



**CONSTRUCTION SPECIFICATION FOR WATERPROOFING BRIDGE DECKS AND
CULVERTS WITH HOT-APPLIED RUBBERIZED ASPHALT (HRA) WATERPROOFING
MEMBRANE**

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914.01 SCOPE

This specification covers the requirements for waterproofing of new and existing concrete bridge decks and cast-in-place concrete culverts with hot-applied rubberized asphalt (HRA) waterproofing membrane.

914.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standards Specifications, Construction

OPSS 929 Abrasive Blast Cleaning - Concrete

Ontario Provincial Standards Specifications, Material

OPSS 1212 Hot-Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1213 Hot-Applied Rubberized Asphalt Waterproofing Membrane
OPSS 1215 Protection Board
OPSS 1216 Primer used with Hot-Applied Rubberized Asphalt Waterproofing Membrane

Ontario Ministry of Transportation Publications

Field Guide for the Acceptance of Hot Mix Asphalt and Hot-applied Rubberized Asphalt Waterproofing Membrane

Laboratory Testing Manual

LS-359 Method of Test for Measuring Thickness of Protection Boards

MTO Forms:

PH-CC-340 Field Sample Data Sheet - Concrete

PH-CC-701 Request to Proceed

PH-CC-702 Notice to Proceed

ASTM International

D2995-14 Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors

914.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Culvert means a cast-in-place concrete structure that is typically embedded in fill, and is used to convey water, pedestrians, vehicles, cyclists, or animals.

Distribution Slab means a reinforced concrete slab on top of the culvert that may be specified when the earth cover is less than 600 mm to improve load distribution on a culvert.

Hot-Applied Rubberized Asphalt (HRA) Waterproofing Membrane means a liquid-applied membrane that is a 100% solids blend of asphalts, synthetic rubber polymers and filler formulated to provide toughness with flexibility and low moisture vapour permeance, which is melted in a kettle and spread out hot onto a concrete surface as a waterproofing membrane.

Joint Sealing Compound means a material used to fill joints in structures prior to waterproofing.

Primer means a cut-back bitumen substance used as a preparatory coat on the exposed concrete surface of a bridge deck or culvert to improve the adhesion of the HRA waterproofing membrane.

Protection Board means a durable panel specifically designed to provide an interface protection barrier between the asphalt and the HRA waterproofing membrane.

Protection Slab means a concrete slab that may be placed on the top of the culvert in an area exposed to chlorides.

Random Location means a location determined by the Contract Administrator based on random numbers or, if protection boards are used, it means the exposed corner of a protection board closest to that location.

Reinforcement means a non-woven sheet material used at joints, cracks, transitions and other areas to strengthen the HRA waterproofing membrane at locations where movement is expected to occur. Also referred to as membrane reinforcement.

Tack Coat means an emulsified asphalt used to bond hot mix asphalt (HMA) to either the protection board, an existing pavement, or another HMA binder course.

Waterproofing System means all components of the waterproofing including, primer, two layers of HRA waterproofing membrane, membrane reinforcement and protection board.

914.04 DESIGN AND SUBMISSION REQUIREMENTS

914.04.01 Submission Requirements

914.04.01.01 HRA Waterproofing Membrane Supporting Documentation

Prior to commencing the waterproofing operation, the following supporting documentation shall be submitted to the Contract Administrator:

- a) Complete details of all equipment to be used for the waterproofing operations.
- b) Sketch of the bridge deck and/or culvert including:
 - i. All locations to receive membrane reinforcement.
 - ii. Designated material laydown areas.
 - iii. Orientation and lapping direction of the protection boards.
 - iv. Joint details for staged construction.
 - v. Direction of application of waterproofing operation on the bridge deck or culvert.
 - vi. Location of kettles during application and location of any other equipment used to perform waterproofing operations.
 - vii. Any other pertinent details.
- c) The following product information, obtained from the manufacturer for every batch or lot of HRA waterproofing membrane, primer, membrane reinforcement, protection board and joint sealing compound to be used in the operation:
 - i. Product name and manufacturer.
 - ii. The manufacturer's batch or lot number.
 - iii. The size of the batch or lot.
 - iv. Application recommendations.
 - v. Manufacturer's recommended heating time and heating temperature range.

914.04.01.02 Cold Weather Protection Plan

When proposing to waterproof at temperatures between 0 °C and 5 °C, a cold weather protection plan shall be submitted to the Contract Administrator for acceptance a minimum of 14 Days prior to commencing waterproofing if the expected ambient air or concrete surface temperature will be between 0 °C and 5 °C.

The plan shall include methods for controlling and monitoring the temperature of the bridge deck or culvert prior to and during placement of the HRA waterproofing membrane.

The cold weather protection plan shall include, as a minimum, the following:

- a) Bridge deck and/or culvert for which the plan applies.
- b) Cold weather protection measures to be used to maintain the concrete deck or culvert at a minimum temperature of 10 °C or higher for a period of 24 hours prior to application of the HRA waterproofing membrane.

- c) Details of the temperature monitoring system, including the locations and frequencies of temperature recordings.
- d) If applicable, type of insulation, R value and number of layers, including test data verifying the R value. The submission for cold weather protective measures shall be accompanied by samples of insulation, if requested by the Contract Administrator.
- e) If applicable, type and layout of heaters and method for ventilation of heater exhaust and type and extent of housing.
- f) Procedure for withdrawing cold weather protective measures.
- g) Method for protecting the placed protection board from snow, rain or ice, prior to paving.
- h) Any other measures to be taken.

914.04.01.03 Protection Board

The manufacturer's recommendations for handling and storage of the protection board shall be submitted to the Contract Administrator a minimum of 7 Days prior to placement of HRA waterproofing membrane.

914.05 MATERIALS

914.05.01 Hot Poured Rubberized Asphalt Joint Sealing Compound

Hot poured rubberized asphalt joint sealing compound shall be according to OPSS 1212.

914.05.02 HRA Waterproofing Membrane

The HRA waterproofing membrane shall be according to OPSS 1213 and supplied to the job site in the manufacturer's sealed and labelled packages ready for melting and application.

914.05.03 Membrane Reinforcement

Reinforcement for HRA waterproofing membrane shall be according to OPSS 1217.

Each meter of reinforcement shall be labelled with the product name and grade.

914.05.04 Primer

Primer for HRA waterproofing membrane shall be according to OPSS 1216.

914.05.05 Protection Board

Protection board shall be according to OPSS 1215.

914.06 EQUIPMENT

914.06.01 Air Compressor

The air compressor shall provide oil and water-free compressed air. The air compressor shall have a minimum capacity of 3.5 m³/min.

914.06.02 Heating and Mixing Kettle for HRA Waterproofing Membrane and Hot-Poured Rubberized Asphalt Joint Sealing Compound

Heating and mixing kettles shall be used for the HRA waterproofing membrane and the hot-poured rubberized asphalt joint sealing compound.

The kettles shall be of the double boiler oil heat transfer type with a built-in agitator and equipped with two functional permanently installed dial type thermometers with an accuracy of ± 2 °C to measure the temperature of the melted compound and the temperature of the oil. Heating shall be controlled by an automatic thermostat to maintain the temperature of the product used within the range specified by the manufacturer. Infrared or direct heat kettles shall not be used.

Certificates of calibration from an organization accredited by the Standards Council of Canada shall be supplied for each gauge certifying that the thermometers can measure the temperature within a tolerance of ± 2 °C.

914.06.03 Thermometer

A separate calibrated thermometer with an accuracy of ± 2 °C for verification of the material temperature shall be available on the site.

914.07 CONSTRUCTION

914.07.01 Existing Asphalt Covered Decks

When an asphalt riding surface is to be stripped from the existing concrete structure deck, at least 7 Days prior to the commencement of the asphalt stripping operation, the Contract Administrator shall be informed, in writing, of the date and time that the work is to commence.

914.07.02 Notice to Proceed with Waterproofing Operations

At least 48 hours prior to each placement of waterproofing, a MTO form PH-CC-701, Request to Proceed accompanied with all supporting documentation shall be submitted to the Contract Administrator.

Waterproofing shall not commence until a MTO form PH-CC-702, Notice to Proceed has been received from the Contract Administrator.

914.07.03 General Waterproofing Operations and Operational Constraints

Concrete bridge deck or culvert waterproofing shall consist of:

- a) Bridge deck or culvert surface preparation.
- b) Application of primer.
- c) Application of first layer of HRA waterproofing membrane.
- d) Application of the membrane reinforcement immediately after application of the first layer of waterproofing membrane.
- e) Application of second layer of HRA waterproofing membrane.
- f) Application of protection board immediately after placement of the second layer of HRA waterproofing membrane.

- g) If applicable, forming grooves along the surface that is to receive HRA waterproofing membrane and filling them monolithically with the application of joint sealing compound where there are no separate tender items for this work.

The waterproofing operations shall be performed sequentially with no delay between operations. Any part of the bridge deck or culvert to be waterproofed shall be primed the same Day as the HRA waterproofing membrane is applied.

Waterproofing of bridge decks shall include the waterproofing of approach slabs.

Waterproofing operations, filling of grooves, and joint sealing shall only be carried out when:

- a) The air and concrete surface temperature are 5 °C or higher; and
- b) Precipitation is not expected to occur during the work.

Waterproofing and joint sealing shall not be acceptable if placed when the ambient air temperature is below 0 °C.

A proposal to carry out waterproofing operations when the ambient air temperature is between 0 °C and 5 °C may be submitted. If the proposal is accepted by the Owner, waterproofing operations shall be according to the approved cold weather protection plan and all surfaces against which the waterproofing system is placed shall be at a minimum temperature of 10 °C for a minimum period of 24 hours prior to application of the waterproofing system.

All concrete surfaces against which the waterproofing system is applied shall be air cured, with no exposure to precipitation or water, for at least 72 hours immediately prior to the application of the waterproofing system.

Primer and protection board shall be stored at a minimum temperature of 10 °C for 24 hours prior to application and within the manufacturer's recommended temperature range, and in conditions that prevent exposure to water or precipitation. HRA waterproofing membrane and membrane reinforcement shall be stored within the manufacturer's recommended temperature range, and in conditions that prevent exposure to water or precipitation. The Contract Administrator shall be granted access to randomly inspect off-site material storage if requested.

Drainage holes through the deck shall not be plugged or covered by HRA waterproofing membrane, reinforcement, or protection boards.

914.07.04 Applicators

HRA waterproofing membrane applicators shall be from the current Approved Applicators List for Waterproofing Membrane from the manufacturer of the HRA waterproofing membrane that is used.

914.07.05 Bridge Deck or Culvert Surface Preparation

914.07.05.01 Treatment of Grout Tubes on Bridge Deck Surfaces

Grout tubes shall be cut flush with the bridge deck surface prior to abrasive blast cleaning and shall be recut flush with the concrete surface if abrasive blast cleaning results in the tube projecting from above the concrete. A 450 × 450 mm piece of membrane reinforcement, centred on the tube, shall be installed.

914.07.05.02 New Concrete Bridge Decks, Culverts and Concrete Bridge Deck Overlays

The surface of the concrete shall be completely treated by abrasive blast cleaning, according to OPSS 929, to expose sound, laitance-free concrete. Curing compound, if used on the concrete surface, shall be completely removed. All dirt and debris shall be removed from the bridge deck or culvert and adjacent surfaces.

Immediately prior to the application of the primer, the concrete surface shall be cleaned with an air compressor to remove all dust, debris, and other foreign material.

After abrasive blast cleaning operations have commenced, equipment and any vehicles shall not be allowed on the abrasive blast cleaned area other than the construction equipment directly associated with the waterproofing operations.

914.07.05.03 Existing Bridge Deck or Culvert Surface Preparation

All areas of the concrete bridge deck or culvert that have a textured surface, not including sawcut grooves, shall be bush hammered, ground down, or scabbled to reduce the depth of texture to 2 mm or less prior to abrasive blast cleaning operations for waterproofing.

Prior to waterproofing, all existing waterproofing material shall be removed and all concrete surfaces prepared according to the New Concrete Bridge Decks, Culverts and Concrete Bridge Deck Overlays clause. No residual HRA waterproofing membrane shall be on the prepared concrete surface to be primed and waterproofed.

914.07.05.04 Modification of Deck Joint Assemblies of Existing Bridge Decks

Modifications to the deck joint assemblies involving welding or other means of attachment to existing armouring shall be carried out as specified in the Contract Documents prior to waterproofing.

914.07.05.05 Modification of Deck Drains

Modification of deck drains shall be as specified in the Contract Documents. The modifications shall be carried out prior to waterproofing the deck.

914.07.05.06 Contamination of Bridge Deck or Culvert Surface

If an oil spill or any other contamination of the bridge deck or culvert surface occurs on the concrete prior to or during the waterproofing operation, the waterproofing operations shall not proceed until:

- a) A repair proposal to address the contamination has been accepted by the Contract Administrator; and
- b) The repair has been carried out to the satisfaction of the Contract Administrator.

914.07.06 Primer

The primer shall be applied when the concrete is surface dry and clean. Primer shall not be applied if there is any dust, debris and other foreign material on the concrete surface to be primed. Primer shall be applied wherever HRA waterproofing membrane is to be applied. The primer shall extend into the chase or, where there is no chase, be extended up the face of the curbs, concrete barrier walls, concrete parapet walls, deck joint assemblies and deck drains to the level of the top of the proposed HMA base course, if applicable.

The primer material shall be uniformly applied at a rate of 0.25 l/m² or as required by the manufacturer, without puddling, using equipment approved by the manufacturer of the primer material. Primer shall only be applied to areas that will be waterproofed during the same Day.

Waterproofing equipment and any vehicles shall not be permitted upon the primer until it has fully cured. Primer is cured when it reaches a tacky condition to touch without leaving residue on one's finger. After the primer has fully cured, equipment and any vehicles shall not be allowed on the primed surface other than the construction equipment directly associated with the waterproofing operations.

Drying of the concrete or primed surface shall not be expedited by use of a torch or open flame.

If the primed surface is exposed to any precipitation or water, the surface shall be re-primed prior to application of HRA waterproofing membrane.

914.07.07 HRA Waterproofing Membrane and Hot Poured Joint Sealing Compound Preparation

The HRA waterproofing membrane and joint sealing compound shall be slowly melted with constant agitation within the application temperature range recommended by the manufacturer for the application until it is in a lump-free, and free-flowing state.

Packages of HRA waterproofing membrane and joint sealing compound shall be melted at the job site and shall be continuously agitated in the mechanically agitated heating and mixing kettle. The contents shall be continuously agitated until the material is homogenous and can be drawn free flowing and lump free from the mixing kettle at a temperature within the range recommended by the manufacturer.

HRA waterproofing membrane and joint sealing compound shall not be re-heated.

The Contract Administrator shall be informed at least 24 hours prior to the charging of the kettle with HRA waterproofing membrane or joint sealing compound. The initial charge of material shall be placed in an empty kettle for each Day's placement of waterproofing. The Contract Administrator shall be granted access to witness the empty kettle and initial charge of sealant upon request. HRA waterproofing membrane and joint sealant compound shall not to be mixed together in the same kettle.

914.07.08 Application of HRA Waterproofing Membrane

Areas of the bridge deck or culvert with sawcut grooves shall be filled with a scratch coat of HRA waterproofing membrane after the primer coat has cured. The HRA waterproofing membrane shall be applied immediately after application of the scratch coat.

The waterproofing membrane shall be applied in two layers, interlayered with membrane reinforcement. The first layer of HRA waterproofing membrane shall not be applied until the primer has cured completely. The primer shall be free of any surface moisture. The HRA waterproofing membrane shall be applied within the temperature range recommended by the manufacturer to form a uniform film having a thickness of 2 to 3 mm in each layer. The combined total thickness of both layers of HRA waterproofing membrane and the membrane reinforcement shall be 5 mm \pm 1 mm. There shall be no discontinuities, such as bubbles or other voids that extend through the full depth of the HRA waterproofing membrane.

The application of the HRA waterproofing membrane shall be continuous. If discontinuities cannot be avoided, the HRA waterproofing membrane shall be lapped a minimum of 150 mm.

The HRA waterproofing membrane shall extend into the chase or, where there is no chase, be extended up the face of curbs, concrete barrier walls, concrete parapet walls, deck joint assemblies, and deck drains to the level of the top of the proposed HMA base course, if applicable and according to the Contract Documents.

914.07.09 Membrane Reinforcement

The membrane reinforcement shall be:

- a) Placed directly over the first layer of HRA waterproofing membrane and pressed in while it is still tacky.
- b) Lapped 10 to 15 mm.
- c) Free of any visible voids or air pockets.
- d) Pressed into to the first layer of HRA waterproofing membrane ensuring the reinforcement is adhered to the HRA waterproofing membrane.

- e) Extend into the chase or, where there is no chase, be extended up the face of the curbs, concrete barrier walls, expansion joints, and deck drains to the level of the top of the proposed hot mix base course.
- f) Completely covered with a second layer of HRA waterproofing membrane.

914.07.10 Application of Protection Board

The protection board shall be placed immediately after application of the second layer of HRA waterproofing membrane, while the HRA waterproofing membrane is still tacky. The protection board shall bond with the HRA waterproofing membrane. The protection board shall be laid transverse to the centreline of the bridge deck or culvert. Sand used to separate individual protection boards, or any other material, shall be prevented from getting blown onto the abrasive blast cleaned surface, primed surface or the HRA waterproofing membrane surface prior the installation of the protection board. The protection boards shall be placed with all edges overlapping 12 mm \pm 6 mm. The protection board edge shall be within 6 mm of all curbs, vertical faces of drains, and vertical faces of expansion joints. Where there is a chase, the protection board edge shall extend into the chase. Protection boards shall be placed so that the joints lap in the direction of traffic flow and staggered a minimum of 150 mm.

No construction equipment or any vehicles shall be allowed on the protection boards once placed, except construction equipment directly associated with the paving operations, that follow after the HRA waterproofing membrane has fully set. The HRA waterproofing membrane is set when the liquid membrane is solidified and there is no movement of the protection board when pressure is applied.

Drying or heating of the protection board, after placement, shall not be expedited by use of a torch or open flame.

If paving is specified, the binder course pavement shall be placed within 7 Days of waterproofing. Prior to placement of the binder course, the protection board shall be clean, dry, free of sand and other debris and contamination and protected from ice, snow and rain. The protection board shall remain stable, with no movement, and shall have no perforations prior to and during placement of binder course pavement.

914.07.11 Additional Requirements for Waterproofing of Culverts

HRA waterproofing membrane with protection board shall be applied to the top surface of the culvert except when a protection or distribution slab is specified, where waterproofing shall be applied to the top of the protection slab or distribution slab.

The application shall be to the top surface of the culvert that will be covered with fill material and extend to 1000 mm beyond the limit of the fill material specified in the Contract Documents.

The HRA waterproofing membrane application, including the protection board, shall extend 300 mm down the vertical faces from:

- a) The top of the culvert or, when specified.
- b) The top of the protection or distribution slab.

If a headwall is specified in the Contract Documents, the application shall extend a minimum of 50 mm up the headwall.

Protection board shall extend over all areas of waterproofing on the culvert.

914.07.12**Form and Fill Grooves**

Where forming and filling grooves are specified in the Contract Documents, the grooves shall be made by dry sawing. Forming and filling of grooves shall be performed within 14 Days of surface course asphalt placement at each groove location.

Immediately prior to placing the joint sealing compound, the groove shall be dried, and any dust or debris cleaned using an air compressor.

Joint sealing compound shall be poured using hand pouring pots, mechanical methods, or any other method that gives acceptable results.

Shields shall be provided to prevent joint sealing compound from spilling onto existing surfaces, such as concrete curbs, concrete barrier, concrete parapet walls, deck joint assemblies, deck drains, and on the newly placed pavement.

Sufficient joint sealing compound shall be poured into the groove so that upon completion of the work, the surface of the compound is flush with the surface of the pavement. If the compound subsides to a level below the surface of the pavement, a second pouring shall be done. When more than one pouring is required to fill the groove, succeeding pours shall be made immediately.

Any damage to the joint sealing compound caused by construction operations shall be repaired.

Traffic shall not be permitted over the joint sealing compound until the compound has cooled to ambient temperature.

914.07.13**Material Sampling and Testing**

For each lot, as defined in the Quality Assurance section of this specification, representative samples of the following shall be taken for quality assurance testing by the Owner:

- a) A 4 litre sample of HRA waterproofing membrane sampled from the heating and mixing kettle.
- b) A 1 litre sample of primer.
- c) A 300 x 300 mm piece of membrane reinforcement.
- d) A 300 x 300 mm piece of protection board.
- e) A 1 litre sample of joint sealing compound, when specified.

Sampling of the lot shall be as directed by the Contract Administrator. The time of sampling shall be determined using the Field Guide for the Acceptance of Hot Mix Asphalt and Hot-applied Rubberized Asphalt Waterproofing Membrane.

Additional samples from the lot may be taken at the discretion of the Owner to determine acceptability of the lot, if changes are noted in the HRA waterproofing membrane, after the quality assurance sample is taken. The Contract Administrator shall note on form PH-CC-340, Field Sample Data Sheet - Concrete, that the sample is an additional sample for quality assurance testing of the lot as well as reason for taking the additional sample.

All containers used for sampling the HRA waterproofing membrane, primer and joint sealing compound, if used, shall be metal, with double tight lids. The Contract Administrator shall be allowed to examine the sample containers prior to sampling to ensure they are clean and free of debris.

A single 4 L container shall be used to sample the HRA waterproofing membrane. The HRA waterproofing membrane sample will be split at the laboratory into two parts; one part will be tested for acceptance and the other will be retained for referee testing.

For sampling of the primer, the sample shall be taken from the discharge point of the equipment used to apply the primer. The lid of the sample container shall be immediately applied and sealed after the primer sample is taken.

The Contract number, date sampled, manufacturer name, product name and manufacturer's lot/batch number(s) shall be marked legibly on all containers used for sampling.

The membrane reinforcement samples shall be taken from a section labelled with manufacturer and product information.

The samples of HRA waterproofing membrane, primer, membrane reinforcement and protection board for each lot shall be placed in a single plastic bag along with a MTO form PH-CC-340, Field Sample Data Sheet - Concrete and fitted with a security tag by the Contract Administrator. Samples of joint sealing compound, if used, shall be placed in a plastic bag along with a MTO form PH-CC-340, Field Sample Data Sheet - Concrete, and fitted with a security tag by the Contract Administrator. All samples shall immediately be given to the Contract Administrator, with a transmittal form, for transportation to the designated laboratory.

914.07.14 Repairs

A repair proposal may be submitted for work that does not meet the requirements of this specification. The repair proposal is subject to acceptance by the Owner, prior to the repair being carried out.

Repairs shall be full lane or full shoulder width except where localized repairs are permitted or specified in the Contract Documents. New HRA waterproofing membrane material shall be lapped according to the Application of HRA Waterproofing Membrane clause.

The repairs shall meet all requirements of this specification.

Lots that have been repaired or replaced shall be subject to the Quality Assurance acceptance requirements.

The Contractor shall be responsible for all costs associated with repairs.

914.07.15 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

914.08 QUALITY ASSURANCE

914.08.01 General

The waterproofing system shall be acceptable if the requirements of this specification are met.

Unacceptable lots may be rejected, and removed and replaced, or may be left in place with a payment adjustment calculated according to this specification. Rejectable waterproofing system shall be removed and replaced.

Removal and replacement of rejectable lots shall consist of the removal and replacement of the waterproofing system, and pavement, if applicable, to neat lines. The construction of the replacement waterproofing system shall be according to this specification.

The replacement waterproofing system for lots that have been removed and replaced shall be evaluated for acceptance on the same basis as the original lots.

The Contractor shall be responsible for all costs associated with removing and replacing rejectable lots.

914.08.02 Field Inspection

The Contract Administrator will inspect the work and will reject all or a portion of the work based on the presence of one or more of the following defects:

- a) Surface preparation not meeting the requirements of this specification:
 - i. Existing waterproofing that has not been properly removed.
 - ii. Grout tubes that have not been properly treated, when applicable.
 - iii. Textured surfaces, when applicable, that have not been properly ground down to 2 mm or less.
 - iv. Improper abrasive blast cleaning.
 - v. Improper cleaning of the concrete surface prior to applying the primer.
 - vi. Presence of any contamination on the concrete surface prior to application of primer.
- b) Areas without sufficient application of primer, based on visual inspection.
- c) Application of HRA waterproofing membrane that is not within the acceptable manufacturer's recommended temperature range.
- d) The presence of discontinuities, including bubbles or other voids in the HRA waterproofing membrane that extend through the full depth of the HRA waterproofing membrane.
- e) HRA waterproofing membrane that is not adhered to the primed concrete surface.
- f) Protection board that is not properly coated with asphalt.
- g) Membrane reinforcement or protection board that is not bonded to the HRA waterproofing membrane.
- h) Protection board that is cracked, torn or damaged.
- i) Grooves or joint sealing compounds that have damages and are not as specified in the Contract Documents.

914.08.03 Verification of Application Rate of Primer

The Owner may verify the application rate of primer according to ASTM D2995 (Option A). Lots not meeting the primer application rate of this specification shall be removed and replaced.

914.08.04 Acceptance of HRA Waterproofing Membrane Quality

914.08.04.01 Lot Size

Acceptance of the HRA waterproofing membrane quality shall be on a lot basis.

A lot shall be a single bridge deck or culvert or part of a bridge deck or culvert with a surface area of 800 m² or less. Bridge decks or culverts larger than 800 m² shall be divided into the least number of equal sized lots of 800 m² or less. Bridge decks or culverts separated into segments for staged construction shall be treated as separate lots. The Contract Administrator shall determine the limits of each lot prior to commencement of the waterproofing operations.

914.08.04.02 Basis of Acceptance

A lot shall receive a HRA waterproofing membrane quality payment adjustment factor of one if all the test results for the sample representing that lot are within the specification limits shown in Table 2.

If the sample test results are in the marginal range of Table 2 for one or more tests, the payment adjustment shall be determined according to the Payment Adjustment Due to HRA Waterproofing Membrane Quality Deficiency clause.

A lot is rejectable if any of the following criteria are met:

- a) The total number of adjustment points (PT), as shown in Table 2 is greater than 20.
- b) Any test result for a sample is in the rejection value range, as shown in Table 2.
- c) The sample representing the lot is not able to be tested due to the condition in which it is received (e.g., the sample is too hard, too fluid, contaminated, or in an unacceptable container).

Rejectable lots shall be removed and replaced.

All testing specified in Table 2, shall be carried out according to OPSS 1213.

914.08.04.03 Referee Testing

Referee testing of HRA waterproofing membrane quality may only be invoked by the Contractor within 3 Business Days of receiving notification of payment adjustment or rejection of the lot. Lots for which quality assurance testing was not able to be performed due to the condition of the sample shall not be tested for referee, but the sample shall be available for viewing at the designated laboratory. Lots for which an insufficient sample size was received shall not be tested for referee, and acceptance shall be based on the quality assurance testing.

Referee testing shall be carried out for all properties specified in Table 2.

The results of the referee test shall replace the acceptance test results and shall be used for acceptance determination. If the referee testing results in either a payment adjustment or rejection of the lot, the Contractor shall bear the cost of the referee testing. If the referee testing results in the material passing all test criteria, the referee testing charge shall be paid by the Owner.

914.08.05 Acceptance of HRA Waterproofing Membrane Thickness

914.08.05.01 General

The Contract Administrator shall determine the acceptability of the HRA waterproofing membrane thickness by measurement on a lot basis.

Lots for HRA waterproofing membrane thickness acceptance shall match the lots established for HRA waterproofing membrane quality acceptance. Each lot shall be divided into 10 equal sublots.

914.08.05.02 Testing

A measurement shall be taken by the Contract Administrator at a random location in each subplot according to the Field Guide for the Acceptance of Hot Mix Asphalt and Hot-applied Rubberized Asphalt Waterproofing Membrane and shall be taken after each lot has been completed, including the placement of protection board. The measurement shall include the thickness of the two-layers of HRA waterproofing membrane, including the membrane reinforcement.

914.08.05.03 Basis of Acceptance

The decision to accept the HRA waterproofing membrane thickness shall be based on the mean and standard deviation of each lot.

If the lot mean is less than 4.0 mm or greater than 6.0 mm, the entire lot is rejectable and the Contractor shall remove and replace the waterproofing system of the lot.

If the lot mean is greater than or equal to 4.0 mm and less than or equal to 6.0 mm, the mean and the standard deviation shall be rounded to the closest 0.1 mm and 0.05 mm, respectively, and shall then be applied to Table 1 to determine if the lot is in the acceptable, marginal, or rejectable range. If the lot is within the marginal range as shown in Table 1, the Contractor may repair the lot as outlined below or request that the Owner accept the lot as is with a payment adjustment as outlined in the Payment Adjustment Due to HRA Waterproofing Membrane Thickness Deficiency clause. If the lot is within the rejectable range as shown in Table 1, the Contractor shall remove and replace the waterproofing system of the lot.

When the HRA waterproofing membrane thickness lot mean is greater than 6.0 mm, the Contractor may submit a proposal in writing for an alternative to removal and replacement for rejectable HRA waterproofing membrane thickness for the Owner's consideration.

914.08.05.04 Referee Testing

The Contractor may request referee testing of the lot, immediately after being advised of test results, and challenge any or all of the 10 subplot test values. If this occurs, 10 new thickness measurements shall be taken at new random locations within the lot by the Contract Administrator in the presence of the Contractor. The new test values shall replace the acceptance results and shall be used to determine acceptance. Acceptance shall be based on the criteria specified in the Acceptance of HRA Waterproofing Membrane Thickness subsection.

If the referee testing results in either a marginal or a rejectable lot, the Contractor shall bear the cost of the referee testing. If the referee testing results in an acceptable lot, the Owner shall bear the cost of the referee testing.

914.08.06 Acceptance of Protection Board Thickness

914.08.06.01 Lot Size

Acceptability of protection board thickness shall be determined on a lot basis. A lot shall be the total number of protection boards required to cover a single bridge deck or culvert or part of a bridge deck or culvert with a surface area of 800 m² or less. Bridge decks or culverts larger than 800 m² shall be divided into the least number of equal sized lots of 800 m² or less. Bridge decks or culverts separated into segments for staged construction shall be treated as separate lots. The Contract Administrator shall determine the limits of each lot.

914.08.06.02 Testing

Two protection boards per lot shall be randomly selected by the Contract Administrator for testing of thickness; one board for measurement in the field by the Contract Administrator (field-tested), and one board for testing at the designated laboratory (laboratory-tested). Thickness of the field-tested board shall be measured by the Contract Administrator according to LS-359.

914.08.06.03 Basis of Acceptance

Protection board shall be acceptable if it meets the requirements of OPSS 1215 and this specification.

Lots shall be acceptable when the two protection boards measured for acceptance meet the thickness requirements of this specification. Lots where any of the measured protection boards have an average thickness less than 3.2 mm or greater than 4.0 mm shall be rejectable.

All of the protection boards in a failed lot shall not be placed in the work. All of the protection boards from failed lots that have been placed in the work, along with the entire waterproofing system, shall be removed and replaced.

914.08.06.04 Referee Testing

The Contractor may request referee testing for thickness of protection board.

For the field-tested protection boards, the Contractor shall invoke referee testing immediately after quality assurance testing is complete. If this occurs, the same protection board, as was used for field quality assurance testing shall be used for referee testing. Referee thickness testing and basis of acceptance shall be according to the Acceptance of Protection Board Thickness subsection of this specification. The new test values shall then be used to determine acceptance.

For the laboratory-tested protection board, referee testing may only be invoked by the Contractor within 3 Business Days of receipt of the acceptance test result. Referee thickness testing shall be carried out on the same board as was used for laboratory quality assurance testing. The new test value shall then be used to determine acceptance.

914.09 MEASUREMENT FOR PAYMENT

914.09.01 Actual Measurement

914.09.01.01 Membrane Reinforcement

Measurement of membrane reinforcement shall be by length in metres. Allowance shall not be made in the measurement for the turn-up at vertical faces or for any overlap.

914.09.01.02 Form and Fill Grooves

Measurement of forming and filling grooves shall be by length in metres.

914.09.01.03 Modification of Deck Drains

For measurement purposes, a count shall be made of the number of deck drains modified, regardless of type and size.

914.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

914.10 BASIS OF PAYMENT

914.10.01 Bridge Deck Waterproofing - Item Cast-in-Place Concrete Culvert Waterproofing - Item

914.10.01.01 General

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work, subject to payment adjustment.

When the Contract Administrator directs repairs or remedial work that is not specified in the Contract Documents to the concrete deck or culvert prior to abrasive blast cleaning the work directed shall be administered as a Change in the Work.

914.10.01.02 Payment Adjustment Due to HRA Waterproofing Membrane Thickness Deficiency

When a lot is within the acceptable range as shown in Table 1, a thickness adjustment factor of 1.00 shall be applied to the Contract price for the lot.

When a lot is within the marginal range as shown in Table 1 and the Contractor requests that the Owner accept the lot as is, the HRA waterproofing membrane thickness adjustment factor as shown in Table 1 shall be applied. Where a lot with mean thickness greater than 6.0 mm has been deemed acceptable and the Contractor requests that the Owner accept the lot as is, a payment adjustment factor of 0.60 shall be applied due to membrane thickness deficiency.

914.10.01.03 Payment Adjustment Due to HRA Waterproofing Membrane Quality Deficiency

HRA Waterproofing membrane quality adjustment factors are calculated as follows:

- a) If the sample test results are in the marginal range for one or more tests, the adjustment points as shown in Table 2 for each borderline test result shall be totalled. If the total exceeds 20, the lot is rejectable. If the total is less than or equal to 20, the Contract Administrator shall assign a payment adjustment factor which shall be 100 minus the total of all the adjustment points (PT) and the result divided by 100.
- b) If the sample test results meet all specification limits as shown in Table 2, the Contract Administrator shall assign a payment adjustment factor of 1.00.

914.10.01.04 Calculation for Total Payment Adjustment

The total payment adjustment for the lot shall be based on the thickness and on the quality for the HRA waterproofing membrane and is calculated as follows:

- a) The Contract price for the lot shall be multiplied by the HRA waterproofing membrane thickness adjustment factor and the results shall then be multiplied by the HRA waterproofing membrane quality adjustment factor.

**914.10.02 Form and Fill Grooves - Item
Membrane Reinforcement - Item
Modification of Deck Drains - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Acceptance Determination and Payment Adjustment Factors for
HRA Waterproofing Membrane Thickness

Lot Standard Deviation	Lot Mean														Lot Standard Deviation
	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	
0.0															0.0
.05															.05
.10															.10
.15															.15
.20															.20
.25															.25
.30															.30
.35															.35
.40															.40
.45	Acc														.45
.50	.99	Acc													.50
.55	.94	.99	Acc												.55
.60	.83	.95	.99	Acc											.60
.65	Rej	.86	.95	.99	Acc										.65
.70	Rej	.59	.87	.96	.99	Acc									.70
.75		Rej	.71	.89	.96	.99	Acc								.75
.80			Rej	.76	.91	.96	.99	Acc							.80
.85				Rej	.81	.91	.96	.99	Acc	Acc					.85
.90					Rej	.83	.92	.97	.99	.99	Acc				.90
.95					Rej	.64	.84	.93	.97	.99	.99	Acc			.95
1.00						Rej	.71	.87	.93	.97	.99	.99	Acc		1.00
1.05							Rej	.76	.87	.94	.97	.99	.99	Acc	1.05

Continues on Next Page

TABLE 1 (Cont'd)
Acceptance Determination and Payment Adjustment Factors for
HRA Waterproofing Membrane Thickness

Lot Standard Deviation	Lot Mean														Lot Standard Deviation
	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	
1.10	Rej	.79	.89	.94	.97	.99	.99	Acc							1.10
1.15	Rej	.59	.81	.90	.95	.97	.99	.99	Acc						1.15
1.20		Rej	.64	.83	.91	.95	.97	.99	.99	Acc					1.20
1.25			Rej	.71	.84	.91	.95	.97	.99	.99	Acc				1.25
1.30				Rej	.76	.86	.92	.95	.97	.99	.99	Acc			1.30
1.35					Rej	.77	.87	.92	.95	.98	.99	.99	Acc		1.35
1.40					Rej	.59	.79	.87	.93	.96	.98	.99	.99	Acc	1.40
1.45						Rej	.68	.82	.88	.93	.96	.98	.99	.99	1.45
1.50							Rej	.71	.83	.89	.93	.96	.98	.99	1.50
1.55								Rej	.74	.84	.90	.94	.96	.98	1.55
1.60									Rej	.78	.86	.91	.94	.96	1.60
1.65									Rej	.64	.79	.87	.91	.94	1.65
1.70										Rej	.68	.81	.87	.91	1.70
1.75											Rej	.71	.82	.87	1.75
1.80												Rej	.74	.83	1.80
1.85												Rej	.59	.76	1.85
1.90													Rej	.64	1.90
1.95														Rej	1.95
2.00														Rej	2.00

Notes:

- A. Cells containing the Payment Adjustment Factors form the marginal range.
- B. "Acc" means acceptable.
- C. "Rej" means rejectable.

TABLE 2
Acceptance Determination and Payment Adjustment Factors for HRA
Waterproofing Membrane Quality

Test	Specification Limits	Marginal Range (B) (Note 1)	Adjustment Points	Rejection Value
Low Temperature Flexibility at -25 °C	Pass	N/A	N/A	Fail
Cone Penetration at 25 °C (0.1 mm)	Max. 110	111 to 130	$P1 = 0.4 \times (B - 110)$	> 130
Cone Penetration at 50 °C (0.1 mm)	Max. 160	161 to 180	$P2 = 0.4 \times (B - 160)$	> 180
Flow at 60 °C (mm)	Max. 3 mm	3.1 to 5.0	$P3 = 4 \times (B - 3)$	> 5
Toughness (joules)	Min. 5.5	5.4 to 4.0	$P4 = 5 \times (5.5 - B)$	< 4.0
Toughness/Peak Load (joules/newton)	Min. 0.040	0.039 to 0.030	$P5 = 500 \times (0.040 - B)$	< 0.030
Adhesion	Pass	N/A	N/A	Fail
$PT = P1 + P2 + P3 + P4 + P5$				
Notes: 1. B is an observed test result within the marginal range to be used for calculation of adjustment points.				