



Florida Department of Transportation

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SECRETARY

July 30, 2020

Khoa Nguyen
Director, Office of Technical Services
Federal Highway Administration
3500 Financial Plaza, Suite 400
Tallahassee, Florida 32312

Re: State Specifications Office
Section: **334**
Proposed Specification: **3340203 SUPERPAVE ASPHALT CONCRETE.**

Dear Mr. Nguyen:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

The changes are proposed by Wayne Rilko to clarify the continuous RAP stockpile approval procedure, allow more RAP in PG 76-22 structural course mixtures, change the frequency of asphalt mixture recovery samples, clarify the number of required density cores for acceptance, and add specific gravity correction factor requirements to mix design submissions to the Standard Specification.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to daniel.strickland@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at 414-4130.

Sincerely,

Signature on file

Daniel Strickland, P.E.
State Specifications Engineer

DS/dh

Attachment

cc: Florida Transportation Builders' Assoc.
State Construction Engineer

SUPERPAVE ASPHALT CONCRETE
(REV 5-8-20)

SUBARTICLE 334-2.3.1 is deleted and the following substituted:

334-2 Materials.

334-2.3 Reclaimed Asphalt Pavement (RAP) Material:

334-2.3.1 General requirements: RAP may be used as a component of the asphalt mixture subject to the following requirements:

1. When using a PG 76-22 asphalt binder in friction course mixtures, limit the amount of RAP material used in the mix to a maximum of 20% by weight of total aggregate. As an exception, amounts greater than 20% RAP by weight of total aggregate can be used if no more than 20% by weight of the total asphalt binder comes from the RAP material. When using a PG 76-22 asphalt binder in structural course mixtures, refer to 334-2.3.6. RAP is not allowed in mixtures containing High Polymer asphalt binder. High Polymer asphalt is defined in Section 916.

2. Assume full responsibility for the design, production and construction of asphalt mixes which incorporate RAP as a component material.

3. Use RAP from a Department approved stockpile or millings from a Department project.

4. Provide stockpiled RAP material that is reasonably consistent in characteristics and contains no aggregate particles which are soft or conglomerates of fines.

5. Provide RAP material having a minimum average asphalt binder content of 4.0% by weight of RAP. As an exception, when using fractionated RAP, the minimum average asphalt binder content for the coarse portion of the RAP shall be 2.5% by weight of the coarse portion of the RAP. The coarse portion of the RAP shall be the portion of the RAP retained on the No. 4 sieve. The Engineer may sample the stockpiles to verify that this requirement is met.

SUBARTICLE 334-2.3.3 is deleted and the following substituted:

334-2.3.3 RAP Stockpile Approval: Prior to the incorporation of RAP into the asphalt mixture, stockpile the RAP material and obtain approval for the stockpile by one of the following methods:

1. Continuous stockpile: When RAP is obtained from one or multiple sources and is either processed, blended, or fractionated, and stockpiled in a continuous manner, assure an adequate number of test results are obtained for stockpile approval. Test the RAP material for gradation and asphalt content at a minimum frequency of one sample per 1000 tons with a minimum of six test results. Test the RAP material for G_{mm} (for G_{sb} determination) at a minimum frequency of one sample per 5000 tons with a minimum of two test results. Based on visual inspection and a review of the test data, the Engineer will determine the suitability of the stockpiled material. In addition, address the details and specifics of the processing, sampling, testing and actions to be taken in the Producer Quality Control (QC) Plan.

When RAP is added to the continuous stockpile after original approval of the stockpile as described above, test the RAP material for gradation and asphalt

content at a minimum frequency of one sample per 1000 tons with a minimum of six test results. Test the RAP material for G_{mm} (for G_{sb} determination) at a minimum frequency of one sample per 5000 tons with a minimum of two test results. Monitor test results during crushing operations for conformance to the requirements of Table 334-1. After the minimum frequency of tests have been performed, the Engineer will review the test data and visually inspect the stockpiled material. The average gradation and G_{mm} of the added material shall be within the allowable ranges shown in Table 334-1 from the originally approved stockpile values. If the added RAP material does not meet the conditions of Table 334-1, then the Contractor must create a new stockpile when resuming crushing operations and the stockpile will receive a new number designation from the Department. The previously crushed material, which was added to the continuous stockpile and did not meet the conditions of Table 334-1, may remain and that stockpile used until depleted.

| <u>Table 334-1</u> | |
|---|---|
| <u>Allowable Ranges for Continuous RAP Stockpile Properties</u> | |
| <u>Characteristic</u> | <u>Limit from Original Approved Stockpile Gradation</u> |
| <u>No. 8 sieve and coarser</u> | <u>$\pm 6.0\%$</u> |
| <u>No. 16 sieve</u> | <u>$\pm 5.0\%$</u> |
| <u>No. 30 sieve</u> | <u>$\pm 5.0\%$</u> |
| <u>No. 50 sieve</u> | <u>$\pm 4.0\%$</u> |
| <u>No. 100 sieve</u> | <u>$\pm 3.0\%$</u> |
| <u>No. 200 sieve</u> | <u>$\pm 2.0\%$</u> |
| <u>G_{mm}</u> | <u>± 0.040</u> |

2. Non-continuous single stockpile: When an individual stockpile is being constructed, obtain representative samples at random locations and test the RAP material for gradation and asphalt content at a minimum frequency of one sample per 1000 tons with a minimum of six test results. Test the RAP material for G_{mm} (for G_{sb} determination) at a minimum frequency of one sample per 5000 tons with a minimum of two test results. Based on visual inspection and a review of the test data, the Engineer will determine the suitability of the stockpiled material. If the properties of the new stockpile compare with the properties of an existing stockpile within the ranges provided in Table 334-1, the RAP in the new stockpile may be added to the existing stockpile. Once the RAP stockpile has been approved, do not add additional material without prior approval of the Engineer.

Determine the asphalt binder content and gradation of the RAP material in accordance with FM 5-563 and FM 1-T 030, respectively. Establish the G_{sb} of the RAP material by using one of the following methods:

a. Calculate the G_{sb} value based upon the effective specific gravity (G_{se}) of the RAP material, determined on the basis of the asphalt binder content and maximum specific gravity (G_{mm}) of the RAP material. The Engineer will approve the estimated asphalt binder absorption value used in the calculation.

b. Measure the G_{sb} of the RAP aggregate, in accordance with FM 1-T 084 and FM 1-T 085. Obtain the aggregate by using a solvent extraction method.

SUBARTICLE 334-2.3.5 is deleted and the following substituted:

334-2.3.5 Asphalt Binder for Mixes with RAP: Select the appropriate asphalt binder grade based on Table 334-~~2~~⁴. The Engineer reserves the right to change the asphalt binder grade at design based on the characteristics of the RAP asphalt binder, and reserves the right to make changes during production.

| Table 334- 2 ⁴ Asphalt Binder Grade for Mixes Containing RAP | |
|---|----------------------|
| Percent RAP | Asphalt Binder Grade |
| 0 - 15 | PG 67-22 |
| 16 - 30 | PG 58-22 |
| >30 | PG 52-28 |

SUBARTICLE 334-2.3 is expanded by the following:

334-2.3.6 Allowable RAP Percentages for Type SP Structural Mixtures with PG 76-22 Asphalt Binder: For Type SP structural mixtures using PG 76-22 asphalt binder, select the percentage of RAP material based on Table 334-3.

| Table 334-3 <u>Allowable RAP Percentages¹ in Type SP Structural Mixtures with PG 76-22 Asphalt Binder</u> | | | |
|--|-----------------------------------|---|------------------------------------|
| | <u>Coarse RAP</u> | <u>Intermediate RAP</u> | <u>Fine RAP</u> |
| <u>Gradation² % Passing #16 Sieve²</u> <u>% Passing #16 Sieve</u> | <u>Coarse RAP</u> <u>≤ 40%</u> | <u>Intermediate RAP</u> <u>> 40% to ≤ 50%</u> | <u>Fine RAP</u> <u>> 50%</u> |
| <u>PG_{HT}³ > 100.0° C</u> | <u>Allowable RAP Percentage</u> | <u>≤ 25%</u> | <u>≤ 20%</u> |
| <u>PG_{HT}³ ≤ 100.0° C</u> | | <u>≤ 30%</u> | |
| <u>Notes:</u> | | | |
| <u>1. RAP aggregate by weight of total aggregate or RAP binder by weight of total binder.</u> | | | |
| <u>2. RAP gradations based on ignition oven extraction of RAP material in accordance with FM 5-563.</u> | | | |
| <u>3. PG_{HT}: asphalt binder high temperature continuous performance grade of RAP in accordance with Section 916.</u> | | | |

SUBARTICLE 334-3.2.1 is deleted and the following substituted:

334-3.2 Mix Design:

334-3.2.1 General: Design the asphalt mixture in accordance with AASHTO R 35-1~~7~~², except as noted herein. Prior to the production of any asphalt mixture, submit the proposed mix design with supporting test data indicating compliance with all mix design criteria to the Engineer. For all mix designs, include representative samples of all component materials, including asphalt binder. Allow the Director of the Office of Materials a maximum of four weeks to either conditionally verify or reject the mix as designed.

For a Traffic Level A mixture, meet the mix design criteria for a Traffic Level B mixture and for a Traffic Level D mixture meet the mix design criteria for a Traffic Level E mixture.

At no additional cost to the Department, for~~In addition,~~ a Type SP mix ~~one traffic level higher than the traffic level specified in the Contract Documents may be substituted, at no cost to the Department. In addition~~Based on the previous conditions, the following Traffic Level substitutions are allowed:

Traffic Level E can be substituted for Traffic Level D.

Traffic Level D or E can be substituted for Traffic Level C.

Traffic Level C can be substituted for Traffic Level B.

Traffic Level B or C can be substituted for Traffic Level A.

The same traffic level and binder type that is used for the mainline traffic lanes may be placed in the shoulder at no additional cost to the Department, even if the conditions stated above are not met for the shoulder.

Do not use more than four mix designs per nominal maximum aggregate size per traffic level per binder grade per year, where the year starts at the Notice to Proceed. Exceeding this limitation will result in a maximum Composite Pay Factor (CPF) of 1.00 as defined in 334-8.2 for all designs used beyond this limit.

Warm mix technologies (additives, foaming techniques, etc.) listed on the Department's website may be used in the production of the mix. The URL for obtaining this information, if available, is: <https://www.fdot.gov/materials/mac/production/warmmixasphalt/>.

When warm mix technologies are used, for mixtures containing a PG 52-28, PG 58-22, or PG 67-22 binder, a mixture will be considered a warm mix asphalt design if the mixing temperature is 285°F or less. For mixtures containing a PG 76-22 or High Polymer binder, a mixture will be considered a warm mix asphalt design if the mixing temperature is 305°F or less.

The Engineer will consider any marked variations from original test data for a mix design or any evidence of inadequate field performance of a mix design as sufficient evidence that the properties of the mix design have changed, and the Engineer will no longer allow the use of the mix design.

SUBARTICLE 334-3.2.2 is deleted and the following substituted:

334-3.2.2 Mixture Gradation Requirements: Combine the coarse and fine aggregate in proportions that will produce an asphalt mixture meeting all of the requirements defined in this specification and conform to the gradation requirements at design as defined in AASHTO M 323-172, Table 43. Aggregates from various sources may be combined.

334-3.2.2.1 Mixture Gradation Classification: Plot the combined mixture gradation on an FHWA 0.45 Power Gradation Chart. Include the Control Points from AASHTO M 323-172, Table 43, as well as the Primary Control Sieve (PCS) Control Point from AASHTO M 323-172, Table 54. Fine mixes are defined as having a gradation that passes above the primary control sieve control point and above the maximum density line for all sieve sizes smaller than the primary control sieve and larger than the No. 30100 sieve.

SUBARTICLE 334-3.2.3.1 is deleted and the following substituted:

334-3.2.3.1 Coarse Aggregate Angularity: When tested in accordance with ASTM D-5821-~~1304~~ (2017~~06~~), meet the percentage of fractured faces requirements specified in AASHTO M 323-17~~2~~, Table ~~65~~.

SUBARTICLE 334-3.2.3.2 is deleted and the following substituted:

334-3.2.3.2 Fine Aggregate Angularity: When tested in accordance with AASHTO T 304-17~~4~~, Method A, meet the uncompacted void content of fine aggregate specified in AASHTO M 323-17~~2~~, Table ~~65~~.

SUBARTICLE 334-3.2.3.3 is deleted and the following substituted:

334-3.2.3.3 Flat and Elongated Particles: When tested in accordance with ASTM D-4791-19~~0~~, (with the exception that the material passing the 3/8 inch sieve and retained on the No. 4 sieve shall be included), meet the requirements specified in AASHTO M 323-17~~2~~, Table ~~65~~. Measure the aggregate using the ratio of 5:1, comparing the length (longest dimension) to the thickness (shortest dimension) of the aggregate particles.

SUBARTICLE 334-3.2.3.4 is deleted and the following substituted:

334-3.2.3.4 Sand Equivalent: When tested in accordance with AASHTO T 176-17~~08~~, meet the sand equivalent requirements specified in AASHTO M 323-17~~2~~, Table ~~65~~.

SUBARTICLE 334-3.2.4 is deleted and the following substituted:

334-3.2.4 Gyratory Compaction: Compact the design mixture in accordance with AASHTO T 312-19~~2~~, with the following exception: use the number of gyrations at N_{design} as defined in Table 334-~~42~~. Measure the inside diameter of gyratory molds in accordance with AASHTO T 312-19~~2~~.

| Table 334- 42 | |
|----------------------------------|---|
| Gyratory Compaction Requirements | |
| Traffic Level | N_{design} Number of Gyrations |
| A | 50 |
| B | 65 |
| C | 75 |
| D | 100 |
| E | 100 |

SUBARTICLE 334-3.2.5 is deleted and the following substituted:

334-3.2.5 Design Criteria: Meet the requirements for nominal maximum aggregate size as defined in AASHTO M 323-172, as well as for relative density, VMA, VFA, and dust-to-binder ratio as specified in AASHTO M 323-172, Table 76. N_{initial} and N_{maximum} requirements are not applicable.

SUBARTICLE 334-3.2.6 is deleted and the following substituted:

334-3.2.6 Moisture Susceptibility:

1. For all traffic levels, use a liquid anti-strip agent listed on the APL at the specified dosage rate. Hydrated lime may be used instead of the liquid anti-strip agent.
2. Provide a mixture having a retained tensile strength ratio of at least 0.80 and a minimum tensile strength (unconditioned) of 100 psi in accordance with FM1-T 283.

SUBARTICLE 334-3.2.7 is deleted and the following substituted:

334-3.2.7 Additional Information: In addition to the requirements listed above, provide the following information with each proposed mix design submitted for verification:

1. The design traffic level and the design number of gyrations (N_{design}).
2. The source and description of the materials to be used.
3. The Department source number and the Department product code of the aggregate components furnished from a Department approved source.
4. The gradation and proportions of the raw materials as intended to be combined in the paving mixture. The gradation of the component materials shall be representative of the material at the time of use. Compensate for any change in aggregate gradation caused by handling and processing as necessary.
5. A single percentage of the combined mineral aggregate passing each specified sieve. Degradation of the aggregate due to processing (particularly material passing the No. 200 sieve) should be accounted for and identified.
6. The bulk specific gravity (G_{sb}) value for each individual aggregate and RAP component, as identified in the Department's aggregate control program.
7. A single percentage of asphalt binder by weight of total mix intended to be incorporated in the completed mixture, shown to the nearest 0.1%.
8. A target temperature for the mixture at the plant (mixing temperature) and a target temperature for the mixture at the roadway (compaction temperature) in accordance with 320-6.3. Do not exceed a target temperature of 340°F for High Polymer asphalt binder, 330°F for PG 76-22 asphalt binders, and 315°F for unmodified asphalt binders.
9. Provide the physical properties at the optimum asphalt content, which must conform to all specified requirements.
10. The name of the Construction Training Qualification Program (CTQP) Qualified Mix Designer.
11. The ignition oven and maximum specific gravity (G_{mm}) calibration factors.
12. The warm mix technology, if used.

SUBARTICLE 334-3.3 is deleted and the following substituted:

334-3.3 Mix Design Revisions: During production, the Contractor may request a target value revision to a mix design, subject to meeting the following requirements: the target change falls within the limits defined in Table 334-53, appropriate data exists demonstrating that the mix complies with production air voids specification criteria, and the mixture gradation meets the basic gradation requirements defined in 334-3.2.2.

| Characteristic | Limit from Original Mix Design |
|--|--------------------------------|
| No. 8 sieve and Coarser | ± 5.0% |
| No. 16 sieve | ± 4.0% |
| No. 30 sieve | ± 4.0% |
| No. 50 sieve | ± 3.0% |
| No. 100 sieve | ± 3.0% |
| No. 200 sieve | ± 1.0% |
| Asphalt Binder Content ⁽¹⁾ | ± 0.3% |
| Each Component of Aggregate Blend ⁽²⁾ | ± 5.0 % |

⁽¹⁾ Reductions to the asphalt binder content will not be permitted if the VMA during production is lower than 1.0% below the design criteria.
⁽²⁾ Revisions to FC-5 mixtures to be determined by the Engineer.

Submit all requests for revisions to mix designs, along with supporting documentation, to the Engineer. In order to expedite the revision process, the request for revision or discussions on the possibility of a revision may be made verbally, but must be followed up by a written request. The verified mix design will remain in effect until the Engineer authorizes a change. In no case will the effective date of the revision be established earlier than the date of the first communication between the Contractor and the Engineer regarding the revision.

A new design mix will be required if aggregate sources change, or for any substitution of an aggregate product with a different aggregate code, unless approved by the Engineer.

SUBARTICLE 334-5.1.1 is deleted and the following substituted:

334-5.1.1 Sampling and Testing Requirements: Obtain the samples in accordance with FM 1-T 168. Obtain samples at the plant of a sufficient quantity to be split into three smaller samples; one for QC, one for Verification testing and one for Resolution testing. Obtain each split sample of a sufficient quantity, approximately 40 pounds, for all required testing at approximately 35 pounds. The split samples for Verification testing and Resolution testing shall be reduced in size and stored in three boxes each. The approximate size of each box must be 12 inches x 8 inches x 4 inches. Provide, label, and safely store sample boxes in a manner agreed upon by the Engineer for future testing.

The asphalt content of the mixture will be determined in accordance with FM 5-563. The gradation of the recovered aggregate will be determined in accordance with FM 1-T 030. Volumetric testing will be in accordance with AASHTO T 312-19~~2~~ and FM 1-T 209. Prior to testing volumetric samples, condition the test-sized sample for one hour, plus or minus five minutes, at the target roadway compaction temperature in a shallow, flat pan, such that the mixture temperature at the end of the one hour conditioning period is within plus or minus 20°F of the roadway compaction temperature.

If one of the QC gyratory specimens is damaged, make an additional gyratory specimen.

For situations where two properly prepared gyratory specimens do not meet single-operator precision requirements for G_{mb} as provided in FM 1-T 166:

1. Retest both gyratory specimens in accordance FM 1-T 166.

2. Following the retest, if the newly measured G_{mb} values do not meet single-operator precision requirements, QC shall prepare a third gyratory specimen in accordance with AASHTO T 312-19 and test in accordance with FM 1-T 166. All three test results shall be input into MAC. The average G_{mb} will be determined by MAC after performing an outlier check in accordance with ASTM E178.

Test for roadway density in accordance with FM 1 T 166.

SUBARTICLE 334-5.1.2 is deleted and the following substituted:

334-5.1.2 Acceptance Testing Exceptions: When the total combined quantity of hot mix asphalt for the project, as indicated in the Plans for Type B-12.5, Type SP and Type FC mixtures only, is less than 2000 tons, the Engineer will accept the mix on the basis of visual inspection. The Engineer may require the Contractor to run process control tests for informational purposes, as defined in 334-4, or may run independent verification tests to determine the acceptability of the material.

Density testing for acceptance will not be performed on widening strips or shoulders with a width of 5 feet or less, open-graded friction courses, variable thickness overbuild courses, leveling courses, any SP-9.5 or SP-12.5 asphalt layer placed on subgrade with a layer thickness less than or equal to 3 inches, ~~except if the layer thickness is greater than 3 inches or is a Type SP-19.0 mixture (regardless of thickness type)~~, miscellaneous asphalt pavement, shared use paths, crossovers, gore areas, or any course with a specified thickness less than 1 inch or a specified spread rate that converts to less than 1 inch as described in 334-1.4. Density testing for acceptance will not be performed on asphalt courses placed on bridge decks or approach slabs; compact these courses in static mode only per the requirements of 330-7.7. In addition, density testing for acceptance will not be performed on the following areas when they are less than 500 feet (continuous) in length: turning lanes, acceleration lanes, deceleration lanes, shoulders, parallel parking lanes or ramps. Do not perform density testing for acceptance in situations where the areas requiring density testing is less than 50 tons within a subplot.

Density testing for acceptance will not be performed in intersections. The limits of the intersection will be from stop bar to stop bar for both the mainline and side streets. A random core location that occurs within the intersection shall be moved forward or backward from the intersection at the direction of the Engineer.

Where density testing for acceptance is not required, compact these courses (with the exception of open-graded friction courses) in accordance with the rolling

procedure (equipment and pattern) as approved by the Engineer or with Standard Rolling Procedure as specified in 330-7.2. In the event that the rolling procedure deviates from the procedure approved by the Engineer, or the Standard Rolling Procedure, placement of the mix shall be stopped.

The density pay factor (as defined in 334-8.2) for areas not requiring density testing for acceptance will be paid at the same density pay factor as for the areas requiring density testing within the same LOT. If the entire LOT does not require density testing for acceptance, the LOT will be paid at a density pay factor of 1.00.

SUBARTICLE 334-5.4.4 is deleted and the following substituted:

334-5.4.4 Individual Test Tolerances for QC Testing: Terminate the LOT if any of the following QC failures occur:

1. An individual test result of a subplot for air voids does not meet the requirements of Table 334-64,
2. The average subplot density does not meet the requirements of Table 334-64,
3. Two consecutive test results within the same LOT for gradation or asphalt binder content do not meet the requirements of Table 334-64,

When a LOT is terminated due to a QC failure, stop production of the mixture until the problem is resolved to the satisfaction of the QC Manager and/or Asphalt Plant Level II technician responsible for the decision to resume production after a QC failure, as identified in Section 105. In the event that it can be demonstrated that the problem can immediately be or already has been resolved, it will not be necessary to stop production. When a LOT is terminated, make all necessary changes to correct the problem. Do not resume production until appropriate corrections have been made. Prior to resuming production, inform the Engineer of the problem and corrections made to correct the problem. After resuming production, sample and test the material to verify that the changes have corrected the problem. Summarize this information and provide it to the Engineer prior to the end of the work shift when production resumes.

In the event that a QC failure is not addressed as defined above, the Engineer's approval will be required prior to resuming production after any future QC failures.

Address any material represented by a failing test result, as defined above in this subarticle, in accordance with 334-5.9.5. Any LOT terminated under this subarticle will be limited to a maximum Pay Factor of 1.00 (as defined in 334-8.2) for all quality characteristics and will include all material placed up to the point when the LOT was terminated.

In the event that a G_{mm} test result differs by more than 0.040 from the mix design G_{mm} , investigate the causes of the discrepancy and report the findings and proposed actions to the Engineer.

| Table 334-64 Master Production Range | |
|---|--------------------------|
| Characteristic | Tolerance ⁽¹⁾ |
| Asphalt Binder Content (%) | Target ± 0.55 |
| Passing No. 200 Sieve (%) | Target ± 1.50 |

| Table 334- 64 | |
|--|--------------------------|
| Master Production Range | |
| Characteristic | Tolerance ⁽¹⁾ |
| Air Voids (%) | 2.30 – 6.00 |
| Density (minimum % G_{mm}) ⁽²⁾ | 89.50 |
| (1) Tolerances for sample size of $n = 1$ from the verified mix design | |
| (2) Based on an average of three to five 3-5 randomly located cores | |

SUBARTICLE 334-5.5.1 is deleted and the following substituted:

334-5.5.1 Plant Testing: At the completion of each LOT, the Engineer will test a minimum of one Verification split sample randomly selected from the LOT. Results of the testing and analysis for the LOT will be made available to the Contractor within one working day from the time the LOT is completed. Verification samples shall be reheated at the target roadway compaction temperature for 1-1/2 hours, plus or minus 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. In lieu of the 1-1/2 hours reheating procedure, the mixture may be reheated to within plus or minus 20°F of the roadway compaction temperature using a microwave oven. Stir the mixture as necessary during the reheating process to maintain temperature uniformity. Subsequently, condition and test the mixture as described in 334-5.1.1.

The Verification test results will be compared with the QC test results based on the between-laboratory precision values shown in Table 334-~~75~~.

| Table 334- 75 | |
|---------------------------------------|-----------------------|
| Between-Laboratory Precision Values | |
| Property | Maximum Difference |
| G_{mm} | 0.016 |
| G_{mb} (gyratory compacted samples) | 0.022 |
| G_{mb} (roadway cores) | 0.014 |
| P_b | 0.44% |
| P_{-200} | FM 1-T 030 (Figure 2) |
| P_{-8} | FM 1-T 030 (Figure 2) |

If all of the specified mix characteristics compare favorably, then the LOT will be accepted, with payment based on the Contractor's QC test data for the LOT.

If any of the results do not compare favorably, then the Resolution samples from the LOT will be sent to the Resolution laboratory for testing, as described in 334-5.6.

SUBARTICLE 334-5.5.2 is deleted and the following substituted:

334-5.5.2 Roadway Testing: At the completion of each LOT, the Engineer will determine the density (G_{mb}) of each core (previously tested by QC) as described in 334-5.1.1 from the same subplot as the plant samples. For situations where roadway density is not required for the random subplot chosen, then another subplot shall be randomly chosen for roadway density

cores only. Results of the testing and analysis for the LOT will be made available to the Contractor within one working day from the time the LOT is completed.

The individual Verification test results will be compared with individual QC test results by the Engineer based on the between-laboratory precision values given in Table 334-75.

If each of the core test results compare favorably, then the LOT will be accepted with respect to density, with payment based on the Contractor's QC test data for the LOT.

If any of the results do not compare favorably, then the core samples from the LOT will be sent to the Resolution laboratory for testing as specified in 334-5.6.

SUBARTICLE 334-5.6.1 is deleted and the following substituted:

334-5.6 Resolution System:

334-5.6.1 Plant Samples: In the event of an unfavorable comparison between the Contractor's QC test results and the Engineer's Verification test results on any of the properties identified in Table 334-75, the Resolution laboratory will test all of the split samples from the LOT for only the property (or properties) in question. Resolution samples shall be reheated at the target roadway compaction temperature for 1-1/2 hours, plus or minus 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. In lieu of the 1-1/2 hours reheating procedure, the mixture may be reheated to within plus or minus 20°F of the roadway compaction temperature using a microwave oven. Stir the mixture as necessary during the reheating process to maintain temperature uniformity. Subsequently, condition and test the mixture as described in 334-5.1.1.

SUBARTICLE 334-5.6.3 is deleted and the following substituted:

334-5.6.3 Resolution Determination: The Resolution test results (for the property or properties in question) will be compared with the QC test results based on the between-laboratory precision values shown in Table 334-75.

If the Resolution test results compare favorably with all of the QC results, then acceptance and payment for the LOT will be based on the QC results, and the Department will bear the costs associated with Resolution testing. No additional compensation, either monetary or time, will be made for the impacts of any such testing.

If the Resolution test results do not compare favorably with all of the QC results, then acceptance and payment for the LOT will be based on the Resolution test data for the LOT, and the costs of the Resolution testing will be deducted from monthly estimates. No additional time will be granted for the impacts of any such testing.

In addition, the material failure requirements of 334-5.4.4 apply to the Resolution test data. Address any material represented by the failing test results in accordance with 334-5.9.5. For this situation, the LOT will be limited to a maximum Pay Factor of 1.00 (as defined in 334-8.2) for all quality characteristics.

In the event of an unfavorable comparison between the Resolution test results and QC test results, make the necessary adjustments to assure that future comparisons are favorable.

SUBARTICLE 334-5.7.1 is deleted and the following substituted:

334-5.7 Independent Verification (IV) Testing:

334-5.7.1 Plant: The Contractor shall provide sample boxes and take samples as directed by the Engineer for IV testing. Obtain enough material for three complete sets of tests (two samples for IV testing by the Engineer and one sample for testing by the Contractor). If agreed upon by both the Engineer and the Contractor, only one sample for IV testing by the Engineer may be obtained. IV samples will be reheated at the target roadway compaction temperature for 1-1/2 hours, plus or minus 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. The Contractor's split sample, if tested immediately after sampling, shall be reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. If the Contractor's sample is not tested immediately after sampling, then the sample shall be reheated at the target roadway compaction temperature for 1-1/2 hours, plus or minus 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. For the IV and Contractor's samples, in lieu of the 1-1/2 hours reheating procedure, the mixture may be reheated to within plus or minus 20°F of the roadway compaction temperature using a microwave oven. Stir the mixture as necessary during the reheating process to maintain temperature uniformity. Subsequently, condition and test the mixture as described in 334-5.1.1. The Contractor's test results shall be provided to the Engineer within one working day from the time the sample was obtained.

If any of the IV test results do not meet the requirements of Table 334-64, then a comparison of the IV test results and the Contractor's test results, if available, will be made. If a comparison of the IV test results and the Contractor's test results meets the precision values of Table 334-75 for the material properties in question, or if the Contractor's test results are not available, then the IV test results are considered verified and the Contractor shall cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Address any material represented by the failing test results in accordance with 334-5.9.5.

If a comparison of the IV test results and the Contractor's test results does not meet the precision values of Table 334-75 for the material properties in question, then the second IV sample shall be tested by the Engineer for the material properties in question. If a comparison between the first and second IV test results does not meet the precision values of Table 334-75 for the material properties in question, then the first IV test results are considered unverified for the material properties in question and no action shall be taken, with the following exception: if the first and second IV test results do not meet the precision values of Table 334-7 and the first IV test result and Contractor's test result do not meet the precision values of Table 334-7, yet all three test results do not meet the requirements of Table 334-6, then address any material represented by the failing test results in accordance with 334-5.9.5.

If a comparison between the first and second IV test results meets the precision values of Table 334-75 for the material properties in question, then the first IV sample is considered verified and the Contractor shall cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already

has been) resolved. Address any material represented by the failing test results in accordance with 334-5.9.5.

The Engineer has the option to use the IV sample for comparison testing as specified in 334-6.

SUBARTICLE 334-5.7.1 is expanded by the following:

334-5.7.1.1 Asphalt Binder and Mixture Sampling for Determination of Asphalt Binder Quality: At the Department's request, obtain an asphalt binder sample from the asphalt plant storage tank and a corresponding asphalt mixture sample utilizing using binder from the same storage tank at the request of the Department. Samples of asphalt binder and mixture should shall be sampled the same day. The asphalt binder from the storage tank and the asphalt binder recovered from the asphalt mixture will be tested by the Department for compliance with Contract Documents.

SUBARTICLE 334-5.7.2 is deleted and the following substituted:

334-5.7.2 Roadway: Obtain five 6-inch diameter roadway cores within 24 hours of placement, as directed by the Engineer, for IV testing. In situations where it is impractical to cut five cores per subplot, obtain a minimum of three cores per subplot at random locations, as identified by the Engineer. These independent cores will be obtained from the same LOTs and sublots as the Independent Verification Plant samples, or as directed by the Engineer. The density of these cores will be obtained as described in 334-5.1.1. If the average of the results for the subplot does not meet the requirements of Table 334-64 for density, then a comparison of the IV G_{mm} test results and the Contractor's G_{mm} test results, if available, will be made in accordance with the procedure provided in 334-5.7.1. Address any material represented by the failing test results in accordance with 334-5.9.5.

SUBARTICLE 334-8.2.2 is deleted and the following substituted:

334-8.2.2 Two or Less Sublot Test Results: In the event that two or less subplot test results are available for a LOT, Pay Factors will be determined based on Table 334-86, using the average of the accumulated deviations from the target value. (Except for density, deviations are absolute values with no plus or minus signs.) Use the 1-Test column when there is only one subplot test result and use the 2-Tests column when there are two sublots.

| Table 334-86 Small Quantity Pay Table | | |
|--|------------------------------|---------------------------------|
| Pay Factor | 1 Sublot Test Deviation | 2 Sublot Test Average Deviation |
| Asphalt Binder Content | | |
| 1.05 | 0.00-0.23 | 0.00-0.16 |
| 1.00 | 0.24-0.45 | 0.17-0.32 |
| 0.90 | 0.46-0.55 | 0.33-0.39 |
| 0.80 | >0.55 | >0.39 |
| No. 8 Sieve | | |
| 1.05 | 0.00-2.25 | 0.00-1.59 |
| 1.00 | 2.26-4.50 | 1.60-3.18 |
| 0.90 | 4.51-5.50 | 3.19-3.89 |
| 0.80 | >5.50 | >3.89 |
| No. 200 Sieve | | |
| 1.05 | 0.00-0.55 | 0.00-0.39 |
| 1.00 | 0.56-1.10 | 0.40-0.78 |
| 0.90 | 1.11-1.50 | 0.79-1.06 |
| 0.80 | >1.50 | >1.06 |
| Air Voids | | |
| 1.05 | 0.00-0.50 | 0.00-0.35 |
| 1.00 | 0.51-1.00 | 0.36-0.71 |
| 0.90 | 1.01-1.70 | 0.72-1.20 |
| 0.80 | 1.71-2.00 | 1.21-1.41 |
| 0.70 | 2.01-2.50 | 1.42-1.77 |
| 0.55 | >2.50 | >1.77 |
| Density ⁽¹⁾ | | |
| 1.05 | + (0.00-2.00), - (0.00-0.50) | + (0.00-1.40), - (0.00-0.35) |
| 1.00 | + (2.01-3.00), - (0.51-1.00) | + (1.41-2.10), - (0.36-0.71) |
| 0.95 | + (3.01-3.50), - (1.01-2.00) | + (2.11-2.80), - (0.72-1.41) |
| 0.90 | + (3.51-4.00), - (2.01-3.00) | + (2.81-3.50) - (1.42-2.12) |
| 0.80 | + (>4.00), - (>3.00) | + (>3.50), - (>2.12) |
| (1). Each density test result is the average of <u>three to five randomly located</u> cores. The target density is 93.00 percent of G_{mm} (92.00 percent when compaction is limited to the static mode or for layers specified to be one inch thick). When compaction is limited to the static mode, no vibratory mode in the vertical direction will be allowed. Other vibratory modes will be allowed, if approved by the Engineer. In this case, the target density is 92.00 percent of G_{mm} . | | |

SUBARTICLE 334-8.2.3.1 is deleted and the following substituted:

334-8.2.3.1 Percent Within Limits: The percent within limits (PWL) and Pay Factors for the LOT will be calculated as described below. Variables used in the calculations are as follows:

- x = individual test value (sublot)
- n = number of tests (sublots)
- s = sample standard deviation

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

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

Q_U = upper quality index

USL = upper specification limit (target value plus upper

specification limit from Table 334-97)

Q_L = lower quality index

LSL = lower specification limit (target value minus

lower specification limit from Table 334-97)

P_U = estimated percentage below the USL

P_L = estimated percentage above the LSL

1. Calculate the arithmetic mean (\bar{X}) of the test values:

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

2. Calculate the sample standard deviation (s):

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

3. Calculate the upper quality index (Q_U):

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

4. Calculate the lower quality index (Q_L):

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

5. From Table 334-108, determine the percentage of work below the USL (P_U).

6. From Table 334-108, determine percentage of work above the LSL (P_L) Note: If USL or LSL is not specified; percentages within (USL or LSL) will be 100.

7. If Q_U or Q_L is a negative number, then calculate the percent within limits for Q_U or Q_L as follows: enter Table 334-108 with the positive value of Q_U or Q_L and obtain the corresponding percent within limits for the proper sample size. Subtract this number from 100.00. The resulting number is the value to be used in the next step (Step 8) for the calculation of quality level.

8. Calculate the percent within limits (PWL) = ($P_U + P_L$) - 100

9. Calculate the Pay Factor (PF) for each quality characteristic using the equation given in 334-8.2.3.2.

| Quality Characteristic | Specification Limits |
|---|-------------------------------------|
| Passing No. 8 sieve (percent) | Target \pm 3.1 |
| Passing No. 200 sieve (percent) | Target \pm 1.0 |
| Asphalt Content (percent) | Target \pm 0.40 |
| Air Voids (percent) | 4.00 \pm 1.20 |
| Density, vibratory mode (percent of G_{mm}): | 93.00 + 3.00, - 1.20 |
| Density, static mode (percent of G_{mm}): | 92.00 + 4.00, - 1.50 ⁽¹⁾ |

(1): No vibratory mode in the vertical direction will be allowed. Other vibratory modes will be allowed, if approved by the Engineer.

| Quality Index | Percent within Limits for Selected Sample Size | | | |
|---------------|--|-------|-------|-------|
| | n = 3 | n = 4 | n = 5 | n = 6 |
| 0.00 | 50.00 | 50.00 | 50.00 | 50.00 |
| 0.05 | 51.38 | 51.67 | 51.78 | 51.84 |
| 0.10 | 52.76 | 53.33 | 53.56 | 53.67 |
| 0.15 | 54.15 | 55.00 | 55.33 | 55.50 |
| 0.20 | 55.54 | 56.67 | 57.10 | 57.32 |
| 0.25 | 56.95 | 58.33 | 58.87 | 59.14 |
| 0.30 | 58.37 | 60.00 | 60.63 | 60.94 |
| 0.35 | 59.80 | 61.67 | 62.38 | 62.73 |
| 0.40 | 61.26 | 63.33 | 64.12 | 64.51 |
| 0.45 | 62.74 | 65.00 | 65.84 | 66.27 |
| 0.50 | 64.25 | 66.67 | 67.56 | 68.00 |
| 0.55 | 65.80 | 68.33 | 69.26 | 69.72 |
| 0.60 | 67.39 | 70.00 | 70.95 | 71.41 |
| 0.65 | 69.03 | 71.67 | 72.61 | 73.08 |
| 0.70 | 70.73 | 73.33 | 74.26 | 74.71 |
| 0.75 | 72.50 | 75.00 | 75.89 | 76.32 |
| 0.80 | 74.36 | 76.67 | 77.49 | 77.89 |
| 0.85 | 76.33 | 78.33 | 79.07 | 79.43 |
| 0.90 | 78.45 | 80.00 | 80.62 | 80.93 |
| 0.95 | 80.75 | 81.67 | 82.14 | 82.39 |
| 1.00 | 83.33 | 83.33 | 83.64 | 83.80 |
| 1.05 | 86.34 | 85.00 | 85.09 | 85.18 |
| 1.10 | 90.16 | 86.67 | 86.52 | 86.50 |
| 1.15 | 97.13 | 88.33 | 87.90 | 87.78 |

| Table 334-108 | | | | |
|-----------------------|--|--------|--------|--------|
| Percent Within Limits | | | | |
| Quality Index | Percent within Limits for Selected Sample Size | | | |
| | n = 3 | n = 4 | n = 5 | n = 6 |
| 1.20 | 100.00 | 90.00 | 89.24 | 89.01 |
| 1.25 | 100.00 | 91.67 | 90.54 | 90.19 |
| 1.30 | 100.00 | 93.33 | 91.79 | 91.31 |
| 1.35 | 100.00 | 95.00 | 92.98 | 92.37 |
| 1.40 | 100.00 | 96.67 | 94.12 | 93.37 |
| 1.45 | 100.00 | 98.33 | 95.19 | 94.32 |
| 1.50 | 100.00 | 100.00 | 96.20 | 95.19 |
| 1.55 | 100.00 | 100.00 | 97.13 | 96.00 |
| 1.60 | 100.00 | 100.00 | 97.97 | 96.75 |
| 1.65 | 100.00 | 100.00 | 98.72 | 97.42 |
| 1.70 | 100.00 | 100.00 | 99.34 | 98.02 |
| 1.75 | 100.00 | 100.00 | 99.81 | 98.55 |
| 1.80 | 100.00 | 100.00 | 100.00 | 98.99 |
| 1.85 | 100.00 | 100.00 | 100.00 | 99.36 |
| 1.90 | 100.00 | 100.00 | 100.00 | 99.65 |
| 1.95 | 100.00 | 100.00 | 100.00 | 99.85 |
| 2.00 | 100.00 | 100.00 | 100.00 | 99.97 |
| 2.05 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.10 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.15 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.20 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.25 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.30 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.35 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.40 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.45 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.50 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.55 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.60 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.65 | 100.00 | 100.00 | 100.00 | 100.00 |

SUPERPAVE ASPHALT CONCRETE
(REV 5-8-20)

SUBARTICLE 334-2.3.1 is deleted and the following substituted:

334-2 Materials.

334-2.3 Reclaimed Asphalt Pavement (RAP) Material:

334-2.3.1 General requirements: RAP may be used as a component of the asphalt mixture subject to the following requirements:

1. When using a PG 76-22 asphalt binder in friction course mixtures, limit the amount of RAP material used in the mix to a maximum of 20% by weight of total aggregate. As an exception, amounts greater than 20% RAP by weight of total aggregate can be used if no more than 20% by weight of the total asphalt binder comes from the RAP material. When using a PG 76-22 asphalt binder in structural course mixtures, refer to 334-2.3.6. RAP is not allowed in mixtures containing High Polymer asphalt binder. High Polymer asphalt is defined in Section 916.

2. Assume full responsibility for the design, production and construction of asphalt mixes which incorporate RAP as a component material.

3. Use RAP from a Department approved stockpile or millings from a Department project.

4. Provide stockpiled RAP material that is reasonably consistent in characteristics and contains no aggregate particles which are soft or conglomerates of fines.

5. Provide RAP material having a minimum average asphalt binder content of 4.0% by weight of RAP. As an exception, when using fractionated RAP, the minimum average asphalt binder content for the coarse portion of the RAP shall be 2.5% by weight of the coarse portion of the RAP. The coarse portion of the RAP shall be the portion of the RAP retained on the No. 4 sieve. The Engineer may sample the stockpiles to verify that this requirement is met.

SUBARTICLE 334-2.3.3 is deleted and the following substituted:

334-2.3.3 RAP Stockpile Approval: Prior to the incorporation of RAP into the asphalt mixture, stockpile the RAP material and obtain approval for the stockpile by one of the following methods:

1. Continuous stockpile: When RAP is obtained from one or multiple sources and is either processed, blended, or fractionated, and stockpiled in a continuous manner, assure an adequate number of test results are obtained for stockpile approval. Test the RAP material for gradation and asphalt content at a minimum frequency of one sample per 1000 tons with a minimum of six test results. Test the RAP material for G_{mm} (for G_{sb} determination) at a minimum frequency of one sample per 5000 tons with a minimum of two test results. Based on visual inspection and a review of the test data, the Engineer will determine the suitability of the stockpiled material. In addition, address the details and specifics of the processing, sampling, testing and actions to be taken in the Producer Quality Control (QC) Plan.

When RAP is added to the continuous stockpile after original approval of the stockpile as described above, test the RAP material for gradation and asphalt content at a minimum frequency of one sample per 1000 tons with a minimum of six test results.

Test the RAP material for G_{mm} (for G_{sb} determination) at a minimum frequency of one sample per 5000 tons with a minimum of two test results. Monitor test results during crushing operations for conformance to the requirements of Table 334-1. After the minimum frequency of tests have been performed, the Engineer will review the test data and visually inspect the stockpiled material. The average gradation and G_{mm} of the added material shall be within the allowable ranges shown in Table 334-1 from the originally approved stockpile values. If the added RAP material does not meet the conditions of Table 334-1, then the Contractor must create a new stockpile when resuming crushing operations and the stockpile will receive a new number designation from the Department. The previously crushed material, which was added to the continuous stockpile and did not meet the conditions of Table 334-1, may remain and that stockpile used until depleted.

| Characteristic | Limit from Original Approved Stockpile Gradation |
|-------------------------|--|
| No. 8 sieve and coarser | $\pm 6.0\%$ |
| No. 16 sieve | $\pm 5.0\%$ |
| No. 30 sieve | $\pm 5.0\%$ |
| No. 50 sieve | $\pm 4.0\%$ |
| No. 100 sieve | $\pm 3.0\%$ |
| No. 200 sieve | $\pm 2.0\%$ |
| G_{mm} | ± 0.040 |

2. Non-continuous single stockpile: When an individual stockpile is being constructed, obtain representative samples at random locations and test the RAP material for gradation and asphalt content at a minimum frequency of one sample per 1000 tons with a minimum of six test results. Test the RAP material for G_{mm} (for G_{sb} determination) at a minimum frequency of one sample per 5000 tons with a minimum of two test results. Based on visual inspection and a review of the test data, the Engineer will determine the suitability of the stockpiled material. If the properties of the new stockpile compare with the properties of an existing stockpile within the ranges provided in Table 334-1, the RAP in the new stockpile may be added to the existing stockpile. Once the RAP stockpile has been approved, do not add additional material without prior approval of the Engineer.

Determine the asphalt binder content and gradation of the RAP material in accordance with FM 5-563 and FM 1-T 030, respectively. Establish the G_{sb} of the RAP material by using one of the following methods:

a. Calculate the G_{sb} value based upon the effective specific gravity (G_{se}) of the RAP material, determined on the basis of the asphalt binder content and maximum specific gravity (G_{mm}) of the RAP material. The Engineer will approve the estimated asphalt binder absorption value used in the calculation.

b. Measure the G_{sb} of the RAP aggregate, in accordance with FM 1-T 084 and FM 1-T 085. Obtain the aggregate by using a solvent extraction method.

SUBARTICLE 334-2.3.5 is deleted and the following substituted:

334-2.3.5 Asphalt Binder for Mixes with RAP: Select the appropriate asphalt binder grade based on Table 334-2. The Engineer reserves the right to change the asphalt binder grade at design based on the characteristics of the RAP asphalt binder, and reserves the right to make changes during production.

| Percent RAP | Asphalt Binder Grade |
|-------------|----------------------|
| 0 - 15 | PG 67-22 |
| 16 - 30 | PG 58-22 |
| >30 | PG 52-28 |

SUBARTICLE 334-2.3 is expanded by the following:

334-2.3.6 Allowable RAP Percentages for Type SP Structural Mixtures with PG 76-22 Asphalt Binder: For Type SP structural mixtures using PG 76-22 asphalt binder, select the percentage of RAP material based on Table 334-3.

| | | Coarse RAP | Intermediate RAP | Fine RAP |
|---|--------------------------|------------|------------------|----------|
| Gradation % Passing #16 Sieve ² | | ≤ 40% | > 40% to ≤ 50% | > 50% |
| PG _{HT} ³ > 100.0° C | Allowable RAP Percentage | ≤ 25% | ≤ 20% | ≤ 20% |
| PG _{HT} ³ ≤ 100.0° C | | ≤ 30% | ≤ 25% | |
| Notes: | | | | |
| 1. RAP aggregate by weight of total aggregate or RAP binder by weight of total binder. | | | | |
| 2. RAP gradations based on ignition oven extraction of RAP material in accordance with FM 5-563. | | | | |
| 3. PG _{HT} : asphalt binder high temperature continuous performance grade of RAP in accordance with Section 916. | | | | |

SUBARTICLE 334-3.2.1 is deleted and the following substituted:

334-3.2 Mix Design:

334-3.2.1 General: Design the asphalt mixture in accordance with AASHTO R 35-17, except as noted herein. Prior to the production of any asphalt mixture, submit the proposed mix design with supporting test data indicating compliance with all mix design criteria to the Engineer. For all mix designs, include representative samples of all component materials, including asphalt binder. Allow the Director of the Office of Materials a maximum of four weeks to either conditionally verify or reject the mix as designed.

For a Traffic Level A mixture, meet the mix design criteria for a Traffic Level B mixture and for a Traffic Level D mixture meet the mix design criteria for a Traffic Level E mixture.

At no additional cost to the Department, for a Type SP mix the following Traffic Level substitutions are allowed:

- Traffic Level E can be substituted for Traffic Level D.
- Traffic Level D or E can be substituted for Traffic Level C.
- Traffic Level C can be substituted for Traffic Level B.
- Traffic Level B or C can be substituted for Traffic Level A.

The same traffic level and binder type that is used for the mainline traffic lanes may be placed in the shoulder at no additional cost to the Department, even if the conditions stated above are not met for the shoulder.

Do not use more than four mix designs per nominal maximum aggregate size per traffic level per binder grade per year, where the year starts at the Notice to Proceed. Exceeding this limitation will result in a maximum Composite Pay Factor (CPF) of 1.00 as defined in 334-8.2 for all designs used beyond this limit.

Warm mix technologies (additives, foaming techniques, etc.) listed on the Department's website may be used in the production of the mix. The URL for obtaining this information, if available, is: <https://www.fdot.gov/materials/mac/production/warmmixasphalt/>.

When warm mix technologies are used, for mixtures containing a PG 52-28, PG 58-22, or PG 67-22 binder, a mixture will be considered a warm mix asphalt design if the mixing temperature is 285°F or less. For mixtures containing a PG 76-22 or High Polymer binder, a mixture will be considered a warm mix asphalt design if the mixing temperature is 305°F or less.

The Engineer will consider any marked variations from original test data for a mix design or any evidence of inadequate field performance of a mix design as sufficient evidence that the properties of the mix design have changed, and the Engineer will no longer allow the use of the mix design.

SUBARTICLE 334-3.2.2 is deleted and the following substituted:

334-3.2.2 Mixture Gradation Requirements: Combine the coarse and fine aggregate in proportions that will produce an asphalt mixture meeting all of the requirements defined in this specification and conform to the gradation requirements at design as defined in AASHTO M 323-17, Table 4. Aggregates from various sources may be combined.

334-3.2.2.1 Mixture Gradation Classification: Plot the combined mixture gradation on an FHWA 0.45 Power Gradation Chart. Include the Control Points from AASHTO M 323-17, Table-4, as well as the Primary Control Sieve (PCS) Control Point from AASHTO M 323-17, Table 5. Fine mixes are defined as having a gradation that passes above the primary control sieve control point and above the maximum density line for all sieve sizes smaller than the primary control sieve and larger than the No. 30 sieve.

SUBARTICLE 334-3.2.3.1 is deleted and the following substituted:

334-3.2.3.1 Coarse Aggregate Angularity: When tested in accordance with ASTM D5821-13 (2017), meet the percentage of fractured faces requirements specified in AASHTO M 323-17, Table 6.

SUBARTICLE 334-3.2.3.2 is deleted and the following substituted:

334-3.2.3.2 Fine Aggregate Angularity: When tested in accordance with AASHTO T 304-17, Method A, meet the uncompacted void content of fine aggregate specified in AASHTO M 323-17, Table 6.

SUBARTICLE 334-3.2.3.3 is deleted and the following substituted:

334-3.2.3.3 Flat and Elongated Particles: When tested in accordance with ASTM D4791-19, (with the exception that the material passing the 3/8 inch sieve and retained on the No. 4 sieve shall be included), meet the requirements specified in AASHTO M 323-17, Table 6. Measure the aggregate using the ratio of 5:1, comparing the length (longest dimension) to the thickness (shortest dimension) of the aggregate particles.

SUBARTICLE 334-3.2.3.4 is deleted and the following substituted:

334-3.2.3.4 Sand Equivalent: When tested in accordance with AASHTO T 176-17, meet the sand equivalent requirements specified in AASHTO M 323-17, Table 6.

SUBARTICLE 334-3.2.4 is deleted and the following substituted:

334-3.2.4 Gyrotory Compaction: Compact the design mixture in accordance with AASHTO T 312-19, with the following exception: use the number of gyrations at N_{design} as defined in Table 334-4. Measure the inside diameter of gyrotory molds in accordance with AASHTO T 312-19.

| Table 334-4 Gyrotory Compaction Requirements | |
|---|---|
| Traffic Level | N_{design} Number of Gyrotations |
| A | 50 |
| B | 65 |
| C | 75 |
| D | 100 |
| E | 100 |

SUBARTICLE 334-3.2.5 is deleted and the following substituted:

334-3.2.5 Design Criteria: Meet the requirements for nominal maximum aggregate size as defined in AASHTO M 323-17, as well as for relative density, VMA, VFA, and dust-to-binder ratio as specified in AASHTO M 323-17, Table 7. N_{initial} and N_{maximum} requirements are not applicable.

SUBARTICLE 334-3.2.6 is deleted and the following substituted:

334-3.2.6 Moisture Susceptibility:

1. For all traffic levels, use a liquid anti-strip agent listed on the APL at the specified dosage rate. Hydrated lime may be used instead of the liquid anti-strip agent.
2. Provide a mixture having a retained tensile strength ratio of at least 0.80 and a minimum tensile strength (unconditioned) of 100 psi in accordance with FM1-T 283.

SUBARTICLE 334-3.2.7 is deleted and the following substituted:

334-3.2.7 Additional Information: In addition to the requirements listed above, provide the following information with each proposed mix design submitted for verification:

1. The design traffic level and the design number of gyrations (N_{design}).
2. The source and description of the materials to be used.
3. The Department source number and the Department product code of the aggregate components furnished from a Department approved source.
4. The gradation and proportions of the raw materials as intended to be combined in the paving mixture. The gradation of the component materials shall be representative of the material at the time of use. Compensate for any change in aggregate gradation caused by handling and processing as necessary.
5. A single percentage of the combined mineral aggregate passing each specified sieve. Degradation of the aggregate due to processing (particularly material passing the No. 200 sieve) should be accounted for and identified.
6. The bulk specific gravity (G_{sb}) value for each individual aggregate and RAP component, as identified in the Department's aggregate control program.
7. A single percentage of asphalt binder by weight of total mix intended to be incorporated in the completed mixture, shown to the nearest 0.1%.
8. A target temperature for the mixture at the plant (mixing temperature) and a target temperature for the mixture at the roadway (compaction temperature) in accordance with 320-6.3. Do not exceed a target temperature of 340°F for High Polymer asphalt binder, 330°F for PG 76-22 asphalt binders, and 315°F for unmodified asphalt binders.
9. Provide the physical properties at the optimum asphalt content, which must conform to all specified requirements.
10. The name of the Construction Training Qualification Program (CTQP) Qualified Mix Designer.
11. The ignition oven and maximum specific gravity (G_{mm}) calibration factors.
12. The warm mix technology, if used.

SUBARTICLE 334-3.3 is deleted and the following substituted:

334-3.3 Mix Design Revisions: During production, the Contractor may request a target value revision to a mix design, subject to meeting the following requirements: the target change

falls within the limits defined in Table 334-5, appropriate data exists demonstrating that the mix complies with production air voids specification criteria, and the mixture gradation meets the basic gradation requirements defined in 334-3.2.2.

| Table 334-5 Limits for Potential Adjustments to Mix Design Target Values | |
|---|--------------------------------|
| Characteristic | Limit from Original Mix Design |
| No. 8 sieve and Coarser | ± 5.0% |
| No. 16 sieve | ± 4.0% |
| No. 30 sieve | ± 4.0% |
| No. 50 sieve | ± 3.0% |
| No. 100 sieve | ± 3.0% |
| No. 200 sieve | ± 1.0% |
| Asphalt Binder Content ⁽¹⁾ | ± 0.3% |
| Each Component of Aggregate Blend ⁽²⁾ | ± 5.0 % |

⁽¹⁾ Reductions to the asphalt binder content will not be permitted if the VMA during production is lower than 1.0% below the design criteria.
⁽²⁾ Revisions to FC-5 mixtures to be determined by the Engineer.

Submit all requests for revisions to mix designs, along with supporting documentation, to the Engineer. In order to expedite the revision process, the request for revision or discussions on the possibility of a revision may be made verbally, but must be followed up by a written request. The verified mix design will remain in effect until the Engineer authorizes a change. In no case will the effective date of the revision be established earlier than the date of the first communication between the Contractor and the Engineer regarding the revision.

A new design mix will be required if aggregate sources change, or for any substitution of an aggregate product with a different aggregate code, unless approved by the Engineer.

SUBARTICLE 334-5.1.1 is deleted and the following substituted:

334-5.1.1 Sampling and Testing Requirements: Obtain the samples in accordance with FM 1-T 168. Obtain samples at the plant of a sufficient quantity to be split into three smaller samples; one for QC, one for Verification testing and one for Resolution testing. Obtain each split sample of a sufficient quantity, approximately 40 pounds, for all required testing. The split samples for Verification testing and Resolution testing shall be reduced in size and stored in three boxes each. The approximate size of each box must be 12 inches x 8 inches x 4 inches. Provide, label, and safely store sample boxes in a manner agreed upon by the Engineer for future testing.

The asphalt content of the mixture will be determined in accordance with FM 5-563. The gradation of the recovered aggregate will be determined in accordance with FM 1-T 030. Volumetric testing will be in accordance with AASHTO T 312-19 and FM 1-T 209. Prior to testing volumetric samples, condition the test-sized sample for one hour, plus or minus five minutes, at the target roadway compaction temperature in a shallow, flat pan, such that the

mixture temperature at the end of the one hour conditioning period is within plus or minus 20°F of the roadway compaction temperature.

If one of the QC gyratory specimens is damaged, make an additional gyratory specimen.

For situations where two properly prepared gyratory specimens do not meet single-operator precision requirements for G_{mb} as provided in FM 1-T 166:

1. Retest both gyratory specimens in accordance FM 1-T 166.
2. Following the retest, if the newly measured G_{mb} values do not meet single-operator precision requirements, QC shall prepare a third gyratory specimen in accordance with AASHTO T 312-19 and test in accordance with FM 1-T 166. All three test results shall be input into MAC. The average G_{mb} will be determined by MAC after performing an outlier check in accordance with ASTM E178.

Test for roadway density in accordance with FM 1 T 166.

SUBARTICLE 334-5.1.2 is deleted and the following substituted:

334-5.1.2 Acceptance Testing Exceptions: When the total combined quantity of hot mix asphalt for the project, as indicated in the Plans for Type B-12.5, Type SP and Type FC mixtures only, is less than 2000 tons, the Engineer will accept the mix on the basis of visual inspection. The Engineer may require the Contractor to run process control tests for informational purposes, as defined in 334-4, or may run independent verification tests to determine the acceptability of the material.

Density testing for acceptance will not be performed on widening strips or shoulders with a width of 5 feet or less, open-graded friction courses, variable thickness overbuild courses, leveling courses, any SP-9.5 or SP-12.5 asphalt layer placed on subgrade with a layer thickness less than or equal to 3 inches, , miscellaneous asphalt pavement, shared use paths, crossovers, gore areas, or any course with a specified thickness less than 1 inch or a specified spread rate that converts to less than 1 inch as described in 334-1.4. Density testing for acceptance will not be performed on asphalt courses placed on bridge decks or approach slabs; compact these courses in static mode only per the requirements of 330-7.7. In addition, density testing for acceptance will not be performed on the following areas when they are less than 500 feet (continuous) in length: turning lanes, acceleration lanes, deceleration lanes, shoulders, parallel parking lanes or ramps. Do not perform density testing for acceptance in situations where the areas requiring density testing is less than 50 tons within a subplot.

Density testing for acceptance will not be performed in intersections. The limits of the intersection will be from stop bar to stop bar for both the mainline and side streets. A random core location that occurs within the intersection shall be moved forward or backward from the intersection at the direction of the Engineer.

Where density testing for acceptance is not required, compact these courses (with the exception of open-graded friction courses) in accordance with the rolling procedure (equipment and pattern) as approved by the Engineer or with Standard Rolling Procedure as specified in 330-7.2. In the event that the rolling procedure deviates from the procedure approved by the Engineer, or the Standard Rolling Procedure, placement of the mix shall be stopped.

The density pay factor (as defined in 334-8.2) for areas not requiring density testing for acceptance will be paid at the same density pay factor as for the areas

requiring density testing within the same LOT. If the entire LOT does not require density testing for acceptance, the LOT will be paid at a density pay factor of 1.00.

SUBARTICLE 334-5.4.4 is deleted and the following substituted:

334-5.4.4 Individual Test Tolerances for QC Testing: Terminate the LOT if any of the following QC failures occur:

1. An individual test result of a subplot for air voids does not meet the requirements of Table 334-6,
2. The average subplot density does not meet the requirements of Table 334-6,
3. Two consecutive test results within the same LOT for gradation or asphalt binder content do not meet the requirements of Table 334-6,

When a LOT is terminated due to a QC failure, stop production of the mixture until the problem is resolved to the satisfaction of the QC Manager and/or Asphalt Plant Level II technician responsible for the decision to resume production after a QC failure, as identified in Section 105. In the event that it can be demonstrated that the problem can immediately be or already has been resolved, it will not be necessary to stop production. When a LOT is terminated, make all necessary changes to correct the problem. Do not resume production until appropriate corrections have been made. Prior to resuming production, inform the Engineer of the problem and corrections made to correct the problem. After resuming production, sample and test the material to verify that the changes have corrected the problem. Summarize this information and provide it to the Engineer prior to the end of the work shift when production resumes.

In the event that a QC failure is not addressed as defined above, the Engineer's approval will be required prior to resuming production after any future QC failures.

Address any material represented by a failing test result, as defined above in this subarticle, in accordance with 334-5.9.5. Any LOT terminated under this subarticle will be limited to a maximum Pay Factor of 1.00 (as defined in 334-8.2) for all quality characteristics and will include all material placed up to the point when the LOT was terminated.

In the event that a G_{mm} test result differs by more than 0.040 from the mix design G_{mm} , investigate the causes of the discrepancy and report the findings and proposed actions to the Engineer.

| Table 334-6 Master Production Range | |
|---|--------------------------|
| Characteristic | Tolerance ⁽¹⁾ |
| Asphalt Binder Content (%) | Target ± 0.55 |
| Passing No. 200 Sieve (%) | Target ± 1.50 |
| Air Voids (%) | 2.30 – 6.00 |
| Density (minimum % G_{mm}) ⁽²⁾ | 89.50 |
| <small>(1) Tolerances for sample size of n = 1 from the verified mix design</small> | |
| <small>(2) Based on an average of three to five randomly located cores</small> | |

SUBARTICLE 334-5.5.1 is deleted and the following substituted:

334-5.5.1 Plant Testing: At the completion of each LOT, the Engineer will test a minimum of one Verification split sample randomly selected from the LOT. Results of the testing and analysis for the LOT will be made available to the Contractor within one working day from the time the LOT is completed. Verification samples shall be reheated at the target roadway compaction temperature for 1-1/2 hours, plus or minus 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. In lieu of the 1-1/2 hours reheating procedure, the mixture may be reheated to within plus or minus 20°F of the roadway compaction temperature using a microwave oven. Stir the mixture as necessary during the reheating process to maintain temperature uniformity. Subsequently, condition and test the mixture as described in 334-5.1.1.

The Verification test results will be compared with the QC test results based on the between-laboratory precision values shown in Table 334-7.

| Table 334-7 Between-Laboratory Precision Values | |
|--|-----------------------|
| Property | Maximum Difference |
| G_{mm} | 0.016 |
| G_{mb} (gyratory compacted samples) | 0.022 |
| G_{mb} (roadway cores) | 0.014 |
| P_b | 0.44% |
| P-200 | FM 1-T 030 (Figure 2) |
| P-8 | FM 1-T 030 (Figure 2) |

If all of the specified mix characteristics compare favorably, then the LOT will be accepted, with payment based on the Contractor's QC test data for the LOT.

If any of the results do not compare favorably, then the Resolution samples from the LOT will be sent to the Resolution laboratory for testing, as described in 334-5.6.

SUBARTICLE 334-5.5.2 is deleted and the following substituted:

334-5.5.2 Roadway Testing: At the completion of each LOT, the Engineer will determine the density (G_{mb}) of each core (previously tested by QC) as described in 334-5.1.1 from the same subplot as the plant samples. For situations where roadway density is not required for the random subplot chosen, then another subplot shall be randomly chosen for roadway density cores only. Results of the testing and analysis for the LOT will be made available to the Contractor within one working day from the time the LOT is completed.

The individual Verification test results will be compared with individual QC test results by the Engineer based on the between-laboratory precision values given in Table 334-7.

If each of the core test results compare favorably, then the LOT will be accepted with respect to density, with payment based on the Contractor's QC test data for the LOT.

If any of the results do not compare favorably, then the core samples from the LOT will be sent to the Resolution laboratory for testing as specified in 334-5.6.

SUBARTICLE 334-5.6.1 is deleted and the following substituted:

334-5.6 Resolution System:

334-5.6.1 Plant Samples: In the event of an unfavorable comparison between the Contractor's QC test results and the Engineer's Verification test results on any of the properties identified in Table 334-7, the Resolution laboratory will test all of the split samples from the LOT for only the property (or properties) in question. Resolution samples shall be reheated at the target roadway compaction temperature for 1-1/2 hours, plus or minus 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. In lieu of the 1-1/2 hours reheating procedure, the mixture may be reheated to within plus or minus 20°F of the roadway compaction temperature using a microwave oven. Stir the mixture as necessary during the reheating process to maintain temperature uniformity. Subsequently, condition and test the mixture as described in 334-5.1.1.

SUBARTICLE 334-5.6.3 is deleted and the following substituted:

334-5.6.3 Resolution Determination: The Resolution test results (for the property or properties in question) will be compared with the QC test results based on the between-laboratory precision values shown in Table 334-7.

If the Resolution test results compare favorably with all of the QC results, then acceptance and payment for the LOT will be based on the QC results, and the Department will bear the costs associated with Resolution testing. No additional compensation, either monetary or time, will be made for the impacts of any such testing.

If the Resolution test results do not compare favorably with all of the QC results, then acceptance and payment for the LOT will be based on the Resolution test data for the LOT, and the costs of the Resolution testing will be deducted from monthly estimates. No additional time will be granted for the impacts of any such testing.

In addition, the material failure requirements of 334-5.4.4 apply to the Resolution test data. Address any material represented by the failing test results in accordance with 334-5.9.5. For this situation, the LOT will be limited to a maximum Pay Factor of 1.00 (as defined in 334-8.2) for all quality characteristics.

In the event of an unfavorable comparison between the Resolution test results and QC test results, make the necessary adjustments to assure that future comparisons are favorable.

SUBARTICLE 334-5.7.1 is deleted and the following substituted:

334-5.7 Independent Verification (IV) Testing:

334-5.7.1 Plant: The Contractor shall provide sample boxes and take samples as directed by the Engineer for IV testing. Obtain enough material for three complete sets of tests (two samples for IV testing by the Engineer and one sample for testing by the Contractor). If

agreed upon by both the Engineer and the Contractor, only one sample for IV testing by the Engineer may be obtained. IV samples will be reheated at the target roadway compaction temperature for 1-1/2 hours, plus or minus 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. The Contractor's split sample, if tested immediately after sampling, shall be reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. If the Contractor's sample is not tested immediately after sampling, then the sample shall be reheated at the target roadway compaction temperature for 1-1/2 hours, plus or minus 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. For the IV and Contractor's samples, in lieu of the 1-1/2 hours reheating procedure, the mixture may be reheated to within plus or minus 20°F of the roadway compaction temperature using a microwave oven. Stir the mixture as necessary during the reheating process to maintain temperature uniformity. Subsequently, condition and test the mixture as described in 334-5.1.1. The Contractor's test results shall be provided to the Engineer within one working day from the time the sample was obtained.

If any of the IV test results do not meet the requirements of Table 334-6, then a comparison of the IV test results and the Contractor's test results, if available, will be made. If a comparison of the IV test results and the Contractor's test results meets the precision values of Table 334-7 for the material properties in question, or if the Contractor's test results are not available, then the IV test results are considered verified and the Contractor shall cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Address any material represented by the failing test results in accordance with 334-5.9.5.

If a comparison of the IV test results and the Contractor's test results does not meet the precision values of Table 334-7 for the material properties in question, then the second IV sample shall be tested by the Engineer for the material properties in question. If a comparison between the first and second IV test results does not meet the precision values of Table 334-7 for the material properties in question, then the first IV test results are considered unverified for the material properties in question and no action shall be taken, with the following exception: if the first and second IV test results do not meet the precision values of Table 334-7 and the first IV test result and Contractor's test result do not meet the precision values of Table 334-7, yet all three test results do not meet the requirements of Table 334-6, then address any material represented by the failing test results in accordance with 334-5.9.5.

If a comparison between the first and second IV test results meets the precision values of Table 334-7 for the material properties in question, then the first IV sample is considered verified and the Contractor shall cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Address any material represented by the failing test results in accordance with 334-5.9.5.

The Engineer has the option to use the IV sample for comparison testing as specified in 334-6.

SUBARTICLE 334-5.7.1 is expanded by the following:

334-5.7.1.1 Asphalt Binder and Mixture Sampling for Determination of Asphalt Binder Quality: At the Department's request, obtain an asphalt binder sample from the asphalt plant storage tank and a corresponding asphalt mixture sample using binder from the same storage tank. Samples of asphalt binder and mixture shall be sampled the same day. The asphalt binder from the storage tank and the asphalt binder recovered from the asphalt mixture will be tested by the Department for compliance with Contract Documents.

SUBARTICLE 334-5.7.2 is deleted and the following substituted:

334-5.7.2 Roadway: Obtain five 6-inch diameter roadway cores within 24 hours of placement, as directed by the Engineer, for IV testing. In situations where it is impractical to cut five cores per subplot, obtain a minimum of three cores per subplot at random locations, as identified by the Engineer. These independent cores will be obtained from the same LOTs and sublots as the Independent Verification Plant samples, or as directed by the Engineer. The density of these cores will be obtained as described in 334-5.1.1. If the average of the results for the subplot does not meet the requirements of Table 334-6 for density, then a comparison of the IV G_{mm} test results and the Contractor's G_{mm} test results, if available, will be made in accordance with the procedure provided in 334-5.7.1. Address any material represented by the failing test results in accordance with 334-5.9.5.

SUBARTICLE 334-8.2.2 is deleted and the following substituted:

334-8.2.2 Two or Less Sublot Test Results: In the event that two or less subplot test results are available for a LOT, Pay Factors will be determined based on Table 334-8, using the average of the accumulated deviations from the target value. (Except for density, deviations are absolute values with no plus or minus signs.) Use the 1-Test column when there is only one subplot test result and use the 2-Tests column when there are two sublots.

| Table 334-8 Small Quantity Pay Table | | |
|---|------------------------------|---------------------------------|
| Pay Factor | 1 Sublot Test Deviation | 2 Sublot Test Average Deviation |
| Asphalt Binder Content | | |
| 1.05 | 0.00-0.23 | 0.00-0.16 |
| 1.00 | 0.24-0.45 | 0.17-0.32 |
| 0.90 | 0.46-0.55 | 0.33-0.39 |
| 0.80 | >0.55 | >0.39 |
| No. 8 Sieve | | |
| 1.05 | 0.00-2.25 | 0.00-1.59 |
| 1.00 | 2.26-4.50 | 1.60-3.18 |
| 0.90 | 4.51-5.50 | 3.19-3.89 |
| 0.80 | >5.50 | >3.89 |
| No. 200 Sieve | | |
| 1.05 | 0.00-0.55 | 0.00-0.39 |
| 1.00 | 0.56-1.10 | 0.40-0.78 |
| 0.90 | 1.11-1.50 | 0.79-1.06 |
| 0.80 | >1.50 | >1.06 |
| Air Voids | | |
| 1.05 | 0.00-0.50 | 0.00-0.35 |
| 1.00 | 0.51-1.00 | 0.36-0.71 |
| 0.90 | 1.01-1.70 | 0.72-1.20 |
| 0.80 | 1.71-2.00 | 1.21-1.41 |
| 0.70 | 2.01-2.50 | 1.42-1.77 |
| 0.55 | >2.50 | >1.77 |
| Density ⁽¹⁾ | | |
| 1.05 | + (0.00-2.00), - (0.00-0.50) | + (0.00-1.40), - (0.00-0.35) |
| 1.00 | + (2.01-3.00), - (0.51-1.00) | + (1.41-2.10), - (0.36-0.71) |
| 0.95 | + (3.01-3.50), - (1.01-2.00) | + (2.11-2.80), - (0.72-1.41) |
| 0.90 | + (3.51-4.00), - (2.01-3.00) | + (2.81-3.50) - (1.42-2.12) |
| 0.80 | + (>4.00), - (>3.00) | + (>3.50), - (>2.12) |
| <small>(1). Each density test result is the average of three to five randomly located cores. The target density is 93.00 percent of G_{mm} (92.00 percent when compaction is limited to the static mode or for layers specified to be one inch thick). When compaction is limited to the static mode, no vibratory mode in the vertical direction will be allowed. Other vibratory modes will be allowed, if approved by the Engineer. In this case, the target density is 92.00 percent of G_{mm}.</small> | | |

SUBARTICLE 334-8.2.3.1 is deleted and the following substituted:

334-8.2.3.1 Percent Within Limits: The percent within limits (PWL) and Pay Factors for the LOT will be calculated as described below. Variables used in the calculations are as follows:

- x = individual test value (sublot)
- n = number of tests (sublots)
- s = sample standard deviation

$\Sigma(x^2)$ = summation of squares of individual test values
 $(\Sigma x)^2$ = summation of individual test values squared
 Q_U = upper quality index
 USL = upper specification limit (target value plus upper specification limit from Table 334-9)
 Q_L = lower quality index
 LSL = lower specification limit (target value minus lower specification limit from Table 334-9)
 P_U = estimated percentage below the USL
 P_L = estimated percentage above the LSL

1. Calculate the arithmetic mean (\bar{X}) of the test values:

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

2. Calculate the sample standard deviation (s):

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

3. Calculate the upper quality index (Q_U):

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

4. Calculate the lower quality index (Q_L):

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

5. From Table 334-10, determine the percentage of work below the USL (P_U).

6. From Table 334-10, determine percentage of work above the LSL (P_L) Note: If USL or LSL is not specified; percentages within (USL or LSL) will be 100.

7. If Q_U or Q_L is a negative number, then calculate the percent within limits for Q_U or Q_L as follows: enter Table 334-10 with the positive value of Q_U or Q_L and obtain the corresponding percent within limits for the proper sample size. Subtract this number from 100.00. The resulting number is the value to be used in the next step (Step 8) for the calculation of quality level.

8. Calculate the percent within limits (PWL) = ($P_U + P_L$) - 100

9. Calculate the Pay Factor (PF) for each quality characteristic using the equation given in 334-8.2.3.2.

| Table 334-9 Specification Limits | |
|---|-------------------------------------|
| Quality Characteristic | Specification Limits |
| Passing No. 8 sieve (percent) | Target \pm 3.1 |
| Passing No. 200 sieve (percent) | Target \pm 1.0 |
| Asphalt Content (percent) | Target \pm 0.40 |
| Air Voids (percent) | 4.00 \pm 1.20 |
| Density, vibratory mode (percent of G_{mm}): | 93.00 + 3.00, - 1.20 |
| Density, static mode (percent of G_{mm}): | 92.00 + 4.00, - 1.50 ⁽¹⁾ |

(1): No vibratory mode in the vertical direction will be allowed. Other vibratory modes will be allowed, if approved by the Engineer.

| Table 334-10 Percent Within Limits | | | | |
|---------------------------------------|--|-------|-------|-------|
| Quality Index | Percent within Limits for Selected Sample Size | | | |
| | n = 3 | n = 4 | n = 5 | n = 6 |
| 0.00 | 50.00 | 50.00 | 50.00 | 50.00 |
| 0.05 | 51.38 | 51.67 | 51.78 | 51.84 |
| 0.10 | 52.76 | 53.33 | 53.56 | 53.67 |
| 0.15 | 54.15 | 55.00 | 55.33 | 55.50 |
| 0.20 | 55.54 | 56.67 | 57.10 | 57.32 |
| 0.25 | 56.95 | 58.33 | 58.87 | 59.14 |
| 0.30 | 58.37 | 60.00 | 60.63 | 60.94 |
| 0.35 | 59.80 | 61.67 | 62.38 | 62.73 |
| 0.40 | 61.26 | 63.33 | 64.12 | 64.51 |
| 0.45 | 62.74 | 65.00 | 65.84 | 66.27 |
| 0.50 | 64.25 | 66.67 | 67.56 | 68.00 |
| 0.55 | 65.80 | 68.33 | 69.26 | 69.72 |
| 0.60 | 67.39 | 70.00 | 70.95 | 71.41 |
| 0.65 | 69.03 | 71.67 | 72.61 | 73.08 |
| 0.70 | 70.73 | 73.33 | 74.26 | 74.71 |
| 0.75 | 72.50 | 75.00 | 75.89 | 76.32 |
| 0.80 | 74.36 | 76.67 | 77.49 | 77.89 |
| 0.85 | 76.33 | 78.33 | 79.07 | 79.43 |
| 0.90 | 78.45 | 80.00 | 80.62 | 80.93 |
| 0.95 | 80.75 | 81.67 | 82.14 | 82.39 |
| 1.00 | 83.33 | 83.33 | 83.64 | 83.80 |
| 1.05 | 86.34 | 85.00 | 85.09 | 85.18 |
| 1.10 | 90.16 | 86.67 | 86.52 | 86.50 |
| 1.15 | 97.13 | 88.33 | 87.90 | 87.78 |

| Table 334-10 Percent Within Limits | | | | |
|---------------------------------------|--|--------|--------|--------|
| Quality Index | Percent within Limits for Selected Sample Size | | | |
| | n = 3 | n = 4 | n = 5 | n = 6 |
| 1.20 | 100.00 | 90.00 | 89.24 | 89.01 |
| 1.25 | 100.00 | 91.67 | 90.54 | 90.19 |
| 1.30 | 100.00 | 93.33 | 91.79 | 91.31 |
| 1.35 | 100.00 | 95.00 | 92.98 | 92.37 |
| 1.40 | 100.00 | 96.67 | 94.12 | 93.37 |
| 1.45 | 100.00 | 98.33 | 95.19 | 94.32 |
| 1.50 | 100.00 | 100.00 | 96.20 | 95.19 |
| 1.55 | 100.00 | 100.00 | 97.13 | 96.00 |
| 1.60 | 100.00 | 100.00 | 97.97 | 96.75 |
| 1.65 | 100.00 | 100.00 | 98.72 | 97.42 |
| 1.70 | 100.00 | 100.00 | 99.34 | 98.02 |
| 1.75 | 100.00 | 100.00 | 99.81 | 98.55 |
| 1.80 | 100.00 | 100.00 | 100.00 | 98.99 |
| 1.85 | 100.00 | 100.00 | 100.00 | 99.36 |
| 1.90 | 100.00 | 100.00 | 100.00 | 99.65 |
| 1.95 | 100.00 | 100.00 | 100.00 | 99.85 |
| 2.00 | 100.00 | 100.00 | 100.00 | 99.97 |
| 2.05 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.10 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.15 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.20 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.25 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.30 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.35 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.40 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.45 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.50 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.55 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.60 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.65 | 100.00 | 100.00 | 100.00 | 100.00 |