SECTION 691 - WATERPROOFING OF CONCRETE BRIDGE DECKS

##This section cross-references Sections 160, 175, 407, 687 and 689. If any of the above sections are relevant, they should be included in the specification. If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent:

###691.01 GENERAL

This section specifies the requirements for the supply and quality of materials, surface preparation, application, relevant testing and acceptance criteria of waterproofing membrane systems on concrete bridge decks.

The waterproofing membrane system comprises a primer, a preformed sheet or liquid applied membrane, and may also include a protective layer and a tack coat.

This section does not cover waterproofing membrane systems for use on steel or timber bridge decks.

Requirements for asphalt and asphalt wearing course to be placed over the waterproofing membrane systems are specified in Section 407.

###691.02 STANDARDS

Concrete waterproofing materials, surface preparation and application shall comply with the requirements of the following standards and test methods:

(a) Australian Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS 1580.108.2</td>
<td>Paints and related materials – Methods of test - Dry film thickness - Paint inspection gauge</td>
</tr>
<tr>
<td>AS 1580.408.5</td>
<td>Paints and related materials – Methods of test – Adhesion - Pull-off test</td>
</tr>
<tr>
<td>AS 1627.1</td>
<td>Metal finishing - Preparation and pretreatment of surfaces – Removal of oil, grease and related contamination</td>
</tr>
<tr>
<td>AS 1627.4</td>
<td>Metal finishing - Preparation and pretreatment of surfaces – Abrasive blast cleaning of steel</td>
</tr>
<tr>
<td>AS/NZS 2312</td>
<td>Guide to the protection of structural steel against atmospheric corrosion by use of protective coatings</td>
</tr>
<tr>
<td>AS/NZS ISO 9001</td>
<td>Quality management systems - Requirements</td>
</tr>
</tbody>
</table>

(b) Additional Test Methods

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM D4263-83 (2012)</td>
<td>Moisture in Concrete by the Plastic Sheet Method</td>
</tr>
<tr>
<td>ASTM D4414-95 (2007)</td>
<td>Measurement of Wet Film Thickness by Notch Gauges</td>
</tr>
<tr>
<td>BS EN 1109 (2013)</td>
<td>Flexible sheets for roofing. Bitumen sheets for roof waterproofing. Determination of flexibility at low temperature</td>
</tr>
</tbody>
</table>


(c) Additional Referenced Documents


NACE WJ-2/SSPC-SP - WJ-2  Waterjet Cleaning of Metals—Very Thorough Cleaning (WJ-2)

Section 175 details the relevant references to these documents.

691.03 DEFINITIONS

Adhesion/bond strength:  The sum total of the forces of attachment between a dry film and its concrete substrate.

Bonded membrane:  Waterproofing membrane applied and bonded to the concrete surface. This term is applicable to both preformed sheet and liquid applied membranes.

Bonding agent:  An adhesive material applied to the waterproofing membrane or to the substrate to promote bonding.

Dry film thickness (DFT):  The thickness of the liquid applied membrane(s) after the curing or drying time has elapsed.

Liquid applied membrane:  A resin based membrane applied as a liquid, and does not contain any aggregates.

Holiday:  A discontinuity, pinhole, void, crack, thin spot, foreign inclusion or contaminant in the coating film.

Outgassing:  Release of water vapour from the voids in concrete bridge decks due to increase in the ambient air temperature.

Oxidised bitumen:  Also known as blown bitumen. Bitumen whose rheological properties have been substantially modified by reaction with air at elevated temperatures.

Pinhole:  A local failure in the waterproofing membrane caused by bursting of small blisters on the surface as a result of outgassing, which if not repaired will leave a permanent pathway for moisture to reach the concrete deck.

Preformed waterproofing membrane:  A preformed membrane consisting of bituminised fabric, polymer or elastomer based sheets.

Primer:  A bituminous or resinous solution of low viscosity and low surface tension used without aggregate to penetrate into concrete plastic shrinkage cracks and pores, and to promote adhesion and compatibility with the waterproofing membrane.

Protective Layer:  An additional layer separate from, or integral with, the waterproofing membrane which is laid on top of the membrane to protect it from damage during construction.

Tack Coat:  A light application of a bituminous material without cover aggregate, to a prepared base as a preliminary treatment to promote surface adhesion of the waterproofing membrane to the protective layer or asphalt.

Unbonded Membrane:  Waterproofing membrane material prior to installation. This term is applicable to both preformed sheet or liquid applied membranes.
**Waterproofing Membrane**: The main part of a waterproofing system which is either a Preformed Waterproofing Membrane or a Liquid Applied Membrane.

**Waterproofing System**: Combination of materials in layers that may include primers, waterproofing membranes, protective layers and/or tack coats, applied to a concrete bridge deck forming a watertight system to protect the deck from ingress of water and/or chloride ions.

**Wet film thickness (WFT)**: The thickness of the wet liquid applied membrane immediately after application.

### 691.04 MATERIALS

Waterproofing systems shall be used in accordance with the manufacturer’s recommendations and materials safety data sheets.

The Contractor shall submit for review by the Superintendent not less than twenty-one (21) days prior to the commencement of the waterproofing works, details of the waterproofing operations including information on the proposed waterproofing system, substrate preparation, method of application, equipment and operators, demonstrating compliance with the requirements of this specification.

Material details shall include information on the properties of the proposed products, documented evidence of previous performance and relevant test results traceable to the proposed waterproofing system, which shall not be more than twenty-four (24) months old.

**HP** Waterproofing works shall not take place until the Contractor’s proposed materials and procedures and surface preparation in accordance with Clause 691.08 have been reviewed and accepted by the Superintendent.

### 691.05 WATERPROOFING MEMBRANE SYSTEMS

(a) General Requirements

Waterproofing systems shall be procured from manufacturers/suppliers who have implemented a quality management system to AS/NZS ISO 9001, with third-party certification accredited or accepted by JAS-ANZ or equivalent.

The Contractor shall supply the Superintendent with a certificate from the manufacturer in the form of a guarantee confirming that the waterproofing system and materials comply with the requirements of this section, including a guaranteed in-service performance of not less than ten (10) years from the date of installation.

Waterproofing systems applied to highly porous and/or relatively soft concrete substrates shall include a high quality pore-filling primer to be applied prior to the application of the overall waterproofing system. The primer and/or the waterproofing system as a whole shall also offer surface binding and toughening effect.

The Contractor shall provide evidence as to the compatibility of the proposed waterproofing system to the nominated substrate. Such evidence shall include but not be limited to test certificates endorsed in accordance with the AS ISO/IEC 17025 accreditation for the testing laboratory and history of previous performance.

(b) Primers

Bituminous primers shall be bitumen, with or without polymer modification, blended together in a hydrocarbon solvent.

Resin based primers shall be either moisture (from the air) curing, or two part chemical curing.

Resin based primers shall have a pot life longer than the duration required for application of
the primer.
Primers of low viscosity shall be used to provide adequate workability at the application temperature.

(c) Preformed Waterproofing Membrane
Preformed waterproofing membrane shall be made of bituminous fabric, polymer extrusions or elastomeric membranes with a thickness not less than 4 mm.
Bituminised fabric membranes shall comprise an absorbent fabric of polyester fleece or woven polypropylene impregnated and coated with bitumen.
Polymeric membranes shall be extruded bituminised or laminated polymers, based on polymer plasticised polyvinylchloride or polyethylene.
Elastomeric membranes shall be made of vulcanised polyisoprene rubber.

(d) Liquid Applied Membrane
Liquid applied membrane shall be made of polyurethane, acrylic, polyurea, polyester or other polymer derivatives with a thickness not less than 2 mm, and may consist of one or more components. The liquid applied membrane may be air or chemically cured.

(e) Protective Layer
Where required, a protective layer shall be used to prevent damage to the waterproofing membrane during construction, in particular from the penetration of hot aggregates into the membrane during compaction rolling of the asphalt.
The protective layer may be either self-adhesive, or bonded to the membrane using oxidised bitumen.
The protective layer shall be placed immediately following the installation of the membrane, unless more time is required for drying or curing of the membrane or other materials underneath it.
Sand or mineral granules shall not be spread over the liquid applied membrane as a protective layer, unless working samples are submitted which show that the membrane thickness is not reduced, and adhesion to asphalt is not compromised by the use of the granules. Granules that melt during asphalt application are allowed.

(f) Tack Coat
Tack coat shall be applied as required, in accordance with the manufacturer’s recommendations to provide adequate adhesion of asphalt to the waterproofing membrane over its service life. The tack coat shall be applied uniformly to the waterproofing membrane with spraying equipment, or by another method approved by the Superintendent.
The tack coat shall be formulated such that it is activated by the hot asphalt placed on the tack coat.

691.06 SPECIFIC WATERPROOFING MEMBRANE SYSTEM REQUIREMENTS

(a) General
The selection of the waterproofing membrane system shall allow for the type of asphalt overlay shown on the Drawings and specification.

(b) Requirements during Application
The waterproofing membrane system shall satisfy the following requirements during its application:
(i) suitable for installation under the expected weather conditions
(ii) thermally stable up to 180°C, during asphalt placement
(iii) achieve full adhesion of all interfaces, joints and overlaps
(iv) be resistant to puncture by loose particles
(v) integrity of the constituent materials prior to mixing, and ability to form a homogeneous material when mixed
(vi) safe to handle and work with, in accordance with all relevant occupational health and safety regulations.

(c) Requirements in-Service

The waterproofing membrane system shall satisfy the following in-service requirements:

(i) will provide full adhesion to the concrete bridge deck and the overlying asphalt
(ii) will not delaminate and able to remain waterproof
(iii) capable of bridging over cracks up to 1 mm width in the concrete deck
(iv) resistance to puncture from overlying asphalt under traffic loads
(v) able to withstand asphalt milling and resurfacing without loss of adhesion to the concrete bridge deck
(vi) able to maintain shear resistance of all interfaces to stresses from traffic, including braking and turning
(vii) resistance to moisture ingress from traffic-induced pressure
(viii) chemically resistant to spillage of fuel and other substances.

691.07 WATERPROOFING MEMBRANE PERFORMANCE REQUIREMENTS

The Contractor shall submit a Certificate of Conformity, including all relevant test results shown in Table 691.071 and Table 691.072, verifying conformity of the supplied materials for every lot/batch delivered. A Certificate of Conformity may be in the form of a British Board of agrément (BBA) current Roads and Bridges agrément Certificate.

Unbonded sheets, boards and film forming liquid applied membranes as defined in Clause 691.03 shall comply with the performance requirements of Table 691.071, when tested in accordance with the specified test methods.

Bonded sheets, boards and film forming liquid applied membranes as defined in Clause 691.03 shall comply with the performance requirements of Table 691.072, when tested in accordance with the specified test methods.

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Membrane Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preformed Waterproofing Membrane</td>
</tr>
<tr>
<td></td>
<td>Liquid Applied Waterproofing Membrane</td>
</tr>
<tr>
<td>Thickness variation</td>
<td>≤ 10 % of nominal</td>
</tr>
<tr>
<td>Straightness of sheets</td>
<td>≤ 10 mm in 2 m length</td>
</tr>
<tr>
<td></td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Width of sheets</td>
<td>Uniform within ± 10 mm</td>
</tr>
<tr>
<td></td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Unit weight variation</td>
<td>≤ 5% of nominal</td>
</tr>
<tr>
<td>Water absorption</td>
<td>≤ 5% of specimen weight</td>
</tr>
<tr>
<td>Water penetration</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>Nil</td>
</tr>
<tr>
<td>Pliability (ASTM D146M)</td>
<td>Not Applicable</td>
</tr>
<tr>
<td></td>
<td>No break</td>
</tr>
<tr>
<td>Handling</td>
<td>Satisfy BD 47/99 or similar</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Flow resistance at elevated temperature (BS EN 1110)</td>
<td>≥100 °C</td>
</tr>
<tr>
<td>Tensile strength (BS EN 12311-1)</td>
<td>≥550 N/50mm/ ≥400 N/50 mm</td>
</tr>
<tr>
<td>Ultimate elongation</td>
<td>≥30%/ ≥30 %</td>
</tr>
<tr>
<td>Shear resistance</td>
<td>400 N/50 mm</td>
</tr>
<tr>
<td>Resistance to tearing (BS EN 12310-1)</td>
<td>200 N</td>
</tr>
<tr>
<td>Flexibility at low temperature (BS EN 1109)</td>
<td>≤-10 °C</td>
</tr>
</tbody>
</table>

**Note:** All tests shall be in accordance with BD 47/99, except as shown otherwise. Equivalent test methods may be accepted by the Superintendent.

### Table 691.072

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile adhesion (waterproofing membrane to concrete deck)</td>
<td>≥0.75 MPa</td>
</tr>
<tr>
<td>Resistance to chloride ion penetration (after 28 days) at 23°C</td>
<td>≤ 0.04%</td>
</tr>
<tr>
<td>Resistance to heat aging</td>
<td>Tensile test at 23°C</td>
</tr>
<tr>
<td></td>
<td>≥ 0.5 MPa</td>
</tr>
<tr>
<td></td>
<td>Chloride ion test at 23°C</td>
</tr>
<tr>
<td></td>
<td>≤ 0.04%</td>
</tr>
<tr>
<td>Resistance to chisel impact</td>
<td>Chloride ion test at -10°C, 23°C, 40°C</td>
</tr>
<tr>
<td></td>
<td>≤ 0.04%</td>
</tr>
<tr>
<td>Resistance to aggregate indentation</td>
<td>Chloride ion test at 40°C, 80°C, 125°C</td>
</tr>
<tr>
<td></td>
<td>≤ 0.04%</td>
</tr>
<tr>
<td></td>
<td>Volume change at 40°C, 80°C, 125°C</td>
</tr>
<tr>
<td></td>
<td>≤ 50%</td>
</tr>
<tr>
<td>Resistance to pin or blow hole</td>
<td>Within a 250 x 250 mm area - there shall be no blisters; and - no more than 4 pin or blow holes</td>
</tr>
</tbody>
</table>

**Note:** All tests shall be in accordance with BD 47/99.

### 691.08 SURFACE PREPARATION

#### (a) General

The surface preparation shall be in accordance with the manufacturer’s recommendations for the waterproofing membrane system to be applied and as specified in this section.

#### (b) Concrete Surface Preparation

Concrete surfaces to which the waterproof membranes are applied shall be dry, clean, sound and free of dust or loose particles. Cement laitance, oil, grease, and any remnants of curing compounds and previous asphalt layers shall be removed from concrete surfaces by using grit blasting or bush hammer, scabbler, ultra high pressure potable water jetting to NACE WJ-
2/SSPC-SP - WJ-2, or other approved means to provide a strong, hard surface. Areas of persistent contamination shall be removed from the surface by the use of appropriate solvents or detergents followed by washing with potable water in accordance with AS 1627.1. Any abrasive blast cleaning shall be carried out in accordance with AS 1627.4 and other OH&S and Environmental regulations imposed by the local government authority and the Environment Protection Authority Victoria (EPA).

If the surface of the concrete is weak, honeycombed or characterised by loose surface layers more material shall be removed, and repaired in accordance with the requirements Section 689. Shrinkage cracks of width less than 0.2 mm shall be filled with a suitable fairing coat cementitious repair material in accordance with the requirements of Section 689. Such repairs shall be sufficient to result in a strong, sound substrate suitable for the intended waterproofing membrane system. Projecting fins, rough spots and sudden steps shall be removed by light abrasion with an angle grinder to provide a surface which is suitable for the waterproofing membrane.

A trial application to check the suitability of the surface, the surface preparation methods and other requirements shall be undertaken as set out in Clause 691.16.

(c) Primer Application

Primers shall be applied by brush, mop, broom or spray in accordance with the manufacturer's recommendations.

Sufficient resources shall be provided for the application of resinous primers to ensure that the area to be primed is covered within the specified time limits. The pot life/gel and cure time of resinous primers at high ambient temperatures shall be allowed for during application. Solvent-based primers shall be applied in layers of uniform thickness to avoid leaving pockets of liquid beneath the dry skin. Trapped solvents which may expand rapidly under hot asphalt and which may lead to premature failure of the membrane shall be avoided.

Primed surfaces which have become brittle or powdery shall be nonconforming. In such cases the deteriorated primer shall be removed and a new primer coat applied.

691.09 WATERPROOFING MEMBRANE APPLICATION

(a) General

All concrete surfaces to receive a waterproofing membrane shall be dry at the time of application. Sufficient drying time shall be allowed after wet preparation methods to satisfy the requirements of Clause 691.17.

Waterproofing membranes shall not be installed on wet concrete surfaces.

The waterproofing membrane system shall be applied within 24 hours unless otherwise expressed in writing by the manufacturer after the preparation of the concrete surface. The prepared surface shall be protected against contamination and rain or expected rain if the waterproofing is not undertaken within 24 hours.

The waterproofing membrane shall not be applied if any of the conditions stated in Clause 691.14 exist. In addition, the membrane shall not be applied over any previously applied layer/coat which contains application defects or any damage until such defects have been repaired in accordance with Clause 691.20.

Air shall not be allowed to be trapped at the concrete/primer/membrane interfaces.

A trial application to check the suitability of the method of waterproofing membrane application shall be undertaken as set out in Clause 691.16.

(b) Liquid Waterproofing Membrane Application

(i) General
The liquid waterproofing membrane system shall be applied in accordance with the manufacturer’s requirements including application methods, overcoating times and coverage rates, mixing requirements, current materials safety data sheets and as specified in this section. Coverage rates of liquid applied membranes shall be checked for compliance with the manufacturer’s requirements. The surface area of the concrete structure subject to application and the volume of liquid applied membrane used shall be recorded by the Contractor.

For multiple liquid applied membrane applications, the manufacturer’s stated minimum and maximum overcoating times for the prevailing weather conditions shall be satisfied, and successive coats shall have slightly different colour shades to assist in achieving uniform coverage. The difference in colour shall be such that a coat when either wet or dry shall be clearly distinguishable by means of colour difference, from the preceding coat.

If the applied layer is too thin, or shows evidence of having been applied under unfavourable conditions, or the workmanship is poor, or the specified requirements are not fulfilled, the surface shall be re-treated to the extent required by the Superintendent.

Where the methods of application are unacceptable to the Superintendent because of undesirable effects such as over spray, spatter or significant disruption to the public, alternative methods shall be used.

If, in the opinion of the Superintendent, conditions become unsatisfactory, work shall not be continued, and newly waterproofed surfaces shall be protected with shelters from rain or other damage as approved by the Superintendent.

(ii) Specific Requirements

The liquid waterproofing membrane shall be applied by spraying or using a roller or squeegee to form a continuous and seamless film with uniform thickness and complete area coverage.

The Contractor shall take precautions to prevent the primer, liquid membrane, adhesives, tack coats or any other material from entering or adhering to gratings, kerbs, expansion joints and associated concrete surfaces, and other road fixtures.

Any excess material shall be cleaned and removed immediately after application of the waterproofing membrane, such that the bridge deck is left in a satisfactory condition for asphalt placement.

A debonding wax tape shall be applied to deck joints prior to the waterproofing application, unless stated otherwise in the manufacturer’s technical data sheet.

The waterproofing membrane shall be applied within the temperature range specified by the manufacturer for installation of the waterproofing membrane system, and during the placement of asphalt.

The waterproofing membrane shall be protected from mechanical damage during installation by using polystyrene boards or similar approved methods as recommended by the material manufacturer.

All materials shall be mixed according to the material manufacturer’s instructions. The components shall be mixed in the specified proportions. The specified reaction period shall be allowed from the time the components are mixed until the application begins. No material shall be thinned unless specified by the material manufacturer.

No material shall be applied after its pot life has expired.

Where quantities of material are being applied by spraying successive batches of premixed multi-part material, the equipment shall be flushed and purged with clean solvent after 2/3 of the pot life of the material has expired from either the mixing of the
first batch or since the last purge and cleaning of the equipment. Material ingredients shall be kept properly mixed in the spray pots or container during the application of the material whether by continuous mechanical agitation or intermittent manual agitation as required.

All waterproofing operations shall be performed in a neat and workmanlike manner by personnel with experience in the use of waterproofing membrane systems and application methods.

Each applied layer shall have the required colour, gloss and opacity.

Each applied layer shall have the specified dry film thickness. This film thickness shall be applied to all edges and corners. Applied layers which, in the opinion of the Superintendent, show excessive film builds shall be removed.

Each applied layer shall be smooth, uniform and free from sags, runs, mud cracking, wrinkling, fat edges, blisters, pinholes, holidays, dry spray, entrapped foreign bodies and heavy brush marks.

(c) Preformed Waterproofing Membrane Application

(i) General

Placement of preformed sheets shall commence at the lowest section and proceed to higher sections, so that water does not flow into any joints during service.

All necessary precautions shall be taken during asphalt placement to avoid softening, indentation and damage of the waterproofing membrane.

The Contractor shall ensure compliance with the manufacturer’s recommendations for heating method, duration of heating and temperature of oxidised bitumen adhesives, to prevent embrittlement, and long-term degradation and debonding from the concrete substrate.

Preformed sheets shall be joined by lapping, with minimum end and side lap lengths of 100 mm and 150 mm respectively, unless specified otherwise by the manufacturer. Joints shall be arranged such that:

(1) at any point on the joint, there is a maximum overlap of three sheet layers;
(2) water will drain away from the exposed edge.

(ii) Pour-and-Roll Type

Pour-and-roll type membranes shall be bonded to the primed deck using a layer of heated oxidized or modified bitumen.

Bitumen shall be heated and poured in a uniform manner in front of the sheet during unrolling, with the sheet pressed into the molten bitumen to assist with the bonding. Excess bitumen exuded by this process shall be used to seal the lap joints.

(iii) Torch-Applied Type

Torch applied membranes shall be supplied with a layer of bonding agent such as modified bitumen or similar.

As the membrane is rolled out onto the deck, the bonding layer shall be heated on the underside, preferably with a butane gas torch. Overheating of the bonding layer shall be avoided.

(iv) Self-Adhesive Type

Self-adhesive membranes shall be rolled out and manual pressure applied immediately to ensure satisfactory adherence to the concrete deck.

(d) Coverage
Coverage of the waterproofing membrane must be continuous over the entire deck area, including service bays, between parapets, medians and kerbs.

The layout of the waterproofing membrane shall be detailed such that water seepage beneath the membrane is prevented, particularly at the area around the deck joints, kerbs and scuppers.

At the junction with vertical concrete surfaces, the membrane shall continue up the vertical concrete surface, terminating at a level 10 mm below the top level of the proposed asphalt surface.

Where specified or shown on the drawings the waterproofing membrane system shall extend a minimum distance beyond the extremities of the concrete deck in the longitudinal direction.

The waterproofing membrane shall be applied with minimum side and end overlaps of 100 mm and 150 mm respectively.

(e) Specific Detailing

Waterproofing details at expansion joints, kerbs and pit lids and other specific deck points shall be as specified in the drawings and specification.

(f) Provision of Telltale Indicator

A telltale indicator in the form of a different colour coating layer, or a thickness of coloured asphalt or other suitable indicator shall be provided as part of the application of the waterproofing membrane to indicate to milling machine operators during subsequent removal of asphalt from the concrete deck that the waterproofing membrane is being approached such that precautions are put in place to avoid damaging the waterproofing membrane.

### 691.10 PROTECTION OF WATERPROOFING MEMBRANE DURING THE WORKS

Suitable temporary protection of the membrane shall be provided to the satisfaction of the Superintendent.

Only plant and equipment which are fitted with rubber tyres shall be allowed to stand or travel on the waterproofing membrane, and only for the purpose of installing subsequent layers. Regular inspection shall be undertaken to remove any embedded stones in tyre threads of plant or equipment.

Rollers shall not be allowed to stand or travel directly on the waterproofing membrane.

A protective system shall be used to prevent damage of the waterproofing membrane associated with the high temperature during asphalt rolling.

### 691.11 POST INSTALLATION OF MEMBRANE

The protective layer or asphalt shall be firmly bonded to the waterproofing membrane.

Where a tack coat for the asphalt is not provided as part of the waterproofing system, a satisfactory bond to the waterproofing membrane shall be achieved from the binder within the asphalt.

Where a tack coat for the asphalt is provided, the manufacturer’s recommended time required for the tack coat to cure shall be satisfied.

The asphalt shall be placed as soon as the tack coat is fully cured and without delay, to avoid over-curing or contamination of the tack coat.
691.12 SPRAY EQUIPMENT
The spray equipment shall be suitable for the work intended. Multi-component airless spray equipment shall be used to apply membranes formulated from mixing two constituents, where applicable, to ensure correct mix proportions. It shall be capable of properly atomising the membrane material to be applied and shall be equipped with accurate pressure regulators and gauges. The spray gun, nozzles and needles shall conform to the waterproofing membrane material manufacturer’s recommendations for the membrane to be applied. The spray equipment shall be kept in such condition to permit efficient and effective liquid applied membrane material application. An efficient air line filter shall be fitted as close as possible to the pressure pot to eliminate line condensate and oil in the air supply to the spray gun. The air of the spray gun impinging against the surface shall show no condensed water or oils.

691.13 DRYING AND CURING
The Contractor shall adhere to the manufacturer’s instructions regarding drying and curing requirements, and overcoating time intervals, for the prevailing weather conditions.

691.14 ENVIRONMENTAL CONDITIONS
Waterproofing systems shall not be applied under any of the following conditions:
(a) windy conditions where over spray and/or spatter may be generated
(b) when wind-borne debris is likely to contaminate the uncured surface of the freshly applied membrane
(c) when the ambient temperature exceeds 35°C or is below 10°C unless otherwise expressed in writing by the manufacturer
(d) when the relative humidity exceed 85% or where it may be expected to exceed 85% during the subsequent 12 hour curing period
(e) when rain spatter or run-off, including leakage through deck joints, contaminating the surface and adversely affecting the adhesion to the substrate, may occur
(f) when the substrate surface is wet or damp, unless the waterproofing system is specifically required to be applied on a damp concrete surface in accordance with the requirements of Clause 691.05
(g) the surface temperature of the substrate is less than 3°C above the dew point calculated in accordance with AS/NZS 2312 (Fig. 8.1) or exceeds 40°C.

The environmental conditions shall be measured, recorded and assessed against the requirements above once every four hours of each shift. A calibrated commercially available hygrometer (psychrometer) or electronic climatic measuring gauge shall be used to determine the parameters which require readings (i.e. items (a), (c), (d), (f) and (g)).

691.15 WATERPROOFING MEMBRANE MATERIAL, HANDLING AND STORAGE
Materials shall remain in their original, preformed rolls or sealed containers until the time of use and shall be stored in dry conditions in strict accordance with the manufacturer’s recommendations. Storage facilities shall provide protection from the elements and be safe and secure. Relevant warning signs shall be displayed. Preformed rolls shall be stored on end and shall not be stored lying down.

All material shall be brought to site in the original preformed rolls or unopened cans clearly labelled with the manufacturer’s name, product type, reference and batch numbers.
The Contractor shall provide a certificate from the manufacturer for each batch of waterproofing membrane and primer material confirming:

(a) manufacturer’s name and address
(b) product reference
(c) batch number of identification
(d) quantity manufactured in the batch
(e) date of manufacture.

The Contractor shall maintain records showing which elements were treated with each waterproofing membrane batch. These records shall be handed over to the Superintendent before the Date of Practical Completion.

Materials stored beyond the manufacturers recommended shelf-life shall not be used.

All waterproofing membrane materials to be used on the works shall be free from contamination, gelling, drying out, heavy skin formation and severe segregation of ingredients.

### 691.16 TRIAL APPLICATION

A trial application of the waterproofing membrane system shall be conducted on a test area of the actual substrate of not less than 10 m$^2$, fourteen (14) days prior to the commencement of waterproofing work. The test area or test panel shall be prepared and membrane applied by the Contractor to satisfy the requirements of Clauses 691.08, 691.09, 691.14, 691.17, and 691.18, and in accordance with the material manufacturer’s recommendations.

HP The Contractor shall not proceed with the full scale waterproofing works until the trial waterproofing membrane application has been carried out and the outcomes reviewed and approved by the Superintendent.

Actual coverage rates of liquid applied waterproofing system shall be recorded, in order that due allowance may be made in the full scale application for rough, irregular or highly absorbent concrete substrate. Additional requirements or observations shall be recorded and considered for the full scale application.

If the waterproofing membrane system trial application is deemed by the Superintendent not to comply with the requirements of this section a further waterproofing application shall be made until the performance criteria of this specification are met.

In the event that the trial application is rejected, the Contractor shall remove and dispose of any work deemed as unacceptable by the Superintendent, submit a new proposal to rectify the deficiencies (including prequalification testing of any new materials/methods) and repeat the trial application as described above. Any delays caused through rejection shall not constitute justification for extension of time.

### 691.17 TESTING BEFORE AND AFTER APPLICATION OF WATERPROOFING MEMBRANE

The Contractor shall carry out testing in at least one 1 m$^2$ test area in accordance with this clause.

(a) Testing before Application

All concrete surfaces prepared for waterproofing shall be sampled and tested in accordance with the requirements of this section. Each sample of prepared concrete surface shall be tested as required for surface moisture condition, moisture content of concrete and environmental conditions as specified in this section.

At least one test per sample shall be carried out immediately prior to the commencement of each day’s waterproofing membrane application to ensure that:
(i) surface moisture conditions of concrete satisfy the manufacturer’s recommendations;
(ii) moisture content of concrete and other substrates is free of water back pressure to
satisfy the manufacturer’s recommendations, in accordance with ASTM D4263-83:2012;
(iii) the environmental conditions, as specified in Clause 691.14, are satisfied.

(b) Testing after Application

(i) General

All applied waterproofing membrane system shall be sampled and tested with calibrated
equipment in accordance with the requirements of this section. Each sample of applied
waterproofing membrane system shall be tested as required for bond strength, WFT and
DFT, as specified in this section.

At least three measurements per sample of each of the specified tests shall be carried
out after the application of materials to demonstrate compliance with this section.

(ii) Liquid Applied Waterproofing Membrane

(1) The bond strength to the substrate shall be tested using aluminium dollies with a
minimum diameter of 50 mm in accordance with AS 1580.408.5. The bond strength
shall be greater than 0.75 MPa, seven (7) days after the application and curing
process.

(2) The WFT of the waterproofing membrane measured in accordance with ASTM D4414
shall be as specified by the material manufacturer.

(3) The DFT measured in accordance with AS 1580.108.2 using a paint inspection
 gauge, shall not be less than 2 mm as specified in Clause 691.05.

The DFT of waterproofing membrane may be measured using the waterproofing
membrane remnants attached to the aluminium dollies from the adhesion testing
provided the waterproofing membrane material remains intact and the correct
frequency of testing is satisfied in accordance with the requirements of
Clause 691.17(c).

(4) Measurements of dry film thickness shall satisfy the following conditions:
   • no more than 15% of measurements of dry film thickness shall be more than
     10% under the specified thickness
   • no more than 15% of the dry film thickness measurements taken in the 1 m² test
     area shall be less than the specified minimum.

(5) A visual inspection and electronic pinhole and holiday survey shall be undertaken to
determine the integrity of the entire area of the waterproofing membrane system.

(iii) Preformed Waterproofing Membrane

The bond strength to the substrate shall be tested using aluminium dollies with a
minimum diameter of 50 mm in accordance with AS 1580.408.5. A circular hole cutter
of diameter slightly larger than the diameter of the aluminium dolly shall be used, to cut
through the preformed waterproofing membrane to the substrate around the dolly. The
bond strength shall be greater than 0.75 MPa, seven (7) days after the application and
curing process.

(c) Location and Frequency of Sampling and Testing after Application of Waterproofing Membrane

System

Sampling and testing in accordance with Clause 691.17(b) shall be undertaken in at least one
1 m² test area for every 50 m² on completion of the application of the waterproofing
membrane system.
691.18 INSPECTION AND TESTING

The Contractor shall undertake all inspection and testing as specified in this clause and Clause 691.17. The Contractor shall maintain all required quality documentation including inspection reports, records of environmental conditions and test results as specified in this section and Section 160 for all stages of the work.

The work shall be inspected for defects by the Contractor at each stage of the waterproofing membrane operation as a minimum, i.e. after surface preparations, prior to each layer and after final layer application and any touch-up layers that may be required. The surface to be membrane applied shall be clean and free of defects. When applied the liquid applied membrane shall be free of lumps, bubbles, inclusions, ripples, sags, runs, air holes and other film faults.

For the purpose of surveillance and audits as specified in Clause 160.A10, the Contractor shall give the Superintendent five (5) days written notice of its intention to apply membrane to the concrete and shall provide adequate access to enable surveillance of the Works by the Superintendent.

691.19 APPROPRIATE TIMINGS FOR APPLICATION OF WATERPROOFING MEMBRANES

(a) Age of Concrete

Waterproofing membrane systems shall be applied no earlier than twenty-eight (28) days after concrete has been placed to ensure that no outgassing and subsequent pinholes or bubbles occur in the membrane.

(b) Repaired Concrete

Where concrete repairs have been completed with proprietary cementitious materials, the application of waterproofing membranes shall be carried out no earlier than fourteen (14) days after completion of repair.

Where normal concrete is used for repair, waterproofing membranes shall be applied no earlier than twenty-eight (28) days after the completion of repair.

Waterproofing membrane application may be undertaken earlier if it can be established using a commercially available calibrated moisture meter, that the concrete moisture content is less than 7%, but no earlier than 50% of the time periods stated in (a) and (b) above, and provided the concrete surface is dry at the time of application.

691.20 WATERPROOFING MEMBRANE REPAIRS

Should any of the waterproofing application work not comply with the provisions of this specification then the areas concerned shall be repaired to the satisfaction of the Superintendent. Such repair work may include removal of the waterproofing membrane, followed by surface preparation and application of a new waterproofing membrane. The procedure for any repair work shall be reviewed by the Superintendent. For the purpose of this clause, non-complying work shall include waterproofing membrane due to loss of adhesion during the contract liability period.

All areas of waterproofing damaged by the Contractor during its operation shall be made good to the satisfaction of the Superintendent.

Where required, preformed sheets shall be repaired by cutting back the affected area using a sharp knife, or similar tool, until undamaged and well-bonded membrane is exposed. Unless specified otherwise by the manufacturer, liquid bitumen shall be used to seal the exposed edges of the preformed sheets.

The area under repair shall be abraded and the primer applied by brush or spray. The primer shall be allowed to cure for the minimum recommended time. The membrane shall be applied at the minimum specified thickness, ensuring a peripheral lap of 100 mm around the repair. The repair
shall be allowed to set and cure, prior to tack coat application.

691.21 SEALING OF CRACKS

Inactive cracks of width equal to or greater than 0.20 mm shall be sealed by resin injection in accordance with Section 687. Active cracks equal to or greater than 0.20 mm shall be treated by methods approved by the Superintendent and in accordance with Section 687.

691.22 REPAIR OF DAMAGED OR HONEYCOMBED CONCRETE

Any reinstatement or repair of damaged or honeycombed concrete shall be undertaken in accordance with the requirements of Section 689 and shall provide a smooth and level surface prior to the installation of the waterproofing membrane.

691.23 CONTRACTOR COMPETENCY

The waterproofing membrane application supervisor and sub-contractors undertaking this work shall have a minimum of 5 years experience and a demonstrated competency for surface preparation and application of waterproofing membrane systems. All application personnel undertaking this work shall also have a minimum of 2 years experience.

The waterproofing membrane application supervisor shall be trained and qualified in all aspects of application techniques and shall be present at all times during waterproofing work.

Application personnel shall be trained and skilled in the application procedures of the waterproofing membrane system to be applied.

Documented evidence shall be available to demonstrate experience, qualification, skills and training of all personnel and sub-contractors.

691.24 REMOVAL AND REINSTATEMENT OF THE ASPHALT PAVEMENT ON CONCRETE BRIDGE DECKS

(a) Removal of Asphalt

The Contractor shall ensure the removal of the existing asphalt does not damage the concrete deck or create grooves within the concrete. The asphalt shall be removed such that the concrete surface remains relatively smooth and level in order to ensure optimum performance of the waterproofing membrane.

Prior to undertaking installation works for the waterproofing of concrete bridge decks, the Contractor shall undertake an investigation to determine both the depth of concrete cover to the steel reinforcement and the thickness of the existing asphalt, as affected by any variability that may exist in shape and profile of the concrete deck. These measurements shall be allowed in the installation of the waterproofing membrane system. Such measurements shall be undertaken at 3 metre intervals and within a 3 metre grid over the whole area where cold milling (cold planing) of asphalt will be undertaken.

The depth of concrete cover to the steel reinforcement shall be determined by using a commercially available concrete cover meter. The cover meter shall be supported with a current calibration certificate and shall be capable of detecting the presence of reinforcement and indicating the depth from the concrete surface to the nearest point on the surface of the reinforcement with an accuracy of ±1 mm at a depth of 25 mm. The thickness of asphalt shall be determined by taking 25 diameter cores through to the top surface of the concrete deck.

An asphalt milling procedure and ITP shall be submitted a minimum of 7 days prior to the commencement of cold milling of asphalt over the concrete bridge deck, allowing for the planned base of cut to the top surface of the concrete deck. The milling procedure shall include details
on the type, mass and number of milling machine(s) and other equipment to be used and the proposed measures to control dynamic effects and proposed measures to avoid cutting damage to the concrete surface and steel reinforcement.

Nil tolerance shall apply on the depth of milling cut to the surface of the concrete deck. No grooving of the concrete surface shall be allowed.

A milling machine with fine milling drum shall be used on concrete bridge decks.

During the cold milling operation all necessary precautions shall be taken to prevent the cutting teeth from contacting the concrete surface or existing waterproofing membrane. The actual depth of cut shall be measured on both sides of the cold milling machine at intervals not exceeding 3 metres.

All milling work shall be subject to continuous observation for variability or change in cut surface appearance and all observations documented.

In the event that the cutting teeth contact the concrete surface the progress of the cold milling machine shall cease immediately, any machine fault repaired and the machine settings and controls readjusted.

Milling operators shall have adequate training and experience in the operation of the cold milling machine and automatic sensing equipment. Relevant experience and training records of each operator shall be submitted to the Superintendent for review prior to the commencement of work on site.

During milling operations the Contractor shall provide three suitably trained and skilled milling machine operators at the cold milling machine at all times, one on the driving platform and one on each side of the machine generally in the vicinity of the sensor/cutting mandrel.

At the completion of cold milling, all loose milled material shall be removed and the concrete surface prepared in accordance with the requirements of this section.

(b) Reinstatement of Asphalt

The asphalt layers shall be placed and compacted to the original road level and profile over the bridge deck in accordance with Section 407 to provide a smooth transition between the bridge approaches/bridge departures, over expansion joints and the bridge deck pavement.

Care shall be taken during the placement and compaction of the asphalt layer to ensure that the asphalt machinery does not damage the waterproofing membrane system.

691.25 WORK METHOD STATEMENT AND INSPECTION AND TEST PLANS

The Contractor shall submit a detailed work method statement (WMS) and inspection and test plans (ITPs) for the specific waterproofing works and associated works. The WMS and ITPs shall reference all specification clauses and identify all performance requirements and hold points. Generic or incomplete WMSs and ITPs shall not be allowed.

The Contractor shall provide documented evidence of conducting tool box meetings of all waterproofing membrane system application personnel on all aspects of the WMS, the ITPs and specification requirements, including sampling and testing, immediately prior to the commencement of installation of the waterproofing membrane system.

*HP The Contractor shall not proceed with the trial system application or the permanent waterproofing membrane system installation works until the WMS and ITPs have been reviewed and approved by the Superintendent.*
691.26 PROTECTION OF WORKS AND PROPERTY AND CLEAN UP

(a) Protection of Works/Property

The Contractor shall protect already membrane applied or galvanized surfaces, services, joints, and signs during abrasive blasting operations or any other surface preparation process and during the membrane application processes.

The Contractor shall remove from the site all spent abrasive and all other rubbish accumulated during the work. The Contractor shall dispose of such wastes to the satisfaction of the Superintendent and by a means which conforms to this clause.

The Contractor shall ensure that the waterproofing works are protected from adverse conditions, dust and debris during the curing period of the waterproofing membrane system in accordance with the requirements of Clause 691.14.

HP No spray application of liquid applied membrane shall be carried out within ten (10) metres of buildings, footpaths, roadways, pedestrians or vehicles without protective measures or methods being used which shall be submitted to the Superintendent for approval, a minimum of two working days in advance of the proposed works.

(b) Environmental and Occupational Health and Safety Requirements

The Contractor shall remove all residues, droppings and smudges from all surfaces, including surfaces not being treated. The Contractor shall remove from the site all spent abrasive and all other rubbish accumulated during the work on a daily basis.

The Contractor shall dispose of such wastes and shall adhere to EPA and other local, state and federal government requirements with respect to how waste generated during surface preparation, waterproofing membrane system application, and clean-up will be collected, segregated, handled, controlled and disposed of.

All relevant requirements of the Occupational Health and Safety Act 2004 and Occupational Health and Safety Regulations 2017 shall be satisfied with respect to all formwork.

(c) Disposal of Waste Materials

Waste materials including liquid wastes shall be deposited in suitable containers and disposed of at sites to be located by the Contractor that are acceptable to the EPA and other relevant authorities.

Liquid or other waste material shall not contaminate creeks, waterways or storm water drainage systems.