DOCUMENT 00715

SUPPLEMENTAL SPECIFICATIONS

(English Units)

DATE: JUNE 30, 2020

The 2020 *Standard Specifications for Highways and Bridges* are amended by the following modifications, additions and deletions. This Supplemental Specifications prevail over those published in the Standard Specifications.

The MassDOT–Highway Specifications Committee has issued these Supplemental Specifications for inclusion into each proposal until such time as they are approved as Standard Specifications.

Contractors are cautioned that these Supplemental Specifications are dated and may vary from time to time as they are updated.

DIVISION I
GENERAL REQUIREMENTS AND COVENANTS

SECTION 4.00: SCOPE OF WORK

Subsection 4.04 Changed Conditions.
(page I.22) Delete the two sequential paragraphs near the end that begin "The Contractor shall be estopped…" and "Any unit item price determined …"

SECTION 8.00: PROSECUTION AND PROGRESS

Subsection 8.08 Preservation of Roadside Growth
(page I.74) Delete the last paragraph of this subsection which reads; All scars on trees shall be painted as soon as possible with an approved tree paint.

DIVISION II
CONSTRUCTION DETAILS

SECTION 200: DRAINAGE
SUBSECTION 230: CULVERTS, STORM DRAINS, AND SEWAR PIPES

Subsection 230: CULVERTS, STORM DRAINS, AND SEWAR PIPES
(page II.63) Change SEWAR to SEWER in the title of this subsection.

230.20 General.
(page II.63) Delete the words Reinforced Concrete or Metal.

230.40 General.
230.62 Pipe Joints.
230.82 Payment Items
(page II.63, II.64 and II.68) Replace the words Corrugated Plastic (Polyethylene) Pipe with the words Corrugated Plastic Pipe.

230.64 Field Testing of Corrugated Plastic Pipe
(page II.65) Delete the word thermoplastic in the first sentence of this subsection.

SECTION 400: SUB-BASE, BASE COURSES, SHOULDERS, PAVEMENTS AND BERMS
SUBSECTION 450: HOT MIX ASPHALT PAVEMENT

SUBSECTION 453.93 Payment Items.
(page II.181) Change the pay unit of item 452. Tack Coat from Ton to Gallons and the pay unit of item 453. HMA Joint Sealant from Ton to Foot.

SECTION 700: INCIDENTAL WORK
SUBSECTION 702: HOT MIX ASPHALT SIDEWALKS AND DRIVEWAYS

SUBSECTION 702.41 Preparation of Underlying Surface.
(page II.303) Add the following sentence to the end of the first paragraph;

Existing pavements shall be sawcut in accordance with 450.49: Hot Mix Asphalt Joints.

SUBSECTION 702.81 Basis of Payment.
(page II.314) Add the following after the last paragraph;

All required sawcutting in the existing pavement in accordance with this specification will be included in the contract unit price for Hot Mix Asphalt Sidewalks and Driveways.

SUBSECTION 765: SEEDING

SUBSECTION 765.40 General.
(page II.332) Add the following material to the end of this subsection;

Seed for Short Term Erosion Control M6.03.1

SUBSECTION 765.63 Seeding Grass.
(page II.333) Replace the first sentence with the following;

After the loamed or topsoil areas have been prepared and treated as hereinbefore described, grass seed conforming to the respective formulas hereinbefore specified shall be carefully sown thereon at the rate as specified by the supplier.

SUBSECTION 765.65 Seeding Grass by Spray Machine.
(page II.333) Change the title of this subsection to Hydroseeding. Delete the last paragraph of this subsection that begins with "If the results …", and Replace the first two sentences of the first paragraph with the following;

A hydroseed machine approved by the Engineer and designed specifically for seed dissemination may be utilized. The application of limestone as necessary, fertilizer as necessary and grass seed may be accomplished in one operation by the use of the approved hydroseed machine.

SUBSECTION 765.81 Basis of Payment.
(page II.334) Replace this subsection with the following;

Payment for Seeding and Seeding for Short Term Erosion Control, including all mowing, will be paid for at the contract unit price per square yard, complete in place. When a satisfactory stand of grass has not been established at the time of acceptance, no payment for seeding shall be allowed at the time of acceptance. At the time the final estimate is ready to be forwarded to the Contractor the seeded areas will again be inspected by the Engineer and the seeded areas with a satisfactory stand of grass will be included for payment.

SUBSECTION 765.82 Payment Items.
(page II.334) Add the following payment item;

765.2 Seed for Short Term Erosion Control.....Square Yard

SUBSECTION 766: REFERTILIZATION

SUBSECTION 766 Refertilization.
(page II.335) Delete this entire subsection.

SUBSECTION 767: MULCHING; SEED FOR EROSION CONTROL

SUBSECTION 767 Mulching; Seed for Erosion Control.
(page II.336) Change the title of this subsection to Mulching and Erosion Control.

SUBSECTION 767.40 General.
(page II.336) Delete Seeding for Erosion Control … M6.03.1.

SUBSECTION 767.62 Hay Mulch with Seed for Erosion Control.
(page II.337) Change the title of this subsection to Hay Mulch with Seed for Short Term Erosion Control.

SUBSECTION 767.80 Method of Measurement.
(page II.338) Delete the last paragraph of this subsection which reads "Seed for Erosion Control will be measured by the pound."

SUBSECTION 767.81 Basis of Payment.
(page II.338) Delete the last paragraph of this subsection which reads "Seed for Erosion Control will be paid for at the contract unit price per pound."

SUBSECTION 767.82 Payment Items.
(page II.339) Delete item 765.2 Seed for Erosion Control.

SUBSECTION 771: PLANTING TREES, SHRUBS AND GROUNDCOVER

SUBSECTION 771.40 General.
(page II.338) Replace the last three paragraphs of third, fourth and fifth paragraphs of this subsection with the following;

All plants shall be northern grown nursery stock. The American Standards for Nursery Stock (ANSI Z60.1 shall serve as the Department's standard for plants and for plant, root ball, and container size, as well as growth and form requirements.

The latest editions of ANSI A300 Standards Part 1 Pruning and Part 6 Planting and Transplanting shall apply for all work of planting and pruning.

Trees and shrubs shall be balled and burlapped (B&B) or containerized. The caliper, height, age and other dimensions as specified for all planting material shall apply at the time planting is done and the plants will be inspected by the Engineer at this time as to these requirements as well as the quality or grade and varieties required. The Contractor shall remove all plants not approved by the Engineer from the project.

SUBSECTION 771.61 Seasons for Planting.
(page II.346) In table 771.61-1: Calendar Guidance for Planting replace "March 21 through May 15" with "March 21 through June 15".

SECTION 900: STRUCTURES

SUBSECTION 965: MEMBRANE WATERPROOFING FOR NEW BRIDGE DECKS

SUBSECTION 965 Membrane Waterproofing for New Bridge Decks.
(page II.552) Add this new section.

SUBSECTION 965: MEMBRANE WATERPROOFING FOR NEW BRIDGE DECKS

DESCRIPTION

965.20: General

Membrane waterproofing systems are defined as a thin impermeable membrane that is used to protect the concrete deck from penetration of moisture and deicing chemicals.

The work to be performed shall consist of the furnishing and application of an approved membrane system and all concrete surface preparation work necessary to install the membrane system. The membrane waterproofing system applied to the surface of the bridge deck as indicated on the plans shall consist of the primer, spray applied membrane (either methyl methacrylate, polyurea, or polyurethane methyl methacrylate), aggregate keycoat, and polymer modified tack coat.

MATERIALS

965.30: General

Materials shall meet the requirements specified in the following Subsections of Division III, Materials:

Spray Applied Waterproofing Membrane M9.08.1

CONSTRUCTION METHODS

965.40: Submittals

The Contractor shall submit to the Engineer for approval the following documents:

1. Initial submission (at least 30 days prior to application):
   - The membrane system to be installed.
   - The manufacturer's installation instructions for the applicable system
   - Safety data sheets (SDS) for all components
   - Cleaning solvents approved by the membrane manufacturer
2. At the pre-application meeting (at least 14 days prior to application):
   - Manufacturer's written approval of the Applicator's qualifications.
   - List of personnel performing the installation, inspection, and testing.
   - Installation procedure including storage and protection instructions as well as handling and mixing instructions.
   - List of application equipment to be used.
   - Manufacturer's written approval of the proposed polymer modified tack coat and the application rate that it shall be applied at.
   - Certificate of Compliance certifying that the aggregate for the keycoat meets the required hardness.
3. A minimum of 48 hours prior to installation a certificate of analysis for the proposed polymer modified tack coat shall be submitted by the Supplier of the tack coat to the Engineer for approval.
4. Upon completion of installation:
   - All QC installation test results for the tests specified in the materials section, including the name, address, and contact person of the laboratory that performed the tests and the date of the tests.

- A Certificate of Compliance, from the membrane waterproofing system manufacturer, certifying that the membrane waterproofing system materials meet the requirements of the manufacturer and the contract specifications.

965.41: Preconstruction

Membrane waterproofing shall be installed in accordance with the manufacturer's instructions. The handling, mixing, and addition of membrane components shall be performed in a safe manner to achieve the desired results in accordance with the manufacturer's recommendations. Care shall be taken to prevent adjacent areas from overspray or other contamination.

965.42: Applicator Qualifications

The Contractor applying the waterproofing system shall be certified by the membrane waterproofing system manufacturer and have at least 2 years of experience in membrane installation. The Engineer shall receive the manufacturer's written approval of the contractor's qualifications at least 30 days prior to the application of any system component. This approval shall apply only to the named individuals performing the application.

965.43: Material Delivery and Storage

All components of the membrane system shall be delivered to the site in the manufacturer's original packaging, clearly identified with the products type and batch number. The storage area for all components shall be cool, dry, out of direct sunlight, and comply with relevant health and safety regulations. Copies of safety data sheets for all components shall be given to the Engineer and kept on site at the Contractor's field office.

965.44: Pre-Application Meeting

A minimum of 14 days before the anticipated start of membrane application, the Contractor shall schedule and conduct a pre-application meeting at the site to review the approved submittals, and other pertinent matters related to the application including the schedule for coordination between trades. At a minimum, the Contractor, the subcontractor performing the application and the Engineer shall be present at the meeting.

965.45: Mockup to Validate Bond Strength

For those projects where the concrete will be aged less than 28 days the manufacturer shall concur that the system is acceptable for use with the shortened aging period and a mockup shall be required. The intent is to validate the bond strength using the membrane waterproofing manufacture's primer and membrane.

In order to emulate the actual placement conditions, the mockup shall take place as close as possible to the intended date of the waterproofing application but be a minimum of 7 days before concrete placement. The mockup activities shall be representative of what will take place during the specified final bridge placement. It shall include the placement and surface preparation of the concrete and installation of membrane waterproofing system.

Inspection and testing shall be in accordance with Tables 965.63-1 and 965.64-1. The results of moisture and adhesion testing performed on a mockup of the bridge deck and closure pours shall meet these specifications. The mockup shall simulate the actual job conditions in all respects including air temperature, transit equipment, travel conditions, admixtures, forming, placement equipment, and personnel. If the mockup is unable to validate that the waterproofing membrane meets the project requirements, then the Engineer may require the Contractor to conduct additional mockups.

Removal of the mockup after its completion shall be the responsibility of the Contractor. In addition to the requirements contained herein, all weather and concrete temperature requirements contained in Section 901 shall be satisfied.

Acceptance of the mockup shall be the responsibility of the Engineer.

965.46: Application

The installation procedure shall consist of preparation of the concrete surface and application of primer, membrane, aggregate keycoat, and polymer modified tack coat. Special attention shall be paid to the bridge deck surface preparation prior to the membrane waterproofing system application. The membrane system shall be installed in accordance with the manufacturer's requirements. The Contractor shall be responsible for the field testing including, but not limited to, adhesion bond testing, deck moisture content measurement, and all other required documentation and reporting.

The membrane waterproofing system shall not be applied in either wet, damp, or foggy weather, or when the ambient temperature is 40°F or below or is forecast to fall below 40°F during the application period. The temperature of the concrete deck surface shall also exceed the dew point by at least 5°F.

The membrane waterproofing shall not be placed until the Contractor is ready to follow within 24 hours with the first layer of hot mix asphalt pavement. A longer period will be allowed only with prior written approval from the Engineer.

Where the areas to be waterproofed are bound by a vertical surface including, but not limited to, a curb or a wall, the membrane waterproofing system shall be continued up the vertical as necessary. A neat finish with well-defined boundaries and straight edges shall be provided.

A. Concrete Surface Preparation

Concrete surfaces which are to be waterproofed shall be screeded to the true cross section and sounded. All spalls and depressions shall be repaired prior to the application of the primer. Depressions shall be filled to a smooth flush surface with 1:2 mortar (1-part cement to two parts sand) or an approved rapid setting patching mortar that is compatible with the membrane waterproofing system. Other surfaces shall be trimmed free of rough spots, projections, or other defects which might cause puncture of the membrane so that the surface profile of the prepared concrete surface shall not exceed a ¼ inch amplitude, peak to valley.

The use of resin or wax-based deck curing membranes are not acceptable. Unless a mockup is completed in accordance with 965.45, the concrete shall be aged a minimum of 28 days, including curing time, before application of the membrane waterproofing system.

Immediately prior to the application of the primer, the concrete to which the membrane is to be applied shall be cleaned of all existing bond inhibiting materials in accordance with ASTM D4259 or as required by the manufacturer. Dust or loose particles shall be removed using clean, dry, oil-free compressed air or industrial vacuums. The surface preparation shall produce a clean dry surface and ensure that the concrete surface is free of asphaltic product, surface laitance, oil staining, soiling, and dust.

Any exposed steel components to receive membrane waterproofing shall be blast cleaned in accordance with the Society for Protective Coatings (SSPC) SSPC-SP6 or as required by the manufacturer and coated with the membrane waterproofing system within the same work shift.

B. Applying Primer

The primer shall only be applied when the temperature of the concrete deck surface exceeds the dew point by at least 5°F and when the concrete deck surface has a moisture content of 5% or less, as confirmed by a portable electronic surface moisture meter supplied by the Contractor.

The primer shall be applied in a manner to ensure full coverage and shall consist of one coat with an overall coverage rate of 125-175 ft^2/gallon unless otherwise recommended in the manufacturer's written instructions. All components shall be measured and mixed in accordance with the manufacturer's recommendations. The primer shall be spray applied using a single or multiple component spray system approved for use by the manufacturer. If required by site conditions, brush or roller application shall be allowed. The primer shall be allowed to cure tack-free for a minimum of 30 minutes or as required by the manufacturer's instructions, whichever time is greater, prior to application of the first lift of waterproofing membrane.

A second coat of primer shall be required if the first coat is absorbed by the concrete. The membrane shall be applied within the primer re-coat drying time allowed by the manufacturer but in no case shall it exceed 24 hours. Beyond this period, the surface shall be prepared again and re-primed following the manufacturer's recommendations prior to membrane application.

C. Applying Membrane

The waterproofing membrane shall be applied following the approved mixing and application procedure. The membrane shall be spray applied, with the mixing of the two components taking place at the nozzle and shall be applied to the primed deck in accordance with the manufacturer's instructions. The spray equipment shall be controlled so that the quantities applied may be monitored and shall allow for coverage rates to be checked.

Following the application of the membrane waterproofing system, the cured surface shall be visually inspected. If any defects or pinholes are found, an appropriate quantity of membrane material shall be mixed and repaired in accordance with Subsection 965.46 Part D. In all cases, the thickness of the repair shall be sufficient to bring the area up to the specified thickness. The thickness of the repair patch, measured over peaks, shall be a minimum of 80 mils or the thickness used to pass the ASTM C1305 Crack Bridging Test, whichever is greater.

For multi-stage construction, the subsequent stage membrane application shall overlap the existing cured membrane from the previous stage to form a continuous layer with a 6-inch overlap onto the existing membrane. The existing membrane shall be cleaned of all contamination including tack coat material or dirt to an edge distance of a least 6 inches and wiped with a solvent as approved by the membrane waterproofing manufacturer.

D. Repairs

If an area of membrane requires repair or if the membrane becomes damaged, a patch repair shall be carried out to restore the integrity of the membrane waterproofing system. The damaged area shall be cut back to sound materials and wiped with a solvent up to a width of at least 6 inches beyond the periphery of the damaged area, removing contaminants. The concrete shall be primed as necessary followed by the application of the membrane. A continuous layer shall be obtained over the concrete with a 6-inch overlap onto the existing membrane. The solvent shall be as approved by the membrane waterproofing manufacturer. Repairs shall comply with the manufacturer's guidelines for any over-coating times.

Where the membrane is to be joined to existing cured material and at joints, the new application shall overlap the existing membrane/joint by at least 4 inches. The existing membrane/joint shall be cleaned of all contamination including tack coat material or dirt to an edge distance of a least 6 inches and wiped with a solvent as approved by the membrane waterproofing manufacturer.

If pin holes or holidays are observed in the membrane surface they shall be repaired in accordance with the manufacturer's instructions and the approved Contractor Quality Control Plan (QC Plan).

In all cases, the thickness of the repair shall be sufficient to bring the area up to the specified thickness. The thickness of the repair patch, measured over peaks, shall be a minimum of 80 mils or the thickness used to pass the ASTM C1305 Crack Bridging Test, whichever is greater.

E. Applying Aggregate for Keycoat

Following the membrane application, an additional layer of membrane or resin, compatible with the membrane, shall be spray applied to a thickness of 30 to 40 mils into which an aggregate approved by the membrane manufacturer shall be broadcast ensuring a minimum coverage of 95%. The application rate shall be designated by the manufacturer. Loose aggregate shall be removed with brooms or oil/moisture-free compressed air before applying the tack coat.

For multi-stage construction, the aggregate keycoat of the previous stage shall be applied to a limit of 6-inches from the stage construction joint to allow the subsequent stage membrane material to bond directly to

the existing membrane. The application of the aggregate keycoat for the subsequent stage shall cover the 6-inch overlap.

F. Applying Tack Coat

The polymer modified tack coat shall be applied in accordance with the membrane manufacturer's recommendations after a minimum of three hours from initial membrane application. The tack coat shall be allowed to cool for a minimum of 1 hour prior to HMA paving. The tack coat application rate shall be in accordance with the manufacturer's recommendation. The application rate of the tack coat shall be set at a rate that achieves the specified residual rate and coverage. Tack coat shall be applied to cover a minimum of 95% of the membrane surface. The tack coat application shall be monitored by Quality Control personnel in accordance with the approved QC Plan.

G. HMA Pavement Over Membrane

Placement of the HMA surface shall be in accordance with Section 450 and the contract specifications. During paving, a light soap spray should be applied to the paving equipment wheels to prevent tack coat pick-up.

965.47: Protection of Exposed Surfaces

The Contractor shall exercise care in the application of the waterproofing membrane system to prevent surfaces not receiving treatment from being spattered or marred, such as the face of curbs, copings, finished surfaces, substructure exposed surfaces, and outside faces of the bridge. Any material that spatters on these surfaces shall be removed and the surfaces cleaned to the satisfaction of the Engineer.

CONTRACTOR QUALITY CONTROL

965.60: General

The Contractor shall provide a Quality Control System (QC System) and, when required, a QC Plan, adequate to ensure that all materials and workmanship meet the required quality levels for each specified Quality Characteristic. The Contractor shall provide qualified QC personnel and QC laboratory facilities and perform Quality Control inspection, sampling, testing, data analysis, corrective action (when necessary), and documentation as outlined further below.

965.61: Contractor Quality Control Plan

The Contractor shall provide and maintain a QC Plan which should sufficiently document the QC processes of all Contractor parties (i.e. Prime Contractor, Subcontractors, Producers) performing work required under this specification.

A. QC Plan Submittal Requirements

At the pre-construction meeting, the Contractor shall be prepared to discuss the QC Plan. Information to be discussed shall include the proposed QC Plan submittal date, QC organization, and sources of materials. The Contractor shall submit the QC Plan to the Engineer for approval not less than 30 days prior to the start of any work activities related to membrane waterproofing installation (including preparation of underlying surface) addressed in Subsections 965.40 thru 965.47. The Contractor shall not start work on the subject work items without an approved QC Plan.

B. QC Plan Format and Contents

The QC Plan shall be structured to follow the format and section headings outlined in the MassDOT Model QC Plan. The pages of the QC Plan shall be sequentially numbered. The QC Plan shall address, in sufficient detail, the specific information requested under each section and subsection contained in the MassDOT Model QC Plan.

C. QC Plan Approval and Modifications

Approval of the QC Plan will be based on the inclusion of the required information. Revisions to the QC Plan may be required prior to approval for any part of the QC Plan that is determined by the Department to be insufficient. Approval of the QC Plan does not imply any warranty by the Engineer that the QC Plan will result in completed work that complies with the specifications. It remains the responsibility of the Contractor to demonstrate such compliance. The Contractor may modify the QC Plan as work progresses when circumstances necessitate changes in Quality Control personnel, laboratories, or procedures. In such case, the Contractor shall submit an amended QC Plan to the Department for approval a minimum of three calendar days prior to the proposed changes being implemented.

965.62: Quality Control Personnel Requirements

The Contractor's Quality Control organization shall, at a minimum, consist of the personnel qualified by the manufacturer to perform the required inspection and testing. Every effort should be made to maintain consistency in the QC organization; however, substitution of qualified personnel shall be allowed. When circumstances necessitate substitution of QC personnel not originally listed in the approved QC Plan, the Contractor shall submit an amended QC Plan for approval in accordance with Subsection 965.61 Part C.

965.63: Quality Control Inspection

The Contractor shall perform QC inspection of all work items addressed under this specification. Inspection activities during placement may be performed by qualified production personnel (e.g. Skilled Laborers, Foremen, and Superintendents). However, the Contractor's QC personnel shall have overall responsibility for QC inspection. The Contractor shall not rely on the results of the Engineer's Acceptance inspection for QC purposes. The Engineer shall be provided the opportunity to monitor and witness all QC inspection.

QC inspection activities must address the following four primary components:

a) Equipment
b) Materials
c) Environmental Conditions
d) Workmanship

The minimum frequency of QC inspection activity shall be in accordance with the requirements below and as outlined in the approved QC Plan. The Contractor shall document the results and findings of QC inspection.

The quality of each waterproofing membrane surface will be inspected and evaluated on the basis of Lots and Sublots. A Lot is defined as an isolated quantity of work which is assumed to be produced by the same controlled process. A Lot shall constitute no greater than the entire waterproofing membrane surface area on the bridge deck completed within the same construction season using the same placement process. Each Lot shall be divided into Sublots of equal sizes unless specified otherwise below.

All inspection reports shall be submitted to the Engineer within 72 hours of the test completion.

A. QC Inspection for Preparation of Underlying Surface

The Contractor's personnel will perform QC inspection during preparation of the underlying surface in accordance with the requirements of Subsection 965.46 Part A. The minimum items to be inspected shall be as outlined in Table 965.63-1. The Contractor shall identify in the QC Plan the specific inspection activities necessary to ensure the quality of the work, including any additional inspection activities not specifically listed in the table.

B. QC Inspection for Placement of Waterproofing Membrane

The Contractor's QC personnel will perform QC inspection at the site of waterproofing membrane field placement to ensure that the production and placement processes are providing work conforming to the contract and manufacturer requirements. The minimum items to be inspected for each waterproofing membrane Lot shall be in accordance with the requirements of Subsection 965.43 thru Subsection 965.47 and

as outlined in Table 965.63-1. The Contractor shall identify in the QC Plan the specific inspection activities necessary to ensure the quality of the work, including any additional inspection activities not specifically listed in the table. Inspection shall include:

a) Pin Hole/Holidays: The surface of the membrane shall be inspected for pin holes and/or holidays. All pin hole/holidays shall be located, marked for repair, documented, and repaired in accordance with a repair procedure developed by the manufacturer and approved by the Engineer.
b) Coverage Rates: Rates for all layers shall be monitored by checking quantity of material used against the area covered.
c) Visual inspections shall be conducted throughout the application process. The Contractor shall take progress photos for incorporation with the final review report to the Engineer.

Table 965.63-1 - Minimum QC Inspection of Waterproofing Membrane Operations

Inspection Component	Inspection Attribute	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Equipment	As specified in QC Plan	Per QC Plan	Per QC Plan	Per QC Plan
Materials	Primer (Correct Type)	Per QC Plan	Per QC Plan	Check Manufacturer COC
	Membrane (Correct Type)	Per QC Plan	Per QC Plan	Check Manufacturer COC
	Aggregate (Correct Type)	Per QC Plan	Per QC Plan	Check Manufacturer COC
	Tack Coat (Correct Type)	Per QC Plan	Per QC Plan	Check Manufacturer COC
Environmental Conditions	Temperature of Air & Underlying Surface	1 per Day	At Project Site	Check Measurement
	Underlying Surface (Soundness)	Per QC Plan	Underlying Surface	Visual Check
	Surface (Standing Moisture)	Per QC Plan	Underlying Surface & Membrane Surface	Visual Check
	Surface (Cleanliness)	Per QC Plan	Underlying Surface & Membrane Surface	Visual Check
Workmanship	Pin Hole/Holidays	Per QC Plan	Membrane Surface	Visual Check
	Membrane Coverage Rate	Per QC Plan	From Distributor	Check Measurement
	Aggregate Coverage Rate	Per QC Plan	Membrane Surface	Visual Check
	Tack Coat Application Rate	Per QC Plan	From Distributor	Check Measurement

965.64: Quality Control Sampling and Testing Requirements

The Contractor's QC personnel will perform QC sampling and testing at the site of membrane waterproofing placement to ensure that the production and placement processes are providing work conforming to the contract and manufacturer's requirements. The Engineer will not sample or test for Quality Control or assist in controlling the Contractor's operations. All QC sampling and testing shall be in accordance with the current AASHTO, ASTM, NETTCP, or Department procedures specified in Table 965.64-1. The Contractor shall furnish approved containers for all material samples. The Engineer shall be provided the opportunity to monitor and witness all QC sampling and testing.

The following testing shall be conducted and recorded on a test report form to be submitted to the Engineer. All reports shall be submitted to the Engineer within 72 hours of the test completion.

a) Deck moisture: The concrete deck's surface moisture content shall be measured to determine if it is suitable to allow for installation to proceed.
b) Primer Adhesion: Random tests for adequate tensile bond strength shall be conducted in accordance with ASTM D7234 using the membrane Manufacture's primer. Minimum bond strength of 100 psi and failure in the concrete will be required for acceptance. Testing shall be at a frequency of 1 test per 5,000 square feet with a minimum of 3 tests per day. Areas smaller than 5,000 square feet shall receive a minimum of 3 tests.
c) Film Thickness:
    - Wet film thickness shall be checked every 300 square feet in accordance with ASTM D4414 using a gauge pin or standard comb type thickness gauge or a magnetic gauge. Film thickness checks shall be carried throughout the application process.
    - Dry Film Thickness: If the membrane waterproofing system cures too quickly to perform wet film thickness testing, dry film thickness shall be checked every 300 square feet in accordance with ASTM D6132 using magnetic or ultrasonic gauges or using a destructive method. If a destructive method is used, areas shall be repaired in accordance with Subsection 965.46 Part C.
d) Membrane Adhesion: Random tests for adequate tensile bond strength shall be conducted in accordance with ASTM D7234 using the membrane Manufacture's primer and membrane. The portion of the membrane to be tested shall be separated from the rest of the membrane surface prior to performing the test so only that portion under the dolly receives the tensile force. A minimum bond strength of 100 psi and failure in the concrete will be required for acceptance. Testing shall be at a frequency of 1 test per 5,000 square feet with a minimum of 3 tests per day. Areas smaller than 5,000 square feet shall receive a minimum of 3 tests.

The Contractor shall take a representative sample of the membrane from that day's installation. The samples shall consist of 2 10-inch by 10-inch square samples of the membrane with smooth surfaces. The primer and aggregate shall not be incorporated into the sample. The sample shall be sprayed separate from the bridge deck on a non-adhesive surface using the same application techniques used for the deck. These samples shall be peeled off the non-adhesive surface and be provided to the Engineer to be tested by the Department.

Table 965.64-1: Minimum Quality Control Sampling & Testing of Waterproofing Membrane Lots

Quality Characteristic	Test Method(s)	Sublot Size	Minimum Test Frequency	Point of Sampling	Engineering Limits
Deck Concrete Moisture	Manufacturer's Recommendation	5,000 ft^2	1 per Sublot (1)	Deck Concrete Surface	≤ 5%
Primer Adhesion to Concrete	ASTM D7234	5,000 ft^2	1 per Sublot (1)	Primed Concrete Surface	≥ 100 psi minimum and failure in concrete
Film Thickness	Wet: ASTM D4414 Dry: ASTM D6132 or other approved method	300 ft^2	1 per Sublot (1)	Membrane Surface	≥ 80 mils minimum measured over peaks or ≥ Thickness used to pass ASTM C1305 (Whichever thickness is greater)
Membrane Adhesion to Concrete	ASTM D7234	5,000 ft^2	1 per Sublot (1)	Membrane Surface	≥ 100 psi minimum and failure in concrete

(1) In the event that the total daily production is less than three Sublots, a minimum of three random QC samples shall be obtained for the day's production.

DEPARTMENT ACCEPTANCE

965.70: General

The Department is responsible for performing all Acceptance activities and making the final Acceptance determination for each membrane waterproofing surface. The Department's Acceptance system will include monitoring the Contractor's QC activity and performing Acceptance inspection and testing in order to determine the quality and corresponding payment for each Lot.

965.71: Acceptance Inspection

The Engineer will perform Acceptance inspection of all work items addressed under Section 965 to ensure that materials and completed work are in conformance with the contract requirements. Acceptance inspection is intended to visually assess the quality of each Lot produced and placed and will address only the inspection components of Materials and Workmanship in support of the Department's final Acceptance determination.

All Acceptance inspection activities by the Department will be performed independent of the Contractor's QC inspection.

Table 965.71-1 – Department Acceptance Inspection of Waterproofing Membrane Operations

Inspection Component	Inspection Attribute	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Materials	Primer (Correct Type)	1 Per Day	At Placement Site	Check Manufacturer COC
	Membrane (Correct Type)	1 Per Day	At Placement Site	Check Manufacturer COC
	Aggregate (Correct Type)	1 Per Day	At Placement Site	Check Manufacturer COC
	Tack Coat (Correct Type)	1 Per Day	At Placement Site	Check Manufacturer COC
Workmanship	Pin Hole/Holidays	25% of Sublots	Membrane Surface	Visual Check
	Membrane Coverage Rate	25% of Sublots	From Distributor	Check Measurement
	Aggregate Coverage Rate	25% of Sublots	Membrane Surface	Visual Check
	Tack Coat Application Rate	25% of Sublots	From Distributor	Check Measurement

965.72: Acceptance Sampling and Testing Requirements

The 2 10-inch by 10-inch samples fabricated by the Contractor during installation shall be submitted to the Department for testing.

Table 965.72-1: Department Acceptance Sampling and Testing of Waterproofing Membrane Lots

Quality Characteristic	Test Method(s)	Engineering Limits
Minimum Thickness (Membrane only)	ASTM D6132 or other approved method	≥ 80 mils minimum measured over peaks or ≥ thickness used to pass ASTM C1305 (Whichever thickness is greater)
Percent Elongation at Break	ASTM D638	≥ 130%
Tensile Strength	ASTM D638 Type IV @ 2 in/min	> 1,100 psi
Shore Hardness	ASTM D2240 (1)	≥ 50 Type 00
(1) ASTM D2240 shall be modified in accordance with ASTM C836 Section 6.5.		

965.73: Lot Acceptance Determination Based on Inspection Results

The Engineer's Acceptance inspection results will be used in the final Acceptance determination for all Lots. Prior to final Acceptance of each Lot produced and placed, the Engineer will periodically evaluate all Acceptance inspection information for the prepared underlying surface and the Lot. The materials and product workmanship for the completed work will be evaluated for conformance with the plans and the requirements specified in Subsections 965.40 thru 965.47.

When the Acceptance information identifies deficiencies in either material quality or product workmanship for any underlying surface location or waterproofing membrane Sublot(s), the location or Sublot(s) will be isolated and further evaluated by the Engineer through additional Acceptance inspection (or sampling and testing, if relevant or possible). Depending upon the findings of the additional Acceptance inspection activity, the Engineer will determine the disposition of the nonconforming work in accordance with Division I, Subsection 5.03, Conformity with Plans and Specifications.

965.74: Lot Acceptance Determination Based on Testing Data

Evaluation of Testing Data

Prior to final Acceptance of each Lot produced and placed; the Engineer will periodically evaluate all available Acceptance testing data for the Lot.

Conformance with Engineering Limits

The Engineer will evaluate all Acceptance testing data and Contractor QC testing data for each Lot to determine conformance with the Engineering Limits in Tables 965.63-1 and 965.72-1. Each Sublot test value for the Acceptance Quality Characteristics identified in the tables shall be within the Engineering Limits.

If a Sublot test result is outside of the Engineering Limits, the Contractor and Engineer will further assess the Sublot quality to determine whether the material in the Sublot can remain in place. The Engineer will determine the disposition of the Sublot in accordance with Division I, Subsection 5.03, Conformity with Plans and Specifications.

If the Engineer's assessment determines that the material quality is not sufficient to permit the Sublot to remain in place the Sublot shall be removed and replaced. When a nonconforming Sublot is corrected or replaced, the Engineer will perform Acceptance testing of the Sublot and evaluate the test results for conformance with the Engineering Limits. Once the above requirements have been met, the Engineer will accept all completed Sublots.

965.75: Final Lot Acceptance Determination

For each Lot produced and placed, the Engineer will evaluate all Acceptance inspection and testing data for the Lot after all Sublots are complete in place. The final review and visual inspection shall be conducted jointly by the Contractor and Engineer. Irregularities or other items that do not meet the requirements of the specifications and plans shall be addressed/repaired at this time, at no additional cost to the Department.

After each Lot is complete, including any corrective action, the Engineer will perform a final evaluation of all Acceptance data and Contractor QC data for the Lot. The Engineer will accept the Lot if the Engineer's evaluation of all inspection and testing data for the Lot is in conformance with this specification and the contract documents.

COMPENSATION

965.90: Method of Measurement

Membrane Waterproofing for Bridge Decks will be measured by the square foot of the membrane system complete in place with no allowance for overlapping or for edges turned up or carried into recesses for seals, except that the area of the full membrane turned down in back of the backwalls and extended up the face of the curb or under and in back of median curbs shall be included for payment.

965.91: Basis of Payment

Payment under this Item shall be made at the unit bid price per square foot, which includes the primer, spray applied membrane, aggregate for keycoat, polymer modified tack coat, and all labor, materials, equipment, safety devices, tools, inspections and incidentals necessary to complete all work specified under this Item.

965.92: Payment Items

965.	Membrane Waterproofing for Bridge Decks	Square Foot

SUBSECTION 966: MEMBRANE WATERPROOFING FOR BRIDGE DECK REPAIRS

SUBSECTION 966 Membrane Waterproofing for Bridge Deck Repairs.
(page II.552) Add this new section.

SUBSECTION 966: MEMBRANE WATERPROOFING FOR BRIDGE DECK REPAIRS

DESCRIPTION

966.20: General

Membrane waterproofing applied to the repaired deck surface as indicated on the plan and elsewhere as directed shall consist of one of the following systems:

- Sheet membrane - either reinforced rubberized asphalt or reinforced tar and resin.
- Hot applied rubberized asphalt membrane. This system shall not be used on grades in excess of 3 percent.

MATERIALS

966.30: General

Materials shall meet the requirements specified in the following Subsections of Division III, Materials:

Asphalt Emulsions	M3.03.1
Sheet Membrane	M9.08.2
Hot Applied Rubberized Asphalt Membrane	M9.08.3
Primer	M9.09.1

CONSTRUCTION METHODS

966.40: Application

A. Preparation of Surface

No waterproofing shall be done in wet, damp or foggy weather, nor when the ambient temperature is 40°F or below, without permission of the Engineer.

The membrane waterproofing on bridge deck repairs shall not be placed unless the Contractor is ready to follow within 24 hours with the first layer of hot mix asphalt pavement; a longer period of time will be allowed only with the approval of the Engineer.

Immediately prior to the membrane application, the concrete surface shall be thoroughly swept and blown clean with an air compressor to remove any loose debris. If the concrete surface is damp it shall be dried by use of a propane gas torch or similar equipment.

B. Applying Primer

The primer shall be applied to all surfaces at a rate of 0.015 gallon per square yard. The primer shall be thoroughly mixed and continuously agitated during application. It shall be applied by spray or squeegee. It shall thoroughly dry before application of the rubberized asphalt membrane. Should the membrane not be placed over the primed surface within 8 hours the surface shall be re-primed.

C. Applying Membrane

(1) Sheet Membranes

This system shall consist of the application of preformed reinforced rubberized asphalt membrane. Composition and dimensional requirements shall be as stipulated by the manufacturer of the sheet membrane.

Membrane Application

Membrane application shall be in accordance with the manufacturer's instructions. The preformed membrane sheets shall be applied to the primed surfaces either by hand or by mechanical applicators.

The membrane sheet shall be placed in such a manner that a shingling effect is achieved in the direction that water will drain. After being laid, the membrane sheets shall be rolled with hand rollers or other apparatus as necessary to develop a firm and uniform bond with the primed concrete surface. Wrinkles and air bubbles shall be eliminated to the extent possible.

A mastic, approved by the Sheet Membrane manufacturer, shall be applied as a bead along the exposed edge of the membrane sheet that extends up the barrier railing or curb face and that terminates in the high-side gutter after the sheets have been installed.

Any tears, cuts, or narrow overlaps shall be patched, using a satisfactory adhesive and by placing sections of membrane sheet over the defective area in such a manner that the patch extends at least 6 inches beyond the defect.

(2) Hot Applied Rubberized Asphalt Membrane

Membrane Application

Melting of the rubberized asphalt membrane shall be in accordance with the manufacturer's instructions. The kettle shall be equipped with a suitable agitator and temperature gauges for the kettle.

Sufficient lead time shall be allowed for heating of the rubberized asphalt so that it will be in a fluid state at the time scheduled for application. Caution should be observed that the melting temperature does not exceed the manufacturer's recommendation. When fluid, the material shall be drawn off in suitable containers and poured onto the primed and dried deck surface.

It shall be evenly spread with a special spray nozzle or silicone squeegees at a uniform rate to yield a coating at a minimum thickness of 1/8 inch and an average of 3/16 inch All horizontal surfaces shall be completely covered and vertical surfaces (curbing, edging, etc.) shall be covered up to 4 inches above the deck surface.

Any defects shall be repaired in accordance with the manufacturer's recommendations prior to HMA pavement overlayment.

Immediately following the application of the hot applied rubberized asphalt membrane and before it cools, the protective covering shall be laid parallel to the roadway centerline covering the entire area of membrane waterproofing.

D. Repairs

If an area of membrane requires repair or if the membrane becomes damaged, a patch repair shall be carried out to restore the integrity of the membrane waterproofing system. The damaged area shall be cut back to sound materials to a width of at least 6 inches beyond the periphery of the damaged area, removing contaminants. The concrete shall be primed as necessary followed by the application of the membrane. A continuous layer shall be obtained over the concrete with a 6-inch overlap onto the existing membrane. The solvent shall be as approved by the membrane waterproofing manufacturer. Repairs shall comply with the manufacturer's guidelines.

Where the membrane is to be joined to existing cured material and at joints, the new application shall overlap the existing membrane/joint by at least 4 inches. The existing membrane/joint shall be cleaned of all contamination including tack coat material or dirt to an edge distance of a least 6 inches.

If pin holes or holidays are observed in the membrane surface they shall be repaired in accordance with the manufacturer's instructions.

E. Applying Tack Coat

Tack coat, meeting Subsection 966.30, shall be applied in accordance with the membrane manufacturer's recommendations after a minimum of three hours from initial membrane application. The tack coat application rate shall be in accordance with the manufacturer's recommendation. The application rate of the tack coat shall be set at a rate that achieves the specified residual rate and coverage.

F. HMA Pavement Over Membrane

Placement of the HMA surface shall be in accordance with Section 450 and the contract specifications. To eliminate any possible damage to the membrane and in accordance with Subsection 450.50, the HMA overlayment shall be applied as soon as possible. Caution must be observed to assure that the paver does not cause damage to the membrane. During paving, a light soap spray should be applied to the paving equipment wheels to prevent tack coat pick-up.

966.41: Protection of Exposed Surfaces

The Contractor shall exercise care in the application of the waterproofing membrane system to prevent surfaces not receiving treatment from being spattered or marred, such as the face of curbs, copings, finished surfaces, substructure exposed surfaces, and outside faces of the bridge. Any material that spatters on these surfaces shall be removed and the surfaces cleaned to the satisfaction of the Engineer.

CONTRACTOR QUALITY CONTROL

966.60: General

The Contractor shall provide Quality Control (QC) activities to ensure that their operations will provide waterproofing that conforms to the specified material and workmanship requirements.

966.61: Quality Control Inspection

The Contractor shall perform QC inspection of all work items addressed under this specification. Inspection activities during placement may be performed by qualified production personnel (e.g. Skilled Laborers, Foremen, and Superintendents). The Contractor shall not rely on the results of the Engineer's Acceptance inspection for QC purposes. The Engineer shall be provided the opportunity to monitor and witness all QC inspection.

QC inspection activities must address the following four primary components:

a) Equipment.
b) Materials.
c) Environmental Conditions.
d) Workmanship.

The minimum frequency of QC inspection activity shall be in accordance with the requirements below. The Contractor shall document the results and findings of QC inspection.

A. QC Inspection for Preparation of Underlying Surface

The Contractor's personnel will perform QC inspection during preparation of the underlying surface in accordance with the requirements of Subsection 966.40 Part A. The minimum items to be inspected shall be as outlined in Table 966.61-1.

B. QC Inspection for Placement of Waterproofing Membrane

The Contractor will perform QC inspection at the site of waterproofing membrane field placement to ensure that the production and placement processes are providing work conforming to the contract and manufacturer requirements. The minimum items to be inspected for each waterproofing membrane shall be in accordance with the requirements of Subsection 966.40 Parts C thru F and as outlined in Table 966.61-1. Inspection shall include:

a) Pin Hole/Holidays: The surface of the membrane shall be inspected for pin holes and/or holidays. All pin hole/holidays shall be located, marked for repair, documented, and repaired in accordance with a repair procedure approved by the manufacturer.
b) Visual inspections shall be conducted throughout the application process. The Contractor shall take progress photos for incorporation with the final review report to the Engineer.

Table 966.61-1 - Minimum QC Inspection of Waterproofing Membrane Operations

Inspection Component	Inspection Attribute	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Equipment	As specified by Contractor	As specified by Contractor	As specified by Contractor	As specified by Contractor
Materials	Primer (Correct Type)	1 per Day	As specified by Contractor	Check Manufacturer COC
	Membrane (Correct Type)	1 per Day	As specified by Contractor	Check Manufacturer COC
	Tack Coat (Correct Type)	1 per Day	Per QC Plan	Check Manufacturer COC
Environmental Conditions	Temperature of Air & Underlying Surface	1 per Day	At Project Site	Check Measurement
	Underlying Surface (Soundness)	Entire Surface	Underlying Surface	Visual Check
	Surface (Standing Moisture)	Entire Surface	Underlying Surface & Membrane Surface	Visual Check
	Surface (Cleanliness)	Entire Surface	Underlying Surface & Membrane Surface	Visual Check
Workmanship	Pin Hole/Holidays	Entire Surface	Membrane Surface	Visual Check
	Membrane Coverage Rates	Entire Surface	From Distributor	Visual Check
	Tack Coat Application Rate	1 per Day	From Distributor	Check Measurement

DEPARTMENT ACCEPTANCE

966.70: General

The Department is responsible for performing all Acceptance activities and making the final Acceptance determination for each membrane waterproofing surface. The Department's Acceptance system will include monitoring the Contractor's QC activity and performing Acceptance inspection in order to determine the quality and corresponding payment.

966.71: Acceptance Inspection

The Engineer will perform Acceptance inspection of all work items addressed under Section 966 to ensure that materials and completed work are in conformance with the contract requirements. Acceptance inspection is intended to visually assess the quality of the materials and work and will address only the inspection components of Materials and Workmanship in support of the Department's final Acceptance determination.

All Acceptance inspection activities by the Department will be performed independent of the Contractor's QC inspection.

Table 965.71-1 – Department Acceptance Inspection of Waterproofing Membrane Operations

Inspection Component	Inspection Attribute	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Materials	Primer (Correct Type)	1 Per Day	At Placement Site	Check Manufacturer COC
	Membrane (Correct Type)	1 Per Day	At Placement Site	Check Manufacturer COC
	Tack Coat (Correct Type)	1 Per Day	At Placement Site	Check Manufacturer COC
Workmanship	Pin Hole/Holidays	Entire Surface	Membrane Surface	Visual Check
	Membrane Coverage Rates	Entire Surface	At Placement Site	Visual Check
	Tack Coat Application Rate	1 per day	At Placement Site	Check Measurement

966.72: Acceptance Determination

The Engineer's Acceptance inspection results will be used in the final Acceptance determination. Prior to final Acceptance, the Engineer will periodically evaluate all Acceptance inspection information for the prepared underlying surface and the waterproofing membrane. The materials and product workmanship for the completed work will be evaluated for conformance with the plans and the requirements specified in Subsections 966.40 and 966.41.

When the Acceptance information identifies deficiencies in either material quality or product workmanship for any underlying surface location or waterproofing membrane, the location will be isolated and further evaluated by the Engineer through additional Acceptance inspection. Depending upon the findings of the additional Acceptance inspection activity, the Engineer will determine the disposition of the nonconforming work in accordance with Division I, Subsection 5.03, Conformity with Plans and Specifications.

The final review and visual inspection shall be conducted jointly by the Contractor and Engineer. Irregularities or other items that do not meet the requirements of the specifications and plans shall be addressed/repaired at this time, at no additional cost to the Department.

After the work is complete, including any corrective action, the Engineer will perform a final evaluation of all Acceptance data and Contractor QC data. The Engineer will accept the work if the Engineer's evaluation of all inspection data is in conformance with this specification and the contract documents.

COMPENSATION

966.90: Method of Measurement

Membrane waterproofing for bridge deck repairs will be measured by the square foot of surface covered with no allowance for overlapping or for edges turned up or carried into recesses for seals, except that the area of the full membrane turned down in back of the backwalls and extended under and in back of curb or edging will be included for payment.

966.91: Basis of Payment

The membrane waterproofing will be paid for at the contract unit price per square foot under the item for Membrane Waterproofing for Bridge Deck Repairs, complete in place. Tack coat shall be paid under item 452. Tack Coat.

966.92: Payment Items

966.	Membrane Waterproofing for Bridge Deck Repairs	Square Foot

SUBSECTION 970: BITUMINOUS DAMP-PROOFING

SUBSECTION 970 Bituminous Damp-Proofing.
(page II.552) Replace this subsection with the following.

SECTION 970: DAMP-PROOFING

DESCRIPTION

970.20: General

Damp-proofing to be applied as shown on the plans shall consist of a primer and damp-proofing material. If material other than that specified herein is permitted to be used, the method of application shall conform to the published specifications of the manufacturer.

MATERIALS

970.30: General

Materials shall meet the requirements specified in the following Subsections of Division III, Materials:

Primer.....M9.09.1
Damp-proofing M9.09.2

CONSTRUCTION METHODS

970.40: General

Concrete surfaces shall be allowed to dry for a period of at least 5 days after the removal of forms before damp-proofing is applied.

Surfaces to be damp-proofed shall be made reasonably smooth and free from all projections and holes. All holes in concrete surfaces shall be satisfactorily filled with 1-part cement to 2 parts sand mortar before damp-proofing is applied. Concrete surfaces shall be properly cured before being damp-proofed. Surfaces shall be dry and immediately before the application of the damp-proofing shall be thoroughly cleaned of dust and all loose material. Damp-proofing shall not be done during wet, damp, or foggy weather, or when the ambient temperature is 40°F or below or is forecast to fall below 40°F during the application period. The temperature of the concrete surface shall also exceed the dew point by at least 5°F.

One coat of primer shall be uniformly applied to the surface in accordance with the manufacturer's recommendation. The material for damp-proofing shall be mopped or sprayed on the designated surfaces in two coats. Application methods, rates, temperature constraints shall be as recommended by the manufacturer.

The initial coat of damp-proofing shall be allowed to dry thoroughly before a second coat is applied. The final coat shall be thoroughly dry before any fill is placed against it.

CONTRACTOR QUALITY CONTROL

970.60: General

The Contractor shall provide Quality Control (QC) activities to ensure that their operations will provide damp-proofing that conforms to the specified material and workmanship requirements.

970.61: Damp-proofing Materials and Workmanship

The Contractor shall verify that they are using the correct damp-proofing materials as specified under Subsection 970.30. All damp-proofing operations shall exhibit satisfactory workmanship including ensuring a dry, smooth, and clean concrete surface which is cured properly, as well as, correct application of the primer and damp-proofing.

DEPARTMENT ACCEPTANCE

970.70: General

The Department shall verify that the Contractor is correctly performing the work and QC activities.

970.71: Damp-proofing Materials and Workmanship

The Engineer will verify that the damp-proofing materials and workmanship conform with Subsection 970.61.

COMPENSATION

970.80: Method of Measurement

Damp-proofing will be measured by the actual area of surface covered in square foot.

970.81: Basis of Payment.

Damp-proofing will be paid for at the contract unit price per square yard of surface and shall include the primer and all materials, equipment and labor to install the damp-proofing complete in place.

970.82: Payment Items.

970.	Damp-Proofing	Square Foot

DIVISION III
MATERIALS SPECIFICATIONS

SECTION M2: AGGREGATES AND RELATED MATERIALS

SUBSECTION M2.01.0 Crushed Stone.
(page III.10) In table M2.01.0-1 under the column for M2.01.6 3/8 Inch Crushed Stone change the percent passing the No.4 sieve from 20-20 to 20-50.

SECTION M3: ASPHALTIC MATERIALS

SECTION M3: ASPHALTIC MATERIALS
(page III.15) Replace this subsection with the following;

M3.00.0 General.

Asphaltic materials (also referred to as bituminous materials) include liquid asphalts as well as Hot Mix Asphalt (HMA) mixtures and other related materials. All asphaltic materials shall conform to the requirements of the specifications as designated hereinafter.

Unless otherwise stipulated, the sampling of liquid asphalt materials shall be in accordance with AASHTO R 66.

The following procedure shall be followed in obtaining liquid asphalt samples from pressure distributors or tankers used for the transport of liquid asphalt materials:

1. Distributors and tankers shall be equipped with approved sampling valves. The sampling valves on tankers shall be installed in the rear bulkhead approximately 1/3 of the height from the bottom. The sampling valves on pressure distributors may be located in the side of the tank somewhere in the middle third of the tank depth.
2. At least 1 gallon of material shall be drained off through the sampling valve and discarded before the sample is obtained.
3. Sample containers shall be new, clean and sealed with a tight-fitting cap. Washing of sample containers with solvents or water will not be permitted.

M3.01.0 Performance Graded Asphalt Binder.

Performance Graded Asphalt Binder (PGAB) delivered to a project or to an HMA plant must be accompanied by a Bill of Lading (BOL) signed by the asphalt binder Supplier's authorized representative in accordance with AASHTO R 26. Shipments of material not accompanied by a BOL will not be accepted for use in the work.

The PGAB Supplier and the Contractor shall perform random Quality Control (QC) sampling and testing of PGAB as specified in Subsection 450.65F(1). The Contractor shall furnish, to the Engineer, the PGAB Supplier's BOL for each truckload of asphalt binder shipped to the project or HMA plant. The Contractor shall also submit to the Engineer the Supplier's Certificate of Compliance (COC) along with copies of the Certificate of Analysis (COA) showing the certified AASHTO M 320 test results for each Supplier Lot of PGAB. The COA shall meet the requirements of AASHTO R 26. The Contractor shall maintain a copy of the COA for each Lot of PGAB used, with a copy attached to each sample obtained for testing.

The Contractor shall assist the Engineer in obtaining random Department Acceptance samples of PGAB from the HMA plant in accordance with AASHTO R 66 and as specified in Subsection 450.74C. Each sample shall be labeled with the PGAB grade, Supplier source and Lot number, sampling location, quantity represented, project name, plant, date, and the sampling inspector. When the PGAB is used for HMA production under Section 450 the sample shall be obtained from an in-line sample valve located between the asphalt tanks and mixing chamber at a sampling location downstream of all additive injection ports.

The Engineer will test the Department Acceptance samples for verification of the PGAB grade. The material shall conform to the specification requirements for the applicable performance grade as specified herein. Material not conforming to specification requirements shall be subject to corrective action, production suspension, rejection, or removal as determined by the Engineer.

The blending of binder of different grades or binder from different Suppliers at the HMA plants is strictly prohibited without the Engineer's approval. Contractors may switch to another approved source of binder, upon written notification to the Engineer, and by certifying that the tank to be utilized has been drained to an un-pumpable condition. The binder tanks at the HMA production facility shall be managed in a manner which prevents contamination.

Contractors who modify, blend PG binders, or add additives to the PGAB at the HMA production facility will be reclassified as a Supplier and shall be required to certify the binder in accordance with AASHTO R 26.

A copy of the COA for each Lot shall be provided in accordance with AASHTO R 26. The data reported shall meet the requirements of the specific binder specification:

1. For AASHTO M 320 – Table 1
2. For AASHTO M 332 – Table 1
3. For Crumb Rubber Modified Asphalt ASTM D6114-09 – Table 1

M3.01.1 Standard Asphalt Binder Grade.

The asphalt binder for HMA mixtures shall be a PGAB which meets the specification requirements of AASHTO Standard M 320. PGAB shall be provided by an Approved Supplier in accordance with AASHTO R 26. Approved Suppliers shall be listed on the MassDOT Qualified Construction Materials List (QCML).

Unless indicated otherwise on the Plans or in the Special Provisions, the standard PGAB Grade of **PG64-28** shall be used.

M3.01.2 Modified Asphalt Binder Grades.

When specified by the contract documents, the PGAB shall be modified in accordance with the following:

A. Polymer Modified Asphalt Binder

The polymer modified asphalt binder shall be a PGAB which meets the specification requirements of AASHTO M 332, however "E" grades will not be subject to the J_{nrdiff} difference requirement. PGAB shall be provided by an approved Supplier in accordance with the AASHTO R 26. The modified PGAB Grade of **PG64E-28** shall be used.

B. Crumb Rubber Modified Asphalt Binder

The modified binder shall be in accordance with ASTM D6114-09, Type II. Virgin PGAB for the crumb rubber modified asphalt shall be a PG 58-28 or PG 64-28 provided by an approved Supplier in accordance with the AASHTO R 26. The grade selected shall be based on laboratory testing by the asphalt rubber Manufacturer.

The granulated rubber shall be vulcanized rubber product from the ambient temperature processing of scrap, pneumatic tires. The granulated rubber shall meet the gradation found in Table M3.1.

Table M3.1 – Crumb Rubber Gradation

Sieve Size	Percent by Weight Passing
#10	100
#16	90 – 100
#30	25 – 75
#80	0 – 20

The use of crumb rubber of multiple types from multiple sources is acceptable provided that the overall blend of crumb rubber meets the gradation requirements. The length of the individual rubber particles shall not exceed 1/8". The rubber shall be certified by the crumb rubber Manufacturer.

The percent of crumb rubber shall be a minimum of 15% by weight of binder. The temperature of the asphalt shall be between 350°F and 400°F at the time of addition of the granulated crumb rubber. The asphalt and crumb rubber shall be combined and mixed together in a blender unit and reacted in the distributor for a period of time as required by design. The temperature of the asphalt rubber mixture shall be above 325°F during the reaction for a period of one hour.

M3.01.3 Asphalt Binder Grade for Recycled Asphalt Materials.

For any HMA mixture containing recycled asphalt materials, a binder that is softer than the standard asphalt binder shall be utilized in the mixture to account for the amount and stiffness of the recycled binder in accordance with Table M3.2.

If greater than 25% Reclaimed Asphalt Pavement (RAP) or any quantity of Recycled Asphalt Shingles (RAS) are used in an asphalt mixture, the virgin PGAB grade when blended with the RAP binder shall meet the binder grade specified by the project. The resulting final PGAB grade shall be in accordance with Table M3.2. Only PGABs meeting the requirements of AASHTO M 320 or M 323 will be used.

The type and amount of virgin asphalt binder to be used in the HMA mixture shall be included as part of the Laboratory Trial Mix Formula (LTMF). The Contractor shall submit certified test results from an AASHTO accredited laboratory showing the testing of the individual binders and the blending.

Table M3.2 – PGAB Grades for HMA Containing RAP/RAS

Amount of RAP in Mixture	Virgin PGAB Grade	Resulting PGAB Grade
≤ 25% RAP by Weight of Mixture	Project Specified Grade	Project Specified Grade
> 25% to 40% RAP by Weight of Mixture	Follow AASHTO M 323 Appendix X1	
≤ 5% RAS by Weight of Mixture	Follow AASHTO PP 78	

M3.01.4 Warm Mix Asphalt Additive.

All HMA shall be modified using a warm mix asphalt (WMA) additive. The WMA additive shall be evaluated by AASHTO's National Transportation Product Evaluation Program (NTPEP) and be listed on the MassDOT QCML. No WMA foaming technology which requires the mechanical injection of steam or water into the liquid asphalt will be permitted.

For HMA placed on bridge decks, the WMA additive shall not be used to lower the mixing and compaction temperatures. The mixing and compaction temperatures specified for the binder prior to addition of the WMA additive shall be used.

The WMA additive must be compatible with polyphosphoric acid modified binders, polymer modified binders, and anti-stripping agents. The WMA additive shall be introduced in accordance with the Manufacturer's dosing rates and approved blending methods.

The HMA mixture design shall incorporate the requirements of AASHTO R35 Appendix X2: Special Mixture Design Considerations and Practices for Warm Mix Asphalt (WMA). Laboratory mixing and compaction temperatures shall be reduced per the WMA Manufacturer's recommendations, however, the optimum laboratory compaction temperature for unmodified asphalt binders shall be less than 260°F. Target laboratory mixing and compaction temperatures shall be submitted to the Research & Materials Section (RMS) for review prior to performing a mix design.

When the asphalt binder is modified with the WMA additive at the HMA plant, all WMA additive equipment shall be fully automated and integrated into the plant controls and shall record actual dosage rates on the plant printouts. The Contractor's Quality System Manual shall provide mixture production and placement alterations due to the WMA additive and shall incorporate the modification of asphalt binders when the WMA additive is blended with the asphalt binder at the plant. This plan shall specifically address WMA metering requirements, tolerances and other Quality Control measures.

M3.01.5 Asphalt Anti-Stripping Additive.

An anti-stripping additive may be required in an HMA mixture to increase the resistance of the asphalt binder coating to stripping in the presence of water. An anti-stripping additive may be a liquid anti-strip or hydrated lime.

The Engineer may verify the effectiveness of the anti-strip used in an HMA mixture. When added at the dosage rate recommended by the Manufacturer to an HMA mixture showing moisture susceptibility, the anti-strip shall cause an improvement to the mixture's moisture susceptibility. This shall be determined by testing specimens with and without the liquid anti-strip additive in accordance with AASHTO T 324. If the antistrip does not show an improvement in the moisture susceptibility the additive will not be permitted for use.

The Manufacturer shall certify that the material is in accordance with this specification. The Manufacturer shall submit a COC for each Lot in accordance with Division 1 Section 6.0. The COC shall also include the:

1. Brand name and designation.
2. Composition or description of the anti-strip additive.
3. Manner in which the material will be identified on the containers.

A. Hydrated Lime

The hydrated lime for HMA shall conform to the requirements of AASHTO M 303.

B. Liquid Anti-Strip

The anti-strip Manufacture shall submit product documentation, including the recommended dosage rate, to RMS for approval. Approved anti-strip additives shall be listed on the MassDOT QCML.

Anti-stripping additives shall be an organic chemical compound free from inorganic mineral salts or inorganic mineral soaps. The anti-strip additive shall be chemically inert to asphalt binder and shall not appreciably alter the specified characteristics of the asphalt binder. When blended with asphalt binder, it shall be stable and withstand storage at a temperature of 400°F for extended periods without loss of effectiveness.

M3.01.6 Asphalt Release Agents.

Approved asphalt release agents will be listed on the MassDOT QCML. The asphalt release agent shall not be detrimental to the HMA and shall not dissolve asphalt binder when applied to the truck bed. Dilution by diesel or other petroleum products will not be permitted.

Asphalt release agents shall be evaluated by AASHTO's National Transportation Product Evaluation Program (NTPEP). Release agents shall meet the following minimum requirements:

1. 7-Day Stripping Test
   a. No stripping or discoloration when used in full strength and diluted forms.
2. Mixture Slide Test
   a. 10.0 grams retained, maximum.
3. Asphalt Performance Test
   a. Able to pull the cooled binder from the metal plate without adherence, a minimum of three pours.
4. Flash Point, ASTM D93
   a. Have a flash point greater than 400°F on the undiluted product and contain no flammable materials, solvents, or petroleum elements.

The Manufacturer shall submit a Certificate of Compliance (COC) for each Lot of asphalt release agent in accordance with Division 1 Section 6.0. The COC shall also include the:

1. Brand name and designation.
2. Composition or description of the release agent.
3. Manner in which the material will be identified on the containers.

The Manufacturer shall certify that the material is in accordance with this specification. In addition, the Manufacturer shall furnish information for any dilution requirements, including the minimum dilution rate and special application requirements.

M3.02.0 Cutback Asphalts.

These materials shall be blends of asphalt cements and suitable solvents. They shall be homogeneous, free from water and conform to the requirements of AASHTO M 81 for the rapid curing type and AASHTO M 82 for the medium curing type.

M3.03.0 Asphalt Emulsions.
M3.03.1 Anionic Emulsified Asphalt.

These materials shall conform to the requirements of AASHTO M 140. Anionic emulsion used for tack coat shall be grade **RS-1h**.

When supplied in 5-gallon buckets the anionic emulsion used for tack coat shall be grade **RS-1**.

M3.03.2 Cationic Emulsified Asphalt.

This material shall conform to the requirements of AASHTO M 208. Cationic asphalt emulsion used for tack coat shall be grade **CRS-1h**.

When supplied in 5-gallon buckets the cationic emulsion used for tack coat shall be grade C**RS-1**.

M3.03.3 Polymer Modified Emulsified Asphalt.

This material shall conform to the requirements of AASHTO M 316. Polymer modified asphalt emulsion used for tack coat shall be grade **CRS-1P**.

M3.05.0 Hot Poured Joint Sealer.

This sealer shall meet the requirements of ASTM D6690 Type II. Products shall be evaluated by the National Transportation Product Evaluation Program (NTPEP) as an HMA Crack Sealer (CS) and be listed on the MassDOT QCML.

M3.05.1 Asphalt-Fiber Joint and Crack Sealer.

This material shall consist of a blend of asphalt cement (PG64-28) and polyester fibers. The asphalt-fiber blend shall consist of 6% fiber by weight of asphalt binder.

M3.05.2 Preformed Bituminous Joint Filler for Concrete.

This material shall be a non-extruding and resilient bituminous type preformed expansion joint filler. It shall conform to the requirements of AASHTO M 213.

M3.05.3 Hot Applied Asphalt Crack Sealer.

This specification covers a hot applied crack sealer suitable for use in cement concrete and hot mix asphalt pavement. This sealer shall meet the requirements of ASTM D6690 Type II. Products shall be evaluated by the National Transportation Product Evaluation Program (NTPEP) as an HMA Crack Sealer (CS) and be listed on the MassDOT QCML.

M3.11.0 Hot Mix Asphalt.

M3.11.1 General.

All Hot Mix Asphalt (HMA) mixtures shall meet the requirements of the Superpave volumetric mix design system as well as the following. Asphalt mixtures shall be composed of the following:

1. Mineral aggregate.
2. Mineral filler (if required).
3. Performance Graded Asphalt Binder (PGAB).

The use of recycled materials shall be at the Contractor's option in accordance with these specifications. And as permitted, recycled materials shall be limited to:

1. Recycled Asphalt Pavement (RAP).
2. Recycled Asphalt Shingles (RAS).
3. Processed Glass Aggregate (PGA).

Each HMA pavement course placed shall be compromised of one of the mixture types listed in Table 450.1HMA Pavement Courses & Mixture Types.

M3.11.2 Aggregate for Hot Mix Asphalt.

A. Coarse Aggregate

The coarse mineral aggregate shall be clean, hard, durable, crushed rock consisting of the angular fragments obtained by breaking and crushing shattered natural rock, reasonably free from thin and/or elongated pieces, free from dirt or other objectionable materials. It shall be surface dry and shall have a moisture content of not more than ½ percent after drying. Aggregates from multiple sources of supply shall not be mixed or stored in the same stockpile.

B. Fine Aggregate

The fine aggregate shall consist of one of the following:

1. 100% Natural Sand.
2. 100% Stone Sand.
3. A blend of sand and stone screenings, the proportions of which shall be approved by the Engineer.
4. A blend of natural sand and stone sand.

Natural sand shall consist of inert, hard, durable grains of quartz or other hard, durable rock, free from topsoil or clay, surface coatings, organic matter or other deleterious materials.

Stone sand shall be a processed material prepared from stone screenings to produce a consistently graded material conforming to specification requirements.

Stone screenings shall be the product of a secondary crusher and shall be free from dirt, clay, organic matter, excess fines or other deleterious material.

C. Consensus Properties

Aggregates utilized in HMA mixtures, including RAP if used in the mixture, shall be tested for conformance with the Consensus Property requirements outlined in AASHTO M 323 Sections 6.2 to 6.6 and Table M3.5 below.

D. Source Properties

The coarse aggregate utilized in asphalt mixtures shall be clean, crushed rock consisting of the angular fragments obtained by breaking and crushing shattered natural rock. It shall be free from dirt or other objectionable materials. The coarse aggregate, including RAP if used in the mixture, shall be tested for conformance with the requirements indicated in Table M3.6. The specific gravity of each aggregate component shall be determined as specified in Table M3.7 below.

To determine the bulk specific gravity of RAP aggregate, the method outlined in FHWA Publication Number FHWA-HRT-11-021 "Reclaimed Asphalt Pavement in Asphalt Mixtures: State of the Practice" shall be used. The following excerpt is the method to be followed:

If the source of RAP is known and original construction records are available, the bulk specific gravity (BSG) value of the virgin aggregate from the construction records may be used as the BSG value of the RAP aggregate. However, if original construction records are not available, the recommended procedure for estimating BSG of the RAP aggregate is a simple three-step process as follows:

Determine the maximum theoretical specific gravity of the RAP mixture, G_{mm}^{RAP}, according to AASHTO T 209.

Calculate the effective specific gravity of the RAP aggregate, G_{se}^{RAP}, using G_{mm}^{RAP}, the asphalt content of the RAP mixture (P_b) and an assumed asphalt specific gravity (G_b) as follows:

$$G_{se}^{RAP} = \frac{100 - P_b}{\frac{100}{G_{mm}} - \frac{P_b}{G_b}}$$

Where $G_b = 1.030$.

The asphalt absorption, P_{ba}, shall be assumed to be 0.5%. Use this value to estimate the BSG of the RAP aggregate, G_{sb}^{RAP}, from the calculated G_{se}^{RAP}.

$$G_{sb}^{RAP} = G_{se}^{RAP} / \left(\frac{P_{ba} \times G_{se}^{RAP}}{100 G_b} + 1 \right)$$

E. Recycled Asphalt Pavement

Reclaimed Asphalt Pavement (RAP) shall meet the requirements of Subsection M3.11.2C and D as well as the following. RAP shall consist of the material obtained from state highways or streets by crushing or milling existing HMA pavements. This material shall be transported to the HMA production facility yard and processed through an appropriate crusher so that the resulting material will contain no particles larger than the maximum aggregate size of the HMA mixture in which it will be used.

The RAP shall be stockpiled on a free draining base and kept separate from the other aggregates. RAP stockpiles shall be covered in a manner that prevents the intrusion of water but also allows the flow of air. The RAP stockpiles shall have a reasonably uniform gradation from fine to coarse and shall not be contaminated by foreign materials. The RAP used in the HMA mix production shall have a moisture content such that the final HMA contains no more than 0.5% moisture.

The use of RAP will be permitted at the option of the Contractor and provided that the end product is in conformance with the approved Job Mix Formula (JMF). The proportion of RAP to virgin aggregate shall be in accordance with Table M3.4 and Subsection M3.01.3.

Table M3.4 – Maximum Allowed RAP Content by Mix Type

Mix Type	Maximum Amount of RAP Allowed (%)	Maximum Amount of RAS Allowed (%)(1)
Friction Course (OGFC)	0	0
Friction Course (ARGG)	10	0
Surface Course	15	0
Leveling Course		5
Bridge Surface Course		0
Bridge Protective Course		0
Intermediate Course	40	5
Base Course		5
(1) When RAS is used in HMA mixtures containing RAP or other recycled materials, the RAS will be considered as part of the overall allowable weight of recycled materials in the mixture.		

F. Recycled Asphalt Shingles

Recycled Asphalt Shingles (RAS) shall consist of only the by-product materials obtained from the roofing shingle manufacturing process. Post-consumer shingle waste and re-roofing shingle scrap will not be allowed. The Contractor or the plant shall provide certification from the roofing shingle manufacturer that RAS material provided is a by-product of the shingle manufacturing process. This material shall be transported to the HMA production facility yard and processed through an appropriate crusher so that the resulting material will contain no particles larger than ½ inch. The material shall be stockpiled on a free draining base and kept separate from the other aggregates. The material contained in the processed stockpile shall not be contaminated by foreign materials. RAS stockpiles shall be covered in a manner that prevents the intrusion of water but also allows the flow of air.

RAS may be used in HMA leveling courses, HMA intermediate courses, and HMA base courses at a maximum rate of 5% by weight. When RAS is used in HMA mixtures containing RAP or other recycled materials, the RAS will be considered as part of the overall allowable weight of recycled materials in the mixture.

G. Processed Glass Aggregate

The use of Processed Glass Aggregate (PGA) meeting the requirements of Subsection M2.01.8 may be added at a maximum addition rate of 10% by weight. This addition will only be allowed in base and intermediate mixtures. PGA in mixes containing RAP will be considered as part of the overall allowable mass of RAP in the mix. If PGA is used in the mix, a separate aggregate bin shall be used and the use of lime as an anti-stripping agent shall be required.

Table M3.5 – Aggregate Consensus Property Requirements

Traffic Level	Design ESALs (Millions)(1)	Fractured Faces, Coarse Aggregate, (2) % Minimum		Uncompacted Void Content of Fine Aggregate, % Minimum		Sand Equivalent, % Minimum	Flat and Elongated,(2) % Maximum
		All Courses (except Base Course)	Base Course	All Courses (except Base Course)	Base Course		
1	< 0.3	55/--	--/--	--(4)	--	40	--
2	0.3 to < 10	85/80(3)	60/--	45	40	45	10
3	≥ 10	95/90	80/75	45	40	45	10

(1) The anticipated project traffic level expected on the design lane over a 20-year period. Regardless of the actual design life of the roadway, determine the design ESALs for 20 years.
(2) This criterion does not apply to 4.75 mm nominal maximum size mixtures.
(3) 85/80 denotes that 85 percent of the coarse aggregate has one fractured face and 80 percent has two or more fractured faces.
(4) For 4.75 mm nominal maximum size mixtures designed for traffic levels below 0.3 million ESALs, the minimum Uncompacted Void Content is 40.

Table M3.6 – Aggregate Source Property Requirements

Source Property Test	Test Method	Limit
Toughness	AASHTO T 96	< 30 %
Soundness	AASHTO T 104	< 10 %
Deleterious Materials	AASHTO T 112	< 0.5 %

Table M3.7 – Aggregate Specific Gravity Test Method

Aggregate Type	Test Method
Coarse	AASHTO T 85
Fine	AASHTO T 84 or ASTM D7370
Mineral Filler	AASHTO T 100
RAP	From FHWA-HRT-11-021

M3.11.3 Performance Graded Asphalt Binder.

The PGAB utilized in the HMA mixture shall be specified by the Contract and shall comply with the requirements of Subsection M3.01.0.

M3.11.4 Hot Mix Asphalt Mixture Design.

The Contractor shall be responsible for development of all HMA mixture designs. All HMA surface courses, intermediate courses, base courses, leveling courses, bridge surface courses, and bridge protective courses shall be supported by volumetric mixture designs using the Superpave mixture design system. All Superpave HMA designs shall be developed in accordance with the following AASHTO standards, as modified herein:

1. AASHTO M 323
2. AASHTO R 35
3. AASHTO T 312

Open Graded Friction Course (OGFC) and Asphalt Rubber Gap Graded (ARGG) mixtures shall be designed in accordance with Subsections M3.11.4G and M3.11.4H, respectively.

A. Development of Laboratory Trial Mix Formula

The Contractor shall develop and submit a Laboratory Trial Mix Formula (LTMF) for each HMA mixture type, which is to be proposed as a Job Mix Formula (JMF), a minimum of sixty (60) days prior to HMA production. Each LTMF shall be submitted with supporting documentation and adequate amount of blended aggregate material and PGAB in order to verify the LTMF.

Once verified by the Department, the LTMF may become the Job Mix Formula (JMF) for a project. Two or more JMFs per HMA type may be approved for a particular plant, however, only mixture conforming to one JMF is permitted to be produced and placed on any given day.

B. Estimated Design Traffic

The estimated traffic level to be used for HMA mix designs shall be specified by the contract. The traffic level shall be expressed in Equivalent Single Axle Loads (ESALs) for the design travel lane over a 20-year period in million 18-kip ESALs.

C. Specific Gravity Requirements

The individual aggregate, mineral filler, and PGAB specific gravities shall be included with the LTMF. The Contractor shall provide samples of each aggregate material a minimum of sixty (60) days prior to production for each LTMF to the Department for verification specific gravity of each stockpile.

D. Superpave Aggregate Gradation Requirements

The combined aggregate blend for each Superpave HMA mixture shall conform to the Gradation Control Point requirements specified in Table M3.8. The results of the selected optimum design aggregate structure shall be plotted on a 0.45 power chart and included with the LTMF.

The combined aggregate gradation shall be classified as coarse-graded when it passes below the Primary Control Sieve (PCS) control point as defined in Table M3.9. All other gradations shall be classified as fine graded.

When a Superpave Surface Course - 19.0 (SSC - 19.0) is specified in the contract, the LTMF aggregate gradation shall provide a fine-graded HMA mixture as defined in Table M3.9.

E. Gyratory Compaction Criteria

Each asphalt mixture shall be designed and controlled during production using an approved gyratory compactor which meets the requirements of AASHTO T 312. Compaction shall be in accordance with the requirements of AASHTO T 312. The density of each HMA mixture shall be evaluated at the initial number of gyrations ($N_{initial}$), the design number of gyrations (N_{design}), and the maximum number of gyrations (N_{max}). The gyratory-compacted specimens for each LTMF shall meet the density requirements specified in Table M3.10 below.

F. Superpave Volumetric Design Requirements.

Each Superpave HMA mixture shall be designed in accordance with the volumetric mixture design specifications contained in AASHTO M 323 and procedures contained in AASHTO R 35, as modified herein. Each HMA mixture LTMF shall be tested for conformance with the following volumetric properties:

1. Air Voids at N_{design} (V_a).
2. Voids in the Mineral Aggregate at N_{design} (VMA).
3. Voids Filled with Asphalt at N_{design} (VFA).
4. Fines to Effective Asphalt Ratio ($P_{0.075}$ / P_{be}).

The volumetric property test results shall be submitted with the LTMF for each Superpave HMA mixture. The required minimum or maximum criteria for each of the volumetric property tests are specified in Tables M3.10, M3.11, and M3.12.

Table M3.8 – Superpave Aggregate Gradation Control Points

Sieve	Nominal Maximum Aggregate Size – Control Points (% Passing)											
	#4 (4.75 mm)		3/8" (9.5 mm)		1/2" (12.5 mm)		3/4" (19.0 mm)		1" (25.0 mm)		1 1/2" (37.5 mm)	
Inches	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
2											100	
1 1/2									100		90	100
1							100		90	100		90
3/4					100		90	100		90		
1/2	100		100		90	100		90				
3/8	95	100	90	100		90						
#4	90	100		90								
#8			32	67	28	58	23	49	19	45	15	41
#16	30	55										
#30												
#50												
#100												
#200	6	13	2	10	2	10	2	8	1	7	0	6

Table M3.9 – Gradation Classification

PCS Control Point for Mixture Nominal Maximum Aggregate Size (% Passing)					
Nominal maximum aggregate size	3/8" (9.5 mm)	1/2" (12.5 mm)	3/4" (19.0 mm)	1" (25.0 mm)	1 ½" (37.5 mm)
Primary control sieve	#8 (2.36 mm)	#8 (2.36 mm)	#4 (4.75 mm)	#4 (4.75 mm)	3/8" (9.5 mm)
PCS control point, % passing	47	39	47	40	47

Table M3.10 – Superpave Asphalt Mixture Design Laboratory Compaction Requirements

Traffic Level	Design ESALs	Number of Gyrations			Percent Density of G_{mm} from Asphalt Mixture Gyratory Specimen		
	(millions)	N_{ini}	N_{des}	N_{max}	N_{ini}	N_{des}	N_{max}
1	< 0.3	6	50	75	≤ 91.5	96.0	≤ 98.0
2	0.3 to < 10	7	75	115	≤ 90.5	96.0	≤ 98.0
3	≥ 10	8	100	160	≤ 89.0	96.0	≤ 98.0

Table M3.11 – Superpave Volumetric Requirements

	Nominal Maximum Aggregate Size					
	#4 (4.75 mm)	3/8" (9.5 mm)	1/2" (12.5 mm)	3/4" (19.0 mm)	1" (25.0 mm)	1 ½" (37.5 mm)
P_b	LTMF Value					
G_{mb}						
G_{mm}						
V_a	4.0					
VMA	≥ 17.0	≥ 16.0	≥ 15.0	≥ 14.0	≥ 13.0	≥ 12.0
VFA	Table M3.12					
Dust/P_{be}(1)	0.9 - 2.0	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2
Mixture Temp	Unmodified PGAB ≤ 325°F Modified PGAB ≤ 350°F					

(1) If the aggregate gradation passes beneath the PCS Control Point specified in M 323 Table 5, the dust-to-binder ratio range may be increased from 0.6-1.2 to 0.8-1.6 at the Engineer's discretion.

(2) Laboratory mixing and compaction temperatures shall be based on the PGAB Certificate of Analysis. When additives such as WMA, polymers, and rubber are introduced the mixing and compaction temperatures may be modified from the PGAB COA. Temperature modifications shall be recommended by the binder Supplier and approved at the Engineer's discretion.

Table M3.12 – Superpave Asphalt Mixture VFA Requirements

Traffic Level	Design ESALs (Millions)	Voids Filled with Asphalt (VFA) Based on Nominal Maximum Aggregate Size					
		#4 (4.75 mm)	3/8" (9.5 mm)	1/2" (12.5 mm)	3/4" (19.0 mm)	1" (25.0 mm)	1 ½" (37.5 mm)
1	< 0.3	70 - 80	70 – 80	70 - 80	70 - 80	67 – 80	64 - 80
2	0.3 to < 10	65 - 78	65 – 78	65 - 78	65 - 78	65 – 78	64 - 78
3	≥ 10	75 - 78	73 – 76	65 - 75	65 - 75	65 – 75	64 - 75

G. Open Graded Friction Course Design Requirements

Each OGFC asphalt mixture shall be designed in accordance AASHTO PP 77, as modified herein. The combined aggregate gradation shall conform to Table M3.13 and the mixture shall conform to Table M3.14.

1. OGFC-P will utilize asphalt binder meeting the requirements of Subsection M3.01.2A.
2. OGFC-AR will utilize asphalt binder meeting the requirements of Subsection M3.01.2B.

Table M3.13 – OGFC Aggregate Gradation Control Points

Sieve	Nominal Maximum Aggregate Size Control Points (% Passing)	
	3/8" (9.5 mm)	
Inches	Min	Max
1	-	-
3/4	-	-
1/2	100	-
3/8	85	100
#4	20	40
#8	5	15
#200	0	4

Table M3.14 – OGFC Mixture Requirements

Property	Requirement
N_{des}, gyrations	50
P_b, % (Polymer)	≥ 6.5
P_b, % (Asphalt Rubber)	≥ 7.5
V_a, %	18 – 22
VCA_{mix}, %	< VCA_{DRC}
Draindown, %(1)	≤ 0.3
Abrasion Loss, %(2)	≤ 15
Moisture Susceptibility, %(3)	≥ 70
Permeability, in/sec(4)	≥ 0.0178
(1) Draindown shall be tested in accordance with AASHTO T 305 at the production temperature. (2) Abrasion loss shall be tested in accordance with AASHTO TP 108. (3) Moisture susceptibility shall be tested in accordance with AASHTO T 283. (4) Permeability shall be performed in accordance with the procedure outlined by RMS.	

H. ARGG Design Requirements

Each Asphalt Rubber Gap Graded (ARGG) asphalt mixture shall be designed in accordance with the AASHTO M 323 and procedures contained in AASHTO R 35, as modified herein. The combined aggregate gradation shall conform to Table M3.15 and the mixture shall conform to Table M3.16.

ARGG will utilize asphalt binder meeting the requirements of Subsection M3.01.2B.

Table M3.15 – ARGG Aggregate Gradation Control Points

Sieve	Nominal Maximum Aggregate Size Control Points (% Passing)	
	½" (12.5 mm)	
Inches	Min	Max
1	-	-
3/4	100	-
1/2	90	100
3/8	83	87
#4	28	42
#8	14	22
#200	0	6

Table M3.16 – ARGG Mixture Requirements

Property	Requirement
N_{des}, gyrations	100
P_b, %	≥ 7.6
V_a, %	3 – 6
VMA, %	18 – 23
Draindown, %(1)	≤ 0.3
(1) Draindown shall be tested in accordance with AASHTO T 305 at the production temperature.	

M3.11.5 Verification of Laboratory Trial Mix Formula.

The Contractor shall submit an LTMF in accordance with Subsection M3.11.4. The Engineer will perform laboratory verification of each LTMF.

If the Engineer is unable to verify the Contractor's LTMF in accordance with the applicable LTMF Verification Limits in Table M3.17, Table M3.18, or Table M3.19, then the Engineer will work with the Contractor to resolve the verification issue(s). The Contractor shall not proceed with production and placement of a Control Strip under Section 450 until the LTMF is verified by the Engineer.

Table M3.17 – Superpave LTMF Verification Limits

Properties	Test Method	LTMF Verification Limit
Asphalt Binder Content (P_b)	AASHTO T 308	Target ± 0.3%
Gradation Passing #4 (4.75 mm) and Larger Sieves	AASHTO T 30	Target ± 6.0%
Gradation Passing #8 (2.36 mm) Sieve		Target ± 5.0%
Gradation Passing #16 (1.18 mm) to #50 (0.30 mm) Sieve		Target ± 3.0%
Gradation Passing #100 (0.15 mm) Sieve		Target ± 2.0%
Gradation Passing #200 (75 µm) Sieve		Target ± 1.0%
Bulk Specific Gravity (G_{mb})	AASHTO T 166	Target ± 0.022
Max. Theo. Specific Gravity (G_{mm})	AASHTO T 209	Target ± 0.020
Air Voids (V_a)	AASHTO R 35	Target ± 1.0%
Voids in Mineral Aggregate (VMA)		Target ± 1.0%
Voids Filled With Asphalt (VFA)		Target ± 5.0%
Rutting and Moisture Susceptibility	AASHTO T 324	Table M3.20

Table M3.18 – OGFC LTMF Verification Limits

Properties	Test Method	LTMF Verification Limit
Asphalt Binder Content (P_b)	AASHTO T 308	Target ± 0.3%
Gradation Passing #4 (4.75 mm) and Larger Sieves	AASHTO T 30	Target ± 6.0%
Gradation Passing #8 (2.36 mm) Sieve		Target ± 5.0%
Gradation Passing #16 (1.18 mm) to #50 (0.30 mm) Sieve		Target ± 3.0%
Gradation Passing #100 (0.15 mm) Sieve		Target ± 2.0%
Gradation Passing #200 (75 µm) Sieve		Target ± 1.0%
Bulk Specific Gravity (G_{mb})	AASHTO T 331	Target ± 0.022
Max. Theo. Specific Gravity (G_{mm})	AASHTO T 209	Target ± 0.020
Air Voids (V_a)	AASHTO R 35	Target ± 2.0%
Voids in Mineral Aggregate (VMA)		Target ± 2.0%
Voids Filled with Asphalt (VFA)		Target ± 5.0%
Draindown	AASHTO T 305	≤ 0.3%
Abrasion Loss	AASHTO TP 108	≤ 15%
Tensile Strength Ratio	AASHTO T 283	≥ 70%

Table M3.19 – ARGG LTMF Verification Limits

Properties	Test Method	LTMF Verification Limit
Asphalt Binder Content (P_b)	AASHTO T 308	Target ± 0.3%
Gradation Passing ¾" (19.0 mm) Sieve	AASHTO T 30	Target ± 0.0%
Gradation Passing #4 (4.75 mm) to ½" Sieve		Target ± 6.0%
Gradation Passing #8 (2.36 mm) Sieve		Target ± 5.0%
Gradation Passing #16 (1.18 mm) to #50 (0.30 mm) Sieve		Target ± 3.0%
Gradation Passing #100 (0.15 mm) Sieve		Target ± 2.0%
Gradation Passing #200 (75 µm) Sieve		Target ± 1.0%
Bulk Specific Gravity (G_{mb})	AASHTO T 166	Target ± 0.022
Max. Theo. Specific Gravity (G_{mm})	AASHTO T 209	Target ± 0.020
Air Voids (V_a)	AASHTO R 35	Target ± 1.0%
Voids in Mineral Aggregate (VMA)		Target ± 1.0%
Draindown	AASHTO T 305	≤ 0.3%
Rutting and Moisture Susceptibility	AASHTO T 324	Table M3.20

Evaluation of Rutting and Moisture Sensitivity

Each HMA mixture, with the exception of Base Courses and OGFC, shall be tested by RMS for rutting and moisture sensitivity in accordance with the requirements of AASHTO T 324 using the Hamburg Wheel-Tracking Device (HWTD).

The Engineer may also require that mixtures meet the requirements of AASHTO T 283 with a minimum tensile strength ratio of 80%.

Table M3.20 – Hamburg Wheel Tracking Device Requirements

Traffic Level	Maximum Rut Depth Inches (mm)	Minimum number of passes before Stripping Inflection Point is observed
1	½ (12.5)	10,000
2		15,000
3		15,000

M3.11.6 HMA for Driveways, Sidewalks, Berm, and Curb.

HMA mixtures for driveways, sidewalks, berm, and curb shall conform to the master ranges in Table M3.21. The PGAB shall conform to Subsection M3.01.1. The Contractor shall submit a Job Mix Formula (JMF) prior to production which shows the target aggregate gradation and PG asphalt binder content for each HMA mixture for driveways, sidewalks, berm, and curb.

With the approval of the Engineer, the Contractor may substitute a MassDOT approved 9.5 mm or 12.5 mm Superpave Surface Course mixture (Traffic Level 1 or 2) for Driveways and Sidewalks.

The Contractor shall perform QC testing at the start of plant production and in conjunction with the calibration of the plant in order to verify that the JMF can be produced within the Engineering Limits specified in Table M3.22.

The composition limits in Table M3.21 are HMA mix design master ranges for aggregate gradation and asphalt binder content. The JMF for each HMA mixture type shall establish a single percentage of aggregate passing each required sieve size, and a single percentage of asphalt binder material to be added to the aggregate.

The JMF shall be submitted in writing by the Contractor to the Engineer at least 30 days prior to the start of paving operations and shall include the following as a minimum:

1. Source of materials.
2. Percent of each aggregate stockpile.
3. Percent passing each sieve size.
4. Combined aggregate specific gravity.
5. Percent of asphalt binder.
6. Performance grading test results and Certificate of Compliance certifying the PG grade.
7. Mixing temperature.
8. Compaction temperature.
9. Temperature of mix when discharged from the mixer.
10. Maximum theoretical specific gravity of the mixture.

AASHTO T 195 (Ross Count) with a coating factor of 98% will be used when necessary to evaluate proper mixing time.

The use of recycled materials will be permitted at the option of the Contractor and provided that the end product is in conformance with the designated JMF. The proportion of reclaimed materials (including RAP, PGA, and RAS) in the total mix shall be limited to a maximum of 15%.

All HMA JMFs for sidewalks, wheelchair ramps, driveways, and berm will be submitted to the Engineer for approval. The JMF shall bind the Contractor to furnish paving mixtures not only within the master ranges, but also conforming to the exact formula thus set up for the project, within the Engineering Limits found in Table M3.22.

For each project, at least one QC sample shall be randomly obtained by the Contractor for every 2,000 tons produced, but not less than one QC sample per day. The Engineer shall also obtain a minimum of one random Acceptance sample for every 2,000 tons produced. The sample will be tested for conformance with the submitted JMF and Engineering Limits. When testing shows the mixture is not in conformance the Engineer will determine the disposition in accordance with Section 6.04 of Division I.

The JMF for each mixture shall be in effect until modified in writing by the Contractor and approved by the Engineer. Should a change in sources of materials be made, a new JMF must be approved by the Engineer before the new material is used.

Table M3.21 – Master Ranges for HMA for Driveways, Sidewalks, Berm, and Curb

	Nominal Maximum Aggregate Size Control Points (% Passing)			
Mixture Type	Driveways, Sidewalks, and Berm		Berm and Curb Only	
Sieve (Inches)	Min	Max	Min	Max
1	-	-	-	-
3/4	100	-	-	-
1/2	95	100	100	-
3/8	87	93	87	93
#4	57	69	62	73
#8	41	45	52	55
#16	30	36	40	45
#30	21	25	28	34
#50	14	17	18	23
#100	9	12	10	14
#200	4	5	6	6
P_b, %	6.0	6.6	7.4	7.6

Table M3.22 – Engineering Limits for Aggregate Gradation and Asphalt Binder Content

Sieve Designation / Binder Content	Engineering Limits
Passing No. 4 and larger sieve sizes	JMF Target ± 6%
Passing No. 8 sieve	JMF Target ± 5%
Passing No. 16 to No. 50 sieves (inclusive)	JMF Target ± 3%
Passing No. 100 sieve	JMF Target ± 2%
Passing No. 200 sieve	JMF Target ± 1%
Asphalt Binder Content	JMF Target ± 0.4%

M3.11.7 Cold Patch for Temporary Patching.

When HMA is not available due to seasonal limitations the Contractor shall use stockpiled cold patch mixtures approved by the Research & Materials Section.

M3.11.8 Stress Absorbing Membrane & Stress Absorbing Membrane Interlayer.

All Stress Absorbing Membrane (SAM) and Stress Absorbing Membrane Interlayer (SAMI) mixtures shall meet the requirements as specified below. SAM & SAMI mixtures shall be composed of the following:

1. Mineral aggregate
2. Performance Graded Asphalt Binder

A. Aggregate.

The aggregate shall conform to Subsection M3.11.2. Crushed gravel stone will not be permitted. The aggregate shall be pre-heated to a temperature between 200°F and 300°F, and be pre-coated with 0.4% to 0.8% asphalt binder (by weight of aggregate) prior to application. The aggregate shall meet the requirements in Tables M3.23 and M3.24.

Table M3.23 – SAM & SAMI Aggregate Control Points

	Nominal Maximum Aggregate Size – Control Points (% Passing)					
Type	3/8" (9.5 mm)		1/2" (12.5 mm)		3/8" (9.5 mm) SAMI ONLY	
Sieve (Inches)	Min	Max	Min	Max	Min	Max
5/8	100	-	100	-	100	-
½	100	-	90	100	100	-
3/8	85	100	25	65	85	100
#4	0	8	0	8	0	30
#8	0	4	0	4	0	5
#200	0	2	0	2	0	2

Table M3.24 – SAM & SAMI Aggregate Source Property Requirements

Source Property Test	Test Method	Limit
Toughness	AASHTO T 96	< 30 %
Flakiness Index (For SAM)	TEX-224-F(1)	< 20%
Flakiness Index (For SAMI)	TEX-224-F(1)	< 30%
(1) Determined following TxDOT's Test Procedure for Determining Flakiness Index.		

B. Performance Graded Asphalt Binder.

The PGAB binder to be applied to the pavement shall be in conformance with Subsection M3.01.2B. Asphalt binder that is pre-coated onto the aggregate shall be in conformance with Subsection M3.01.1.

M3.11.9 Ultrathin Bonded Overlay

All Ultrathin Bonded Overlay (UTBO) mixtures shall meet the requirements as specified below. UTBO mixtures shall be composed of the following:

1. Mineral aggregate.
2. Mineral filler (if required).
3. Performance Graded Asphalt Binder (PGAB).

The use of recycled materials will not be permitted.

A. Coarse Aggregate.

Coarse aggregate shall meet the requirement of M3.11.2A. Where coarse aggregates for these mixes are from more than one source or of more than one type of material, they shall be proportioned and blended to provide a uniform mixture.

B. Fine Aggregate.

Fine aggregate shall meet the requirement of M3.11.2B as well as one of the following. Fine aggregate shall be 100% crushed and consist of one of the following:

1. 100% Stone Sand.
2. A blend of stone sand and stone screenings.

Table M3.25 – Fine Aggregate Consensus Property Requirements

Source Property Test	Test Method	Limit
Sand Equivalence	AASHTO T 176	> 60 %
Methylene Blue	AASHTO T 330	≤ 10 mg/g

C. Mineral Filler

Hydrated lime, fly ash, baghouse fines, and cement are acceptable as mineral filler.
Typical acceptable gradation: #30 - 100% passing
#200 - 75-100% passing

D. Performance Graded Asphalt Binder.

The PGAB utilized in the HMA mixture shall be specified by the Contract and shall comply with the requirements of Subsection M3.01.2.

E. UTBO Mixture Design.

The Contractor shall be responsible for development of all UTBO mixture designs. All UTBO designs shall be developed in accordance with the requirements specified below.

F. Development of Laboratory Trial Mix Formula

The Contractor shall develop and submit a Laboratory Trial Mix Formula (LTMF) for each UTBO mixture type, which is to be proposed as a Job Mix Formula (JMF), a minimum of sixty (60) days prior to UTBO production. Each LTMF shall be submitted with supporting documentation and adequate amount of blended aggregate material and PGAB in order to verify the LTMF. Once verified by the Department, the LTMF may become the Job Mix Formula (JMF) for a project.

G. Specific Gravity Requirements

The individual aggregate, mineral filler, and PGAB specific gravities shall be included with the LTMF. The Contractor shall provide samples of each material a minimum of sixty (60) days prior to production for each LTMF to the Department for verification specific gravity of each stockpile.

H. UTBO Aggregate Gradation Requirements

The combined aggregate blend for each UTBO mixture shall conform to the Gradation Control Point requirements specified in Table M3.26. The results of the selected optimum design aggregate structure shall be plotted on a 0.45 power chart and included with the LTMF.

Table M3.26 – UTBO Aggregate Control Points

	Nominal Maximum Aggregate Size – Control Points (% Passing)					
Type	Type 1		Type 2(1)		Type 3(1)	
Sieve (Inches)	Min	Max	Min	Max	Min	Max
¾	100	-	100	-	100	-
½	100	-	92	100	85	100
3/8	85	100	55	90	45	85
#4	24	40	24	41	24	41
#8	21	32	21	33	21	33
#16	16	26	15	26	15	26
#30	12	20	11	20	11	20
#50	8	16	8	16	8	16
#100	5	10	5	10	5	10
#200	5	7	4	7	4	7
(1) When asphalt rubber is specified the gradation master ranges may be modified with the prior approval from the Research & Materials Section.						

I. UTBO Mixture Requirements

The combined mixture for each UTBO mixture shall conform to the mixture requirements specified in Table M3.27. The results of the selected optimum design shall be included with the LTMF.

Table M3.27 – UTBO Mixture Requirements

Property	Requirement
P_b, % (Polymer)	4.8 – 5.2
P_b, % (Asphalt Rubber)(1)	5.8 – 6.2
Draindown, %(2)	≤ 0.1
Moisture Susceptibility, %(3)	≥ 80
(1) Type 1 UTBO shall not use asphalt rubber. (2) Draindown shall be tested in accordance with AASHTO T 305 at the production temperature. (3) The mixture shall be compacted according to AASHTO T 312 and tested in accordance with AASHTO T 283.	

J. Verification of Laboratory Trial Mix Formula.

The Contractor shall submit an LTMF in accordance with Subsections M3.11.9A to M3.11.9I. The Engineer will perform laboratory verification of each LTMF.

If the Engineer is unable to verify the Contractor's LTMF in accordance with the applicable LTMF Verification Limits in Table M3.28, then the Engineer will work with the Contractor to resolve the verification issue(s). The Contractor shall not proceed with production and placement of a Control Strip under Section 467 until the LTMF is verified by the Engineer.

Table M3.28 – UTBO LTMF Verification Limits

Properties	Test Method	LTMF Verification Limit
Asphalt Binder Content (P_b)	AASHTO T 308	Target ± 0.3%
Gradation Passing ¾" (19.0 mm) Sieve	AASHTO T 30	Target ± 0.0%
Gradation Passing #4 (4.75 mm) and Larger Sieves		Target ± 6.0%
Gradation Passing #8 (2.36 mm) Sieve		Target ± 5.0%
Gradation Passing #16 (1.18 mm) to #50 (0.30 mm) Sieve		Target ± 3.0%
Gradation Passing #100 (0.15 mm) Sieve		Target ± 2.0%
Gradation Passing #200 (75 µm) Sieve		Target ± 1.0%
Draindown	AASHTO T 305	≤ 0.1%
Tensile Strength Ratio	AASHTO T 283	≥ 80%

M3.12.0 Hot Mix Asphalt Production Facility.

All facilities producing HMA must be approved on an annual basis by the Department. All sources of materials used for the production of HMA must be approved by the Department prior to their use. Such materials shall include:

1. Coarse aggregate.
2. Fine aggregate.
3. Mineral filler.
4. Performance graded asphalt binder.
5. Modifiers and/or additives.

HMA production operations shall follow industry accepted best management practices including:

1. Aggregate handling and stockpile management.
2. Recycled asphalt pavement handling and stockpile management.
3. PGAB storage.
4. Plant process controls.
5. Silo loading.
6. Truck loading.

The plant shall meet the requirements of AASHTO M 156 as well as the following provisions. HMA plants meeting these requirements and which have been approved by RMS shall be listed on the MassDOT QCML.

An adequate quantity of each size aggregate, mineral filler and asphalt binder shall be maintained at the HMA plant site at all times while the plant is in operation to ensure that the plant can continuously produce mixtures that meet these specifications. The quantity of such materials shall never be less than one day's production capacity.

M3.12.1 Scales.

Plant and truck scales shall be certified:

1. At the start of each construction season, prior to use for MassDOT projects.
2. At intervals of not more than 90 calendar days.
3. Whenever the plant changes location.
4. At any time as requested by the Engineer.

M3.12.2 Calibration of Plant Equipment.

The plant's systems shall be calibrated:

1. At the start of each construction season, prior to use for MassDOT projects.
2. Whenever there is a significant change to the material.
3. Whenever a plant component supply system affecting the ingredient proportions has been repaired, replaced, or adjusted.
4. At any time as requested by the Engineer.

M3.12.3 Automatic Recordation.

Recordation equipment shall be provided. Each recorder shall include an automatic printer system. The printer shall be so positioned that the digital display and the printer can be readily observed within the plant's control room by the Engineer and the plant operator, simultaneously. The delivery ticket shall be printed with an original and at least one copy. The original shall be furnished to the Engineer at the paving site and the copy to the Engineer at the plant. The delivery ticket format shall be approved by RMS and will include the following information:

1. Company / plant location.
2. MassDOT contract number and/or distinct project name.
3. MassDOT mix ID number and/or distinct mix description.
4. Percentage of RAP in the mixture.
5. Percentage of asphalt binder in the mixture.
6. Date and time of loading.
7. Sequential load number for the contract for a 24-hour period.
8. Total weight of mix in truck (pay weight).

The following mixture production information shall also be provided:

For Batch Plants
1. Date mixed.
2. Time of batching.
3. Tare weight of aggregate weigh box.
4. Tare weight of PGAB weigh bucket.
5. Moisture content of recycled materials.
6. Target and actual cumulative or net weights as batched for each bin with a batch total for all net ingredients.
7. Target and actual weight of PGAB.
8. Total weight of mix in truck (pay weight).

Note: This information shall be included on the delivery ticket when the mix is batched directly into a truck. When the mix is batched and stored in a silo the information may be separate from the delivery ticket however it must be provided to the Engineer at the plant.

For Drum Plants
1. Percent of mixture as well as the target and actual production rate for each individual mix component including:
   a. Aggregate
   b. Mineral Filler
   c. PGAB
   d. Recycled materials
   e. Additives
2. Moisture content of aggregates and recycled materials.
3. PGAB temperature.
4. Target and actual mix temperature.
5. Target and actual mix production rate.

Note: This information is not required to be included on the delivery ticket however it must be provided to the Engineer at the plant.

M3.12.4 Surge and Storage Silo Holding Time.

Unless otherwise permitted by the Engineer, the mixtures shall not be stored in surge and storage bins longer than the following:

1. Unheated and not insulated ..... 2 hours
2. Unheated and insulated with heated gate ..... 15 hours
3. Insulated and heated ..... 24 hours

Note: In order to prevent excessive draindown, OGFC shall not be stored in a surge or storage bin for longer than two (2) hours. ARGG shall not be stored for more than six (6) hours.

M3.12.5 Asphalt Release Agents.

The plant shall have a method of applying MassDOT approved asphalt release agents to the haul units in accordance with the Manufacturer's recommendations. Spray systems may either be manual or automated but application of the release agent must be at the rate specified by the Manufacturer.

M3.12.6 Air Quality.

The plant shall be designed and operated to meet all current Federal and State air quality requirements.

M3.12.7 Equipment Failure.

If at any time the automatic proportioning or recording system becomes inoperative, the plant will cease all HMA production. Work will only be allowed to restart once all automatic controls and recording systems are functional.

M3.12.8 HMA Plant Facility Inspection.

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

1. Inspections of the conditions and operations of the plant.
2. Confirmation of the adequacy of the equipment in use.
3. Verification of the character and proportions of the mixture.
4. Determination of temperatures being maintained in the preparation of the mixture.
5. Inspection of incidental related procedures.

M3.13.0 Hot Mix Asphalt Materials Testing Laboratory and Equipment.

M3.13.1 Contractor Quality Control Laboratory.

All Contractor QC testing shall be performed in laboratories that are approved by RMS and qualified through the NETTCP Laboratory Qualification Program (LQP) or accredited through the AASHTO Accreditation Program (AAP). All laboratories shall maintain a Quality System Manual (QSM) in accordance with the outline maintained by the Research & Materials Section.

1. Laboratories that perform HMA mix designs or QC testing under Section 450 shall at a minimum be qualified as a NETTCP LQP Category 2 laboratory.
2. Laboratories performing only QC testing shall be qualified as a NETTCP LQP Category 3 laboratory.
   a. Contractors who do not produce mixtures under Section 450 will not be required to have their own laboratory at the production facility but will be required to either test at their central laboratory or hire a Consultant testing company to perform the QC testing required in the specification. The Contractor will still be required to maintain a QSM for the HMA Production Facility.

The Contractor's QC laboratory shall be qualified to perform all testing required by Table M3.29 as well as contract specifications.

Laboratories meeting these requirements, and which have been approved by the RMS shall be listed on the MassDOT QCML.

The Contractor's QC Manager shall have overall responsibility for ensuring that all laboratories utilized for Quality Control are in compliance with the requirements of the NETTCP LQP. This includes providing required AASHTO, ASTM, and NETTCP reference documents and ensuring that all required equipment and tools are properly functioning and calibrated.

The Engineer shall be permitted unrestricted access to inspect and review the Contractor's laboratory facility.

Along with the required testing capabilities the laboratory facilities shall meet the following:

1. Be kept clean and all equipment shall be maintained in proper working condition.
2. Provide adequate environmental control to the satisfaction of the Engineer and must be able to maintain an inside temperature of 68 to 86°F during working hours.
3. Adequate ventilation to remove dust and fumes from the laboratory.
4. Hot and cold potable water.
5. First aid kit and emergency eye wash station.
6. Multi-class ABC fire extinguisher.
7. A restroom shall also be made available within 500 ft of the laboratory during all work shifts. The restroom facilities shall be enclosed in a separate room with proper ventilation and comply with applicable sanitary codes as well as:
    a. A flush toilet.
    b. A sink with hot and cold running water.
    c. A sewer or septic tank with connections.
    d. Adequate rest room supplies.
    e. Maintained environmental control and cleanliness.

M3.13.2 Department Acceptance Laboratory at HMA Production Facility

The Engineer shall be provided laboratory working space meeting the requirements of Subsection M3.12.1 as well as the following. A desk must be located in close proximity to the laboratory but be separated from the ovens, sieve shakers, and anything else that can cause poor air and sound quality. The Engineer's desk and laboratory space will not be shared with any other entity.

Contractors who do not produce mixtures under Section 450 will not be required to have a Department Acceptance Laboratory at the production facility but will be required to allow the Engineer to perform Acceptance testing at their central laboratory or Consultant testing company laboratory. These laboratories are still required to meet Subsection M3.12.1.

If the Engineer is unable to perform their duties either due to lack of working space, poor working conditions, or access to equipment it will be considered a laboratory facility deficiency. The Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. Deficiencies shall be grounds for the Engineer to order an immediate stoppage of work until the deficiencies are corrected.

Unless approved by the Engineer, the plant, silos, and sample rack shall be in view of laboratory when performing testing under Section 450.

The Engineer shall be provided with the following:

A. Computer

For plants producing HMA in accordance with Section 450, the Engineer shall be furnished with a computer with high speed internet access which conforms to the requirements determined by RMS. The minimum requirements shall include:

1. The Engineer is required to have one (1) computer at the laboratory.
2. Computers shall be required to have the latest MS Office Professional with all security updates, Antivirus software with all current security updates maintained, and any other software required by RMS.
3. A laser printer with the capability to also scan and copy. The printer shall be compatible and connected to the laboratory's computer.

B. Testing Equipment

The Contractor shall supply the Engineer with the following equipment. This equipment shall only be utilized by the Engineer and shall be labeled as such. It shall be the Contractor's responsibility to maintain and replace equipment as needed.

1. For T 27 and T 30:
   a. 12-inch sieve stack (2 inch to #200) with cover and pan.
   b. Mechanical sieve shaker (only for Section 450 Category A Lots).
   c. Electronic balance (only for Section 450 Category A Lots).
2. For T 166 and T 209:
   a. Complete setup (only for Section 450).
3. For T 312:
   a. Gyratory mold.
4. For T 308:
   a. Ignition oven sample basket.
   b. Ignition oven and two (2) sample baskets (only for Section 450 Category A Lots).
5. Miscellaneous equipment such as sample buckets, scoops, pans, brushes, thermometers, etc.
6. Oven which meets AASHTO R 30 and is capable of storing the sample buckets for 3 samples (only for Section 450 Category A Lots).
7. Supply of sample boxes.
8. Sample rack which is a suitable sampling platform from which the Engineer is able to stand and sample the material in the truck bed adequately and safely. The rack shall:
   a. Be of sturdy construction.
   b. Be able to safely accommodate at least two people at a time (min. standing area of 4 ft x 4 ft).
   c. Have a safe stairway that is attached to the sampling platform.
   d. Be at a height which allows the Technician the ability to reach the HMA in the bed of any size truck safely and efficiently.
   e. Have a mounted spot light to allow for sampling at night.
   f. Be within 100 ft of the laboratory and visible from the laboratory.
   g. Meet applicable OSHA standards.

Table M3.29 – Required Test Methods by Laboratory

Test Method	Description	Mix Design Laboratory	QC Laboratory	Department Acceptance Laboratory
AASHTO M 323	Superpave Volumetric Mix Design	X		
AASHTO R 30(1)	Mixture Conditioning of HMA	X		
AASHTO R 35	Superpave Volumetric Design for Asphalt Mixtures	X		
AASHTO R 47	Reducing Samples of HMA to Testing Size	X	X	X
AASHTO R 66	Sampling of Asphalt Materials		X	
AASHTO R 76	Reducing Samples of Aggregate to Testing Size	X	X	
AASHTO R 79 (2)	Vacuum Drying Compacted HMA Specimens		X	
AASHTO R 90	Sampling of Aggregates		X	
AASHTO R 97	Sampling Bituminous Paving Mixtures		X	X
AASHTO T 11	Material Finer Than #200 Sieve by Washing	X	X	X
AASHTO T 27	Sieve Analysis of Fine and Coarse Aggregates	X	X	X
AASHTO T 30	Sieve Analysis of Extracted Aggregate	X	X	X
AASHTO T 84	Specific Gravity and Absorption of Fine Aggregate	X		
AASHTO T 85	Specific Gravity and Absorption of Coarse Aggregates	X		
AASHTO T 96	Coarse Aggregate L.A. Abrasion	X		
AASHTO T 104	Soundness of Aggregates	X		
AASHTO T 166	Bulk Specific gravity of HMA	X	X	X
AASHTO T 176	Sand Equivalence	X		
AASHTO T 209	Theoretical Maximum Specific Gravity of HMA	X	X	X
AASHTO T 255	Moisture Contents of Aggregates		X	
AASHTO T 283(4)	Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage	X		
AASHTO T 304	Un-compacted Void Content of Fine Aggregate	X		
AASHTO T 305(3)	Draindown in Uncompacted Asphalt Mixtures	X		
AASHTO T 308	Asphalt Binder Content by Ignition Oven		X	X
AASHTO T 312	Density of HMA by Superpave Gyratory	X	X	X
AASHTO T 329	Moisture Control of HMA		X	X
AASHTO T 331(4)	Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing	X	X	X
AASHTO T 335	Determining the Percentage of Fracture in Coarse Aggregate	X		
ASTM D3549	Thickness of Compacted HMA Specimens		X	
ASTM D4791	Flat & Elongated Particles in Coarse Aggregate	X		
ASTM D7370 (2)	Relative Density and Absorption of Aggregate Using Combined Vacuum Saturation and Rapid Submersion	X		

(1) Two ovens shall be required; one to heat binder, aggregate, and mixing tools to mixing temperature and one to condition the loose mixture at the compaction or conditioning temperature.
(2) Optional test.
(3) Required for Open Graded Friction Course and Asphalt Rubber Gap Graded.
(4) Required for Open Graded Friction Course.

SECTION M5: PIPE, CULVERT SECTIONS AND CONDUIT

SUBSECTION M5.03.10 Corrugated Plastic Pipe.
(page III.74) Replace this subsection with the following;

Pipe shall consist of corrugated polyethylene or polypropylene tubing, flare ends, couplings and fittings. Materials, dimensions, physical properties and fabrication shall be in accordance with AASHTO M 294, Type S or D or AASHTO M330 Type S or D. Perforated pipe shall meet Type SP, DP or CP.

SECTION M6: ROADSIDE DEVELOPMENT MATERIALS

SUBSECTION M6.03.0 Long Term Seed Mixes for Lawns and Slopes.
(page III.79) In table M6.03.0-1 Grass Seed Requirements for Lawn Grass Areas change the proportion of Creeping Red and/or Chewing Fescue from 55% to 59% and change the proportion of Dutch White Clover from 5% to 1%. In table M6.03.0-2 Grass Seed Requirements for Slopes and Shoulders change Kentucky Blue Grass to Tall Fescue. Delete table M6.03.0-3 Grass Seed Requirements for Warm Season Mix.

SUBSECTION M5.03.1 Short Term Erosion Control Seed.
(page III.79) Change the subsection number from M5.03.1 to M6.03.1. Change the table number from M5.03.1-1 to M6.03.1-1.

SECTION M9: MISCELLANEOUS MATERIALS

SUBSECTION M9.08.0: Preformed Sheet Membrane
(page III.128) Replace this subsection with the following;

M9.08.0: Waterproofing Membranes

M9.08.1: Spray Applied Waterproofing Membrane

A. General Requirements

Only products listed on the MassDOT Qualified Construction Materials List (QCML) will be accepted for use. The membrane waterproofing system shall consist of:

- Primer
- One or two coat rapid curing cold liquid spray applied seamless methyl methacrylate, polyurea, or polyurethane methyl methacrylate membrane
- Aggregate keycoat
- Polymer modified tack coat

B. Material Requirements

The total minimum base thickness for the membrane shall be 80 mils measured over peaks. The membrane shall easily accommodate the need for day joints and patch repairs. The membrane shall be able to bridge live cracks up to 1/8 inch in width and meet the criteria specified in Table M9.08.1-2.

The membrane waterproofing system shall be asbestos-free. The chemical composition of the primer, membrane, aggregate keycoat and tack coat that make up the membrane waterproofing system shall conform to the manufacturer's specifications for the material. All components shall be approved by the manufacturer as being compatible for use with the specified membrane. Cleaning solvents shall also be approved by the manufacturer for use with the membrane.

Primer for Spray Applied Membrane

The primer shall promote adhesion of the membrane to the concrete surface.

Table M9.08.1-1: Primer Material Properties

Property	Test	Requirements
Gel Time		> 5 minutes
Tack Free Time		< 2.5 hours, max at 77°F
Adhesion to Concrete	ASTM D7234	≥ 100 psi minimum and failure in concrete

Membrane

The membrane shall be meet the requirements in Table M9.08.1-2.

Table M9.08.1-2: Spray Applied Waterproofing Membrane Material Properties

Property	Test	Requirements
Solids Content		100%
Stability	ASTM C836	≥ 6 months
Crack Bridging (Neat Material + Aggregated Keycoat)	ASTM C1305 (1)	Pass, no cracking
Extensibility after Heat Aging	ASTM C1522	For information only
Percent Elongation at Break	ASTM D638	≥ 130%
Tensile Strength	ASTM D638 Type IV @ 2 in/min	> 1,100 psi
Shore Hardness	ASTM D2240 (2)	≥ 50 Type 00
Minimum Thickness (Membrane only)	ASTM D6132 or other approved method	≥ 80 mils minimum measured over peaks or ≥ thickness used to pass ASTM C1305 (Whichever thickness is greater)
Membrane Waterproofing System Adhesion to Concrete	ASTM D7234	≥ 100 psi minimum and failure in concrete
Permeance	ASTM E96 Water Method, Procedure B	≤ 1.0 perms

(1) ASTM C1305 shall be modified to 25 cycles at -15°F no failure at 1/8 inch per hour.
(2) ASTM D2240 shall be modified per ASTM C836 section 6.5.

Aggregate for Keycoat

The broadcast aggregate shall be durable and provide shear resistant to prevent the hot mix asphalt (HMA) from shoving. Aggregate shall have a minimum Mohs hardness rating of seven (7) and be approved by the manufacturer.

Polymer Modified Tack Coat

The tack coat shall consist of either a polymer modified asphalt emulsion, or a polymer modified asphalt binder approved for use by the membrane waterproofing manufacturer and the Engineer.

C. Material Qualification

A manufacturer requesting approval of a spray applied membrane system shall furnish to the Research and Materials Section the following:

1. The membrane system material specifications including product performance data.
2. Certified independent test reports demonstrating conformance to Table M9.08.1-2.
   - The independent lab shall be recognized by the National Cooperation for Laboratory Accreditation (NACLA) in Construction Materials Engineering and Testing (CMET) or an equal program approved by Research and Materials.
   - All testing shall be performed by one independent lab unless approved by the Engineer. Independent test reports must be dated within two (2) years from the initial submission.
   - Samples for all required testing shall be fabricated at the same time. Test reports shall denote the lot of material as well as the sample fabrication and testing dates.
3. MassDOT shall perform prequalification testing on the membrane.
   - Two (2) 10 inch by 10-inch square samples of the proposed membrane with smooth surfaces (no primer or aggregate in the keycoat). The samples shall be a minimum of 80 mils thick or the thickness used to pass the crack bridging requirement found in Table M9.08-4.

All submittals shall be certified to be in conformance with the manufacturer's instructions. Systems qualified by MassDOT per the performance criteria shall be considered for placement on the MassDOT QCML. Membrane waterproofing systems shall remain on the QCML for a period of five (5) years at which time the manufacturer will be required to submit certified test reports demonstrating conformance to this specification.

M9.08.2: Sheet Membrane

A. General Requirements

Only products listed on the MassDOT Qualified Construction Materials List (QCML) will be accepted for use. Chemical composition, physical properties and dimensional requirements of the sheet membrane shall conform to the manufacturer's specifications for the material.

Also, all accessory materials such as, flashing, primer, etc., used in the application of the sheet membrane will be considered a part of this specification and shall conform to the manufacturer's requirements. The membrane waterproofing system shall consist of:

- Primer
- Sheet Membrane
- Mastic

B. Material Requirements

The primer shall meet the requirements of Subsection M9.09.1.

The membrane sheet shall meet the requirements in Table M9.08.2-1.

The mastic for use with rubberized sheets shall be a rubberized asphalt cold-applied joint sealant. The mastic for use with modified bitumen sheet shall be a blend of bituminous and synthetic resins. The mastic shall be approved for use by the manufacturer.

Table M9.08.2-1: Sheet Membrane Material Properties

Property	Test	Requirements
Thickness	ASTM D3767	≥60 mils
Thickness at 350°F		≥55 mils
Thermal stability at 350°F		≤5% increase in area
Tensile Strength, Membrane	ASTM D412, Die C	≥250 psi
Tensile Strength, Film	ASTM D882 (1)	≥3,000 psi
Elongation	ASTM D412	≥300%
Flexibility	ASTM D1970 (2)	Unaffected
Adhesion to Concrete	ASTM D903 (3)	≥6 lbs/in.
Permeance	ASTM E96 Water Method, Procedure B	≤0.1 perms
Water Absorption	ASTM D570	≤0.5%
Puncture Resistance	ASTM E154	≥40 lbs

(1) Method A, 1-inch wide strip with 4-inch minimum initial separation and 4-inch gage length at 2 inches per minute at 73.4F ± 3.6F. Average 5 samples.
(2) ASTM D1970 shall be based on a 180° bend over 1 in. mandrel at -20°F.
(3) Concrete is cast against the protective coating surface of the membrane and allowed to cure (7 days minimum). Peel adhesion of membrane to concrete is measured at a rate of 2 in. per minute at room temperature.

C. Material Qualification

A manufacturer requesting approval of a preformed sheet membrane shall furnish to the Research and Materials Section the following:

1. The membrane system material specifications including product performance data.
2. The peel-off backing material shall be tear resistant to prevent portions of it from remaining after the membrane is applied.
3. Certified independent test reports demonstrating conformance to Table M9.08.2-1.
   - The independent lab shall be recognized by the National Cooperation for Laboratory Accreditation (NACLA) in Construction Materials Engineering and Testing (CMET) or an equal program approved by Research and Materials. All testing shall be performed by the same independent lab
   - Independent test reports must be dated within two (2) years from the initial submission. Samples for all required testing shall be fabricated at the same time. Test reports shall denote the lot of material as well as the sample fabrication and testing dates.

M9.08.3: Hot Applied Rubberized Asphalt Membrane

A. General Requirements

Only products listed on the MassDOT Qualified Construction Materials List (QCML) will be accepted for use. Chemical composition, physical properties and dimensional requirements of the sheet membrane shall conform to the manufacturer's specifications for the material. The membrane waterproofing system shall consist of:

- Primer
- Hot poured rubberized asphalt membrane consisting of a single component hot applied asphalt
- Protective covering

B. Material Requirements

The primer shall meet the requirements of Subsection M9.09.1.

The membrane shall be able to bridge live cracks up to 1/8 inch in width and meet the criteria specified in Table M9.08.3-1.

The protective covering shall be rolled asphalt sheets conforming to ASTM D6380, Type II.

Table M9.08.3-1: Hot Applied Rubberized Asphalt Membrane Material Properties

Property	Test	Requirements
Solids Content		100%
Flash Point	AASHTO T 48	≥ 500°F
Bond, Non-Immersed	ASTM D5329	Pass, no separation
Flexibility	ASTM D5329	No delamination or cracking
Flow	ASTM D5329	at 120°F = 0 in. at 140°F ≤ 1/8 in.
Penetration	ASTM D5329	at 77°F ≤ 110 at 140°F ≤ 200
Permeance	ASTM E96 Water Method, Procedure B	≤ 0.1 perms

C. Material Qualification

A manufacturer requesting approval of a hot applied rubberized asphalt membrane shall furnish to the Research and Materials Section the following:

1. The membrane system material specifications including product performance data.
2. Certified independent test reports demonstrating conformance to Table M9.08.3-1.
   - The independent lab shall be recognized by the National Cooperation for Laboratory Accreditation (NACLA) in Construction Materials Engineering and Testing (CMET) or an equal program approved by Research and Materials. All testing shall be performed by one independent lab unless approved by the Engineer.
   - Independent test reports must be dated within two (2) years from the initial submission. Samples for all required testing shall be fabricated at the same time. Test reports shall denote the lot of material as well as the sample fabrication and testing dates.

SUBSECTION M9.09.0 Primer and Damp-Proofing.
(page III.15) Add this new subsection.

M9.09.1: Primer

This material shall be suitable for priming concrete and masonry surfaces prior to the application of waterproofing or damp-proofing and shall meet the requirements of ASTM D41.

M9.09.2: Damp-Proofing

This material shall meet the requirements of ASTM D449, Type II.

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END OF INTERIM SUPPLEMENTAL SPECIFICATIONS