**SECTION 04030 – HOT MIX ASPHALT PAVEMENTS**

## DESCRIPTION

The work under this item shall consist of furnishing hot mix asphalt (HMA) composed of mineral aggregate and asphalt binder, mixed in a central mixing plant and placed on a prepared course in accordance with the Standard Specification Sections 4.06 Revised January 1, 2011 and M.04 Revised October 1, 2012, or as amended herein.

Each course shall be constructed to the depth, typical section, or elevation required by the contract and/or plans and shall be rolled, finished, and approved before the placement of the next course.

## QUALITY CONTROL

Refer to Standard Section 04.06.03-9 "Contractor Quality Control of HMA Pavement" except as amended herein.

The Contractor assumes the responsibility of the quality for all materials and construction incorporated into the work and will control all the processes leading to the final result through this function. Quality Control activities should include:

Maintain a Contractor Quality Control System;

Quality Control Plan when the total project tonnage is 5000 tons or more;

Proficiency testing prior to production with Engineer;

Inspection and Testing of Hot Mix Asphalt Production;

Inspection and Testing of Hot Mix Asphalt Placement.

## QUALITY ACCEPTANCE

The City of Meriden, or their authorized agent, will perform the Quality Acceptance function for this work. All material will be considered for acceptance through a sampling and testing program performed by the Engineer or their agent. Quality Acceptance activities include:

Proficiency testing prior to production with Contractor;

Inspection of HMA Production Plant and Testing Laboratory;

Production Trials of HMA Products Intended For Use in Meriden;

Inspection/Testing for Acceptance of Hot Mix Asphalt Production;

Inspection/Testing for Acceptance of Hot Mix Asphalt Placement;

HMA Quality Acceptance Daily Report of Activities;

# MATERIALS

## Aggregate

Refer to Standard Section M.04.01 and as noted herein.

Aggregate shall consist of crushed stone, or crushed gravel, with or without sand or other inert finely divided mineral aggregate. The portion of the materials retained on the #4 sieve (4.75mm) shall be known as coarse aggregate, the portion passing the #4 sieve (4.75mm) and being retained by the #200 sieve (0.075mm) as fine aggregate, and the portion passing the #200 sieve (0.075mm) as mineral filler when tested in accordance with AASHTO T27 and AASHTO T11.

## Coarse Aggregate

Refer to Standard Section M.04.01-1.

## Fine Aggregate

Refer to Standard Section M.04.01-2 except that Marshall Mixtures shall have the combined aggregate structure conforming to TABLE M.04.02-3 "Superpave Master Range for Consensus Properties of Combined Aggregate Structures" Traffic Level 2, not Level 1 as indicated.

## Mineral Filler

Refer to Standard Section M.04.01-3

## Recycled Asphalt Pavement (RAP)

Refer to Standard Sections M.04.01-5 and M.04.02-3(a) except as amended herein.

Standard Section M.04.02-1(d) Marshall Mixtures with RAP shall be deleted.

The laboratory RAP-virgin binder blend viscosity value established from the RTFO residue at 140°F (60°C) shall establish the maximum viscosity allowed for the binder after discharge from the HMA plant and/or silo storage, if applicable, when recovered by AASHTO T170 and tested in accordance with AASHTO T202 and AASHTO TP48.

For design purposes, the specific gravity of the combined aggregate blend with RAP used in a HMA mixture shall be determined in accordance with AASHTO R35.

## Sampling and Testing

All aggregates samples required for testing shall be furnished by the Contractor when requested. AASHTO T2 shall be used in sampling coarse aggregate and fine aggregate, and AASHTO T127 shall be used in sampling mineral filler.

## Asphalt Binder Material

The types, grades, and controlling specifications, the maximum mixing temperatures and compaction temperatures for the asphalt binder materials shall conform to the following:

Refer to Standard Section M.04.01-4 except as amended herein.

The City may specify that a modified binder be used under certain traffic conditions as noted below:

**TABLE 2. SUPERPAVE PGAB Adjustment for Design Traffic Conditions**

| **Traffic Loading** | **Adjustment to PGAB Grade** |
|---|---|
| Standing <12mph (<20 km/h) | Increase high temperature grade by 2 grades (12° C), or 76-XX. Use low temperature grade as determined by LTTP BIND software. |
| Slow Transient 12 to 44mph (20 to 70 km/h) | Increase high temperature grade by 1 grade (6° C), or 70-XX. Use low temperature grade as determined by LTTP BIND software. |
| **Traffic Level (ESALs)** | **Adjustment to PGAB Grade** |
| $1 \times 10^7$ to $3 \times 10^7$ | Consideration should be given to increasing high temperature grade by 1 grade (6° C), or 70-XX. Use low temperature grade as determined by LTPP BIND software |
| $>3 \times 10^7$ | Increase high temperature grade by 1 grade (6° C), or 70-XX. Use low temperature grade as determined by LTTP BIND software. |

**Asphalt Binder Anti-Stripping Additive**

This specification provides for an additive to asphalt to assist in the coating of wet aggregate and to increase the resistance of the binder coating to stripping in the presence of water. The additive shall be chemically inert to asphalt (heat stable) and when blended with asphalt shall withstand storage at a temperature of 400°F (204°C) for extended periods without loss-of effectiveness.

Composition: Anti-stripping compound shall be an organic chemical compound, free from inorganic mineral salts or inorganic mineral soaps. It shall contain no ingredient harmful to the binder material or to the operator, and shall not appreciably alter the specified characteristics of the binder material.

Anti-stripping additive shall be incorporated and thoroughly dispersed in the asphalt binder material in an amount equal to the percent by weight established by the job mix formula. This percent is based on the efficiency of the additive as determined by laboratory tests.

The treated composite mixture shall have a minimum tensile strength ratio (TSR) of not less than 80, when tested in accordance with AASHTO T283 with the freeze/thaw cycle. The specimens for the AASHTO procedure shall be 4" (100mm) in diameter, compacted with the Marshall hammer or 6" diameter molds by the Superpave gyratory compactor to the desired air void level of 7.0 $\pm$ .5%.

If the TSR ratio is less than 80, the aggregates shall be treated with an approved antistrip in sufficient quantity to produce acceptable results. The hot mix asphalt materials and asphalt binder material that

require antistrip additives (either liquid or mineral) shall continue to meet all requirements specified herein for binder and HMA. The anti-strip agent shall be included in the bid price.

The contractor shall submit the results of the TSR testing prior to production as part of the JMF submittal.

## COMPOSITION OF HMA MIXTURES

### Hot Mix Asphalt

HMA plant mix may be composed of a homogeneous mixture of aggregate, filler if required, bitumen, and/or additives, combined to meet the composition limits by weight and other characteristics as specified. The several aggregate fractions shall be sized, uniformly graded and combined in such proportions that the resulting mixture meets the grading requirements of these specifications.

### Hot Mix Asphalt Mix Design

Delete Standard Sections M.04.02-1 and M.04.02-2 Marshall Method and Cold Patch Method and refer to Standard Section M.04.02-3.

The Contractor shall submit the JMF to the City on the latest forms provided by ConnDOT along with all certifications required by this specification.

### JOB MIX FORMULA (JMF)

Work shall not begin nor shall any mixture be accepted until the Engineer has reviewed and approved a job mix formula (JMF) submitted by the Contractor for each mixture.

The Engineer may approve the JMF if the production plant's current Mix Status report provided by ConnDOT, as outlined in the Standard Section M.04.02-3(c), is "A" Approved.

Delete M.04.02-3(c) "Ratings are defined as:" PPT (Pre-Production Trial) and U (No Acceptable Mix Design on File)

### JMF Tolerances

The job mix formula, operating with the allowable action limits for individual measurements as specified in Table 10 herein, shall be set within the design master limits specified for each mixture, as per TABLE M.04.02-2 of the Standard Specifications except that the Engineer may modify the design limits if they determine this to be necessary and in the best interest of the Engineer.

## EQUIPMENT

### Hot Mix Asphalt Mixing Plant

Refer to Standard Sections M.04.01-8 and as noted herein.

### Hauling Equipment

Refer to Standard Section 4.06.03-2.

### Pavers, Rollers, Lighting and Material Transfer Vehicle

Refer to Standard Section 4.06.03-3.

## HMA CONSTRUCTION

Refer to Standard Section 4.06.03 except as noted herein.

### Weather Limitations

Refer to Standard Section 4.06.04 and as noted herein.

The hot mix asphalt shall not be placed when weather conditions of fog or rain prevail or when the pavement surface or base shows signs of free moisture (film of water).

The Engineer will not permit work to continue when overtaken by sudden storms until the pavement surface shows no signs of free moisture. The material in transit at the time of shutdown will not be placed until the pavement surface shows no signs of free moisture, provided the mixture is within temperature limits as specified.

### Tack Coat

Refer to Standard Section 4.06.03-7 except as amended herein.

Contact surfaces of manholes, structures, longitudinal joints, vertical pavement edges, etc. shall be painted with a thin, uniform tack coat just before the material is placed against them.

All surfaces in contact with the HMA that have been in place over night shall have an application of tack coat.

Paving courses will be evaluated for bond after 15 days have elapsed since the date of placement. Two (2) core samples shall be randomly taken by the Engineer using a 6 inch diameter wet-core bit specifically designed for cutting pavement. These cores may also be used for density gauge correlation, density verification, thickness determinations, and for density adjustment at the option of the Engineer.

If it is determined that there is poor or no bond between paving layers then the Engineer may require that an increase in tack coat be applied.

### HMA Production

The aggregates and the asphalt binder material shall be weighed or metered and introduced into the mixer in the amount specified by the JMF and within the allowable action limits as stated in Table 10 HMA PRODUCTION LIMITS. These limits shall be applied to the target values established in the JMF. Corrective action shall be taken by the Contractor when the calculated individual result for gradation or asphalt content falls outside the target JMF value beyond the action limits listed in Table 10. The Contractor shall take the appropriate action when results indicate the material is out of tolerance. The Contractor shall be required to suspend production when the calculated individual results fall outside the target JMF values beyond the limits allowed in the CORRECTIVE ACTION section of the specification.

**Plant Trials**

If production is suspended, the Contractor shall be required to produce material on a trial basis for testing purposes without shipment to the project. No payment will be made for material and labor employed for nonconforming plant trials. The Contractor shall pay for any acceptance sampling and testing for the trials necessary to determine conformance with the specification requirements during production suspension. When trials have been approved, the plant will return to its normal operation.

Failure to stop production and make adjustments when required due to an individual test not meeting the specified requirements shall subject all mix from the stop point to the point when the next individual test is back on or within the action limits, or to the point when production is actually stopped, whichever occurs first, to be considered unacceptable. This material shall be removed and replaced with materials that comply with the specifications at the Contractor's expense. Any sampling, testing, or evaluation services required during the Contractor's failure to stop production shall be paid for by the Contractor.

**Placing and Finishing**

Refer to Standard Section 4.06.03-6 and 4.06.03-7 and as noted herein.

No traffic of any kind shall be permitted on binder or base when dirt or any other foreign substance may be tracked thereon.

**Suspension Control Test Section**

Refer to Standard Section 4.06.03-5 except as amended herein.

If it is determined by the Engineer during the performance of the contract, that the Marshall or Superpave pavement does not conform to the specifications, tolerance, density and/or uniformity requirements, the Engineer may order the Contractor to cease all operations and construct an HMA SUSPENSION CONTROL TEST SECTION.

The amount of mixture should be sufficient, at a minimum, to construct a test section 300 feet long and 20 to 30 feet wide placed in two lanes, with a longitudinal joint, and shall be of the same depth specified for the construction of the course which it represents. A control section may be required each time a change is made in the Job Mix Formula, sources of supply or paving and rolling equipment. A suspension control test section will be required when either of the following conditions exist:

1. Two consecutive streets or two consecutive 1,000 ton lots of material tested for mat density or longitudinal joint density falls below the minimum threshold density for 100% adjustment, as noted in Table 11 and Table 12.

2. When the average of the last five streets or five 1,000 ton lots of material tested for mat density or longitudinal joint density falls below the threshold density for 100% adjustment, as noted in Table 11 and Table 12.

The mixture shall be prepared, placed, and compacted in accordance with this specification. When the control section pavement has cooled sufficiently, a total of six (6) samples of the finished pavement including three (3) samples from the longitudinal joint, shall be taken and tested for conformance to density requirements.

If the suspension control section tests conducted by the Engineer, and paid for by the Contractor, indicate that pavement does not conform to specification requirements, necessary adjustment to plant operation and placement/rolling procedures shall be made and another control section constructed.

The Contractor shall not be permitted to re-core a control section or place HMA courses until a control section is approved by the Engineer.

**Transverse Joints**

Refer to Standard Section 4.06.03-7.

**Longitudinal Joints**

Refer to Standard Section 4.06.03-8 and as noted herein.

Method III – Butt Joint with Hot Poured Rubberized Asphalt Treatment will be at the contractor's expense.

For Methods II and III, the top of the longitudinal joint in one course shall offset the top of the longitudinal joint in the course immediately below by at least 1 foot, however, the joint in the top layer shall be at the centerline for two lane roadways. Longitudinal paving joints shall not fall within the travel lanes but be located on the solid, skip, or edge lines established for that roadway. Longitudinal joint(s) of the top layer shall be marked prior to paving so as to create a neat, straight line at the lane breaks where necessary. First paver pass shall use the marked joint as the guide to develop the longitudinal joint of the top layer; using the curb edge or edge of pavement as a guide is unacceptable. The goal is to end up with a true straight longitudinal joint at centerline or at lane breaks. The Contractor shall inform the Engineer of the proposed paving joint locations for the entire pavement structure prior to placing the first intermediate course.

**Compaction of HMA Mixture after Placing**

Refer to Standard Section 4.06.03-7 and as amended herein.

The speed of the roller shall, at all times, be sufficiently slow and of uniform speed to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once.

Pneumatic rollers may be used in the intermediate mode.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers and vibratory plate compactors.

Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed.

**Shaping Edges**

While the surface is being compacted and finished, the Contractor shall carefully trim the outside edges of the pavement to the proper alignment. Edges so formed shall be beveled while still hot with the back of a lute or smoothing iron and thoroughly compacted by tampers or by other satisfactory methods.

**Surface Smoothness**

Refer to Standard Section 4.06.03-7.

**Corrective Work**

Refer to Standard Section 4.06.03-13 and as noted herein.

The corrective method(s) chosen by the Contractor shall be approved for use by the Engineer and shall be performed at the Contractor's expense, including all necessary equipment and traffic control. Areas of removal and replacement shall be removed the full width of the lane. The removal areas shall begin and end with a transverse butt joint which shall be constructed with a transverse saw cut perpendicular to the centerline. Replacement materials shall be paver placed in sufficient quantity so the finished surface will conform to grade, smoothness and cross-section requirements.

The Engineer shall retest any sections where corrections were made to verify that the corrections produced a surface that conforms to the grade and smoothness requirements.

**Uniformity**

Refer to Standard Section 4.06.03-7 and as amended herein.

The Contractor shall review all potential causes of segregation as it relates to its operation, including but not limited to HMA plant production and storage, loading and transportation, paver/equipment, placement and/or handwork. The Contractor shall employ additional investigation methods and make the necessary changes in their operation such that segregation is eliminated and mat uniformity is acceptable.

At the Engineer's discretion, the Engineer shall obtain two (2) six inch diameter cores from the identified (segregated) area and two (2) six inch diameter cores from the non-segregated area. The cores may be evaluated for resilient modulus, dry tensile strength, change in air voids, maximum in place air voids, aggregate gradation and binder content. The results of the data obtained on the cores from the segregated area will be compared to the results of tests performed on the cores from the non-segregated area.

If any mix property is beyond the tolerance limits stated in the table below, that area shall be considered segregated and shall be repaired by the Contractor.

**SEGREGATION LIMITS**

| Change in Mix Properties Expressed as a Percentage of the Properties in the Non-Segregated Areas | |
|---|---|
| **Property** | **Limits** |
| Resilient Modulus, psi @ 77$^{o}$F | <80% |
| Dry Tensile Strength, psi @ 77$^{o}$F | <90% |
| Aggregate Gradation and Binder Content | Refer to Table 10 (Action Limits) |
| Change in Air Voids | >2.5% |

The samples for the segregation analysis will be considered separately from the mat and joint cores tested for acceptance.

Segregated areas not meeting the requirements stated above or areas having more than 11% air voids shall be removed and replaced for the entire pavement thickness and lane width, and be paver-machine placed, or as directed by the Engineer. All corrective methods shall be performed at the Contractor's expense. The removal areas shall begin and end with a transverse butt joint which shall be constructed with a transverse saw cut perpendicular to the centerline. The corrective area shall conform to all grades, smoothness, material, and density specification requirements. The Engineer may retest any areas where corrections were made to verify that the material meets specification requirements.

### Thickness

Refer to Standard Section 4.06.03-7 and 4.06.04-2 and as noted herein.

The thickness requirements contained herein shall apply only when each pavement layer is specified to be a uniform compacted thickness of 1 inch (25mm) or greater. Measurements of thickness for acceptance shall be made by the Engineer using six-inch minimum diameter pavement cores (removed also for subsequent density measurement), and then verified according to Section 4.06.04-2.

## CONTRACTOR QUALITY CONTROL OF HMA PAVEMENT

Standard Section 4.06.03-9 is deleted and replaced as amended herein.

### General

The Contractor is encouraged to establish, provide, and maintain a Quality Control System (QCS) that will detail the methods and procedures that will be taken to assure that all materials and completed construction conform to project specifications, plans, technical specifications and other requirements, whether manufactured or processed by the Contractor or procured from subcontractors or vendors.

If the project data during production indicates a problem and the Contractor is not taking satisfactory corrective action as is their responsibility under quality control, then the Engineer may suspend production or acceptance of the material, in accordance with these specifications.

**TABLE 10 HMA Production Limits for Individual Measurements**

| Sieve Size | Action | Suspension |
|---|---|---|
| 1-1/2" (37.5mm) | 0% | 0% |
| 1" (25.0 mm) | ±6% | ±9% |
| 3/4" (19.0 mm) | ±6% | ±9% |
| 1/2" (12.5 mm) | ±6% | ±9% |
| 3/8" (9.5 mm) | ±6% | ±9% |
| #4 (4.75 mm) | ±6% | ±9% |
| #8 (2.36 mm) | ±5% | ±7.5% |
| #16 (1.18 mm) | ±5% | ±7.5% |
| #30 (0.600 mm) | ±4% | ±5.5% |
| #50 (0.300 mm) | ±3% | ±4.5% |
| #100 (0.150 mm) | ±3% | ±4.5% |
| #200 (0.075 mm) | ±2% | ±3% |
| Asphalt Binder Content | ±0.4% | ±0.70% |
| Design Air Voids (4.0%) | ±1.0% | ±1.7% |

When evaluating the production limits, the sieve sizes above the maximum size aggregate should be deleted from the Individual Measurements Chart and the maximum aggregate sieve size Action and Suspension Limits should be changed to 0%.

## CORRECTIVE ACTION

The Contractor's Quality Control system shall include an appropriate action to be taken when the process is believed to be out of tolerance. The Contractor should review the control charts on a continuous basis making adjustments to the process when necessary to keep the product consistent.

As a minimum, a process shall be deemed out of control and production stopped and corrective action taken, if:

One point falls outside the Suspension Limit line for individual measurements; or

Design Air Voids falls outside the Suspension Limit line for its individual measurement or range as indicated in Table 10; or

Design Air Voids and two or more points fall outside the Action Limit line for individual measurements as indicated in Table 10; or

Design Air Voids fall outside the Action Limit and one point falls outside the Suspension Limit for individual measurements or range as indicated in Table 10; or

Three points in a row fall outside the Action Limit line for individual measurements as indicated in Table 10.

Three nonconsecutive samples out of five samples fall outside the Action Limit line for individual measurements as indicated in Table 10.

The dust to effective binder ratio on two consecutive samples fall outside the Control Point limits for individual measurements as indicated in Table 6.

Dust to effective binder ratio of three (3) nonconsecutive samples out of five (5) samples fall outside the Control Point limits for individual measurements as indicated in Table 6.

Two consecutive streets or two consecutive 1,000 ton lots of material tested for mat density or longitudinal joint density falls below the threshold density for 100% adjustment, as noted in Table 11 and Table 12.

The average of the last five streets or five 1,000 ton lots of material tested for mat density or longitudinal joint density falls below the threshold density for 100% adjustment, as noted in Table 12 and Table 13.

Acceptance testing requirements are the responsibility of the Engineer.

## QUALITY ACCEPTANCE OF HMA

Standard Section M.04.03-1 and M.04.03-2 are deleted and replaced as amended herein.

All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the Engineer at no cost to the Contractor, unless otherwise stated herein. Testing organizations performing these tests shall meet the requirements of ASTM D 3666. All equipment in Contractor furnished laboratories shall be calibrated and verified by a testing organization prior to the start of operations. Such verification/certification shall be furnished to the Engineer prior to production. Engineer's testing personnel shall be certified by the Northeast Transportation Training and Certification Program (NETTCP). This function does not relieve the Contractor from performing their daily quality control tasks as part of their normal operating business.

The Engineer or their agent shall have access at any time to all parts of the producing plant for:

Inspection of the condition and operations of the yard, plant and laboratory.

Confirmation of the adequacy of equipment in use.

Verification of the character and proportions of the mixture.

Determination of temperatures being maintained in the preparation of the mixtures.

Inspection of incidental related procedures.

Samples of all material including compacted specimens and certified copies of all reports and printouts shall be made available to the Engineer or its agent as often as requested including: asphalt binder; recycling agents; virgin aggregates; reclaimed pavement materials; modifiers, loose and compacted mixture specimens; and combined aggregate samples.

### Plant-Produced Material

Plant-produced material shall be sampled and tested for VMA, gradation, asphalt binder content, and air voids (Marshall or Superpave) at $N_{design}$ (Superpave only) on a lot basis. The Engineer's testing personnel shall be certified by the Northeast Transportation Training and Certification Program

(NETTCP), as HMA Plant Technicians. Sampling shall be from material deposited into trucks at the plant or from trucks at the job site. A lot will consist of:

- one day's production

Where more than one plant is simultaneously producing material for, the job, the lot sizes shall apply separately for each plant.

**Sampling**

Each lot will be divided into 300 ton sublots. Sufficient material for analysis and preparation of test specimens will be sampled by the Engineer on a random basis, in accordance with the procedures contained in ASTM D 3665. One set of laboratory compacted specimens will be prepared for each sublot in accordance with AASHTO T312, at the number of gyrations at $N_{design}$ required by Table 5 herein for Superpave, or in accordance with AASHTO T245, at the number of blows required by Table M.04.02-1. Each set of laboratory compacted specimens will consist of two test portions prepared from the same field sample, with the volumetric analysis based on the average of the two specimens and a minimum of one theoretical maximum specific gravity sample.

The sample of hot mix asphalt may be put in a covered metal tin and placed in an oven for not more than 30 minutes to regulate or adjust the temperature. The compaction temperature of the specimens should be as specified in the JMF.

In addition to the hot mix asphalt samples, the Contractor shall take one, one-quart sample of the PG binder used to produce the hot mix asphalt at the start of the work. The PG sample shall be turned over to the Engineer on the first day of project production.

**Testing**

Bulk Specific Gravity - Sample specimens shall be tested for bulk specific gravity in accordance with AASHTO T166 or T275, whichever is applicable, for use in computing air voids and density. Air voids will be determined in accordance with AASHTO T269.

Stability and Flow (Marshall specimens) – Sample specimens shall be tested for stability and flow in accordance with AASHTO T245, paragraph 4.

Gradation and Asphalt Binder Content - The gradation and asphalt binder content of the mixture shall be measured for each sublot in accordance with the following:

> Asphalt Binder Content - Extraction tests shall be performed once per sublot in accordance with AASHTO T164 or AASHTO T308 for determination of asphalt content. The weight of ash portion of the extraction test, as described in AASHTO T164, shall be determined as part of the first extraction test performed at the beginning of plant production; and as part of every twentieth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture. If utilizing AASHTO T308 for asphalt content determination, the calibration process and calibration factor, as described in AASHTO T308, shall be determined as stated, prior to acceptance testing. A verification shall be performed as part of every twentieth test performed thereafter or when changes in the mix are apparent.

Gradation - Aggregate gradations shall be determined once for each sublot from mechanical analysis of extracted aggregate in accordance with AASHTO T30 and AASHTO T27 (Dry Sieve).

The Dust-to-Effective Asphalt ratio shall be determined once for each sublot from the mechanical analysis of extracted aggregate and the effective asphalt binder content. The Dust-to-Effective Asphalt ratio shall be determined by the Engineer in accordance with AASHTO R35.

HMA mixtures shall contain a dust to effective asphalt ratio by mass between 0.6 and 1.2 utilizing AASHTO T30 and a washed sieve, the #4 mixture shall have a dust to effective asphalt ratio between 0.9 and 2.0, utilizing AASHTO T30 and a washed sieve. If the gradation of the mixture passes beneath the Primary Control Sieve (PCS), the Engineer may increase the dust to effective asphalt from 0.6 – 1.2 to 0.8 – 1.6, utilizing AASHTO T30 and a washed sieve.

When tested in accordance with AASHTO T30 utilizing a dry sieve analysis the dust to effective asphalt ratio shall be 0.3 to 0.9, the #4 mixture shall have a dust to effective asphalt ratio between 0.6 to 1.2. If the gradation of the mixture passes beneath the PCS the Engineer may increase the dust to effective asphalt ratio from 0.3 –0.9 to 0.5-1.3, the #4 mixture may be increased from 0.6-1.2 to 0.8-1.6 based on a dry gradation. The Primary Control Sieve (PCS) shall be as determined in accordance with AASHTO M323 for both the Marshall mixes and Superpave mixes.

The Theoretical Maximum Specific Gravity of the mixture shall be measured for each sublot in accordance with AASHTO T209, Type C, D, or E container. Samples shall be taken on a random basis in accordance with ASTM D 3665. The value used in the field placed density computations shall be the average of the most recent maximum specific gravity lot measurements.

Temperatures. Temperatures shall be checked, at least three times per lot, at necessary locations to determine the temperatures of the dryer, the asphalt binder in the storage tank, the mixture at the plant, and the mixture at the job site.

Voids in Mineral Aggregate (VMA), for each plant sample, will be determined by the Engineer in accordance with the procedures contained in Chapter 4, VOLUMETRIC PROPERTIES OF COMPACTED PAVING MIXTURES, of the Asphalt Institute's Manual Series No. 6 (MS-2), Mix Design Methods for Asphalt Concrete. The VMA, and air voids for each sublot shall be computed by averaging the results of the two test specimens representing that sublot.

**Acceptance of Plant Produced HMA**

Acceptance of plant produced HMA material will be based upon plant air voids, Marshall stability and flow (if applicable), VMA, gradation, asphalt binder content, dust to effective binder ratio, mix temperature, and shall be determined by the Engineer in accordance with these specifications.

**Field Placed HMA Material**

HMA material placed in the field shall be tested for mat and longitudinal joint density on a completed street or public facility basis. The Engineer's testing personnel shall be certified by the Northeast Transportation Training and Certification Program (NETTCP), as HMA Paving Technicians or HMA Plant Technicians. The Engineer may conduct any necessary testing to monitor the specified density, uniformity and smoothness. A properly correlated density gauge may be used to monitor the pavement density in accordance with ASTM D2950 or ASTM 7113 and these specifications. Monitoring density

with density gauges by the Engineer does not imply acceptance or rejection; the Contractor is ultimately responsible to meet the requirements of the specification.

**Sampling for Density Adjustment**

Density gauges may be used by the Engineer to determine density of the surface course mat and/or surface course longitudinal joints in accordance with the correlation procedures outlined in this specification. Cores of surface course material shall be minimized and only taken at the direction of the Engineer and approval of the City.

Mat and longitudinal joint acceptance density tests will be located by the Engineer on a stratified random sampling basis for each street or facility paved within three days of construction. The length of the longitudinal paving joint will be divided into sub-lots for sampling and testing purposes. If more than one longitudinal joint is formed on a street, then the random sample length will be the total lineal feet of longitudinal joint placed. A mat and longitudinal joint test will be taken by the Engineer randomly from each of these sub-lot intervals. Sub-lots will be determined on the basis of five (5) sub-lots per one thousand (1,000) tons of material placed or a minimum of five (5) sub-lots from each street or facility paved. Sampling and testing for density will be conducted in the following manner:

Intermediate paving courses will be tested with the density gauge (for correlation), then sampled by coring the mat and the longitudinal joint using a 6 inch diameter wet-core bit specifically designed for cutting pavement. The cores will be tested for density and thickness.

Surface courses will be tested for density with a density gauge that has been correlated as described in this section.

When sampling of the longitudinal joint for density determinations by coring, the center of the core will be taken on the hot side of the joint and 6-inches from the top of the wedge joint, or directly over the vertical edge of an existing longitudinal joint.

A core sample for intermediate course density and a density sample for surface course density will be tested from each sub-lot segment. The total width of the paved surface (curb to curb) will be determined at the longitudinal sub-lot location to sample and test for mat density. A transverse off-set distance from the centerline of the roadway will be established for mat density sampling and testing. The location, either right or left of centerline, will be based on whether a random number is “odd or even” (odd=left; even=right). When the off-set location is within 2 foot of the pavement edge, curb, catch basin or structure, or 1 foot off a longitudinal joint, or 10 foot off a transverse joint, the sample shall be relocated.

For nuclear gauge test locations, two 60 second increments will be taken with the gauge turned 180 degrees for each reading. The average of the two surface course mat density values will be reported for each location. For non-nuclear density tests, five (5) increments will be used, moving the gauge six inches after each reading in a square pattern, taking one reading in each corner and one in the center using the manufacturers operating procedures. The average of the five density values will be reported for each location.

If the results of the average density gauge readings for a street or pavement facility are below the threshold for 100% adjustment as indicated in Table 12 and Table 13, pavement cores will be removed as per this specification, and used for determining the actual pavement density.

**In-Place Density Gauge Correlation to Pavement Cores**

This procedure covers the determination of the in-place density of HMA by using an approved density gauge correlated to HMA cores from the project on a periodic basis.
The correlation (bias) value for each density gauge shall be mix, plant and project specific. A bias for a density gauge cannot be carried over from one project to another using the same mix from the same plant. A new correlation may also be required when a different paver is used, the paver screed is repaired or replaced, a mix design change occurs, conditions otherwise change and at the start of the construction season.

a) The location selected for the correlation shall be on the project site on the street but in a location that is safely accessible for the duration of the project (such as a driveway apron area or non-parking pavement toward the curbline).
b) Five gauge (5) readings and three (3) cores will be used to establish the correct bias and correlation. These readings must be taken four (4) feet from an unconfined edge and a minimum of 50 feet beyond the beginning of a paver pass or as directed by the Engineer. No reading shall be taken in the vicinity of a vertical object or other interferences according to manufacturers' instructions.
c) The five gauge readings will be spaced 4 feet apart for a total distance of sixteen feet thereby taking a reading at 0 foot, 4 foot, 8 foot, 12 foot and 16 foot location. The three (3) cores for the correlation will be taken in the same line and offset and location of the density gauge readings specifically at the 0 foot, 8 foot and 16 foot location. The cores must be taken from within the center of each of the density gauge footprints. Ice should be used to minimize any distortion or damage to the cores.
d) Each density gauge shall be operated using the number of test increments and locations of test increments as given under Sampling for Density Adjustment.
e) The gauge readings must be taken parallel to the direction of paving for nuclear density gauges and on the same longitudinal tangent line for any density gauge.
f) The density difference from the high-low reading of the 5 locations must be $\leq$ 1.0 percent of the mean of the determined density or a new location will be selected.
g) Core thicknesses must match the project plans for the street or a new location must be selected.
h) The final core average of percent maximum density from the three cores must be determined and written on the project pavement near the correlation site to serve as a correlation reference site. The core density average must meet specifications or a new location must be established.
i) The density gauge correlation (bias) will be determined as the difference from the known average core density to the known average gauge density value, as determined above.
j) If the density gauge cannot meet the accuracy requirements of less than or equal to 1.0 percent of know density, the gauge must be repaired.
k) The bias must be utilized by the density gauge user and recorded on the daily test reports.

All core samples shall be neatly cut with a core drill and water cooled bit where the cutting edge of the core drill bit shall be of hardened steel or other suitable material with diamond chips embedded in the metal cutting edge. The minimum diameter of the sample shall be 6 inches. Samples that are clearly defective, as a result of sampling, shall be documented and retained, then another sample taken for testing. The Engineer or the Owner's agent shall furnish all tools, labor, and materials for cutting samples and filling the cored pavement. Cored holes shall be filled by the Engineer and within one day after sampling.

Pavement cores will be used to determine the average percent density and thickness of intermediate courses and correlated density gauge readings may be used for density testing of surface courses. The average density will be used to determine the percent payment. Resampling of the pavement shall be in accordance with applicable provisions of the NETTCP Quality Assurance Technologist Manual, latest edition and these specifications.

With the exception of any Control Strips, if the Contractor is concerned about the test results obtained by the Engineer, the Contractor may request up to one time, that an equal number of random core samples be obtained and tested to supplement (not replace) the original core or density gauge samples. The coring, patching and testing of the additional samples will be the responsibility of the Contractor. Cores for the mat and/or longitudinal joint density tests will be located by the Engineer and witnessed by the Contractor. Cores locations will be based on a new stratified random sampling plan for each street or facility paved in accordance with the procedures stated above. Upon approval of the coring operation, the Contractor will notify the Engineer 48 hours in advance of the cores being taken such that the Engineer can witness the sampling. The additional cores must be tested by a certified HMA plant technician or HMA paving technician in the presence of the Engineer or his designated representative.

Only one (1) set of additional mat and/or longitudinal joint cores will be allowed on a street or lot.

**Testing**

The bulk specific gravity of each cored sample will be measured by the Engineer's NETTCP certified technician in accordance with AASHTO T166 or T275, whichever is applicable. The theoretical maximum specific gravity shall be measured once for each HMA sub-lot in accordance with the plant-produced material section. The theoretical value used for the percent density determinations of the random samples shall be the average of the daily sub-lot measurements for maximum specific gravity. When daily sub-lot measurements are not available, the average of the previous five (5) laboratory measurements for that mix, or a representative test sample from the lift cored shall be used. The percent density of each test sample will be determined in accordance with AASHTO T269, using the bulk specific gravity obtained by cores or density gauge readings and the average theoretical maximum specific gravity. Retesting of pavement shall be in accordance with applicable provisions of the NETTCP Quality Assurance Technologist Manual, latest edition and these specifications.

**Adjustment Pay Schedule for Density**

The total HMA Adjustment (%) will be determined as described below based on the density adjustment schedule (Table 12) for Mat and (Table 13) for Longitudinal Joint (LJ). The total HMA Adjustment (%) shall be applied to the bid price per ton for compacted mixtures greater than or equal to 1 1/2 inches (37.5mm) in thickness as shown in the contract award to arrive at the total Asphalt Adjustment Cost based on density. Any incentive adjustments (greater than 100) will first be applied to offset penalty adjustments (less than 100).

Adjustment Pay Schedule for Mat Density - The pay factor based on the density adjustment schedule will be applied to the bid price per ton for compacted mixtures greater than or equal to 1-1/2 inches thickness as shown in the contract award.

**Table 12.**
**HOT MIX ASPHALT MAT DENSITY**
**Adjustment Schedule**

| Average Percent of Maximum Density (minimum 5 samples) | Percent Payment |
|---|---|
| 100.0 - 98.1 | 98 |
| 98.0 - 95.0 | 102 |
| 94.9 - 92.0 | 100 |
| 91.9 – 89.0 | 90 |
| 88.9 – 87.0 | 75 |
| 86.9 or less | rejection |

Adjustment Pay Schedule for Longitudinal Joint Density - The pay factor based on the joint density adjustment schedule will be applied to the bid price per ton for compacted mixtures greater than or equal to 1 1/2 inches thickness as shown in the contract award.

**Table 13.**
**HOT MIX ASPHALT LONGITUDINAL-JOINT DENSITY**
**Adjustment Schedule**

| Average Percent of Maximum Density (minimum 5 samples) | Percent Payment |
|---|---|
| 100.0 - 98.1 | 98 |
| 98.0 - 95.0 | 102 |
| 94.9 - 90.0 | 100 |
| 89.9 - 89.0 | 90 |
| 88.9 - 88.0 | 80 |
| 87.9 - 87.0 | 70 |
| 86.9 or less | 50% or rejection |

The total hot mix asphalt adjustment will be based on the weighted sum as follows:

.60 Mat Adjustment + .40 LJ Adjustment = Total HMA Adjustment

When the construction of the pavement does not include the construction of a longitudinal joint, the payment adjustment will be based on Table 12 only, no weighted sum will be calculated. Any bonus will be credited against any payment adjustment in the contract for HMA, but in no case will the payment for HMA exceed 100%.

**Rejection of Inferior HMA**

The Engineer may at any time, not withstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of hot mix asphalt which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or improper mix temperature. Such rejection may be based on only visual inspection or temperature measurements. Similarly, the Engineer may at any time, not withstanding field acceptance for mat density, reject and require the Contractor to correct any HMA pavement that was placed with unacceptable mat uniformity or paving joints, due to low density, lack of bond, segregation, improper elevation, or tearing. In the event of such rejection, the Contractor and Engineer may take random split samples of the area(s) in question in the presence of the Engineer, and if it can be demonstrated in the laboratory, in the presence of the Engineer, that such material/pavement was erroneously rejected, payment will be made for the material at the contract unit price.

## MEASUREMENT

### Method of Measurement

The quantity of hot mix asphalt to be paid for shall be measured by the number of tons of hot mix asphalt used in the accepted work. The quantity of each truckload shall be obtained from printed tickets indicating the recorded batch weights or certified truck scale weights that have been properly countersigned by an authorized representative of the Engineer at the time of delivery. HMA quantities shall be verified by the Engineer using HMA yield calculations which will include the in-place bulk specific gravity and actual area and nominal depth for the mixture placed.

## PAYMENT

### Basis of Payment

Payment shall be made at the contract unit prices per ton complete in place with any applicable adjustments. This payment shall be full compensation for furnishing and placing all quality hot mix asphalt materials, including tack coat where specified, cutting of keyways or milling/stripping of pavement to produce neat joints, mechanical sweeping of streets, costs for Engineer testing due to inferior production or placement, and for all labor, tools, equipment, materials, and all incidentals necessary to complete the work. The payment for individual pavement lifts will be based on the tolerances identified in Table 4.06-3 of the Standard Specifications. An adjustment to the overall tonnage for the roadway will be made prior to paying for the surface course based on the overall tolerance as identified in the table. The Contractor will not be paid for any quantity over these tolerances.

The cost for tack coat and saw cutting of pavement limits where specified on the plans will be paid for under their respective items in the contract.

### Adjustment for Density

A payment adjustment for density shall be made when the HMA material varies from the specification target limits, but is within the tolerances stated in Section "Adjustment Pay Schedule for Density". The ‘Total HMA Adjustment’ for that street or facility shall be applied to the actual tonnage accepted for that street or facility. Incentives will be applied to offset any penalties. Penalties resulting from the "Adjustment Pay Schedule for Density" shall be incorporated into the "Asphalt Adjustment Cost" (AAC) pay item as follows:

AAC = (Total HMA Adjustment (%) – 100) x Contract Price/Ton x Accepted Tonnage

The "Asphalt Adjustment Cost" will be calculated using the formulas indicated above for the Adjustment for Density. An increase in contract payment will NOT be made for incentive density results, any incentive densities payments will be applied to off-set penalty adjustments. A deduction from monies due the contractor will be made for any penalty densities remaining after deducting for incentive densities.

The sum of money shown on the estimate for Asphalt Adjustment Cost, and in the itemized proposal as "Estimated Cost", for this item will be considered the bid price although payment will be made as described above but in no case will the payment for HMA exceed 100%.

| **PAY ITEM** | **DESCRIPTION** | **PAY UNIT** |
|---|---|---|
| Bid Item ????? | Superpave S0.25 Level 1 | TON |
| Bid Item ????? | Superpave S0.375 Level 1 | TON |
| Bid Item ????? | Superpave S0.5 Level 1 | TON |
| Bid Item ????? | Superpave S1.0 Level 1 | TON |
| Bid Item ????? | Superpave S0.25 Level 2 | TON |
| Bid Item ????? | Superpave S0.375 Level 2 | TON |
| Bid Item ????? | Superpave S0.5 Level 2 | TON |
| Bid Item ????? | Superpave S1.0 Level 2 | TON |
| Bid Item ????? | Superpave S0.25 Level 3 | TON |
| Bid Item ????? | Superpave S0.375 Level 3 | TON |
| Bid Item ????? | Superpave S0.5 Level 3 | TON |
| Bid Item ????? | Superpave S1.0 Level 3 | TON |