# SPRAY SEALING

DIPL Roadworks Master – June 2021

## STANDARDS, Codes, Guides, Test Methods, and Acts

Conform to the following Standards and Publications unless specified otherwise:

AS 1141(set) Methods for sampling and testing aggregates

AS 1141.14 - Particle shape, by proportional caliper

AS 1141.15 - Flakiness index

AS 1141.18 - Crushed particles in coarse aggregate derived from gravel

AS 1141.20.1 - Average least dimension - Direct measurement (nominal size 10 mm and greater)

AS 1141.20.2 - Average least dimension - Direct measurement (nominal sizes 5 mm and 7 mm)

AS 1141.23 - Los Angeles value

AS 1141.24 - Aggregate soundness - Evaluation by exposure to sodium sulphate solution

AS 1141.25.1 - Degradation factor - Source rock

AS 1141.26 - Secondary minerals content in igneous rocks

AS 1141.29 - Accelerated soundness index by reflux

AS 1141.40 - Polished aggregate friction value - Vertical road wheel machine

AS 1141.41 - Polished aggregate friction value - Horizontal bed machine

AS 1141.50 - Resistance to stripping of cover aggregates from binders

AS 1160 Bitumen emulsions for the construction and maintenance of pavements

AS 1742.3 Manual of uniform traffic control devices - Traffic control for works on roads

AS 1906.3 Retroreflective materials and devices for road traffic control purposes - Raised pavement markers (retroreflective and non-retroreflective)

AS 2008 Bitumen for pavements

AS 2106.2 Methods for the determination of the flash point of flammable liquids (closed cup) – Determination of flash point - Penksy Martens closed cup method

AS 2157 Cutback bitumen

AS 2341(set) Methods of testing bitumen and related roadmaking products

AS 2341.6 - Determination of density using a hydrometer

AS 2341.9 - Determination of water content (Dean and Stark)

AS/NZS 2341.13 - Long-term exposure to heat and air

AS 2758.2 Aggregates and rock for engineering purposes - Aggregate for sprayed bituminous surfacing

AS 2809.5 Road tank vehicles for dangerous goods - Tankers for bitumen based products

AS 3568 Oils for reducing the viscosity of residual bitumen for pavements

AS 3706 Geotextiles - Methods of Test

AS 3706.1 - General requirements, sampling, conditioning, basic physical properties and statistical analysis

AS 3706.2 - Determination of tensile properties - Wide strip and grab method

AS 3706.3 - Determination of tearing strength - Trapezoidal method

NORTHERN TERRITORY TEST METHODS

NTTM 215.1 Standard bell penetration test

NTTM 304.1 Determination of skid resistance with the portable skid tester

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM D86 Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure

ASTM D445 Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

ASTM D1298 Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

AUSTROADS

AGPT04H-08 Austroads Guide to Pavement Technology - Part 4H: Test Methods

AGPT04K-09 Guide to Pavement Technology - Part 4K: Seals

AGPT/T103 Pre-treatment and Loss on Heating of Bitumen Multigrade and polymer Binders (rolling thin film oven [RTFO] test)

AGPT/T108 Segregation of Polymer Modified Binders

AGPT/T109 Ease of Remixing of Polymer Modified Binders

AGPT/T111 Handling Viscosity of Polymer Modified Binders (Brookfield Thermosel)

AGPT/T112 Flash Point of Polymer Modified Binders

AGPT/T121 Shear Properties of Polymer Modified Binders (ARRB ELASTOMETER)

AGPT/T122 Torsional Recovery of Polymer Modified Binders

AGPT/T131 Softening Point of Polymer Modified Binders

AGPT/T132 Compressive Limit of Polymer Modified Binders

AGPT/T142 Rubber content of digested crumb rubber binders - Trichlor bath method

AGPT/T190 Specification Framework for Polymer Modified Binders and Multigrade Bitumens

AP-C87-15 Austroads Glossary of Terms

AP-G41-08 Bituminous Materials Sealing Safety Guide

AP-T68/06 Update of the Austroads Sprayed Seal Design Method

AP-T235-13 Guide to the Selection and Use of Polymer Modified Binders and Multigrade Bitumens

AP-T236-13 Update of Double/Double Design for Austroads Sprayed Seal Design Methods

NT Weeds Management Act

## DEFINITIONS

Reference should be made to AUSTROADS - AP-C87-15 Austroads Glossary of Terms to give definitions on all aspects of Bituminous Surfacing works where required.

AADT Annual average daily traffic

ADHESION AGENT: A substance used for the purpose of promoting the adhesion between binder and aggregate.

ASTM American Society for Testing and Materials

COARSE GRAINED AGGREGATE: Where the average grain size of the constituent minerals is greater than 1mm. The average grain size is determined optically under a petrographic microscope or by calibrated hand lens.

CUTTER (Kerosene): A light petroleum distillate added to bitumen to temporarily reduce its viscosity.

DEPARTMENT, THE / DIPL Department of Infrastructure, Planning and Logistics.

FINE GRAINED AGGREGATE: Where the average grain size of the constituent minerals is less than 1 mm. The average grain size is determined optically under a petrographic microscope or by calibrated hand lens.

FLUX OIL A petroleum distillate added to bitumen to produce a long term reduction in its viscosity.

mPa.s Milli Pascal seconds – a unit of measure of viscosity

NATA National Association of Testing Authorities

NTCP Northern Territory Code of Practice

NTMTM Northern Territory Materials Testing Manual - available at

<https://transport.nt.gov.au/infrastructure/technical-standards-guidelines-and-specifications/materials-testing-manual>

NTTM Northern Territory Test Method

PMB Polymer Modified Binder

PRECOATING MATERIAL: A material used for pre-coating aggregate to promote adhesion of bitumen. Do not use diesel.

PRIME An application of a Primer to a prepared base, without cover aggregate, to provide penetration of the surface, temporary waterproofing and to obtain a bond between the pavement and the subsequent seal or asphalt. It is a preliminary treatment to a more permanent bituminous surface.

PRIMERSEAL An application of primer binder with a fine cover aggregate to a prepared base to provide penetration of the surface and retain a light cover aggregate.

RESEAL A seal applied to an existing sealed, asphalt or concrete surface.

SAMI Strain Alleviating Membrane Interlayer

SEAL A sprayed application of bituminous binder into which aggregate is incorporated. May include more than one application of binder and aggregate, and may include geotextile fabric.

TBA To be advised (by Superintendent).

TBR To be reported (by Contractor).

VPD Vehicles per day

## SCOPE

Spray sealing treatments include:

* Prime
* Primerseal
* Enrichments
* Initial Seal or Reseal:
* With conventional bitumen, cutback bitumen or bitumen emulsion binder
* With modified binder
* Incorporating geotextile fabric reinforcement.

Spray sealing work consists of:

* Supply and delivery of materials.
* Storage and handling of raw materials.
* Precoating of aggregate.
* Final preparation of surface to receive spray seal treatments.
* Preparation of bituminous materials.
* Recording of spray sealing works.
* Sampling of Bituminous Products
* Application of primer and/or primerbinder and/or binder.
* Spreading and rolling of aggregate.
* Removal of loose aggregate.
* Traffic Control
* Installation of temporary pavement markers
* Installation and retrieval of after-care signage
* Traceability of works and materials

## MATERIAL REQUIREMENTS

### Aggregates

Aggregates must be clean, hard, durable, skid resistant, dry crushed stone, or gravel of uniform quality free from noxious weeds and other deleterious material, and conform with the properties specified. Minimum 3 crushed faces.

Nominate source of aggregate supply. Submit to the Superintendent current NATA endorsed test result certificates providing evidence that the nominated aggregate supply conforms to specified properties. Aggregate used for testing must be sampled from project site and must conform to the ***Table - Aggregate Grading and Average Least Dimension (ALD)***, and must conform to the ***Table - Aggregate Properties - Construction.***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Table - Aggregate Grading and Average Least Dimension (ALD)** | | | | | | |
| **Sieve Size**  **(mm)** | **% Passing (Dry Mass)** | | | | | |
| **Nominal Size of Aggregate** | | | | | |
|  | **20 mm** | **16 mm** | **14 mm** | **10 mm** | **7 mm** | **5 mm** |
| 26.5 | 100 |  |  |  |  |  |
| 19.0 | 85 ‑ 100 | 100 |  |  |  |  |
| 16.0 | - | 80 - 100 | 100 |  |  |  |
| 13.2 | 0 ‑ 15 | 0 – 20 | 85 ‑ 100 | 100 |  |  |
| 9.5 | 0 ‑ 5 | 0 – 2 | 0 ‑ 15 | 85 ‑ 100 | 100 |  |
| 6.7 | 0 ‑ 2 |  | 0 ‑ 5 | 0 ‑ 15 | 85 ‑ 100 | 100 |
| 4.75 |  |  | 0 ‑ 2 | 0 ‑ 5 | 0 ‑ 15 | 85 ‑ 100 |
| 2.36 |  |  |  | 0 ‑ 2 | 0 ‑ 5 | 0 ‑ 15 |
| 1.18 |  |  |  |  | 0 ‑ 2 | 0 ‑ 5 |
| Min. ALD (1) | 12.0mm | 9.5mm | 8.0mm | 5.5mm | 3.5mm | 2.5mm |
| Note: (1). Test Methods AS 1141.20.1, AS 1141.20.2 - Direct Measurement. | | | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Table – Aggregate Properties - Construction** | | | |
| **Aggregate Property** | **Traffic Count (AADT: Two Lanes)** | | |
| **Less Than 300 VPD** | **300 to 6,000 VPD** | **More Than 6,000 VPD** |
| AS 1141.14 Misshapen Particles: Caliper Ratio 2:1 | 25% maximum | 15% maximum | 12% maximum |
| AS 1141.15 Flakiness Index | 25 maximum | 25 maximum | 25 maximum |
| AADT - Annual Average Daily Traffic  VPD - Vehicles Per Day | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Table – Aggregate Source Rock Properties Requirements** | | | |
| AS 1141.23 Los Angeles Abrasion (LAA): | | | |
| - Fine Grained Aggregate | 30% maximum | 25% maximum | 20% maximum |
| - Coarse Grained Aggregate | 40% maximum | 35% maximum | 30% maximum |
| AS 1141.24 Sulphate Soundness | 15% maximum | 12% maximum | 10% maximum |
| AS 1141.40, AS 1141.41 Polished Aggregate Friction Value | 40 minimum | 40 minimum | 45 minimum |
| AS 1141.18 - Crushed particles in coarse aggregate derived from gravel.  Ensure 80% minimum by mass are classified as crushed particles. | | | |
| AS 1141.25.1 - Degradation factor – Source rock (Washington Degradation Test).  Igneous rocks shall have a minimum value of 50. | | | |
| AS 1141.26 - Secondary minerals content in igneous rocks shall not exceed 25%. | | | |
| AS 1141.29 - Accelerated soundness index by reflux.  Igneous rocks shall have a minimum value of 94. | | | |
| AS 1141.50 - Resistance to stripping of cover aggregates from binders.  Binder to be S10E with 1% adhesion agent.  Precoat to be 100/0/100 with 1% adhesion agent.  The maximum wet stripping (saturated, surface dry) value of the precoated aggregate shall no exceed 10%. | | | |

### Cutter

Cutter is to be Kerosene or Jet A1 Aviation Turbine Fuel - conform to ***Table - Cutter Oil Properties***.

|  |  |  |  |
| --- | --- | --- | --- |
| **Table – Cutter Oil Properties** | | | |
| Refer AS 3568 – 1999 Table 1 for complete specification requirements. | | | |
| **Property** | **Min.** | **Max.** | **Test Method** |
| Density at 15 oC, kg/m3 | 775 | 830 | ASTM D1298, AS 2341.6 |
| Distillation  Initial Boiling Point oC  Final Boiling Point oC | 140 | 280 | ASTM D86 |
| Flash Point oC (Penksy Martens closed) | 38 |  | AS 2106.2 |
| Water content, % by volume | - | 0.1 | AS 2341.9 |
| Viscosity, mPa.s at 40 oC |  | 2.0 | ASTM D445 |

### Precoat and Adhesion Agents

Adhesion Agents are to be in the concentrated form and not contain Diesel as part of the mixture.

Precoat all aggregates to conform to the following:

Precoat mixture is to be 100/0/100/1 and not contain Diesel as part of the mixture.

Bitumen residue (by mass): 50%.

Kerosene (by Mass) 50%

Adhesion agent (by mass): minimum 1%

### Bitumen

Standard Classes of bitumen to conform to the requirements of AS 2008.

Manufacture all AS 2008 bitumens in a refinery and have NATA endorsed certificates of manufacture.

Durability Value in accordance with AS/NZS 2341.13 is to be a minimum of 7 days with no maximum value.

Multigrade bitumen to comply with AGPT/T190.

### Cut Back Bitumen

Conform to the requirements of AS 2157 and ***Table - Cut Back Bitumen Properties***.

Designation is by AMC class.

| **Table - Cut Back Bitumen Properties** | | | |
| --- | --- | --- | --- |
| **Class**  **(AS 2157)** | **Viscosity (Dynamic)**  **at 60oC (Pa.s)** | **Approximate Parts Bitumen to Cutter** | **Spraying Temperature (oC)** |
| **Prime Coats** | | | |
| AMC 00 | 0.008 ‑ 0.016 | 100 ‑ 100 | Ambient |
| AMC 0 | 0.025 ‑ 0.05 | 100 ‑ 80 | 35 ‑ 55 |
| **Primer Seal Coats** | | | |
| AMC 5 | 5.5 ‑ 11.0 | 100 ‑ 12 | 120 ‑ 150 |
| AMC 6 | 13.0 ‑ 26.0 | 100 ‑ 7 | 135 ‑ 160 |
| AMC 7 | 43.0 ‑ 86.0 | 100 ‑ 3 | 150 ‑ 175 |

### Bitumen Emulsion

Conform to the requirements of AS 1160.

Bitumen emulsion to be;

Type; CRS

Binder Grade; 170

%Binder; 60

[Specify type of emulsion, based on the following types:

A - anionic

C - cationic.

AM - aggregate mixing

RS - rapid setting

SS - slow setting

Specify Binder Grade, either 170 or 320

Specify percent bitumen content, usually 60%

Example: ASS-170‑60 is anionic, slow setting, class 170 bitumen, with 60% bitumen content]

Utilise within 90 days of manufacture.

Spraying temperature: 60% bitumen content 30 to 60°C.

### Polymer Modified Binder

A mixture of Standard Class bitumen and elastomeric polymer or crumb rubber additive.

All conformance testing to be carried out in accordance with Austroads and Australian Standard Test Methods.

Base binders for the production of PMB must meet the specification limits outlined in ***Table - Base Binder for Polymer Modified Bitumen***, from the refinery. All base binders must be process tested for conformance to ensure compliance before manufacture into PMB's.

|  |  |  |
| --- | --- | --- |
| **Table – Base Binder for Polymer Modified Bitumen** | | |
| **Property** | **Specification limit**  **minimum** | **Specification limit**  **maximum** |
| Viscosity at 60oC, Pa.s | 140 | 380 |
| Viscosity at 135oC, Pa.s | 0.25 | 0.65 |
| Penetration at 25oC (100g, 5s),*pu* (*pu* unit is  0.1mm) | 40 |  |
| Flashpoint oC | 250 | N/A |
| Matter Insoluble in toluene, percent mass | N/A | 1.0 |
| Short Term effect of heat and air  (Rolling Thin film Oven Test)  Viscosity of residue at 60oC as a  percentage of original | N/A | 300 |
| Long term effect of Heat and air, days | 7 | 7 |
| Density at 15oC, t/m3 | To be reported | To be reported |

Polymer Modified Binders must conform to the requirements outlined in ***Table - Polymer Modified Binders for Sprayed Sealing Applications***.

Manufacture of Polymer Modified Binders must meet the requirements of the Guide to the Manufacture, Storage and Handling of Polymer Modified Binders, Australian Asphalt Pavement Association, 2013.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Table – Polymer Modified Binders for Sprayed Sealing Applications** | | | | | | | |
| **Test Method** | **Binder Property** | **PMB CLASS** | | | | | |
| **S10E** | **S15E** | **S20E** | **S25E** | **S35E** | **S45R** |
| AGPT/T121 | Consistency at 60°C (Pa.s) min. | 250 | 700 | 700 | 5000 | 300 | 1000 |
| AGPT/T121 | Underlying Viscosity at 60°C (Pa.s) | TBR | TBR | TBR | TBR | TBR | TBR |
| AGPT/T121 | Stiffness at 15°C (kPa) max. | 140 | 140 | 140 | 95 | 180 | 180 |
| AGPT/T142 | Rubber Content by analysis (%) min | NA | NA | NA | NA | NA | 10 |
| AGPT/T132 | Compression Limit at 70°C, 2kg (mm) min. | NA | NA | NA | NA | NA | 0.2 |
| AGPT/T121 | Elastic Recovery at 60°C, 100s (%) min. | NA | NA | NA | 85 | NA | 25 |
| AGPT/T111 | Viscosity at 165°C (Pa.s) max. | 0.55 | 0.55 | 0.55 | 0.8 | 0.55 | 4.5 |
| AGPT/T112 | Flash Point (°C) min. | 250 | 250 | 250 | 250 | 250 | 250 |
| AGPT/T103 | Loss on Heating (% mass) max. | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| AGPT/T122 | Torsional Recovery at 25°C, 30s (%). | 22 - 50 | 32 - 62 | 45 - 74 | 54 - 85 | 16 - 32 | 25 - 55 |
| AGPT/T131 | Softening Point (°C). | 48 - 64 | 55 - 75 | 62 - 88 | 82 - 100 | 48 - 56 | 55 - 65 |
| AGPT/T108 | Segregation value (%) max. | 8 | 8 | 8 | 8 | 8 | 8 |
| Notes:  1. Class of PMB: S=Sealing, E=Elastomeric Polymer, R=Granulated Crumbed Rubber  2. NA means not applicable for that PMB class, TBR = To be reported  3. AGPT Test Methods are available from Austroads Guide to Pavement Technology Part 4H: Test Methods  4. S35E must be manufactured with Polybutadiene (PBD) polymers (To be used only if approved by the Superintendent, as an alternative to S10E). | | | | | | | |

### Geofabric

Use non-woven, polyester, isotropic, needle punched fabric for geotextile reinforced seals.

Conform to the ***Table - Geofabric Properties***.

Supply certificate of compliance with the respective AE Lot data. Include Traceability of Batch Numbers with the respective AE Lot data.

|  |  |  |  |
| --- | --- | --- | --- |
| **Table – Geofabric Properties** | | | |
| **Property** | **Test Method** | **Units** | **Value** |
| Mass per unit area | AS 3706.1 | g/m2 | 140 min |
| Wide strip tensile strength in both directions. | AS 3706.2 | kN/m | 8.0 min |
| Elongation range in both directions. | AS 3706.2 | % | 40 – 60 |
| 5% Secant modulus in both directions. | AS 3706.2 | kN/m | 5.0 min |
| Trapezoidal tear strength in both directions. | AS 3706.3 | N | 240 min |
| Melt temperature | - | °C | 250 min |
| Supply certificate of compliance with the respective AE Lot data. Include Traceability of Batch Numbers with the respective AE Lot data. | | | |

## SPRAYERS AND PERSONNEL

Sprayers must have current calibration accredited by a tester nominated on the Australian Asphalt Pavement Association (AAPA) website. All calibrated sprayers must be listed on the AAPA website. A copy of the calibration certificate must be with the vehicle at all times.

Calibrate sprayers yearly.

Ensure sprayer driver and operator are skilled and trained with an understanding of sprayer calibration and an appreciation of the requirements of the work.

Ensure relevant personnel understand the types and quantities of the various materials and mixtures to be used.

Bitumen Spraying plant and equipment must be in good working condition at all times.

## FINAL PREPARATION OF PAVEMENT SURFACE

Remove raised reflective pavement markers. Repair any damage to the pavement surface caused by the removal of raised reflective markers with an emulsion/sand mixture before sealing.

Remove deleterious materials, rocks, refuse and organic materials such as timber, branches, leaves, and exposed roots and the like.

Immediately before spraying, sweep the entire pavement surface to remove all loose stones, dust, dirt and foreign matter.

Do not sweep Fine Crushed Rock type, or low plasticity type materials, or Airstrips, with steel brooms.

Maintain the prepared final surface to be free of loose foreign objects.

Remove adherent patches of foreign material with a steel scraper.

Dampen the prepared surface lightly immediately before spraying (for priming and primersealing only)

Remove water from the surface of primed or sealed pavements before applying binder.

Do not allow traffic on the prepared surface.

## SETTING OUT

New works to be set out by a qualified surveyor.

Include pavement widening.

Resealing works to follow existing seal.

## BINDER COAT REQUIREMENTS

### General

Rectify bleeding or flushing seals during the defined defects period at no cost to the Principal.

#### References

DIPL Technical Standard - Bituminous Surfacing Works Treatment and Selection

<https://dipl.nt.gov.au/infrastructure/technical-standards-guidelines-and-specifications/road-surfacing-standards>

Austroads Guide to Pavement Technology Part 4K Selection and Design of Sprayed Seals

AS 2008 - Bitumen for Pavements

#### Definitions

S10E - A class of polymer modified bitumen, used for spray seal work, with an elastomeric modifier, conforming to specified binder properties in this specification. It must be manufactured from bitumen that conforms to the classes in AS 2008.

SAMI - Strain Alleviating Membrane Interlayer. A layer of seal sprayed onto an existing cracked surface, prior to asphalt resurfacing.

#### Requirements

Selection of binder type other than those specified in the ***Table – Binder coat requirements*** can be considered in special circumstances and to the approval of the Executive Director Civil Services. For example, resealing a heavily cracked surface may require a S20E or S25E binder type or crumb rubber S45R.

Emulsion primes require the approval of the Executive Director Civil Services before use.

Material properties for S10E binders and other binder types are contained in the ***Table – Polymer Modified Binders for Sprayed Sealing Applications*** in **Polymer Modified Binder** sub-clause in **Material Requirements** clause in this work section.

For further guidance refer to Austroads - Guide to the Selection and Use of Polymer Modified Binders and Multigrades (TT1357 2012)

Heat to spraying temperature, generally between 180°C and 200°C, but do not exceed the maximum. Avoid heating bitumen in quantities excess to requirements

Prevent foaming.

Ensure product meets the requirements of the specification at point of delivery.

|  |  |
| --- | --- |
| ***Table - Binder Type Requirements*** | |
| PRIMING AND PRIMER SEALING | |
| **Region** | **Binder Type** |
| All | Class C240 / C320 Applied in cutback form. |
| TACK COAT AND ENRICHMENT | |
| **Region** | **Binder Type** |
| All | CRS170/60 Applied in emulsion form. |
| INITIAL SEAL WORK | |
| **Region** | **Binder Type** |
| Darwin, Katherine, East Arnhem, Tennant Creek, Alice Springs | S10E |
| RESEALING WORK | |
| **Region** | **Binder Type** |
| All | S10E |
| SAMI WORK (Using 14 mm aggregate) | |
| **Region** | **Binder Type** |
| All | S25E |

### Prime, primer seals, seals, pre-coats, and enrichment coats

Provide bitumen complying with ***Table - Base Binder for Polymer Modified Bitumen*** in the Polymer Modified Binder sub-clause in the Material Requirements clause in this work section.

Cut back requirements are:

Prime: AMC 0 to AMC 00

[Edit if requirements differ from default..

Primer Seal: AMC **[enter data]** to AMC **[enter data]**

[Generally AMC 2 to AMC 4].

Enrichment Coat: Emulsion based TBA

[Specify the enrichment coat]

Cut-back bitumen to be mixed on site:

Heat bitumen to a temperature appropriate for achieving final spraying temperature making allowance for incorporation of the unheated cutter.

Add unheated cutter to heated bitumen and circulate until a homogeneous mixture is achieved.

Spray immediately circulation is complete.

Allow at least three days to elapse after priming before applying the binder coat.

Keep traffic off the primed surface for this period.

Use a primer seal if traffic cannot be kept off surface for 3 days.

### Straight Run Binder Coats

Do not use Straight Run Binder Coats unless you have prior approval from the Executive Director Civil Services.

Provide bitumen Class 320 complying to AS 2008

Ensure product meets the requirements of the specification at point of delivery.

### Polymer Modified Binder Coats

Provide bitumen in conformance with ***Table - Base Binder for Polymer Modified Bitumen*** blended with the required polymer as follows:

Prepare the product in a manufacturing or blending plant that complies with the Guide to the Manufacture, Storage and Handling of Polymer Modified Binders, Australian Asphalt Pavement Association, 2013.

Ensure product meets the requirements of the specification at point of delivery.

Store, mix, heat and spray the polymer modified binder as recommended by the polymer manufacturer.

Both coats of two coat seals shall contain polymer. Do not vary from this requirement unless an exemption is permitted by the Executive Director Civil Services prior to carrying out the affected works.

Initial seal coat: Class S10E

Reseal coat: Class S10E

### Binder Coats, Tender Quantities

Spray rates used as a basis for calculating tender quantities are as follows:

**Enrichment Coat**: **[enter data]** litres/m2

[generally 0.2 to 0.4 L /m2]

**Prime:** **[enter data]** litres/m2

[Generally 0.8 to 1.2L /m2]

**Primer Seal**

( **[enter data]** mm aggregate): **[enter data]** litres/m2

[Generally 1.1 to 1.4 L /m2 for 10mm size]

**Single Coat Seal**

( **[enter data]** mm aggregate): **[enter data]** litres/m2

**Reseal**

( **[enter data]** mm aggregate): **[enter data]** litres/m2

**Two Coat Seals**

First Coat Seal

(**[enter data]** mm aggregate): **[enter data]** litres/m2

Second Coat Seal

(**[enter data]** mm aggregate): **[enter data]** litres/m2

## SAMPLING OF BINDER

### Test Request

Darwin Urban areas - Test requests are to be sent to the panel period contractor to witness sampling and arrange testing.

All other areas - the supplier is to sample and deliver the sample to Departmental staff within 48 hours.

### Supply of Sampling Containers

Supply all sampling containers as required for sampling purposes.

Sample containers are to be leak proof and having a capacity of not less than one litre.

Sample containers must be clean, rust free and capable of receiving a product at high temperatures.

### Definition of Sampling

A sample is three containers of product collected at the same time from the same supply source.

One sample container is for the Contractor's analysis.

Two sample containers are for the Department to analyse.

Note: Refer to the Superintendent for requirements if samples are non-conforming

### Frequency of Samples

Refer to CONFORMANCE TESTING.

### Collection of Samples – Witness Point

Take samples prior to addition of adhesion agents.

Conformance test sampling is to be collected at point of delivery.

Ensure bulkers and road tankers have adequate sampling cocks installed so that samples can be taken on transfer from the bulker to the sprayer. Do not take bituminous samples from the spray wagon, except for prime samples.

**Witness Point** - Take samples from the point of delivery on transfer from the bulker to the sprayer or as directed. Where transfer is for works in the urban area or for small works ensure that conformance testing is ordered and samples are taken at the point of transfer from bulker to sprayer.

All sampling must be in accordance with Australian or Austroads standards. The supplier is to perform the sampling. Ensure staff carrying out sampling are competent in sampling methods.

Ensure sampling techniques do not allow contamination of the samples.

Where samples are not collected, 10% reduction adjustments (***Table - Payment Adjustments*** in MEASUREMENT AND PAYMENT) will apply to the total materials represented.

### Sample Identification

Samples must be clearly identified with permanent marker on adhesive labels on each tin.

Mark samples with the following information on the container at the time of collection.

* Container number.
* Sample number.
* Date and time of sample taken.
* Designation or Classification of Materials.
* Sample Temperature.
* Tanker/Sprayer Identification Number.
* Name of Supplier.
* Road Name and number.
* Site Identification.
* Location and Chainage.

Reseals - Maintain an electronic register of all samples which includes the information listed above. Provide a copy of this register to the Superintendent on request.

### Storage and Delivery of Samples

Store all samples taken to prevent accidental damage or contamination. Submit sample containers at the completion of each days spraying.

## STOCKPILE SITES

### Stockpiles of materials

Stockpiles in urban areas are not permitted.

Urban areas for Darwin region is nominated as - North of Cox Peninsula Road (Stuart Highway), West of Trippe Road (Arnhem Highway) and the end of seal on Gunn Point Road.

Other urban areas are nominated as being within, and extending to, town boundaries.

Existing stockpile sites - clean existing stockpile site to suit, at no cost to the Principal.

Provide a separate site for each aggregate size. Allow 15 metres between adjacent sites.

Ensure sites are well drained and on hard ground. Avoid contamination by dust.

Maintain access roads and stockpile sites.

Do not allow stockpiled aggregates to become wet due to rain. Cover all stockpiles with sheet plastic or similar material.

Avoid sites under trees, telephone lines, overhead transmission lines or where overhead clearance is less than 6 metres.

Clear all vegetation within the existing stockpile boundary only.

Remove from site any non-conforming aggregate.

For work in or close to regional centres, towns and urban areas (50 km), remove all unused aggregate from stockpile sites at conclusion of work.

For rural work, prepare unused aggregate into one neat and tidy stockpile, per aggregate size. Aggregate remaining in stockpiled areas becomes property of the Northern Territory Government at Practical Completion stage.

Neatly stockpile all waste materials from the screening process.

## PRECOATING AGGREGATE

All aggregates used must be dry before precoating.

No precoat is required for SAMI and Emulsion seals, unless stated in the response schedules.

Apply a uniform film of precoating material to all the aggregate used for sealing purposes.

Do not load directly into trucks from a precoater machine.

Aggregate which has been excessively precoated will be rejected.

Precoating is to take place at pre-approved site stockpile locations unless otherwise approved by the Superintendent.

All precoating must be performed with a powered shaking screen deck precoater, which removes dust, dirt and oversize materials and evenly applies precoat to the aggregate.

## ADHESION AGENT

Adhesion agent must be used. Do not use diesel based adhesion agents.

Use 1% adhesion agent in the binder. Written Superintendent approval must be obtained for variation of this rate.

Circulate in binder for 20 minutes before spraying.

Provide the Superintendent a copy of the Safety Data Sheet information of the adhesion agent prior to its intended use.

## SPRAYING - WITNESS POINT

**Witness Point** - Give the Superintendent 48 hours notice of intention to spray bitumen.

Store bitumen at lowest practical temperature and for the shortest possible duration.

Comply with ***Table - Temperature Control Requirements for Polymer Modified Binders***.

Seek approval to vary these requirements.

Remove bitumen from the site when temperature limits are exceeded.

|  |  |  |
| --- | --- | --- |
| **Table – Temperature Control Requirements for Polymer Modified Binders** | | |
| **Property** | **Straight Run Binder** | **Polymer Modified Binder** |
| Temperature at point of spraying | 175 to 185°C | 180 to 200°C |
| Holding time at spraying temperature | 7 days maximum | 2 days maximum |
| Temperature for medium term storage | 130 to 150°C | 140 to 160°C |
| Holding time for medium term storage | 30 days | 7 to 10 days |

### Atmospheric Conditions

Commence spraying only when pavement temperature

* is in excess of 20°C, or
* has been in excess of 15°C for at least one hour.

For cutback work, commence spraying when pavement temperature is in excess of 10°C.

For emulsion work, commence spraying when pavement temperature is in excess of 5°C.

Cease spraying if rain threatens, or in windy or dusty conditions.

Protect the work in the event of a sudden change in weather by closing the affected section of road or by rigidly controlling traffic speed.

### Preparing the Sprayer

Circulate the mixture.

Check the horizontal and vertical alignment and the cleanliness of the spraybar and its extensions.

Determine the appropriate number of nozzles for the width to be sprayed. Ensure the end nozzles fitted are EAN18W.

Check that the nozzles in use are symmetrical about the sprayer.

Check the alignment and setting of the nozzle to ensure that the fans of material from intermediate nozzles are parallel and at an angle of 30 degrees to the centre line of the spraybar. Ensure that the fans from the end nozzles are parallel to each other and at an angle of 45 degrees to the centre line of the spraybar.

Set the height of the spraybar so that the lower faces of the nozzles are 250 mm (or that specified on the calibration certificate) above the pavement when the sprayer is full.

Fit an end shield to the spraybar when necessary to prevent spraying material on the kerb, or to counter any wind effects which would compromise uniform spraying.

Position the guide rod to conform to the setting out and edges of spray. Check by making a dummy run.

### Application Spray Rates - Hold Point

Application spray rates shall be determined by the Superintendent; using Austroads Guide to Pavement Technology Part 4K Selection and Design of Sprayed Seals.

For new seals and reseals, supply the following to the Superintendent, 3 working days prior to the planned commencement of sealing, to allow the spray rates to be calculated:

* Particle Size Distribution (1 per 250 tonne - minimum 3 tests)
* Average Least Dimension (ALD) (1 per 250 tonne - minimum 3 tests)
* Flakiness Index (FI) of the aggregate, (1 per 250 tonne - minimum 3 tests)
* Ball Penetration testing (for new seal work)
* Dryback results (for new seal work)

Refer to Conformance Testing for sampling requirements of aggregates.

**Hold Point** - Do not commence spraying until the spray rates are advised by the Superintendent.

Spray rates to be at 15°C adjusted in accordance with ***Table - Bitumen Equivalent Volumes*** in **Calculation of Equivalent Volumes for Spray Rates** clause in this work section.

For primers, primer seals and polymer modified binders, the rate of application refers to the whole of the mixture, including all modifiers, cutback materials, combining oils and adhesion agents. For enrichments and emulsion seals, the rate of application refers to the whole of the mixture.

### Preparation for Sprayer Run - Witness Point

**Witness Point** - Record the volume and temperature of the sprayer contents before each run, while sprayer is on level ground. Dip Sprayer Tank before and after each sprayer run. Record the dip readings, and the temperature of the sprayer contents at the time the dip was done. Provide copies of records of Sprayer Tank dips and temperatures of tank contents within one day of the completion of a day’s work.

**Witness Point** - Allow visual inspection when requested.

**Witness Point** - Check that the spray bar is at the correct height before spraying begins.

Determine the length of sprayer run from the available quantity in the sprayer and the application rate. Ensure the area to be sprayed is not greater than the area that can be covered by aggregate in the loaded trucks.

Start and finish each spray run on a protective strip of paper placed on the pavement. The paper to be wide enough to ensure the sprayed material is being discharged correctly over the full width of spray. Place sufficient protective paper to protect road fixtures.

Place paper on the pavement and masking around areas to be sprayed or wherever the sprayer is stationary on the road pavement.

Seal joins are only allowed where linemarking is to be placed. No joins are allowed in wheel paths.

Excess overspray and spills must be removed before sealing works proceed.

### Installation of Temporary Pavement Markers

Temporary Pavement Markers to conform to AS 1906.3.

Spacings of temporary pavement markers to be in accordance with AS 1742.3 or as directed by the Superintendent.

### Sprayer Run

Attain uniform spraying speed before spraying commences.

Avoid an excess or deficiency of material due to faulty overlap at longitudinal joints when spraying a road in half-widths.

Overlap to be 300 mm with an intermediate nozzle.

Do not use end nozzles on an overlap.

Make allowances for "Fog Spraying" when joining to existing seals.

Cease spraying before the level of material in the tank falls to a level which reduces the full discharge of the pump.

Remove and dispose of all paper as per the Environmental Management Plan.

Clean off any sprayed material from road fixtures.

### Hand Spraying

Plan work to minimise the requirement for the use of a hand sprayer.

Any strips of pavement not adequately covered with sprayed material to be sprayed later with the hand attachment.

## APPLICATION OF GEOFABRIC - HOLD POINT

**Hold Point** - Submit details of proposed machinery and method of application.

Overlap longitudinal and transverse joints 150 mm minimum.

Place longitudinal joints in the fabric along lane boundaries within 100 mm of lane marker. Trim the fabric as required to achieve this.

Bond the fabric to the pavement with a tack coat sprayed 100 mm wider than the fabric and in accordance with the Superintendent's directions for location. Use Standard Bitumen Class C320 for the tack coat.

Place the fabric under tension when laying, using suitable machinery, ensuring that folds or creases do not occur. Use equipment to place fabric that does not cause undue migration of the underlying tack coat into the fabric.

Upon completion of placing of fabric and prior to application of the second/top binder coat, roll the fabric with minimum 4 passes of a pneumatic multi-wheel roller. Carry out rolling of the geofabric at a constant roller velocity with no acceleration or deceleration.

## APPLICATION OF AGGREGATE - HOLD POINT

Load aggregate into appropriate aggregate spreading trucks using an approved loader which does not contaminate the aggregate with dust, dirt and oversize stone.

**Hold Point** - Obtain approval from the Superintendent for use of the proposed aggregate loader before commencing loading operations.

Apply aggregate to sprayed binder within:

* 10 minutes where the pavement temperature is 20°C or greater.
* 5 minutes where the pavement temperature is between 15°C and 20°C.

Polymer Modified Binders: Apply aggregate within 5 minutes irrespective of pavement temperature.

Apply aggregate to emulsion coat before the emulsion breaks.

Use "cut off plates" on spreader boxes to ensure that the correct widths are covered in aggregate, without overlap.

Apply both coats of a two coat seal on the same day. Do not allow traffic until the second coat has been applied.

### Aggregate Spread Rates

Spread the aggregate evenly and uniformly over the sprayed surface at a rate complying with ***Table - Aggregate Spread Rates***.

Use a mechanical spreader, manual spreader boxes are not to be used.

Rerun or hand cover bare or insufficiently covered areas after the first spreading.

Remove all excess aggregate.

|  |  |
| --- | --- |
| **Table – Aggregate Spread Rates** | |
| **SINGLE / SINGLE SEALS** | |
| Straight Run Binder Coats Multi Grade And Polymer Modified Binders | 900/ALD m2/m3 |
| Emulsions And Cut Back Binders | 800/ALD m2/m3 |
| SAMI | 1000/ALD to 1100/ALDm2/m3 |
| **DOUBLE / DOUBLE SEALS – FIRST COAT APPLICATION** | |
| Straight Run Binder Coats Multi Grade And Polymer Modified Binders | 950/ALD m2/m3 |
| Emulsions And Cut Back Binders | 850/ALD m2/m3 |
| **DOUBLE / DOUBLE SEALS – SECOND COAT APPLICATION** | |
| All Binders | 900/ALD m2/m3 |

### Rolling Rate

Roll the treated surface with self-propelled rubber tyred rollers with a minimum tyre pressure of 600 kPa and a minimum wheel load of 1 tonne.

Roller speed on the first pass to be between 5 and 10 km/h, with subsequent passes between 15 and 25 km/h.

Conform to the following:

* Entire area to receive one roller pass immediately after covering.
* 75% of rolling within 1 hour of covering.
* 100% of rolling within 2 hours of covering.

Minimum Rolling Rate: 1 roller hour per 2,000 litres of binder.

Ensure a uniform distribution of aggregate. Drag broom to distribute surplus aggregate but do not dislodge embedded aggregate. Drag broom before 50% of rolling is complete. Drag brooms are not to be rotary brooms.

For two coat treatments, double the specified rolling rate for the second coat.

Roll in daylight hours only.

Sweep all loose aggregate from the carriageway at completion of rolling.

Ensure aggregate on the final surface is uniformly distributed and firmly held by the binder.

Adjust drag broom to distribute surplus aggregate, but not to dislodge embedded aggregate.

Re-roll the surface after sweeping to ensure uniform bedding of aggregate in binder.

### Rolling Rate for Airstrips

Roll the treated surface with at least one self-propelled rubber tyred roller with a minimum weight of 20 tonnes.

Roll the treated surface with self-propelled rubber tyred rollers with a minimum tyre pressure of 600kPa and a minimum wheel load of 1 tonne.

Rubber Tyred Minimum Rolling Rate: One roller hour per 800 litres of binder.

Steel Drum Roller Minimum Rolling Rate: One pass on the final coat.

For two coat treatments, double the rolling rate on the final coat only.

Ensure a uniform distribution of aggregate. Drag broom to distribute surplus aggregate but do not dislodge embedded aggregate. Drag broom before 50% of rolling is complete. Drag brooms are not to be rotary brooms.

Ensure aggregate on the final surface is uniformly distributed and firmly held by the binder.

Roll in daylight hours only.

Use a suction type broom to sweep all loose aggregate from the airstrip and surrounds at completion of rolling, and remove the collected aggregate from site.

Re-roll the surface after sweeping to ensure uniform bedding of aggregate in binder.

### Self-Propelled Multi Rubber Tyred Vibrating Rollers – Hold Point

**Hold Point** – Obtain Superintendent’s approval for the use of self-propelled multi rubber tyred vibrating rollers before using them.

Do not use steel drum rollers fitted with rubber covers.

Self-propelled multi rubber tyred vibrating rollers must not be used on works other than resealing works.

All self-propelled multi rubber tyred vibrating rollers must meet the same requirements as are required for self-propelled multi rubber tyred non-vibrating rollers in respect to rolling speeds, tyre pressures, and wheel loadings. If the self-propelled multi rubber tyred vibrating rollers meet all the above requirements, one self-propelled multi rubber tyred vibrating roller will be considered to be equivalent to 2 self-propelled multi rubber tyred non-vibrating rollers for calculations of rolling times.

A minimum of 2 self-propelled multi rubber tyred non-vibrating rollers must be on site at all times during execution of the works.

## TRAFFIC ON RESEALS

Cross reference; PROVISION FOR TRAFFIC, **Workzone Traffic Management** clause, **Traffic Escort Vehicle - Resealing Works** sub-clause.

Co-ordinate work to minimise traffic delays.

Prohibit traffic;

* until at least 1 pass of the rollers has taken place or until sufficient rolling has taken place to prevent damage to the applied seal, whichever is greater; and
* from adjacent strip of roadway during spraying.

## WASTE MATERIAL – Hold Point

In urban areas, remove all excess aggregate by suction broom. Ensure no aggregates are distributed onto the verge.

**Hold Point** - Obtain written approval from the Superintendent for use of rotary type brooms to windrow the loose aggregate in the urban area. Suction type brooms are still to be used to remove the waste aggregate.

Remove from the site and dispose of all waste material.

Clean and remove all aggregate from the shoulders and verges in urban areas.

Urban areas aggregate removal / sweeping regime:

* **Initial** sweep after rolling has concluded
* **Second** sweep after 24 hours
* **Third** sweep after 48 hours.

## REPORTING

### Spraysheets – Witness Point

**Witness Point** - Supply spraysheets (paper or electronic formats are acceptable) to the Superintendent at the end of each day’s production. Record the following information for all spray runs conducted.

* Contractors Name
* Project Details
* Contract Number
* Specification schedule number
* Road Name
* Product Type Sprayed
* Precoat type used, Precoat litres / m3
* Aggregate supplier, Aggregate Type, Aggregate size
* Run number, Start Time of spray run
* Pavement Temperature, Ambient Temperature
* Start Chainage of spray run - actual km of road
* End chainage of spray run - actual km of road
* Total Length, Width of spray run
* Total area of spray run
* Temperature of product at spraying
* Start Dip, End Dip
* Total sprayed hot, Correction factor, Total sprayed cold
* Application rate cold
* Ordered application rate
* Percent of application rate ordered
* Number of rollers used
* Bitumen sample number
* Signature of contractor representative
* Signature section for client representative

## CONFORMANCE - TOLERANCES

Final surfaces shall conform to the following:

Aggregates are to conform to Table - Aggregate Properties in Material Requirements clause, Aggregates sub-clause in this work section.

Skid Resistance determined by NTTM 304.1.

Skid resistance testing may be carried out by the Superintendent.

Final surfaces with non-conforming skid resistance will be rejected.

Rectify non-conforming work by methods approved by the Superintendent. Rectification work be at the Contractor's expense, including the cost of testing and re-testing.

Remove from the site binder which has been overheated or has deteriorated or become contaminated prior to its application to the road.

Spray rates applied at less than 95% or more than 105% of the rate indicated in the procedure will be rectified by resurfacing at the Contractor’s expense inclusive of all materials.

## CALCULATION OF EQUIVALENT VOLUMES FOR SPRAY RATES

This includes the prime coat, enrichment coat, emulsion coat, primerseal and seal coats.

Refer to MEASURMENT AND PAYMENT for schedules of adjustments.

### Bitumen Equivalent Volumes

Equivalent volumes of bituminous material measured at higher temperature are to be converted to an equivalent volume at 15°C (15°C converted higher temperature).

Interpolate to determine equivalent volumes at temperatures other than those specified in the ***Table – Bitumen Equivalent Volumes***.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table - Bitumen Equivalent Volumes** | | | | |
| **Temp. (°C)** | **Factor** |  | **Temp. (°C)** | **Factor** |
| 15 | 1.0000 (1.0000) |  | 120 | 0.9356 (1.0688) |
| 40 | 0.9844 (1.0158) |  | 130 | 0.9296 (1.0757) |
| 50 | 0.9782 (1.0223) |  | 140 | 0.9237 (1.0826) |
| 60 | 0.9720 (1.0288) |  | 150 | 0.9178 (1.0896) |
| 70 | 0.9659 (1.0353) |  | 160 | 0.9119 (1.0966) |
| 80 | 0.9597 (1.0420) |  | 170 | 0.9060 (1.1038) |
| 90 | 0.9537 (1.0486) |  | 180 | 0.9002 (1.1109) |
| 100 | 0.9476 (1.0553) |  | 190 | 0.8944 (1.1181) |
| 110 | 0.9416 (1.0620) |  | 200 | 0.8886 (1.1253) |
|  |  |  | 210 | 0.8829 (1.1326) |

## Price Adjustment for Bitumen

### General – Witness Point

The basis of price adjustment (rise and fall), to the Contract rates shall be as follows.

The Contract requires a review of the Contract Unit Rates for Bituminous Products during the Contract period. With applicable claims for price adjustment, the Contractor shall submit a request for price adjustment to the Principal with all invoices. The price adjustment claimed must be calculated in accordance with the formula below.

**Witness Point -** The claim must be supported by adequate information to substantiate the adjustment in Unit Rates. The Contractor must provide details of the relevant average bitumen price indexes from both the date of Contract Award, and the commencement date of application of the seal or the approved program date for the commencement of sealing application. The commencement of sealing date is to be confirmed by the Superintendent.

It is the intention that revised Rates shall reflect the Contractor’s current costs incurred at the time of application of Bitumen Products based on relevant cost adjustment indices or other industry factors.

Where the delays to the Sealing Date are not approved by the Principal as an approved deviation from the Construction Programme (in accordance with the Contract), then for the purpose of calculating adjustments the Sealing Date will be back dated to a date that reflects the Construction Programme as provided in accordance with the Contract.

### Definitions

**Bitumen Products:** Are the Schedule of Rates line items subject to adjustment, which include (where applicable); Primer Seal, Seal, Pre-coat, Enrichment Coat, Seal Coat, applied to Aggregate.

**Average Bitumen Price:** Is the average published list selling price (per tonne) for Class 170 bitumen for the applicable month, The applicable month is the month during which the applicable date falls. The applicable dates are Contract Award date, and/or Approved Program Date for the commencement of sealing works (application of bitumen products), and/or the actual date on which sealing works (application of bitumen products) commenced.

**Approved Sealing Date:** Is the date that the Bitumen Products were applied to the works if this is the approved date, or the approved scheduled date for commencement of sealing works. It is not the date that payment is claimed.

### Basis of Adjustment

Price Adjustment for Bitumen will be on the following basis:

1. The adjustment shall be undertaken at the time of making claims for payment of applicable bitumen works undertaken.
2. The relevant statistics used for calculation of price adjustment of Bitumen Products rates shall be drawn from the VicRoads Publication “Rise and Fall Indices LABOUR, CONSTRUCTION & AVERAGE BITUMEN PRICE” available at <https://webapps.vicroads.vic.gov.au/VRNE/tenconin.nsf/webFreeForms/4B01451960BD9891CA257367001DFA9A?OpenDocument>.
3. The Principal will not calculate split payments where sealing operations occur during more than one month.

|  |  |  |
| --- | --- | --- |
| **Pn** | Is the new scheduled bitumen price, expressed as dollars per litre, calculated by applying the formula set out below. | |
| **Pb** | This is the base scheduled bitumen price, expressed as dollars per litre, accepted by the Principal in the initial contract rate or sum in the Schedule of Rates or Bill of Quantities. | |
| **Mn** | Is the applicable New Monthly Average Bitumen Price. This will be the value for the month during which sealing operations commenced, or the date sealing operations were scheduled to commence in the approved programme of works. It is expressed in dollars per tonne. | |
| **Mb** | Is the monthly Base Average Bitumen Price for the month during which the Contract award date falls, for this Contract, expressed in dollars per tonne. | |
| **Pn = Pb + ( (Mn/970) - (Mb/970) )** | |
| **Note:** 970 is representative of the litres of bitumen at 15 degrees in 1000kg of bitumen  **Note:** “+” means add; “-“ means subtract, “**/”** means divide by the value following the symbol; calculations in the brackets to be performed first. | | |