# KANSAS DEPARTMENT OF TRANSPORTATION
# SPECIAL PROVISION TO THE
# STANDARD SPECIFICATIONS, EDITION OF 1990

NOTE: This special provision is generally written in the imperative mood. The subject, "the *Contractor*" is implied. Also implied in this language are "*shall*", "*shall be*", or similar words and phrases. The word "*will*" generally pertains to decisions or actions of the Kansas Department of Transportation.

**Add a new section to Division 600:**

## DIVISION 600

## PLANT MIX BITUMINOUS CONSTRUCTION
## (Quality Control/Quality Assurance (QC/QA))
## (Bituminous Overlay Projects)

### 1.0 DESCRIPTION.

Mix and place 1 or more courses of plant mixed bituminous mixture on a prepared surface. Demonstrate quality control by providing the quality control testing.

| **BID ITEM** | **UNIT** |
|---|---|
| Asphaltic Pavement Sampling (Set Price) | Each |
| Bituminous Base (*)(**)(***) | Ton (megagram) |
| Bituminous Surface (*)(**)(***) | Ton (megagram) |
| Emulsified Asphalt (****) | Ton (megagram) |
| Material for Bituminous Patching (Set Price) | Ton (megagram) |
| Quality Control Testing (Bituminous) | Ton (megagram) |

*Mix Designation
**Grade of Asphalt Cement
***Shoulder
****Type and Grade of Emulsified Asphalt

### 2.0 CONTRACTOR QUALITY CONTROL REQUIREMENTS.

**a. General.**

(1) Provide qualified personnel and sufficient equipment complying with the requirements listed in the Department's KDOT Construction Manual, Part V to conduct quality control testing which complies with the Sampling and Testing Frequency Chart for Bituminous Construction Items for Quality Control/Quality Assurance Projects (Appendix A).

Allow the Engineer access to the Contractor’s laboratory so that he may observe any and all testing procedures, calculations, test documentation, and plotting of test results.

(2) Calibrate and correlate the testing equipment with prescribed procedures and conduct tests in compliance with specified testing procedures as listed in the KDOT Construction Manual, Part V, Section 5.17.10.

(3) Store and retain all quality control samples for the Department for at least 7 days. The Department will retain gyratory compacted air voids verification samples and the remaining material not previously used for testing (back half of sample) for a minimum period of 7 days, or until the sample no longer affects the F&t test. When the hot mix plant shuts down for the winter, the samples may be discarded after 7 days.

(4) Maintain control charts on an ongoing basis.

(5) File reports, records, and diaries developed during the progress of construction activities directed by the Engineer. Such documents will become the property of the Department.

(6) Provide the following test data to the KDOT Project Representative (the KDOT Project Representative will fax or send an electronic copy of the results to the Construction Office and the District Materials Engineer):

- Copies of all test results and control charts on a weekly basis, representing the prior week's production.
- Copies of the quality control summary sheet on a daily basis. Include, as a minimum, mix gradation, binder content, theoretical maximum specific gravity, air voids at $N_{des}$, , voids in mineral aggregate, percent $G_{mm}$ at $N_{ini}$ and $N_{max}$, voids filled with asphalt, and dust/binder ratio.
- Copies of all failing test results (based on a moving average of 4 tests, when appropriate). Include all applicable sieves, voids in mineral aggregate, voids filled with asphalt, density at $N_{ini}$ and $N_{max}$, and dust/binder ratio.

**b. Quality Control Plan.**

(1) Submit to the Engineer for approval, at the preconstruction conference, a quality control plan as outlined in the KDOT Construction Manual, Part V, Section 5.17.10. Follow Appendix A of the Contractor's Quality Control Plan as a general guideline. The Contractor's laboratory and equipment will be inspected and approved as outlined in the KDOT Construction Manual, Part V, Section 5.17.10. Include a listing of the names and phone numbers of individuals and alternates responsible for quality control administration and inspection in the quality control plan. Show the specified lines of authority relating both to mix design and quality control operations during production on the Contractor's organizational chart. Post the organizational chart in the Contractor's test facility.

(2) The Contractor's quality control organization or private testing firms representing the Contractor must include individuals who have complied with the certification requirements for the appropriate categories listed in the Policy and Procedure Manual for the Certified Inspection and Testing Training ($CIT^2$) Program. Only technicians certified in the SF or SD category may perform process control testing on the project. The contractor is required to have at least 1 employee on the project certified in QC/QA Asp Category (employees certified in the SF or SD categories prior to July 1, 2000 will be considered as certified in the QC/QA Asp category until their current certification expires). Profilograph operators must be certified in the PO category. Nuclear meter operators must be certified in the NUC category.

**c. Testing Facilities.**

(1) Locate the Contractor's testing facility at the plant site and get approval by the Engineer prior to the commencement of mixture production. Any other laboratory location must be approved by the District Materials Engineer. Provide suitable space and specified testing equipment for use by the Contractor's quality control personnel to perform tests as required.

Locate the KDOT field laboratory near the Contractor's testing facility and have it fully functional 2 working days before placement of the pre-production sample.

(2) To facilitate communication between the Contractor and the Engineer regarding quality control, equip the Contractor's testing facility with the following:

- A telephone with a private line for the exclusive use of the testing facility's quality control personnel.
- A copying machine for use by the Contractor's personnel and the Engineer.

(3) Equip the KDOT field laboratory with the following:

- A facsimile machine for use by the Contractor's personnel and the Engineer.
- An air conditioner that can maintain a temperature below 77°F (25ºC) in the main part of the Type A Field Office and Laboratory.

**d. Testing Requirements.**

(1) Take all samples for tests at random locations as designated in the approved quality control plan at the rates specified in the Sampling and Testing Frequency Chart for Bituminous Construction Items for Quality Control/Quality Assurance Projects (see Appendix A). Note "k" in Appendix A deals with special testing requirements for pre-production, lot 1, and lots greater than or equal to 2.

Provide the KDOT Project Representative with the random locations before going to the roadway to determine density or sample the bituminous mixture. The Engineer reserves the right to generate the random locations. If KDOT plans to generate the random locations, the Contractor will be notified before he goes to the roadway to sample the bituminous mixture or determine density.

(2) Conduct the tests for mixture properties, aggregate gradation and binder content on representative portions of the hot mix, quartered from a larger sample of hot mix taken at random behind the paver. At the paver, take a sample weighing at least 55 pounds (25 kg) and transport it to the test facility, using a method to retain heat, to facilitate sample quartering procedures.

(3) During pre-production, the Engineer will observe the Contractor obtaining and splitting the hot mix sample into 4 representative portions as specified in Appendix A, Note "k", and observe the testing of the sample.

(4) Record and document all test results and calculations on data sheets provided by the Department. Record specific test results on a daily summary sheet provided by the Department to facilitate the computation of moving test averages. Base moving averages on 4 consecutive test results. Calculations are to be based on the precision displayed on the data sheets. Use "precision displayed" when calculating within Excel. Appendix A shows the accuracy to "record to" for the tests listed. Include a description of quality control actions taken (adjustment of cold feed percentages, changes in Job Mix Formulas (JMFs), etc.) in the Daily Quality Control Summary Sheet. In addition, post and keep current quality control charts showing both individual test results and moving average values. As a minimum, plot the single test values and the 4 test moving

average values, as applicable, on Department approved control charts for the mix characteristics shown in **TABLE 7** of this **Special Provision** along with the following properties:

- Maximum specific gravity (Rice Test) to third decimal point.
- Gradation (No. 4, 8, and 200 (4.75 mm, 2.36 mm, 600 μm, and 75 μm) sieves as a minimum) and binder content for the RAP used in SR type mixtures.

(5) Plot individual test results in black for each test point. Connect those points with a solid black line. Plot the moving average for each test variable in red, starting with the 4th test. Connect those points with a dashed red line. Plot the Department's verification test results with green asterisks.

(6) Indicate job mix formula and specification working range limits as listed in **TABLE 7** of this **Special Provision** for single test results on the control charts using a green ink dotted line and the 4 point moving average results with a green ink solid line.

**3.0 MATERIALS REQUIREMENTS.**

**a. Bituminous Material.** Furnish bituminous materials that comply with the requirements of **Section 1200** of the **Standard Specifications**. Post a legible copy of the latest bill of lading for the bituminous material on or near the gyratory compactor. Use the mixing and compaction temperatures shown on the bill of lading. Notify the Engineer if the mixing or compaction temperature changes.

Note: it will not be considered to be commingling of asphalt cement when the asphalt cement from the same source has a change in mixing and compacting temperature.

**b. Reclaimed Asphaltic Pavement (RAP).** The Contractor may choose to use RAP in the plant mixed bituminous mixture only when such option is permitted by Contract Special Provisions. If the Contractor chooses to use RAP in the mixture, then the use of RAP will be subject to the limitations (i.e. source, percent in mix, etc.) contained in the appropriate Contract Special Provisions.

**c. Aggregates. Aggregates will comply to the requirements of Subsection 1103 of the Standard Specifications, with the following exceptions and additions:**

**Subsection 1103.02 (a)(1.2). Delete this subsection except the first paragraph and add the following:**

(1.6) Use steel slag produced by the mechanical crushing of electric furnace steel slag. Some sources of steel slag are angular when produced and may be treated the same as crushed gravel and manufactured sand. Use steel slag with an Uncompacted Void Content of the Fine Aggregate "U" Value of greater than 42.00 and the combined Coarse Aggregate Angularity greater than the minimum specified value.

(1.7) Produce manufactured sand by crushing siliceous sand and gravel, or by washing crushed stone or chat.

**Subsection 1103.02(a)(2.2). Add the following:**
Natural sand shall have an Uncompacted Void Content of the Fine Aggregate "U" Value of less than 42.00. Natural sand will be called SSG-1, SSG-2, etc. in the mix design.

**Subsection 1103.02(a)(2.3). Delete this subsection.**

**Subsection 1103.02, TABLE 5. Add the following to this table:**

| | | |
|---|---|---|
| CSSL | Crushed Steel Slag | Blend gradation with other aggregate in the mix |

The quantity of crushed steel slag used in the mix shall not exceed 50% of the total aggregate weight (mass).

**Subsection 1103.02(b)(1). Add the following: Mix Designations shown in TABLE 6** of this **Special Provision.**

**Subsection 1103.02(b)(1)(1.1). Delete the last paragraph and add the following:**

The above requirements for soundness do not apply for aggregates having less than 10% material retained on the No. 4 (4.75 mm) mesh sieve.

The above requirements for wear do not apply to aggregates having less than 10% material retained on the No. 8 (2.36 mm) mesh sieve.

Crushed aggregates with less than 10% material retained on the No. 4 (4.75 mm) mesh sieve (excluding mineral filler supplements) must be produced from a source complying with the official quality requirements of this **Section** prior to crushing.

**Subsection 1103.02 (b)(1.3). Delete this subsection and replace it with the following:**

(1.3) Mix designations SM-9.5T and SR-9.5T may be composed of any combination of aggregate and mineral filler supplements complying the applicable requirements in **TABLE 5**. However, the mix used on the traveled way must include a minimum of 40% primary aggregate based on total aggregate weight (mass). When chat is used as the primary aggregate, a minimum of 50% and a maximum of 80% of the plus No. 4 (4.75 mm) mesh sieve material in the mixture shall be from the primary aggregate. When material other than chat is used as the primary aggregate, a minimum of 50% of the plus No. 4 (4.75 mm) mesh sieve material and a minimum of 45% of the plus No. 8 (2.36 mm) mesh sieve material in the mixture shall be from the primary aggregate. Primary aggregate shall be chat, crushed sandstone, crushed gravel, crushed steel slag, and crushed porphyry (rhyolite, basalt, granite, and Iron Mountain Trap Rock are examples of crushed porphyry). Primary aggregate requirements do not apply to the mixture used on the shoulder.

For all mixes used on the traveled way, the quantity of natural sand shall not exceed 35%.

**Subsection 1103.02(c). Delete this subsection and replace it with the following:**

**(c) Contractor Trial Mix Design.**

(1) At least 10 working days before the start of a bituminous mixture production, submit in writing a proposed JMF for each combination of aggregates to the District Materials Engineer for review and approval. For each JMF submitted, include test data to demonstrate that mixtures complying with each proposed JMF will have properties as specified in **TABLE 6** of this **Special**

**Provision** for the designated mix type at the Recommended Percent Asphalt. Determine the Recommended Percent Asphalt. The Recommended Percent Asphalt shall have an air void content of between 3.5 and 4.5 percent. Submit the proposed JMF on forms provided by KDOT. Submit the worksheets used in the design process; this should include, but not limited to, the theoretical maximum specific gravity ($G_{mm}$) (KT-39), modified Lottman (KT-56) tested at the Recommended Percent Asphalt or at a lower percent asphalt (up to 0.75% lower), sand equivalent (KT-55), and compacted mix properties (bulk specific gravity ($G_{mb}$) (KT-15), percent $G_{mm}$ at $N_{ini}$ and $N_{des}$ and $N_{max}$, air voids, voids in the mineral aggregate, voids filled with asphalt, coarse aggregate angularity, uncompacted voids content of fine aggregate). Contact the District Materials Engineer to determine if additional information should be submitted. Submit 3 samples of aggregate complying with the design job-mix gradation and properly sized for producing 6 inch (150 mm) briquettes. Submit 2 samples of aggregate complying with the design job-mix gradation and properly sized for theoretical maximum gravity (KT-39). Submit a sample of binder sufficient in quantity to produce 3 briquettes at the optimum binder content and 2 $G_{mm}$ (KT-39). Submit a sufficient quantity of each individual aggregate to run specific gravity, if needed. Contact the District Materials Engineer to determine if additional material is needed for additional design check tests, such as the modified Lottman (KT-56). Submit a cold 35 pound (15 kg) uncompacted sample of the mixture plus 2 Superpave Gyratory briquettes compacted at the optimum binder content using the specified maximum number of gyratory revolutions ($N_{max}$) for laboratory examination and evaluation. If the mixture sample is transported to the District lab while hot, and compacted in less than 2 hours, then, at the District Materials Engineer's discretion, the requirement to cool the sample may be waived.

(2) Submit the following test data for each blend and the proposed JMF for the Department's review and approval:

(2.1) Asphalt source, grade, and specific gravity. Also, submit a copy of the mixing and compaction temperatures from the producer of the bituminous material.

(2.2) Each aggregate source and producer, including legal description.

(2.3) The percentage (in units of 1 percent except the No. 200 (75 μm) sieve in units of 0.1 percent) of aggregate retained on each of the specified sieves for each aggregate to be incorporated into the mixture. Derive the gradation for the RAP from material after the residual binder has been removed.

(2.4) The proportion of each material (in percent of aggregate).

(2.5) The composite gradation based on (2.3) and (2.4) above.

(2.6) The composite gradation plotted on KDOT 0.45 power graph paper. (KDOT Form 712)

(2.7) For mixtures containing RAP:

(2.7.1) Provide location where the RAP will be obtained, and the bulk specific gravity of the RAP aggregate. The effective specific gravity ($G_{se}$) of the RAP will be determined and used as the bulk specific gravity ($G_{sb}$). The effective specific gravity will be calculated as shown in subsection 5.17.04(c)(3) of the KDOT Construction Manual. Asphalt content ($P_b$) will be determined by burning the asphalt from the RAP using Kansas Test Method KT-57. Maximum specific gravity ($G_{mm}$) of the RAP will be determined by Kansas Test Method KT-39. Specific gravity of the asphalt in the RAP ($G_b$) will be set equal to 1.035.

(2.7.2) The binder content of the RAP from ignition oven analysis.

(2.7.3) The corrected binder content of the total recycled mixture from ignition oven analysis.

(2.8) The percentage (in units of 0.1 percent) of bituminous material to be added, based upon the total wet weight (mass) of the mixture.

(2.9) The percentage of flat and elongated particles in the coarse aggregate along with the coarse aggregate angularity and the uncompacted voids content of the fine aggregate.

(2.10) The tensile strength ratio of the mixture (Modified Lottman Test).

(2.11) The sand equivalent value for the combined virgin aggregates.

(2.12) A mix design with a minimum of 4 different uniformly spaced binder contents (maximum of 0.5 percent between each point) with at least 2 points above, one at and 1 point below the optimum binder percentage that reports the following (see appropriate KT-Methods):

(2.12.1) A Gmm determination for each binder content.

(2.12.2) Individual and average bulk specific gravity test results for at least 2 specimens at each binder content.

(2.12.3) The percent of air voids in the mixture for each binder content when compacted to $N_{ini}$, $N_{des}$ and $N_{max}$ gyratory revolutions along with copies of the Gyratory graphs.

(2.12.4) The percent Voids in Mineral Aggregate (VMA) at each binder content. (Note: The Contractor is cautioned that plant produced material generally yields a mixture with less VMA than predicted by the design. In such case, the design VMA should be increased above the specified minimum accordingly.)

(2.12.5) The dust to effective binder content (D/B) ratio calculated to the nearest 0.1 of a percent at each binder content.

**Subsection 1103.04, TABLE 6. Delete this TABLE and replace it with the following:**

**TABLE 6 MIX DESIGN REQUIREMENT**

| Nominal Max. Size Mix Designation | Percent Retained - Square Mesh Sieves | | | | | | | | Min. VMA (%) |
|---|---|---|---|---|---|---|---|---|---|
| | 1" (25 mm) | 3/4" (19.0 mm) | 1/2" (12.5 mm) | 3/8" (9.5 mm) | No. 4 (4.75 mm) | No. 8 (2.36 mm) | No. 16 (1.18 mm) | No. 200 (75 µm) | |
| SM-4.75A | | | 0 | 0-5 | 0-10 | | 40-70 | 88-94 | 15.0 |
| SM-9.5A & SR-9.5A | | | 0 | 0-10 | 10 min. | 33-53 | | 90-98 | 14.0 |
| SM-9.5B & SR-9.5B | | | 0 | 0-10 | 10 min. | 53-68 | | 90-98 | 14.0 |
| SM-9.5T & SR-9.5T | | | 0 | 0-10 | 10 min. | 53-68 | | 90-98 | 14.0 |
| SM-12.5A & SR-12.5A | | 0 | 0-10 | 10 min. | | 42-61 | | 90-98 | 13.0 |
| SM-12.5B & SR-12.5B | | 0 | 0-10 | 10 min. | | 61-72 | | 90-98 | 13.0 |
| SM-19A & SR-19A | 0 | 0-10 | 10 min. | | | 51-65 | | 92-98 | 13.0 |
| SM-19B & SR-19B | 0 | 0-10 | 10 min. | | | 65-77 | | 92-98 | 13.0 |

1. The requirements for coarse aggregate angularity; uncompacted voids content of fine aggregates; sand equivalent; Superpave gyratory compaction revolutions $N_{ini}$, $N_{des}$, $N_{max}$, $N_{ini}$ level of compaction, and voids filled with asphalt will be as shown in the Contract Special Provisions for each mix designation.

2. The flat and elongated particles in the combined coarse aggregate shall not exceed 10 percent for the total sample.

3. The dust to binder ratio (D/B) shall be within the range of 0.6 to 1.2 for nominal maximum size mix designations ending in A (except SM-4.75A shall have a dust to binder ratio within the range of 0.9 to 2.0). Nominal maximum size mix designations not ending in A (such as SM-9.5B) shall have a dust to binder ratio within the range of 0.8 to 1.6.

4. The maximum percent moisture in the final mixture shall not exceed 0.5 for any mix designation.

5. The target air voids for any mix designation shall be 4.0 % at $N_{des}$ gyrations.

6. The minimum tensile strength ratio shall be 80 % for any mix designation.

7. The level of compaction of the mix when compacted to $N_{ini}$ gyrations shall be less than the percent of the maximum specific gravity shown in the Contract Special Provision, and when compacted to $N_{max}$ gyrations shall be less than 98.0 percent of the maximum specific gravity.

## 4.0 CONSTRUCTION REQUIREMENTS.

**Construction requirements will comply to the requirements of Section 603 of the Standard Specifications, with the following exceptions and additions:**

**Subsection 603.02(a)(2.3.1). Add this after subsection 603.02(a)(2.3):**

(2.3.1) Anti-Strip Additives. If liquid anti-strip additives are added at the Contractor's plant, a "totalizer" must be installed to monitor the quantity of anti-strip additive being added. A method must be provided for the Engineer to continually monitor the percent of additive being added.

If hydrated lime is added, it shall be mixed in an approved pug mill to ensure the adequate coating of the combined aggregates. The combined virgin aggregate shall be moistened to at least 3 percent above the saturated surface dry condition prior to, or during the addition of the hydrated lime.

**Subsection 603.03(e)(1). Add the following paragraphs to the beginning of this subsection:**

Except when placing SM-4.75A, SM-9.5A or SR-9.5A bituminous mixtures, the material transferred from the hauling unit shall be remixed prior to placement. The Contractor shall use equipment such as mobile conveyor, material transfer device, shuttle buggy, material transfer vehicle, material transfer paver, or paver with remixer conveyor system. After starting the project with the equipment listed above, and after producing bituminous pavement density within the limits specified in **subsection 603.03(e)(2)**, the Engineer will consider other types of equipment or modifications to pavers that will produce less segregation. The use of equipment as noted above will not relieve the Contractor of his responsibility to comply with **subsection 603.03(e)(2)**. The Engineer will check the pavement for longitudinal streaks and other irregularities. The Contractor shall make every effort to prevent or correct any irregularities in the pavement, such as changing pavers or using different and additional equipment.

The wings of the paver receiving hopper shall not be raised (dumped) at any time during the paving operation. The Engineer may waive this requirement if he has determined that raising (dumping) the wings will not produce detrimental segregation. If segregation, or irregularities in the pavement surface or density are noted, the Contractor shall review the plant, hauling, and paving operations and take corrective action. The recommendations made in KDOT's "Segregation

Check Points" should reduce the segregation and irregularities to an acceptable level. Copies of KDOT's "Segregation Check Points" may be obtained from the Bureau of Construction and Maintenance.

**Subsection 603.03(e)(2). Add these paragraphs to this subsection:**

Segregation and uniformity of density will be checked by the Engineer using methods outlined in KDOT's "Segregation Check Using the Nuclear Density Gauge". Copies of KDOT's "Segregation Check Using the Nuclear Density Gauge" may be obtained from the Bureau of Construction and Maintenance. The acceptable criteria for density uniformity is as follows:

| Mix Designation | Maximum Density Range (highest - lowest) | Maximum Density Drop (average - lowest) |
|---|---|---|
| All | 4.4 lbs./ cu. ft. (70 kg/cu m) | 2.2 lbs./cu. ft. (35 kg/cu m) |

Whenever the results from 2 consecutive density profiles fail to comply both of the requirements listed above, plant production and paving will be suspended. The Contractor shall follow the procedures listed in the Profile Evaluation section of KDOT's "Segregation Check Using the Nuclear Density Gauge" (latest version) until normal production may be resumed.

**Joint density testing and the requirements listed below do not apply for HMA lift thicknesses ≤ 1 inch (25 mm).**

The Contractor shall evaluate the longitudinal joint density using methods outlined in KDOT Construction Manual, Part V, Section 5.21.04 "Joint Density Evaluation Using the Nuclear Density Gauge" (latest revision). Although it is the contractor's responsibility to perform the joint density evaluation, the Engineer may make as many independent joint density verifications as deemed necessary at the random sample locations. The Engineer's results will be used for acceptance for joint density when ever available. The acceptable criteria for joint density is:

$$\text{Interior Density - Joint Density} \leq 3.0 \text{ lbs/cu ft (50 kg/cu m)}$$

or

$$\text{Joint Density} \geq 90.0\% \text{ of } G_{mm}$$

If the results of 2 consecutive density profiles fail to meet the requirement listed above, the plant production and paving operations will be suspended. The Contractor shall follow the procedures listed in the Joint Evaluation section of KDOT Construction Manual, Part V, Section 5.21.04 "Joint Density Evaluation Using the Nuclear Density Gauge" (latest revision) until normal production may be resumed.

**Subsection 603.03(e)(7) Compaction of Mixtures. Delete the 4th paragraph which reads: "The specified percentage of field molded density shall be the absolute minimum density permitted."**

**Subsection 603.03(e)(8), Density requirements. Delete this subsection and replace it with the following:**

603.03 (e)(8) Density Requirement

(8.1) **For mixes with a specified thickness of 1½ inches (40 mm) or greater**:

For lots 1 and 2, density will be controlled using the requirements shown below in subsection (8.2). Lots 1 and 2 will not have a density pay adjustment.

For lots 3 and greater, the lot density requirements and appropriate pay factor adjustments are shown in **TABLE 8** of this **Special Provision** as the percent of the $G_{mm}$ value based on the average of the density tests. The standard lot size is 10 density tests. Smaller lot sizes may result as outlined in the following table. Normally, the $G_{mm}$ value used to calculate the density percentage is the average value of all $G_{mm}$ tests conducted the same day the lot was placed and compacted. If less than 3 $G_{mm}$ values were obtained that day, then use the moving average value (last 4 tests prior to the end of the day). When starting a mix and less than 4 $G_{mm}$ values have been determined, use the average value of those available at the end of each day.

(8.2) **For mixes with a specified thickness of less than 1½ inches (40 mm)**:

These mixes will not have a density pay adjustment. Density will be controlled using an approved rolling procedure with random nuclear meter density determinations. Include a plan for controlling density in the Quality Control Plan.

The contractor will designate a "Compaction Foreman." This person will control compaction procedures, review nuclear meter results as they are obtained, adjust compaction procedures as needed to optimize compaction, report any changes in the compaction process and results of nuclear meter testing to the Engineer. The compaction foreman may or may not be the nuclear meter operator. The nuclear meter operator will continuously monitor compaction procedures. As a minimum, 10 random nuclear meter density determinations per day will be taken and reported to KDOT. Throughout the day, nuclear meter results will be available for review by the Engineer. The compaction foreman will document that the approved rolling sequence is being followed at a minimum of once every 2 hours. Documentation will include roller passes, the mat temperature at each pass, and amplitude setting of rollers, and roller speed. The documentation will be provided to the Engineer.

An approved rolling procedure will be determined and periodically updated as outlined in **subsection 603.03(e)(8)**. As a minimum, the initial rolling procedure will be evaluated using 3 rollers. If the hot mix plant is operating at over 275 tons (megagram) per hour, a minimum of 4 rollers will be used in the initial evaluation. Vibratory rollers will be operated according to **subsection 151.03(j)**. Bituminous paver screed operation will be evaluated at various vibration settings with the nuclear meter. For screed evaluation, the nuclear meter readings will be taken directly behind the screed and before rolling. Evaluation by the compaction foreman and the Engineer of the densities obtained with the various roller combinations and screed settings will determine the initial approved rolling procedure.

The compaction foreman and Engineer working together will determine when new rolling procedures are required. Hot mix production may be stopped by the compaction foreman or Engineer whenever rolling is not being performed according to the approved rolling procedure.

(8.3) **For all mixes**:

The maximum density must be achieved before the temperature of the bituminous mixture falls below 175°F (80ºC). Excess crushing of the aggregate will not be allowed. Roller marks may be removed from the mat with a self-propelled static steel roller when the mat temperature falls below 175°F (80ºC).

**Daily Production versus Number of Sublots, and Test Requirements**

| Daily Production (tons (Mg)) | Number of Sublots | No. of Cores or Nuclear Density Tests | No. of Verification Cores or Nuclear Density Tests# |
|---|---|---|---|
| 0-599 | 3* | 6* | 3* |
| 600-999 | 4* | 8* | 4* |
| 1000 or more | 5 | 10# | 5 |

*Minimum number for mixes with a specified thickness of 1½" (40 mm) or greater: The Contractor may choose to obtain the number required for 1000 or more tons (megagram). If the Contractor chooses to test 5 sublots (10 tests), the Department will obtain 5 verification tests.

#For mixes with a specified thickness of less than 1½" (40 mm): Verification testing may be performed, but it is not required. Additional testing may be performed by the Contractor. A minimum of 10 tests are required.

**Subsection 603.05. Delete this subsection and replace it with the following:**
**603.05 COMPACTION TESTING.**

**(a)** Make the density determination of the compacted mixture using test results on random samples selected by the Contractor or Engineer (see subsection **2.0 d.(1)** of this **Special Provision**) from each lift placed. When the Contractor selects the sites, select sites in accordance with the approved quality control plan. Take the nuclear density tests or core samples before placement of the next lift and before opening to construction or public traffic, and no later than the next working day following the date of placement.

The following is an exception to coring after any traffic on the overlay. This procedure may not be used more than twice on any one project or tied projects unless approved by the Engineer. The Contractor may request re-evaluation by coring. (Testing and coring will be subsidiary items.) When coring is requested, the following procedures will be followed in the lot under re-evaluation.

(1) Immediately before coring by the Contractor, nuclear meter densities will be determined by the Contractor in the presence of the Engineer in the locations they previously tested. The average nuclear meter density after traffic will be determined. A Contractor density correction factor will be calculated as follows: the average nuclear meter density after traffic minus the average nuclear meter density before traffic. If the calculated Contractor density correction factor is a negative value, the Contractor's density correction factor will be set equal to zero (normally the density correction factor will be a positive number).

(2) Also, immediately before coring by the Contractor, nuclear meter densities will be determined by the Department in the presence of the Contractor in the locations they previously tested. The average nuclear density after traffic will be determined. A Department density correction factor will be calculated as follows, the average nuclear meter density after traffic minus the average nuclear meter density before traffic. If the calculated Department density correction factor is a negative number, the Department's density correction factor will be set equal to zero.

(3) Determine the Traffic Density Correction Factor. It will be the larger of the Contractor's density correction factor or the Department's density correction factor determined in "(1)" and "(2)" above.

(4) The Contractor with the Engineer present will obtain 1 core from each of the Contractor and Department nuclear meter locations. Mark each core as they are taken. Cores will be taken to the Departments field laboratory for drying and evaluation. The Contractor and Engineer working together will determine the density of each core. Determine the corrected core density for each Contractor and Department core as follows: the core density minus the Traffic Density Correction Factor.

(5) Using the corrected Contractor core densities and the corrected Department core densities, the Engineer will re-evaluate this lot using the procedures outlined in 6.0 Basis of Acceptance subsections (a) and (b). Based on this re-evaluation, the Engineer will inform the Contractor of the lots disposition and pay factor.

For shoulders with a Plan width of less than or equal to 3 feet (0.9 m) and placed at the same time as the travelway, the density pay factors for the travelway will apply. Density for all shoulders with a Plan width greater than 3 feet (0.9) and any shoulder not placed at the same time as the travelway will be controlled by the Contractor and be subject to the requirements listed in Note (b) of **TABLE 8** of this **Special Provision**.

A lot consists of a day's production for each lift placed and contains the number of density locations as outlined in the preceding table. Lot acceptance will be based on 2 test results from each sublot unless the Engineer's results (1 test per sublot) are used. (Air voids lots and density lots are normally of different sizes.)

If the lane being placed will be opened to traffic that day, the Engineer and the Contractor may predetermine the sublot size based on anticipated production. If actual production does not comply with anticipated production, the sublot size will be adjusted. The number of tests will be as outlined in the preceding table.

The minimum number of density tests are as listed in the preceding table. The Contractor has the option to take additional tests to provide 10 test results to determine payment. The pay factors for specified density are listed in **TABLE 8** of this **Special Provision**. The pay factors for specified density do not apply to sideroads, entrances, crossovers, and other incidental surfacing.

**(b) Nuclear Density Tests (For mixes with a specified thickness of 1½ inches (40 mm) or greater).**

Take 2 nuclear density tests at random within each sublot. The Engineer will take 1 random nuclear density verification test per sublot. Perform nuclear density testing to be used in the determination of the travelway pay adjustment factors and control of shoulder density. Do not take nuclear meter readings within 1 foot (0.3 m) of a longitudinal joint or edge, nor within 20 feet (6 m) of a transverse joint. Mark the outline of the nuclear meter on the pavement at each location tested with a method of marking that will last a minimum of 24 hours. Take the nuclear density test at the random location, do not move the meter from this location to maximize or minimize the density results. If the Contractor doubts the accuracy of any of the nuclear test results, he may choose to core the pavement at the nuclear meter test locations. If the Contractor chooses to core the pavement to determine the density for pay adjustment purposes then all nuclear density test results representing the lot will be voided and cores will be taken as prescribed in subsection **603.05(c)** of this **Special Provision.**

Verification nuclear density tests, 1 per sublot, will be taken at random locations selected by the Engineer. Payment factors will be based on the Contractor's nuclear density test results provided the Contractor's test results are verified by the Department's nuclear density tests.

**Note**: KDOT will determine a calibration factor for the Contractor's nuclear density device at the same time as a calibration factor is determined for the Department's device. The Contractor will be afforded the opportunity to observe the calibration procedure whether it is performed at the District Laboratory or on the Project site. KDOT Districts should provide calibration factors by the end of the working day following the date of collecting the cores. In cases where this is not possible, the Contractor and KDOT may agree in advance to accept a zero pay adjustment for the concerned lots.

The Engineer and the Contractor will compare nuclear test results before any traffic is allowed on the roadway. If Contractor's or KDOT's density values are suspect, the Engineer may approve re-testing the locations in question. When re-testing is permitted, the new nuclear density values will be substituted for the values in question. The Contractor needs to determine if cores will be taken before traffic is allowed on the roadway.

**(c) Cores (For mixes with a specified thickness of 1½ inches (40 mm) or greater).**

Take 2 cores at random locations within each sublot. The Contractor may be required to chill the compacted mixture before coring samples so that the samples may be removed intact without distortion. Cut the samples using a 4 inch (100 mm) coring device, unless a 6 inch (150 mm) coring device is approved by the Engineer. Mark all samples with the lot number, sublot number, and core number. Transport the cores to the laboratory as soon as possible to prevent damage due to improper handling or exposure to heat. The Contractor is required to cut all cores including the Engineer's verification cores. The Contractor will be paid only for cores cut to calibrate the nuclear meter when requested by the Engineer. Use Kansas Test Method KT-15 Procedure III to determine core density.

Do not take cores within 1 foot (0.3 m) of a longitudinal joint or edge nor within 20 feet (6 m) of a transverse joint.

Take 1 verification core per sublot at locations selected by the Engineer for testing at the Department's laboratory. Payment factors and control of shoulder density are based on the Contractor's core results provided the Contractor's test results are verified by the verification cores sent to the Department's laboratory.

Dry the core holes, tack the sides and bottom, fill them with the same type of material, and properly compact it by the next working day.

**Subsection 603.04. Delete this subsection and replace it with the following:**

**603.O4 PROCESS CONTROL.**

**(a) Requirements for All Mix Designations.**

(1) General. Establish gradation limits and proportions for each individual aggregate, mineral filler and RAP when applicable. Specify the limits and proportions such that the material produced will comply with the applicable requirements of the designated mix type as specified in this special provision. The Contractor is responsible for all process control operations including testing. At no time will the Department's representative issue instructions to the Contractor or

producer as to setting of dials, gauges, scales and meters. The Department will collect and test verification samples and assurance samples and inspect the Contractors quality control operations.

(2) JMF Adjustments. Produce a mixture of uniform composition closely complying with the approved Design JMF to assure that the mixture, when compacted, will achieve the specified properties. If, during production, the Contractor determines from results of quality control tests that adjustments are necessary to the mix design to achieve the specified properties, adjustments to the design JMF single point gradation and binder content values may be made. The JMF adjustments must produce a mix that complies with the requirements of **TABLE 6** of this **Special Provision** for the specified mix designation. It is intended that such adjustments be made on a sublot basis when needed. Report the new JMF to the Department's field representative and the District Materials Engineer before making such changes.

(3) Specification Working Ranges. Establish acceptable limits for field test results by applying the tolerances shown in **TABLE 7** of this **Special Provision** to the JMF or adjusted JMF for binder content. Establish acceptable limits for the other listed mix characteristics by applying the tolerances shown in **TABLE 7** of this **Special Provision** to the specification requirements of **TABLE 6** of this **Special Provision**.

**TABLE 7 SPECIFICATION WORKING RANGES (QC/QA)**

| **Mix Characteristic** | **Tolerance from JMF** | | | |
|---|---|---|---|---|
| | **Single Test Value** | **Plot** | **4 Point Moving Average Value** | **Plot** |
| Binder Content | ±0.6% | * | ±0.3% | * |
| | | | | |
| **Mix Characteristic** | **Tolerance for Specification Limits** | | | |
| | **Single Test Value** | **Plot** | **4 Point Moving Average Value** | **Plot** |
| Gradation (applicable sieve shown in **TABLE 6**) | n/a | * | zero tolerance | * |
| Air Voids @ $N_{des}$ gyrations | ±2.0% | * | n/a | |
| Voids in Mineral Aggregate | 1.0% below min. | * | zero tolerance | * |
| Voids Filled with Asphalt | n/a | | zero tolerance | * |
| Course Aggregate Angularity | zero tolerance | | n/a | |
| Sand Equivalent | zero tolerance | | n/a | |
| Fine Aggregate Uncompacted Voids | zero tolerance | | n/a | |
| Tensile Strength Ratio | zero tolerance | * | n/a | |
| Density @ $N_{ini}$ and $N_{max}$ | n/a | | zero tolerance | |
| Dust/Binder Ratio | n/a | * | zero tolerance | * |

* Values to plot (reference **2.0(d)(4)** of this **Special Provision**). For gradations, as a minimum, plot the No. 4, No. 8, No. 30, and No. 200 (4.75 mm, 2.36 mm, 600 µm, and 75 µm) sieves.

## 5.0 MIXTURE ACCEPTANCE.

**a. General.** Test each mix designation at each plant for compliance with all requirements listed in **TABLE 6** of this **Special Provision**. Acceptance will be made on a lot to lot basis contingent upon satisfactory test results. Obtain test samples of the mix designation from the roadway behind the paving operation before compaction. The sampling device and procedures used to obtain the samples must be approved by the Engineer. Use Kansas Test Method KT-25 for obtaining bituminous mixture from the roadway and splitting of the sample. The Contractors quality control tests will be used for acceptance in accordance with this special provision.

However, any load or loads of mixture which, in the opinion of the Engineer, are unacceptable for reasons such as being segregated, aggregate being improperly coated, foaming aggregate, or being in excess of the maximum mixing temperature may be rejected. (Verification samples will be taken by the Engineer at randomly selected locations from behind the paver. The Contractor will fill all sample locations before compaction).

The air voids test values will also be used to determine air void pay adjustments to the Contract bid price in accordance with **subsection 6.0 c.** of this **Special Provision**. Air void pay adjustments apply to the bituminous mixture placed on the travelway and shoulders (including ramps and acceleration and deceleration lanes.

**b. Lot Definition for Mix Production Sampling and Testing.** A lot is defined as an isolated quantity of a specified material produced from a single source or operation. Each lot will normally be represented by 4 contiguous test results. A lot may be represented by test results on samples taken from 1 or more days' production.

**c. Lot Investigation.** The Engineer may examine materials represented by individual test results which lie beyond the Contractor's normal quality control testing variation. The investigation may be based on either Contractor's test results or the Department's test results. The information from additional testing (including testing of in-place bituminous mix) may be used to define unacceptable work in accordance with **subsection 106.08** of the **Standard Specifications** and apply appropriate price reductions or initiate corrective action as determined by the Engineer.

For any test, if a dispute exists between the Engineer and the Contractor about the validity of the others test results, the KDOT District Materials Laboratory or the Materials and Research Center (MRC) will perform referee testing, except for nuclear density dispute resolution and air void dispute resolution. If the disputed Department test results were generated at the District Laboratory, the MRC will perform the referee tests. If the disputed Department test result was generated at the MRC, then an independent laboratory agreeable to both parties will be selected. The Laboratory must be accredited by the AASHTO Accreditation Program in the appropriate testing category. If referee testing indicates that the Department's test results are correct then the Contractor pays for the additional testing, including referee testing performed at the MRC. If the referee testing indicates that the Contractor's test results are correct then the Department pays for the additional testing. If air void payment is questioned and referee testing indicates KDOT test results will be used to determine air void payment, the Contractor will pay for the additional testing.

(1) For nuclear density dispute resolution (the statistical comparison fails and the Contractor questions the Department's results), the following procedure will be followed:

- Pay factors previously established with the nuclear meter will be discarded and the core results will be used to establish the pay factors.
- The Contractor, with the Engineer present, will take 1 core from each of the locations previously tested with the Contractor's nuclear meter and the Department's nuclear meter (normally 15 cores). Mark all cores with the lot number, sublot number, and core number.

- The cores will be taken to the field laboratory and dried to a constant weight (mass) before testing. The Contractor and the Engineer, working together, will determine the core densities (Kansas Test Method KT-15, Procedure III).
- A statistical comparison will be made between the Contractor's core results and the Department's core results. If the "t" test passes, the Department will pay for all cores. The Contractor's test results will be used to calculate the density pay factors. If the "t" test fails, the Department will not pay for the cores. The Department's test results will be used to calculate the density pay factors.

(2) For air void dispute resolution (the statistical comparison fails and the contractor questions the Department's results), the following procedure will be followed for the lots in question:

- Contractor will determine which lots to dispute. Contractor may only dispute the lot produced immediately prior to the lot currently under production and being tested. The Engineer must be notified prior to the completion of all Contractor air void testing for this lot. When production is completed for any mix, the last lot may be challenged the day production is completed.
- Air voids and air void pay factors previously determined within the lots being questioned will be discarded.
- All saved gyratory compacted air void quality control and verification samples and back half of samples within the lots in question will be taken by KDOT to the District Materials Laboratory. The back half of the sample shall contain a minimum of 35 pounds (15 kg). (Saving of the samples is covered in **subsection 2.0a(3)** of this **Special Provision**). Copies of all paper work, including work sheets, associated with previous air void calculations for the disputed lots will also be taken to the District Materials Laboratory.

Following retesting will be completed by KDOT:

- Check the samples to be sure they are dry before retesting. Reweigh the original gyratory compacted air void quality control and verification samples. Determine the $G_{mb}$ at $N_{des}$ revolutions for all saved gyratory plugs. Compare retest results with original test results.
- Determine the $G_{mm}$ using the back half of all samples within each lot being questioned. Normally there will be 5 back halfs (4 contractors and 1 KDOT) to test within each lot.
- Recompact the back halfs and determine the $G_{mb}$ at $N_{des}$ revolutions.
- Use $G_{mm}$ determined above and the $G_{mb}$ determined from the recompacted samples calculate $V_a$ at $N_{des}$ revolutions for the lots in question.
- Using the retest air void results, a statistical comparison will be made. If the "t" test passes, the contractor's retest results will be used to calculate the pay factor and KDOT will pay for all retesting. The procedures shown in Basis of Acceptance 6.0 (c) Air Void Pay Adjustment of this special provision will be used. If the "t" test fails, the Department's retest results will be used to calculate the pay factor and the contractor will pay for all retesting.

When a deficiency within a lot is determined to exist for properties other than density and air voids (air voids and density deficiencies are addressed elsewhere in the **Special Provision**), the

Engineer shall decide on the disposition of each lot as to the acceptance, the rejection, or the acceptance at an adjusted payment. The Engineer's decision will be final.

**d. Resampling of Lots.** It is the intent of these specifications that lots of materials, products, items of construction, or completed construction will comply with the specification requirements at the time of sampling. No samples for re-test will be taken for pay adjustment purposes except as noted in **subsection 603.05(b)** and **5.0 c.** of this **Special Provision**.

**e. Multiple Projects.** If multiple projects are supplied from 1 or more plants, the lots at each hot mix plant will carry over from project to project.

**f. Lot Size.** A standard size mix production lot (density test lots are defined previously in this special provision) consists of 4 equal sublots of 750 tons (megagram) each of bituminous mix (lot size 3,000 tons (megagram)).

It is anticipated that lot size will be as specified. However, the Contractor may, with concurrence of the Engineer, re-define lot size for reasons such as, but not limited to, change in Contract quantities or interruption of the work. Take 1 sample during production of each sublot and utilize it to determine disposition of the lot in which it occurs.

**g. Increased Lot Size.** After 8 consecutive sublots have been produced within the tolerances shown for all mix characteristics listed in **TABLE 7** of this **Special Provision** and without an air voids penalty, the sublot size may be increased by the Contractor to 1,000 tons (megagram) (lot size 4,000 tons (megagram)), provided the normal production rate of the plant is greater than 250 tons (megagram) per hour. Immediate notification of lot size changes must be provided to the Engineer any time a change is made.

After 8 additional consecutive sublots have been produced at the 1,000 tons (megagram) sublot size, the sublot size may again be increased by the Contractor to 1,250 tons (megagram) per sublot, provided all 8 consecutive 1,000 ton (megagram) sublots have been produced within the tolerances shown for all mix characteristics listed in **TABLE 7** of this **Special Provision**, without an air voids penalty, production rates for the previous 2 days have been greater than 3,750 tons (megagram), and at least 2 of the last 3 segregation profile checks comply with the requirements that follow:

| Mix Designation | Maximum Density Range (highest to lowest) | Maximum Density Drop (average-lowest) |
|---|---|---|
| All | 3.1 lbs./cu. ft.<br>50 kg/m³ | 1.9 lbs./cu. ft.<br>30 kg/m³ |

If subsequent test results fall outside the tolerances shown for any mix characteristics listed in **TABLE 7** of this **Special Provision** or an air voids penalty is incurred, the sublot size will be decreased to 750 tons (megagram). If the production rates fall below 3,750 tons (megagram) per day for 2 consecutive days or at least 2 of the last 3 segregation profile checks fail the above requirements , then the 1,250 ton (megagram) sublots size will be reduced to 1,000 ton (megagram) per sublot provided the **TABLE 7** of this **Special Provision** criteria is met and no air voids penalty is incurred. When the Increased lot Size criteria is again met, the sublot size may be increased to the limits given above.

**h. Decreased Lot Size for Small Quantities.** This is to be used when a small quantity (less than 3,000 tons (megagram)) of a particular mix will be used. The lot size will be the plan (or planned) quantity. The Contractor will reduce the sublot size below 750 tons (megagram) by dividing the lot into 3 or 4 equal sublots. Before beginning production, the Contractor will provide the Engineer with the number and size of the sublots.

**i. Pre-Production Sample.** A pre-production sample, limited to a maximum of 200 tons (megagram), from each plant and plant site will be tested and evaluated by the Contractor before delivery of bituminous mixture from that plant to the project or projects. Pre-production samples will be evaluated at initial start-up and after suspension of production resulting from failing test results. Pre-production sample test results will not be used in determining adjusted air void payment for a lot. Pre-production sample test results must be in compliance with the gradation, dust to binder ratio, binder content, VMA, level of compaction for $N_{ini}$, $N_{des}$, $N_{max}$ and laboratory air voids requirements before delivery of hot mix to a project will be permitted. For binder content, air voids at $N_{des}$, and VMA, use the "Single Test Value" listed in **TABLE 7** of this **Special Provision** for comparison. For the other tests listed, use the values listed in **TABLE 6** of this **Special Provision** or in the **Project Special Provision** for each mix. Except for initial start-up, normal delivery of material to the project before completion of certain test results on pre-production samples may be authorized by the District Materials Engineer.

The material produced for the pre-production sample will be placed in locations specifically requested by the Contractor and approved by the District Materials Engineer. Non-critical areas such as side roads, entrances, shoulders, or deep in the base should be considered for the pre-production sample.

**j. Suspension of Mix Production.** Suspend production of the mix until appropriate corrections have been made, if 2 consecutive test results for any single mix characteristic fails to fall within the limits established by the tolerances shown in the single test value column of **TABLE 7** of this **Special Provision**. Additionally, suspend production of the mix until appropriate corrections have been made, if any 4 point moving average value for any single mix characteristic fails to fall within the limits established by the tolerances shown in the 4 point moving average value column of **TABLE 7** of this **Special Provision**. Production remains suspended pending the satisfactory results of a pre-production sample, unless waived by the District Materials Engineer.

The Engineer may cause production of bituminous mix to cease at any time the mix or process is determined to be unsatisfactory. The Contractor must make the necessary corrections before production will be allowed to resume. Failure to cease operations for the conditions cited above will subject all subsequent material to rejection by the Engineer or acceptance at a reduced price as determined by the Engineer.

**k. Non-Complying Materials.** Establish and maintain an effective and positive system for controlling non-complying material, including procedures for its identification, isolation and disposition. Reclaim or rework non-complying materials in accordance with procedures acceptable to the Engineer. This could include removal and replacement of in-place pavement.

Positively identify all non-complying materials and products to prevent use, shipment, and intermingling with complying materials and products. Provide holding areas, mutually agreeable to the Engineer and the Contractor.

## 6.0 BASIS OF ACCEPTANCE.

**a. General.** Acceptance of the mixture will be on the basis of Contractor quality control test results on consecutive random samples. The Department will routinely compare the variances (f test) and the means (t test) of the verifications test results with the quality control test results for air voids, $G_{mm}$, and density using a spreadsheet provided by the Department. If the Department's verification test results do not show favorable comparison with the Contractors quality control test results then the Department's test results will be used for material acceptance, material rejection and/or the determination of any pay adjustment on the air voids and roadway density. Disputed test results will be handled in accordance with **subsection 5.0 c.** of this **Special Provision**.

KDOT will use a spreadsheet program to calculate pay density and air voids, and to compare the Contractor's QC and KDOT's QA test results (including theoretical maximum specific gravity). KDOT will provide a copy of this program to the Contractor if one is requested. MICROSOFT EXCEL software is required to run this program; it is the Contractor's responsibility to obtain the correct software. Values computed using tables referenced in this specification may vary slightly from the spreadsheet values due to rounding of numbers. In such cases the numbers computed by the spreadsheet shall take precedence.

The comparison of quality control and verification tests will be completed using the t-tests to compare their population means and the F-test to compare their variances. The F and t tests, along with the EXCEL Spreadsheet used to compare the Contractors Quality Control (QC) results and KDOT's verification (QA) results, are described in Section 5.17.08 of the KDOT Construction Manual. Examples of Air Voids F and t tests, along with Density F and t tests are shown in this Section. Additional information on the program may be obtained from the Bureau of Materials and Research.

**b. Compaction Payment.**

**Mixes with specified thickness of less than 1½ inches (40 mm) are not subject to density payment adjustments.**

**For mixes with specified thickness of 1½ (40 mm) inches or greater:** Density payment adjustment for compaction of the completed pavement will be by lot based on the percentage of maximum specific gravity obtained. Density pay adjustment (incentive or disincentive) will be computed by multiplying the density pay adjustment factor ($P_D$) times the number of tons included in the lot times $31 per ton ($34 per megagram). (Air voids lots and density lots are normally of different sizes.)

Payment factors will be determined from **TABLE 8** of this **Special Provision** (for **TABLE 8**, average the percent of $G_{mm}$ values to 0.01% and calculate the pay factors to 0.001).

**TABLE 8 DENSITY PAY FACTORS FOR SPECIFIED THICKNESS[d]**

| Specified Thickness ≥ 2" (50 mm) or ≥1½" (40 mm) [c] | | | Specified Thickness 1½" to 1⅞" (40 to 49 mm) [f] | |
|---|---|---|---|---|
| % of Maximum Specific Gravity Average of 10 Density Tests[a] | Pay Factor[b] | | % of Maximum Specific Gravity Average of 10 Density Tests[a] | Pay Factor[b] |

| | | | | |
|---|---|---|---|---|
| 93.0% or greater | 1.040 | | 93.0% or greater | 1.040 |
| 92.0 to 92.9% | A1 | | 92.0 to 92.9% | A1 |
| 91.0 to 91.9% | 1.000 | | 90.0 to 91.9% | 1.000 |
| 90.0 to 90.9% | A2 | | 89.0 to 89.9% | A3 |
| less than 90.0% | [c] | | less than 89.0% | [c] |

[a] For low daily production rates less than 1000 tons (megagram) or when the Engineer's verification tests are to be used for density pay determination, the lot sample size is as determined under **subsection 603.03(e)(8)** for compaction testing.

[b] For shoulders with a Plan width greater than 3 feet (0.9 m) and any shoulder not placed at the same time as the travelway, compact the bituminous mixture in the lot to greater than or equal to 90.0% (if specified thickness is ≥2" (50 mm)) or 89.0% (if the specified thickness is from 1½" (40 mm) to 1⅞" (49 mm)) of the maximum specific gravity, otherwise the Engineer will determine whether the bituminous mixture in the lot may remain in place or be removed. Any such material left in place shall have a pay factor of 0.950 or less.

[c] The Engineer will determine if the travelway, shoulders with a Plan width of 3 feet (0.9 m) or less and placed with the travelway, ramps, acceleration and deceleration lanes may remain in place or be removed. The Engineer will notify the Contractor before 11 a.m. of the next working day if the area is to be removed. Any such material left in place shall have a pay factor of 0.840.

[d] Specified thickness is the total thickness shown in the Contract Documents for the mix being placed.

[e] Use for ≥1½" (40 mm) when another continuous action, such as milling, surface recycling, cold recycling, or overlay, is completed ahead of this overlay.

[f] Use when another continuous action is not completed before the overlay.

**Calculations for Pay Factors A1, A2, and A3:**

**A1** = [100 + 4 (% of lot maximum specific gravity - 92.0)] ÷ 100

**A2** = [84 + 16 (% of lot maximum specific gravity - 90.0)] ÷ 100

**A3** = [84 + 16 (% of lot maximum specific gravity - 89.0)] ÷ 100

**Pay Factor Calculation:**

Density Pay Adjustment Factor ($P_D$)* = Pay Factor - 1.000

*($P_D$ will be rounded to the nearest 0.001)

**c. Air Void Pay Adjustment.** Payment adjustment for air voids will be made on a lot basis and based on the measured air voids of samples of plant produced material. The air voids pay factor ($\boldsymbol{P_V}$) (positive or negative) will be determined and used to compute the air voids pay adjustment by multiplying $\boldsymbol{P_V}$ times the number of tons included in the lot times $31 per ton ($34 per megagram). The pay adjustment amount will be added or subtracted as extras and contingencies on the pay estimate. When the statistical comparison between the quality control and the verification tests passes use the procedures in paragraph number (1) to compute $\boldsymbol{P_V}$. When the statistical comparison fails, calculate $\boldsymbol{P_V}$ using procedures in paragraph number (2) below.

A lot will normally be comprised of the results of 4 contiguous individual air void tests performed on Superpave gyratory compacted samples of a given mix design. Lot size is defined in subsections **5.0 f.**, **5.0 g.**, and **5.0 h.** of this Special Provision. When there are 1 or 2 tests remaining, such as at the end of a project or season, combine them with the previous 4 tests to create a 5 or 6 test lot respectively. When there are 3 tests remaining, combine the 3 tests into a lot. (Air voids lots and density lots are normally of different sizes).

(1) Air Voids Pay Factor (Passing "t" Test). Calculate the upper and lower air voids quality indices ($Q_{UV}$ and $Q_{LV}$) for each lot using equations 1 and 2, respectively and round to hundredths (0.01). Locate the $Q_{UV}$ value in the left column of the Percent Within Limits (PWL) Table in section 5.17.09 of Part V of the Construction Manual. Select the appropriate upper percent within limit value ($PWL_{UV}$) by moving across the selected quality index row to the column representing the number of samples (N) in the lot. Repeat the process using the $Q_{LV}$ value and select the appropriate value for the lower percent within limits ($PWL_{LV}$). If the $Q_{UV}$ or $Q_{LV}$ value is greater than the largest quality index value shown in the table, then a value of 100.00 is assigned as the value for $PWL_{UV}$ or $PWL_{LV}$, respectively. If both $Q_{UV}$ and $Q_{LV}$ exceed the values shown in the table then a value of 100.00 is assigned as the value for both $PWL_{UV}$ and $PWL_{LV}$. If either $Q_{UV}$ or $Q_{LV}$ is a negative value or $PWL_{UV} + PWL_{LV}$ is less than 150 then the Engineer will determine if the material in the lot may remain in place. If the Engineer determines that the material may remain in place then the maximum value of $P_V$ for the lot will be equal to –0.120. The Engineer may choose to establish lower values for $P_V$ (-0.200, -0.300, etc.) in such instances. Otherwise, calculate $P_V$ using equation 3 and round to thousandths (0.001).

Equation 1: $$Q_{UV} = \frac{USL - \overline{X}}{S}$$

Where: $\overline{X}$ is the average measured air voids of all samples within a lot rounded to hundredths (0.01).

$USL$ is the upper specification limit for air voids and is defined as 5.00%.

$S$ is the standard deviation of the measured air voids for all samples within a lot and is calculated using equation 2 rounded to hundredths (0.01).

Equation 2: $$Q_{LV} = \frac{\overline{X} - LSL}{S}$$

Where: $\overline{X}$ is the average measured air voids of all samples within a lot rounded to hundredths (0.01).

$LSL$ is the lower specification limit for air voids and is defined as 3.00%.

$S$ is the standard deviation of the measured air voids for all samples within a lot and is calculated using equation 2 rounded to hundredths (0.01).

Equation 3: $$P_V = \left(\left(PWL_{UV} + PWL_{LV} - 100\right) * 0.0030\right) - 0.270$$

Where: $\boldsymbol{PWL_{UV}}$ is the upper percent within limits value for air voids.
$\boldsymbol{PWL_{LV}}$ is the lower percent within limits value for air voids

(2) Air Voids Pay Factor (Failing "t" Test). If the "t" test fails, the Department's test result will be used to calculate the air void pay factor for the lot. Follow the procedures given in paragraph 1 above to determine the pay factor or disposition of the lot. Use the following values in equations 1 and 2 above. The value of $\overline{X}$ will be the Departments test result for the lot, the value of $S$ will be 0.50, the value of $USL$ will be 5.50% and the value of $LSL$ will be 2.50%. When selecting the $\boldsymbol{PWL_{UV}}$ and $\boldsymbol{PWL_{LV}}$ values from the PWL Table in 5.17.09 the value of N will be 3.

**7.0 MEASUREMENT AND PAYMENT.**

**Measurement and Payment will comply to the requirements of Section 603 of the Standard Specifications, with the following exceptions and additions:**

**Subsection 603.08(a). Delete the first sentence and replace it with the following:**

(a) Bituminous Surface and Bituminous Base shall be measured by the ton (megagram) of material at the time of delivery to the road and no deduction will be made for the weight (mass) of bituminous material in the mixture.

**Subsection 603.08(b)(c)(d). Delete these subsections and replace with the following:**

(b) When the Contractor is required to remove any base course, subgrade or existing surface course and provisions are not made in the Plans or Contract, the material used for repair and patching will be measured separately, by the ton (megagram) at the time of delivery to the road. No deduction will be made for the asphalt cement in the mixture, and the material will be paid as provided in **subsection 603.09(b).**

(c) Bituminous materials will be measured by the ton as provided in **Division 100**. For mixes containing Reclaimed Asphaltic Pavement (RAP), compute the bituminous material contained in the RAP using the binder content determined from ignition oven testing. Maintain this information for materials tracking purposes. No separate payment for bituminous material in RAP will be made.

(d) Each set of cores required by the Engineer to calibrate the nuclear density meters will be measured per each set for payment. Three cores constitute a set. No payment will be made for cores deemed unsuitable for calibrating the nuclear density meters. No payment will be made for cores taken at the Contractor's option to determine density.

Each core taken for nuclear density dispute resolution (see **subsection 5.0 c.** of this **Special Provision**) will be measured as one-half of a set for payment if the Contractor's test results are used for payment. No payment will be made for nuclear density dispute resolution cores if the Department's test results are used for payment.

**Subsection 603.08. Add the following as a new paragraph to this subsection.**

(g) Quality control testing (Bituminous) performed by the Contractor will be measured on a per ton (megagram) basis of Bituminous Surface and Bituminous Base placed on the project.

**Subsection 603.09 (a)(b)(f). Delete paragraphs and add the following:**

(a) The quantity of completed work measured as provided above will be paid for at the Contract unit price per 1,000 gallons (megagram) for "Water". The various types and grades of bituminous material used for tack coats will be paid for at the Contract unit price per ton (megagram). The bituminous material added to the mixture will not be paid for separately but shall be included in the bid price for "Bituminous Base" and "Bituminous Surface". "Bituminous Base" and "Bituminous Surface" will be paid for at the Contract unit price per ton (megagram). The pay adjustments if any, resulting from both the air voids pay factor and the density pay factor will both be applied and payment adjusted accordingly. The adjusted payment will be full compensation for furnishing all materials, for all labor, equipment, tools, supplies and incidentals necessary to complete the work.

(b) "Material for Bituminous Patching" used in repair and patching of the base and/or subgrade, including the existing surface course is the "Hot Mix Asphalt - Commercial Grade" as provided in **subsection 605.02** of the **Standard Specifications**; except, the Contractor has the option to use the "Bituminous Base" if such items are included in the Contract. Otherwise, the Contractor has the option to use "Bituminous Surface". The quantity of completed and accepted work measured as provided in **subsection 603.08(b)** will be paid for at the Contract unit price set for "Material for Bituminous Patching", which price will be full compensation for all excavation, compaction of subgrade or subbase if required, disposal of waste material and for furnishing all material (including asphalt cement and asphalt for tack), for all labor, equipment, tools, supplies and incidentals necessary to complete the work. No payment will be made for the quantity of material used in the repair of damage due to the Contractor's negligence.

(f) Sideroads, entrances and mailbox turnouts that are not shown on the Plans or listed in the Contract that are to be surfaced shall be paid for at 1½ times the unit price for "Bituminous Surface" or "Bituminous Base".

(g) Contractor “Quality Control Testing (Bituminous)” will be paid for at the bid price per ton (megagram). No adjustment in the bid price will be made for overruns or underruns in the Contract quantity. The bid price will constitute payment for all necessary mix design testing, field process control testing, the testing laboratory and all necessary test equipment.

# APPENDIX A
# SAMPLING AND TESTING FREQUENCY CHART FOR BITUMINOUS CONSTRUCTION ITEMS FOR QUALITY CONTROL/QUALITY ASSURANCE PROJECTS

| TESTS REQUIRED (Record To) | QUALITY CONTROL BY CONTRACTOR | VERIFICATION BY KDOT | INDEPENDENT ASSURANCE BY KDOT |
|---|---|---|---|
| Binder Sampling (KT-26) | [CMS=VER] 1 sample per 3 loads (note a) | 1 per project | |
| Binder Content (by ignition) (0.1 g or 0.01% of mass) (KT-57) | 1 per sublot | 1 per lot (note g) | Witness and test split sample - 1 per year per certified technician. |
| Mix Gradation (after ignition) (0.1 g or 0.01% of mass) (KT-34) | 1 per sublot | 1 per lot | Witness and test split sample - 1 per year per certified technician. |
| Theoretical Max. Sp. Gr. (Rice)(Gmm = 0.001) (KT-39) (note h) | 1 per sublot | 1 per lot | Witness and test split sample - 1 per year per certified technician. |
| Air Voids (Va = 0.01%; Gmb = 0.001) (KT-15, KT-58 and SD/SF Manual) | 1 per sublot | 1 per lot (note g) | Witness and test split sample - 1 per year per certified technician. Compact split sample on KDOT gyratory; 1 per week or 15,000 tons (Mg) |
| Binder Content in RAP (by ignition) (0.1 g or 0.01% of mass) (KT-57) | 1 per 1,000 tons (Mg) | 1 per 20,000 tons (Mg) (note g) | |
| RAP Gradation (after ignition) (0.1 g or 0.01% of mass) (KT-34) | 1 per 1,000 tons (Mg) | 1 per project | |
| Moisture Damage to Mix (Modified Lottman) (0.1%) (KT-56) | 1 on first lot, then 1 per week or 10,000 tons (Mg) (note i) | 1 per project performed at the District Laboratory | Witness - 1 per year per certified technician. |
| Sand Equivalent (1%) (KT-55) | 1 per lot (note b) | 1 per project | Witness and test split sample - 1 per year per certified technician. |

| TESTS REQUIRED (Record To) | QUALITY CONTROL BY CONTRACTOR | VERIFICATION BY KDOT | INDEPENDENT ASSURANCE BY KDOT |
|---|---|---|---|
| Coarse Aggregate sample - Angularity (0.1% of mass) (KT-31) | 1 per lot of combined aggregate (note c & d) | 1 per week or per 10,000 tons (Mg) | Witness and test split sample - 1 per year per certified technician. |
| Uncompacted Voids Content of Fine Aggregates (0.01%) (KT-50) | 1 on the first lot, then 1 per 10,000 tons (Mg) of combined aggregates | 1 per project | Witness and test split sample - 1 per year per certified technician |
| | 1 on the first lot, then 1 per 10,000 tons (Mg) of crushed gravel (note j) | 1 per project | Witness and test split sample - 1 per year per certified technician |
| Gradation of individual aggregate (1%, 0.1% for No. 200 [75 µm], of mass) (KT-2) | 1 per 1,000 tons (Mg) of each individual aggregate (note d) | 1 per project per individual aggregate | Witness and test split sample - 1 per year per certified technician |
| % Moisture in Mixture (0.1 g or 0.01% of mass) (KT-11) | 1 per lot | 1 per project | (note e) |
| % Moisture in Combined Virgin Aggregate (0.1 g or 0.01% of mass) (KT-11) | 1 per lot | 1 per project | (note e) |
| % Moisture in RAP (0.1 g or 0.01% of mass) (KT-11) | 1 per lot | 1 per project | (note e) |
| P I of Mineral Filler (0.01 g or 0.01% of mass) (KT-10) & Gradation of Mineral Filler (1%, 0.1% for No. 200 [75 µm], of mass) (KT-2) | 1 per 250 tons (Mg) (note d) | 1 per project | Witness and test split sample - 1 per year per certified technician |
| Field Density Tests Cores or Nuclear Density Gauge (Gmb = 0.001; 0.1 lbs./ft.³ (1 kg/m$^3$) or 0.01% of optimum density) (KT-15 Procedure III or KT-32) | 10 tests per lot (note f) | 5 companion tests per lot (note f) | Witness and replicate test - 1 per year per certified technician. |

| TESTS REQUIRED (Record To) | QUALITY CONTROL BY CONTRACTOR | VERIFICATION BY KDOT | INDEPENDENT ASSURANCE BY KDOT |
|---|---|---|---|
| Flat and Elongated Particles (1%)(KT-59) | 1 on first lot | 1 per project | Witness and test split sample - 1 per year per certified technician. |

**General note:** All sampling and testing frequencies are minimum. Additional quality control, verification and assurance tests will be performed, when necessary, to provide effective control of the work. When any quality control test result fails to comply with the specification requirements then the next sublot of production after obtaining the failing test results will be sampled and tested, regardless of any lesser frequency specified in **APPENDIX A**.

**Note a:** Specification compliance will be determined on a producer basis, not on a project basis. Producer and product testing frequency is maintained in CMS. Generally, the sampling frequency will start with 1 sample in 3 loads, then be reduced to 1 sample per 6 loads and then per 12 loads if test results determined by the Department show satisfactory compliance of the material with the specifications. Samples will be tested by KDOT at the Materials and Research Center.

**Note b:** Determine the Sand Equivalent (SE) value on the combined virgin aggregates on the first lot of production and the frequency may be reduced to 1 test per week provided the SE value exceeds the minimum specified value by 5 percentage points. The frequency may be reduced to 1 test per 2 weeks provided the SE value exceeds the minimum specified value by 25 percentage points. When any test (including verification and assurance) shows the SE value to be less that 5 percentage points above the specified minimum value then the testing frequency will revert to 1 per lot until 2 consecutive tests exceed the minimum specified value by 5 percentage points.

**Note c:** All aggregate types except siliceous gravels and steel slag will be considered to have at least 2 crushed faces on 100 percent of the aggregate particles. For mixes containing crushed or uncrushed siliceous gravels or steel slag, determine the Coarse Aggregate Angularity (CAA) value of the combined virgin aggregate of the first lot of production. After 3 consecutive passing tests, the frequency may be reduced to 1 per 3 lots or 1 per week. If any of the quality control or verification test fail, the frequency will revert to 1 per lot until the above criteria for reduced frequency is met.

**Note d:** The aggregate producers tests may be used for quality control purposes if the tests were performed by an appropriately certified technician. In such cases, the Contractor shall perform testing as necessary to determine the degrading effects of hauling and stockpiling on the individual aggregates. If during the determination of individual aggregate gradation, soft or friable particles, shale or shale like materials or sticks are found then perform KT-7, KT-8, and KT-35 respectively at such frequencies as jointly deemed necessary by the Contractor and the District Materials Engineer.

**Note e:** Witness 1 KT-11 and KT-16 test procedure per certified technician per year, regardless of the type of material being tested.

**Note f:** For small lots (lots with less than 1 000 ton (megagram)), the number of tests may be reduced (see this **Special Provision**).

**Note g:** Provide access to Contractor owned forced air ignition furnace, oven, and Superpave Gyratory compactor for the State inspector to perform verification tests.
**Note h:** If more than 1 test is performed on the sample, use the average value.
**Note i:** The first Modified Lottman test will cover the first week or 10,000 tons (megagram) of production.
**Note j:** This testing of crushed gravel is only needed to confirm that less than 35% natural sand is used in the traveled way mixes. If 95% or more of crushed gravel is retained on the No. 8 (2.36 mm) sieve, it will not normally be necessary to determine uncompacted voids on that material unless required by the Engineer. This crushed gravel will be considered to have a "U" value of greater than 42.00.
**Note k:** Comparison testing for the pre-production samples, treatment of lot 1, and additional lots are as listed below:

**a. Pre-production Testing.**

(1) The pre-production sample (test section sample) will be obtained by the Contractor and be split 4 ways. The Contractor will retain and test ½ of the sample (enough for 2 sets of tests); the Contractor will supply ¼ of the sample to the KDOT Field Laboratory for testing; and the last ¼ for the KDOT District Materials Laboratory for testing.

(1)(a). Each sample set consists of enough material for 2 Superpave gyratory specimens, $G_{mm}$, and ignition burnoff. Compact 1 sample set immediately while still hot (additional heating may be required to raise the temperature of the sample to compaction temperature). Determine $G_{mm}$ and perform ignition burnoff and complete calculations.

Allow the second sample to cool to ambient air temperature, and test after 8 a.m. the next working day. Record date and time cooling begins and provide this to the District Materials Laboratory. Then reheat to compaction temperature and mold 2 superpave gyratory specimens, determine $G_{mm}$, perform ignition burnoff, and complete calculations.

Provide the KDOT Field Representative with the 3$^{rd}$ sample where percent air voids, VMA, and ignition oven results will be determined. Provide the 4$^{th}$ sample to the KDOT Field or District Materials Representative. KDOT will provide this sample to the KDOT District Materials Laboratory. Allow the 4$^{th}$ sample to cool to ambient air temperature and then be transported to the District Materials Laboratory where percent air voids, VMA, and ignition oven results will be determined. (If the project sample is collected, transported while hot to the KDOT District Materials Laboratory, and compacted in less than 2 hours, then, at the District Materials Engineer's discretion, the requirement to cool the sample may be waived.) The results of the testing will be compared.

(2) The Contractor and KDOT, working together, will resolve any differences in the test results.

(3) If results are not acceptable to either party (Contractor or KDOT), repeat the above steps (1) and (1)(a) for the Contractor's Field Laboratory, KDOT's Field Laboratory, and KDOT's District Laboratory until the issues can be resolved satisfactorily by all parties. The cold sample required under pre-production need not be ran by the Contractor (3-way split only) for additional split comparisons unless specified by the Engineer.

**b. Lot 1 Testing.** For the first lot of mix production on the project, the following procedure will be used:

(1) KDOT field personnel will determine the random truck load quantity for the Contractor for sublots A, B, C, and D, and the KDOT verification test. The random spots to sample from behind the paving operations before compaction (Kansas Test Method KT-25) will be provided by KDOT. The identity of the truckload to be sampled will not be supplied to the Contractor ahead of time. After the aggregate has left the cold feeds, and before the truck is finished loading, the Contractor's laboratory will be notified of which truck to sample. Also, the Contractor will be notified if the sample is to be a split sample with KDOT. KDOT will determine if the split sample will be taken from sublot A or B. If the results do not compare favorably, additional split samples will be taken in Lot 1 sublots C and D, if time allows. If the sample is to be a split sample, the Contractor will obtain a sample large enough to split 3 ways for testing. The Contractor will retain and test ⅓ of the sample; the Contractor will supply ⅓ of the sample to the KDOT field laboratory for testing; and the Contractor will retain (or supply) ⅓ of the sample for the KDOT District Materials Laboratory.

(2) If the Contractor's and the KDOT field laboratory's test results compare favorably, the Contractor's test results will be used for quality control, and the KDOT field laboratory's results will be used for "information only." The District Materials Laboratory has the option to test their ⅓ of the sample at this point.

(3) If the Contractor's and the KDOT field laboratory's test results do not compare favorably, the District Materials Laboratory will test their ⅓ of the sample. KDOT and the Contractor, working together, will investigate the differences in test results and take appropriate action. KDOT field laboratory test results and District Materials Laboratory test results will be reported as "information only" samples.

(4) The verification sample will be sampled and tested by KDOT field personnel. The verification sample must be randomly taken within the lot and can not be the same truck load as picked for the Contractor's sublot A, B, C, or D.

**c. Lots ≥ 2 Testing.** The Contractor or the Engineer (see **subsection 2.0.d.(1)** of this **Special Provision**) will determine the location of quality control samples. If the Contractor and the Engineer agree, the procedures shown for sampling, testing, and evaluation of Lot 1 can be used for any other Lot produced on the project.