

**DIVISION 6**  
**ASPHALT PAVEMENTS**  
**SECTION 600**  
**PRIME COAT**

**600-1 DESCRIPTION.**

Perform the work covered by this section including but not limited to treating an existing non-asphalt base course with asphalt material by furnishing and applying the prime, furnishing and placing granular material to protect the prime, and maintaining the prime coat in accordance with these specifications.

Treat all non-asphalt bases beneath an asphalt surface treatment with a prime coat.

**600-2 MATERIALS.**

Use materials for prime coat application which are on the Department's "Approved Product List for Materials used for Prime Coat Applications" and meet the requirement shown below.

Refer to Division 10:

Prime Coat Materials.....Article 1020-3

These materials must meet the manufacturer's specifications as submitted to and approved by the Department. This list is on file at the Materials and Tests Unit in Raleigh.

Where the grade of prime coat material is not established by the special provisions, the Contractor may select from the approved list the grade to be used. All prime coat materials must be delivered to the project ready for use.

**600-3 WEATHER LIMITATIONS.**

Apply prime coat only when the surface to be treated is sufficiently dry and the atmospheric temperature in the shade away from artificial heat is 40°F (4.4°C) or above for plant mix, and 50°F (10°C) or above for asphalt surface treatment.

Do not apply prime coat on a frozen surface or when the weather is foggy or rainy.

**600-4 BASE PREPARATION.**

Clean the base of objectionable debris, excessive dust, and any other deleterious matter prior to placing the prime coat.

When directed, dampen the surface of the base prior to application of the prime coat.

**600-5 APPLICATION EQUIPMENT.**

Provide, maintain, and operate a pressure distributor that is designed and equipped such that the asphalt material remains at a constant temperature and may be applied uniformly on variable widths of surface at predetermined and controlled rates. Use a distributor equipped with a tachometer or synchronizer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a mounted thermometer for measuring temperature.

Utilize a distributor equipped with a power driven pump of sufficient capacity to distribute the required quantity of asphalt material at constant flow and uniform pressure. Provide a full circulation spray bar adjustable laterally and vertically and adjustable in length to conform to the required width of application without overlapping. Provide and maintain nozzles designed to provide equal and uniform application at all times. Provide a hand spray hose and nozzle to cover areas inaccessible to the spray bars. Equip the distributor with a positive shut-off control for the spray bar and hand hose.

Have the volume of the distributor tank calibrated by a commercial laboratory or the manufacturer prior to use. Provide a calibration chart with an accurately calibrated

measuring stick graduated in increments of not more than 25 gallons (100 liters) on the distributor at all times for use by the Engineer.

**600-6 APPLICATION RATES AND TEMPERATURES.**

Apply the prime coat at a rate from 0.20 to 0.50 gallons per square yard (0.9 to 2.3 liters per square meter). The exact rate for each application will be established by the Engineer prior to application, in accordance with the limits shown in the approved products list referenced in Article 600-2.

The required rate of application of asphalt materials will be based on the volume of material measured at the application temperature. Apply the prime coat material at a temperature that is in accordance with the manufacturer's recommendations or as approved.

**600-7 APPLICATION OF PRIME COAT.**

When the plans require the base course to be constructed with side slopes flatter than 1:1, apply prime to the full width of the base including the side slopes.

Apply the prime coat only when the base to be treated has been approved.

Place a string line to provide alignment control for the distributor during prime coat application unless waived by the Engineer.

Cover bridge floors, curbs, and handrails of structures and all other appurtenances to protect them from tracking or splattering of prime coat.

After the prime coat has penetrated sufficiently and when directed, roll the primed surface until all loose base material is thoroughly bonded.

**600-8 MAINTENANCE AND PROTECTION.**

Allow the prime coat to thoroughly penetrate the base. When directed, apply blotting sand in accordance with the provisions of Section 818.

Maintain the prime coat in an acceptable condition until such time as the pavement is placed. Replace any damaged prime coat at no cost to the Department.

**600-9 METHOD OF MEASUREMENT.**

The quantity of prime coat to be paid for will be the number of gallons (liters) of prime coat material which has been placed on the roadway with the following exception. Each distributor load of prime coat material delivered and utilized on the project will be measured. Deductions will be made from each measured tank of material for all material placed on the roadway which exceeds the application rate established by the Engineer by more than 0.03 gallons per square yard (0.14 liters per square meter).

The quantity of prime will be determined by measuring the material at the actual application temperature and free from air bubbles.

**600-10 BASIS OF PAYMENT.**

The quantity of prime coat, measured as provided in Article 600-9, will be paid for at the contract unit price per gallon (liter) for "Prime Coat".

Blotting sand will be paid for as provided in Article 818-5 for "Blotting Sand".

Payment will be made under:

Prime Coat .....Gallon (liter)

## SECTION 605 ASPHALT TACK COAT

### 605-1 DESCRIPTION.

Apply tack coat material to existing asphalt or concrete surfaces in accordance with these specifications.

Apply tack coat beneath each layer of asphalt plant mix to be placed, unless otherwise approved. Where a prime coat or a newly placed asphalt surface treatment mat coat has been applied, apply tack coat as directed.

### 605-2 MATERIALS.

Refer to Division 10:

Asphalt binder, Grade PG 64-22 .....	Article 1020-2
Emulsified Asphalt, Grade RS-1H.....	Article 1020-6
Emulsified Asphalt, Grade CRS-1H .....	Article 1020-7
Emulsified Asphalt, Grade CRS-1 .....	Article 1020-7
Emulsified Asphalt, Grade HFMS-1.....	Article 1020-6
Emulsified Asphalt, Grade CRS-2 .....	Article 1020-7

Do not dilute or mix the tack coat material with water, solvents, or other materials prior to application.

Unless otherwise specified in the project special provisions, the Contractor may utilize any of the grades of tack coat material specified in this article.

When tack coat is required beneath an open-graded asphalt friction course, the asphalt grade and rate of application to be used on the project will be specified on the job mix formula in accordance with Section 650.

### 605-3 WEATHER LIMITATIONS.

Apply tack coat only when the surface to be treated is sufficiently dry and when the atmospheric temperature is 35°F (1.7°C) or above in the shade away from artificial heat.

Do not apply tack coat when the weather is foggy or rainy.

### 605-4 SURFACE PREPARATION.

Clean the existing asphalt or concrete surface to which tack coat is to be applied of all dust and foreign material prior to placing the tack coat.

Remove grass, dirt, and other materials from the edge of the existing pavement prior to the placement of tack coat.

### 605-5 ACCEPTANCE OF ASPHALT MATERIALS.

The acceptance of asphalt materials will be in accordance with the provisions of Article 1020-1.

### 605-6 APPLICATION EQUIPMENT.

Provide equipment for heating and uniformly applying the asphalt material in accordance with the requirements of Article 600-5.

### 605-7 APPLICATION RATES AND TEMPERATURES.

Apply tack coat uniformly at a rate from 0.04 to 0.08 gallons per square yard (0.18 to 0.36 liters per square meter). The exact rate for each application will be established by the Engineer. A different rate of application for different layers or surfaces may be established.

The established rates of application will be based on the volume of material at the actual application temperature. Apply tack coat at a temperature within the ranges shown in Table 605-1.

**TABLE 605-1  
APPLICATION TEMPERATURE FOR TACK COAT**

Asphalt Material	Temperature Range
Asphalt Binder, Grade PG 64-22	375- 425°F (191 to 218°C)
Emulsified Asphalt, Grade RS-1H	90-150°F (32 to 66°C)
Emulsified Asphalt, Grade CRS-1	90-150°F (32 to 66°C)
Emulsified Asphalt, Grade CRS-1H	90-150°F (32 to 66°C)
Emulsified Asphalt, Grade HFMS-1	90-160°F (32 to 71° C)
Emulsified Asphalt, Grade CRS-2	125-185°F (52 to 85°C)

**605-8 APPLICATION OF TACK COAT.**

Apply only as much tack coat material as can be covered with base, intermediate, or surface course material during the next day's operation except where public traffic is being maintained.

Where public traffic is being maintained, apply only as much tack coat as can be covered during the same day's operation. In addition, the Engineer may limit the application of tack coat in advance of the paving operation depending on traffic conditions, project location, proximity to business or residential areas, or other reasons. In the event that tack coat material is not covered in the same day's operation, the Engineer may require the application of suitable granular material or other means to provide a safe traffic condition at no additional cost to the Department.

Apply tack coat material with a distributor spray bar which can be adjusted to uniformly coat the entire surface at the directed rate. Use a hand hose attachment only on irregular areas and areas inaccessible to the spray bar. Cover these areas uniformly and completely.

Apply tack coat as directed by and in the presence of the Engineer. Do not place any asphalt mixture until the tack coat has sufficiently cured.

Paint or spray contact surfaces of headers, curbs, gutters, manholes, vertical faces of old pavements, and all exposed transverse and longitudinal edges of each course with tack coat before mixture is placed adjacent to such surfaces.

Cover bridge floors, curbs, and handrails of structures, and all other appurtenances in order to protect them from tracking or splattering tack coat material.

**605-9 PROTECTION OF TACK COAT.**

After the tack coat has been applied, protect it until it has cured for a sufficient length of time to prevent it from being picked up by traffic.

**605-10 COMPENSATION.**

There will be no direct payment for the work covered by this section.

Payment at the contract unit prices for the various mix items covered by Sections 610, 650, and 654 will be full compensation for all work covered by this section.

## SECTION 607 MILLING ASPHALT PAVEMENT

### 607-1 DESCRIPTION.

Perform the work covered by this section including but not limited to milling and remilling the pavement at locations, depths, widths, and typical sections indicated in the plans and special provisions, cleaning the milled surface, loading, hauling, stockpiling the milled material for use in recycled asphalt mixtures, and disposal of any excess milled material.

Except where the milled material is used in the work, provide areas outside the right of way to dispose of milled material, which becomes property of the Contractor.

### 607-2 EQUIPMENT.

Use a self-propelled unit capable of removing the existing asphalt pavement to the depths, widths, and typical sections shown in the plans. Design and build the equipment exclusively for pavement milling operations and with sufficient power, traction, and stability to accurately maintain depth of cut and slope. Utilize milling machines equipped with a control system which will automatically control the longitudinal profile and cross slope of the pavement through the use of either a mobile grade reference(s), an erected string line(s), joint matching shoe(s) or other methods or combination of approved methods. Use an erected fixed stringline when required by the contract; otherwise, use a mobile grade reference system capable of averaging the existing grade or pavement over a minimum 30 foot (9 m) distance. Coordinate the position of the grade control system such that the grade sensor is at the approximate midpoint of the mobile reference system. Provide a machine capable of leaving a uniform surface suitable for handling traffic without excessive damage to the underlying pavement structure. Provide a milling machine and other loading equipment capable of loading milled material to be used in other parts of the work without excessive segregation.

Provide additional equipment necessary to satisfactorily remove the pavement in the area of manholes, water valves, curb and gutter, and other obstructions.

Equip the milling equipment with a means of effectively limiting the amount of dust escaping from the removal operation in accordance with local, State, and Federal air pollution control laws and regulations.

### 607-3 CONSTRUCTION REQUIREMENTS.

Mill the existing pavement in a manner which will restore the pavement surface to a uniform longitudinal profile and cross section at the locations and in accordance with typical sections shown in the plans. Where indicated in the plans or Project Special Provisions, remove pavement to a specified depth and produce a specified cross slope. Mill intersections and other irregular areas as indicated in the plans or Project Special Provisions.

The Contractor may elect to make multiple cuts to achieve the required depth of cut or cross slope required by the plans.

Establish the longitudinal profile of the milled surface by a mobile string line on the side of the cut nearest the centerline of the road. Establish the cross slope of the milled surface by an automatic cross slope control mechanism or by a second skid sensing device located on the opposite edge of the cut. The Engineer may waive the requirement for automatic grade and cross slope controls where conditions warrant.

Operate the milling equipment in such a manner as to prevent damage to the underlying pavement structure, utilities, drainage facilities, curb and gutter, paved surfaces outside the milled area, and any other appurtenances. Produce milled pavement surfaces that are reasonably smooth and free of excessive scarification marks, gouges, ridges, continuous grooves, or other damage. Repair any leveling or patching required as a result of

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negligence by the Contractor with hot asphalt plant mix at no cost to the Department and in a manner acceptable to the Engineer. Coordinate the adjustment of manholes, meter boxes, and valve boxes with the milling operation.

The Engineer may require remilling of any area exhibiting defects such as laminations or defects. If the defects are determined to be the result of the Contractor's negligence, then measurement for the remilling, as specified in Article 607-5, will not be made. If however, the Engineer directs the remilling of an area which is not due to the Contractor's negligence, measurement of the remilled area will be made under provisions of Article 607-5.

Thoroughly clean the milled pavement surface of all loose aggregate particles, dust, and other objectionable material using power brooms, power blowers, power vacuums, or other means. Disposing or wasting of oversize pieces of pavement or loose aggregate material will not be permitted within the right of way.

Conduct pavement removal operations in a manner that effectively minimizes the amount of dust being emitted. Plan and conduct the operation so it is safe for persons and property adjacent to the work including the traveling public.

### **607-4 TOLERANCE.**

Remove the existing pavement to the depth required by the plans or project special provisions. The Engineer may vary the depth of milling by not more than one inch. In the event the directed depth of milling per cut is altered by the Engineer more than one inch (25 mm), either the Department or the Contractor may request an adjustment in unit price under the provisions of Article 104-3. In administering the provisions of Article 104-3 the Department will give no consideration to value given to reclaimed asphalt pavement unless that value has been included in the unit bid price for recycled plant mix.

The provisions of Article 104-3 will not apply to the item of "Incidental Milling".

### **607-5 METHOD OF MEASUREMENT.**

#### **(A) General:**

The quantity of milled asphalt pavement to be paid for will be the actual number of square yards (square meters) of pavement surface which has been milled in accordance with the requirements of this section. In measuring this quantity, the length will be the actual length milled, measured along the pavement surface. The width will be the width required by the plans or directed, measured along the pavement surface.

#### **(B) Milling Asphalt Pavement, \_\_\_\_\_ Inch (mm) Depth:**

For each and every square yard (square meter) that the Engineer directs to be milled; including that requiring any additional equipment necessary to remove pavement in the area of manholes, water valves, curb and gutter, and other obstructions; measured as provided in Subarticle 607-5(A); compensation will be made as provided in Articles 607-4 and 607-6. Where the Engineer directs multiple cuts to achieve the final depth, measurement will be made for each cut. Where the Contractor elects to make multiple cuts to achieve the final depth, no additional measurement will be made.

#### **(C) Incidental Milling:**

Where the Contractor is required by the plans to mill irregular areas and intersections or is directed to remill areas whose length is less than 100 feet (30.5 meters), measurement will be made as provided in Subarticle 607-5(A) for each cut he is directed to perform. Where the Contractor elects to make multiple cuts to achieve the final depth, no additional measurement will be made.

### **607-6 BASIS OF PAYMENT.**

The quantity of milled asphalt pavement, measured as provided in Article 607-5, will be paid for at the contract unit price per square yard (square meter) for "Milling Asphalt Pavement, \_\_\_\_\_ Inch Depth" or "Incidental Milling", as the case may be.

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Where the depth of milling varies from the required depth, no adjustment in the contract unit price for "Milling Asphalt Pavement, \_\_\_\_\_ Inch (mm) Depth" will be made except as provided in Article 607-4.

Payment will be made under:

Milling Asphalt Pavement, \_\_\_" (mm) Depth ..... Square Yard (Sq. Meter)  
Incidental Milling ..... Square Yard (Sq. Meter)

**SECTION 609  
QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS**

**609-1 DESCRIPTION.**

Produce and construct asphalt mixtures and pavements in accordance with a quality management system as described in these specifications. Apply these specifications to all materials and work performed in accordance with Division 6. Perform all quality control activities in accordance with the Department’s “Hot Mix Asphalt Quality Management System (HMA/QMS)” Manual in effect on the date of contract advertisement, unless otherwise approved.

**609-2 DESCRIPTION OF RESPONSIBILITIES.**

**(A) Quality Control:**

Provide and conduct a quality control program in accordance with Article 609-5 and these specifications. A quality control program is defined as all activities, including mix design, process control inspection, plant and equipment calibration, sampling and testing, and necessary adjustments in the process that are related to production of a pavement which meets all requirements of the specifications.

**(B) Quality Assurance:**

The Department will conduct a quality assurance program in accordance with Article 609-6 and these specifications. A quality assurance program is defined as all activities, including inspection, sampling, and testing related to determining that the quality of the completed pavement conforms to specification requirements.

**609-3 MIX DESIGN/JOB MIX FORMULA REQUIREMENTS.**

Apply all requirements of Article 610-3.

**609-4 FIELD VERIFICATION OF MIXTURE AND JOB MIX FORMULA ADJUSTMENTS.**

Conduct field verification of the mix at each plant within 60 calendar days prior to beginning production of each mix design. Anytime more than a 60 calendar day lapse in quality control testing of any mix has occurred, mix verification must be performed again.

Field verification testing consists of performing a minimum of one full test series on mix sampled and tested in accordance with Subarticle 609-5(C)2, “Required Sampling and Testing Frequencies”. Obtain the mix verification sample and split in accordance with current procedures in the Department’s HMA/QMS Manual. Do not begin normal plant production until all field verification test results have been completed and the mix has been satisfactorily verified by the Contractor’s Level II Technician. Verification is considered satisfactory when all volumetric properties except %Gmm@Nini are within the applicable mix design criteria and the gradation, binder content, and %Gmm@Nini are within the individual limits for the mix type being produced.

In addition to the required sampling and testing for field verification, perform all preliminary inspections and plant calibrations as outlined in the HMA/QMS Manual.

Retain records of these calibrations and mix verification tests at the QC laboratory. In addition, furnish copies to the Engineer for review and approval within one working day after beginning production of the mix.

Conduct the initial mix verification of all new mix designs with the plant set up to produce the aggregate blend and binder content in accordance with the initially approved JMF. If the Contractor and/or the Engineer determine from results of quality control tests conducted during mix verification that adjustments to the JMF are necessary to achieve specified mix properties, adjustments to the JMF may be made within tolerances permitted by specifications for the mix type being produced, subject to approval. No reduction of asphalt binder content will be made when the average production VMA computes below the minimum specification requirement. All JMF adjustments will be approved by the Engineer and documented in writing.

Failure by the Contractor to fully comply with the above mix verification requirements will result in immediate production stoppage by the Engineer. Do not resume normal production until all mix verification sampling and testing, calibrations, and plant inspections have been performed and approved.

**609-5 CONTRACTOR'S QUALITY CONTROL SYSTEM.**

**(A) Personnel Requirements:**

Obtain all certifications in accordance with the Department's QMS Asphalt Technician Certification Program as outlined in the HMA/QMS Manual. Perform all sampling, testing, data analysis and data posting by or under the direct supervision of a certified QMS asphalt plant technician.

Provide a certified Asphalt Plant Technician Level I to perform quality control operations and activities at each plant site at all times during production of material for the project. A plant operator who is a certified Asphalt Plant Technician Level I may be utilized to meet this requirement when daily production for each mix design is less than 100 tons (100 metric tons) provided the randomly scheduled increment sample as defined in Article 609-5(C)2 is not within that tonnage. When performing in this capacity, the plant operator will be responsible for all quality control activities which are necessary and required. Absences of the Level I Technician, other than those for normal breaks and emergencies, must be pre-approved by the appropriate QA Supervisor or his designated representative. Any extended absence of the Technician that has not been approved will result in immediate suspension of production by the Engineer. All mix produced during this absence will be accepted in accordance with Article 105-3.

Provide and have readily available a certified Asphalt Plant Technician Level II to supervise, coordinate, and make any necessary adjustments in the mix quality control process in a timely manner. The Level II Technician may serve in a dual capacity and fulfill the Level I Technician requirements specified above.

Provide a certified QMS Roadway Technician with each paving operation at all times during placement of asphalt. This person is responsible for monitoring all roadway paving operations and directly supervising all quality control processes and activities. Provide a certified nuclear gauge operator when nuclear density control is being used.

Post in the quality control laboratory an organizational chart, including names, telephone numbers and current certification numbers of all personnel responsible for the quality control program while asphalt paving work is in progress.

**(B) Field Laboratory Requirements:**

For a contract with 5000 or more total tons (metric tons) of asphalt mix, furnish and maintain a Department certified laboratory at the plant site. A minimum of 320 square feet (30 square meters) of floor space (exclusive of toilet facilities), equipment, and supplies necessary for performing Contractor quality control testing is required. Provide convenient telephone and fax machine access for QMS personnel at the plant site.

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For a contract with less than 5000 total tons (metric tons) of asphalt mix, the quality control testing may be conducted in a Department certified off-site laboratory. All other requirements in these specifications still apply.

Provide testing equipment meeting the requirements of the test methods herein identified in Subarticle 609-5(C)2. Provide equipment that is properly calibrated and maintained. Allow all measuring and testing devices to be inspected to confirm both calibration and condition. If at any time the Engineer determines that the equipment is not operating properly or is not within the limits of dimensions or calibration described in the applicable test method, the Engineer may stop production until corrective action is taken. Maintain and have available a record of all calibration results at the laboratory.

**(C) Plant Mix Quality Control:**

**(1) General:**

Include in the quality control process the preliminary inspections, plant calibrations and field verification of the mix and JMF as described in Article 609-4. In addition, conduct at a minimum but not limited to, the sampling, testing, and determination of all parameters outlined in these provisions using test methods and minimum frequencies as specified herein. Perform additional sampling and testing when conditions dictate. Obtain all scheduled samples at randomly selected locations in accordance with the current edition of the Department's "HMA/QMS Manual". Log all samples taken on forms provided by the Department. Split and retain all samples taken in accordance with prescribed procedures in the manual. Provide documentation as required in Subarticle 609-5(E).

Retain the untested split portion of quality control aggregate and mix samples and the tested TSR specimens for 5 calendar days at the plant site, commencing the day the samples are tested. Retain the QC compacted volumetric test specimens for 2 calendar days, commencing the day the specimens are prepared. Permission for disposal may be given by Quality Assurance personnel prior to these minimum storage periods. Retain the split portion of the Contractor's mix verification and referee mix samples until either procured by or permission for disposal is given by QA. Store all retained samples in a dry and protected location.

**(2) Required Sampling and Testing Frequencies:**

Maintain minimum test frequencies as established in the schedule below. Complete all tests within 24 hours of the time the sample is taken, unless specified otherwise within these provisions. Should the specified tests not be completed within the required time frame, cease production at that point until such time the tests are completed.

Should the Contractor's testing frequency fail to meet the minimum frequency requirements as specified, all mix without the specified test representation will be considered unsatisfactory. If the Engineer allows the mix to remain in place, payment will be made at 50 percent of the contract unit bid price for the mixture.

If desired, innovative equipment or techniques not addressed by these specifications to produce or monitor the production of mix may be utilized, subject to approval.

**QUALITY CONTROL MINIMUM SAMPLING AND TESTING SCHEDULE**

Sample and test the completed mixture from each job mix formula at the following minimum frequency during mix production:

<u>Accumulative Production Increment</u>	<u>Number of Samples per Increment</u>
750 tons (750 Metric Tons)	1

If production is discontinued or interrupted before the accumulative production increment tonnage is completed, continue the increment on the next production day(s)

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until the increment tonnage is completed. Obtain a random sample within the specified increment at the location determined in accordance with the current edition of the Department's HMA/QMS Manual. Conduct quality control sampling and testing on each random sample as scheduled below. When daily production of each mix design exceeds 100 tons (100 metric tons) and a regularly scheduled full test series random sample location for that mix design is not reached during that day's production, perform at least one partial test series consisting of Items A and B in the schedule below. These partial test series and associated tests do not substitute for the regularly scheduled random sample for that increment.

Perform the following full test series on all regularly scheduled random samples:

Asphalt Mixture - Sampled From Truck at Plant (AASHTO T 168)(Split Sample Required)

- A. Binder Content, % (Contractor may select either option below):
  - 1. Ignition Furnace (AASHTO T 308 Modified)
  - 2. Other (Contractor may request and use other means of determining percent asphalt binder, subject to approval).
- B. Gradation on Recovered Blended Aggregate from Mix Sample  
(AASHTO T 30 and T 11) Grade on all sieves specified on JMF
- C. Maximum Specific Gravity (AASHTO T 209)
- D. Bulk Specific Gravity of Compacted Specimens (AASHTO T 166),  
Average of 3 specimens at  $N_{des}$  gyrations
- E. Air Voids (VTM), Average of 3 specimens at  $N_{des}$  gyrations
- F. Voids in Mineral Aggregate (VMA) (calculation)
- G. Voids Filled with Asphalt (VFA) (calculation)
- H.  $P_{0.075}/P_{be}$  Ratio
- I. % Maximum Specific Gravity at  $N_{ini}$  (calculation)

In addition to the above schedule, conduct the following sampling and testing as indicated:

- A. Aggregate Stockpile Gradations (AASHTO T 27 and T 11)  
(Sampled from stockpiles or cold feed system as follows; split samples not required)
  - 1. Coarse Aggregates (Approved Standard Sizes)
    - a. At beginning of production\*
    - b. Weekly thereafter\*
  - 2. Fine Aggregates (Stone Screenings, Natural Sands, Etc.)
    - a. At or within 1 week prior to mix verification (Gradations valid for multiple mix designs).
    - b. Weekly after mix verification\*,
    - c. Anytime production is stopped due to plant mix gradation related problems.

\*In lieu of the aggregate stockpile gradations performed by QC, gradation quality control data conducted by the aggregate producer, which is representative of the Contractor's current stockpiles, may be furnished.

- B. Reclaimed Asphalt Pavement (RAP) Extraction (AASHTO T 164 and T 30) (sampled from stockpiles or cold feed system at beginning of production and weekly thereafter). Have RAP approved for use in accordance with Article 1012-1(F).
- C. Combined Aggregate Moisture Content (AASHTO T 255) Drum Plant Only (sampled from stockpiles or cold feed system a minimum of once daily).
- D. Retained Tensile Strength (TSR) - (AASHTO T 283 Modified):

Option 1:

Mix sampled from truck at plant, tested, and results furnished to the Engineer within seven (7) calendar days after beginning production of each new mix design. From the split sample, QC will prepare and submit within 5 calendar days of the sample date, an additional set of specimens to the QA Lab for TSR testing (Split Sample Required).

Option 2:

Mix sampled from truck at plant with one set of specimens prepared by the Contractor and then tested jointly by QA and QC at a mutually agreed upon lab site within the first seven (7) calendar days after beginning production of each new mix design. Specimens must be tested on either a recording test press or a test press that maintains the peak load reading after the specimen has broken.

Additional TSR testing required prior to mix production in accordance with above procedures is required when a change is made in anti-strip additive dosage or when a new anti-strip additive source or grade is utilized, unless otherwise approved. Other TSR test(s) may be directed as deemed necessary. TSR testing not required for mix verification, but may be performed at that time.

- E. % Maximum Specific Gravity at  $N_{max}$ . (Split Sample Required)
  - 1. Sampled from plant produced mix during mix verification
  - 2. 3 specimens compacted at  $N_{max}$  gyrations
  - 3. %Gmm@ $N_{max}$  calculated from average of 3 specimens.

**(3) Control Charts:**

Maintain standardized control charts furnished by the Department at the field laboratory. Record all regularly scheduled random sample or directed sample full test series results for mix incorporated into the project on control charts the same day the tests are conducted. Partial test series results obtained due to reasons outlined in Sub-Article 609-5(C)2 will be reported but will not be plotted on the control charts.

Results of quality assurance tests performed by the Engineer will be posted on the Contractor's control charts as data becomes available.

Record the following data on the standardized control charts:

- 1. Aggregate Gradation Test Results:
  - a. For each mix type: one sieve size smaller than the mix nominal maximum size.
  - b. For all mix types: 2.36 mm and 0.075 mm sieves
- 2. Binder Content, %,  $P_b$
- 3. Bulk Specific Gravity of Compacted Specimens at  $N_{des}$  (measured)
- 4. Maximum Specific Gravity Determined by AASHTO T 209

5. Percent Voids in Total Mix at  $N_{des}$  Gyration
6. Percent Voids in Mineral Aggregate at  $N_{des}$  Gyration
7.  $P_{0.075}/P_{be}$  Ratio
8. Percent Maximum Specific Gravity at  $N_{ini}$  Gyration

Both the full test series individual test values and the moving average of the last four (4) data points will be plotted on each chart. The Contractor's test data will be shown in black and the moving average in red. The Engineer's assurance data will be plotted in blue. Denote the warning control limits with a dash green line, the moving average control limits with a dash blue line, and individual test limits with a dash red line.

Maintain a continuous moving average with the following exceptions. Re-establish a new moving average only when:

1. A change in the binder percentage or aggregate blend is made in the JMF, or,
2. When the Contractor elects to stop or is required to stop production after one or two moving average values, respectively, fall outside the warning limits as outlined in Subarticle 609-5(C)6, or,
3. When reverification of the mix is required due to a 90 day lapse in quality control testing.

In addition, if failure to stop production after two consecutive moving averages exceed the warning limits occurs, but production does stop at a subsequent time, re-establish a new moving average beginning at the actual production stop point. Re-establish the moving averages for all mix properties. Moving averages will not be re-established when production stoppage occurs due to an individual test result exceeding the individual test limits and/or specifications.

All individual test results are part of the plant quality control record and must be included in moving average calculations with the following exception. When the Contractor's testing data has been proven incorrect, use the correct data as determined by the Engineer in lieu of the Contractor's data to determine the appropriate pay factor in accordance with Subarticle 609-5(C)6. In this case, replace the data in question and any related data proven incorrect.

#### (4) Control Limits:

The following are established as control limits for mix production. Control limits for the warning and moving average limits are based on a moving average of the last four (4) data points. Apply all control limits to the applicable target source.

**Control Limits**

Mix Property	Target Source	Warning Limit	Moving Average Limit	Individual Limit
2.36mm Sieve	JMF	±4.0 %	±5.0 %	±8.0 %
0.075mm Sieve	JMF	±1.5 %	±2.0 %	±2.5 %
Binder Content	JMF	±0.3 %	±0.5 %	±0.7 %
VTM @ $N_{des}$	JMF	±1.0 %	±1.5 %	±2.0 %
VMA @ $N_{des}$	Min. Spec. Limit	-0.5%	-0.8%	-1.0%
$P_{0.075}/P_{be}$ Ratio	Max. Spec. Limit	0.0	N/A	+0.4%
% $G_{mm}$ @ $N_{ini}$	Max. Spec. Limit	+1.0%	N/A	+2.0%

**(5) Warning Bands:**

Warning bands are defined as the area between the warning limits and moving average limits.

**(6) Corrective Actions:**

Immediately notify the Engineer when moving averages exceed the warning limits. All required corrective actions are based upon initial test results and must be taken immediately upon obtaining those results. In the event situations occur which warrant more than one corrective action and/or adjustment, give precedence to the more severe of these actions. Stopping production when required takes precedence over all other corrective actions. Document all corrective actions.

Immediately cease production of a mix when any of the following occur. Do not resume normal production of the mix in question until approval is given.

1. When an individual test result for a mix control criteria (including results for required partial test series on mix) exceeds both the individual test control limits and the applicable specification design limits, or,
2. When two consecutive field TSR values fail to meet the minimum specification requirement, or,
3. When two consecutive binder content test results exceed the individual limits.

Acceptance of all mix failing to meet the individual test control limits (including results for required partial test series on mix) or minimum TSR requirements as described above will be determined in accordance with Article 105-3. In addition, any mix which is obviously unacceptable will be rejected for use in the work.

Failure to stop production when required due to an individual mix test not meeting the specified requirements will subject all mix from the stop point tonnage to the point when the next individual test is back on or within the warning limits, or to the tonnage point when production is actually stopped, whichever occurs first, to being considered unacceptable.

Failure to stop production when required due to two consecutive TSR tests failing to meet the specification requirements will subject all mix from the stop point tonnage to the point when the next TSR test meets or exceeds the specification requirement, or to the tonnage point when production is actually stopped, whichever occurs first, to being considered unacceptable.

In either case, remove and replace this mix with materials which comply with the specifications at no additional costs to the Department, unless otherwise approved.

Immediately notify the Engineer when any moving average value exceeds the warning limit. If two consecutive moving average values for any one of the mix control criteria fall outside the warning limits, cease production of that mix and make adjustments. The Contractor may elect to stop production after only one moving average value falls outside the warning limits. In either case, do not determine a new moving average until the fourth test after the elective or mandatory stop in production. Do not resume normal production of the mix in question until approved.

If the process adjustment improves the property in question such that the moving average after four additional tests is on or within the warning limits, the Contractor may continue production with no reduction in payment.

If the adjustment does not improve the property in question such that the moving average after four additional individual tests stays in the warning bands, the mix will be considered not to be within reasonably close conformity, but reasonably acceptable. Reduced payment for the mix in question will be applied starting from the plant sample

tonnage at the stop point to the sample tonnage when the moving average is on or within the warning limits in accordance with the following table.

Payment for Mix Produced in the Warning Bands\*

<u>Property</u>	<u>Pay Factor</u>
2.36mm Sieve	90%
0.075mm Sieve	90%
Binder Content	85%
VTM @ $N_{des}$	70%
VMA @ $N_{des}$	90%

- \* When two or more properties are in question, only the lower pay factor will be applied to the mix unit bid price.

If the adjustment does not improve the property in question such that the moving average after four additional tests exceeds the moving average control limits, the mix will be considered not to be within reasonably close conformity with specifications. If the Engineer determines the mix is reasonably acceptable based on test data and an inspection of the completed pavement and allows it to remain in place, the mix will be accepted in accordance with Article 105-3. If the mix is determined to be unacceptable, the mix will be removed and replaced with materials which comply with the specifications. In either case, the adjustment or removal, respectively, for the mix in question will be applied starting from the plant sample tonnage at the stop point to the sample tonnage when the moving average is on or within the warning limits. In addition, any mix which is obviously unacceptable will be rejected for use in the work.

Failure to stop production and make adjustments when required due to two consecutive moving average values falling outside the warning limits will subject all mix produced from the stop point tonnage to the tonnage point when the moving average is back on or within the warning limits or to the tonnage point when production is actually stopped, whichever occurs first, to being considered unacceptable. Remove this material and replaced with materials which comply with the specifications at no additional costs to the Department, unless otherwise approved.

**(7) Allowable Retesting for Mix Deficiencies:**

The Contractor may elect to resample and retest for plant mix deficiencies when individual QC test(s) exceed one or more mix property target(s) by more than the tolerances indicated below. Perform the retesting within 10 days after initial test results are determined. Retesting must be approved prior to being performed and in accordance with the Department's "GUIDELINES FOR RETESTS OF PLANT MIX DEFICIENCIES" outlined in the HMA/QMS Manual. Retests for any mix deficiency other than as listed below will not be allowed unless otherwise permitted. Acceptance of the mix in question will be based on the retest data in accordance with Article 105-3.

The Department reserves the right to require the Contractor to resample and retest at any time or location as directed.

- VTM -- by more than +/- 2.5%
- VMA -- by more than +/- 2.0%
- % Binder Content -- by more than +/- 1.0%
- 0.075 mm sieve -- by more than +/- 3.0%
- 2.36 mm sieve -- exceeds both the Specification mix design limits and one or more of the above tolerances
- TSR -- by more than -15% from Specification limit

**(D) Field Compaction Quality Control:****(1) General:**

Perform quality control of the compaction process in accordance with these provisions and applicable requirements of Article 610-9. The Contractor may elect to use either cored sample density procedures or nuclear gauge density procedures. Provide to the Department at the pre-construction conference the method of density quality control which will be used on the project.

Establish acceptable control strips when required at locations approved by the Engineer. Construct control strips which are 300 feet (91.4 m) in length at the paver laydown width being placed. When utilizing core sample control, place control strips anytime placement is proceeding on limited production due to failing densities. When utilizing nuclear density control, place control strips at the minimum frequencies specified in the Department's current Nuclear Gauge Operator's Manual. In addition, place control strips anytime deemed necessary by the Engineer.

Conduct density sampling and testing by either method based on test sections consisting of not more than 2000 linear feet (600 linear meters) or fraction thereof per day on pavement placed at the paver laydown width. Perform density sampling and testing on all pavement widening 4.0 feet (1.2 m) or greater, on uniform width paved shoulders 2.0 feet (0.6 m) or greater, and on all full width travel lane pavements, including normal travel lanes, turn lanes, collector lanes, ramps and loops, and temporary pavements, unless otherwise approved.

For base and intermediate mix types (surface mixes not included) used to widen pavements less than 4.0 feet (1.2 m) and for all mix types used in intersections (exclusive of full width travel lanes), tapers, and for irregular areas, a specified density will not be required provided the pavement is compacted using approved equipment and procedures. The Engineer may require occasional density sampling and testing to evaluate the compaction process. Irregular areas are defined as areas which have irregular shapes which make them difficult to compact with conventional asphalt rollers.

Perform the sampling and testing at the minimum test frequencies as specified above. Should the density testing frequency fail to meet the minimum frequency as specified above, all mix without the required density test representation will be considered unsatisfactory and if allowed to remain in place, will be paid for at 50 percent of the contract unit bid price for the mixture.

Conduct all QC nuclear density testing the same day that the mix being tested is placed and compacted. Obtain all core samples no later than the beginning of the next production day, not to exceed three (3) calendar days. Test QC core samples and submit test results within one working day of the time the samples are taken. Should the specified density tests not be completed within the allowable time cease production at that point until such time the required tests are completed. Failure to provide samples may result in suspension of all project operations.

Retain quality control density core samples at the plant site for 5 calendar days, commencing the day the samples are tested, or until permission for disposal is granted by the quality assurance personnel, whichever occurs first. Retain the Department's quality assurance comparison and verification core samples in a sealed container at the plant site until obtained by quality assurance personnel. Store all retained density samples on a smooth, flat surface in a cool, dry, and protected location.

Check core samples may be taken by the Contractor for any of the following reasons:

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1. When core sample control is being used and a test section core sample(s) is more than 2.0 percent below the average of all core samples from the same lot, that core(s) samples may be checked,
2. When nuclear gauge control is being utilized and a control strip fails solely because of any individual core(s) being more than 1.0 percent below the minimum density, that core(s) sample may be checked,
3. When a control strip fails and a core sample(s) is more than 2.0 percent below the average of the control strip, that core(s) may be checked.

For each core sample that is to be checked, take 3 check samples as follows: one adjacent to the initial sample and one ten feet (3 meters) in each direction, longitudinally, of the initial sample. The results of these 3 check samples will be averaged and this average will be used in lieu of the initial core results in question. The initial core sample results will not be used if check samples are taken.

Check samples must be taken within 2 calendar days of the date of the initial sample. Only one set of check samples per sample location will be allowed. If full depth cores are necessary at these check sample locations, separation of the layer to be tested will be the responsibility of the Contractor. Take all check samples in the presence of a representative of the Engineer. In addition, a QA comparison core sample(s) may be taken adjacent to one or more of these check samples.

### **(2) Pavement Samples (Cores):**

When cored samples are required by either density method, obtain cores from the full layer depth of the compacted pavement at random locations determined in accordance with procedures in the Department's HMA/QMS Manual. Full depth cores may be taken in lieu of placing a separator medium beneath the layer to be tested. If full depth cores are taken, the Contractor is responsible for separating the layer of mix to be tested in a manner such that it is not damaged.

Pavement layers may be cooled by approved artificial methods to allow cutting the core samples as quickly as possible. No additional compensation will be made for the costs of artificial cooling.

Take pavement specimens for density testing purposes utilizing a 6 inch (152.4 mm) core drill. Use approved coring equipment that is capable of taking a representative sample of the compacted pavement. In the event a malfunction of the coring equipment occurs, utilize other approved means to obtain the required samples. Repair the coring equipment and restore to use within three working days.

Where samples have been taken, clean the inside surfaces of the sample hole, dry, lightly coat with tack coat, and immediately place and compact new mix of the same type to conform with the surrounding area. Use a circular tamp or other approved device to achieve compaction.

### **(3) Cored Sample Density Procedures:**

In addition to the above requirements, perform core sample density control procedures as noted herein. When cored sample control is being utilized, the testing frequency will be a minimum of one random 6 inch (152 mm) core sample taken from each test section, except take a minimum of at least three core samples from each mix type and/or lot placed on a given day.

An initial control strip is not required at the beginning of placement of each job mix formula but may be performed by the Contractor for use in determining the necessary compactive effort and roller patterns. Cored sample control strips will be required if production and placement is being performed under limited production procedures due to failing densities.

**(4) Nuclear Gauge Density Procedures:**

In addition to the requirements in Subarticle 609-5(D)1, perform nuclear density control procedures in accordance with the Department's most current Nuclear Gauge Operator's Manual. This manual may be obtained through the Department's M & T Soils Section. Determine density by the backscatter method of testing using a thin-lift nuclear gauge, with printer, which has been approved by the Department. Furnish, maintain, and operate the nuclear gauge. Furnish an operator that has been certified by the Department.

Provide a gauge which has been calibrated within the previous 12 months by an approved calibration service. Maintain documentation of such calibration service for a 12 month period.

Conduct all QC nuclear density tests the same day the mix being tested is placed and compacted. Furnish summary of density results to the Engineer no later than the end of each day's production. Furnish a copy of the nuclear gauge printout(s) to the Engineer upon request.

Determine target density for testing by constructing control strip(s) in accordance with and at the frequencies prescribed in the Nuclear Gauge Operator's Manual. Core samples from the control strips may be checked in accordance with the criteria established in Subarticle 609-5(D)1.

Conduct sampling and testing as specified based on test sections consisting of not more than 2000 linear feet (600 linear meters) or fraction thereof per day on pavement placed at the paver laydown width. The nuclear density testing frequency will consist of five random gauge readings (one random reading from each of five equally spaced increments) from each test section. In addition, take at least five gauge readings during any day's production of a given mix type. Random locations for gauge readings will be determined in accordance with the procedures in the Department's most current Nuclear Gauge Operator's Manual. Test section pavement must be of the same mix design as the pavement utilized in the applicable control strip.

**(5) Limited Production Procedure:**

Proceed on limited production when three consecutive failing density lots occur, not to exceed two production days.

Limited production is defined as being restricted to the production, placement, and compaction of a sufficient quantity of mix necessary to construct only a 300 foot (100 meter) control strip plus 100 feet (30 meters) of pavement adjacent to each end of the control strip.

Remain on limited production until such time as satisfactory density results are achieved or until two control strips have been attempted without achieving acceptable density test results. If the Contractor fails to achieve satisfactory density after two control strips have been attempted, cease production of that mix type until such time as the cause of the failing density test results can be determined. As an exception, the Engineer may grant approval to produce a different mix design of the same mix type if the cause is related to mix problem(s) rather than compaction related problems.

If the Contractor does not operate by the limited production procedures as specified above, the three consecutive failing lots or two production days, whichever is applicable, and all mix produced thereafter will be considered unacceptable. Remove this material and replace with material which complies with the Specifications, unless otherwise approved.

**(E) Documentation (Records):**

Document all quality control observations, records of inspection, samples taken, adjustments to the mix, and test results on a daily basis. Note the results of observations

and records of inspection as they occur in a permanent field record. Record adjustment to mix production and test results on forms provided.

Make all such records available to the Engineer, upon request, at any time during project construction. Complete all QC records and forms and distribute in accordance with the most current edition of the Department's "HMA/QMS Manual". At the end of each quarter, provide a copy of the control charts (with the moving average shown in (red) in a neat and orderly manner. Maintain the QC testing forms for 90 calendar days after project completion. Failure to maintain QC records and forms as required, or to provide these records and forms to the Engineer upon request, may result in production and/or placement stoppage until the problem is resolved.

Falsification of test results, documentation of observations, records of inspection, adjustments to the process, discarding of samples and/or test results, or any other deliberate misrepresentation of the facts will result in the revocation of the applicable person's QMS certification. There will be no pay for all tonnage represented by the falsified test(s) results or documentation. The Engineer will determine acceptability of the mix and/or pavement in question. If mix and/or pavement represented by the falsified results is determined not to be acceptable, remove and replace it with mix which complies with the Specifications.

#### **609-6           QUALITY ASSURANCE.**

The Department's quality assurance program will be conducted by a certified QMS technician(s) and will be accomplished in the following ways:

##### Plant Mix Quality Assurance:

1. By conducting assurance testing of split samples obtained by the Contractor at a frequency equal to or greater than 10% of the frequency required of the Contractor;
2. By periodically observing tests performed by the Contractor;
3. By monitoring required control charts exhibiting test results of control parameters;
4. By directing the Contractor to take additional samples at any time and any location during production (in lieu of the next scheduled random sample) and;
5. By conducting verification sampling and testing on samples taken independently of the Contractor's quality control samples; and
6. By any combination of the above

The Engineer will conduct assurance tests on split samples of mix taken by the Contractor for quality control testing. These samples may be the regular quality control samples or a sample selected by the Engineer from any location in the process. The frequency will be equal to or greater than 10% of that required of the Contractor as stated in Subarticle 609-5(C)2. The Engineer may select any or all split samples for assurance testing.

##### Density Quality Assurance:

1. By retesting randomly selected quality control test sections (either cores or nuclear) at a frequency equal to or greater than 10% of the frequency required of the Contractor,
2. By periodically observing tests performed by the Contractor;
3. By testing randomly selected comparison core samples taken adjacent to the Contractor's quality control core samples (8 inches center-to-center) at a frequency equal to or greater than 10% of the frequency required of the Contractor; and

4. By conducting verification sampling and testing on test sections (either core or nuclear) independently of the Contractor's quality control test sections.

Comparison and verification core samples will be taken in the presence of a DOT technician, and either delivered directly to the appropriate QA Lab by a DOT technician or placed in a sealed container and delivered to the Contractor's QC Lab for QA testing.

The Engineer will periodically obtain quality assurance and verification samples for testing independently of the Contractor's quality control process. These samples will be split for testing by the Engineer and the Contractor.

Results of quality assurance tests will be provided to the Contractor within 3 working days after the sample has been obtained, except for verification TSR test results which will be provided within 7 calendar days.

Limits of Precision:

Differences between the Contractor's and the Department's split sample test results will be considered acceptable if within the following limits of precision:

<u>Mix Property</u>	<u>Limits of Precision</u>
25.0mm sieve(Base Mix)	± 10.0%
19.0mm sieve(Base Mix)	± 10.0%
12.5mm sieve(Intermediate Mix)	± 6.0%
9.5mm sieve(Surface Mix)	± 5.0%
4.75mm sieve(Surface Mix)	± 5.0%
2.36mm sieve(All Mixes)	± 5.0%
0.075mm sieve(All Mixes)	± 2.0%
Asphalt Binder Content	± 0.5%
Maximum Specific Gravity( $G_{mm}$ )	± 0.020
Bulk Specific Gravity ( $G_{mb}$ )	± 0.030
TSR	± 15.0%
Retest of QC Core Sample	± 0.030
Comparison QA Core Sample	± 0.050
Nuclear Comparison of QC Test	± 2.0%

In the event comparison test results are outside the above acceptable limits of precision or the quality assurance test results are either outside the individual test control limits or fail to meet specification requirements, the Engineer will immediately investigate the reason for the difference. If the potential for a pavement failure exist, the Engineer may suspend production, wholly or in part, in accordance with Article 108-7 while the investigation is in progress. The Engineer's investigation may include, but not be limited to the following:

1. Joint testing of any remaining split samples,
2. Review and observation of the QC technician's sampling and testing procedures,
3. Evaluation and calibration of QC testing equipment, and/or
4. Comparison testing of other retained quality control samples, and/or additional density core samples.

If additional mix samples or core samples are necessary to resolve the difference, these samples will be taken as directed and tested jointly by the Contractor's quality control and Department's quality assurance personnel. If reasons for the difference cannot be determined, payment for the mix in question will be determined in accordance with Article 105-3. If the reason for the difference is determined to be an error or other discrepancy in the quality control test results, the applicable quality assurance test results

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will be used to determine compliance with the applicable mix or density specification requirements.

The Engineer will periodically witness the sampling and testing being performed by the Contractor. If the Engineer observes that the sampling and quality control tests are not being performed in accordance with the applicable test procedures, the Engineer may stop production until corrective action is taken. The Engineer will promptly notify the Contractor of observed deficiencies, both verbally and in writing. The Engineer will document all witnessed samples and tests.

**609-7 ACCEPTANCE.**

Final acceptance of the asphalt pavement will be made by the Department in accordance with the following:

Mix Acceptance:

The Engineer will base final acceptance of the mix on the results of random testing made on split samples during the assurance process and validation of the Contractor's quality control process as outlined in Subarticle 609-5(C) and Article 609-6.

Density Acceptance:

The Department will evaluate the asphalt pavement for density compliance after the asphalt mix has been placed and compacted using the Contractor's quality control test results, the Department's quality assurance test results, and by observation of the Contractor's density quality control process as outlined in Subarticle 609-5(D), Article 609-6 and Article 610-13.

**609-8 COMPENSATION.**

Produce and construct all asphalt mixtures and pavements in accordance with these specifications. There will be no direct payment for work covered by this specification. Payment at the contract unit prices for the various asphalt items will be full compensation for all work covered by these specifications.

**SECTION 610  
ASPHALT CONCRETE PLANT MIX PAVEMENTS**

**610-1 DESCRIPTION.**

Perform the work covered by this section, including but not limited to the construction of one or more courses of asphalt mixture placed on a prepared surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness, and typical sections shown on the plans. This work includes producing, weighing, transporting, placing and compacting the plant mix; furnishing aggregate, asphalt binder, anti-strip additive, and all other materials for the plant mix; furnishing and applying tack coat as specified in Section 605; furnishing scales; maintaining the course until final acceptance of the project; making any repairs or corrections to the course that may become necessary; providing and conducting quality control as specified in Section 609; and surface testing of the completed pavement. The design requirements for the various mix types are given in Table 610-1 and Table 610-2 for Superpave mix types, Section 650 for OGAFc and Section 652 for PADc.

Provide and conduct the quality control and required testing for acceptance of the asphalt mixture in accordance with Section 609.

**610-2 MATERIALS.**

See Division 10:

Coarse aggregate .....	Article 1012-1
Fine aggregate .....	Article 1012-1

Mineral filler ..... Article 1012-1  
 Stone screenings ..... Article 1012-1  
 Reclaimed asphalt pavement ..... Article 1012-1  
 Reclaimed asphalt shingles ..... Article 1012-1  
 Natural sand ..... Article 1012-1  
 Anti-strip additive (hydrated lime) ..... Article 1012-1  
 Anti-strip additive (chemical) ..... Article 1020-2  
 Asphalt Binder, Performance Grade ..... Article 1020-2  
 Silicone..... Article 1020-4

**610-3 COMPOSITION OF MIXTURES (MIX DESIGN AND JOB MIX FORMULA)**

**(A) Mix Design-General:**

Prepare the asphalt mix design utilizing a mixture of coarse and fine aggregate, asphalt binder, mineral filler, and other additives when required. Size, uniformly grade, and combine the several aggregate fractions in such proportions that the resulting mixture meets the grading and physical requirements of the specifications for the specified mix type. Materials which will not produce a mixture within the design criteria required by the specifications will be rejected, unless otherwise approved.

At least 10 days prior to start of asphalt mix production, submit, in writing and in electronic form, the mix design and proposed job mix formula (JMF) targets for each required mix type and combination of aggregates to the Engineer for review and approval. Prepare the mix design using a Department approved mix design technician in an approved mix design laboratory. Perform the mix design in accordance with the Superpave mix design system as described in AASHTO PP 28 “Standard Practice for Designing Superpave HMA” as modified by the Department. Perform, document and submit all mix designs in accordance with Department policies, procedures and computerized mix design programs. Submit the mix design and proposed job mix formula targets on approved forms and in the format required by the Department for the appropriate mix type. In addition, submit the mix design data in electronic format using the Department’s latest mix design programs and procedures for the specified mix type.

Reclaimed asphalt pavement (RAP) may constitute up to 50 percent of the total material used in recycled mixtures, except for mix Type S 12.5D and mixtures containing reclaimed asphalt shingle material (RAS). Reclaimed asphalt shingle (RAS) material may constitute up to six (6) percent by weight of total mixture for any mix. When both RAP and RAS are used, do not use a combined percentage of RAS and RAP greater than 15% by weight of total mixture, unless otherwise approved.

For Type S 12.5D mixes, the maximum percentage of reclaimed asphalt material is limited to 15% and must be produced using virgin asphalt binder grade PG 76-22. For all other recycled mix types, when the percentage of RAP is 15 percent or less of the total mixture, or when the percentage of binder contributed by RAP is 15 percent or less of the total binder in the completed mix, the virgin binder PG grade must be as specified for the specified mix type. When the percentage of RAP is greater than 15 but not more than 25 percent of the total mixture, and the percentage of binder contributed by the RAP is greater than 15 but not more than 25 percent of the total binder in the completed mixture, the virgin binder PG grade must be one grade below the specified grade (both high and low temperature grade) for the specified mix type. When the percentage of RAP is greater than 25 percent of the total mixture and the percentage of binder contributed by the RAP is greater than 25 percent of the total binder in the completed mix, the Engineer will establish and approve the asphalt binder grade.

Should a change in the source of RAP or RAS be made, a new mix design and/or job mix formula may be required in accordance with Article 1012-1. Samples of the completed recycled mixture may be taken by the Department on a random basis to

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determine the PG grading on the recovered asphalt binder in accordance with AASHTO MP 1. If the grading is determined to be a value other than required for the specified mix type, the Engineer may require the Contractor to adjust the grade and/or percentage of additional asphalt binder, and/or the blend of reclaimed material to bring the grade to the specified value.

Prepare all proposed mix design data in accordance with Department policies and procedures, including but not limited to, the following information:

1. Source and percentage of each aggregate component to be used in the design aggregate blend gradation, including RAP and RAS.
2. Percentage of asphalt binder in RAP and RAS.
3. Gradation of each aggregates component, including RAP and RAS.
4. The following aggregate properties: bulk specific gravity ( $G_{sb}$ ), apparent specific gravity ( $G_{sa}$ ) and absorption of the individual aggregate components to be used when tested in accordance with AASHTO T 84 and T 85, except report the effective bulk specific gravity ( $G_{se}$ ) of RAP and RAS aggregate as determined by AASHTO T 209. Report coarse aggregate angularity, fine aggregate angularity, flat and elongated percentages, and sand equivalent for the total aggregate blend.
5. Source(s), modification method, and percent of modifier by weight of asphalt binder, if modified.
6. Supplier, source, grade, and equi-viscous mixing and compaction temperatures of the asphalt binder. Determine equi-viscous temperatures using the rotational viscometer in accordance with ASTM D 4402 corresponding to the following recommended viscosity ranges:

Range for mixing = 0.150 to 0.190 Pa-s

Range for compaction = 0.250 to 0.310 Pa-s

When PG 76-22 or other modified binders are used, base the temperatures on the documented supplier's recommendations.

7. Name of product, manufacturer, shipping point, grade and percentage of anti-strip additive used in the mix design. Determine TSR data in accordance with AASHTO T 283 as modified by the Department.
8. Target value for percent passing each standard sieve for the design aggregate gradation. Data will show the percent passing for all standard sieves listed in Table 610-1 for the specified mix type. Show the percentages in units of one percent of aggregate passing, except for the 0.075 mm (No. 200) sieve, show in units to one-tenth of one percent. Base percentages on the dry weight of aggregate determined in accordance with AASHTO T 11 and T 27.
9. Volumetric properties of the compacted mixture calculated on the basis of the mixture's maximum specific gravity as determined by AASHTO T 209. The mixture must be aged in accordance with AASHTO PP 2 and the bulk specific gravity of specimens determined by AASHTO T 166, Method A, for each asphalt content tested. Determine and report properties in accordance with the requirements of AASHTO PP 28 except as modified herein, and Department Mix Design Policies and Procedures.
10. Graphical plots of percent asphalt binder by total weight of mix ( $P_b$ ) versus the following properties at the design number of gyrations,  $N_{des}$ , specified
  - a. SGC bulk gravity,  $G_{mb}$  @  $N_{des}$
  - b. %  $G_{mm}$  @  $N_{ini}$
  - c. Voids in total Mix (VTM)
  - d. Voids Filled With Asphalt (VFA)
  - e. Voids in Mineral Aggregate (VMA)
  - f. % Compaction vs Log of Gyrations
11. Graphical plot of the design aggregate gradation (design blend) on FHWA 0.45 power chart showing the applicable control points, restricted zone guidelines, and maximum density line. Plot all standard sieves for the applicable mix type.

12. Proposed target value of asphalt binder content by weight of total mix and specification design properties at that percentage.

When the mix design is submitted, submit TSR specimens and data to the appropriate Division QA Laboratory in accordance with Department policies and procedures.

In addition, when requested by the Engineer, submit to the Department's Materials & Tests Unit in Raleigh, representative samples of each mix component, including RAP, RAS, mineral filler, asphalt binder, chemical anti-strip additive and hydrated lime as noted below. Provide the samples at least 10 days prior to beginning placement of mixture.

- 250 lb. (115 kg) of each coarse aggregate
- 150 lb. (70 kg) of each intermediate and fine aggregate
- 150 lb. (70 kg) RAP and / or RAS
- 1 gal. (4 liters) of mineral filler and/or baghouse fines
- 2 gal. (8 liters) of asphalt binder
- 1 gal. (4 liters) of hydrated lime

When the submitted aggregate samples are combined according to the Contractor's proposed blend percentages, the combined gradation must be within the gradation band defined by the design criteria specified in Table 610-1 for each sieve or the samples will not be considered representative and new samples may be required.

**(B) Mix Design Criteria:**

Design and produce asphalt concrete mixtures which conform to the gradation requirements and design criteria in Table 610-1 and Table 610-2 for the mix type specified. The mix type designates the nominal maximum aggregate size and the design traffic level.

Table 610-1 provides gradation control points to be adhered to in the development of the design aggregate structure for each mix type. Aggregate gradations must be equal to or pass between the control points, unless approved in writing. Table 610-2 provides the mix design criteria for the various mix types.

Use an anti-strip additive in all Superpave asphalt mixes. It may be hydrated lime or a chemical additive or a combination of both as needed to meet the retained strength requirements as specified in TABLE 610-2. When a chemical additive is used, add at a rate of not less than 0.25% by weight of binder in the mix. When hydrated lime is used, add at a rate of not less than 1.0 % by weight of the total dry aggregate.

**(C) Job Mix Formula:**

Establish the job mix formula (JMF) gradation target values within the design criteria specified for the particular type of asphalt mixture to be produced. Establish the JMF asphalt binder content at the percentage which will produce voids in total mix (VTM) at the midpoint of the specification design range for VTM, unless otherwise approved. The formula for each mixture will establish the following: blend percentage of each aggregate fraction, the percentage of reclaimed aggregate, if applicable, a single percentage of combined aggregate passing each required sieve size, the total percentage and grade of asphalt binder required for the mixture (by weight of total mixture), the percentage and grade of asphalt binder to be added to the mixture (for recycled mixtures), the percentage of chemical anti-strip additive to be added to the asphalt binder or percentage of hydrated lime to be added to the aggregate, the temperature at which the mixture is to be discharged from the plant, the required field density, and other volumetric properties.

The mixing temperature at the asphalt plant will be established on the job mix formula between 265°F (130°C) and 350°F (175°C) or as approved. Unless otherwise requested, the JMF temperature will be established as follows:

Mixes with binder grade:	PG 64-22	300°F (149°C)
	PG 70-22	315°F (157°C)
	PG 76-22	335°F (168°C)

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Have on hand at the asphalt plant the approved mix design and job mix formula issued by the Department, prior to beginning the work.

The job mix formula for each mixture will remain in effect until modified in writing, provided the results of QMS tests performed in accordance with Section 609 on material currently being produced conform with specification requirements. When a change in sources of aggregate materials is to be made, a new mix design and job mix formula will be required before the new mixture is produced, unless otherwise approved. When a change in sources of RAP or RAS material is to be made, a new mix design and/or job mix formula may be required in accordance with Article 1012-1. When unsatisfactory results or other conditions make it necessary, the Engineer may revoke the existing job mix formula or establish a new job mix formula.

**TABLE 610-1  
SUPERPAVE AGGREGATE GRADATION DESIGN CRITERIA**

Standard Sieves (mm)	Percent Passing Criteria (Control Points)									
	Mix Type (Nominal Maximum Aggregate Size)									
	9.5 mm		12.5 mm		19.0 mm		25.0 mm		37.5 mm	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
50.0										100.0
37.5								100.0	90.0	100.0
25.0						100.0	90.0	100.0		90.0
19.0				100.0	90.0	100.0		90.0		
12.5		100.0	90.0	100.0		90.0				
9.5	90.0	100.0		90.0						
4.75		90.0								
2.36	32.0	67.0	28.0	58.0	23.0	49.0	19.0	45.0	15.0	41.0
1.18										
0.600										
0.300										
0.150										
0.075	4.0	8.0	4.0	8.0	3.0	8.0	3.0	7.0	3.0	6.0

Restricted Zone Guidelines										
4.75							39.5	39.5	34.7	34.7
2.36	47.2	47.2	39.1	39.1	34.6	34.6	26.8	30.8	23.3	27.3
1.18	31.6	37.6	25.6	31.6	22.3	28.3	18.1	24.1	15.5	21.5
0.600	23.5	27.5	19.1	23.1	16.7	20.7	13.6	17.6	11.7	15.7
0.300	18.7	18.7	15.5	15.5	13.7	13.7	11.4	11.4	10.0	10.0

Aggregate Nominal Maximum Size is defined as one standard sieve size larger than the first sieve to retain more than 10 percent aggregate. Maximum Size is defined as one standard sieve size larger than the nominal maximum size.

**TABLE 610-2  
SUPERPAVE MIX DESIGN CRITERIA**

Mix Type	Design ESALs (millions) (a)	Binder PG Grade (b)	Compaction Levels			Volumetric Properties (c)			
			No. Gyration @			VMA % Min.	VTM %	VFA Min. - Max.	%Gmm @ N <sub>ini</sub>
			N <sub>ini</sub>	N <sub>des</sub>	N <sub>max</sub>				
S-9.5A	< 0.3	64 - 22	6	50	75	15.0	3.0 - 5.0	70 - 80	≤ 91.5
S-9.5B	0.3 - 3	64 - 22	7	75	115	15.0	3.0 - 5.0	65 - 80	≤ 90.5
S-9.5C	3 - 30	70 - 22	8	100	160	15.0	3.0 - 5.0	65 - 76	≤ 89.0
S-12.5B	< 3	64 - 22	7	75	115	14.0	3.0 - 5.0	65 - 78	≤ 90.5
S-12.5C	3 - 30	70 - 22	8	100	160	14.0	3.0 - 5.0	65 - 75	≤ 89.0
S-12.5D	> 30	76 - 22	9	125	205	14.0	3.0 - 5.0	65 - 75	≤ 89.0
I-19.0B	< 3	64 - 22	7	75	115	13.0	3.0 - 5.0	65 - 78	≤ 90.5
I-19.0C	3 - 30	64 - 22	8	100	160	13.0	3.0 - 5.0	65 - 75	≤ 89.0
I-19.0D	> 30	70 - 22	9	125	205	13.0	3.0 - 5.0	65 - 75	≤ 89.0
B-25.0B	< 3	64 - 22	7	75	115	12.0	3.0 - 5.0	65 - 78	≤ 90.5
B-25.0C	> 3	64 - 22	8	100	160	12.0	3.0 - 5.0	65 - 75	≤ 89.0
B-37.5C	> 3	64 - 22	8	100	160	11.0	3.0 - 5.0	63 - 75	≤ 89.0
All Mix Types	<b>Design Parameter</b>					<b>Design Criteria</b>			
	1. %G <sub>mm</sub> @ N <sub>max</sub>					≤ 98.0% (d)			
	2. Dust to Binder Ratio (P <sub>0.075</sub> / P <sub>be</sub> )					0.6 - 1.4			
3. Retained Tensile Strength (TSR) (AASHTO T 283 Modified)					85 % Min. (e)				

- Notes:
- (a) Based on 20 year design traffic.
  - (b) When Recycled Mixes are used, select the binder grade to be added in accordance with Article 610-3(A).
  - (c) Volumetric Properties based on specimens compacted to N<sub>des</sub> as modified by the Department.
  - (d) Based on specimens compacted to N<sub>max</sub> at selected optimum asphalt content.
  - (e) No Freeze-Thaw cycle required. Minimum TSR for Type B 25.0 and Type B 37.5 mixes is 80% minimum.

#### **610-4 WEATHER, TEMPERATURE, AND SEASONAL LIMITATIONS FOR PRODUCING AND PLACING ASPHALT MIXTURES.**

Do not produce or place asphalt mixtures during rainy weather, when the subgrade or base course is frozen, or when the moisture on the surface to be paved would prevent proper bond. Do not place asphalt material when the air temperature, measured in the shade away from artificial heat at the location of the paving operation and the road surface temperature in the shade is less than the temperatures shown in Table 610-3.

Do not place surface course material which is to be the final layer of pavement between December 15 and March 16 of the next year if it is 1" (25 mm) or greater in thickness or between November 15 and April 1 of the next year if it is less than 1" (25 mm) in thickness, unless otherwise approved. Do not place open-graded asphalt friction course between October 31 and April 1 of the next year, unless otherwise approved.

As an exception to the above, when in any day's operations the placement of a layer of asphalt base course material or intermediate material 2" (50 mm) or greater in thickness has started, it may continue until the temperature drops to 32°F (0° C).

Do not place plant mix base course or intermediate course that will not be covered with surface course during the same calendar year or within 15 days of placement if the plant mix is placed in January or February. Failure by the Contractor to cover the plant mix as required above will result in the Engineer notifying the Contractor in writing to cover the plant mix with a sand seal. Apply the sand seal in accordance with the requirements of Section 660 of the Standard Specifications, except that Articles 660-3, 660-11, and 660-12 will not apply. Perform this work at no cost to the Department. In the

event the Contractor fails to apply the sand seal within 72 hours of receipt of such notice, the Engineer may proceed to have such work performed with Department forces and equipment. The cost of such work performed by Department forces will be deducted from monies due or to become due to the Contractor.

**TABLE 610-3  
SUPERPAVE MIX TYPE TEMPERATURE REQUIREMENTS**

<b>Asphalt Concrete Mix Type</b>	<b>Minimum Air Temperature</b>	<b>Minimum Road Surface Temperature</b>
ACBC, Type B 25.0B, C, B 37.5C	35°F (2°C)	35°F (2°C)
ACIC, Type I 19.0B, C, D	35°F (2°C)	35°F (2°C)
ACSC, Type S 9.5A, B, S 12.5B	40°F (5°C)	50°F (10°C)
ACSC, Type S 9.5C, S 12.5C, D	50°F (10°C)	50°F (10°C)

### **610-5 ASPHALT MIXTURE PRODUCTION.**

#### **(A) General:**

Utilize plants which are either of the batch mixing, continuous mixing, or drum mixing type, and so designed, equipped, and operated that the weighing, proportioning, and mixing of the materials will result in a uniform and satisfactory asphalt mixture meeting the requirements of these specifications. All plants must conform to requirements of Subarticle 610-5(B) for the preparation of asphalt mixtures. In addition, batch mixing plants must conform to the requirements of Subarticle 610-5(C), continuous mixing plants must conform to the requirements of Subarticle 610-5(D), and drum mixing plants must conform to the requirements of 610-5(E).

Prior to production of the mix, stockpile aggregates for a sufficient period of time to facilitate the drainage of free moisture. Keep the different aggregate sizes separated until they have been delivered to the cold feeders. Keep the separate stockpiles readily accessible for sampling.

When mineral filler is required in the mix, feed or weigh-in separately from the other aggregates.

Introduce the asphalt binder and other additives, when required, into the mixture at the amounts and percentages specified by the job mix formula. No working tolerance will be allowed. Introduce the dried and heated aggregates, and mineral filler, when required, in amounts and at temperatures such that the mixture produced is within the production control limits of Subarticle 609-5(C)(4). Provide a positive means of controlling mixing time so as to obtain complete and uniform coating of the aggregate particles and thorough distribution of the asphalt binder throughout the aggregate.

Produce the mixture at the asphalt plant within  $\pm 15^{\circ}\text{F}$  ( $\pm 8^{\circ}\text{C}$ ) of the temperature established on the JMF. Assure the temperature of the mix immediately prior to discharge from the hauling vehicle is within  $+15^{\circ}\text{F}$  ( $\pm 8^{\circ}\text{C}$ ) to  $-25^{\circ}\text{F}$  ( $-14^{\circ}\text{C}$ ) of the JMF temperature.

All asphalt plants must be certified by the Department as meeting the requirements of these specifications. Certification is effective from the date of issuance and is non-expiring subject to continued compliance. The Department will check the plant on an annual basis or as deemed necessary by the Engineer. Any plant which is relocated, modified, or changes ownership must be recertified prior to use.

Any completely automatically controlled asphalt plant which, due to the basic design of the plant, does not meet all the requirements of these specifications for conventional batch mixing, continuous mixing, or drum mixing may be utilized on a project by project basis provided a uniformly consistent mix meeting all mix requirements can be produced and the plant has been approved in writing.

**(B) Requirements for All Plants:****(1) Equipment for Preparation of Asphalt Binder:**

Equip tanks for the supplying of asphalt binder to the plant to uniformly heat and hold the material at the required temperature prior to introduction into the mixer unit. Provide a circulating system for asphalt materials which is capable of the proper mixing of additives. Provide a system with adequate pump or pumps to charge the mixing unit and unload asphalt material simultaneously. Include provisions for measuring and sampling plant supply tanks.

**(2) Anti-Strip Additive Equipment:**

When chemical anti-strip additive is to be added to the asphalt binder at the asphalt plant in lieu of at the terminal, equip the plant with an in-line blending system capable of metering the additive within plus or minus 10 percent of the amount specified. Provide a thermostatically controlled heating system capable of heating and maintaining the additive tanks, contents and distribution system at the additive supplier's recommended temperature for the additive being used. Interlock the additive metering system with the asphalt binder control equipment in such a manner as to automatically vary the additive feed rate to maintain the required proportions. Provide a system which will automatically indicate in the plant control room the amount or rate of flow, when flow is occurring, and when flow is obstructed or stops. Inject the additive into the asphalt binder feed line prior to introduction into the aggregate. Equip the feed line with an in-line blending device capable of thoroughly mixing the additive with the asphalt binder prior to mixing with the aggregate. Provide a metering system capable of being calibrated, checked, and monitored for accuracy and amount of additive used.

Equip the system with an in-line totalizing flow meter capable of measuring the actual quantity in gallons (liters) of anti-strip additive which is injected into the asphalt binder being introduced into the aggregate. Provide a system which is capable of being easily read but not capable of being reset. Install the totalizer meter in the anti-strip feedline beyond the calibration bypass and as close to the actual point of additive introduction into the feedline as practical.

When hydrated lime anti-strip additive is used, provide a separate bin or tank and feeder system to store and proportion the lime into the aggregate in either dry or slurry form. Mix the lime and aggregate by pugmill or other approved means to achieve a uniform lime coating of the aggregate prior to entering the drier. When the lime is added in dry form, the aggregate must contain at least 3 percent free moisture. The stockpiling of lime treated aggregate will not be permitted. Control the lime feeder system by a proportioning device which is accurate to within  $\pm 10$  percent of the specified amount. Provide a proportioning device with a convenient and accurate means of calibration and which is interlocked with the aggregate feed or weigh system so as to maintain the correct proportion. Provide a flow indicator or sensor which is interlocked with the plant controls such that production of the mixture will be interrupted if there is a stoppage or reduction of the lime feed.

**(3) Aggregate Cold Feed Equipment:**

Utilize cold bins and a feeder system to proportion the aggregates and feed them to the dryer. Use separate cold bins for each size aggregate and each natural sand being used to provide a uniform and continuous flow. Provide separate dry storage when mineral filler is required. Equip cold aggregate bins with feeder units having interlocking controls capable of maintaining a constant ratio between the relative quantities of each size aggregate at varying plant production rates.

Provide cold feeders which are capable of being easily and accurately calibrated to ensure full control of the mix gradation.

**(4) Dryer:**

Use a plant with a dryer or dryers which continuously agitate the aggregate during the heating and drying process.

**(5) Control Unit for Asphalt Binder:**

Provide satisfactory means, either by weighing or metering to introduce the proper amount of asphalt binder into the mix.

**(6) Thermometric Equipment:****(a) Asphalt Binder Thermometric Equipment:**

Provide a thermometric device of adequate temperature range fixed in the asphalt binder feed line.

**(b) Dryer Thermometric Equipment:**

Equip the dryer with an automatic burner control device which uses an approved thermometric instrument located in the discharge chute to actuate the automatic controls.

**(7) Pollution Control Equipment:**

Equip all plants with such pollution control equipment as is necessary to meet all applicable local, State, and Federal pollution requirements. Register and certify all plants by applicable environmental regulatory agencies prior to being certified by the Department.

**(8) Safety Requirements:**

Provide adequate safety devices at all points where accessibility to plant operations is required. Provide accessibility to the top of truck bodies by a platform or other suitable device to enable Quality Control and Quality Assurance personnel to obtain samples and mixture temperature data. Thoroughly guard and protect all gears, pulleys, chains, sprockets, and other dangerous moving parts. Provide ample and unobstructed space on the mixing platform. Maintain a clear and unobstructed passage at all times in and around the truck loading area. Keep all work areas free from asphalt drippings.

**(9) Production Consistency:**

Any asphalt plant that cannot consistently produce a high quality mix meeting the requirements of these specifications will be considered in non-compliance with these specifications and may have its certification revoked.

Upon a malfunction of required automatic equipment on a batch mixing plant, the plant may continue to operate manually for the following 2 consecutive working days, provided acceptable mixture is being produced.

When a malfunction of required automatic equipment on a drum mixer or continuous plant occurs, manual operation of the plant will not be allowed except that if, in the opinion of the Engineer, an emergency traffic condition exists, the plant may be allowed to operate manually until the unsafe traffic condition is corrected. All mix produced by manual operation will be subject to the provisions of Section 609.

**(C) Requirements for Batch Mixing Plants:****(1) Plant Scales and/or Weighing Devices:**

Provide and keep scales accurate to 0.5 percent at anticipated scale settings that may be required.

Scales will be inspected and tested as described in the latest edition of the Department's HMA/QMS Manual or as the Engineer may deem necessary to assure their continued accuracy.

Provide not less than ten 50-pound (22.68 kg) weights for testing the plant scales.

**(2) Screens:**

Provide plant screens which are capable of adequately screening aggregates to the specified sizes necessary to consistently produce a mixture meeting the requirements of the job mix formula. Provide screens for removing all oversize materials.

**(3) Hot Bins:**

Include hot storage bins of sufficient capacity and number to supply the mixer with uniform material. Equip each compartment with adequate and convenient devices to provide for sampling. Provide each compartment with an overflow pipe of such sizes and at such locations as to prevent any backing up of the material into other bins or interference with the operations of screens. Provide gates which close tightly so that no material is allowed to leak into the weigh hopper.

**(4) Weigh Box or Hopper:**

Use equipment which includes a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without running over. Provide a gate which closes tightly so that no material is allowed to leak into the mixer while a batch is being weighed.

**(5) Asphalt Binder Controls:**

Use equipment to measure the asphalt binder which is capable of an accuracy of plus or minus 0.5 percent by weight of the amount of asphalt binder required. Locate the flow indicator, whether scale or metering device is used, in full view of the operator.

Provide an asphalt binder bucket of the non-tilting type with a removable top.

Provide gates which close tightly such that no material is allowed to leak into the weigh hopper. Adequately heat the asphalt binder bucket, its discharge valve or valves, and distribution bar. Ensure heating connections are so constructed that they will not interfere with the efficient operation of the asphalt binder scales. Provide an asphalt binder bucket with a capacity of at least 15 percent in excess of the weight of asphalt binder required in any batch. Locate an adequately heated, quick-acting, non-drip, charging valve near the asphalt binder bucket.

When a metering device is substituted for an asphalt binder bucket, use a flow indicator with a capacity of at least 15 percent in excess of the quantity of asphalt binder used in a batch. Provide a valve and outlet for checking the meter in the section of asphalt feed line between the charging valve and distribution bar.

Provide a system capable of discharging all of the asphalt binder required for one batch in not more than 15 seconds after the flow has started. Make the size and spacing of the distribution bar openings capable of providing a uniform application of asphalt binder across the full length of the mixer.

**(6) Mixer:**

Provide batch mixer of an approved type which is capable of producing a uniform mixture. If not enclosed, equip the mixer box with a dust hood to prevent loss of dust. Provide a batch mixer with a rated capacity of not less than 3,000 pounds (1360 kg).

Maintain the clearance of blades from all fixed and moving parts such as to insure complete coating and mixing of aggregates and asphalt binder.

**(7) Control of Proportioning and Mixing:**

Utilize plants with fully automated controls for proportioning and mixing. Equip the mixer with an accurate interlocking timing device to control the operations of a complete mixing cycle.

Use a timing device capable of being set at intervals of 5 seconds or less throughout a total cycle.

Mixing time will be established by the Engineer. Provide means by lock, cover, or other methods to prevent unauthorized changes in mixing time.

**(D) Requirements for Continuous Mixing Plants:****(1) General:**

Utilize continuous mixing plants which have fully automated proportioning and mixing controls and a rated capacity of at least 90 tons (82 metric tons) per hour.

**(2) Aggregate Proportioning:**

Equip the plant with a feeder system capable of being accurately calibrated to uniformly produce the specified mixture.

Include means for accurately proportioning each size of aggregate to consistently meet the requirements of the job mix formula.

**(3) Screens:**

Provide plant screens which are capable of adequately screening aggregates to the specified sizes necessary to consistently produce a mixture meeting the requirements of the job mix formula. Use screens which are capable of removing all oversize materials.

**(4) Hot Bins:**

Provide hot storage bins of sufficient capacity and number to supply the mixer with uniform material. Equip each compartment with adequate and convenient devices to allow for sampling. Equip each compartment with an overflow pipe of such sizes and at such locations as to prevent any backing up of material into other bins or interference with the operations of screens. Provide adjustable gates such that the rate of flow can be controlled.

**(5) Synchronization of Aggregate Feed and Asphalt Binder Feed:**

Provide satisfactory means to afford positive interlocking control between the flow of aggregate from the bins and the flow of asphalt binder from the meter or other proportioning device. Accomplish this control by interlocking mechanical means or by other positive methods satisfactory to the Engineer.

**(6) Mixer:**

Provide a continuous mixer of an approved type, adequately heated and capable of producing a uniform mixture. Equip the mixer with a discharge hopper with dump gates which will permit rapid and complete discharge of the mixture. Provide paddles which are adjustable for angular position on the shafts and reversible to retard the flow of the mix. Provide the manufacturer's plate giving the net volumetric contents of the mixer at several heights inscribed on a permanent gauge. Provide charts showing the rate of feed per revolution and per interval of time at the plant operating speed.

**(E) Requirements for Drum Mix Plants:****(1) Aggregate Feed Equipment:**

Equip each cold feeder with an automatic device which activates a warning alarm and/or flasher light when any bin becomes empty or when aggregate flow becomes

restricted. Interlock the automatic device with the plant control system so as to automatically stop production if normal aggregate flow is not resumed within 60 seconds.

**(2) Scalping Screen:**

Provide a vibratory screening system capable of removing all oversize materials for the particular mix being produced prior to entry of the aggregate into the dryer-drum mixer. Locate the screening system in the aggregate flow prior to the material passing over the aggregate weighing system.

**(3) Weight Measurement of Aggregate:**

Provide a system which ensures positive weight measurement of the combined cold aggregate feed rate by the use of belt scales or other approved devices. Provide means to allow correction for variations in the moisture content of the cold aggregate. Provide a continuous readout or other means that can be monitored in the plant control room and which indicates the aggregate dry-weight equivalent feed rate. Interlock the aggregate weighing system binder flow to automatically maintain the required proportions. Provide a weighing system capable of being easily and accurately calibrated.

**(4) Dryer-Drum Mixer Unit:**

Provide a drum mixer which is specifically designed and constructed for the process and capable of producing a uniform mixture. Control heating to prevent damage to the aggregate and asphalt binder. Provide a dryer-drum mixer with a rated capacity of at least 90 tons (82 metric tons) per hour when producing a finished mixture at 300°F (149°C) with removal of 5 percent moisture.

**(5) Asphalt Binder Controls:**

Provide a metering system capable of introducing the required amount of asphalt binder in the mix, including a means of correcting the delivered asphalt binder flow rate for temperature and specific gravity variations. Connect the flow meter to the asphalt binder supply so as to measure and display only the asphalt binder being fed to the mixer unit. Position the meter readout for convenient observation by the plant operator.

Provide means for checking the rate of flow of asphalt binder into the mixing unit. Assure the rate of flow is accurate to 0.5 percent by weight of the amount of asphalt binder required.

**(6) Synchronization of Aggregate Feed and Asphalt Binder Feed:**

Interlock the asphalt binder feed control with the total aggregate weight measurement device in such a manner as to automatically vary the asphalt binder feed rate as necessary to maintain required proportions. Interlock the controls in a manner that will automatically stop all feed components if either the aggregate or asphalt flow stops.

**(7) Asphalt Mixture Storage Facilities:**

Provide hot mix surge storage facilities in accordance with Article 610-6 that are adequate to minimize production interruptions during operation and ensure the mixture meets the requirements of the job mix formula when discharged from the storage bin.

**610-6 HOT MIX STORAGE SYSTEMS:**

When a storage system is used, provide a system capable of conveying the mix from the plant to the storage bin and storing the mix without a loss in temperature, segregation or oxidation of the mix. Limit storage time to the ability of the storage system

to maintain the mix within the specification requirements. Material may be stored in storage bins without an approved heating system for no more than 24 hours.

Provide a continuous type or skip bucket type conveyor system. Enclose continuous type conveyors so that the mix temperature is maintained within specification requirements. Provide a system designed in such manner as to prevent segregation of the mix during discharge from the conveyor into the bins and equipped with discharge gates that will not cause segregation of the mix while loading the mix into trucks.

#### **610-7 HAULING OF ASPHALT MIXTURE.**

Transport the mixture from the mixing plant to the point of use in vehicles which have tight, clean, smooth metal beds that have been sprayed with an approved release agent, or other approved material, to prevent the mixture from adhering to the beds. Remove excess release agent prior to loading. Cover each load of mixture with a canvas or other suitable material. Use covers which are so constructed and secured as to prevent the entrance of moisture and the rapid loss of temperature. Provide a 3/8 inch (9.5 mm) diameter hole on each side of the vehicle body near the center of the body and 6 inches (150 mm) above the bed of the vehicle for the purpose of inserting a thermometer.

Assure temperature of the mixture immediately prior to discharge from the hauling vehicle is within a tolerance of plus 15°F (8°C) to minus 25°F (14°C) of the specified job mix formula temperature.

#### **610-8 SPREADING AND FINISHING.**

Apply tack coat in accordance with the provisions of Section 605.

Mixtures produced simultaneously from different plant sources can not be intermingled by hauling to the same paver on the roadway unless the mixtures are being produced from the same material sources and same job mix formula.

Utilize a self-contained, power propelled paver capable of spreading and finishing the asphalt mixture to the required grades, cross sections, thicknesses, and widths shown on the plans and typical sections and to uniform density and texture. Equip and operate the paver with a fully activated screed plate which is designed to be preheated for the full length whenever necessary. Provide a screed of adequate length to spread and finish the full uniform width travel lane being placed, unless otherwise permitted. Do not use strike off devices, either mechanically or manually operated, in spreading and finishing mixture placed in the uniform width travel lane.

Utilize a the paver with a receiving hopper and an automatically controlled distribution system which is capable of uniformly maintaining a proper head of material in front of the full length of the screed, including screed extensions. Equip the screed unit with a sliding shoe attachment which will form a slope on the edge of the mat to prevent edge raveling when the mixture is compacted.

Place a string line for the first lane of each layer of mixture placed to provide alignment control for the paver, except that a string line will not be required when the first layer is placed adjacent to a curb section.

Operate pavers at forward speeds consistent with plant production, material delivery, and satisfactory laying of the mixture so as to ensure a uniform and continuous laydown operation. Coordinate and adjust the paving operation and loading operation so as to maintain an adequate amount of asphalt mixture in the paver hopper between truck exchanges. Do not allow the paver hopper to become empty between loads. Should unevenness of texture, tearing, segregation, or shoving occur during the paving operation due to unsatisfactory methods or equipment, immediately take such action as may be necessary to correct such unsatisfactory work. Excessively throwing back material will not be permitted.

Utilize pavers equipped with a screed control system which will automatically control

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the longitudinal profile and cross slope of the pavement through the use of either a mobile grade reference(s), including mechanical, sonic and laser grade sensing and averaging devices, an erected string line(s), joint matching shoe(s), slope control devices or other approved methods or combination of methods. Unless otherwise specified, use a mobile grade reference system capable of averaging the existing grade or pavement over a minimum 30 foot (9.1 meter) distance. Establish the position of the mobile reference system such that the grade sensor is at the approximate midpoint of the system.

Use an erected fixed stringline for both and longitudinal profile and cross slope control when required by the contract. When an erected fixed string line is required, furnish and erect the necessary guide line for the equipment. Support the stringline with grade stakes placed at maximum intervals of 25 feet (7.6 meter) for the finished pavement grade.

Utilize the 30 foot (9.1 meter) minimum length mobile grade reference system to control the longitudinal profile when placing the initial lanes and all adjacent lanes of all courses, including resurfacing and asphalt in-lays, unless otherwise specified or approved. A joint matching device short (6 inch [152.4 mm] shoe) may be used only when approved.

Utilize the automatic slope control system unless otherwise approved. The Engineer may waive the use of automatic slope controls in areas where the existing surface (subgrade, base, asphalt layer, etc.) exhibits the desired cross slope of the final surface. The Engineer may also waive the use of automatic slope controls in areas where the use of such equipment is impractical due to irregular shape or cross section (such as resurfacing). When the use of the automatic slope controls is waived, the Engineer may require the use of mobile grade references on either or both sides of the paver. Manual screed operation will be permitted in the construction of irregularly shaped and minor areas, subject to approval.

In the case of malfunction of the automatic screed control equipment, the paver may be manually operated for the remainder of the work day provided this method of operation produces acceptable results. Do not resume work thereafter until the automatic system is functional.

The Engineer will waive the requirement for use of pavers for spreading and finishing where irregularities or obstacles make their use impractical. Spread, rake, and lute the mixture by hand methods or other approved methods in these areas.

Operate the paver as continuously as possible. Pave intersections, auxiliary lanes, and other irregular areas after the main line roadway has been paved, unless otherwise approved.

### **610-9            COMPACTION.**

Immediately after the asphalt mixture has been spread, struck off, and surface and edge irregularities adjusted, thoroughly and uniformly compact the pavement. Compact the mix to the required degree of compaction for the type of mixture being placed.

Provide sufficient number and weight of rollers, except as noted, to compact the mixture to the required density while it is still in a workable condition. Obtain approval of equipment used in compaction from the Engineer prior to use. Where uniform density is not being obtained throughout the depth of the layer of material being tested, change the type and/or weight of the compaction equipment as necessary to achieve uniform density even though such equipment has been previously approved.

Compact all final wearing surfaces, except open-graded asphalt friction course, using a minimum of 2 steel wheel tandem rollers, unless otherwise approved. Pneumatic-tired rollers with 2 tandem axles and smooth tread tires may be used for intermediate rolling.

Limit rolling for open-graded asphalt friction course to one coverage with a tandem steel wheel roller weighing a maximum of 10 tons (9.1 metric tons), with additional rolling limited to one coverage with the roller where necessary to improve the riding surface.

## Section 610

Steel wheel tandem vibratory rollers which have been specifically designed for the compaction of asphalt pavements may be used on all layers 1 inch (25 mm) or greater in thickness during the breakdown and intermediate rolling phase. Do not operate vibratory rollers in the vibratory mode during the finish rolling phase on any mix type or pavement course, open-graded asphalt friction course, or on permeable asphalt drainage course.

When vibratory rollers are used, use rollers which have variable amplitude and frequency capabilities and which are designed specifically for asphalt pavement compaction. Provide rollers equipped with controls which automatically disengage the vibration mechanism before the roller stops when being used in the vibratory mode.

The Engineer may prohibit or restrict the use of vibratory rollers where damage to the pavement being placed, the underlying pavement structure, drainage structures, utilities, or other facilities is likely to occur or is evident.

Do not use rolling equipment which results in excessive crushing of the aggregate or excessive displacement of the mixture.

In areas inaccessible to standard rolling equipment, thoroughly compact the mixture by the use of hand tampers, hand operated mechanical tampers, small rollers, or other approved methods.

Use rollers which are in good condition and capable of being reversed without backlash to compact the mixture. Operate rollers with the drive wheels nearest the paver and at uniform speeds slow enough to avoid displacement of the mixture. Equip steel wheel rollers with wetting devices which will prevent the mixture from sticking to the roller wheels.

Begin compaction of the material immediately after the material is spread and shaped to the required width and depth. Carry out compaction in such a manner as to obtain uniform density over the entire section. Perform compaction rolling at the maximum temperature at which the mix will support the rollers without moving horizontally. Complete the compaction (including both intermediate rolling) prior to the mixture cooling below a workable temperature. Perform finish rolling to remove roller marks resulting from the compaction rolling operations.

### 610-10 DENSITY REQUIREMENTS.

**TABLE 610-4  
MINIMUM DENSITY REQUIREMENTS**

<b>MIX TYPE SUPERPAVE MIXES</b>	<b>MINIMUM % OF <math>G_{mm}</math> (AASHTO T 209)</b>
All Mix Types Listed in Table 610-2	92.0

Compact the asphalt plant mix to at least the minimum percentage of the maximum specific gravity (AASHTO T 209) listed in Table 610-4, except as noted below. Perform density sampling and testing on all pavement widening 4.0 feet (1.2 m) or greater, on uniform width paved shoulders 2.0 feet (0.6 m) or greater, and on all full width travel lane pavements, including normal travel lanes, turn lanes, collector lanes, ramps and loops, and temporary pavements, unless otherwise approved.

For base and intermediate mix types (surface mix types not included) used to widen pavements less than 4.0 feet (1.2 m), for all mix types used in intersections (exclusive of full width travel lanes), tapers, and for irregular areas, a specified density will not be required provided the pavement is compacted using approved equipment and procedures.

Irregular areas are defined as areas which have irregular shapes which make them difficult to compact with conventional asphalt rollers.

Where the mixture is to be compacted to a specified density in accordance with these specifications, utilize either nuclear density testing methods or cored sample testing methods to determine the density in accordance with Article 609-5.

**610-11 JOINTS.**

**(A) Transverse Joints:**

When the placing of the mixture is to be suspended long enough to permit the mixture to become chilled, construct a transverse joint.

If traffic will not pass over the end of the paving, a butt joint will be permitted, provided proper compaction is achieved. If traffic will pass over the joint, construct a sloped wedge ahead of the end of the full depth pavement to provide for proper compaction and protection of the full depth pavement. Construct the joint square to the lane alignment and discard all excess material. Place a paper parting strip beneath this wedge to facilitate joint construction unless waived by the Engineer.

Before paving operations are resumed, remove the sloped wedge and cut back into the previously constructed pavement to the point of full pavement depth. Coat the exposed edge of the previously constructed pavement with tack coat.

When laying of the mixture is resumed at the joint, complete and then test the construction of the joint in accordance with Article 610-12 while the mixture is still in a workable condition.

**(B) Longitudinal Joints:**

Tack the exposed edge of all longitudinal joints prior to placing the adjoining pavement.

Form longitudinal joints by allowing the paver to deposit the mixture adjacent to the joint to such depth that maximum compaction can be obtained along the joint. Pinch the joint by rolling immediately behind the paver.

When multi-lane multi-layer construction is required, offset the longitudinal joints in each layer from that in the layer immediately below by approximately 6 inches (150 mm). Construct the joints in the final layer, where possible, between designated travel lanes of the final traffic pattern.

**610-12 SURFACE REQUIREMENTS AND ACCEPTANCE.**

Construct the surface of the plant mix pavement smooth and true to the required cross section and grade. Immediately correct any defective areas with satisfactory material compacted to conform with the surrounding area. Remove and replace any area showing an excess of asphalt binder or segregation.

Provide a surface of the pavement after compaction that conforms to the requirements below, except in the case where the Project Special Provision titled, "FINAL SURFACE TESTING - ASPHALT PAVEMENTS" is included in the contract. In that case, adhere to the project special provision.

Each pavement layer will be tested by the Contractor and the Engineer at all joints and at other selected locations using a 10 foot (3.05 m) straightedge furnished by the Contractor. Apply the straightedge parallel to the centerline of the surface. Do not exceed 1/8 inch (3.2 mm) variation of the surface being tested from the edge of the straightedge between any 2 contact points. Correct areas found to exceed this tolerance by removal of the defective work and replacement with new material, unless other corrective measures are permitted. Provide the work and materials required in the correction of defective work at no cost to the Department.

**610-13 DENSITY ACCEPTANCE.**

The Department will evaluate the asphalt pavement for density acceptance after the asphalt mix has been placed and compacted using the Contractor's quality control test results, the Department's quality assurance test results, including verification samples, and by observation of the Contractor's density quality control process conducted in accordance with Section 609. Minimum density requirements for all mixes will be as specified in Article 610-10, Table 610-4. Density acceptance will be as provided herein. Core sample densities will be determined by use of the average maximum specific gravity ( $G_{mm}$ ), until a moving average of the last four maximum specific gravities is attained. Once a moving average of the last four maximum specific gravities is established, the last  $G_{mm}$  moving average in effect at the end of the same day's production will then be used to determine density acceptance.

The pavement will be accepted for density on a lot by lot basis. A lot will consist of one day's production of a given job mix formula on the project except that when portions of the pavement being placed falls in both the "New" construction or "Other" construction categories as described below, separate lots will be established accordingly. In addition, individual map sections will be evaluated as separate lots, unless otherwise approved. The Engineer will determine the final category and quantity of each lot for acceptance purposes.

The "New" construction category will be defined as pavements, exclusive of irregular areas, meeting all three of the following criteria:

- (1) pavement placed on a new aggregate or soil base compacted to the specified density or pavement placed on a new asphalt mix layer (excluding wedging and leveling);
- (2) pavement which is within a designated travel lane of the final traffic pattern;  
and
- (3) pavement which is 4.0 feet (1.2 meters) or wider.

As an exception, when the first layer of mix is placed on an unprimed aggregate base and is 2.0 inches (50 millimeters) or less in thickness, the layer will be included in the "Other" construction category.

The "Other" construction category will include all pavement except as described above.

A failing lot for density acceptance purposes is defined as a lot for which the average of all test sections fails to meet the minimum specification requirement. In addition, any lot or portion of a lot that is obviously unacceptable will be rejected for use in the work.

If the Engineer determines that a given lot of mix which falls in the "New" category does not meet the minimum specification requirements but the work is reasonably acceptable, the lot will be accepted at a reduced pay factor in accordance with the following formula. The reduced pay factor will apply only to the mix unit price.

$$PF = 100 - 10(D)^{1.465}$$

where: PF = Pay Factor (computed to 0.1%)  
D = the deficiency of the lot average density,  
not to exceed 3.0%

Acceptance of all failing lots in the "Other" category will be made under the provisions of Article 105-3 of the Standard Specifications.

When the deficiency of the lot average density exceeds 3.0 %, the Engineer will determine whether or not the mix is reasonably acceptable. If determined to be reasonably acceptable, the mix will be paid for at 50 percent of the contract price. If it is determined not acceptable, the mix will be removed and replaced with mix meeting the requirements of these specifications.

Any reduction in pay due to failing density will be in addition to any reduction in pay due to failing mix property test results on the same mix.

Perform the production and construction of all asphalt mixtures and pavements in accordance with these provisions. There will be no direct payment for work covered by this provision. Payment at the contract unit prices for the various asphalt items will be full compensation for all work covered by this provision.

**610-14 MAINTENANCE.**

Maintain the plant mix pavement in an acceptable condition until final acceptance of the project. Immediately repair any defects or damage that may occur. Perform maintenance to damaged or defective pavement and repeat as often as may be necessary to keep the base or pavement in an acceptable condition at no cost to the Department.

**610-15 METHOD OF MEASUREMENT.**

The quantity of hot mix asphalt pavement to be paid for will be the actual number of tons (metric tons) of each type of hot mix asphalt pavement which has been incorporated into the completed and accepted work. The hot mix asphalt pavement will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

**610-16 BASIS OF PAYMENT.**

Furnishing asphalt binder will be paid for as provided in Article 620-5 for "Asphalt Binder for Plant Mix" for each grade required.

The quantity of hot mix asphalt pavement, measured as provided in Article 610-15, will be paid for at the contract unit prices per ton (metric ton) for "Asphalt Concrete Surface Course, Type S 9.5A, Type S 9.5B, or Type S 9.5C", "Asphalt Concrete Surface Course, Type S 12.5B, Type S 12.5C, or Type S 12.5D", "Asphalt Concrete Intermediate Course, Type I 19.0B, Type I 19.0C, or Type I 19.0D", and "Asphalt Concrete Base Course, Type B 25.0B, Type B 25.0C, or Type B 37.5C".

Payment will be made under:

Asphalt Concrete Base Course, Type B 25.0B .....	Ton (Metric Ton)
Asphalt Concrete Base Course, Type B 25.0C .....	Ton (Metric Ton)
Asphalt Concrete Base Course, Type B 37.5C .....	Ton (Metric Ton)
Asphalt Concrete Intermediate Course, Type I 19.0B .....	Ton (Metric Ton)
Asphalt Concrete Intermediate Course, Type I 19.0C .....	Ton (Metric Ton)
Asphalt Concrete Intermediate Course, Type I 19.0D.....	Ton (Metric Ton)
Asphalt Concrete Surface Course, Type S 9.5A .....	Ton (Metric Ton)
Asphalt Concrete Surface Course, Type S 9.5B .....	Ton (Metric Ton)
Asphalt Concrete Surface Course, Type S 9.5C .....	Ton (Metric Ton)
Asphalt Concrete Surface Course, Type S 12.5B .....	Ton (Metric Ton)
Asphalt Concrete Surface Course, Type S 12.5C .....	Ton (Metric Ton)
Asphalt Concrete Surface Course, Type S 12.5D .....	Ton (Metric Ton)

**SECTION 620**  
**ASPHALT BINDER FOR PLANT MIX**

**620-1 DESCRIPTION.**

Perform the work covered by this section including but not limited to furnishing of asphalt binder, with anti-strip additive when required, at an asphalt plant and incorporating the asphalt binder and anti-strip additive into the asphalt plant mix.

**620-2 MATERIALS.**

Refer to Division 10:

Asphalt binder, All Grades.....	Article 1020-2
Anti-strip additive (Chemical).....	Article 1020-8
Anti-strip additive (Hydrated lime).....	Article 1012-1
Silicone.....	Article 1020-4

The asphalt binder for the mixture will be accepted at the source subject to the provisions of Article 1020-1.

Add silicone to all asphalt binder used in surface courses and open-graded asphalt friction course, unless otherwise directed. The amount of silicone added will range from 1 oz. per 2,000 gallons (30 ml per 7570 liters) of asphalt binder to 1 oz. per 2,500 gallons (30 ml per 9465 liters). Add silicone to the asphalt binder at the plant site unless added at the source and it is so noted on the delivery ticket. Use a brand of silicone from the list published by the Materials and Tests Unit. Submit a sample and manufacturer's data to the Engineer for approval prior to use if proposing to use a brand not on the approved list.

When required, incorporate an anti-strip additive. It may be either chemical additive mixed with the asphalt binder or hydrated lime added to the aggregate or a combination of both.

**620-3 GENERAL REQUIREMENTS.**

The requirements of Section 610 which pertain to handling of asphalt binder will be applicable to the work covered by this section.

Do not heat the asphalt binder to a temperature in excess of the supplier's recommendation while stored or when being used in production of mix at the asphalt plant.

Introduce the actual quantity of asphalt binder as established by the percentage shown on the applicable job mix formula into the mix by the plant weighing or metering system. No working tolerance for asphalt binder percentage will be allowed during production.

Furnish the name of the type (lime or chemical), supplier, and shipping point of anti-strip additive. Note on the asphalt binder delivery ticket the rate (or quantity), brand and grade of chemical additive when added at the asphalt supplier's terminal.

Introduce and mix chemical anti-strip additive into the asphalt binder at either the supplier's terminal or at the asphalt plant site at the dosage required by the JMF. Use in-line blending equipment at either location. When added at the asphalt plant, use equipment which meets the requirements of Article 610-5(B). When added at the supplier's terminal, use equipment which in-line blends the additive for a minimum of 80% of the asphalt binder loading time.

When hydrated lime is used, use equipment to introduce the lime which meets the requirements of Article 610-5(B).

Thoroughly mix chemical anti-strip additive and asphalt binder together before incorporating into the asphalt plant mix.

**620-4 METHOD OF MEASUREMENT.**

The quantity of asphalt binder to be paid for will be the theoretical number of tons (metric tons) of the grade of asphalt binder required by the applicable job mix formula based on the actual number of tons (metric tons) of plant mix completed and accepted on the job.

Where recycled plant mix is being produced, the grade of asphalt binder to be paid for will be the grade required for the specified mix type. The theoretical number of tons (metric tons) of the grade of asphalt binder to be paid for will include additional new asphalt binder, salvaged asphalt binder from the reclaimed asphalt pavement material, and salvaged asphalt from the reclaimed shingle material.

**620-5 BASIS OF PAYMENT.**

The quantity of each grade of asphalt binder, measured as provided in Article 620-4, will be paid for at the contract unit price per ton (metric ton) for "Asphalt Binder for Plant Mix, Grade PG XX-XX", except as noted below. Such price and payment will be full compensation for all work covered by this section.

There will be no direct payment for anti-strip additive. Payment at the contract unit prices for the various asphalt plant mix items will be full compensation for the work.

Adjustments will be made to the payments due the Contractor for each grade of asphalt binder when it has been determined that the monthly average terminal F.O.B. Selling Price of asphalt binder, Grade PG 64-22, has fluctuated by more than 5% from the Base Price Index for Asphalt Binder included in the Project Special Provisions. The methods for calculating a base price index, for calculating the monthly average terminal F.O.B. selling price and for determining the terminals used are in accordance with procedures on file with the Department's Construction Unit.

When it is determined that the monthly selling price of asphalt binder on the first business day of the calendar month during which the last day of the partial payment period occurs varies either upward or downward from the base price index by more than 5%, the contract unit price for asphalt binder for plant mix will be adjusted. The adjusted contract unit price will be determined by adding the difference between the selling price and the base price index plus 5% to the contract unit bid price for asphalt binder. If the selling price is less than the base price index by more than 5%, the adjusted contract unit price will be determined by subtracting the difference between the selling price and the base price index less 5% from the contract unit price for asphalt binder.

The adjusted contract unit price will then be applied to the total theoretical quantity of asphalt binder authorized for use in the plant mix placed during the partial payment period involved, including both additional new asphalt binder and salvaged asphalt binder from reclaimed asphalt materials required by the job mix formula.

Adjusted contract unit prices for all grades of asphalt binder, including additional asphalt binder materials in recycled mixtures, will be based on the average selling price and base price index for asphalt binder, Grade PG 64-22, regardless of the actual grade required by the job mix formula.

In determining the adjusted contract unit price for any material specified in this provision the following formula will be used:

$$A = B + (D - C)$$

Where:

- A = Adjusted Contract Unit Price
- B = Contract Unit Price
- C = Base Price Index  $\pm$  5%
- D = Monthly Average Terminal F.O.B. Selling Price

In the event the Department is unable to secure an F.O.B. selling price from at least four terminals in a given month, payment will be at the contract unit price for each ton of asphalt binder used in the work during that month.

Payment will be made under:

- Asphalt Binder for Plant Mix, Grade PG 64-22.....Ton (Metric Ton)
- Asphalt Binder for Plant Mix, Grade PG 70-22.....Ton (Metric Ton)
- Asphalt Binder for Plant Mix, Grade PG 76-22.....Ton (Metric Ton)

**SECTION 650**  
**OPEN-GRADED ASPHALT FRICTION COURSE,**  
**TYPES FC-1, FC-1 MODIFIED, AND FC-2 MODIFIED.**

**650-1 DESCRIPTION.**

Perform the work covered by this section including but not limited to construction of a plant mixed open-graded asphalt friction course (OGAFC) properly laid upon a prepared surface in accordance with these specifications and in conformity with the lines, grades, thickness, and typical sections shown on the plans; producing, weighing, transporting, placing, and rolling the plant mix as specified in Section 610; furnishing the asphalt binder, anti-strip additive, fiber stabilizing additive, and all other materials for the plant mix; furnishing and applying tack coat as specified in Section 605; providing quality control as specified in Section 609 as modified for OGAFC; surface testing of the completed pavement; furnishing scales; making any repairs or corrections to the friction course that may become necessary, and maintaining the friction course until final acceptance of the project.

**650-2 MATERIALS.**

See Division 10:

- Asphalt binder, Grade PG 64-22, PG 76-22 ..... Article 1020-2
- Anti-strip additive (Chemical) ..... Article 1020-8
- Anti-strip additive (Hydrated lime)..... Article 1012-1
- Coarse aggregate ..... Article 1012-1
- Mineral filler ..... Article 1012-1
- Stone screenings..... Article 1012-1
- Fiber Stabilizing Additives:

Use fiber stabilizing additives which are capable of stabilizing the asphalt film surrounding the aggregate particles in order to reduce drain-down of the asphalt binder. A fiber stabilizer such as cellulose or mineral fiber may be used. The selected fiber must meet the properties described below. Dosage rates given are typical ranges but the actual dosage rate used will be approved by the Engineer.

**(A) MINERAL FIBERS:**

Mineral fibers must be made from virgin basalt, diabase, or slag and which have been treated with a cationic sizing agent to enhance disbursement of the fiber as well as increase adhesion of the fiber surface to the asphalt binder. Add the fiber at a dosage rate between 0.2% to 0.4% by weight of total mix, as approved.

1. Size Analysis:
  - Average Fiber length: 0.25 inches (6.4 mm) maximum
  - Average Fiber thickness: 0.0002 inches (0.005 mm) maximum
2. Shot Content (ASTM C 612)
  - Passing No. 60 (0.250 mm) sieve 90- 100%
  - Passing No. 230 (0.063 mm) sieve 65- 100%
3. Degradation (GDT-124/McNett Fractionation) 30% (maximum)

**(B) CELLULOSE FIBERS:**

Add cellulose fibers at a dosage rate between 0.2% and 0.4% by weight of total mix as approved. Fiber properties must be as follows:

- |                         |                                 |
|-------------------------|---------------------------------|
| 1. Fiber length:        | 0.25 inches (6.4 mm) maximum    |
| 2. Sieve Analysis:      |                                 |
| (a) Alpine Sieve Method |                                 |
| Passing No. 100 sieve   | 60-80%                          |
| (b) Ro-Tap Sieve Method |                                 |
| Passing No. 20 Sieve:   | 80-95%                          |
| Passing No. 40 Sieve:   | 45-85%                          |
| Passing No. 100 Sieve:  | 5-40%                           |
| 3. Ash Content:         | 18% non-volatiles ( $\pm 5\%$ ) |
| 4. pH:                  | 7.5 ( $\pm 1$ )                 |
| 5. Oil Absorption:      | 5.0 ( $\pm 1$ )                 |
| (times fiber weight)    |                                 |
| 6. Moisture Content:    | 5.0 (maximum)                   |

**(C) CELLULOSE PELLETS:**

Cellulose pellets consist of a 50/50 blend of cellulose fiber and asphalt binder. Use cellulose which complies with Item (B), Cellulose Fibers, above. Add the cellulose pellets at a dosage rate between 0.4% and 0.8% by weight of total mix, as approved.

- |                 |   |
|-----------------|---|
| 1. Pellet Size: | 1/4 cubic inch [4.1 cubic mm] (maximum) |
| 2. Asphalt:     | 25 – 80 pen.                            |

**650-3 COMPOSITION OF MIXTURE (MIX DESIGN & JOB MIX FORMULA).****(A) General:**

Design the open-graded asphalt friction course utilizing a mixture of coarse and fine aggregate, asphalt binder, mineral filler, mineral fiber, fiber stabilizing additive, and other additives as required to produce a mix meeting the requirements of Table 650-1.

Submit in writing a mix design and proposed job mix formula (JMF) targets for each required mix type and combination of aggregates to the Engineer for review and approval at least 10 days prior to start of asphalt mix production. The mix design must be prepared by a mix design technician approved by the Department in an approved mix design laboratory. Perform the mix design in accordance with applicable requirements of Article 610-3 and the Department's mix design procedures titled "DETERMINATION OF OPTIMUM ASPHALT CONTENT FOR OPEN-GRADED ASPHALT FRICTION COURSES". A copy of these procedures can be obtained through the Department's Materials and Tests Unit. Submit the mix design and proposed job mix formula targets on forms and in a format approved by the Department.

The mix design and job mix formula target values will be established within the mix design criteria specified in Table 650-1 for the particular type mixture to be produced. The formula for each mixture will indicate the blend percentage of each aggregate fraction to be used, a single percentage of combined aggregate passing each required sieve, the percentage and grade of asphalt binder (by weight of total mixture) to be incorporated into the mixture, the percentage of anti-strip additive to be added to the asphalt binder, the percentage of fiber stabilizing additive (by weight of total mix), and the temperature at which the mixture is to be discharged from the plant.

Have on hand at the asphalt plant the approved mix design and job mix formula issued by the Department, prior to beginning the work.

The job mix formula for each mixture shall remain in effect until modified in writing, provided the results of QMS tests performed on material currently being produced conform with specification requirements.

Should a change in sources of aggregate materials to be made, a new mix design and job mix formula will be required before the new mixture is produced.

When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new job mix formula.

**(B) Mix Design Criteria:**

Design open-graded asphalt friction course mixtures conforming to the gradation requirements and other mix design criteria in Table 650-1 for the mix type specified.

Use the asphalt binder grade shown in Table 650-1 for the mix type specified.

Use an anti-strip additive in all OGAF C mixes. It may be hydrated lime or a chemical additive or both. Add chemical anti-strip additive at a rate of 0.5% by weight of asphalt binder. Add hydrated lime at a rate of 1.0% by weight of dry aggregate. Use approved source and grade.

Incorporate a mineral fiber stabilizing additive into all OGAF C types. Add the fiber at a dosage rate by weight of the total mix as approved.

When requested, submit to the Materials & Tests Unit in Raleigh, samples of mix components. Submit sample sizes as noted below or as requested. Provide the samples at least 10 days prior to beginning placement of OGAF C mixture.

- 250 lb. (115 kg) of each coarse aggregate
- 150 lb. (70 kg) fine aggregate
- 1 gal. (4 liters) of mineral filler and/or baghouse fines
- 1 gal. (4 liters) of hydrated lime
- 1 pint (0.5 liters) of chemical anti-strip additive
- 4 lb. (1 kg) of fiber stabilizing additive

Aggregate samples when combined according to the Contractor's proposed aggregate blend percentages must be within the gradation range defined by the target values of Table 650-1 for each sieve or the samples will not be considered representative.

The mixing temperature at the asphalt plant will be established on the job mix formula.

Add the anti-strip additive to the asphalt binder in accordance with Article 620-3.

**TABLE 650-1  
OGAFC MIX DESIGN CRITERIA**

Grading Requirements Sieve Designations	Total Percent Passing		
	Type FC-1	Type FC-1 Modified	Type FC-2 Modified
3/4 inch (19.0 mm)			100
1/2 inch (12.5 mm)	100	100	85-100
3/8 inch (9.5 mm)	75-100	75-100	55-75
No. 4 (4.75 mm)	25-45	25-45	15-25
No. 8 (2.36 mm)	5-15	5-15	5-10
No. 200 (0.075 mm)	1.0-3.0	1.0-3.0	2.0-4.0
<b>Design Requirements</b>			
Asphalt Binder, Performance Grade	PG 64-22	PG 76-22	PG 76-22
Asphalt Binder, % Range	5.0-8.0	5.0-8.0	5.0-8.0
Mixing Temperature Range (To be established by the Engineer)	200 - 275°F (93 - 135°C)	300 - 350°F (165 - 175°C)	300 - 350°F (165 - 175°C)
Retention Coating (AASHTO T 195)	95% min.	95% min.	95% min.
Draindown, Percent (AASHTO T 305)	0.3 max.	0.3 max.	0.3 max.

#### **650-4 PLANT EQUIPMENT.**

Use plant equipment in accordance with Article 610-5 and the following requirements:

When fiber stabilizing additives are required as an ingredient of the mixture, utilize a separate feed system capable of accurately proportioning the required quantity into the mixture and in such a manner that uniform distribution will be obtained. Interlock the proportioning device with the aggregate feed or weigh system so as to maintain the correct proportions for all rates of production and batch sizes. Accurately control the proportion of fibers to within plus or minus 10 percent of the amount required. Provide flow indicators or sensing devices for the fiber system which are interlocked with plant controls such that mixture production will be interrupted if introduction of the fiber fails.

When a batch type plant is used, add the fiber to the aggregate in the weigh hopper or as approved. Increase the batch dry mixing time by 8 to 12 seconds, or as directed, to assure the fibers are uniformly distributed prior to the injection of asphalt binder into the mixer.

When a continuous mix or drier-drum type plant is used, add the fiber to the aggregate and uniformly disperse at the point of injection of asphalt binder. Add the fiber in such a manner that it will not become entrained in the exhaust system of the drier or plant.

#### **650-5 CONSTRUCTION REQUIREMENTS.**

Produce, transport to the site, and place the OGAFC in accordance with the applicable requirements of Section 610, except as otherwise provided below.

Prior to starting production of the mix, stockpile all aggregates for a sufficient period of time to facilitate the drainage of free moisture.

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Produce the mixture at the asphalt plant within  $\pm 15^{\circ}\text{F}$  ( $\pm 8^{\circ}\text{C}$ ) of the temperature established on the JMF. Assure the temperature of the mix immediately prior to discharge from the hauling vehicle is within  $+15^{\circ}\text{F}$  ( $+8^{\circ}\text{C}$ ) to  $-25^{\circ}\text{F}$  ( $-14^{\circ}\text{C}$ ) of the JMF temperature.

Add the anti-strip additive to the asphalt binder in accordance with Article 620-3.

Clean the existing surface in an acceptable manner prior to placement of any asphalt material.

Remove all existing raised pavement markers as directed and repair as approved any damaged areas caused by the removal. Use an approved dense graded mixture of similar type material for the repair.

Apply tack coat in accordance with the provisions of Section 605 and the following:

1. Use Asphalt Binder, Grade PG 64-22 tack coat material or as approved.
2. Uniformly apply the tack coat material at a rate of application 0.06 to 0.08 gal. per square yard (0.25 to 0.35 liters per square meter), as directed.  
Spread and finish the friction course as specified in Article 610-8.  
Roll the friction course as specified in Article 610-9.

Remove and replace any part of the finished friction course which shows non-uniform distribution of asphalt binder, aggregate or fiber at no additional cost to the Department.

Coordinate plant production, transportation, and paving operations such that uniform continuity of operation is maintained. If spreading operations are interrupted, the Engineer may require that a transverse joint be constructed any time the mixture immediately behind the paver screed cools to less than  $250^{\circ}\text{F}$  ( $120^{\circ}\text{C}$ ).

When OGAF C, Type FC-2 Modified mixture is specified, use OGAF C, Type FC-1 Modified on entrance and exit ramps, gore areas, and at end of project construction joints. Adjust the thickness of placement as specified below.

For end of project joints, provide a transition area consisting of one load of mixture per lane, or as directed. Taper the mixture in thickness from  $3/8$  inch (9.5 mm) at the end of the project to the typical thickness (approximately  $3/4$  inch (19 mm)) within the maximum distance of spread for one load of mixture. For ramps and gore areas, taper the mixture in thickness from that at the edge of the mainline, approximately  $3/4$  inch (19 mm) to  $3/8$  inch (9.5 mm) at the point of the ramp transverse joint. Construct the ramp transverse joint at a point specified by the plans or as directed.

### **650-6 QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS.**

Produce the OGAF C in accordance with the applicable provisions of Section 609 and Project Special Provisions titled "QMS for ASPHALT PAVEMENTS: (OGAF C, PAD C, and ULTRATHIN VERSION)".

### **650-7 METHOD OF MEASUREMENT.**

The quantity of OGAF C to be paid for will be the actual number of tons (metric tons) of friction course which has been incorporated into the completed and accepted work. The friction course will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

### **650-8 BASIS OF PAYMENT.**

The quantity of friction course, measured as provided in Section 650-7 above, will be paid for at the contract unit prices per ton (metric ton) for "Open-Graded Asphalt Friction Course, Type FC-1, Type FC-1 Modified, or Type FC-2 Modified".

Furnishing asphalt binder for the mix will be paid for as provided in Article 620-5 of the Standard Specifications for "Asphalt Binder for Plant Mix, Grade PG XX-XX". Adjustments in contract unit price due to asphalt binder price fluctuation will be made in accordance with Section 620.

Providing QMS for asphalt pavements will be in accordance with the project special provision entitled “QMS for Asphalt Plant Mix Pavements” contained elsewhere in this provision form.

Payment will be made under:

Open-Graded Asphalt Friction Course, Type FC-1 .....	Ton (Metric Ton)
Open-Graded Asphalt Friction Course, Type FC-1 Modified .....	Ton (Metric Ton)
Open-Graded Asphalt Friction Course, Type FC-2 Modified .....	Ton (Metric Ton)

**SECTION 652  
PERMEABLE ASPHALT DRAINAGE COURSE  
TYPES P-78M AND P-57**

**652-1 DESCRIPTION.**

Perform the work covered by this section including but not limited to the construction of a plant mixed permeable asphalt drainage course (PADC) properly laid upon a prepared surface in accordance with these specifications and in conformity with the lines, grades, thickness, and typical sections shown on the plans; producing, weighing, transporting, placing, and rolling the plant mix as specified in Section 610; furnishing the asphalt binder, anti-strip additive, and all other materials for the plant mix; furnishing and applying tack coat as specified in Section 605; furnishing scales; providing quality control as specified in Section 609 as modified for PADC; making any repairs or corrections to the friction course that may become necessary; and maintaining the friction course until final acceptance of the project.

**652-2 MATERIALS.**

See Division 10:

Coarse aggregate .....	Article 1012-1
Asphalt binder, Grade PG 64-22 .....	Article 1020-2
Anti-strip additive (Chemical) .....	Article 1020-8

The coarse aggregate must meet the requirements of Article 1012-1 except that that portion of the coarse aggregate retained on the No. 4 (4.75 mm) sieve must contain at least 60 percent by weight of crushed pieces having 2 or more mechanically induced fractured faces.

**652-3 COMPOSITION OF MIXTURE.**

**(A) General:**

Formulate the permeable asphalt drainage course from a mixture of crushed aggregate, asphalt binder, anti-strip additive and other additives as required to produce a mix meeting the requirements of Table 652-1.

Submit in writing the proposed job mix formula (JMF) targets for each required mix type and combination of aggregates to the Engineer for review and approval at least 10 days prior to start of asphalt mix production. A mix design will not be required. The job mix formula (JMF) will be established in accordance with the applicable requirements of Article 610-3. Establish the asphalt binder content at the midpoint of the range specified in Table 652-1 or as approved. Submit the proposed job mix formula targets on forms and in a format approved by the Department.

The formula for each mixture will indicate the blend percentage of each aggregate fraction to be used, a single percentage of combined aggregate passing each required sieve, the percentage and grade of asphalt binder (by weight of total mixture) to be incorporated

into the mixture, the percentage of anti-strip additive to be added to the asphalt binder, and the temperature at which the mixture is to be discharged from the plant.

Have on hand at the asphalt plant the approved mix design and job mix formula issued by the Department, prior to beginning the work.

The job mix formula for each mixture will remain in effect until modified in writing, provided the results of QMS tests performed on material currently being produced conform with specification requirements.

Should a change in sources of aggregate materials to be made, a new mix design and job mix formula will be required before the new mixture is produced.

When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new job mix formula.

**(B) Mix Design Criteria:**

Design PADC mixtures conforming to the gradation requirements and other mix design criteria in Table 652-1 for the mix type specified.

Use the asphalt binder grade shown in Table 652-1 for the mix type specified or as approved.

Use a chemical anti-strip additive at a rate of 0.5% by weight of asphalt binder in all PADC mixes

When requested, submit to the Materials & Tests Unit in Raleigh, samples of mix components. Submit sample sizes as noted below or as requested. Provide the samples at least 10 days prior to beginning placement of PADC mixture.

- 250 lb. (115 kg) of each coarse aggregate
- 150 lb. (70 kg) fine aggregate
- 2 gal. (8 liters) of asphalt binder
- 1 pint (0.5 liters) of chemical anti-strip additive

Aggregate samples when combined according to the Contractor's proposed aggregate blend percentages must be within the gradation range defined by the target values of Table 652-1 for each sieve or the samples will not be considered representative.

The mixing temperature at the asphalt plant will be established on the job mix formula.

TABLE 652-1  
PERMEABLE ASPHALT DRAINAGE COURSE

<u>Sieve Designation</u>	<u>Total Percent Passing</u>	
	<u>Type P 78M</u>	<u>Type P 57</u>
1 1/2" (37.5 mm)		100
1" (25.0 mm)		95 – 100
3/4" (19.0 mm)	100	
1/2" (12.5 mm)	95 - 100	25 – 60
3/8" (9.5 mm)	75 - 100	
No. 4 (4.75 mm)	20 - 45	0 – 10
No. 8 (2.36 mm)	0 - 15	0 – 5
No. 200 (0.075 mm)	1 - 3	0 – 3
Asphalt Binder Content, %	2.5 - 3.5	2.0 - 3.0
Mixing Temperature at Plant (Established by the Engineer)	225 - 250°F (93 - 121°C)	260 - 290°F (127 - 143°C)

**652-4 CONSTRUCTION REQUIREMENTS.**

Produce, transport to the site, and place the asphalt plant mix in accordance with the applicable requirements of Section 610, except as otherwise provided below.

Produce the mixture at the asphalt plant within  $\pm 15^{\circ}\text{F}$  ( $\pm 8^{\circ}\text{C}$ ) of the temperature established on the JMF. Assure the temperature of the mix immediately prior to discharge from the hauling vehicle is within  $+15^{\circ}\text{F}$  ( $+8^{\circ}\text{C}$ ) to  $-25^{\circ}\text{F}$  ( $-14^{\circ}\text{C}$ ) of the JMF temperature.

Incorporate the asphalt binder into the asphalt plant mix in accordance with Section 620. Add the anti-strip additive to the asphalt binder in accordance with Article 620-3.

A prime coat or tack coat will not be required.

When the PADC is placed in trench sections, the rolling equipment and rolling sequences required by Article 610-9 will not apply. Compact the PADC to a degree acceptable to the Engineer.

When the PADC is to be covered with a subsequent layer of pavement, following placement of the PADC mixture to the appropriate line, grade and thickness, begin rolling when the mat has cooled sufficiently to support the weight of an 8 to 12 ton steel wheel tandem roller. Mat temperature at the time of initial rolling should be approximately  $175^{\circ}\text{F}$  -  $225^{\circ}\text{F}$  ( $80$  -  $107^{\circ}\text{C}$ ). The number of roller passes will be 2 or 3, unless otherwise directed. Consolidate the drainage layer sufficiently with rolling so as to support the weight of equipment that will place the next layer of pavement. Do not compact the drainage layer to the extent that it is not free draining or that the aggregate is crushed.

No traffic will be allowed to travel on any permeable asphalt drainage course. Only equipment necessary to place the next layer of pavement will be allowed on the drainage layer.

**652-5 QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS.**

Produce the PADC in accordance with the applicable provisions in Section 609 of the Project Special Provisions titled "QMS for ASPHALT PAVEMENTS: (OGAFC, PADC, and ULTRATHIN VERSION)".

**652-6 METHOD OF MEASUREMENT.**

The quantity of permeable asphalt drainage course to be paid for will be the actual number of tons (metric tons) of drainage course which has been incorporated into the completed and accepted work. The drainage course will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

**652-7 BASIS OF PAYMENT.**

The quantity of permeable asphalt drainage course, measured as provided in Article 652-6, will be paid for at the contract unit price per ton (metric ton) for "Permeable Asphalt Drainage Course".

Furnishing asphalt binder for the mix will be paid for as provided in Article 620-5 for "Asphalt Binder for Plant Mix, Grade PG 64-22".

Payment will be made under:

Permeable Asphalt Drainage Course, Type P-78M.....	Ton (Metric Ton)
Permeable Asphalt Drainage Course, Type P-57.....	Ton (Metric Ton)

**SECTION 654**  
**ASPHALT PLANT MIX, PAVEMENT**  
**REPAIR**

**654-1 DESCRIPTION.**

Perform the work covered by this section including but not limited to repairing of existing pavement with asphalt plant mix in order to provide a safe, passable, and convenient condition for traffic, or to replace pavement which has been removed in order to remove or to place pipe lines.

Perform the work by cutting of the existing pavement to a neat vertical joint and uniform line; removing and disposing of pavement, base, and subgrade material as approved or directed; coating of the area to be repaired with a tack coat; furnishing, placing, and compacting of asphalt plant mix; furnishing of asphalt binder for the asphalt plant mix; furnishing scales; and replacement of the removed material with asphalt plant mix.

Make the repairs in accordance with the plans, or as approved or directed.

**654-2 MATERIALS.**

Where a pavement repair detail is not shown in the plans, use a type of asphalt plant mix that has have been approved.

Where a pavement repair detail is shown in the plans, the type of plant mix must be in accordance with the pavement repair detail except where the specifications permit the substitution of another type of plant mix or where approved.

In areas where the existing pavement is not to be resurfaced, the Contractor will not be allowed to substitute a different type of surface course from that shown on the pavement repair detail.

**654-3 CONSTRUCTION METHODS.**

**(A) General:**

Perform repair of existing pavement as approved or directed. Coordinate the work with all other work and operations necessary to maintain traffic.

**(B) Pipe Removal or Installation:**

Where traffic is to be maintained, perform the removal or installation of pipe in sections so that half the width of the roadway will be available to traffic. Immediately upon completion of the entire pipe line removal or installation, repair the pavement.

**654-4 METHOD OF MEASUREMENT.**

The quantity of asphalt plant mix to be paid for will be the actual number of tons (metric tons) of asphalt plant mix, complete in place, which has been used to make completed and accepted repairs, except for those repairs which have been made necessary by the contractor's negligence. The asphalt plant mixed material will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

**654-5 BASIS OF PAYMENT.**

The quantity of asphalt plant mix, measures as provided in Article 654-4, will be paid for at the contract unit price per ton (metric ton) for "Asphalt Plant Mix, Pavement Repair".

Any provisions included in the contract in the form of project special provisions or in any other form which provide for adjustments in compensation due to variations in the price of asphalt cement will not be applicable to payment for the work covered by this section.

Payment will be made under:

Asphalt Plant Mix, Pavement Repair .....Ton (Metric Ton)

**SECTION 660  
ASPHALT SURFACE TREATMENT**

**660-1 DESCRIPTION.**

Perform the work covered by this section including but not limited to furnishing, hauling, spreading, and rolling the asphalt material and aggregate consisting of one or more applications of liquid asphalt material and one or more applications of aggregate cover coat material on a prepared surface; furnishing and spreading blotting sand; and maintaining and repairing the asphalt surface treatment.

**660-2 MATERIALS.**

See Division 10:

Use one of the following grades of asphalt for mat coat:

Emulsified Asphalt, Grade CRS-2 ..... Article 1020-7

Emulsified Asphalt, Grade RS-2 ..... Article 1020-6

Use one of the following grades of asphalt for seal coat:

Emulsified Asphalt, Grade CRS-2 ..... Article 1020-7

Emulsified Asphalt, Grade RS-2 ..... Article 1020-6

Emulsified Asphalt, Grade CMS-2 ..... Article 1020-7

Emulsified Asphalt, Grade MS-2 ..... Article 1020-6

Aggregate for mat and seal coat ..... Article 1012-2

Blotting sand ..... Article 1012-3

Before any asphalt surface treatment is placed, obtain from the asphalt supplier and furnish to the Engineer a certification of compatibility of the asphalt with the aggregate proposed for use. Use anionic or cationic emulsion, as indicated by the compatibility test.

**660-3 WEATHER AND SEASONAL LIMITATIONS.**

Do not place any asphalt surface treatment between October 15 and March 16, except for asphalt surface treatment which is to be overlaid with asphalt plant mix.

Apply asphalt material only when the surface to be treated is dry and when the atmospheric temperature is above 60°F (15.6°C) in the shade away from artificial heat.

When placing asphalt surface treatment which is to be subsequently overlaid with asphalt plant mix, the seasonal and temperature limitations of Article 610-4 will apply.

Do not apply asphalt material when the weather is foggy or rainy.

**660-4 SURFACE PREPARATION.**

Clean the surface to be treated of all dust, dirt, clay, grass, sod, and any other deleterious matter prior to application of the asphalt surface treatment.

**660-5 ACCEPTANCE OF ASPHALT MATERIALS.**

The acceptance of asphalt materials will be in accordance with the provisions of Article 1020-1.

**660-6 APPLICATION EQUIPMENT.**

Use asphalt application equipment which meets the requirements of Article 600-5.

**Section 660**

Apply aggregate by the use of a self-propelled, pneumatic tired aggregate spreader capable of maintaining a specified rate with a uniform application for the width of asphalt material being covered. Tailgate spreaders will not be permitted. Areas which are inaccessible to the aggregate spreader may be covered by hand spreading or other acceptable methods.

**660-7 APPLICATION OF ASPHALT MATERIALS.**

The grades, rates of application, and the temperature at which the asphalt material is to be applied must be within the limits shown in Table 660-1.

Base the required rates of application on the volume of material at the application temperature.

**TABLE 660-1  
MATERIAL APPLICATION RATES AND TEMPERATURES**

<b>TYPE OF COAT</b>	<b>GRADE OF ASPHALT</b>	<b>ASPHALT RATE GAL./SQ. YD. (L/ SQ. M)</b>	<b>APPLICA-TION TEMP. °F (°C)</b>	<b>AGGRE-GATE SIZE</b>	<b>AGGREGATE RATE LBS./SQ. YD. (Kg/SQ. M)</b>
Mat	CRS-2 or RS-2	0.35-0.40 (1.58-1.81)	150-175 (66-79)	No. 6*	30-35 (16-19)
	CRS-2 or RS-2	0.45-0.50 (2.04-2.26)	150-175 (66-79)	No. 5*	45-50 (24-27)
	CRS-2 or RS-2	0.30-0.40 (1.36-1.81)	150-175 (66-79)	No. 78M*	15-20 (8-11)
Straight Seal	CRS-2 or RS-2	0.35-0.40 (1.58-1.81)	150-175 (66-79)	No. 78M	17-22 (9-12)
Drag Seal, Type A	CMS-2 or MS-2	0.45-0.50 (2.04-2.26)	150-175 (66-79)	No. 78M	28-32 (15-18)
Drag Seal, Type B	CMS-2 or MS-2	0.55-0.60 (2.49-2.72)	150-175 (66-79)	No. 78M**	30-34 (16-19)
Split Seal	CRS-2 or RS-2	0.45-0.50 (2.04-2.26)	150-175 (66-79)	No.78M	30-35 (16-19)
Triple Seal	CRS-2 or RS-2	0.60-0.75 (2.72-3.40)	150-175 (66-79)	No. 78M	45-51 (24-28)
Sand Seal	CRS-2 or RS-2	0.22-0.30 (1.00-1.36)	150-175 (66-79)	Blotting Sand	12-15 (6-8)

\* Use No. 6 or No. 78M aggregate for retreatment prior to an overlay on existing pavement

Use No. 5 aggregate for initial treatment on new construction

\*\* Apply 8-12 lbs./sq. yd. (4-7 Kg/sq. m) of blotting sand after final application of No. 78M has been completed and rolled.

**660-8 APPLICATION OF AGGREGATES.**

The size of the aggregate must be as shown in Table 660-1 for the mat coat or the type of seal coat to be constructed.

The rate of application for mat and seal aggregates must be within the limits shown in Table 660-1.

When directed, weigh a sufficient number of truck loads of aggregate prior to spreading to verify that the rate of application is within the required limits.

**660-9 CONSTRUCTION METHODS.****(A) Asphalt Mat Coat:**

The surface on which the mat coat is to be applied must be approved before the mat coat liquid asphalt is applied.

Place a string line guide for application equipment unless otherwise permitted.

Place the mat coat in full-lane widths unless otherwise permitted.

Immediately follow the application of mat liquid asphalt with the spreading of the aggregate. No more than 5 minutes can elapse from the time the liquid asphalt is applied until the aggregate is spread.

Test the mat coat aggregate, have it approved, and make sure it is drained of free moisture prior to use. Spread the aggregate uniformly at the required rate and correct all non-uniform areas prior to rolling.

Perform rolling immediately after the aggregate has been uniformly spread. Initial rolling will consist of one complete coverage with a 5 to 8 ton (4.5 to 7.3 Metric Ton) steel wheel roller after which use pneumatic tired rollers. Continue rolling until the aggregate is thoroughly keyed into the mat liquid asphalt. Use rollers which neither crush the aggregate excessively, nor pick up material. The use of a combination steel wheel and pneumatic tired roller will not be permitted. Use two individual rollers.

At the beginning of each mat liquid asphalt application, spread a paper over the end of the previously completed mat coat and begin the asphalt application on the paper. After use, remove the paper and satisfactorily disposed of it.

After the aggregate is thoroughly seated, broom all excess aggregate off of the surface of the mat coat as directed. Traffic may be permitted on the mat coat immediately after the rolling and brooming is complete.

Correct defects or damage to the mat coat prior to the application of seal coat or plant mix overlay.

The seal coat may be applied the same day the mat coat is placed provided the mat coat has been satisfactorily applied and rolled.

**(B) Asphalt Seal Coat:**

Use the type of seal coat as required by the contract.

Test seal coat aggregates, have approved, and drained of free moisture prior to use.

Where it is necessary to permit traffic on sections of a completed seal coat before it has cured sufficiently to prevent picking up, adjust the aggregate rates to provide a sufficient quantity of cover material to be spread over the surface of the seal coat to prevent traffic damage.

Accomplish rolling for all seal coats as described in the following paragraph, except use only the pneumatic tired roller on a sand seal.

Perform rolling immediately after the aggregate has been uniformly spread. Initial rolling will consist of one complete coverage with a 5 to 8 ton (4.5 to 7.3 Metric Ton) steel wheel roller after which pneumatic tired rollers must be used. Continue rolling until the aggregate is thoroughly keyed into the liquid asphalt. A final coverage with the steel wheel roller may be required to provide a satisfactory finished surface. The use of rollers which result in excessive crushing of the aggregate will not be permitted. Use rollers designed to prevent picking up the material. The use of a combination steel wheel and pneumatic tired roller will not be permitted. Use two individual rollers.

The provisions of Subarticle 660-9(A) will apply to the width of seal coat construction, application of liquid asphalt and aggregate, and the construction of joints. When directed, apply blotting sand in accordance with the provisions of Section 818.

The construction of the various types of seal coats will be in accordance with the following additional requirements:

**1. Straight Seal:**

Place the full required amount of asphalt material in one application and immediately cover with seal coat aggregate. Uniformly spread the full required amount of aggregate in one application and correct all non-uniform areas prior to rolling.

Immediately after the aggregate has been uniformly spread, perform rolling as previously described.

When directed, broom excess aggregate material from the surface of the seal coat.

**2. Drag Seal -- Type A:**

Apply approximately 0.20 to 0.25 gallons/square yard (0.91 to 1.10 liters per square meter) of asphalt material to the existing surface immediately followed by the application of approximately 18 to 22 pounds/square yard (10 to 12 kilograms per square meter) of seal coat aggregate spread uniformly over the treated surface. Apply the remainder of the required amount of asphalt material and the aggregate and asphalt material thoroughly mixed by the use of approved drag brooms.

Immediately after acceptable mixing, uniformly spread the remainder of the required amount of seal coat aggregate over the surface and rolled as previously described.

**3. Drag Seal -- Type B:**

Apply approximately 0.10 to 0.15 gallons/square yard (0.45 to 0.68 liters per square meter) of asphalt material to the existing surface immediately followed by the application of approximately 15 to 17 pounds/square yard (8 to 9 kilograms per square meter) of seal coat aggregate. Apply a second application of 0.15 to 0.20 gallons/square yard (0.68 to 0.91 liters per square meter) of asphalt material followed immediately by the application of the remainder of the required amount of seal coat aggregate. Apply the remainder of the required amount of asphalt material and the aggregate and asphalt material thoroughly mixed by the use of approved drag brooms.

Immediately after the aggregate has been uniformly mixed, perform rolling as previously described.

After rolling the seal coat aggregate (No. 78M), lightly sand the surface using 8-12 pounds per square yard (4-7 kilograms per square meter) of blotting sand.

**4. Split Seal:**

Apply approximately 0.20 to 0.25 gallons/square yard (0.91 to 1.13 liters per square meter) of asphalt material to the existing surface immediately followed by the application of approximately 20 to 22 pounds/square yard (11-12 kilograms per square meter) of seal coat aggregate spread uniformly over the treated surface.

Immediately after the first application of seal aggregate has been made uniform, apply the remainder of the required amount of asphalt material and seal coat aggregate and roll the seal coat as previously described.

**5. Triple Seal:**

Apply approximately 0.20 to 0.25 gallons per square yard (0.91 to 1.13 liters per square meter) of the required liquid asphalt to the existing surface immediately followed by the application of approximately 15 to 17 pounds per square yard (8-9 kilograms per square meter) of the required amount of seal coat aggregate

spread uniformly over the treated surface. Perform this operation 3 times and after the final application of aggregate is applied, roll it as previously described.

**6. Sand Seal:**

Place the full required amount of asphalt material in one application and immediately covered with the seal coat aggregate. Uniformly spread the full required amount of aggregate in one application and correct all non-uniform areas prior to rolling.

Immediately after the aggregate has been uniformly spread, perform rolling as previously described.

When directed, broom excess aggregate material from the surface of the seal coat.

When the sand seal is to be constructed for temporary sealing purposes only and will not be utilized by traffic, other grades of asphalt material meeting the requirements of Articles 1020-6 and 1020-7 may be utilized in lieu of the grade of asphalt required by Table 660-1 when approved.

**(C) Asphalt Mat and Seal:**

Construct the mat coat in accordance with Subarticle 660-9(A) using the size aggregate required by the contract.

Construct the seal coat in accordance with Subarticle 660-9(B) using the type seal required by the project special provisions.

**660-10 MAINTENANCE AND PROTECTION.**

Maintain and protect the asphalt surface treatment until it is accepted by the Department. Make all necessary repairs in such a manner as to preserve the uniformity of the surface.

**660-11 METHOD OF MEASUREMENT.**

The quantity of asphalt surface treatment to be paid for will be the actual number of square yards (square meters) of asphalt surface treatment which has been completed and accepted. In measuring this quantity, the length will be the actual length constructed, measured along the surface. The width will be the width required by the plans or directed measured along the surface.

**660-12 BASIS OF PAYMENT.**

The quantity of asphalt surface treatment, measured as provided in Article 660-11, will be paid for at the contract unit prices per square yard (square meter) for "Asphalt Surface Treatment, Mat Coat, No. \_\_\_\_\_ Stone", "Asphalt Surface Treatment, \_\_\_\_\_ Seal", Asphalt Surface Treatment, Drag Seal, Type \_\_\_\_\_", or "Asphalt Surface Treatment, Mat and Seal" in accordance with the type of asphalt surface treatment actually constructed. Payment at the above prices will be made for replacing any satisfactorily completed asphalt surface treatment when such replacement has been made necessary by defects in subgrade or base which has been constructed by others.

When the Engineer directs that the rate of application of asphalt material be decreased below the minimum rate shown in Table 660-1, no reduction in compensation will be made.

When the Engineer directs that the rate of application of asphalt material be increased above the maximum rate shown in Table 660-1, compensation to the Contractor will be made in the amount of 5 cents plus the verified cash cost to the Contractor at the point of delivery for each gallon of asphalt material, measured at application temperature, necessitated by the increase.

Blotting sand will be paid for as provided in Article 818-5 for "Blotting Sand".

Furnishing and applying prime will be paid for as provided in Article 600-10 for "Prime Coat".

Payment will be made under:

- Asphalt Surface Treatment, Mat Coat, No. \_\_\_\_\_ Stone..... Square Yard (Square Meter)
- Asphalt Surface Treatment, \_\_\_\_\_ Seal ..... Square Yard (Square Meter)
- Asphalt Surface Treatment, Drag Seal, Type \_\_\_\_\_ ..... Square Yard (Square Meter)
- Asphalt Surface Treatment, Mat and Seal ..... Square Yard (Square Meter)

**SECTION 665  
MILLED RUMBLE STRIPS**

**665-1 DESCRIPTION.**

Construct rumble strips on asphaltic concrete shoulders in accordance with the plans and as directed by the Engineer. Work includes but is not limited to furnishing all labor and equipment; disposing of milled material; and all incidentals necessary to complete the work satisfactorily.

**665-2 EQUIPMENT.**

Provide equipment consisting of a rotary type cutting head with a maximum outside diameter of 24 inches (609.6 mm) and that is a minimum of 16 inches (406.4 mm) long. Provide a cutting head that has the cutting tips arranged in such a pattern as to provide a relatively smooth cut as well as a cutting head(s) that is on its own independent suspension from that of the power unit to allow the tool to self align with the slope of the shoulder and/or any irregularities in the shoulder surface.

Provide a cutting tool equipped with guides to provide consistent alignment of each cut in relation to the roadway and to provide uniformity and consistency throughout the project.

**665-3 CONSTRUCTION METHODS.**

Demonstrate the ability to achieve desired surface inside each depression without tearing or snagging the asphalt prior to beginning the work.

Provide rumble strips that have finished dimensions of seven inches (177.8 mm) ( $\pm 1/2$  inch) [ $\pm 12.7$  mm] wide in the direction of travel and are a minimum of 16 inches (406.4 mm) long measured perpendicular to the direction of travel. Provide rumble strips having depressions with a concave circular shape with a minimum 1/2 inch (12.7 mm) depth at center (maximum allowable depth 5/8 inch [15.9 mm]). Place rumble strips in relation to the roadway according to the patterns shown in the plans.

Material resulting from the operation becomes the property of the Contractor. Remove and dispose of this material in accordance with Section 802 of Standard Specifications.

At the end of each working day remove all equipment to a location where it does not present a hazard to traffic, clean the pavement by sweeping or flushing, and reopen the work area to traffic.

**665-4 METHOD OF MEASUREMENT.**

The quantity of rumble strips to be paid for will be actual number of linear feet (linear meters) of shoulder, measured longitudinally along the surface of each shoulder, where rumble strips have been constructed.

**665-5 BASIS OF PAYMENT.**

The quantity of rumble strips, measured as provided for above, will be paid for at the contract unit price per linear foot (linear meter) for "Milled Rumble Strips".

Payment will be made:

Milled Rumble Strips ..... Linear Foot (Linear Meter)

## NOTES

