

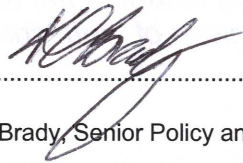
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Level 3

Waterproofing Systems for Underline Bridge decks

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Issue record

Issue	Date	Comments
3	February 2008	Substantial revision, but no fundamental change in the engineering requirements. Changes in format and reference number (from RT/CE/S/041); rationalisation and reordering of text; updating references and test requirements to reflect changes in practice.
2	June 2001	Minor revisions
1A	April 1998	Minor revisions
1	December 1997	New Specification

Compliance

This Network Rail standard is mandatory and shall be complied with by Network Rail and its Contractors from 6th June 2009.

Reference documentation

The following references were extant at the time of the issue of this standard; more recent equivalent issues/versions of them should be used as they become available.

Network Rail standards

[NR/GN/CIV/001](#): Waterproofing Underline Bridge decks.

[NR/L3/CIV/140](#): Model Clauses for Civil Engineering works.

[NR/SP/TRK/006](#): Track ballast and Stoneblower aggregate.

[RT/CE/S/041](#): Waterproofing Systems for Underline Bridge decks.

British Standards, BSI, London

BS 903-A26 (1995), ISO 48 (1994). Physical testing of rubber. Method for determination of hardness (hardness between 10 IRHD and 100 IRHD).

BS 2869 (2006). Fuel oils for agricultural, domestic and industrial engines and boilers – Specification.

BS EN 197-1 (2000). Cement. Composition, specifications and conformity criteria for common cements.

BS EN 1766 (2000). Products and systems for the protection and repair of concrete structures. Test methods. Reference concretes for testing.

BS EN 1848-1 (2000). Flexible sheets for waterproofing. Determination of length, width and straightness. Bitumen sheets for roof waterproofing.

BS EN 1848-2 (2001). Flexible sheets for waterproofing. Determination of length, width and straightness. Plastic and rubber sheets for roof waterproofing.

BS EN 1849-1 (2000). Flexible sheets for waterproofing. Determination of thickness and mass per unit area. Bitumen sheets for roof waterproofing.

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BS EN 1849-2 (2001). Flexible sheets for waterproofing. Determination of thickness and mass per unit area. Plastic and rubber sheets for roof waterproofing.

BS EN 12620 (2002). Aggregates for concrete.

BS EN 13375 (2004). Flexible sheets for waterproofing. Waterproofing of concrete bridge decks and other concrete surfaces trafficable by vehicles. Specimen preparation.

BS EN 13596 (2004). Flexible sheets for waterproofing. Waterproofing of concrete bridge decks and other concrete surfaces trafficable by vehicles. Determination of bond strength.

BS EN 14223 (2005). Flexible sheets for waterproofing. Waterproofing of concrete bridge decks and other concrete surfaces trafficable by vehicles. Determination of water absorption.

BS EN 28510-2 (1993). ISO 8510-2 (1990). Adhesives. Peel test for a flexible-bonded-to-rigid test specimen assembly. 180° peel.

BS EN ISO 1421 (1998). Rubber-or plastics-coated fabrics. Determination of tensile strength and elongation at break.

BS EN ISO 4624, BS 3900-E10 (2003). Paints and varnishes. Pull-off test for adhesion.

BS EN ISO 8501-1 (2007). Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.

BS EN ISO 9001 (2000). Quality management systems. Requirements.

BS EN ISO 11339 (2005). Adhesives. T-peel test for flexible-to-flexible bonded assemblies.

BS EN ISO 12236 (2006). Geosynthetics. Static puncture test (CBR test).

BS ISO 34-1 (2004). Rubber, vulcanized or thermoplastic. Determination of tear strength. Trouser, angle and crescent test pieces.

BS ISO 37 (2005). Rubber, vulcanized or thermoplastic. Determination of tensile stress-strain properties.

BS ISO 1431-1 (2004). Rubber, vulcanized or thermoplastic. Resistance to ozone cracking. Static and dynamic strain testing.

BS ISO 1817 (2005). Rubber, vulcanized. Determination of the effect of liquids.

Highways Agency publications: Stationary Office

Design Manual for Roads and Bridges. Volume 2, Section 3, Part 4: BD 47/99 Waterproofing and surfacing of concrete bridge decks.

Manual of Contract Documents for Highways Works MCHW (1998) (as amended). Volume 1 - Specification for Highway Works. Series 1700 Structural Concrete.

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Other publications

Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 (CHIP3).

Construction Products Directive (89/106/EEC) (1998). Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products.

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Comments

The applicability and content of this standard will be reviewed on a regular basis. Written comments on the accuracy and utility will be taken into account when assessing the need for a new issue of the standard; such comments should be sent to the Principal Policy and Standards Engineer (Civil Engineering) at 40 Melton Street, London NW1 2EE.

Reference Note

Guidance Note [NR/GN/CIV/001](#): *Waterproofing Underline Bridge decks* supplements this document: references to parts of that document are given as [1.1](#) (for example) whilst references to other parts of this document are given as **1.1** (for example).

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1 Purpose

The purpose of this standard is to define;

- the test methods, performance criteria, certification and registration requirements for Waterproofing Systems,
- the requirements to be considered when selecting a Waterproofing System,
- the detailing of a Waterproofing System,
- the requirements for applying a Waterproofing System.

The requirements of this standard are embodied in the 110-114 Sections of Model Clauses as given in [NR/L3/CIV/140](#): *Model Clauses for Civil Engineering works*.

Further information and guidance on Waterproofing Systems is provided in [NR/GN/CIV/001](#): *Waterproofing Underline Bridge decks*.

2 Scope

This standard applies to Waterproofing Systems for use on ballasted Underline Bridge decks.

It is not applicable to;

- other parts of Underline Bridges, such as below ground surfaces and abutments,
- Underline Bridges constructed by a tunnelling technique where the external faces are inaccessible for the application of waterproofing,
- overline bridges,
- the repair of existing Waterproofing Systems¹.

3 Roles and responsibilities

3.1 Designer

The Designer shall:

- 1 Prior to the design stage, confirm that the proposed Waterproofing System is registered in PADS.
- 2 Design and draw-up the detailing of the Waterproofing System.
- 3 Where possible, incorporate proprietary preformed components into the design so that the waterproofing is continuous and sealed.

¹ This requires specialist advice and consultation with Network Rail.

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3.2 Installer

The Installer shall install the Waterproofing System in accordance with the Application Guidelines, and as detailed in the site specific approved drawings and Work Package Plan.

The operatives shall be trained and competent in the installation of the System.

The Installer shall pass to the Employer's Representative records of the environmental conditions that prevailed during the application of the Waterproofing System and the results of post-completion quality control tests.

3.3 SERCO Raildata

On receipt of a Certificate of Conformity and a PADS Form for a Waterproofing System (or a component of one) SERCO Raildata shall send copies of these to Network Rail². Following approval by Network Rail, SERCO Raildata shall register the System (or component) in PADS.

SERCO Raildata shall provide Network Rail² with relevant information regarding the extension, suspension, withdrawal or updating of the registration of an approved Waterproofing System (or the components of one).

3.4 Manufacturer

The Manufacturer is responsible for the costs of;

- testing and assessment of the Waterproofing System,
- registration of the System in PADS,
- five-yearly review of the System (see Appendix C.2.3).

The Manufacturer shall provide information and prepare and supply samples of the various components of the System in accordance with Appendix A.

3.5 Principal Contractor

The Principal Contractor shall confirm that the proposed Waterproofing System is registered in PADS and obtain a copy of the Application Guidelines for the System.

The Principal Contractor is responsible for the detailing of the Waterproofing System and for the production of the Work Package Plan.

Following the installation of the Waterproofing System, the Principal Contractor shall pass to the Employer's Representative the Waterproofing Record Form (see Appendix E) and any other information required to enable the Employer's Representative to sign-off the installation of the System.

² To the Principal Policy and Standards Engineer (Civil Engineering).

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3.6 Principal Independent Test House (PITH)

The PITH is responsible for testing of the Waterproofing System in accordance with Appendix B.

Before issuing a Certificate of Conformity and PADS Form, the PITH shall confirm that the Waterproofing System is compliant with the requirements of this standard and that the performance criteria specified in Appendix B have been met.

Where tests have been undertaken by an Independent Test House (ITH), the PITH shall check that the ITH is competent and/or accredited for undertaking such tests.

Following the approval and registration of the Waterproofing System, the PITH shall carry out a five-yearly review of the System when requested by the Manufacturer. The review shall be completed in accordance with Appendix C.

3.7 Employer's Representative

Prior to any waterproofing works commencing on site, the Employer's Representative shall review and approve the detailing for the Waterproofing System and the Work Package Plan for installing the System. The Representative shall confirm that, where possible, the design incorporates appropriate proprietary components.

Following the installation of a System, the Employer's Representative shall check the detailing against the approved drawings and where compliant sign off the work³ as completed.

4 Definitions

Application Guidelines

Manufacturer's document(s) that define for a particular Waterproofing System;

- the application process, including any limiting environmental conditions,
- the requirements for preparing the substrate.

Backing

For the purpose of this standard, this is a layer of synthetic textile that is affixed to the bottom layer of a waterproofing membrane.

Certificate of Conformity

A document, issued by the PITH, that lists the tests carried out for the assessment of the Waterproofing System, the results of such tests, and instructions and guidance on the installation of the System.

³ In conjunction with the Principal Contractor.

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Fuel and Lubricating Oil

Diesel, and hydraulic oils used for lubrication.

Independent Test House (ITH)

An organisation that has expert knowledge and testing capability for the Waterproofing System, and which is independent of the manufacturing industry and is accredited by the United Kingdom Accreditation Service (UKAS), or equivalent European body, for the tests it undertakes.

Integral Protective Layer (IPL)

A layer (formed from sheets or boards) that is an essential part of a Waterproofing System, and which is laid over the top of the membrane to protect it from damage immediately following its installation and from ballast penetration in service.

Loose-Laid System

A Waterproofing System comprising a preformed impermeable sheet or liquid-applied membrane applied to a synthetic textile which is not bonded or only partially bonded to the substrate; that is, one that does not satisfy the requirements also for minimum tensile adhesion as defined in Appendix B.

Manufacturer

The term Manufacturer is used as shorthand to cover the manufacturer of the waterproofing membrane, the manufacturer's representative, and the promoter/installer/contractor for a particular system. The Manufacturer is the organisation responsible for submission of the System for registration and for initiating the five-year review.

Minimum Thickness

The minimum dry film thickness of the membrane of a liquid-applied Waterproofing System declared by the Manufacturer as that required for the System to perform satisfactorily.

Nominal Thickness

The mean thickness of the membrane of a liquid-applied Waterproofing System.

Non-Integral Protective Layer (NIPL)

A layer that is not an essential part of a Waterproofing System but which can be;

- placed over the membrane to protect it from damage immediately following its installation and/or from ballast penetration in service (for example, for a System that does not have an IPL),
- laid over an IPL (to provide additional protection) when the depth of the ballast is less than the thickness of the layer of ballast used in the resistance to indentation by ballast test (as specified in the Application Guidelines),
- placed beneath the membrane of a Loose-Laid System to protect it from puncture and/or damage due to the presence of contaminants or bitumen on the substrate.

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PADS Form

The document issued by the PITH that lists the essential details of a Waterproofing System (such as limitations on its applicability).

Parts And Drawings System (PADS)

A database of approved products that is maintained and controlled by SERCO Raildata.

Principal Independent Test House (PITH)

The organisation appointed by the Manufacturer of the Waterproofing System to supervise the test programme and undertake most of the tests on the System. The PITH shall have expert knowledge and testing capability for the Waterproofing System, be independent of the manufacturing industry, and be accredited by the United Kingdom Accreditation Service (UKAS), or equivalent European body, for the tests it undertakes.

Reinforced Sheet

An impermeable sheet that has either an internal reinforcing layer (formed from a synthetic textile) or a Backing.

Tightly Bonded System

A Waterproofing System consisting of either (a) a liquid-applied membrane or (b) a preformed sheet membrane that is bonded to the substrate with an adhesive, and which in either case satisfies the requirements for the minimum tensile adhesion as defined in Appendix B.

Underline Bridge

A structure of one or more spans of greater than or equal to 1.8 metres whose main purpose is to carry rail traffic over an obstruction or gap.

Waterproofing System

A material or combination of materials, including a membrane (and where applicable a primer, adhesive, and Integral Protective Layer) that is installed to form an impervious barrier to protect a bridge deck from the damaging effects of water.

5 Waterproofing Systems

5.1 Background

The service life of a bridge can be significantly extended by the application of an effective Waterproofing System: nothing will be gained by the application of an ineffective System.

Waterproofing Systems are defined by type as either Tightly Bonded, or Loose-Laid, and are classified as being 'resistant' or 'not resistant' to Fuel and Lubricating Oils. Tightly-Bonded Systems adhere to the substrate and, therefore, prevent the spread of water under the membrane from edges, imperfections and small punctures. Loose-Laid Systems are not intimately bonded to the substrate and, therefore, cannot prevent the spread of water

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under the membrane from poorly sealed edges, imperfections, small punctures and defective joints.

5.2 General requirements

A Waterproofing System shall be applied to all new Underline Bridges and, when necessary and time is available for its application, to existing Underline Bridges undergoing major refurbishment or alteration.

Only Waterproofing Systems registered in PADS (and which are, therefore, compliant with this standard) shall be used to waterproof Underline Bridge decks.

5.3 Registration

Waterproofing Systems shall be tested, certified and registered in accordance with the procedure shown in Figure 1. Certification requirements are defined in Appendix A; test methods and performance criteria are defined in Appendix B; and information on the registration and review of a registration is given in Appendix C.

Network Rail reserves the right to (a) amend or supplement the test programme, and (b) suspend or withdraw the certification of a previously accepted System.

The costs of testing, certification, registration and review shall be borne by the Manufacturer. The testing of the components shall be carried out as detailed in Appendix B and the relevant pass/fail criteria applied. The Manufacturer shall be informed at the earliest stage of the failure of a component to meet a performance criterion and be given the option to withdraw from the certification procedure.

Some of the tests and requirements specified in Appendix B are identical to those specified in Issue 2 of NR/SP/CIV/041 [which this standard replaced] and also in BD47, which would be used when assessing the components of a Waterproofing System for a Roads and Bridges Agrément Certificate [issued by the British Board of Agrément]. When proof is provided that the formulation and dimensions (such as membrane thickness) of the components tested in accordance with NR/SP/CIV/041 Issue 2 or BD 47 are identical to those submitted for registration in accordance with this standard, the results of these previous tests may be used to demonstrate compliance: there is no need for repeat testing.

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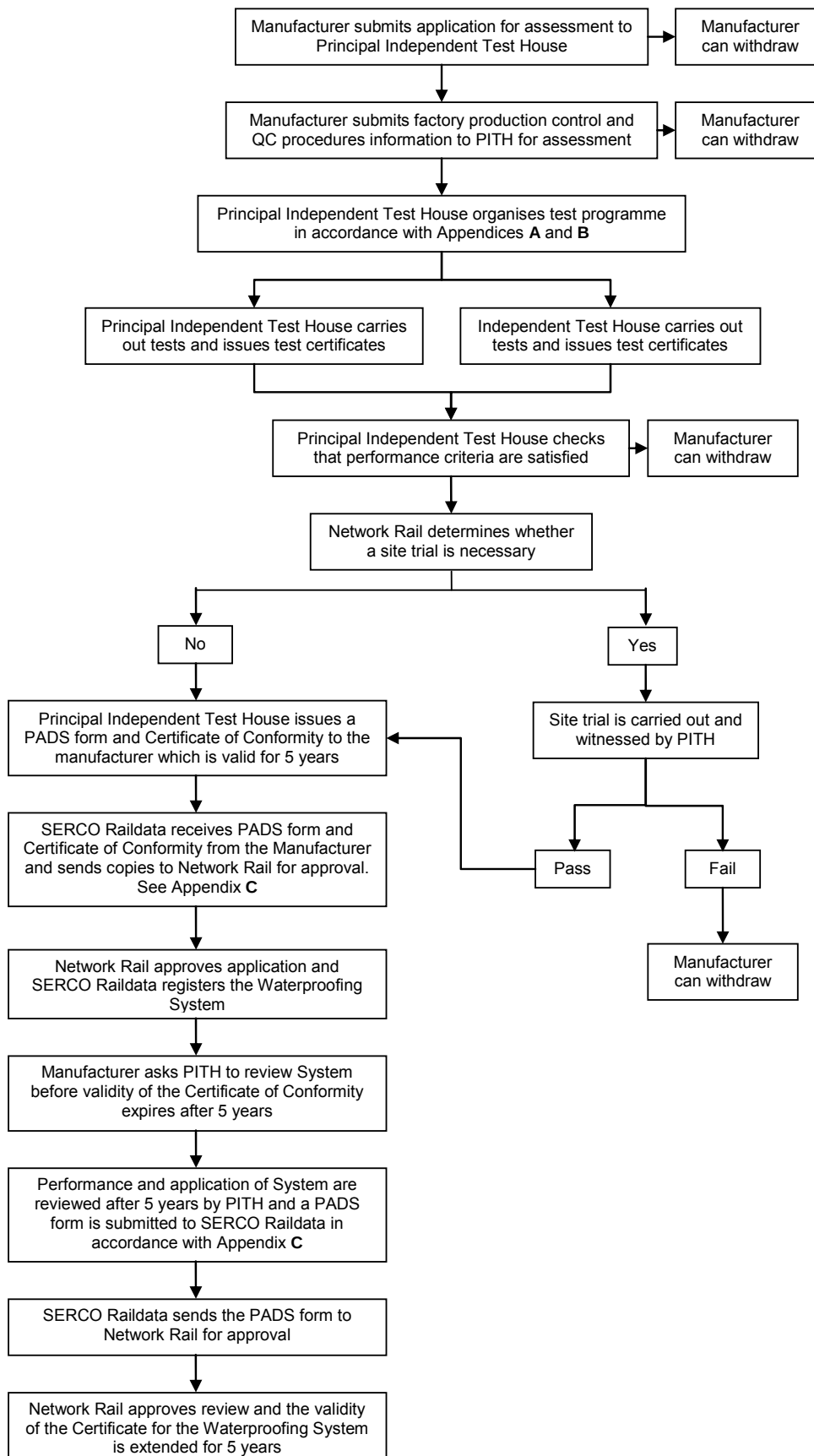


Figure 1: Procedure for registering a Waterproofing System in PADS

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A Waterproofing System proven to satisfy the performance criteria specified in Appendix B shall be issued with a PADS Form and Certificate of Conformity by the Principal Independent Test House (PITH). Following approval by Network Rail, the System shall be registered in PADS by SERCO Raildata.

Queries on the acceptance of a deviation from the performance criteria shall be referred by the PITH to Network Rail⁴ with, where necessary, relevant test data and a case for acceptance.

6 Selection of a Waterproofing System

For a particular bridge deck, the type of Waterproofing System shall:

- 1 Be appropriate for the time available for its application.
- 2 Be tolerant of the conditions that will be encountered during its application and in service⁵.

A Tightly Bonded System shall be applied to a new Underline Bridge when there is sufficient time to complete the application in accordance with the Application Guidelines. When full application in situ is not practicable, partial application of a Tightly Bonded System shall be completed off-site or trackside provided that impermeable joints can be formed within the time available on site. However a Tightly Bonded System shall not be applied to a surface that cannot provide sufficient adhesion, such as a concrete deck or masonry arch that has a porous or friable substrate.

Where the substrate is unsuitable or there is insufficient time to install a Tightly Bonded System, a Loose-Laid System shall be applied but sufficient time shall be made available to complete the installation in accordance with the Application Guidelines.

When a Tightly Bonded System is to be applied to a bridge that has a complex surface profile or complex details, a sheet System shall not be used unless impermeable joints can be formed. A Tightly Bonded sheet System shall not be used when the absence of grooves or chases prevents effective sealing at its edges.

When a Loose-Laid System, or the components thereof, is used to form joints at deck ends and/or joints between parts of a bridge overlaid with a Tightly Bonded System, both types of System shall be compliant with this standard.

The following shall be taken into account when estimating the time required for the application of a Waterproofing System:

⁴ Addressed to the Principal Policy and Standards Engineer (Civil Engineering).

⁵ Thus a System that is resistant to Fuel and Lubricating Oils shall be used where the risk of exposure to a significant quantity of such Oils is high; such as at stations, approaches to depots and other locations where diesel engines are likely to idle.

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- 1 The condition and hence the time required for the preparation of the substrate.
- 2 The likely prevailing weather conditions on site (for the whole or parts of a deck).
- 3 The time for applying and curing the various components of the System.

7 Design and detailing

7.1 Project planning

Before a Waterproofing System is designed for use on a particular Bridge deck, the Principal Contractor shall confirm that the System is registered in PADS (and is therefore compliant with this standard).

The Principal Contractor shall provide the Employer's Representative with drawings showing the detailing for the Waterproofing System (see 7.2) and the Work Package Plan.

The Employer's Representative shall review and approve the detailing for the System and the Work Package Plan before waterproofing works commence.

7.2 Detailing

The waterproofing shall be continuous and cover the entire deck between upstands. Where standard details are not otherwise available, those given in Appendix C (of [NR/GN/CIV/001: Waterproofing of Underline Bridges](#)) should be followed.

Particular attention shall be paid to sealing the membrane at its edges, around drainage holes and other details to prevent the passage of water under the membrane in service. Where necessary, pre-formed details recommended by the Manufacturer shall be used to seal the membrane.

Sharp arrises and internal angles shall be avoided in the surface to be waterproofed. Arrises shall be chamfered or rounded, but when it is not possible to remove sharp arrises on an existing structure;

- before a Loose-Laid System is applied, such arrises shall be covered with either a NIPL or an additional layer of membrane,
- when a Tightly Bonded system is applied, the application rate of the membrane shall be varied so that the required thickness of membrane is provided at such arrises.

Fillets shall be formed in internal angles. When necessary, fillets on existing bridges shall be formed using a cementitious or resin-based repair material that is compatible with the Waterproofing System: such repair materials shall be allowed to cure sufficiently prior to the application of the System.

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All movement joints at deck ends shall be able to accommodate the design thermal and traffic induced movements, and shall be detailed to prevent the passage of water beneath the membrane in service. Whether the joints are formed from a Loose-Laid membrane or from proprietary products, measures shall be taken to prevent the joints being damaged by ballast.

7.3 Drainage

Drainage shall be provided to prevent water accumulating on the waterproofing. Water is best removed by the provision of adequate falls to suitable drainage outlets: where practicable, longitudinal gradients should be a minimum of 1 in 100.

Drainage systems at joints and through a bridge deck shall be detailed so that water is not allowed to fall freely from the deck. Where required, drains shall be connected to a closed drainage system. To prevent water reaching the substructure, waterproofing shall be continued down the back of the cill unit/ballast wall at the ends of a bridge and be wrapped around a perforated drainage pipe: the top of the pipe shall be not less than 300 mm below the underside of the cill unit. Standard details are provided in Figures 3 and 4 of Appendix C.

8 Application and workmanship

8.1 General

The preparation of the substrate, the formation of joints and the application of the Waterproofing System shall be in accordance with the Application Guidelines: sufficient competent and certified staff shall be available on site so that this can be achieved.

Access to the Waterproofing System by plant and personnel likely to cause damage to the System shall be prevented during the application and curing of the waterproofing materials and prior to the placement of the IPL and/or NIPL.

During the installation of the Waterproofing System, the Installer shall record the environmental conditions on site (including temperature, humidity, and wind speed) on a daily worksheet; a copy of these records shall be supplied to the Principal Contractor and the Employer's Representative. The Principal Contractor shall complete the Waterproofing Record Form (as given in Appendix E) and the Employer's Representative shall sign it; see 8.6.

8.2 Competency of operatives

Only operatives trained and certified by the Manufacturer as being capable of applying the Waterproofing System in accordance with the Application Guidelines shall install the waterproofing.

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Operatives shall have proof of certification available for inspection on site: the certificate shall include a recent photograph of the operative.

8.3 Surface preparation

8.3.1 Concrete decks

The surface of a new concrete bridge deck to which the Waterproofing System is to be applied shall have a U4 finish in accordance with the 1700 Series Clauses of the *Specification for Highway Works*.

Power float finishing of a concrete surface should not be specified when a Tightly Bonded System is to be applied to a new deck. However, where this arrangement is proposed Network Rail may require additional laboratory tests and a site trial to be undertaken.

8.3.2 Tightly Bonded Systems on a concrete substrate

Where necessary, concrete surfaces shall be repaired using cementitious or resin-based materials that are compatible with the Waterproofing System so that the membrane is fully supported and, for a liquid-applied System, a continuous, impermeable membrane is formed.

All surface oil, grease, bitumen, laitance and other contaminants shall be removed as far as is reasonably practicable so that the Waterproofing System can be uniformly bonded to the substrate. Surface preparation by grit blasting or, where shown to be appropriate, water jetting, shall be sufficient to remove laitance and any weak material on the surface.

Waterproofing shall not be applied unless the concrete of the substrate is sufficiently dry (as defined in the Application Guidelines) that it is capable of providing good adhesion.

8.3.3 Tightly Bonded Systems on a steel substrate

The surface of a steel bridge shall be blast cleaned using a non-metallic grit to Sa2½ for new steel or Sa2 for existing steel to BS EN ISO 8501-1, or as specified in the Application Guidelines. Blast cleaned steel surfaces shall be primed within four hours of being cleaned.

8.3.4 Loose-Laid Systems

Surface preparation shall be sufficient to prevent the Waterproofing System from being punctured by protrusions in the substrate.

Where practicable, voids in the substrate shall be filled with a rapid curing cementitious or resin-based material so that the waterproofing membrane is uniformly supported: the material shall be allowed to cure sufficiently prior to the application of the Waterproofing System. Where

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necessary, sharp protrusions shall be made smooth, using the same or similar repair materials.

When sand is used to fill voids in the substrate, a NIPL shall be placed below the waterproofing membrane (see Appendix A).

Any loose fill over an arch shall be compacted before treating any voids and protrusions.

Where necessary, a compatible NIPL shall be placed below the waterproofing membrane: for example, to prevent contact between bitumen present on the existing substrate and a membrane that is not resistant to bitumen (see Appendix A). The overlaps of a sheet NIPL shall be not less than 100 mm or the value specified in the Application Guidelines.

8.4 Application of liquid-applied membranes

Unless otherwise specified in the Application Guidelines, the application shall not normally proceed until the surface temperature is greater than 4 °C and rising, the surface temperature is 3 °C above the dew point, and the relative humidity is less than 90 %. Outside these limits, water may condense on the surface and affect the bond that can be developed with the substrate.

When a liquid-applied membrane is applied on site, measures shall be taken to prevent contamination of the environment, watercourses, property or members of the public by wind blow materials.

During the application of a liquid-applied membrane, whether in the factory or on site, the film thickness shall be checked at regular intervals by means of a comb gauge, or other method recommended by the Manufacturer, to check that the Minimum Thickness is being achieved. When this Minimum has not been achieved and/or a large number of pinholes is evident, a further coat shall be applied and the application rate shall be increased for the remainder of the area to be coated.

8.5 Application of Loose-Laid membranes

Loose-Laid membranes shall have their edges sealed to prevent water passing beneath them. Membranes shall be seam jointed, either by hot air welding, solvent welding or using a contact adhesive. Hot air welding shall be used when moisture is present at the time of jointing, or when the temperature is below 5 °C.

8.6 Membrane inspection and test records

The Waterproofing System shall be inspected for damage and defects after its application using an appropriate non destructive technique (NDT). Details of the NDT testing shall be included in the Principal Contractor's inspection test