perform. Where the Contractor elects to make multiple cuts to achieve the final depth, no additional measurement will be made. Compensation will be made at the contract unit price per square yard for *Incidental Milling*.

(D) Milling of Defects

If defects are determined to be the result of the Contractor's negligence, then measurement for the re-milling or repairs will not be made. If the Engineer directs re-milling of an area that is equal to or greater than 100 feet and is not due to the Contractor's negligence, the re-milled area will be measured as provided in Subarticle 607-5(A) and paid at the contract unit price per square yard for *Milled Asphalt Pavement, __" Depth* or *Milling Asphalt Pavement, __" to __"*.

Payment will be made under:

Pay Item	Pay Unit
Milling Asphalt Pavement, __" to __"	Square Yard
Milling Asphalt Pavement, __" Depth	Square Yard
Incidental Milling	Square Yard

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 herein. Apply these *Standard Specifications* to all materials and work performed in accordance with Division 6. Perform all quality control (QC) activities in accordance with the Department's *Asphalt Mixture Quality Management System (QMS) Manual* in effect on the date of contract advertisement.

(A) Quality Control (QC)

Define a "quality control (QC) program" as all activities, including mix design, process control, plant and equipment calibration, sampling and testing and necessary adjustments in the process that are related to production of a pavement that meet the *Standard Specifications*. Provide and conduct a QC program in accordance with this section.

(B) Quality Assurance (QA)

Define a "quality assurance (QA) program" as all activities, including inspection, sampling and testing related to determining that the quality of the completed pavement conforms to specification requirements. The Department will conduct a QA program in accordance with Article 609-10.

609-2 MIX DESIGN/JOB MIX FORMULA REQUIREMENTS

Apply all requirements of Article 610-3.

609-3 FIELD VERIFICATION OF MIXTURE AND JOB MIX FORMULA ADJUSTMENTS

Conduct field verification of the mix at each plant within 45 calendar days before initial production of each mix design, when required by the *Allowable Mix Adjustment Policy* and when directed as deemed necessary.

Field verification testing consists of performing a minimum of one full test series on mix sampled and tested in accordance with Subarticle 609-6(B). Mix obtained from Department or non-Department work may be used for this purpose provided it is sampled, tested and the test data handled in accordance with the *Asphalt QMS Manual* and this article.

Obtain the mix verification sample and split in accordance with procedures in the *Asphalt 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.

In addition to the required sampling and testing for field verification, perform all preliminary inspections and plant calibrations as outlined in the *Asphalt QMS Manual*. Retain records of these calibrations and mix verification tests at the QC laboratory. Furnish copies to the Engineer for review and approval within one working day after beginning production of the mix.

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, testing, calibrations and plant inspections have been performed and approved.

609-4 CONTRACTOR'S QUALITY CONTROL PERSONNEL REQUIREMENTS

Obtain all certifications in accordance with the Department's QMS Asphalt Technician Certification Program as outlined in the *Asphalt 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 QC 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 used to meet this requirement when daily production for each mix design is less than 100 tons provided the randomly scheduled increment sample as defined in Section 7.3 of the *Asphalt QMS Manual* is not within that tonnage. When performing in this capacity, the plant operator will be responsible for all QC activities that are necessary and required. Absences of the Level I technician, other than those for normal breaks and emergencies shall be pre-approved by the appropriate Engineer 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 QC 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 all QC processes and activities, to include stopping production or implementing corrective measures when warranted. Provide a certified density gauge operator when density control is being used.

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

609-5 CONTRACTOR'S QUALITY CONTROL FIELD LABORATORY REQUIREMENTS

For a contract with 5,000 or more total tons of asphalt mix, furnish and maintain a Department certified laboratory at the plant site meeting the minimum requirements outlined in Section 7.2 of the *Asphalt QMS Manual*.

For a contract with less than 5,000 total tons of asphalt mix, the QC testing may be conducted in a Department certified off-site laboratory meeting the requirements.

Provide testing equipment as required in Section 7.2 of the *Asphalt QMS Manual*. 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.

609-6 PLANT MIX QUALITY CONTROL

(A) General

Include in the QC process the preliminary inspections, plant calibrations and field verification of the mix and JMF in accordance with the *Asphalt QMS Manual*. Obtain all scheduled samples at randomly selected locations in accordance with the *Asphalt QMS Manual*. Log all samples taken on forms provided by the Department. Split and retain all samples taken in accordance with the *Asphalt QMS Manual*. Provide documentation as required in Subarticle 609-8. Identify any additional QC samples taken and tested on the appropriate forms. Process control test results shall not be plotted on control charts nor reported to the QA Laboratory.

Retain and store all samples in accordance with the requirements of Section 7.5 of the *Asphalt QMS Manual*.

(B) 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. If the specified tests will not be completed within the required time frame, cease production at that point until such time the tests are completed.

If the Contractor's testing frequency fails to meet the minimum frequency requirements as specified, all mix without the specified test representation will be unsatisfactory. The Engineer will evaluate if the mix may remain in place in accordance with Article 105-3.

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

Accumulative Production Increment	Number of Samples per Increment
750 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) until the increment tonnage is completed. Obtain a random sample within the specified increment at the location determined in accordance with the *Asphalt QMS Manual*. Conduct QC testing on each random sample in accordance with Section 7.3 of the *Asphalt QMS Manual*. When daily production of each mix design exceeds 100 tons and a regularly scheduled full test series on a sample from a random sample location for that JMF does not occur during that day's production, perform at least one partial test series in accordance with Section 7.3 of the *Asphalt QMS Manual*. These partial test series and associated tests do not substitute for the regularly scheduled random sample for that increment.

(C) Control Charts

Maintain standardized control charts furnished by the Department at the field laboratory. For mix incorporated into the project, record full test series data from all regularly scheduled random samples or directed samples that replace regularly scheduled random samples, on control charts the same day the test results are obtained.

Record QC sample data on the standardized control charts in accordance with Section 7.4 of the *Asphalt QMS Manual*.

Maintain a continuous moving average with the following exceptions.

Re-establish a new moving average only when:

(1) A change in the binder percentage, aggregate blend or G_{mm} is made on 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 moving average limits as outlined in Table 609-1, or

(3) Failure to stop production after 2 consecutive moving averages exceed the moving average limits occurs, but production does stop at a subsequent time, re-establish a new moving average beginning at the actual production stop point.

In these cases, 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 or the *Standard Specifications*.

All individual test results for regularly scheduled random samples or directed samples that replace regularly scheduled samples are part of the plant QC record and shall 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 instead of the Contractor's data to determine the appropriate pay factor in accordance with Section 7021 of the *Asphalt QMS Manual*. In this case, replace the data in question and any related data proven incorrect.

(D) Control Limits

Establish control limits for mix production in accordance with Table 609-1. Control limits for the moving average limits are based on a moving average of the last 4 data points. Apply all control limits to the applicable target source.

TABLE 609-1
CONTROL LIMITS

Mix Control Criteria	Target Source	Moving Average Limit	Individual Limit
2.36 mm Sieve	JMF	± 4.0%	± 8.0%
1.18mm Sieve (S4.75A only)	JMF	± 4.0%	± 8.0%
0.075 mm Sieve	JMF	± 1.5%	± 2.5%
Binder Content	JMF	± 0.3%	± 0.7%
VTM @ N_{des}	JMF	± 1.0%	± 2.0%
VMA @ N_{des}	Min. Spec. Limit	Min. Spec. Limit	- 1.0%
$P_{0.075}$/ P_{be} Ratio	1.0	± 0.4 %	± 0.8%
% G_{mm} @ N_{ini}	Max. Spec. Limit	-	+ 2.0%
TSR	Min. Spec. Limit	-	- 15%

(E) Corrective Actions

All required corrective actions are based upon initial test results and shall be taken immediately upon obtaining those results. If more than one corrective action or adjustment applies, give precedence to the more severe of these actions. Stopping production when required takes precedence over all other corrective actions. Document all corrective actions.

If the process adjustment improves the property in question such that the moving average after 4 additional tests is on or within the moving average limits, the Contractor may continue production.

When any of the following occur, production of a mix shall cease immediately:

(1) 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 criteria, or

(2) Two consecutive field TSR values fail to meet the minimum specification requirement, or

(3) Two consecutive binder content test results exceed the individual limits, or

(4) Two consecutive moving average values for any one of the mix control criteria fall outside the moving average limits.

Do not resume normal plant production until one of the following has occurred.

Option 1: Approval has been granted by the appropriate QA supervisor.

Option 2: The mix in question has been satisfactorily verified in accordance with Section 7.4 of the *Asphalt QMS Manual*. Normal production may resume based on the approval of the contractor's Level II technician, provided notification and the verification test results have been furnished to the QA Laboratory.

Failure to fully comply with any of the above corrective actions will result in immediate production stoppage by the Engineer. Normal production shall not resume until a complete verification process has been performed and approved by the Engineer.

Failure to stop production when required will make all mix unacceptable from the stop point tonnage to the point when Option 1 or Option 2 occurs or to the tonnage point when production is actually stopped, whichever occurs first.

In any case, remove and replace this mix with materials that comply with the *Standard Specifications*, unless otherwise approved. The Engineer will evaluate acceptance of the mix in question based on Articles 105-3 and 609-11.

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

(F) Allowable Resampling and Retesting for Mix Deficiencies

The Contractor shall resample and retest for plant mix deficiencies when warranted as outlined in Section 7.19 of the *Asphalt QMS Manual*. Perform the retesting within 10 days after initial test results are determined. Retests for any mix deficiency other than as listed below will not be allowed, unless otherwise permitted.

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

TABLE 609-2 RETEST LIMITS FOR MIX DEFICIENCIES	
Property	**Limit**
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

609-7 FIELD COMPACTION QUALITY CONTROL

(A) General

Perform QC of the compaction process in accordance with these provisions and applicable requirements of Article 610-10. The Contractor may elect to use either pavement core samples or density gauge readings as the method of density control. Provide to the Department at the pre-construction conference the method of density QC that will be used on the project.

Establish acceptable control strips when required at locations approved by the Engineer and in accordance with the *Asphalt QMS Manual*. In addition, place control strips anytime deemed necessary by the Engineer.

Perform density sampling and testing on all pavements as outlined in Sections 10.4 and 10.6 of the *Asphalt QMS Manual* unless otherwise approved.

Perform the sampling and testing at the minimum test frequencies as specified. If the density testing frequency fails to meet the minimum frequency as specified, all mix without the required density test representation will be unsatisfactory. The Engineer will evaluate if the mix may remain in place in accordance with Article 105-3.

(B) Limited Production Procedures

Define "resurfacing" as the first new uniform layer placed on an existing pavement. Proceed on limited production when, for the same mix type and on the same contract, one of the following conditions occur (except as noted below).

(1) Two consecutive failing lots, except on resurfacing,

(2) Three consecutive failing lots on resurfacing, or

(3) Two consecutive failing density gauge control strips.

As exceptions to the above, pavement within each construction category (New and Other), as defined in Section 10.3.3 of the *Asphalt QMS Manual*, and pavement placed simultaneously by multiple paving crews will be evaluated independently for limited production purposes.

Limited production is defined as the production, placement and compaction of a sufficient quantity of mix to construct a 300 feet control strip plus 100 feet of pavement adjacent to each end of the control strip.

Remain on limited production until such time as satisfactory density results are attained 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 Quality Control and Quality Assurance plant mix test indicate the failing densities are attributed to the mix problem(s) rather than compaction related problems and limited production startup would

not be required. The determination of whether a mix problem exists at this time will be made by QA personnel.

If the Contractor does not operate by the limited production procedures when conditions as specified in Section 10.9 of the *Asphalt QMS Manual*, all mix produced thereafter will be unacceptable. Remove this material and replace with material that complies with the *Standard Specifications,* at no additional cost to the Department.

609-8 CONTRACTOR QUALITY CONTROL DOCUMENTATION (RECORDS)

Document all QC activities, 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. Process control sample test results are for the Contractor's informational purposes only.

Make all such records available to the Engineer, upon request, at any time during project construction. Complete and maintain all QC records and forms and distribute in accordance with the *Asphalt QMS Manual*. Submit data electronically using the Department's software. 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 stoppage, placement stoppage, removal from the NCDOT Certified Asphalt Laboratory List and removal from the NCDOT Certified Asphalt Plant List 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. The Engineer will determine acceptability of the mix and/or pavement represented by the falsified results or documentation. If the mix and/or pavement in question is determined to be acceptable, the Engineer may allow the mix to remain in place at no pay for the mix, asphalt binder and other mix components. If the mix or pavement represented by the falsified results is determined not to be acceptable, remove and replace with mix that complies with the *Standard Specifications*.

609-9 QUALITY ASSURANCE

The Department's QA program will be conducted by a certified QMS technician(s) and will be accomplished based on the requirements of Section 7.60 for mix and Sections 10.5 and 10.7 for density in the *Asphalt QMS Manual*.

Differences between the Contractor's and the Department's split sample test results will be acceptable if within the limits of precision in Table 609-3.

TABLE 609-3 LIMITS OF PRECISION FOR TEST RESULTS	
Mix Property	**Limits of Precision**
25.0 mm sieve (Base Mix)	± 10.0%
19.0 mm sieve (Base Mix)	± 10.0%
12.5 mm sieve (Intermediate Mix)	± 6.0%
9.5 mm sieve (Surface Mix)	± 5.0%
4.75 mm sieve (Surface Mix)	± 5.0%
2.36 mm sieve (All Mixes)	± 5.0%
0.075 mm 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%
QA retest of prepared QC Gyratory Compacted Volumetric Specimens	± 0.015
Retest of QC Core Sample	± 1.2% (% Compaction)
QA Verification Core Sample	± 2.0% (% Compaction)
Comparison of Density Gauge QC Test	± 2.0% (% Compaction)
QA Density Gauge Verification Test	± 2.0% (% Compaction)

The Engineer will immediately investigate the reason for differences if any of the following occur: QA test results of QC split sample does not meet above limits of precision, QA test results of QC split sample does not meet the individual test control limits or the specification requirements or QA verification sample test results exceed the allowable retesting tolerances.

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: review and observation of the QC technician's sampling and testing procedures, evaluation and calibration of QC and QA testing equipment, comparison testing of other retained quality control samples, and/or comparison testing of additional density core samples.

The Engineer will periodically witness the sampling and testing being performed by the Contractor. If the Engineer observes that the sampling and QC 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.

609-10 ACCEPTANCE

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

(A) 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, verification samples, retests (if applicable) and validation of the Contractor’s quality control process conducted in accordance with Specifications.

(B) 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 (including verification samples)

and by observation of the Contractor's total density quality control process conducted in accordance with Specifications.

609-11 MEASUREMENT AND PAYMENT

Any mix produced that is not verified may be assessed a price reduction at the Engineer's discretion in addition to any reduction in pay due to mix or density deficiencies.

Produce and construct all asphalt mixtures and pavements in accordance with these *Standard 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.

If the mix or pavement represented by the falsified results is removed and replaced, payment will be made for the actual quantities of materials required to replace the falsified quantities, not to exceed the original amounts.

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; 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 QC as specified in Section 609; and surface testing of the completed pavement. The design requirements for the various mix types are given in Section 610 for dense-graded mix types, Section 650 for OGFC, Section 652 for PADC and Section 661 for UTBWC.

Perform all activities in accordance with the Department's *Asphalt Quality Management System (QMS) Manual* in effect on the date of contract advertisement

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

Define "warm mix asphalt (WMA)" as additives or processes that allow a reduction in the temperature at which asphalt mixtures are produced and placed. Use only WMA additives or processes listed on the NCDOT APL maintained by the Materials and Tests Unit.

610-2 MATERIALS

Refer to Division 10.

Item	Section
Anti-Strip Additives	1020-8
Asphalt Binder, Performance Grade	1020-2
Coarse Aggregate	1012-1(B)
Fine Aggregate	1012-1(C)
Mineral Filler	1012-1(D)
Reclaimed Asphalt Pavement (RAP)	1012-1(F)
Reclaimed Asphalt Shingles (RAS)	1012-1(E)
Silicone	1020-9