The secondary strike-off shall have the same adjustments as the spreader box.

413.10.4.2.3 The spreader box used for rut-filling shall have two metal strike-offs, angled from each side toward the center at approximately 45 degrees. Interrupted flight augers shall be used ahead of the first strike-off plate to spread the mix and maintain laminar flow. The second strike-off plate shall be adjusted to produce the desired grade and depth. The first strike-off and augers shall be adjustable up and down in order to maintain a fairly uniform flow or roll of material in front of the second strike-off. A rubber squeegee shall be attached to the adjustable metal plate at the rear of the spreader box, behind the second strike-off, to texture the surface. The adjustable metal plate shall have sufficient clearance not to affect the grade established by the second strike-off.

413.10.5 Construction Requirements.

413.10.5.14 Weather Limitations. Micro-surfacing shall not be placed when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 50 F, when it is raining, or when there is a chance of temperatures below 32 F within 24 hours after placement.

413.10.5.21 Test Strip. A test strip 500 feet long and the width of one lane shall be provided. The test strip will be evaluated for 24 hours after placement and will be subject to approval from the engineer before any further production. If unsatisfactory, the test strip shall be removed and another strip placed for evaluation at the contractor's expense.

413.10.5.32 Surface Preparation. The surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud, and other objectionable material and shall be pre-wetted as required immediately prior to application of the micro-surfacing. All pavement marking shall be removed, maintained, and compensated for in accordance to Sec 620.

413.10.5.34 Application. The micro-surfacing mixture shall be spread to fill cracks and minor surface irregularities, and shall leave a uniform surface. No lumping, balling or unmixed aggregate will be permitted. Longitudinal joints shall be placed on lane lines. Excessive overlap will not be permitted. The finished micro-surfacing shall have a uniform texture free of scratches, tears and other surface irregularities. The contractor shall repair the surface if any of the following conditions exist:

(a) More than one surface irregularity that is 1/4 inch or wider and 10 feet or longer in any 100-foot section of the micro-surfacing.

(b) More than three surface irregularities that are 1/2 inch or wider and more than 6 inches long in any 100-foot section of the micro-surfacing.

(c) Any surface irregularity that is one inch or wider and more than 4 inches long. The finished longitudinal and transverse joints in the micro-surfacing shall be complete and uniform.

413.10.5.43.1 The contractor shall repair joints if any of these conditions exist:

(a) Build-up of micro-surfacing material at the joints.

(b) Uncovered areas at the joints.

(c) Longitudinal joints with more than 1/2 inch vertical space between the surface and a 4-foot straightedge placed perpendicular to the joint.

(d) Transverse joints with more than 1/4 inch vertical space between the surface and a 4-foot straightedge placed perpendicular to the joint.

413.10.5.43.2 The edges of the micro-surfacing shall follow the centerline, lane lines, shoulder lines and curb lines. The edges shall be repaired if the edges vary more than 3 inches from a 100-foot straight line or from a 100-foot arc on a curved section. The repaired surface shall be dense with a uniform texture.

413.10.5.43.3 Any successive passes shall be separated such that each layer placed undergoes approximately 12 hours of traffic for compaction and curing.

413.10.5.43.4 Type IIIR applications to raise shoulders or fill ruts shall be applied with the rut spreader box, and the contractor shall place a strip as designated in the contract documents to raise an area to match the surroundings. Rutting or traffic-bearing applications, excluding shoulders, shall be crowned 1/8 to 1/4 inch per inch of depth, to allow for compaction. Shoulder applications shall drain and slope uniformly downward to the shoulder point. A Type II or Type III application may follow as a surface course if specified in the contract documents.

413.10.5.43.5 Micro-surfacing shall not be placed over steel expansion plates.

413.10.5.43.6 When micro-surfacing is placed on concrete, a tack coat shall be applied first in accordance with Sec 407 and shall be given adequate time to break.

413.10.5.43.7 The micro-surfacing shall permit traffic operations on a 1/2 inch thick surface within one hour after placement at 75 F and 50 percent humidity.

~~**413.10.5.4 Weather Limitations.** Micro-surfacing shall not be placed when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 50 F, when it is raining, or when there is a chance of temperatures below 32 F within 24 hours after placement. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.~~

413.10.5.5 Repair of Damaged Areas. Any traffic-damaged, marred areas or deficiencies as defined in Sec 413.10.5.4 shall be repaired by the contractor at the contractor's expense.

413.10.5.6 Incidental Construction. Areas that cannot be reached with the mixing machine shall be surfaced using hand squeegees to provide complete and uniform coverage. Utilities shall be protected from coverage by a suitable method. Work at intersections shall be done in stages, or blotter material shall be used to allow crossing or turning movements. Regardless of the method, no marred sections will be permitted.

413.10.6 Quality Control. The contractor shall control and monitor the quality of work.

413.10.6.1 Sample Location. Samples will be taken from the last stockpile location prior to incorporation.

413.10.6.2 Temperature of Air and Base. The contractor shall monitor the environmental conditions that affect microsurfacing production and laydown operations. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

413.10.6.3 Aggregate Gradation. The aggregate gradation shall ~~the aggregate shall~~ be within ± 5 percent of the designated job mix gradation for all plus No. 200 material and within ± 2 percent for the minus No. 200 material.

413.10.6.4 Emulsified Asphalt. A certification shall be reviewed by the contractor and supplied to the engineer. ~~once per shipment for emulsified asphalt.~~

413.10.7 Quality Assurance. The engineer or designated representative will be responsible for monitoring work and quality control efforts fo the contractor.

413.10.7.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when idependent QA samples meet the same specification criteria as QC.

413.10.7.2 Split QA Samples. No split samples required for microsurfacing.

413.10.8 QC/QA Frequency Table

Tested Property	QC Frequency	QA Frequency

		Independent Samples	Split Samples
Temperature of Base and Air	As Needed	As Needed	-
Aggregate Gradation	1 per 1000 Tons	1 per 5000 Tons	-
Emulsified Asphalt	1 per Shipment	1 per Project	-

413.10.96 Method of Measurement. Final measurement of completed Type II and Type III surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of Type II, Type III and Type IIIR micro-surfacing, complete in place, will be made to the nearest square yard. Final measurement of Type IIIR surface may be made as necessary to determine the actual areas placed. Field measurement will be based on the estimated width and length dimensions necessary to bring a designated area to a level plane, and not necessarily for the full rutted area. The revision or correction will be computed and added to or deducted from the contract quantity.

413.10.710 Basis of Payment. The accepted quantities of micro-surfacing will be paid for at the contract unit price for each of the pay items included in the contract. No additional payment will be made for removing and replacing test strips.

SECTION 413.20 SCRUB SEAL.

413.20.1 Description. This work shall consist of producing and placing a polymer modified asphalt (scrub seal) emulsion intended for use as a surface rejuvenation treatment and to fill and seal cracks.

413.20.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Aggregate[a]	1005.3
Emulsion	1015

[a]~~Aggregate substitutions may be allowed as approved by the engineer.~~

413.20.2.1 Aggregate Substitution. Aggregates not meeting Sec 1005.3 may be allowed as approved by the engineer.

413.20.3 Equipment.

413.20.3.1 Aggregate Spreader. The aggregate spreader shall be self-propelled and capable of evenly spreading aggregate.

413.20.3.2 Pneumatic Tire Roller. The pneumatic tire roller shall have a wetting system and be at least 10 tons..

413.20.3.3 Brooms. Brooms shall be capable of adequately scrubbing the mixture into the cracks and surface.

413.20.4 Construction Requirements.

413.20.4.15 Weather Limitations. The scrub seal emulsion shall not be placed on any wet surface or when the ambient temperature or the temperature of the pavement on which the mixture is to be placed is below 60° F. ~~Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.~~

413.20.4.21 Surface Preparation. The surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud and other objectionable material immediately prior to application of the scrub seal emulsion.

413.20.4.32 Application. The scrub seal emulsion shall be uniformly applied with a pressure distributor at the rate specified in the contract or as designated by the engineer. The mixture shall be spread to fill cracks and minor surface irregularities and shall leave a uniform surface.

413.20.4.43 Physical Characteristics for Scrub Seal Emulsion.

Properties	Minimum	Maximum
Application rate of emulsion, gallons/sq. yard[a]	0.18	0.22
Emulsion Temperature, F	110	160
Application rate of aggregate, lb./sy[a]	16	22
Time of set prior to opening, hours[b]	-	2

[a]Application rate may change, final decision will be made by the engineer.
[b]The final decision for opening will be made by the engineer.

413.20.4.54 Method of Placement. After proper surface preparation, a distributor truck shall place the scrub seal emulsion at the prescribed rate. The distributor truck shall pull the broom assembly to sweep and spread the emulsion uniformly on the surface and into the cracks of the pavement.

413.20.4.54.1 Fine aggregate shall be placed immediately after the application of the emulsion and prior to the emulsion breaking. Immediately following the aggregate spreader, a second broom assembly shall be pulled to combine the aggregate with the emulsion.

413.20.4.54.2 The pneumatic tire roller shall immediately follow the second broom and shall make a minimum of two passes.

413.20.4.54.3 All excess sand shall be removed from the roadway, paved shoulders and paved side roads within 24 hours of application or as directed by the engineer.

~~**413.20.4.5 Weather Limitations.** The scrub seal emulsion shall not be placed on any wet surface or when the ambient temperature or the temperature of the pavement on which the mixture is to be placed is below 60°F. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.~~

413.20.4.6 Damaged or Marred Areas. Any traffic damaged or marred areas shall be repaired by the contractor at the contractor's expense.

413.20.5 Quality Control. The contractor shall control and monitor the quality of work.

413.20.5.1 Sample Location. Samples will be taken from the last stockpile location prior to incorporation.

413.20.5.2 Temperature of Air and Base. The contractor shall monitor the environmental conditions that affect scrub seal production and laydown operations. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

413.20.5.3 Aggregate Gradation. The aggregate gradation shall comply with Sec 1005.3.

413.120.5.4 Emulsified Asphalt. A certification shall be supplied to the engineer once per shipment for emulsified asphalt.

413.20.6 Quality Assurance. The engineer or designated representative will be responsible for monitoring work and quality control efforts fo the contractor.

413.20.6.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when idependent QA samples meet the same specification criteria as QC.

413.20.6.2 Split QA Samples. No split samples required for scrub seals.

413.20.7 QC/QA Frequency Table

Tested Property	QC Frequency	QA Frequency	
		Independent Samples	Split Samples
Temperature of Base and Air	As Needed	As Needed	-
Aggregate Gradation	1 per 1000 ~~t~~Tons	1 per 5000 ~~t~~Tons	-
Emulsified Asphalt	1 per Shipment	1 per Project	-

413.20.~~5~~ 8 Method of Measurement. Final measurement of the completed surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of scrub seal emulsion and mineral aggregate, complete in place, including multiple passes or courses, will be made to the nearest square yard. Measurement of individual passes or courses will not be made. The revision or correction will be computed and added to or deducted from the contract quantity.

413.20.~~6~~ 9 Basis of Payment. The accepted quantity of scrub seal, in place, will be paid for at the contract unit price.

SECTION 413.30 ULTRATHIN BONDED ASPHALT WEARING SURFACE.

413.30.1 Description. This work shall consist of producing and placing an ultrathin bonded asphalt wearing surface.

413.30.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows, except as modified herein:

Item	Section
Bituminous Asphalt Mixtures	490
Coarse Aggregate	1002.2
Fine Aggregate	1002.3
Mineral Filler	1002.4
Asphalt Binder, Asphalt Emulsions	1015

~~**413.30.2.1 Coarse Aggregate.** Coarse aggregate may consist of crushed gravel, limestone, dolomite, porphyry, steel slag, flint chat, or blends of two or more of these aggregates will be acceptable. When coarse aggregate for these mixes are from more than one source or of more than one type of material, the coarse aggregate shall be proportioned and blended to provide a uniform mixture. Coarse aggregate shall be material predominantly retained above the No. 4 sieve and shall be in accordance with the following requirements:~~

~~Coarse Aggregate Modified Requirements~~			
~~Test~~	~~Method~~	~~Min.~~	~~Max.~~
~~Los Angeles Abrasion Value, % Loss[a]~~	~~AASHTO T 96~~	~~-~~	~~35~~
~~Soundness, % Loss, Sodium Sulfate[a]~~	~~AASHTO T 104~~	~~-~~	~~12~~
~~Flat & Elongated Ratio, % @ 3:1[b]~~	~~ASTM D 4791~~	~~-~~	~~25~~
~~% Crushed, single face[b]~~	~~ASTM D 5821~~	~~95~~	~~-~~
~~% Crushed, two faces[b]~~	~~ASTM D 5821~~	~~85~~	~~-~~
~~Micro-Deval, % loss[a]~~	~~AASHTO T 327~~	~~-~~	~~18~~

~~[a]Tests shall be determined on each individual ledge basis.~~
~~[b]Tested on the coarse portion of the blended aggregate~~

~~**413.30.2.2 Fine Aggregate.** Fine aggregate shall be material predominantly passing the No. 4 sieve and shall be in accordance with the following requirements:~~

~~Fine Aggregate Modified Requirements~~			
~~Tests~~	~~Method~~	~~Min~~	~~Max~~
~~Sand Equivalent[a]~~	~~AASHTO T 176~~	~~45~~	~~-~~
~~Methylene Blue[a]~~	~~AASHTO T 330~~	~~-~~	~~10~~
~~Uncompacted Void Content[a]~~	~~AASHTO T 304~~	~~40~~	~~-~~

~~[a]Tested on the fine portion of the blended aggregate~~

~~**413.30.2.3 Reclaimed Asphalt Pavement.** The RAP shall be in accordance with Sec 403.2.6 and shall have 100 percent passing the 3/8 inch and no less than 70 percent passing the No. 4 sieve. The mixture shall contain no less than 80 percent effective virgin binder.~~

~~**413.30.2.4 Asphalt Binder.** The asphalt binder shall be in accordance with Sec 1015, including all subsections pertaining to PG76-22.~~

413.30.2.1 Polymer Modified Emulsion Membrane. The emulsion shall be polymer modified and shall be in accordance with Sec. 1015.

413.30.3 Job Mix Formula. ~~-~~ Mix designs meeting the Sec 490 requirement shall be submitted at least seven days prior to placement. Ultra-thin Bonded Wearing Surfaces (UBAWS) mixtures as designated by the plans are used for Section 413 pay items.~~At least 30 days prior to placing any mixture on the project, the contractor shall submit a mix design to Construction and Materials for approval. Representative samples from each ingredient for the mix shall be submitted with the mix design.~~

413.30.3.1 Mix Adjustments. The contractor may make field adjustments to the job mix formula as noted herein. The adjusted job mix formula shall be in accordance with the mix design requirements of Sec ~~413.30~~490~~.~~4. The engineer shall be notified prior to making any change in the cold feed settings, the hot bin settings or the binder content. No additional fractions of material or new material will be permitted for field adjustments.~~**413.30.3.1 Proficiency Sample Program.** Laboratories that participate in and achieve a score of three or greater in the AASHTO proficiency sample program for T 11, T 27, T 84, T 85, T 166, T 176, T 209, T 304 (ASTM C 1252), T 308 and T 312 will have the mixture verification process waived. The mix design shall be submitted to Construction and Materials for approval at least seven days prior to mixture production.~~

~~**413.30.3.2 Required Information.** The mix design shall include raw data from the design process and contain the following information:~~

~~(a) All possible sources intended for use, and grade and specific gravity of asphalt binder.~~

(b) Source, type (formation, etc.), ledge number if applicable, and gradation of the aggregate.

(c) Bulk and apparent specific gravities and absorption of each aggregate fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate including all raw data.

(d) Specific gravity of hydrated lime, mineral filler or baghouse fines, if used, in accordance with AASHTO T 100.

(e) Percentage of each aggregate component.

(f) Combined gradation of the job mix.

(g) Percent asphalt binder, by weight, based on the total mixture.

(h) Theoretical maximum specific gravity (G_{mm}) as determined by AASHTO T 209, in accordance with Sec 403.16.1619.3.1, after the sample has been short term aged in accordance with AASHTO R 30.

(i) The tensile strength ratio as determined by AASHTO T 283 including all raw data.

(j) Mixing temperature and gyratory molding temperature.

(k) Bulk specific gravity (G_{sb}) of the combined aggregate.

(l) Percent chert contained in each aggregate fraction.

(m) Percent deleterious contained in each aggregate fraction.

(n) Blended aggregate properties for clay content, angularity, and thin and elongated particles.

(o) Draindown for mixture.

(p) Film thickness for mixture

413.30.4 Composition of Mixture.

413.30.4.1 Asphalt Amount. The amount of asphalt binder in the mixture shall meet the following limits for the type of mixture specified in the contract.

Mix Design Criteria			
	Type A	**Type B**	**Type C**
Asphalt Content, %	5.3 – 5.8	5.1 – 5.6	4.9 – 5.6

413.30.4.2 Gradation. Prior to mixing with asphalt binder, the combined aggregate gradation, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract.

Mix Design Criteria			
Composition by Weight Percentages			
	Type A	**Type B**	**Type C**
Sieves	**% Passing**	**% Passing**	**% Passing**
3/4 in.	-	100	100
1/2 in.	-	97 – 100	85 – 100
3/8 in.	100	75 – 100	50 – 80
No. 4	40 – 55	25 – 41	25 – 41
No. 8	22 – 32	17 – 27	17 – 27
No. 16	15 – 25	23 max.	23 max.
No. 30	18 max.	18 max.	18 max.
No. 50	13 max.	13 max.	13 max.
No. 100	10 max.	10 max.	10 max.
No. 200	4.0 – 6.0	4.0 – 6.0	4.0 – 6.0

~~**413.30.4.3 Film Thickness.** The film thickness shall be a minimum 10.0 microns when calculated using the effective asphalt content in conjunction with the surface area for the aggregate in the Job Mix Formula. The surface area factors can be found in Table 6.1 of the Asphalt Institute MS-2, *Mix Design Methods for Asphalt Concrete and Other Hot Mix Types*, Sixth Edition.~~

~~**413.30.4.4 Non-Carbonate Aggregate Requirement.** Mixtures containing limestone coarse aggregate shall contain a minimum amount of non-carbonate aggregate as shown in the table below, or the aggregate blend shall have an acid-insoluble residue (A.I.R.), MoDOT Test Method TM-76, meeting the plus No. 4 sieve criteria of crushed non-carbonate material. Non-carbonate aggregate shall have an A.I.R. of at least 85 percent insoluble residue.~~

~~Coarse Aggregate (+ No. 4)~~	~~Minimum Non-Carbonate by Volume~~
~~Limestone~~	~~30% Plus No. 4~~
~~Dolomite~~	~~No Requirement~~

~~**413.30.4.5 Drain Down.** Drain down from the loose mixture shall not exceed 0.10 percent when tested in accordance with AASHTO T 305.~~

~~**413.30.4.6 Moisture Susceptibility.** The mixture shall have a tensile strength ratio (TSR) of 80 percent or greater when compacted to 3.7 inches with 7 +/- 0.5 percent air voids and tested in accordance with AASHTO T 283.~~

413.30.4 Construction Requirements.

413.30.4.1 Weather Limitations. A damp pavement surface may be acceptable for placement if free of standing water and favorable weather conditions are expected to follow. Mix shall not be placed if the air temperature or the temperature of the surface on which the mixture is to be placed is below 50 F, the surface is wet or frozen, or weather conditions prevent the proper handling or finishing of the mixture. ~~Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.~~+

413.30.4.2~~7~~ Bituminous Mixing Plants. Bituminous mixing plants and preparation of materials and mixtures shall be in accordance with Sec 404.

413.30.4.3~~8~~ Hauling Equipment. Trucks used for hauling bituminous mixtures shall be in accordance with Sec 404.

413.30.4.4~~2~~ Paver. The paver shall be capable of spraying the polymer modified asphalt emulsion membrane, applying the hot mix asphalt overlay and leveling the surface of the mat in one pass. Wheels or other parts of the paving machine shall not come in contact with the polymer modified emulsion membrane before the hot mix asphalt concrete wearing course is applied. The screed shall have the ability to crown the pavement at the center and shall have vertically adjusted extensions to accommodate the desired pavement profile.

413.30.4.5~~3~~ Surface Preparation. Immediately prior to placing the ultrathin bonded asphalt wearing surface, the roadway surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud and other objectionable material. All non-working surface cracks with an opening size exceeding 1/4 inch and any size working crack shall be sealed prior to placement of the ultrathin bonded asphalt wearing surface. Immediately prior to spraying the polymer modified emulsion membrane, the surface shall be free of fresh bituminous mix. The ultrathin bonded asphalt wearing surface shall not be placed until the sealant has cured. Curing time of sealant shall be in accordance with the manufacturer's recommendations.

413.30.4.6~~4~~ Application of Membrane. The polymer modified emulsion membrane application shall be applied in accordance with the manufacturer's recommendations. The sprayer shall accurately and continuously monitor the rate of spray and shall provide a uniform application across the entire width to be overlaid.

413.30.4.6~~4~~.1 Adjusting Membrane Rate. The engineer may make adjustments to the spray rate based on the existing pavement surface conditions and the recommendations of the polymer modified emulsion membrane manufacturer.

413.30.4.6~~4~~.2 Application Rate of Membrane. Unless otherwise shown on the plans, the target field application rate of the asphalt emulsion shall be as follows for the type of mixture specified in the contract.

Membrane Application Rate	
Mixture Type	Field Application Rate (gal/sy)
Type A	0.~~15~~17
Type B and C	0.~~19~~20

413.30.4.6.3~~4.2.1~~ Tolerance for Membrane Application Rate. At any given time during placement, the application rate of the asphalt emulsion shall be within 0.02 gal/sy of the target field application rate in the table or as indicated in the plans. The yield of the application rate over the entire project area shall be within 0.01 gal/sy of the target field application rate given in the table or as indicated in the plans.

413.30.4.7~~5~~ Application of Mixture. The hot mix asphalt concrete shall be applied at a temperature of 290 to 330 F and shall be spread over the polymer modified emulsion membrane immediately after application of the polymer modified emulsion. The hot asphalt concrete wearing course shall be placed over the full width of the polymer modified emulsion membrane with a heated vibratory-tamping bar screed.

413.30.4.7.1~~5.2~~ Application Rate of Mixture. The target application rate of the ultrathin bonded asphalt wearing course shall be as shown on the plans. The application rate shall be adjusted to minimize fracturing of the top size aggregate by the screed. The engineer will determine the acceptable extent of fracturing at the edges for tapering purposes.

~~**413.30.5.7.2 Mix Adjustments.** The contractor may make field adjustments to the job mix formula as noted herein. The adjusted job mix formula shall be in accordance with the mix design requirements of Sec 413.30.4. The engineer shall be notified prior to making any change in the cold feed settings, the hot bin settings or the binder content. No additional fractions of material or new material will be permitted for field adjustments.~~

413.30.4.8~~5.1~~ Handwork. For handwork, the hot mix asphalt shall be applied within five minutes after the application of the polymer modified emulsion.

~~**413.30.5.5.2 Application Rate of Mixture.** The target application rate of the ultrathin bonded asphalt wearing course shall be as shown on the plans. The application rate shall be adjusted to minimize fracturing of the top size aggregate by the screed. The engineer will determine the acceptable extent of fracturing at the edges for tapering purposes.~~

413.30.4.9~~6~~ Rolling. Rolling of the wearing course shall consist of no more than three passes immediately following placement of the ultrathin bonded asphalt wearing course with a steel, double-drum, asphalt roller with a minimum weight of 10 tons. All rolling shall be completed before the material temperature has fallen below 195° F. Rollers shall be equipped with a functioning water system and scrapers to prevent adhesion of the fresh mix onto the roller drums. An acceptable release agent approved by the engineer may be added to the water system to prevent adhesion of the fresh mix to the roller drum and wheels. Rolling shall be done in the static mode. Excessive rolling to the extent of aggregate degradation will not be permitted. The engineer will determine the acceptable extent of fracturing at the edge of the pavement from the rolling operation. New pavement shall not be opened to traffic nor shall any roller sit idle on the pavement until the rolling operation is complete and the material has been cooled below 140 F.

413.30.4.10~~9~~ ~~Wearing Course~~Minimum Lift Thicknesses. The finished wearing course shall have a minimum thickness of 1/2 inch for Type A, 3/4 inch for Type B, and 3/4 inch for Type C.

413.30.4.11 Defective Areas. The contractor shall remove and replace defective areas at the contractor's expense with material meeting specification requirements as directed by the engineer.

413.30.4.12 Segregation. No segregation will be permitted in handling the mixture at the plant, from the truck or during spreading operations on the roadbed. Segregated mixture shall be removed and replaced to the limits determined by the engineer.

413.30.4.12~~3~~0 Pavement Marking. Pavement marking shall be replaced in accordance with Sec 620.

413.30.5 Quality Control. The contractor shall control and monitor the quality of work.

413.30.5.1 Sample Location. The gradations of the total aggregate will be determined from samples taken randomly from the composite cold feed belt or the hot bins. The deleterious content of the total aggregate will be determined from the samples taken from the combined cold feed belt. Asphalt content samples shall not be retrieved ~~from the~~after placement on the roadway. ~~hot elevator at the asphalt plant or from the transport truck at the plant by random sampling.~~

~~**413.30.6.1 Quality Control Operations.** Quality control shall be conducted in accordance with Sec 403.17, except as follows.~~

413.30.5.2 Aggregate Gradation. Sieve analysis shall~~ be performed for every 600 tons of mixture produced. Test shall be performed~~ be performed in accordance with AASHTO T 27 from randomly sampled material taken from the composite cold feed belt or the hot bins. The total aggregate gradation shall be within the range specified in Sec 490.10.6 and within the maximum variations from the approved job mix formula shown here:

Gradation Tolerances from JMF			
Sieves	Type A	Type B	Type C
3/4 in.	-	-	-

1/2 in.	-	-	± 5.0
3/8 in.	-	± 5.0	-
No. 4	± 5.0	± 4.0	± 4.0
No. 8	± 4.0	± 4.0	± 4.0
No. 16	± 4.0	-	-
No. 200	± 1.0	± 1.0	± 1.0

413.30.5.3 Mixture Asphalt Content. The asphalt binder content shall be ~~determined for each 600 tons of mixture produced. Test shall be~~ performed in accordance with AASHTO T 287 or AASHTO T 308. The asphalt content of the mix shall be within +/-0.3% of the approved job mix formula.~~Samples for determination of the asphalt binder content shall be retrieved from the hot elevator at the asphalt plant or from the transport truck at the plant by random sampling.~~

413.30.5.4 Deleterious Content. Deleterious content shall be ~~determined for every 600 tons of mixture produced. Test shall be~~ performed in accordance with MoDOT Test Method TM 71. The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in Sec 1002.2.~~ from randomly sampled material taken from the composite cold feed belt.~~

~~**413.30.6.2 Gradation and Asphalt Binder Tolerances.** The total aggregate gradation and asphalt content shall be within the range specified in Sec 413.4.1, Sec 413.30.4.2 and the maximum variations from the approved job mix formula shall be within the following tolerances:~~

~~Gradation and Asphalt Binder Tolerances~~			
	~~Percent Passing~~		
~~Sieves~~	~~Type A~~	~~Type B~~	~~Type C~~
~~3/4 in.~~	~~-~~	~~-~~	~~-~~
~~1/2 in.~~	~~-~~	~~-~~	~~± 5.0~~
~~3/8 in.~~	~~-~~	~~± 5.0~~	~~-~~
~~No. 4~~	~~± 5.0~~	~~± 4.0~~	~~± 4.0~~
~~No. 8~~	~~± 4.0~~	~~± 4.0~~	~~± 4.0~~
~~No. 16~~	~~± 4.0~~	~~-~~	~~-~~
~~No. 200~~	~~± 1.0~~	~~± 1.0~~	~~± 1.0~~
~~Asphalt Content, %~~	~~± 0.3~~	~~± 0.3~~	~~± 0.3~~

~~**413.30.6.3 Deleterious Content Tolerance.** The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in Sec 1002.2.~~

413.30.5.5~~.4.~~ Membrane Application Rate. The application rate of the polymer emulsion membrane shall be verified by dividing the volume of polymer modified emulsion membrane used by the area of paving for that day.

~~**413.30.6.5 Mix Adjustments.** The contractor may make field adjustments to the job mix formula as noted herein. The adjusted job mix formula shall be in accordance with the mix design requirements of Sec 413.30.4. The engineer shall be notified prior to making any change in the cold feed settings, the hot bin settings or the binder content. No additional fractions of material or new material will be permitted for field adjustments.~~

~~**413.30.6.6 Defective Areas.** The contractor shall remove and replace defective areas at the contractor's expense with material meeting specification requirements as directed by the engineer.~~

413.30.5.6 Temperature of Base and Air. The contractor shall monitor the environmental conditions that affect asphalt production and laydown operations. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

413.30.5.7 Binder Quality. The contractor shall ensure the binder is handled and stored in a manner that does not affect its quality. When the contractor is modifying the binder after delivery, additional quality control requirements apply. QC shall either assist QA in taking samples or obtain the QA sample directly in the inspector's absence.

413.30.6 Quality Assurance. The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor. Corrective action shall be taken by the contractor if any QA tests are outside the QC tolerances shown in Sec 413.30.6~~5~~.~~Quality assurance will be conducted in accordance with Sec 403 except as follows:~~

413.30.6.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when independent QA samples meet the same specification criteria as QC.

413.30.6.2 ~~7.2 Testing Retain Samples~~Split QC/QA Split Samples. Split samples shall be clearly labeled and stored by the contractor in a manner that prevents contamination. Uncollected split samples shall be retained by the contractor until the engineer authorizes disposal or until the Final Inspection, whichever occurs earlier. A favorable mixture gradation comparison will be achieved when test results are within the specified tolerances shown in Sec 403.17.2.1. A favorable mixture %AC

comparison shall be obtained when QA is within 0.3% of QC. A favorable comparison for deleterious content shall be obtained when QA is within one half the Sec 1004.2 requirements of the QC results. ~~.The engineer will test, at a minimum, one retained QC gradation sample and one retained QC asphalt binder content sample per calendar week.~~ The engineer's test results, including all raw data, will be made available to the contractor by the next working day.

~~**413.30.7.2.1 Aggregate Comparison.** A favorable aggregate comparison will be achieved when test results are within the specified tolerances shown in Sec 403.18.2.~~

~~**413.30.7.2.2 Asphalt Content Comparison.** A favorable asphalt content will be achieved when test results are within 0.3 percent.~~

413.30.7~~7.1 Sampling~~ QC/QA Frequency Table. ~~Corrective action shall be taken by the contractor if any QA tests are outside the QC tolerances shown in Sec 413.30.6.2. The engineer will, at a minimum, independently sample and test at the following frequency:~~

Tested Property	QC Frequency	QA Frequency	
		Independent Samples	Split Samples
Aggregate Gradation	1 per 600 Tons	1 per Day	-
Mixture Asphalt Content			1 per Week
Deleterious Content			
Membrane Application Rate	1 per Day	1 per Week	-
Temperature of Base and Air	As Needed	As Needed	
Binder Quality	-	1 per Day	

413.30.8~~8~~ Method of Measurement. Final measurement of the completed surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of ultrathin bonded asphalt wearing surface, complete in place, will be made to the nearest square yard. The revision or correction will be computed and added to or deducted from the contract quantity.

413.30.9~~9~~ Basis of Payment. ~~413.30.5.11 Acceptance.~~ Acceptance will be based on test results indicating that the ultrathin bonded asphalt wearing surface meets the specification requirements, the contractor following the approved QC Plan, and favorable comparison of the contractor's QC test and the engineer's QA test.
The accepted quantity of ultrathin bonded asphalt wearing surface will be paid for at the contract unit price.

SECTION 413.31 BONDED HOT MIX ASPHALT USING POLYMER MODIFIED EMULSION MEMBRANE.

413.31.1 Description. This work shall consist of the placement of a Polymer Modified Emulsion Membrane prior to a bituminous overlay of hot asphaltic concrete pavement. The Polymer Modified Emulsion Membrane shall be spray applied immediately prior to the application of the hot asphaltic concrete pavement so as to produce a homogeneous surface in accordance with Secs 401, 402, or 403.

413.31.2 Materials. The Polymer Modified Emulsion Membrane shall be in accordance with Sec 1015.20.6.2.

413.31.3 Construction Requirements. The asphaltic concrete pavement shall be placed in accordance with Secs 401, 402, or 403, except as modified herein.

413.31.4 Equipment. No wheel, track or other part of the paving machine or any hauling equipment shall come in contact with the Polymer Modified Emulsion Membrane before the asphaltic concrete pavement mixture is applied.

413.31.5 Application of Polymer Modified Emulsion Membrane.

413.31.5.1 The Polymer Modified Emulsion Membrane shall be sprayed at a temperature of 120° - 180°. The sprayer shall accurately and continuously monitor the application rate and provide a uniform coverage across the entire width to be overlaid. The target application rate of the asphalt emulsion membrane shall be 0.20 gallons per square yard. The Engineer may make adjustments to the application rate based upon the existing pavement surface conditions and the recommendations of the Polymer Modified Emulsion Membrane supplier; however, the application rate shall be within +/- 0.05 gallon per square yard of the target application rate.

413.31.5.2 The application rate of the Polymer Modified Emulsion Membrane shall be verified by dividing the volume (of Polymer Modified Emulsion Membrane used) by the area of paving for that day.

413.31.5.3 No water shall be added to the Polymer Modified Emulsion Membrane.

413.31.6 Method of Measurement. Measurement of the Polymer Modified Emulsion Membrane shall be based on the volume in gallons in accordance with Sec 1015.

413.31.7 Basis of Payment. The accepted quantity of the Polymer Modified Emulsion Membrane will be paid for at the contract unit price.

SECTION 413.40 BITUMINOUS FOG SEALING.

413.40.1 Description. This work shall consist of furnishing diluted asphalt emulsion and preparing and sealing surfaces by means of a bituminous distributor.

413.40.2 Material. Asphalt emulsion grades SS-1, SS-1H, CSS-1, or CSS-1H shall be in accordance with Sec 1015 and shall be used unless otherwise directed by the engineer.

413.40.3 Equipment. The distributor shall be designed, equipped, maintained and operated such that liquid asphalt at even heat may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.02 to 1.00 gallon per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallon per square yard. The distributor equipment shall include a tachometer, pressure gauges, a calibrated tank and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and with full circulation spray bars adjustable both laterally and vertically. The calibration of all distributors shall be approved by the engineer prior to use, and the contractor shall furnish all equipment, material and assistance necessary if calibration will be required.

413.40.4 Construction Requirements.

413.40.4.1 Asphalt emulsion shall be applied only during weather conditions under which satisfactory application and curing can be obtained. Asphalt emulsion shall not be placed on a damp or wet surface except as approved by the engineer. The surface shall be free of objectionable material prior to sealing.

413.40.4.2 The asphalt emulsion shall be diluted with water prior to application. The dilution rate shall be as shown on the plans or as directed by the engineer. The contractor shall provide documentation to the engineer that the specified coating system has been properly diluted.

413.40.4.3 The diluted asphalt emulsion shall be uniformly applied at the rate of 0.20 gallon per square yard surface. The application rate may be adjusted as directed by the engineer. Application widths shall be such that the entire surface is covered in one application.

413.40.4.4 Care shall be taken such that asphalt emulsion is applied only to designated areas. Sand dams or other approved means may be necessary to prevent emulsion from being applied outside of designated areas. Pavement marking obliterated by this operation shall be replaced by the contractor at the contractor's expense in accordance with Sec 620, unless otherwise provided for in the contract.

413.40.4.5 After application of the sealant, the surface shall be tack-free and capable of being open to traffic within four hours without tracking.

413.40.5 Method of Measurement. Measurement of the undiluted asphalt emulsion, complete in place and accepted by the engineer, will be made to the nearest gallon in accordance with Sec 1015.

413.40.6 Basis of Payment. The accepted quantity of bituminous fog seal will be paid for at the contract unit price for undiluted asphalt emulsion for seal that is mixed and used on the project. Diluted asphalt emulsion that is delivered to the job site, but not applied to the surface, will not be considered for payment. No direct payment will be made for sand.

SECTION 413.50 BITUMINOUS PAVEMENT CRACK SEALING.

413.50.1 Description. This work shall consist of preparing and sealing all working transverse and longitudinal cracks in bituminous pavement as shown on the plans or as directed by the engineer.

413.50.2 Material. The sealant shall be a single-component material in accordance with AASHTO M 324, except as herein modified.

413.50.2.1 The sealant shall be capable of being reheated to pouring temperatures at least once after the initial heating, while retaining the sealant's physical characteristics.

413.50.2.2 Penetration at 77° F, 50 grams, 5 seconds, shall be no less than 50 or greater than 90.

413.50.2.3 When tested at 77° F, the resilience recovery shall be a minimum of 50 percent.

413.50.2.4 The sealant shall meet all physical requirements after prolonged heating for six hours with constant mixing in a laboratory melter at the recommended field pouring temperature, complete cool down, and reheating to the recommended pouring temperature.

413.50.3 Construction Requirements.

413.50.3.1 The engineer will mark the cracks to be sealed. Sealant shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40° F. The contractor shall furnish to the engineer the manufacturer's recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack sealant in accordance with the manufacturer's recommendations.

413.50.3.2 Cracks shall be routed or sawed to provide a reservoir centered over the existing crack. The reservoir shall be slightly larger than the existing crack, with a minimum size of 1/2-inch wide x 1/2-inch deep. The crack shall be clean, free from all loose and foreign material, and dry, prior to application of the sealant. Loose material on the surface within 2 inches of the crack shall be removed to permit proper adhesion.

413.50.3.3 The sealant shall be applied to the reservoir from the bottom up. The reservoir shall be slightly overfilled and excess material squeegeed with a V or U-shaped squeegee, level to the adjoining surface pavement forming a wipe zone 3 to 4 inches wide.

413.50.3.4 The contractor shall apply a light coating of sand or other blotting material to the surface of the newly placed sealant if traffic results in tracking of the crack sealing material.

413.50.4 Method of Measurement. Measurement of crack sealing will be made to the nearest linear foot of cracks sealed, complete in place, and accepted by the engineer.

413.50.5 Basis of Payment. The accepted quantity of pavement crack sealing will be paid for at the contract unit price.

SECTION 413.60 PORTLAND CEMENT CONCRETE PAVEMENT JOINT/CRACK SEALING.

413.60.1 Description. This work shall consist of preparing and resealing all existing transverse and longitudinal joints, and working transverse and longitudinal cracks in Portland cement concrete pavement (PCCP) as shown on the plans or as directed by the engineer.

413.60.2 Material. Sealant material shall be in accordance with Sec 1057.

413.60.3 Construction Requirements.

413.60.3.1 The engineer will mark the existing joints and cracks to be sealed. The sealant shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40° F. The contractor shall furnish to the engineer the manufacturer's recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack sealant in accordance with the manufacturer's recommendations.

413.60.3.2 Cracks shall be routed or sawed to provide a reservoir centered over the existing crack. The reservoir shall be slightly larger than the existing crack, with a minimum size of 3/8-inch wide x d/4 deep, where d is the thickness of the pavement. The joint/crack shall be clean, free from all loose and foreign material, including existing sealant, and dry prior to application of the sealant.

413.60.3.3 Sealant shall be applied to the joint or reservoir uniformly from the bottom to 1/2 inch from the top. Any excess material shall be removed from the pavement surface.

413.60.4 Method of Measurement. Measurement of crack sealing will be made to the nearest linear foot of cracks sealed, complete in place, and accepted by the engineer.

413.60.5 Basis of Payment. The accepted quantity of pavement crack sealing will be paid for at the contract unit price.

SECTION 413.70 BITUMINOUS PAVEMENT CRACK FILLING.

413.70.1 Description. This work shall consist of preparing and filling all cracks in bituminous pavement as shown on the plans or as directed by the engineer.

413.70.2 Material. Filler material shall be in accordance with one of the following:

Item	Section
Asphalt Binder	1015.3
Polymer Modified Emulsion	1015.20.5
Crack Sealing Material	413.50.2

413.70.3 Construction Requirements.

413.70.3.1 The engineer will mark the cracks to be filled. Filler material shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40° F. The contractor shall furnish to the engineer the manufacturer's recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack filler material in accordance with the manufacturer's recommendations.

413.70.3.2 The crack shall be clean, free from all loose and foreign material, and dry prior to application of the filler material. Loose material on the surface within 2 inches of the crack shall be removed to permit proper adhesion.

413.70.3.3 Filler material shall be applied to the crack from the bottom up. The crack shall be slightly overfilled and excess material squeegeed with a V or U-shaped squeegee, level to the adjoining surface pavement forming a wipe zone 3 to 4 inches wide.

413.70.3.4 The contractor shall apply a light coating of sand or other blotting material to the surface of the newly placed filler if traffic results in tracking of the crack sealing material.

413.70.4 Method of Measurement. Measurement of crack filling will be made to the nearest linear foot of cracks filled, complete in place, and accepted by the engineer.

413.70.5 Basis of Payment. The accepted quantity of pavement crack filler will be paid for at the contract unit price.

SECTION 413.80 PORTLAND CEMENT CONCRETE PAVEMENT CRACK FILLING.

413.80.1 Description. This work shall consist of preparing and filling all cracks in PCCP, as shown on the plans or as directed by the engineer.

413.80.2 Material. ~~Filler~~ Sealant material shall be in accordance with Sec 413.50.2 or Sec 1057.

413.80.3 Construction Requirements.

413.80.3.1 The engineer will mark the existing cracks to be filled. Filler material shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40° F. The contractor shall furnish to the engineer the manufacturer's recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack filler material in accordance with the manufacturer's recommendations.

413.80.3.2 The crack shall be clean, free from any loose and foreign material, and dry prior to application of the filler material.

413.80.3.3 Filler material shall be applied to the crack uniformly from the bottom to 1/2 inch from the top. Any excess material shall be removed from the pavement surface.

413.80.4 Method of Measurement. Measurement of crack filling material will be made to the nearest linear foot of cracks sealed, complete in place, and accepted by the engineer.

413.80.5 Basis of Payment. The accepted quantity of pavement crack filler will be paid for at the contract unit price.

SECTION 490
BITUMINUMOUS ASPHALT MIXES

~~401~~490.1 Description. This work covers the requirements for obtaining an approved job mix formula (JMF) for bituminous asphalt mixtures.

490.2 Naming Convention. The nomenclature of bituminous mixture will be as follows. When only the mixture type or aggregate size is shown, such as SP125, the specifications shall apply to all variations of that type or size, such as SP125B, SP125C, SP125CLP, etc. When "x" is indicated, such as SP125xLP, specifications shall apply to all variations of mixture designs. Stone Matrix Asphalt will be generally referred to as SMA and designated by SM or SMR.

Sec 401 Nomenclature	
BP	**Bituminous Pavement**
-x	Design Type -1,-2, or -3
NC	With Non-Carbonate Requirements
BB	**Bituminous Base**
Sec 402 Nomenclature	
SL	**Surface Leveling**
Sec 403 Nomenclature	
SP	**Superpave**
048	4.75mm (No. 4) nominal aggregate size
095	9.5 mm (3/8 inch) nominal aggregate size
125	12.5 mm (1/2 inch) nominal aggregate size
190	19.0 mm (3/4 inch) nominal aggregate size
250	25.0 mm (1 inch) nominal aggregate size
x	Design Level: B, C, E or F
LP	Limestone Porphyry
NC	With Non-Carbonate Requirements
SM	Stone Matrix Asphalt
SMR	Stone Matrix Asphalt Limestone/Non-Carbonate
Sec 413 Nomenclature	
UBAWS	Ultrathin Bonded Wearing Surface
Type x	Type A, B, or C

490.3 Superpave Design Levels. The following cumulative equivalent single axle loads (ESALs) shall be used for the specified Superpave mix design. The same size aggregate mix design at a higher design traffic may be substituted at the contractor's expense for the contract specified mixture design with the approval from the engineer. Substitutions shall be done uniformly and project mixing of various designs for the same work will not be permitted. For example, an SP125B mixture may be substituted for an SP125C mixture, or SP190C for SP190E, etc. Mixture design substitution will be limited to one design level higher than that specified in the contract.

Design Traffic (ESALs)	**Design**
< 300,000	F
300,000 to < 3,000,000	E
3,000,000 to < 30,000,000	C
≥ 30,000,000	B

490.4 Time Limit. Approved mix designs may be transferred to other projects with similar specifications for a period of three years from the original approval date provided satisfactory results are obtained during production and placement.

490.5 Design Methodology. Asphalt mixtures shall be designed by the contractor using a method appropriate for the type as follows and as designated below.

Mixture Type	**BB, BP, SL**	**SP**	**SMA**	**UBAWS**

Design Method	AASHTO R 35 or Marshall	AASHTO R 35	AASHTO R 46	MoDOT Requirements

490.5.1 Marshall Designs. Designs using the Marshall method shall follow Asphalt Institute Publication MS-2, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types. The mixture shall be compacted and tested at a minimum of three asphalt contents separated by a maximum of 0.5 percent in accordance with AASHTO T 245, except as herein noted. The test method shall be modified by short-term aging the specimens in accordance with AASHTO R 30.

490.6 Material. The grade of asphalt binder will be specified in the contract. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Sec 403(SP), Sec 413.30 ~~,~~ (UBAWS) Coarse Aggregate	1002.2
BB, BP, SL~~,~~ Coarse Aggregate~~, Surface Leveling~~	1004.2
Fine Aggregate	1002.3
Mineral Filler	1002.4
Hydrated Lime	1002.5
Asphalt Binder~~, Performance Graded (PG)~~	1015
Additives	1071

490~~02.2~~6.~~2~~1 Wet Bottom Boiler Slag. The contractor may furnish wet bottom boiler slag of approved quality in lieu of coarse aggregate ~~specified in Sec 402.2~~. If wet bottom boiler slag is used, the slag shall meet the requirements for applicable coarse aggregate. The Los Angles Abrasion requirements will not apply.

490.6.2 Reclaimed Asphalt. Reclaimed Asphalt may be obtained from Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS). The asphalt binder content of recycled asphalt materials shall be determined in accordance with AASHTO T 164, ASTM D 2172 or other approved method of solvent extraction. RAP and/or RAS correction factor(s) for binder ignition use during production shall be determined by burning a sample in accordance with AASHTO T 308 and subtracting from the binder content determined by extraction.

490.6.2.1 RAP. Reclaimed Asphalt Pavement (RAP) may be used in any mixture, except SMA mixtures. All RAP material shall be in accordance with Sec 1004 for deleterious and other foreign material. The aggregate specific gravity shall be determined by performing AASHTO T 209 in accordance with Sec 490.9 and calculating the G_{se} as follows:

$$RAP\ G_{sb} = RAP\ G_{se} \times 0.98 = \frac{100 - Pb}{\frac{100}{G_{mm}} - \frac{Pb}{G_b}} \times 0.98$$

~~, UBAWS~~**490.6.2.1.1 RAP Durability** All RAP material not originating from a MoDOT roadway shall be tested in accordance with AASHTO T 327, *Method of Resistance of Coarse Aggregate Degradation by Abrasion in the Micro-Deval Apparatus*. The Micro-Deval percent loss for the RAP aggregate shall not exceed loss of the combined virgin material by more than five percent.

490.6.2.~~3~~1.2 UBAWS RAP. The RAP used in UBAWS shall have 100 percent passing the 3/8 inch and no less than 70 percent passing the No. 4 sieve.

490.6.2.2 RAS. Reclaimed Asphalt Shingles (RAS) may be used in any mixture specified to use PG 64-22. RAS shall be ground to 3/8-inch minus. Waste, manufacturer or new, shingles shall be essential free of deleterious materials. Post-consumer RAS shall not contain more than 1.5 percent wood by weight or more than 3.0 percent total deleterious by weight. Post-consumer RAS shall be certified to contain less than the maximum allowable amount of asbestos as defined by national or local standards. The bulk specific gravity of RAS shall be determined as follows:

Mixture Type	**BB, BP, and SL**	**SP**
RAS Gsb Calculation	$G_{sb} = 2.600$	$G_{sb} = \frac{100 - Pb}{\frac{100}{G_{mm}} - \frac{Pb}{G_b}}$

490.6.2.~~4~~2.1 RAS Gradation. The gradation of the RAS aggregate may be determined by solvent extraction of the binder or by using the following as a standard gradation:

Standard Shingle Gradation

Sieve Size	Percent Passing by Weight
3/8 in.	100%
No. 4	95%
No. 8	85%
No. 16	70%
No. 30	50%
No. 50	45%
No. 100	35%
No. 200	25%

490.6.3 Rejuvenators. Rejuvenators may be used in any asphalt mixture containing reclaimed asphalt. When a rejuvenator is used for the purpose of softening the virgin binder grade, the requirements for the Extraction Grading of the final mixture option in Sec 490.10 must be satisfied.

490.6.4 Anti-Strip Agent. An anti-strip may be used to improve resistance to stripping. Anti-strip agents shall be from the approved list in accordance with Sec 1071.

490.7 Aggregate Correction Factor. When AASHTO T 308 will be used to determine ~~%AC~~mixture asphalt content during production, an aggregate correction factor in accordance with AASHTO T 308 ANNEX 2 shall be determined. The test method shall be modified by adding the following: If the calibration factor exceeds 1.0 percent, lower the test temperature to 800 ± 8 F (428 ± 5 C) and repeat test.

490.8 Compacted Specimens. The surface of puck and cores prepared for testing may have the surface texture removed by sawing a minimal amount. Specimens shall be securely held in a jig or other clamping device to eliminate distortion and retain a face parallel to the original surface. Measurements for lift thickness shall be made prior to sawing.

490.8.1 Bulk Specific Gravity. During both the design and production phases for both gyro pucks and pavement cores; the following shall apply. Either AASHTO T 166 or T 331 shall be used to determine bulk specific gravity of compacted specimens. When AASHTO T 166 is used and absorption is above the 2% limit, ASTM D 1188 shall be used. The use of AASHTO T 275 is prohibited.

490.9 Maximum Theoretical Specific Gravity. AASHTO T 209 shall be used including the supplemental procedure for mixtures containing porous aggregate when the water absorption of any aggregate fraction is greater than 2.0 percent. Design samples shall be short-term aged in accordance with AASHTO R 30.

490.10 Composition of Mixtures.

490.10.1 Gradation. The combined aggregate gradation, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract.

Percent Passing by Weight												
Sieve Size	SP250	SP190	SP125	SP095	SP048	SP125xSM SP125xSMR	SP095xSM SP095xSMR	BB	BP-1	BP2	BP-3	SL
1 1/2 in.	100	-	-	-	-	-	-	-	-	-	-	-
1 in.	90-100	100						100				
3/4 in.	≤90 max	90-100	100	-	-	100	-	85-100	100	100	-	100
1/2 in.	-	90 max≤	90-100	100	-	90-100	100	60-90	85-100	95-100	-	99-100
3/8 in.		-	≤90 max	90-100	100	50-80	70-95	-	-	-	100	90-100
No. 4			-	≤90 max	90-100	20-35	30-50	35-65	50-70	60-90	90-100	60-90
No. 8	19-45	23-49	28-58	32-67	-	16-24	20-30	25-50	30-55	40-70	-	40-70
No. 16	-	-	-	-	30-60	-	≤21 max	-	-	-	30-60	-
No. 30					-		≤18 max	10-35	10-30	15-35	-	15-35
No. 50							≤15 max	-	-	-	-	-
No. 100							-					

No. 200	1-7	2-8	2-10	2-10	7-12	8.0-11.0	8.0-12.0	4-12	5-12	5-12	7-12	5-12

490.10.2 Reclaimed Asphalt Allowances. The use of reclaimed asphalt shall be limited to one of the following options. ~~binder~~The percent binder replacements shown below are the percent recycle binder contribution to the total asphalt binder.

Mixture Type	Binder	Percent Effective Virgin Binder Replacement		
		RAP	RAS	RAP and RAS combination
BP	Contract Grade Virgin Binder	0 - 20	0 -10	RAP + (2*RAS) ≤ 20
	Virgin Binder Softened One Grade	21 - 40	11 - 20	20 < RAP + (2*RAS) ≤ 40
	Blend Chart	0 - 100	N/A	
	Extraction Grading of Final Mixture	0 - 100		
BB	Contract Grade Virgin Binder	0 - 30	0 -15	RAP + (2*RAS) ≤ 30
	Virgin Binder Softened One Grade	31 - 50	16 - 25	30 < RAP + (2*RAS) ≤ 50
	Blend Chart	0 - 100	N/A	
	Extraction Grading of Final Mixture	0 - 100		
SL	Contract Grade Virgin Binder	0 - 30	0 - 15	0 – 30 total and 0-15 from RAS
	Virgin Binder Softened One Grade	31 - 40	16 - 20	31 – 40 total and 0-20 from RAS
	Blend Chart	0 - 100	N/A	
	Extraction Grading of Final Mixture	0 - 100		
SP	Contract Grade Virgin Binder	0 - 30	0 - 30	0-30
	Virgin Binder Softened One Grade	N/A	31 - 40	31-40
	Blend Chart	0 - 100	N/A	
	Extraction Grading of Final Mixture	0 - 100		
UBAWS	Contract Grade Virgin Binder	0 - 20	N/A	
	Virgin Binder Softened One Grade	N/A		
	Blend Chart	0 - 20	N/A	
	Extraction Grading of Final Mixture	0 - 20	N/A	

490.10.2.1 Virgin Binder Soften~~ing~~ed One Grade. When the contractor elects to provide a softer grade of virgin binder than specified in the contract the following shall apply. The virgin binder shall have a low temperature grade 6 degrees lower than the binder grade specified in the contract. Lowering the high temperature of the virgin binder is not required; however, if lowered, the virgin binder shall have a high temperature grade no lower than 6 degrees below the binder grade specified in the contract (Ex. Contract grade PG 64-22; virgin binder could be either PG 58-28 or PG 64-28). The Pressure Aging Vessel (PAV) test temperature (AASHTO M 320) shall be tested at 19° C, regardless of the high temperature grade of the selected virgin binder.

490.10.2.2 Blend Chart. When the contractor elects to utilize a blend chart to prove the as designed binder grade meets the contract specifications the following shall apply. Testing in accordance with AASHTO M 323 shall be performed on all binder supplying components and the raw data included with the mix design. The calculation which demonstrates that the grade of the combine mixture meets the contract requirements shall be included with the mix design. RAS is not allowable when blend charts are used. No significant alterations to binder providing components during production shall be allowed without a new blend chart evaluation.

490.10.2.3 Extraction Grading. When the contractor elects to utilize an extraction process to prove the as designed binder grade meets the contract specifications the following shall apply. Testing in accordance with either AASHTO T 319, or AASHTO T 164 and AASHTO R 59 along with grading in accordance with AASHTO M 320 including raw data shall be included with the mix design which demonstrates that the grade of the combine mixture and rejuvenator, if applicable, meets the contract requirements. No significant alterations to binder providing components during production shall be allowed without a new extraction grading evaluation.

490.10.3 Moisture Susceptibility. Moisture susceptibility shall be tested in accordance with AASHTO T 283, except that SMA mixtures test specimens shall have 6±0.5 percent air voids. An approved anti-strip additive may be added to increase retained strength to a passing level. TSR testing shall only be required for BB and BP mixtures when any plasticity index on a individual aggregate fractions with 10 percent or more passing the No. 30 sieve exceeds 3. The TSR shall meet the following requirements.

Mix Type	BB, BP	SL	SP, UBAWS
Min. TSR	70%	NA	80%

490.10.4 BB, BP, SL Mixture Characteristics.

490.10.4.1 Base, BP-1, BP-2, BP-3, and SL mixtures shall have the following properties, when tested in accordance with AASHTO T 245 or AASHTO T 312. The number of blows with the compaction hammer shall be 35 or the number of gyrations shall be 35 with the gyratory compactor.

Mix Type	Percent Air Voids	AASHTO T 245 Stability (lbs)	Voids in Mineral Aggregate (VMA)[b]		VMA filled with Asphalt (VFA)	Dust to Effective Binder Ratio
			Virgin Binder Replacement			
			≤ 40%	> 40%		
BB	3.5	750	13.0 (12.0)[a]	13.5 (12.5)[a]	-	-
BP-1			13.5	14.0	60 - 80	0.8 - 1.6
BP-2			14.0	14.5		0.8 - 1.6
BP-3			15.0	15.5	≥ 75 ≥ min	0.9 - 2.0
SL			14.5			0.8 - 1.6

[a] Bituminous base mixtures with a gradation that would require 12.0 percent VMA following Asphalt Institute MS-2 may use the lower VMA shown.

490.10.4.2 Non-Carbonate. When specified in the contract as BP-3NC, BP-3 mixtures containing limestone aggregate shall contain a minimum amount of non-carbonate aggregate as shown in the table below, or the aggregate blend shall have an acid-insoluble residue (A.I.R.), MoDOT Test Method TM 76, meeting the criteria of crushed non-carbonate material. The A.I.R. shall be determined on the minus No. 4 sieve. Non-carbonate aggregate shall have an A.I.R. of at least 85 percent insoluble residue.

Aggregate	Minimum Non-Carbonate by Volume
Limestone	20% Minus No. 4
Dolomite	No Requirement

490.10.5 SP Mixture Characteristics

490.10.5.1 Fine Aggregate Angularity. Fine aggregate angularity (FAA) shall be measured on the fine portion of the blended aggregate. When tested in accordance with AASHTO T 304 Method A, aggregate particles passing the No. 8 sieve shall meet the following criteria for the minimum percent air voids in loosely compacted fine aggregate:

Design	FAA
F	-
E	40
C, B	45
SP048	40

490.10.5.2 Coarse Aggregate Angularity. Coarse aggregate angularity (CAA) shall be measured on the coarse portion of the blended aggregate. When tested in accordance with ASTM D 5821, the coarse aggregate shall meet the following percent criteria for the number of fracture faces listed. Crushed limestone, dolomite, steel slag and porphyry will be considered as having 100 percent two fractured faces unless visual observations indicate an undesirable particle shape is being produced.

Design	Fractured Faces	
	One	Two
F	55	-
E	75	-
C	95	90
B	100	100

490.10.5.3 Clay Content. When tested in accordance with AASHTO T 176, blended aggregate particles passing the No. 4 sieve shall meet the following minimum sand equivalent criteria:

Design	Sand Equivalent
F, E	40
C	45
B	50

490.10.5.4 Surface Mixtures. Design level B surface mixtures~~*~~, except non-integral shoulders and other non-traffic areas, containing limestone coarse aggregate shall contain a minimum amount of non-carbonate aggregate. The LA abrasion values, AASHTO T 96, of the limestone will determine the type and amount of non-carbonate aggregate required as shown in the table below. The LA abrasion value will be determined from the most recent source approval sample. In lieu of the above requirements, the aggregate blend shall have an acid insoluble residue (AIR), MoDOT Test Method TM 76, meeting the plus No. 4 criteria of crushed non-carbonate material. Non-carbonate aggregate shall have an AIR of at least 85 percent insoluble residue.

Mixture	Coarse Aggregate (Plus No. 4)	Minimum Non-Carbonate by Volume
SP095	Dolomite	No Requirement
SP125	Limestone, LA ≤ 30	30% of Plus No. 4
	Limestone, LA > 30	20% of Minus No. 4
SP095	All Limestone	

490.10.5.5 Design Gyrations. The number (N) of gyrations required for gyratory compaction shall be as follows:

Design	$N_{initial}$	N_{design}	$N_{maximum}$
F	-	50	-
E	7	75	115
C	8	100	160
	-	80	-
B	9	125	205
SMA	-	100	-

490.10.5.5 Design Density. The density, as a percent of theoretical maximum specific gravity, shall be as follows:

Design	$N_{initial}$	N_{design}	$N_{maximum}$
F	91.5 max	96.0	98.0 max
E	90.5 max		
C	89.0 max		
B			
SMA			

490.10.5.6 ~~Mixture~~Volumetric Characteristics. When compacted in accordance with AASHTO T 312, the mixture shall meet the following criteria.

490.10.5.~~7~~6.1 Air Voids (V_a). Design air voids for all mixtures at all traffic levels shall be 4.0%.

490.10.5.6.2~~8~~ Voids in the Mineral Aggregate (VMA).

Mixture	VMA Minimum
SP250	12.0%
SP190	13.0%
SP125 (except for SMA)	14.0%
SP095 (except for SMA)	15.0%
SP048	16.0%
SMA	17.0%

490.10.5.6.3~~9~~ Voids Filled With Asphalt (VFA).

Design	VFA
F	70 – 80%
~~SP048F~~	
E	65 – 78%
B, C	65 – 76%
~~SP095B~~	~~76%~~

%SMA, SP048F	75% min

490.10.5.6.40 Dust to Binder Ratio. For all mixtures the ratio of minus No. 200 material to effective asphalt binder (Pbe) shall as follows.

Design	D/B
SP095, SP125, SP190, SP250	0.8 – 1.6
SP048	0.9 – 2.0
SMA	-

101 WWMBs – S – W

490.10.5.127 Porphyry Mixtures. In addition to the SP mixture requirements, mixtures designated as porphyry (LP) mixtures shall meet the following. At least 50 percent by volume of the aggregate shall be crushed porphyry retained on the following sieves: No. 30 for SP048, No. 16 for SP095 and No. 8 for SP125. Depending on the actual gradation of porphyry aggregate furnished, the amount of crushed porphyry required may vary, however at least 40 percent by weight of crushed porphyry will be required. Steel slag may be substituted for porphyry in LP mixtures, except at least 45 percent by weight of crushed porphyry and/or slag will be required. The engineer may approve the use of other hard, durable aggregate in addition to porphyry and steel slag.

490.10.5.138 Stone Matrix Asphalt Mixtures. In addition to the SP mixture requirements, SMA mixtures shall meet the following. Coarse aggregate shall consist of crushed limestone and either porphyry or steel slag in accordance with the quality requirements of Sec 1002, except as follows. The Los Angeles (LA) abrasion, when tested in accordance with AASHTO T 96, shall not exceed 40 percent based on initial ledge approval and source approval. The percent absorption, when tested in accordance with AASHTO T 85, shall not exceed 3.5 percent based on the individual fractions. The amount of flat and elongated particles, measured on material retained on a No. 4 sieve, of the blended aggregate shall not exceed 20 percent based on a 3:1 ratio or 5 percent based on a 5:1 ratio.

490.10.5.8.1 Durability. SMA mixtures shall meet the requirements of a Sec 490.10.5.7 for Porphyry mixtures. When an SMR mixture is designated, in lieu of the porphyry requirement, the mixture shall contain aggregate blends with at least 30 percent non-carbonate material as defined in Sec 490.10.5.4.

490.10.5.8.2 Voids in Coarse Aggregate. The percent VCA_{MIX} of SMA mixtures shall be less than or equal to the VCA_{DRC} as determined using AASHTO T 19 using the following equations:

$$VCA_{DRC} = 100 \times (G_{CA}\gamma_W - \gamma_S) / G_{CA}\gamma_W$$

$$VCA_{MIX} = 100 - (P_{bp} \times G_{MB} / G_{CA})$$

$$P_{bp} = P_S \times PA_{bp}$$

Where: G_{CA} = bulk specific gravity of the combined coarse aggregate (AASHTO T 85)
γ_S = unit weight of coarse aggregate in the dry-rodded condition (DRC) (lb/ft3) (AASHTO T 19)
γ_W = unit weight of water (62.34 lb/ft3)
P_{bp} = percent aggregate by total mixture weight retained on No. 4 sieve*
PA_{bp} = percent aggregate by total aggregate weight retained on No. 4 sieve*

*Use No. 8 sieve for SP095xSM

490.10.5.138.1 3 Filler Restriction. Rigden void content determined in accordance with MoDOT Test Method TM-73 shall be no greater than 50 percent.

490.10.5.138.24 Draindown. AASHTO T 305, Draindown Test, shall be performed on all SMA mixtures prior to job mix approval. The mixture shall be stabilized in such a way that the draindown of the asphalt binder shall not exceed 0.3 percent by weight of mixture.

490.10.5.138.35 Fibers. A fiber additive shall be used as a stabilizer in SMA mixtures. Fibers shall be uniformly distributed by the end of the plant mixing process. The dosage rate for fibers shall be no less than 0.3 percent by weight of the total mixture for cellulose and no less than 0.4 percent by weight for mineral fibers.

490.10.5.138.46 Minimum Stone Matrix Asphalt Binder. The percent asphalt binder for SMA mixtures shall not be less than 6.0 percent unless otherwise allowed by the engineer.

~~**105.13.5Durability.** SMA mixtures shall meet the requirements of a Sec 490.10.5.12 for Porphyry mixtures. Win lieu of the porphyry requirement, shallas defined in~~

490.10.6 UBAWS Mixture Characteristics.

490.10.6.1 Coarse Aggregate. Coarse aggregate may consist of crushed gravel, limestone, dolomite, porphyry, steel slag, flint chat, or blends of two or more of these aggregates will be acceptable. When coarse aggregate for these mixes are from more than one source or of more than one type of material, the coarse aggregate shall be proportioned and blended to provide a uniform mixture. Coarse aggregate shall be material predominantly retained above the No. 4 sieve and shall be in accordance with the following requirements:

Coarse Aggregate			
Requirements on Individual Ledge Basis	**Method**	**Min.**	**Max.**
Micro-Deval, % loss	AASHTO T 327	-	18
Los Angeles Abrasion Value, % Loss	AASHTO T 96		35
Soundness, % Loss, Sodium Sulfate	AASHTO T 104		12
Requirements on the Course Portion of the Blended Aggregate	**Method**	**Min.**	**Max.**
Flat & Elongated Ratio, % @ 3:1	ASTM D 4791	-	25
% Crushed, single faces	ASTM D 5821	95	-
% Crushed, two faces	ASTM D 5821	85	

490.10.6.2 Fine Aggregate. Fine aggregate portion of the blended aggregate shall be material predominantly passing the No. 4 sieve and shall be in accordance with the following requirements:

Tests	Method	Min	Max
Sand Equivalent	AASHTO T 176	45	-
Methylene Blue	AASHTO T 330	-	10
Uncompacted Void Content	AASHTO T 304	40	-

490.10.6.3 Gradation. Prior to mixing with asphalt binder, the combined aggregate gradation, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract.

Composition by Weight Percentages			
	Type A	**Type B**	**Type C**
Sieves	**% Passing**	**% Passing**	**% Passing**
3/4 in.	-	100	100
1/2 in.		97 - 100	85 – 100
3/8 in.	100	75 – 100	50 – 80
No. 4	40 – 55	25 – 41	25 – 41
No. 8	22 – 32	17 – 27	17 – 27
No. 16	15 – 25	23 max	23 max
No. 30	18 max	18 max	18 max
No. 50	13 max	13 max	13 max
No. 100	10 max	10 max	10 max
No. 200	4.0 – 6.0	4.0 – 6.0	4.0 – 6.0

490.10.6.4 Non-Carbonate Aggregate Requirement. Mixtures containing limestone coarse aggregate shall contain a minimum amount of non-carbonate aggregate as shown in the table below, or the aggregate blend shall have an acid-insoluble residue (A.I.R.), MoDOT Test Method TM 76, meeting the plus No. 4 sieve criteria of crushed non-carbonate material. Non-carbonate aggregate shall have an A.I.R. of at least 85 percent insoluble residue.

Coarse Aggregate (+ No. 4)	Minimum Non-Carbonate by Volume
Limestone	30% Plus No. 4

Dolomite	No Requirement

490.10.6.5 Asphalt Binder. The asphalt binder shall be PG76-22 or PG70-28 in accordance with Sec 1015, including all subsections pertaining to UBAWS.

490.10.6.6 Binder Content. The amount of asphalt binder in the mixture shall meet the following limits for the type of mixture specified in the contract.

UBAWS	Type A	Type B	Type C
Asphalt Content	5.4 – 5.8 %	5.3 – 5.6 %	5.2 – 5.6 %

490.10.6.7 Film Thickness. The film thickness shall be a minimum 10.0 microns when calculated using the effective asphalt content in conjunction with the surface area for the aggregate in the Job Mix Formula. The surface area factors can be found in Table 6.1 of the Asphalt Institute MS-2, *Mix Design Methods for Asphalt Concrete and Other Hot Mix Types*, Sixth Edition.

490.10.6.8 Drain Down. Drain down from the loose mixture shall not exceed 0.10 percent when tested in accordance with AASHTO T 305.

490.20 Approval Process.

490.20.1 Mix designs may be approved by the engineer either through a full verification process or a 7-day review process. The engineer has the right to perform a full verification on any mixture submitted.

490.20.2 Job Mix Formula Modification. The JMF approved for each mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results occur or should a source of material be changed, a new JMF may be required.

490.20.3 7-Day Review. Laboratories that participate and achieve a score of 3 or greater in the AASHTO proficiency sample program for T 11, T 27, T 84, T 85, T 166, T 176, T 209, T 304, T 308 and T 245 or T 312 will have the option of submitting mix designs for 7-day review. The mix design shall be submitted to Construction and Materials for approval at least seven days prior to mixture production. Samples of components will not be required unless for nuclear density or ignition oven correction factor purposes.

490.20.4 Full Verification. When a full verification is required representative samples of each ingredient for the mixture shall be submitted with the mix design. The mix design and ingredients shall be submitted to Construction and Materials for approval at least thirty days prior to production. Aggregate fractions submitted shall be in the same proportions as the proposed job mix formula with a minimum of 150 pounds required for any individual fraction. The amount of each ingredient submitted shall be as follows for each mix design to be verified:

Ingredient	Marshall Design	Superpave or SMA Design
Aggregate, RAP, and/or RAS	300 Pounds	750 Pounds
Hydrated Lime, Mineral Filler and/or Baghouse Fines	20 Pounds	20 Pounds
Asphalt Binder	10 Gallon	10 Gallons
Antistrip, Warm Mix Additives, and/or Rejuvenating Agents.	1 Gallon	1 Gallon

490.20.5 Required Information. The mix design shall include a detailed description of the mix design process and raw data from the design process including the following information when applicable:

(a) All possible sources intended for use, and grade and specific gravity of asphalt binder.

(b) Source, type (formation, etc.), ledge number(s) if applicable, gradation, and percent chert of each aggregate fraction.

(c) For BB, BP, and SL mixtures, plasticity index of each aggregate fraction which has 10 percent or more passing the No. 30 sieve.

(d) Bulk and apparent specific gravities and absorption of each aggregate fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate, including all raw data, or in accordance with MoDOT TM 81.

(e) Specific gravity of hydrated lime, mineral filler or baghouse fines, if used, in accordance with AASHTO T 100.

(f) Percentage of each aggregate component.

(g) Combined gradation of the job mix.

(h) Percent of asphalt binder, by weight, based on the total mixture.

(i) Bulk specific gravity (G_{mb}) by AASHTO T 166, Method A of a laboratory compacted mixture.

(j) Percent air voids (V_a) of the laboratory compacted specimen.

(k) Voids in the mineral aggregate (VMA) and voids in the mineral aggregate filled with asphalt binder (VFA).

(l) Theoretical maximum specific gravity (G_{mm}) in accordance with Sec 490.9.

(m) Mixing temperature and molding temperature as well as the gyratory sample weight to produce a 115 mm minimum height specimen.

(n) Bulk specific gravity (G_{sb}) of the combined aggregate.

(o) Percent deleterious content of the combine aggregate.

(p) Reclaimed asphalt binder contribution worksheet as well as any extraction or blend calculations needed to prove contract compliance.

(q) The tensile strength ratio as determined by AASHTO T 283 including all raw data.

(r) The film thickness for UBAWS mixtures.

(s) Number of gyrations at $N_{initial}$, N_{design}, and $N_{maximum}$.

(t) Dust proportion ratio (-200/P_{be}).

(u) Percent of G_{mm} at $N_{initial}$ and $N_{maximum}$.

(v) Blended aggregate properties for clay content, angularity, and thin and elongated particles.

(w) Voids in coarse aggregate (VCA) for both the mixture and dry-rodded condition for SMA mixtures.

(x) Draindown for SMA and UBAWS mixtures.

(y) Baghouse fines added for design. Provide the combine gradation with and without the baghouse percentage.

(y-i) Batch and continuous mix plants – Indicate which aggregate fraction to add baghouse percentage during production.

(y-ii) Drum mix plants – Provide cold feed settings with and without baghouse percentage.

(z) Ignition oven correction factor(s) and test temperatures used when testing of the combined aggregate, RAP, or RAS gradations.

SECTION 610

PAVEMENT SMOOTHNESS

610.1 Description. This work shall consist of measuring the smoothness of the final pavement surface. Smoothness shall be measured using the International Roughness Index (IRI). The following pavement types shall comply with this specification:

(a) Multi-lift asphalt construction greater than 3 inches contained in Secs 401 and 403.

(b) Concrete pavement construction contained in Secs 502 and 506.

(c) Combination of surface planning, such as diamond grinding or milling, and single lift asphalt construction or multi-lift asphalt construction less than or equal to 3 inches contained in Secs 401 and 403.

(d) Single lift asphalt construction contained in Secs 401 and 403.

610.2 Material Requirements.

610.2.1 Inertial Profiler. IRI shall be computed from profile data collected with an inertial profiler (IP) that meets the requirements of AASHTO M 328

610.2.2 ProVAL Software. The ProVAL software program shall be used to compute IRI smoothness and locate areas of localized roughness (ALR) in accordance with MoDOT TM-59.

610.2.3 Straightedge. A rolling 10-foot straightedge shall be used for checking longitudinal elevation changes. A 4-foot straightedge shall be used for checking transverse elevation changes.

610.3 Certification. All inertial profilers used to collect data on MoDOT projects shall be annually certified at the MoDOT certification site in accordance with TM-59. The operator of the IP shall be certified through the MoDOT technician certification program.

610.4 Construction Requirements.

610.4.1 Smoothness Increments. Length of pavement shall be defined in the following increments for the purpose of smoothness acceptance:

(a) Section – A section is a day's paving and shall begin and terminate at the construction joints. Interruptions designated by the engineer which cause placement to cease and begin at a new location will considered as a separate section for that day's operation if the separate section is greater than 250 feet.

(b) Segment – Sections shall be divided into segments of 0.1 mile lengths with the exception of the last segment. If the last segment is greater than 250 feet and less than 0.1 mile, then the segment shall be measured for smoothness as an independent segment. If the last segment is 250 feet or less, the profile for that segment shall be

included in the evaluation for the previous segment. The combined segment IRI shall be weighted for the length.

610.4.2 Profiling Areas.

610.4.2.1 Profiling will be applicable to the surface of all the following:

(a) Mainline paving

(b) Auxiliary lanes, turning lanes and ramps for projects or combination of projects, consisting of more than 0.5 mile of total profilable pavement.

610.4.2.2 Profiling will not be required for the following exceptions:

(a) Bridge decks, bridge approach slabs and concrete approach pavements.

(b) Pavement on horizontal curves with centerline radius of curve less than 1000 feet and pavement within the superelevation transition of such curves.

(c) Pavement on vertical curves having a "K" value less than 90 and a length less than 500 feet.

(d) Pavement width transitions.

(e) Fifty feet in direction of travel on each side of utility appurtenances such as manholes and valve boxes.

(f) Fifty feet in direction of travel on each side of intersecting routes ~~with special grade transition.~~.

(g) Shoulders.

(h) Interruptions designated by the engineer which provide independently placed sections shorter than 50 feet.

(i) The last 15 feet of any section where the prime contractor is not responsible for the adjoining surface.

(j) Any lane which abuts an existing lane not constructed under the same contract.

610.4.2.3 In addition to the exceptions in Sec 610.4.2.2, profiling may be waived by the engineer if staging of the overall project; such as multiple entrance lane gaps, lane staging, etc.; affects the normal paving operation, or if multiple profile exceptions continuously exist on a large portion of the same roadway. Upon waiver, exempted areas shall be checked with a 10-foot straightedge.

610.4.3 Longitudinal Straightedging. Any pavement surface not measured with an inertial profiler shall be measured with a 10-foot straightedge. The straightedge path in the longitudinal direction for driving lanes will be located three feet from the outside edge and for shoulders will be located in the center. Additional paths with suspect roughness may be selected at the engineer’s discretion. Shoulders that are paved integrally with an adjacent driving lane will not require straightedging. The engineer also has discretion to use a straightedge for spot checking pavement that had been measured with an inertial profiler. Any variations in the longitudinal direction exceeding 1/4 inch in 10 feet on shoulders and 1/8 inch

in 10 feet on all other pavements shall be marked for correction in a manner approved by the engineer.

610.4.4 Transverse Straightedging. The engineer shall randomly check driving lanes, regardless of the smoothness measurement method used, for variations in the transverse direction with a 4-foot straightedge. Any variations in the transverse direction more than 1/4 inch shall be marked for correction in a manner approved by the engineer.

610.4.5 Full Depth Pavement and Multi-lift Overlays > 3 Inches. These construction procedures apply to pavement treatments described in Sec 610.1 (a) and (b).

610.4.5.1 Quality Control Testing. The contractor shall perform quality control (QC) testing on all eligible profiling areas and provide electronic files for smoothness data in .PFF file format to the engineer in accordance with the testing and reporting procedures in MoDOT TM-59. Reported IRI for each segment is the average of both wheel paths. Furnishing inaccurate test results may result in decertification of the inertial profiler operator. Average segment IRIs shall meet the threshold requirement in Table 1.

610.4.5.2 Quality Assurance Testing. The engineer will perform quality assurance (QA) testing with a MoDOT inertial profiler to verify the QC test results. The engineer shall select a continuous portion of roadway; not adjacent to the beginning or ending of the project limits and free to the degree possible of exempted areas, such as bridges; that constitute at least 10 percent of the project lane-miles, which will be designated as the QA test length. The beginning and ending of the QA test length shall be clearly marked with paint. Both the contractor and engineer shall measure the IRI in both wheel paths for the entire QA test length with their respective inertial profilers. The stat and stop of the inertial profiler runs shall be triggered automatically. The contractor inertial profiler run on the QA test length may constitute the regular QC test result or may be run independently from previous QC test results. The contractor shall provide the electronic file for the QA test length run in .PFF format to the engineer within 24 hours of testing. The IRI value for each segment within the QA test length shall be computed as the average of both wheel paths. The absolute value of the difference between the contractor and engineer IRIs shall be computed for each segment within the QA test length. The average of the absolute values of the IRI difference shall be 8 inches/mile or less. The absolute value of the IRI difference for any single segment shall be 12 inches/mile or less.

610.4.5.3 Areas of Localized Roughness. An area of localized roughness (ALR) is any length of pavement with a continuous 25-foot average IRI measured in the right wheel path that exceeds the maximum threshold set in Table 1. ALRs shall be corrected.

610.4.5.4 Method of Correction. Corrective action to eliminate ALRs and improve the average IRI shall be accomplished by a method approved by the engineer. Diamond grinding may be used for bumps, but the use of an impact device, such as a bush hammer, will not be permitted. Total grinding depth shall be limited to ¼ inch. Satisfactory longitudinal grinding is acceptable as the final surface of the corrected pavements. All corrective work shall be completed prior to determination of pavement thickness. The contractor shall reprofile the corrected lengths to verify smoothness compliance and submit an electronic data file in .PFF format to the engineer within 48 hours after testing.

Table 1				
Treatment Type	**Posted speed > 45 mph**		**Posted speed ≤ 45 mph**	
	Maximum Segment IRI (in/mi)	**Maximum ALR IRI (in/mi)**	**Maximum Segment IRI (in/mi)**	**Maximum ALR IRI (in/mi)**
Full Depth Pavement or Multi-Lift Overlay > 3-inches Sec 610.1 (a) and 610.1 (b)	80.0	125.0	125.0	175.0
Multi-Treatment and Multi-Lift Overlays ≤ 3-inches	**Posted speed > 45 mph and AADT > 3500**		**Posted speed ≤ 45 mph or AADT ≤ 3500**	
	Maximum Segment IRI (in/mi)	**Maximum ALR IRI (in/mi)**	**Maximum Segment IRI (in/mi)**	**Maximum ALR IRI (in/mi)**
	80.0	~~125~~175.0	125.0	175.0

610.4.6 Multi-treatment Overlays or Multi-lift Overlays ≤ 3 Inches. These construction procedures apply to pavement treatments described in Sec 610.1 (c).

610.4.6.1 Quality Control Testing. The requirements are the same as Sec 610.4.5.1, except that segment average IRIs shall meet the threshold requirements for multi-lift overlays less than or equal to 3 inches in Table 1.

610.4.6.2 Quality Assurance Testing. The requirements are the same as Sec 610.4.5.2.

610.4.6.3 Areas of Localized Roughness. All ALRs, as defined in Sec 610.4.5.3, that exceed the maximum threshold set in Table 1~~3 exceeding 175.0 inches/mile~~ shall be corrected.

610.4.6.4 Method of Correction. Corrective action to eliminate ALRs and improve the average IRI shall be accomplished with a method approved by the engineer. Diamond grinding bumps shall only be permitted for a 1 1/2-inch or greater single lift overlay. Grinding depth shall be limited to ¼ inch. The contractor shall reprofile the corrected lengths to verify smoothness compliance and submit an electronic data file in .PFF format to the engineer within 48 hours after testing.

610.4.7 Single Lift Overlays. These construction procedures apply to pavement treatments described in Sec 610.1 (d).

610.4.7.1 Pre-Construction Quality Control Testing. Prior to performing any surface work or pavement repairs, the contractor shall profile the right wheel path in accordance with TM-59. This control profile will serve as the baseline for calculating percent improvement for the project.

610.4.7.2 Post-Construction Quality Control Testing. As soon as practical after resurfacing, the contractor shall profile the right wheel path again. The same stationing shall be used to ensure a direct comparison with the pre-construction profile.

for use with 3/8-inch bolts and shall have a minimum outside diameter of 3/4 inch, and a nominal thickness of 1/16 inch.

1042.2.7 Retroreflective Sheeting. Retroreflective sheeting shall be in accordance with latest versions or ASTM D 4956 and AASHTO M 268, except as noted herein. Color and luminance values for all MoDOT types of reflective sheeting shall be in accordance with ASTM D 4956. Retroreflective sheeting shall have sufficient adhesion, strength and flexibility such that the sheeting can be handled, processed and applied according to the manufacturer's recommendations without appreciable stretching, tearing, cracking or other damage. Adhesive performance for retroreflective sheeting shall be in accordance with ASTM D 4956. The sheeting surface shall be in condition to be readily screen processed and compatible with transparent overlay films, plus recommended transparent and opaque screen process colors. The retroreflective sheeting manufacturer shall furnish information as to the type of solvent or solvents that may be used to clean the surface of the sheeting without detrimental loss of performance and durability. Retroreflective sheeting having a datum mark on the surface shall be oriented vertically. ASTM D 4956 Type IX, XI or AASHTO M 268 Type C or D retroreflective sheeting applied as legend and border for specific signing applications, without a datum mark on the surface of the sheeting, shall be evaluated for rotational sensitivity per AASHTO M 268, Section 3.3. Retroreflective sheeting products that do not meet the rotational sensitivity requirements of Section 3.3 shall follow guidelines detailed in AASHTO M 268 Section 3.3.1 and fabricated per AASHTO M 268 Section 3.3.2.

1042.2.7.1 ASTM D 4956 Type I, Class 1 retroreflective sheeting shall be enclosed lens glass-bead or prismatic sheeting.

1042.2.7.2 Sign Sheeting. Background sheeting applied to flat sheet and extruded panel signs shall be in accordance with ASTM D 4956 Type IV, Class 1. All yellow, orange and yellow green sheeted signs shall be fabricated with ASTM D 4956 Type IX, XI or AASHTO M 268 Type C or D fluorescent yellow, fluorescent orange and fluorescent yellow green sheeting respectively. Retroreflective sheeting shall be high intensity that is an unmetallized micro prismatic reflective material.

1042.2.7.3 Channelizers. All reflective sheeting for channelizers and drum-like channelizers shall be in accordance with ASTM D 4956 Type IX or XI for fluorescent orange sheeting and in accordance with ASTM D 4956 Type IV for orange or white sheeting. All retroreflective marking on channelizers shall be in accordance with ASTM D 4956, Supplemental Requirements, and Section S2. Reflective sheeting applied to channelizers shall be reboundable in accordance with ASTM D 4956. Retroreflective marking on cones will not be required.

1042.2.7.4 Advanced Warning Rails. All reflective sheeting for advanced warning rails shall be in accordance with ASTM D 4956 Type IV.

1042.2.7.5 Delineators. All retroreflective sheeting for delineators shall be in accordance with ASTM D 4956 Type IX or XI requirements, except permanent and temporary tubular delineators, which shall be ASTM D 4956 Type IV requirements. All permanent and temporary tubular delineators' reflective sheeting shall be reboundable in accordance with ASTM D 4956.

1042.2.7.6~~3~~ Retroreflective sheeting applied as legend and border shall be in accordance with ASTM D 4956, Type IX, XI or AASHTO Type C or D, Class 1.Retroreflective sheeting shall be an unmetallized cube corner microprismatic reflective material.

1042.2.7.74 Screen Print and Overlay. For screen printed transparent colored areas or transparent colored overlay films on white sheeting, the coefficient of retroreflection (R_A) shall be no less than 70 percent of the original values for the corresponding color.

~~**1042.2.7.5** Reflective sheeting for temporary traffic control devices and delineators shall be in accordance with Sec 1063 and Sec 1065 respectively.~~

1042.2.8 Outdoor Exposure. Retroreflective sheeting, except for work zone signs, shall be submitted by the manufacturer to NTPEP for two years of 45-degree south-facing outdoor exposure. Retroreflective sheeting for work zone signs shall be submitted by the manufacturer to NTPEP for an exposure time of one year. Results shall be published by NTPEP and available for MoDOT review. For all NTPEP test decks, retroreflective sheeting shall have a coefficient of retroreflection at least 50 percent of the specified value for ASTM D 4956 Type I or 80 percent of the original reading for ASTM D 4956 Type IV, IX or XI.

1042.2.9 Manufacturer and Brand Name Approval. The manufacturer shall make available, upon request, NTPEP test results from all test decks, and certification to Construction and Materials, showing reflective material is in accordance with ASTM D 4956 specification. In addition, the manufacture shall, upon request, submit samples representing the retroreflective sheeting tested by NTPEP, and with compatible inks. These samples shall be accompanied by a product data sheet, an MSDS, technical bulletins on sign fabrication and any special fabrication instructions relative to the retroreflective sheeting submitted. Samples of retroreflective sheeting shall 10 x 10 inches and applied to an aluminum substrate.

1042.2.9.1 Materials that fail to provide satisfactory field performance will be evaluated and may be disqualified from future use on fabricated signs for MoDOT. All corrective actions made by MoDOT will control.

1042.2.10 Type of Characters. Letters, numerals, arrows, symbols, borders and other features of the sign message shall be of the type, size and series shown on the plans or as specified by the engineer. Completed letters, numerals and other units shall be formed to provide a continuous stroke width with smooth edges, and shall yield a flat surface free of air bubbles, wrinkles or other blemishes as determined by the engineer. Units of the sign message shown on the plans shall meet the requirements for the specified type.

1042.2.10.1 Screen Print, Transparent Overlay and Opaque Black Film.

1042.2.10.1.1 The letters, numerals, arrows, symbols and borders shall be applied to the background of the sign by the direct or reverse screen process. Messages and borders of a color darker than the sign field shall be applied to the retroreflective sheeting by the direct process. Messages and borders of a color lighter than the sign field shall be produced by the reverse screen process. Inks used in the silkscreen process shall be of the type to produce the desired color and durability when applied on retroreflective sheeting. Silkscreen inks shall be used in accordance with the manufacturer's recommendations. The ink shall produce the desired color when applied on retroreflective sheeting background and shall dry to a good film without running, streaking or sagging. The screening shall be done in a manner that results in a uniform color and tone, with sharply defined edges of legend and border without blemishes on the sign field that will affect the intended use. Signs after screening shall be dried in accordance with the manufacturer's recommendations to provide a smooth hard finish. Any signs on which blisters appear during the drying process will be rejected.

1042.2.10.1.2 Transparent overlay films may be used as a replacement for the reverse screen process, as recommended by the sheeting manufacturer.

SECTION 1063

TEMPORARY TRAFFIC CONTROL DEVICES

1063.1 Scope. This specification covers material to be used for temporary traffic control devices.

1063.2 General Requirements. All temporary traffic control devices shall be manufactured as shown on the plans and as specified, in accordance with MUTCD requirements and shall be NCHRP 350 compliant. Nominal dimensions will be permitted for dimensional lumber where applicable. All temporary traffic control devices shall exhibit good workmanship and shall be free of objectionable marks or defects that affect appearance or serviceability. The brand name or model number shall be permanently identified on each traffic control device.

1063.3 Channelizers~~ and Tubular Markers~~. All trim-lines and drum-like channelizers~~channelizers and tubular markers~~ shall be manufactured from a non-metallic material, pigmented and molded of a Highway Orange color throughout and stabilized against fading by ultraviolet or other light rays by the incorporation of adequate inhibitors.
All reflective sheeting for channelizers shall be in accordance with Sec 1042.2.7.3.

1063.3.1 Temporary Tubular Delineators. Temporary tubular delineators shall be a nominal height of 28 inches and manufactured from a non-metallic material, pigmented and molded of a Highway Orange color throughout and stabilized against fading by ultraviolet or other light rays by incorporation of adequate inhibitors. All reflective sheeting for temporary tubular delineators shall be in accordance with Sec 1042.2.7.5.~~Tubular markers shall be applied with reflective sheeting meeting either ASTM D 4956 Type 4 or 5. Drum-like channelizers shall be closed top and applied with either ASTM D 4956 Type 3 or 4 reflective sheeting. Trim-line channelizers shall be applied with white sheeting meeting either ASTM D 4956 Type 3 or 4 and fluorescent orange in accordance with Sec 1042.2.7.3. All retroreflective marking on channelizers and tubular markers shall be in accordance with ASTM D 4956, Supplemental Requirements, Section S2. Retroreflective marking on cones will not be required.~~

1063.4 Signs.

1063.4.1 Rigid Signs.

1063.4.1.1 Sign Substrate. All signs shall be fabricated of substrate designed to provide satisfactory structural rigidity.

1063.4.1.2 Sign Sheeting. All signs shall have a retroreflectorized background. Retroreflective sheeting shall be in accordance with Sec 1042.2.7.2~~, Type 4 or fluorescent orange and yellow, as shown on the plans~~. Sheeting shall be applied to the sign substrate in accordance with the manufacturer's recommendations and the surface shall be free of air bubbles, wrinkles or other blemishes as determined by the engineer.

1063.4.2 Roll-up Signs.

1063.4.2.1 Sign Substrate. Sign and overlay blanks shall consist of either white, yellow, fluorescent orange and/or pink microprismatic retroreflective sheeting sealed to a heavy-duty coated fabric or vinyl material. The sheeting shall have a minimum coefficient of retroreflection, expressed as candelas per footcandle per square foot, as shown below, when

measured in accordance with ASTM E 810 and shall meet the minimum color requirements in accordance with MGS-04-01L specification. The color specifications shall be in accordance with ASTM D 4956. Material shall be submitted by the manufacturer to NTPEP for a minimum exposure time of one year. Results shall be published by NTPEP and available for MoDOT review. For all NTPEP test decks, weathered material shall be within the color specification limits. Heat and impact resistance of the sheeting shall be in accordance with the latest version of ASTM D 4956.

1063.4.2.2 Overlays. Overlays, when used, shall be mechanically fastened to the face of the sign in a manner that will ensure the overlay remains securely attached. Fasteners shall not detract from the appearance of the sign when the overlay is not in use. Velcro fasteners will not be permitted.

1063.4.2.3 Bracing. Each sign shall have a horizontal and vertical cross brace and at least one anti-kiting device located near the center of the sign. Cross braces of sufficient cross-section shall be fastened to each other at the midpoints and the ends securely held to the back of the sign by mechanical means. The design shall ensure that the sign remains taut and retains the sign's intended shape when exposed to normal field conditions.

1063.4.3 Legend and Borders. Legends and borders of all signs shall be vinyl or silk-screened. Vinyl shall be cut by die or a computer-driven cutter. Stencil ink used shall be in accordance with the sheeting manufacturer's recommendations. Free-hand legend and borders will not be permitted.

1063.4.4 Sign Layout and Design. Sign layout and design shall be as shown on the plans or as directed by the engineer.

1063.4.5 Flag Assembly. Flag assemblies, when specified, shall consist of a flag bracket and two flags. Flags shall be 18 in x 18 in fluorescent orange, vinyl and be securely attached on one side to a blank suitable for displaying the flag as shown on the plans. The flag shall not be of mesh material. The blank shall be securely attached to the flag bracket, be of sufficient cross-section to display the flag in wind speeds up to 50 mph and be of sufficient length to hold the flags approximately six inches from the sign.

1063.4.6 Advance Warning Rails. Advanced warning rails shall be supplied as a system of three rails as shown on the plans. The rail system may be post mounted or mounted on portable structures**.** When used on post mounted signs, the advance warning rails shall consists of substrate of high-density polyethylene plastic. The rail wall thickness shall be 1/4 in. with white and orange reflective sheeting in accordance with Sec 1042.2.7.~~3~~4, and shall be applied as shown on the plans.

1063.5 Warning Lights.

Warning Lights				
Item	**Type A Low Intensity**	**Type B High Intensity**	**Type C Steady Burn**	**Sequential Flashing**
Lens Directional Faces	**1 or 2**	**1**	**1 or 2**	**1**
Flashing Rate per Minute	**55 to 75**	**55 to 75**	**Constant**	**55 to 75**
Minimum (1)	**10%**	**8%**	**Constant**	**Constant**
Hours of Operation	**Dusk to Dawn**	**24 hrs/day**	**Dusk to Dawn**	**24 hrs/day**

1063.6 Flashing Arrow Panels. All lamps shall have a nominal 5-inch, 360-degree tunnel visor. A lamp on the back side of the flashing arrow panel shall be continuously energized

SECTION 1065

DELINEATORS

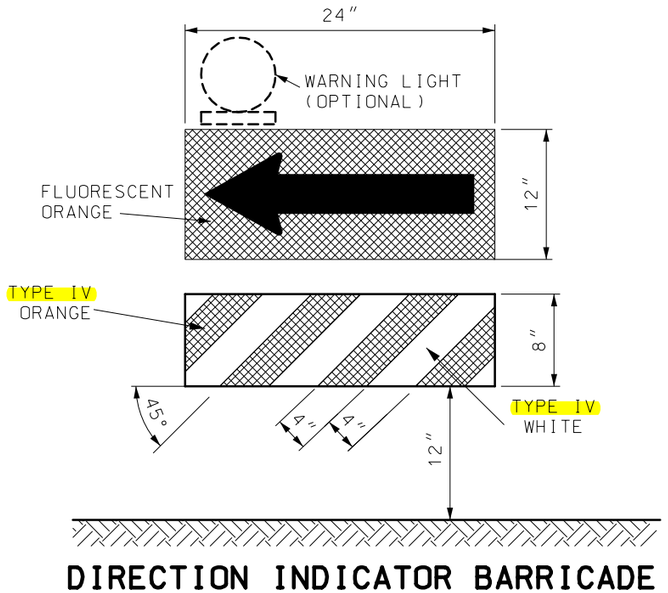
1065.1 Scope. This specification covers delineators for use in highway construction.

1065.2 Delineator Body. The delineator body shall be flat sheet aluminum in accordance with Sec 1042.2.1 and meet dimensions as shown on the plans.

1065.3 Permanent Tubular Delineators. Permanent tubular delineators shall be a nominal height of 36 inches and manufactured from a non-metallic material, pigmented and molded to match the color of the closest pavement or curb marking, and stabilized against fading by ultraviolet or other light rays by incorporation of adequate inhibitors.

1065.4 Temporary Traffic Barrier Delineators. Temporary tabs shall be manufactured from a thermoplastic material and meet dimensions as shown on the plans.

1065.5~~3~~ Retroreflective Sheeting. ~~The retroreflective sheeting shall be in accordance with ASTM D 4956 Type 5 or 8 requirements.~~ Retroreflective sheeting shall be permanently affixed to the body of the delineator and follow guidelines in accordance with Sec 1042.2.7.5 for application of sheeting. Manufacturer's certification shall be provided for delineator sheeting.

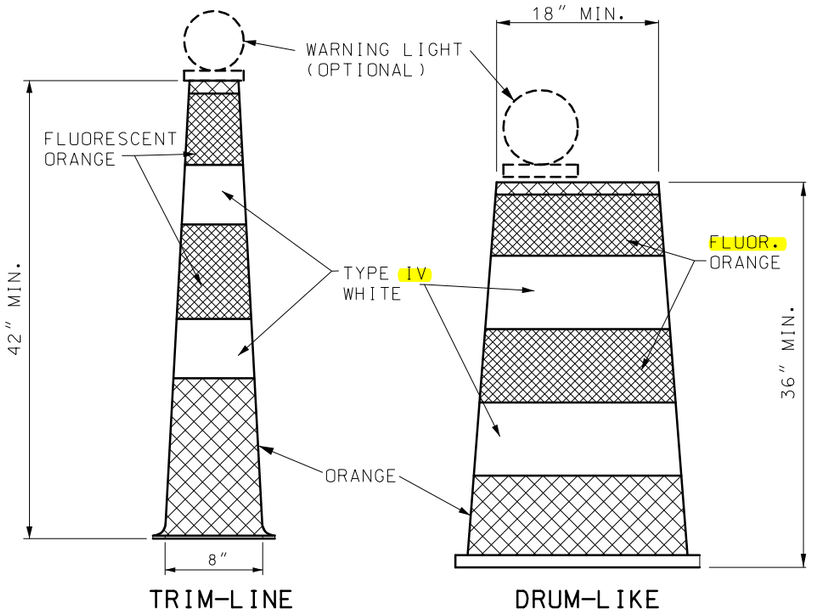


DIRECTION INDICATOR BARRICADE

VERTICAL DIMENSIONS DO NOT INCLUDE PROJECTIONS DESIGNED FOR EASE OF HANDLING.

DIRECTION INDICATOR BARRICADES SHALL NOT BE USED IN SHIFTING TAPERS UNLESS SHOWN ON THE PLANS.

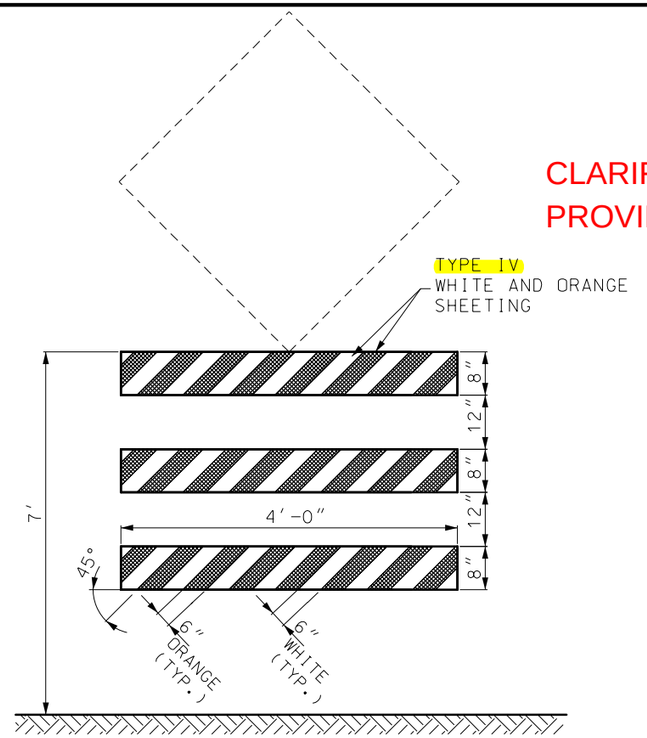
THE PANELS SHALL BE SECURELY ATTACHED TO A SUPPORT THAT IS PORTABLE, CAPABLE OF REMAINING UPRIGHT AND ENTIRELY FREE STANDING.



CHANNELIZERS

WHITE, ORANGE, AND FLUORESCENT ORANGE REFLECTIVE SHEETING SHALL BE IN ACCORDANCE WITH SEC 1042.2.7.3.

STRIPES ON TRIM-LINE CHANNELIZERS SHALL BE 6" TO 8".
STRIPES ON DRUM-LIKE CHANNELIZERS SHALL BE 4" TO 6".



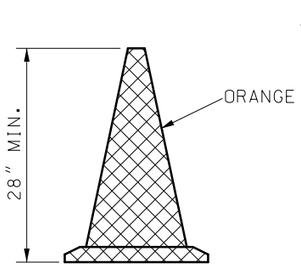
ADVANCE WARNING RAIL SYSTEM

MAXIMUM WEIGHT OF SIGN SHALL NOT EXCEED 25 LBS.

THE SIGN AND RAIL SYSTEM MAY BE MOUNTED AS TWO SEPARATE CRASHWORTHY DEVICES. THE RAIL SYSTEM SHALL BE LOCATED DIRECTLY IN FRONT OF THE SIGN WITH 7 TO 10 FEET SEPARATING THE TWO DEVICES.

WHERE MARKING IS NOT PROVIDED ON THE BACKSIDE, STRIPS OF 3" WIDE MODOT TYPE 7 ORANGE SHEETING MAY BE APPLIED TO THE ENDS OF EACH RAIL TO HELP DELINEATE THE DEVICE.

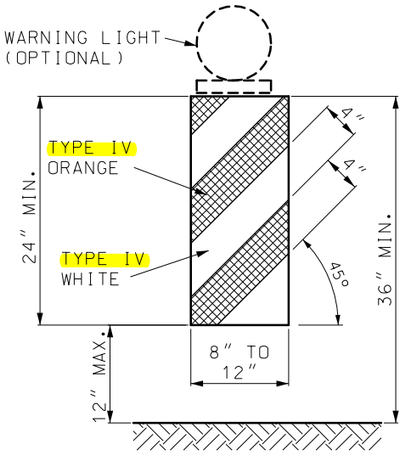
WHITE AND ORANGE REFLECTIVE SHEETING SHALL BE IN ACCORDANCE WITH SEC 1042.2.7.4.



CONE

CONES SHALL MAINTAIN THEIR SHAPE UPON EXPOSURE TO NORMAL WORK CONDITIONS.

CONES SHALL BE USED DURING DAYLIGHT HOURS ONLY.



VERTICAL PANEL

VERTICAL PANELS SHALL BE SECURELY ATTACHED TO A SUPPORT THAT IS PORTABLE, CAPABLE OF REMAINING UPRIGHT AND ENTIRELY FREE STANDING.

CLARIFIED CURRENT REQUIREMENTS FOR SHEETING AND PROVIDED CORRECT SECTION REFERENCES.

GENERAL NOTES:

WHITE, ORANGE, AND FLUORESCENT ORANGE REFLECTIVE SHEETING SHALL BE IN ACCORDANCE WITH SEC 1042.2.7.

BALLAST FOR TRAFFIC CONTROL DEVICES SHALL CONFORM TO MANUFACTURERS' RECOMMENDATION FOR FIELD CONDITIONS WHEN APPLICABLE.

IF USED, THE WARNING LIGHT UNIT AND BATTERY COMPARTMENT SHALL BE FURNISHED BY THE DEVICE MANUFACTURER OR OTHERWISE MEET THE MANUFACTURER'S RECOMMENDATIONS FOR DESIGN AND WILL BE REQUIRED ON ALL DEVICES IN THE SERIES.

WARNING LIGHTS SHALL BE IN ACCORDANCE WITH SEC 1063.5.

UPON APPROVAL OF THE ENGINEER, THE CONTRACTOR MAY, AT NO ADDITIONAL COST, USE DRUM-LIKE CHANNELIZERS IN LIEU OF TRIM-LINE CHANNELIZERS TO PROVIDE LONGITUDINAL CHANNELIZATION WITHIN THE ACTIVITY AREA WHERE NO RAMPS, INTERSECTIONS OR LIMITED LATERAL CLEARANCE EXISTS.

UPON APPROVAL OF THE ENGINEER, THE CONTRACTOR MAY, AT NO ADDITIONAL COST, USE DIRECTION INDICATOR BARRICADES IN LIEU OF TRIM-LINE CHANNELIZERS IN MERGING TAPERS.

UPON APPROVAL OF THE ENGINEER, THE CONTRACTOR MAY, AT NO ADDITIONAL COST, USE VERTICAL PANELS IN LIEU OF TRIM-LINE CHANNELIZERS TO PROVIDE LONGITUDINAL CHANNELIZATION WITHIN THE ACTIVITY AREA.

UPON APPROVAL OF THE ENGINEER, THE CONTRACTOR MAY, AT NO ADDITIONAL COST, USE CONES IN LIEU OF TRIM-LINE CHANNELIZERS DURING DAYTIME OPERATIONS ON MINOR ROUTES.

PANEL AND RAIL MARKINGS FOR TRAFFIC DELINEATION SHALL SLOPE DOWNWARD TOWARD THE INTENDED DIRECTION OF TRAVEL. ILLUSTRATIONS SHOWN ARE FOR INSTANCES WHERE TRAFFIC MOVES TO THE LEFT, REVERSE CONFIGURATIONS SHALL BE USED FOR TRAFFIC MOVEMENTS TO THE RIGHT. MARKINGS SHALL ONLY BE APPLIED TO THE FRONT OF EACH RAIL OR PANEL, OR MAY BE APPLIED TO BOTH THE FRONT AND BACK PROVIDING THE MARKING ON THE BACK DOES NOT CONFLICT WITH INTENDED OPPOSING TRAFFIC MOVEMENT.

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105 WEST CAPITOL
JEFFERSON CITY, MO 65102
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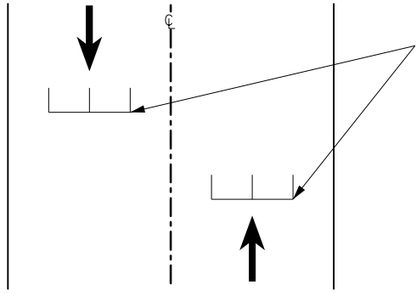
TEMPORARY TRAFFIC CONTROL DEVICES
CHANNELIZERS AND DIRECTION INDICATOR BARRICADE

DATE EFFECTIVE: 07/01/2019
DATE PREPARED: 3/28/2019

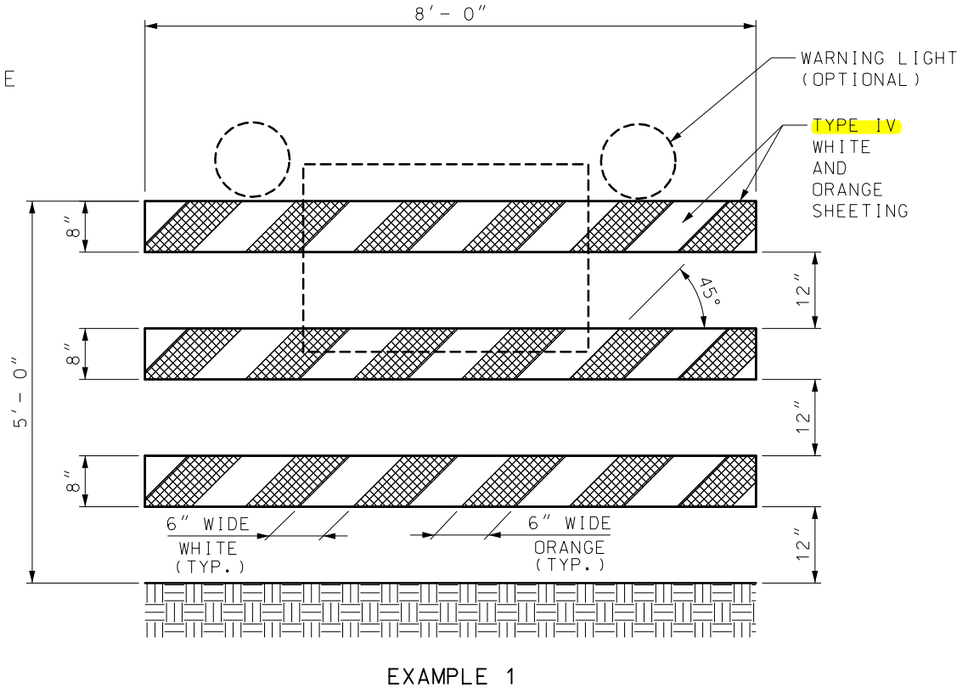
616.10AV

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.

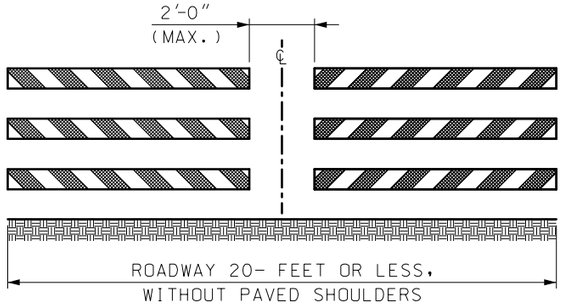


RETROREFLECTIVE MARKING ON TYPE 3 BARRICADES SHALL BE ON BOTH SIDES OF EACH RAIL AND DIRECT TRAFFIC MOVEMENT APPROPRIATELY TO ALLOW VEHICLES TO PASS THROUGH

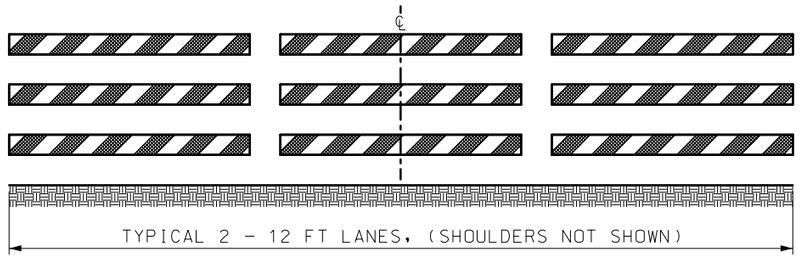
SOFT CLOSURE
PLAN VIEW



EXAMPLE 1

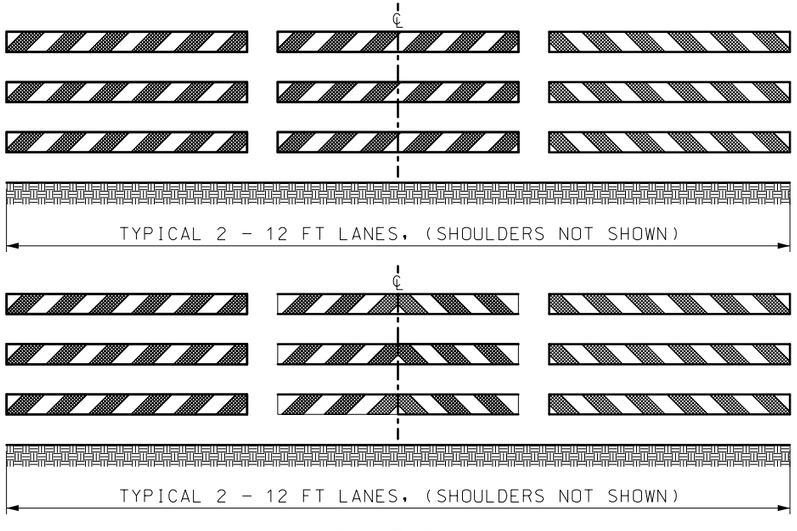


EXAMPLE 2

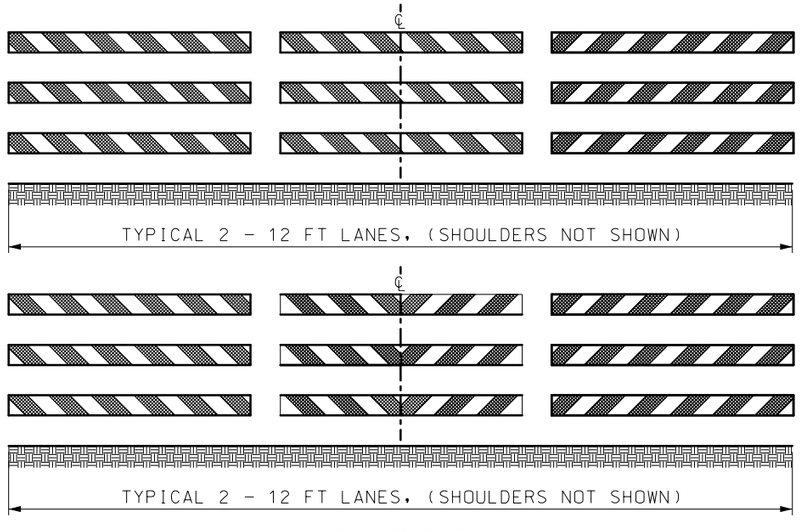


EXAMPLE SHOWS STRIPES SLOPING TO DIRECT
VEHICULAR MOVEMENT TOWARD THE LEFT

EXAMPLE 3



EXAMPLE 4



EXAMPLE 5

SAME AS 1 OF 8

EXAMPLE 1 - ONE TYPE 3 MOVABLE BARRICADE WILL BE REQUIRED TO COMPLETELY CLOSE EACH 8′ OF PAVEMENT. PAVED SHOULDERS SHALL BE INCLUDED IN THE AREA TO BE CLOSED.

SIGNS SHALL BE LIGHT WEIGHT (ROLL-UP OR PLASTIC) AND SHOULD NOT OBSCURE MORE THAN 50 PERCENT OF THE TOP 2 RAILS OR 33 PERCENT OF ALL THREE RAILS.

WARNING LIGHTS SHALL BE LIGHT WEIGHT (3.3 LBS. OR LESS) OR HAVE BATTERY PACK MOUNTED NO HIGHER THAN 18-INCH AND SHALL NOT COVER ANY PORTION OF THE BARRICADE FACE.

IF WARNING LIGHTS ARE USED,THE LIGHT SHOULD BE INSTALLED ON THE BARRICADES IN THE DIRECTION OF TRAFFIC.

IF SIGNS OR LIGHTS CANNOT MEET THE ABOVE REQUIREMENTS, THEY SHALL BE MOUNTED ON SEPARATE CRASHWORTHY DEVICES AT HEIGHTS SPECIFIED FOR POST MOUNTED SIGNS, LOCATED IN TABLE A ON SHEET 1. THE BARRICADE SHALL BE LOCATED IN FRONT OF THE SIGNS OR LIGHTS WITH 7 TO 10 FEET SEPARATING THE DEVICES.

TYPE 3 MOVABLE BARRICADES SHALL BE ENTIRELY FREE STANDING AND PORTABLE. MARKING SHALL ONLY BE APPLIED TO THE FRONT OF EACH RAIL OR MAY BE APPLIED TO BOTH THE FRONT AND THE BACK OF EACH RAIL PROVIDED THE MARKING ON THE BACK DOES NOT CONFLICT WITH INTENDED OPPOSING TRAFFIC MOVEMENT.

WHITE AND ORANGE REFLECTIVE SHEETING SHALL BE IN ACCORDANCE WITH SEC 104.2.7.4.

EXAMPLE 2 - FOR PAVED ROADWAYS WITH A WIDTH OF 20-FEET OR LESS AND WITHOUT PAVED SHOULDERS, TWO BARRICADES ARE ACCEPTABLE.

EXAMPLE 3 - WHERE BARRICADES EXTEND ENTIRELY ACROSS A ROADWAY, STRIPES SLOPE DOWNWARD IN THE DIRECTION TOWARD WHICH ROAD USERS MUST TURN.

EXAMPLE 4 - WHERE BOTH RIGHT AND LEFT TURNS ARE PROVIDED, STRIPES SLOPE DOWNWARD IN BOTH DIRECTIONS FROM THE CENTER OF THE BARRICADE OR BARRICADES.

EXAMPLE 5 - WHERE NO TURNS ARE INTENDED, STRIPES POSITIONED TO SLOPE DOWNARD TOWARD THE CENTER OF THE BARRICADE OR BARRICADES.

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TEMPORARY TRAFFIC CONTROL DEVICES

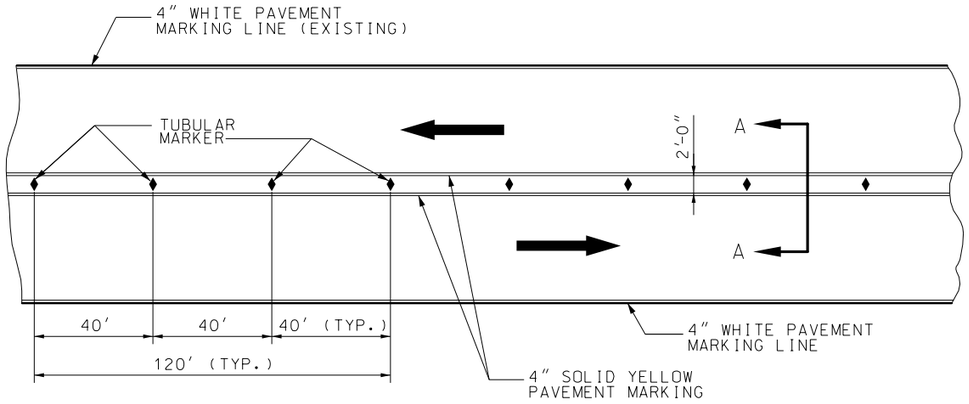
TYPE 3 MOVABLE BARRICADE

DATE EFFECTIVE: 07/01/2019
DATE PREPARED: 3/28/2019

616.10AV

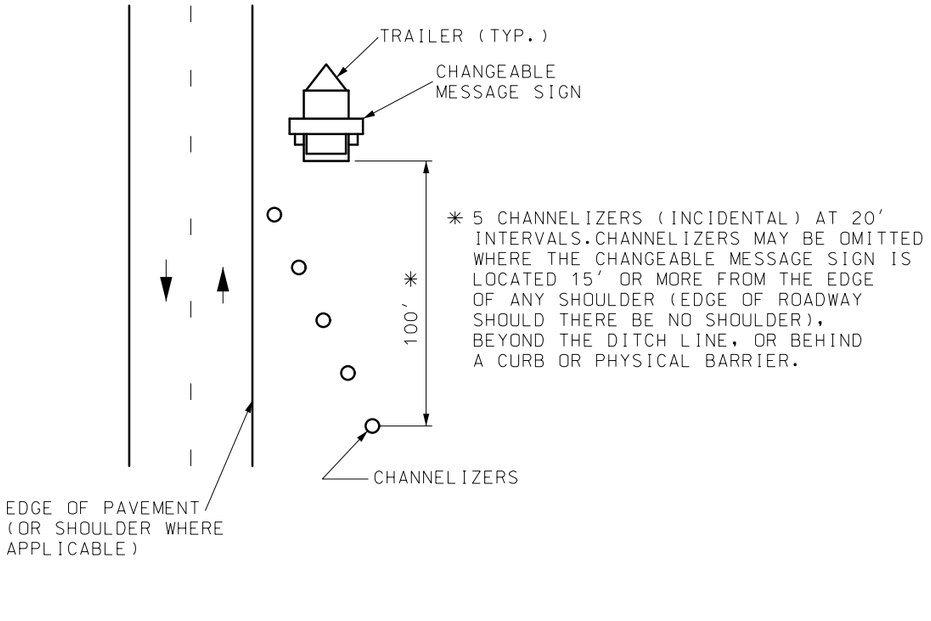
SHEET NO.
4 OF 9

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.

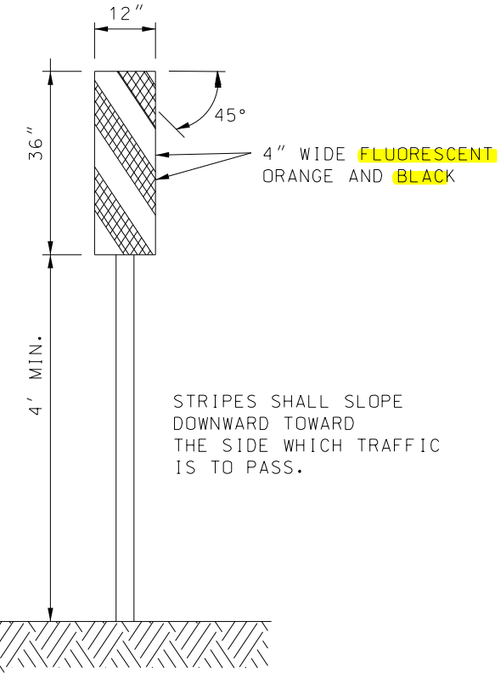


TWO LANE / TWO WAY TRAFFIC DELINEATION PLAN FOR DIVIDED HIGHWAY

IF RAISED PAVEMENT MARKERS ARE PRESENT, THE LENSES SHALL BE REMOVED OR COVERED TO THE SATISFACTION OF THE ENGINEER.



SAME AS 1 & 2 OF 8



TYPE 3 OBJECT MARKERS

FLUORESCENT ORANGE REFLECTIVE SHEETING SHALL BE IN ACCORDANCE WITH SEC 1042.2.7.

SECTION A-A
TUBULAR DELINEATOR DETAIL

AN ADHESIVE, IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS, SHALL BE USED TO APPLY THE TUBULAR DELINEATOR TO THE ROADWAY SURFACE. THE ADHESIVE SHALL PERMIT EASY REMOVAL OF THE TUBULAR DELINEATOR WITHOUT DAMAGE TO THE ROADWAY SURFACE.

REFLECTIVE SHEETING APPLIED TO TUBULAR DELINEATORS SHALL BE IN ACCORDANCE WITH SEC 1042.2.7.5.

CHANGEABLE MESSAGE SIGN

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION
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TEMPORARY TRAFFIC CONTROL DEVICES

DATE EFFECTIVE: 07/01/2019
DATE PREPARED: 3/28/2019

616.10AV

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.

WARNING SIGNS

SIGN	SIZE (IN.)	AREA (SQ. FT.)	SHEETING	COLOR SYM. LEG. BRD.	COLOR BACK GROUND	DESIGNATION	DESCRIPTION
E05-2	48X36	12.00	ASTM 9 OR 11	BK	FL. OR	SHF	EXIT OPEN (3)
E05-2a	48X36	12.00	ASTM 9 OR 11	BK	FL. OR	SHF	EXIT CLOSED
W01-1L	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	TURN (SYMBOL LEFT ARROW)
W01-1R	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	TURN (SYMBOL RIGHT ARROW)
W01-2L	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	CURVE (SYMBOL LEFT ARROW)
W01-2R	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	CURVE (SYMBOL RIGHT ARROW)
W01-3L	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	REVERSE TURN (SYMBOL LEFT ARROW)
W01-3R	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	REVERSE TURN (SYMBOL RIGHT ARROW)
W01-4L	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	REVERSE CURVE (SYMBOL LEFT ARROW)
W01-4R	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	REVERSE CURVE (SYMBOL RIGHT ARROW)
W01-4bL	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	DOUBLE ARROW REVERSE CURVE (SYMBOL LEFT ARROWS) (2)
W01-4bR	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	DOUBLE ARROW REVERSE CURVE (SYMBOL RIGHT ARROWS) (2)
W01-4cL	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	TRIPLE ARROW REVERSE CURVE (SYMBOL LEFT ARROWS) (2)
W01-4cR	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	TRIPLE ARROW REVERSE CURVE (SYMBOL RIGHT ARROWS) (2)
W01-6	60X30	12.50	ASTM 9 OR 11	BK	FL. OR	SHF	HORIZONTAL ARROW (SYMBOL)
W01-6a	72X36	18.00	ASTM 9 OR 11	BK	FL. OR	SHF	HORIZONTAL ARROW (SYMBOL ON PERMANENT BARRICADE) (1)
W01-7	60X30	12.50	ASTM 9 OR 11	BK	FL. OR	SHF	DOUBLE HEAD HORIZONTAL ARROW (SYMBOL)
W01-7a	72X36	18.00	ASTM 9 OR 11	BK	FL. OR	SHF	DOUBLE HEAD HORIZONTAL ARROW (SYMBOL ON PERMANENT BARRICADE)(1)
W01-8	18X24	3.00	ASTM 9 OR 11	BK	FL. OR	SHF	CHEVRON (SYMBOL)
W01-8a	30X36	7.50	ASTM 9 OR 11	BK	FL. OR	SHF	CHEVRON (SYMBOL FOR DIVIDED HIGHWAYS)
W03-1	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	STOP AHEAD (SYMBOL)
W03-2	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	YIELD AHEAD (SYMBOL)
W03-3	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	SIGNAL AHEAD (SYMBOL)
W03-4	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	BE PREPARED TO STOP
W03-5	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	SPEED LIMIT AHEAD
W04-1L	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	MERGE (SYMBOL FROM LEFT)
W04-1R	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	MERGE (SYMBOL FROM RIGHT)
W04-1a(L)	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	MERGE (ARROW SYMBOL) (3)
W04-1a(R)	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	MERGE (ARROW SYMBOL) (3)
W05-1	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	ROAD/BRIDGE/RAMP NARROWS (4)
W05-3	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	ONE LANE BRIDGE
W05-5	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	NARROW LANES (3)
W06-1	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	DIVIDED HIGHWAY (SYMBOL)
W06-2	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	DIVIDED HIGHWAY END (SYMBOL)
W06-3	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	TWO WAY TRAFFIC (SYMBOL)
W07-3a	30X24	5.00	ASTM 9 OR 11	BK	FL. OR	SHF	NEXT XX MILES (PLAQUE)
W08-1	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	BUMP
W08-2	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	DIP
W08-3	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	PAVEMENT ENDS
W08-4	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	SOFT SHOULDER
W08-5	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	SLIPPERY WHEN WET (SYMBOL)
W08-6	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	TRUCK CROSSING WITH FLAGS
W08-6c	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	TRUCK ENTRANCE (3)
W08-7a	36X36	9.00	ASTM 9 OR 11	BK	FL. OR	SHF	FRESH OIL/LOOSE GRAVEL (3)
W08-9	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	LOW SHOULDER
W08-11	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	UNEVEN LANES
W08-12	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	NO CENTER LINE
W08-15	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	GROOVED PAVEMENT
W08-15p	30X24	5.00	ASTM 9 OR 11	BK	FL. OR	SHF	MOTORCYCLE (PLAQUE)
W08-17(L)	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	SHOULDER DROP-OFF (SYMBOL LEFT)
W08-17(R)	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	SHOULDER DROP OFF (SYMBOL RIGHT) (4)
W08-17p	30X24	5.00	ASTM 9 OR 11	BK	FL. OR	SHF	SHOULDER DROP-OFF (PLAQUE)
W10-1	42 RND.	9.62	ASTM 9 OR 11	BK	FL. YL	SHF	RAILROAD CROSSING
W012-1	24X24	4.00	ASTM 9 OR 11	BK	FL. OR	SHF	DOUBLE DOWN ARROW (SYMBOL)
W012-2	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	LOW CLEARANCE (SYMBOL)
W012-2x	24X18	3.00	ASTM 9 OR 11	BK	FL. OR	SHF	LOW CLEARANCE (PLAQUE) (3)
W012-2a	84X24	14.00	ASTM 9 OR 11	BK	FL. OR	SHF	OVERHEAD LOW CLEARANCE (FEET AND INCHES) (3)
SPECIAL	120X60	50.00	ASTM 9 OR 11	BK	FL. OR	SHF	LOW CLEARANCE XX FT XX IN XX MILES AHEAD (3)
SPECIAL	120X60	50.00	ASTM 9 OR 11	BK	FL. OR	SHF	WIDTH RESTRICTION XX FT XX IN XX MILES AHEAD (3)
W013-1	30X30	6.25	ASTM 9 OR 11	BK	FL. OR	SHF	ADVISORY SPEED (PLAQUE)
W016-2	30X24	5.00	ASTM 9 OR 11	BK	FL. OR	SHF	XXX FEET (PLAQUE)
W016-3	30X24	5.00	ASTM 9 OR 11	BK	FL. OR	SHF	X MILE (PLAQUE)
W020-1	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	ROAD/BRIDGE/RAMP WORK AHEAD (4)
W020-2	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	DETOUR AHEAD

(1) SIGN DEPICTION, ARROW, BORDERS AND SPACING SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF "STANDARD HIGHWAY SIGNS" BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA.

(2) REFER TO THE LATEST EDITION OF MUTCD PART VI BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA FOR SIGN DEPICTION. ARROW, BORDERS AND SPACING SHALL CONFORM TO THE GUIDELINES SET FORTH IN THE LATEST EDITION OF "STANDARD HIGHWAY SIGNS" BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA.

(3) ARROW, BORDERS AND SPACING SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF "STANDARD HIGHWAY SIGNS" BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA.

(4) USE OF A SUPPLEMENTAL PLATE FOR LINE 1 IS ACCEPTABLE.

(5) PLAQUE AND APPLICABLE REGULATORY SIGN MAY BE MANUFACTURED AS ONE SIGN.

(6) SHF REFER TO STD. 903.02 SHEET 1 OF 8

REMOVED SIGN
W08-7 LOOSE GRAVEL AND
SPECIAL FRESH OIL/LOOSE GRAVEL.
REPLACED WITH ONE SIGN
W08-7a FRESH OIL/LOOSE GRAVEL,
CLARIFIED REFERENCE (6)

GENERAL NOTES:

SIGN LAYOUTS SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF "STANDARD HIGHWAY SIGNS" BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA, UNLESS SPECIFIED OTHERWISE.

SIGN DIMENSIONS SHOWN ARE MINIMUM. NO ADDITIONAL PAYMENT WILL BE MADE IF CONTRACTORS USE LARGER SIGNS.

NO ADDITIONAL PAYMENT WILL BE MADE FOR PLATES.

ALL PLAQUES SHALL HAVE A BORDER. PLATES SHALL NOT HAVE A BORDER.

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.

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TEMPORARY
TRAFFIC CONTROL DEVICES
WARNING SIGNS

DATE EFFECTIVE: 07/01/2019
DATE PREPARED: 3/28/2019

616.10AV

Level 2 - Issue 11 (10 of 13)

WARNING SIGNS

SIGN	SIZE (IN.)	AREA (SQ. FT.)	SHEETING	COLOR SYM. LEG. BRD.	COLOR BACK GROUND	DESIGNATION	DESCRIPTION
W020-3	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	ROAD CLOSED AHEAD
W020-4	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	ONE LANE ROAD AHEAD
W020-5	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	RIGHT/CENTER/LEFT LANE CLOSED AHEAD (4)
W020-5a	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	2 RIGHT/CENTER/LEFT LANES CLOSED AHEAD (4)
W020-6a	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	RIGHT/CENTER/LEFT LANE CLOSED (3)(4)
W020-7	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	FLAGGER (SYMBOL) WITH FLAGS
W021-5	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	SHOULDER WORK AHEAD (3)
W021-5a	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	RIGHT/LEFT SHOULDER CLOSED
W021-5b	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	RIGHT/LEFT SHOULDER CLOSED AHEAD
W022-1	48X48	16.00	ASTM 9 OR 11	BK	FL. OR	SHF	BLASTING ZONE AHEAD
W022-2	42X36	10.50	ASTM 9 OR 11	BK	FL. OR	SHF	TURN OFF 2-WAY RADIO AND PHONE
W022-3	42X36	10.50	ASTM 9 OR 11	BK	FL. OR	SHF	END BLASTING ZONE

GUIDE SIGNS

E05-1	36X48	12.00	ASTM 9 OR 11	BK	FL. OR	SHF	GORE EXIT (3)
G020-1	60X24	10.00	ASTM 9 OR 11	BK	FL. OR	SHF	ROAD WORK NEXT XX MILES
G020-2	48X24	8.00	ASTM 9 OR 11	BK	FL. OR	SHF	END ROAD WORK
G020-4	36X18	4.50	ASTM 9 OR 11	BK	FL. OR	SHF	PILOT CAR FOLLOW ME - REAR VEHICLE MOUNT SIGN
G020-4a	42X30	8.75	ASTM 9 OR 11	BK	FL. OR	SHF	PILOT CAR IN USE WAIT & FOLLOW - STATE ROUTE SIGN
G020-4a	18X12	1.50	ASTM 9 OR 11	BK	FL. OR	SHF	PILOT CAR IN USE WAIT & FOLLOW - NON-STATE ROUTE SIGN
G020-5aP	36X24	6.00	ASTM 9 OR 11	BK	FL. OR	SHF	WORK ZONE (PLAQUE) (3) (5)
G022-1	15X21	2.19	ASTM 9 OR 11	BK	FL. OR	SHF	WET PAINT (ARROW PIVOTS) (3)
M04-8a	24X18	3.00	ASTM 9 OR 11	BK	FL. OR	SHF	END DETOUR
M04-9L	48X36	12.00	ASTM 9 OR 11	BK	FL. OR	SHF	DETOUR (LEFT ARROW)
M04-9R	48X36	12.00	ASTM 9 OR 11	BK	FL. OR	SHF	DETOUR (RIGHT ARROW)
M04-9P	48X12	4.00	ASTM 9 OR 11	BK	FL. OR	SHF	STREET NAME (PLAQUE)
M04-10L	48X18	6.00	ASTM 9 OR 11	BK	FL. OR	SHF	DETOUR (ARROW LEFT)
M04-10R	48X18	6.00	ASTM 9 OR 11	BK	FL. OR	SHF	DETOUR (ARROW RIGHT)

REGULATORY SIGNS

R1-1	48X48	13.25	ASTM 4	WH	RD	SH	STOP
R1-2	48 TRI.	6.93	ASTM 4	RD	WH	SH	YIELD
R1-2a	36X36	9.00	ASTM 4	BK	WH	SH	TO ONCOMING TRAFFIC (PLAQUE)
R1-3p	30X12	2.50	ASTM 4	WH	RD	SH	ALL WAY (PLAQUE)
R2-1	36X48	12.00	ASTM 4	BK	WH	SH	SPEED LIMIT XX
R3-1	48X48	16.00	ASTM 4	BK/RD	WH	SH	NO RIGHT TURN (SYMBOL)
R3-2	48X48	16.00	ASTM 4	BK/RD	WH	SH	NO LEFT TURN (SYMBOL)
R3-3	36X36	9.00	ASTM 4	BK	WH	SH	NO TURNS
R3-4	48X48	16.00	ASTM 4	BK/RD	WH	SH	NO U-TURN (SYMBOL)
R3-7L	30X30	6.25	ASTM 4	BK	WH	SH	LEFT LANE MUST TURN LEFT
R3-7R	30X30	6.25	ASTM 4	BK	WH	SH	RIGHT LANE MUST TURN RIGHT
R4-1	36X48	12.00	ASTM 4	BK	WH	SH	DO NOT PASS
R4-2	36X48	12.00	ASTM 4	BK	WH	SH	PASS WITH CARE
R4-7a	36X48	12.00	ASTM 4	BK	WH	SH	KEEP RIGHT (HORIZONTAL ARROW)
R4-8a	36X48	12.00	ASTM 4	BK	WH	SH	KEEP LEFT (HORIZONTAL ARROW)
R5-1	30X30	6.25	ASTM 4	RD	WH	SH	DO NOT ENTER
R5-1a	36X24	6.00	ASTM 4	WH	RD	SH	WRONG WAY
R6-1L	54X18	6.75	ASTM 4	BK	WH	SH	ONE WAY ARROW (LEFT)
R6-1R	54X18	6.75	ASTM 4	BK	WH	SH	ONE WAY ARROW (RIGHT)
R6-2L	24X30	5.00	ASTM 4	BK	WH	SH	ONE WAY (LEFT)
R6-2R	24X30	5.00	ASTM 4	BK	WH	SH	ONE WAY (RIGHT)
R10-6	24X36	6.00	ASTM 4	BK	WH	SH	STOP HERE ON RED (45° ARROW)
R11-2	48X30	10.00	ASTM 4	BK	WH	SH	ROAD CLOSED
R11-3a	60X30	12.50	ASTM 4	BK	WH	SH	ROAD CLOSED XX MILES AHEAD LOCAL TRAFFIC ONLY
R11-4	60X30	12.50	ASTM 4	BK	WH	SH	ROAD CLOSED TO THRU TRAFFIC
CONST-3A	60X48	20.00	ASTM 4	BK	WH/FL. OR	SH	FINE SIGN (3)
CONST-3X	56X12	4.67	ASTM 4	BK	WH	SH	SPEEDING/PASSING (PLATE) (3)

SPECIAL SIGNS

CONST-7	72X36	18.00	ASTM 4	WH/BL	BK/FL.OR	SH	RATE OUR WORK ZONE
CONST-7	48X24	8.00	ASTM 4	WH/BL	BK/FL.OR	SH	RATE OUR WORK ZONE
CONST-8	48X36	12.00	ASTM 9 OR 11	BK	FL.OR	SHF	WORK ZONE NO PHONE ZONE

(1) SIGN DEPICTION, ARROW, BORDERS AND SPACING SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF "STANDARD HIGHWAY SIGNS" BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA.

(2) REFER TO THE LATEST EDITION OF MUTCD PART VI BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA FOR SIGN DEPICTION. ARROW, BORDERS AND SPACING SHALL CONFORM TO THE GUIDELINES SET FORTH IN THE LATEST EDITION OF "STANDARD HIGHWAY SIGNS" BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA.

(3) ARROW, BORDERS AND SPACING SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF "STANDARD HIGHWAY SIGNS" BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA.

(4) USE OF A SUPPLEMENTAL PLATE FOR LINE 1 IS ACCEPTABLE.

(5) PLAQUE AND APPLICABLE REGULATORY SIGN MAY BE MANUFACTURED AS ONE SIGN.

(6) SH REFER TO STD. 903.02 SHEET 1 OF 8

(7) SHF REFER TO STD. 903.02 SHEET 1 OF 8

ALTERED G020-4a TO READ
PILOT CAR IN USE WAIT & FOLLOW.
ADDED ALTERNATE SIZE FOR G060-4a.
CLARIFIED REFERENCES IN (6) & (7)

GENERAL NOTES:

SIGN LAYOUTS SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF "STANDARD HIGHWAY SIGNS" BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA, UNLESS SPECIFIED OTHERWISE.

SIGN DIMENSIONS SHOWN ARE MINIMUM. NO ADDITIONAL PAYMENT WILL BE MADE IF CONTRACTORS USE LARGER SIGNS.

NO ADDITIONAL PAYMENT WILL BE MADE FOR PLATES.

ALL PLAQUES SHALL HAVE A BORDER. PLATES SHALL NOT HAVE A BORDER.

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION
105 WEST CAPITOL
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TEMPORARY TRAFFIC CONTROL DEVICES

WARNING, GUIDE AND REGULATORY SIGNS

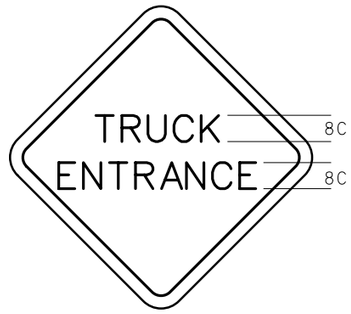
DATE EFFECTIVE: 07/01/2019
DATE PREPARED: 3/28/2019

616.10AV

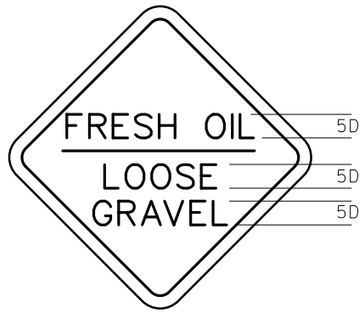
SHEET NO. 7 OF 9

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.

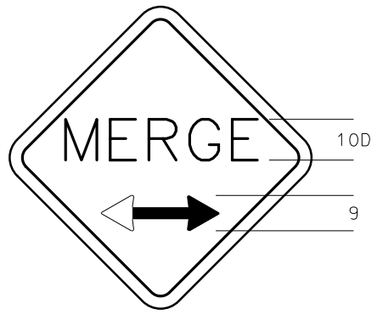
W05-5 (3)



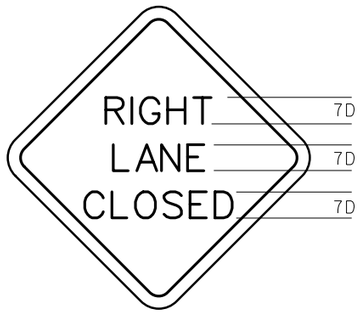
W08-6c (3)



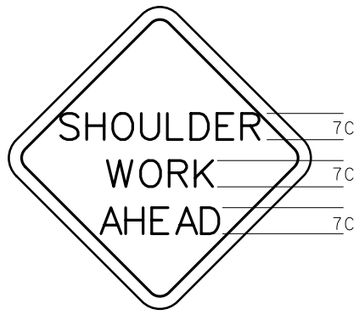
W08-7a (3)



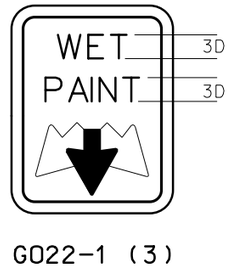
W04-1a



W020-6a (3)(4)



W021-5 (3)



G022-1 (3)

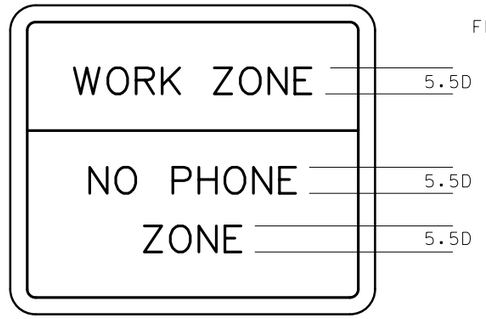
(1) SIGN DEPICTION, ARROW, BORDERS AND SPACING SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF "STANDARD HIGHWAY SIGNS" BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA.

(2) REFER TO THE LATEST EDITION OF MUTCD PART VI BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA FOR SIGN DEPICTION. ARROW, BORDERS AND SPACING SHALL CONFORM TO THE GUIDELINES SET FORTH IN THE LATEST EDITION OF "STANDARD HIGHWAY SIGNS" BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA.

(3) ARROW, BORDERS AND SPACING SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF "STANDARD HIGHWAY SIGNS" BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA.

(4) USE OF A SUPPLEMENTAL PLATE FOR LINE 1 IS ACCEPTABLE.

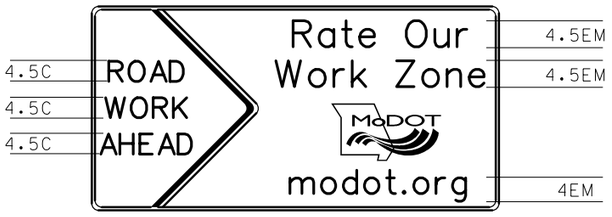
(5) PLAQUE AND APPLICABLE REGULATORY SIGN MAY BE MANUFACTURED AS ONE SIGN.



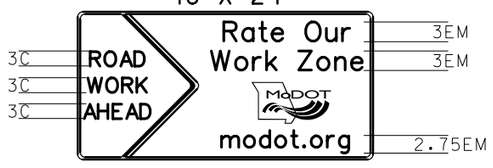
CONST-8 (3)

CONST-3A (3)

72 X 36

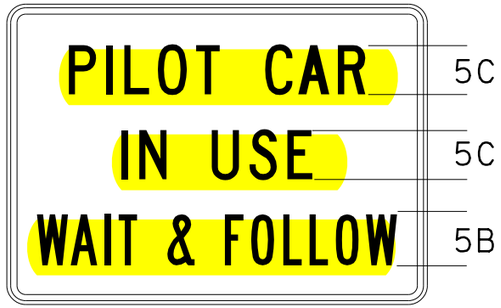


48 X 24

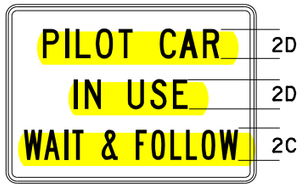


CONST-7

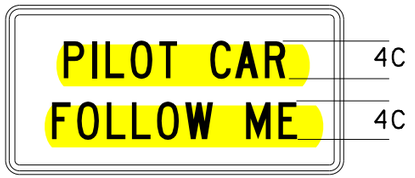
CONST-3X (3)



G020-4a (3)
42X30



G020-4a (3)(4)
18X12



G020-4 (3)
36X18

W012-5 (3)

W012-4 (3)

GENERAL NOTES:

SIGN LAYOUTS SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF "STANDARD HIGHWAY SIGNS" BY THE U.S. DEPARTMENT OF TRANSPORTATION - FHWA UNLESS SPECIFIED OTHERWISE.

SIGN DIMENSIONS SHOWN ARE MINIMUM. NO ADDITIONAL PAYMENT WILL BE MADE IF CONTRACTORS USE LARGER SIGNS.

NO ADDITIONAL PAYMENT WILL BE MADE FOR PLATES.

ALL PLAQUES SHALL HAVE A BORDER. PLATES SHALL NOT HAVE A BORDER.

LETTER DIMENSIONS SHALL BE AS SHOWN.

ALTERED TEXT IN G020-4a AND ADDED NEW SIZE. ADDED G020-4. REMOVED SIGNS STANARD TO MUTCD.

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105 WEST CAPITOL
JEFFERSON CITY, MO 65102
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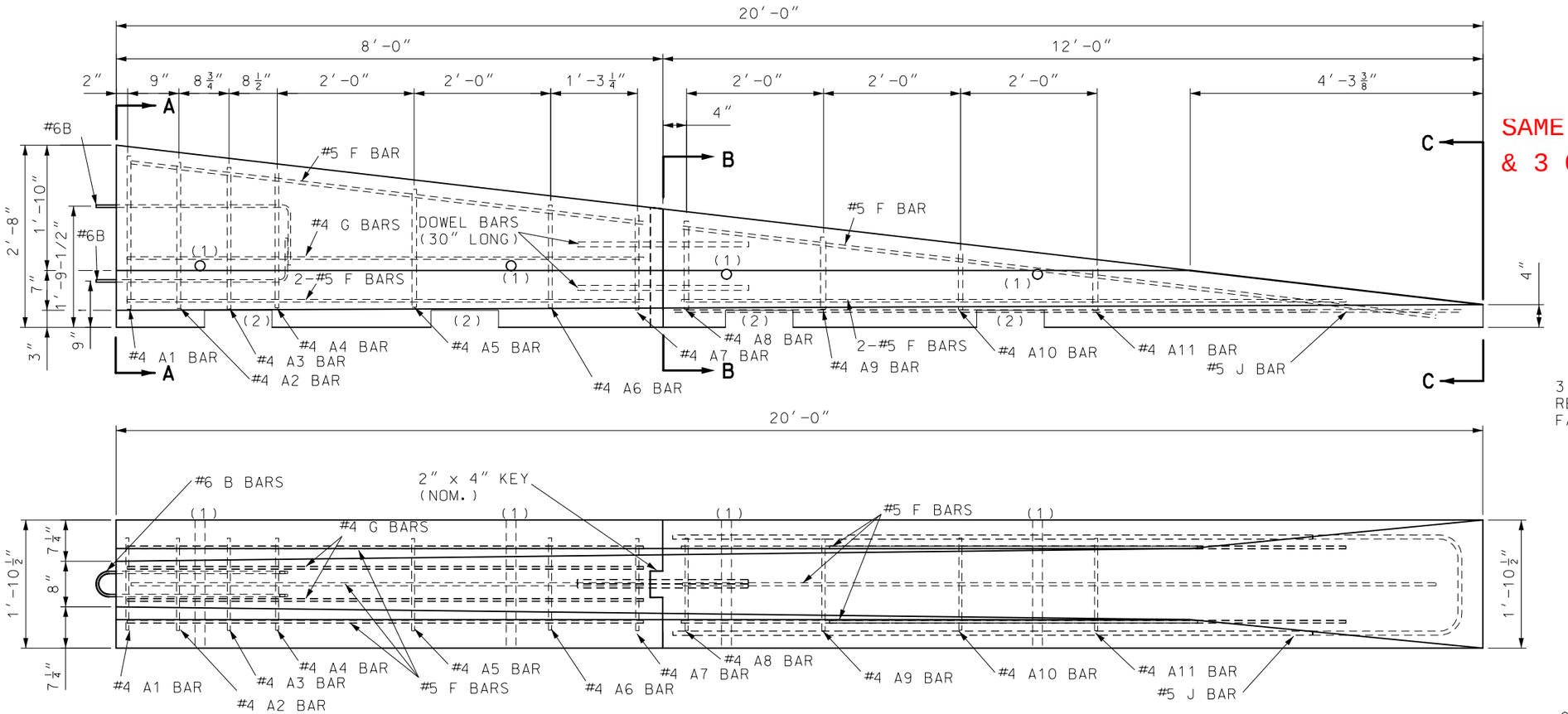
TEMPORARY TRAFFIC CONTROL DEVICES

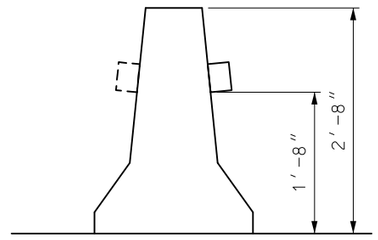
DATE EFFECTIVE: 07/01/2019
DATE PREPARED: 3/28/2019

616.10AV

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.

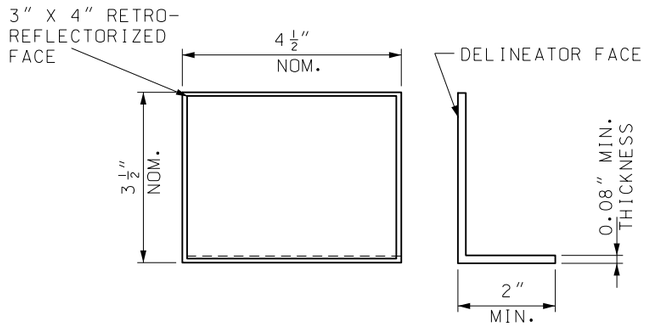


SAME AS 1, 2 & 3 OF 8



TRAFFIC BARRIER DELINEATORS

REFLECTIVE SHEETING APPLIED TO TRAFFIC BARRIER DELINEATORS SHALL BE IN ACCORDANCE WITH SEC 1042.2.7.5.

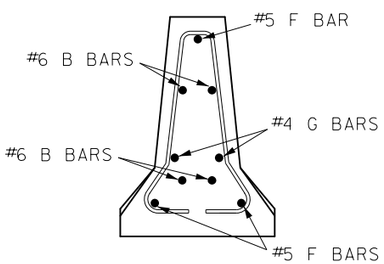


DELINEATOR

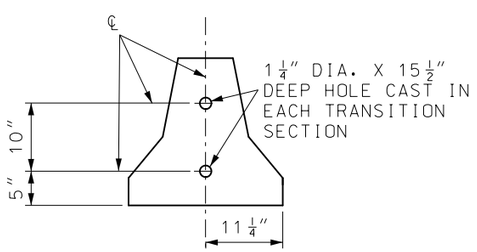
PRECAST BARRIER HEIGHT TRANSITION
(TEMPORARY INSTALLATIONS ONLY)

(1) OPTIONAL 4 INCH DIAMETER, 11 GUAGE STEEL ROUND MECHANICAL TUBING SLEEVE FOR LIFT HOLE ALLOWED. THE LOCATION OF THE HOLE MAY VARY TO ACCOMMODATE THE DIFFERING WEIGHT DISTRIBUTIONS OF TRANSITION SECTIONS.

(2) 3" X 1'-0" SLOTS FOR LIFTING - TWO PER SECTION. LOCATION TO BE DETERMINED BY CONTRACTOR.

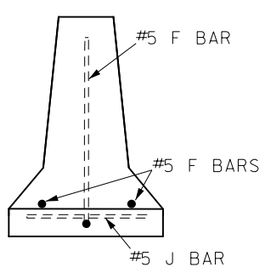


SECTION A-A



SECTION B-B

NOTE: SECTIONS TO BE CONNECTED WITH TWO- 1" DIA. BARS OR #8 REINFORCING BARS 30" LONG IN 1 1/4" DIA. HOLES AS SHOWN.



SECTION C-C

GENERAL NOTES:

REINFORCING STEEL CLEARANCE TO EDGE OF CONCRETE SHALL BE 1 3/4" UNLESS OTHERWISE SHOWN.

HEIGHT TRANSITIONS SHALL NOT BE USED ON INTERSTATE ROUTES OR IN LOCATIONS WHERE THE POSTED SPEED PRIOR TO CONSTRUCTION IS GREATER THAN 35 MPH.

AT NO TIME SHALL THE BARRIERS BE LIFTED OR MOVED BY USE OF THE LOOP BARS.

RETAINER BOLT AND NUT MUST BE USED WITH TRANSITION BARRIER.

AT THE OPTION OF THE CONTRACTOR, HEIGHT TRANSITIONS MAY BE MANUFACTURED IN ONE SECTION. THE PLANS FOR REINFORCEMENT ACROSS JOINT SHALL BE APPROVED BY THE ENGINEER PRIOR TO MANUFACTURE.

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION
105 WEST CAPITOL
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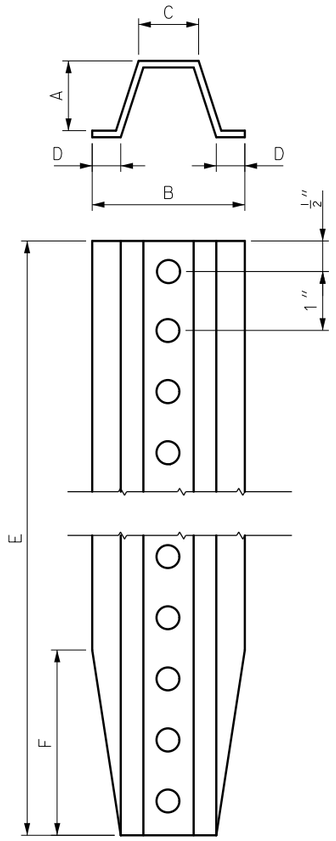
TEMPORARY CONCRETE TRAFFIC BARRIER
TYPE F HEIGHT TRANSITIONS

DATE EFFECTIVE: 07/01/2019
DATE PREPARED: 3/7/2019

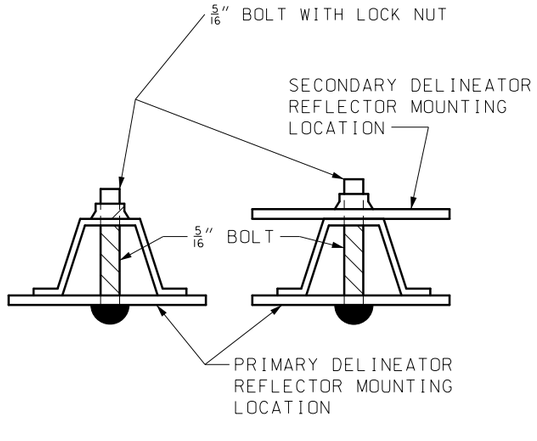
617.20E

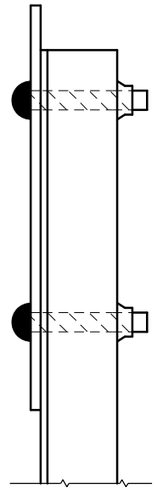
SHEET NO. 3 OF 8

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.



GROUND MOUNT
U-CHANNEL





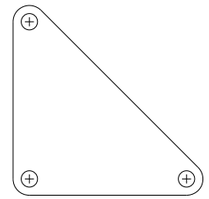
HOLE PUNCHING TO EQUAL 3/8" DIAMETER HOLES, ONE INCH CENTER TO CENTER, BEGINNING ONE-HALF INCH FROM THE END AND CONTINUING THE ENTIRE LENGTH OF THE POST.

CHANNEL POST DELINEATOR							
LIMITS	LBS/FT (2)	DIMENSIONS - INCHES					
		A	B	C	D	E	F
NOMINAL	1.12	1	2 1/4	7/8	3/8	84	1
TOLERANCE	± 5%	± 1/8	± 1/8	± 1/8	± 1/8	±1	± 1/4

(2) WEIGHT BEFORE GALVANIZING OR PUNCHING.

THE CHANNEL POST FOR DELINEATORS SHALL BE MANUFACTURED FROM DUCTILE ASTM A 36 OR ASTM A 1011 GR 60.

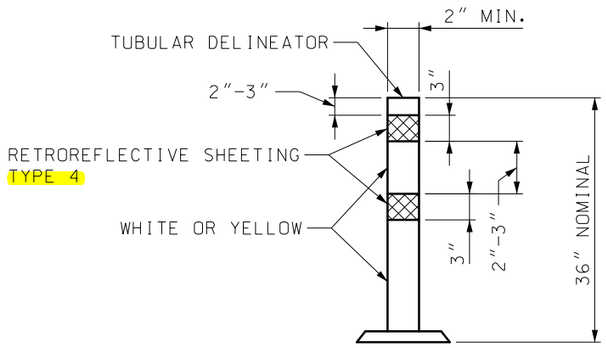
CHANNEL POST DELINEATOR AND FASTENER DETAILS



DELINEATOR PLACEMENT LOCATED
AT THE RADIUS POINTS

TUBULAR DELINEATOR PLACEMENT FOR ISLANDS

DELINEATOR PLACEMENT FOR MEDIAN STRIPS



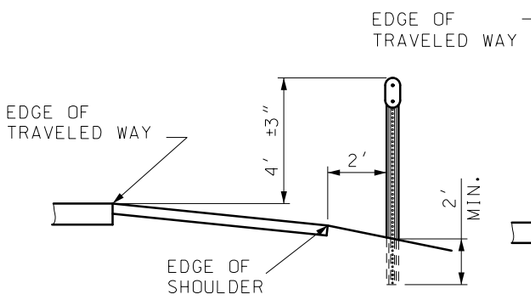
36 INCH SURFACE-MOUNT DELINEATOR POST

TUBULAR DELINEATOR DETAIL

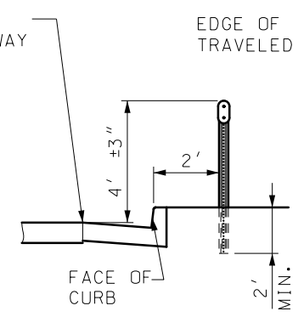
COLOR OF TUBULAR DELINEATOR AND REFLECTIVE SHEETING SHALL MATCH THE COLOR OF THE CLOSEST PAVEMENT MARKING OR CURB MARKING.

TUBULAR DELINEATOR SHAPE MAY BE ROUND OR T-SHAPED. TUBULAR DELINEATOR SHALL BE PERMANENTLY MOUNTED TO THE PAVEMENT SURFACE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.

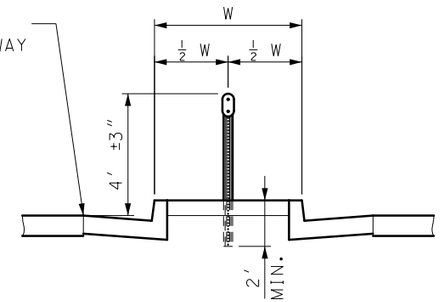
SAME AS 1, 2, 3, & 7 OF 8



SHOULDER MOUNTED

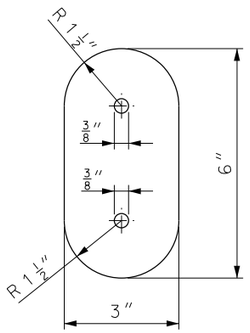


OUTSIDE
BARRIER CURB

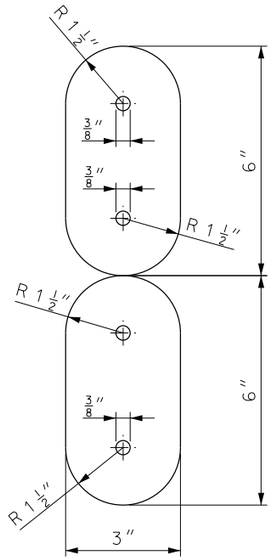


NARROW
PAVED MEDIAN

CHANNEL POST DELINEATOR MOUNTING DETAILS



SINGLE



DOUBLE STACKED

CHANNEL POST DELINEATOR REFLECTOR

NOTES:

RETROREFLECTIVE YELLOW, WHITE OR RED SHEETING IN ACCORDANCE WITH ASTM D4956 TYPE 9 OR 11 SHALL BE APPLIED TO ONLY ONE SIDE OF THE DELINEATOR REFLECTOR BODY.

RETROREFLECTIVE SHEETING SHALL FOLLOW GUIDELINES OUTLINED IN SEC 1042.2.7.5 FOR CORRECT APPLICATION OF SHEETING TO DELINEATOR BODY. THE COLOR OF THE SHEETING SHALL MATCH THE CLOSEST ADJACENT PAVEMENT MARKING.

3" X 6" DELINEATOR BODY SHALL BE MADE FROM 0.080 INCH ALUMINUM.

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION
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SIGN MOUNTING DETAILS
DELINEATORS

DATE EFFECTIVE: 07/01/2019
DATE PREPARED: 3/28/2019

903.03BL

SHEET NO.
11 OF 16

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.

231.4 Shoulder Width

231.4.1 Introduction

A shoulder is the portion of the roadway contiguous to the traveled way that accommodates stopped vehicles, emergency use, and provides lateral support of the subbase, base and pavement. Shoulders may be paved (with concrete or asphalt) or unpaved (with aggregate or soil). This article describes only the geometric aspects of shoulders. For surfacing, refer to Shoulder Surface.

Desirably, a vehicle stopped on the shoulder should clear the edge of the traveled way by at least 1 ft., and preferably by 2 ft. This preference has led to the preferred use of a 10 ft. shoulder on major roadways. A shoulder at least 2 ft. wide is encouraged on minor roadways.

On urban roadways, the shoulder is located inside a curb. Surfaced areas behind curbs located on urban roadways may be perceived as a sidewalk and thus subject to ADA requirements. Therefore, a surfaced area is not to be provided behind a mountable curb.

When roadside barriers, walls, or other vertical elements are present, the shoulder that is provided must be wide enough to ensure the vertical element is offset 2 ft. from the edge of the useable shoulder. This is also true when guardrail is placed along the roadway.

Regardless of the width, a shoulder functions best when it is continuous. The full benefits of a shoulder are not realized unless it provides a driver with refuge at any point along the traveled way. A continuous shoulder provides a sense of security so all drivers making emergency stops will leave the traveled way. Although continuous shoulders are preferred, narrow shoulders and intermittent shoulders are still superior to no shoulders at all.

231.4.2 Pavement Resurfacing and Rehabilitation Projects

Each District has an asset management plan specific to their area and the needs within the district. When a pavement resurfacing or rehabilitation project arises, the district will make shouldering improvement decisions that are consistent with the assumptions in their district's asset management plan.

~~231.4.2 Rehabilitation Projects~~

~~The Asset Management Policy includes the following assumption for the treatment of shoulders in rehabilitation projects:~~

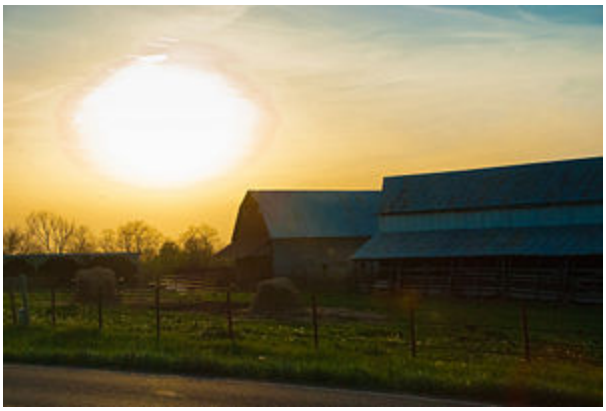
- ~~Not all projects will receive a shoulder treatment as part of the pavement improvement. Only the cost for resurfacing shoulders (match mainline treatment) has been included and only for 50 percent of the roadway treatments.~~

~~The asset management model does not include costs for building new shoulders or adding shoulders as part of a rehabilitation project. However, for districts that can meet asset management goals, funds that exist beyond what is needed to meet asset management goals may be used to construct new shoulders or add shoulders as part of rehabilitation projects.~~

In addition, new paved shoulders may be included as part of rehabilitation projects if safety funding is available for this part of the project cost and if a reasonable expectation of severe crashes exists.

231.4.2~~1~~.1 Rural Major Routes

For rural major routes, rehabilitation projects ~~are to~~~~shall~~should provide a 2 ft. minimum, preferably 4 ft. paved shoulder. A design exception should be submitted when providing a 4 ft. paved shoulder is not feasible or practical. Always consider the context of the surrounding route. New construction projects ~~will provide~~should provide 4 ft. to 10 ft. shoulders.



231.4.~~1~~2.2 Rural Minor Routes

The shoulder on rural minor roadways serves as structural support for the pavement and as additional width for the traveled way. This permits drivers meeting or passing other vehicles to drive on the edge of the roadway without leaving the surfaced area. Roads with a narrow traveled way, narrow shoulders and significant traffic tend to provide a poor level of service, have a higher crash rate, and need frequent and costly maintenance.

If a cost/benefit ratio study identifies the need~~funding (safety funds or flexible funds) allows~~ for the construction of new shoulders or the addition of shoulders as part of a project:

- ~~For rural minor routes, r~~For rural minor roads with a demonstrated history of severe lane departure crashes or with characteristics identified as part of a systemic safety improvement, rehabilitation projects shall~~will~~ provide a minimum 2 ft. paved shoulder and edgeline rumble strip. Always consider the context of the surrounding route. Adjacent segments not meeting this criteria may also be good candidates for paved shoulders, particularly if bookended by segments that do.~~New construction projects are to provide 4 ft. shoulders.~~
- New construction projects should provide 4 ft. shoulders.
- Rural minor routes classified as low-volume (less than 400 AADT) should not receive paved shoulders.

Category:~~Minor Routes~~ Shoulder~~ing~~ Widening Project Guidelines

Introduction

Shoulders are the portion of the roadway contiguous with the traveled way that accommodates stopped vehicles, emergency use, and lateral support of subbase, base, and surface courses. In some cases, the shoulder can accommodate bicyclists. Shoulders typically consist of the following types: earth (sod), aggregate, asphalt, or concrete product. ~~of any width provide the proven safety benefit of extra recovery area for errant vehicles. The public perceives shoulders as an enhancement to the transportation system and have consistently identified them as a top tier desire. In response, MoDOT has challenged their districts to assemble funding from any source possible and provide as many miles of shoulders on its minor routes as possible~~.

The following guidelines should be considered for shoulder widening adjacent to an existing roadway only. See EPG 231.4 for recommended shoulder widths. For new travel lane and shoulder construction, see EPG 231.3 and 231.4. Shoulder widening is not the same as the construction of new Type A2 or A3 shoulders. ~~are offered as an aid to facilitate the design of these projects.~~

Conceptual Stage

A Conceptual Study Report should be completed for all shoulder widening projects. As part of the conceptual stage, all National Environmental Policy Act (NEPA) documentation for environmental and historic preservation clearances must be addressed (see EPG 127). All project documentation shall be stored in eProjects.

Design

Typically, shoulder widening projects are constructed in conjunction with a resurfacing/overlay project. This allows the newly widened shoulder to be overlaid with the same surface material as the travelway lanes. Edgeline rumble strips are a safety enhancement that should be considered with shoulder widening construction (see EPG 626 for rumble strip guidance).

The standard shoulder widening design should include a bituminous base (paid in tons), placed on a compacted subgrade and capped with an asphalt surface that is placed monolithic with the roadway resurfacing. An optional concrete typical section should be included in the plans showing a concrete base in lieu of the bituminous base and capped with an asphalt surface that is placed monolithic with the roadway resurfacing. Include the Special Provision Optional Shoulder (JSP-13-03), which details how a no-cost change order will be issued to accommodate a contractor's choice to use a concrete base. Placement of an aggregate base under the bituminous base is not typically necessary; however, if the existing subgrade is determined to be unstable, a 4 inch aggregate base should be included with both the asphalt and concrete option.

Typically, the thickness of the bituminous base is increased by 2 inches in lieu of a 4 inch aggregate base.

The Type A2 and A3 standards are only appropriate for shoulders constructed with new pavements and should not be used for shoulder widening projects. Use of pay items in square yards should also be avoided for shoulder widening projects.

To address excavation, grading and backfilling, Special Provision Shoulder Grading NJSP-15-27A should be included in the contract documents, along with the following pay item:

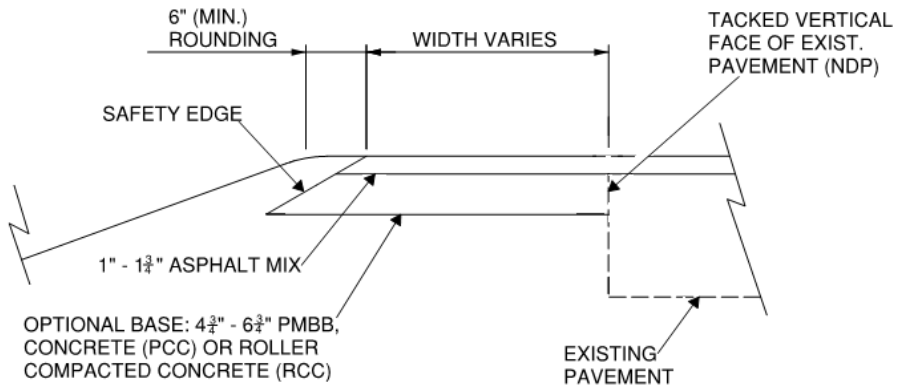
212-99.00 Misc. Shoulder Grading

Other shoulder widening pay items are:

- 402-05.20 Tons Bituminous Pavement Mixture PG64-22 (Surface Leveling) over
- 401-30.00 Tons Bituminous Pavement Mixture PG64-22 (Base) over
- 304-05.04 SY Type 5 Aggregate for Base (4 in. thick) - Optional

OR

- 401-12.09 Tons Bituminous Pavement Mixture PG64-22 (BP-1) over
- 401-30.00 Tons Bituminous Pavement Mixture PG64-22 (Base) over
- 304-05.04 SY Type 5 Aggregate for Base (4 in. thick) - Optional



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Additional Design Considerations

- Drainage pipes and box culverts may need to be extended.
- Slopes may be warped within reason to remain within existing right of way.
- A Safety Edge^{SM} shall be constructed at the edge of each 4 ft. wide or narrower shoulder.

Contents

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Minimum Expectations[edit]

- The finished roadway has a consistent 2-4 ft. wide paved shoulder.
- Edgeline rumble strips are provided.
- No right of way is acquired except in unique, isolated circumstances.
- Ditches, however altered, will flow properly.
- A Safety Edge℠ will be constructed at the edge of each 4 ft. wide or narrower shoulder.
- The traveled way should be overlaid with a 1 in. level course flush with the finished shoulder surface.
- A 2 ft. minimum width shoulder will be provided over all pipes 36 in. or less in diameter. To accomplish this, pipes may be extended, or slopes may be warped within reason. Shoulders may be narrowed or discontinued over box culverts and pipes over 36 in. in diameter.
- Plans should include the Optional Shoulder Construction JSP which gives the contractor the option to utilize either pavement type.

Corridor Consistency[edit]

- Districts will collaborate on corridors that cross district lines.

- Corridors will have logical termini.
- In general, shoulder improvements should appear the same (to the public).

NEPA[edit]

- A standard RES will be submitted for each project.
- All projects will be classified as Categorical Exclusions (CE).
- Impacts to threatened and endangered species or known cultural resources should be discerned.

Conceptual Plans[edit]

- Shouldering jobs fall under the Federal 3R classification as defined in 23CFR 625.2(b), however.
- A conventional Conceptual Study Report, instead of 3R, will be prepared.
- The appropriate rural and urban 3R standards will apply to design.
- Where 3R standards cannot be met, design exceptions will be submitted on a corridor-wide basis.
- The *Highway Safety Manual* (HSM) analysis required of design exceptions may be waived given the narrowly focused scope of shouldering.

Roadside Hardware[edit]

- All blunt ends, turned-down ends, and BCTs will be replaced with crashworthy end terminals.
- Guardrail that is in place but no longer needed will be removed.
- If the height to the top of the guardrail is less than 27 3/4 in. after construction, the entire run of rail shall be replaced with new MGS.

Rumble Strips[edit]

- On rural sections, a 12 in. rumble strip should be milled straddling the line between shoulder and traveled way.
- In the event that the traveled way has not been overlaid, a 12 in. rumble strip should be milled entirely on the shoulder surface, abutting the joint.
- Centerline rumble strips may be milled in isolated locations if the accident history reveals the need to do so, be located as specified in Std. Plan 903.02 and may be relocated by Maintenance forces or justified by design exception.

Signing[edit]

- Signs should be located as specified in Std. Plan 903.02.
- Signs not meeting Std Plan 903.02 may be relocated by Maintenance forces, or justified by design exception.

Drainage Structures[edit]

- A 2 ft. minimum width shoulder will be provided over all pipes 36 in. or less in diameter. To accomplish this,
- Pipes may be extended, or

- Slopes may be warped within reason.
- Shoulders may be narrowed or discontinued over box culverts and pipes over 36 in. in diameter.

Constructability[edit]

- Plans should include the *Optional Shoulder Construction* JSP which gives the contractor the option to utilize either pavement type.
- As a best practice, grading may be quantified, estimated, and paid according to a three-tiered approach, shown below:

Grading Tier	Definition	Action
Simple	Sufficient earth exists in situ to accommodate the entire paved shoulder	Include Shoulder Grading JSP.
Moderate	Some earth exists in situ, but additional material, generally from within the R/W, must be placed to accomodate the shoulder	Include Shoulder Grading JSP and include earthwork volumes for information only.
Complex	Little to no earth exists in situ, and most material must be borrowed off R/W and compacted to accomodate the shoulder	Design conventional earthwork with excavation and compaction volumes, and cross sections.