TECHNICAL COMMENTARY ON PART R26

APPLICATION OF SPRAYED BITUMINOUS SURFACING

SPECIFICATION	COMMENTARY
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1. GENERAL This Part specifies the requirements for the application of sprayed bituminous surfacing or resurfacing (sprayed seal coat treatment). Documents referenced in this Part are listed below: AS 1141 Methods for Sampling and Testing Aggregates AS 1289 Methods of Testing Soils for Engineering Purposes AS 2008 Residual Bitumen for Pavements AS 3706 Geotextiles – Methods of Test	

2. QUALITY REQUIREMENTS The Contractor shall prepare and implement a Quality Plan that includes detailed procedures and documentation for: Primer, Primer Binder, Binder and Overspray (a) Achievement of flux and/or cutter proportions. (b) Achievement of a homogeneous mixture (including the elimination of tank contamination). (c) Transportation of Polymer Modified Binder in accordance with "Code of Practice: Manufacture, Storage and Handling of Polymer Modified Binders, First Edition", Australian Asphalt Pavement Association, June 2004, Clause 4.2.1 and Clause 4.2.6. (d) Control of temperature. (e) Application. (f) Details of spray bars proposed and methods to avoid blockage of nozzles and valves (refer Clause R26.7 "Operation of Sprayer"). (g) Ensuring adequate cure of the primer/overspray. (h) Field sampling of binder.	Adherence to (c) should be audited

In addition to the above, for Emulsions, Polymer Modified Binders and Crumb Rubber (a) Management of curing process for emulsion, including traffic management for emulsions (refer Clause R26.4.1"Constraints to Work") (b) The manufacturer's recommendations regarding: handling instructions including temperature range, maximum storage time for particular temperatures, maximum heating temperature, and any other relevant information (c) For crumb rubber binder and high bitumen content emulsions the achievement of a homogeneous product that can be sprayed as a uniform application of binder across the pavement, free of streaking. Details that shall be included as a minimum are recommended spray nozzle sizes, maximum width of spray runs, and management of storage times & temperatures. (d) Materials Technical Data sheets for each product. Aggregate (a) Controlling loading to avoid contamination and wastage (b) Removal of dust and dirt (c) Application of precoat (d) Application of aggregate (e) Rolling of aggregate. If not part of the Post Tender Submission, the procedures shall be submitted at least 28 days prior to the commencement of site work. Provision of the procedures listed in this Clause shall constitute a hold point.	Want crumb rubber to be well blended, not segregated. Crumb rubber and High Bitumen Content Emulsions should actually be sprayed using B6 nozzles Management of storage times and temperatures is important for emulsions, PMBs & Crumb Rubber
3. MATERIALS **3.1 Quality of Materials** Binder (including Prime, Primer Binder, C170, C320, PMB, Crumb Rubber, Multigrade and Emulsion), Flux and Cutter shall comply with Part 225 "Supply of Bituminous Materials". Paving Fabric shall comply with Part R85 "Supply of Geotextiles". Aggregate shall comply with Part R15 "Supply of Pavement Materials". Where aggregate is supplied by the Contractor: Prior to the use of sealing aggregates, a **HOLD POINT** shall apply for the purpose of ensuring that test certificates have prepared and that the moisture content is in accordance with Clause 4.3 "Aggregate".	ALD test results must be provided. A moisture content test certificate may be requested if doubts about the dryness of the aggregate can not be resolved by the supervisors on site
Prior to the commencement of sprayed bituminous surfacing, the Contractor shall demonstrate (by the submission of positive test results) the precoating system required to ensure compliance with the aggregate stripping requirements as determined by TP 705 for the proposed aggregates.	This should be enforced before the sprayer arrives at any particular job. We are finding now that requirements for adhesion agents for stone from particular quarries are varying from face to face and from time to time; TSD is also using different binders to the past..
At least 7 days prior to the commencement of sprayed bituminous surfacing, the Contractor shall supply a NATA endorsed test certificate for the Average Least Dimension of all sealing aggregates. Aggregates used in the determination of the Average Least Dimension shall be sampled in accordance with TP 226 and the Average Least Dimension shall be determined in accordance with Part R15 "Pavement Materials"	Average least dimension (ALD) and traffic (AADT) are the two most important inputs to a successful seal design. Where the contractor supplies aggregate, but the bitumen application rate is provided by DPTI, then this application rate is based on a complete guess. In order to reduce stripping and bleeding of new work, it is important that the nominal design is replaced with an actual design, which requires actual ALD. This is particularly critical in designs under high traffic, such as overtaking lanes.
Where aggregate is supplied by the Principal: Prior to the use of sealing aggregates a **HOLD POINT** shall apply for the purpose of ensuring that the quantity of stockpiled material is agreed and that the moisture content is in accordance with Clause 4.3 "Aggregate".	A moisture content test certificate may be requested if doubts about the dryness of the aggregate can not be resolved by the supervisors on site
At least 7 days prior to the commencement of sprayed bituminous surfacing, the Contractor may, upon request be supplied with test results for the Average Least Dimension of all sealing aggregates. **3.2 Measurement of Materials** Unless otherwise stated all rates and quantities under this Specification relating to Prime, Primer Binder, C170, C320, PMB, Crumb Rubber, Multigrade, Emulsion and cutter shall refer to measurement by volume at 15ºC. Where the volume of such materials is measured at a higher temperature, the Volume Conversion Formulae shall be used for converting the volume to equivalent volume at 15ºC. The Volume Conversion Tables are included as Appendix 1 and Appendix 2. For the purpose of	

sprayed bituminous surfacing, rates and quantities relating to volume of aggregate shall refer to loose volume.

4. CONSTRAINTS TO WORK

4.1 Binder and Traffic

The Contractor shall comply with the constraints regarding binder listed in Table 4.1 Refer to Part CH20 "Provision for Traffic" for other constraints relating to traffic control.

TABLE 4.1

Treatment	Constraint
Prime	Traffic shall not be permitted on the surface within 24 hours of spraying or until the prime has dried sufficiently so as not to be damaged by vehicles. A binder shall not be applied over a cutback prime within 72 hours of spraying of the prime, or in cold weather until the solvent cutters have substantially evaporated.
Primer binder	A binder shall not be applied over a cutback Primerseal within 6 months of spraying of the Primerseal.
Crumb Rubber	Crumb Rubber shall not be stored longer than 12 hours unless sufficient evidence is provided that demonstrates the ability of the storage/blending vessel to maintain the consistency of the binder. In that case, an additional 12 hours of storage will be allowed provided that the temperature of the binder is held between 140^{o}C and 150^{o}C. Plant blended crumb rubber may only be transported for one hour from the point of manufacture, and both plant blended and field blended crumb rubber must be sprayed within four hours from the transfer into the sprayer. Base binder shall consist of C170 bitumen complying with AS 2008 Once rubber has been added to the base binder the contents shall be circulated for the minimum period indicated in the quality plan to provide a homogenous product of consistent quality.
Emulsion	In addition to the protective measures specified in the Quality Plan, the Contractor may be required to provide pilot vehicles to control traffic speeds to 25 km/h for at least 2 hours or until the binder has cured sufficiently to retain the screenings.
All two-coat seals	Both courses of a double seal shall be laid on the same day. The top seal shall overlap each finished edge of the bottom seal by 50 mm.

The word “traffic” here refers to construction light-vehicles only. Public and commercial traffic let loose on a prime will damage the surface within hours.
Cutback primes contain a large amount of volatiles. If these become trapped under a new seal, the seal could be expected to bleed during the next bout of warm weather. The “72 hours” is a consensus between industry and DPTI. Obviously, the longer this is left, the better the long term outcome.

Cutback primer binders also contain a large amount of volatiles. If these become trapped under a new seal, the seal could be expected to bleed during the next bout of warm weather. Previous specifications required “14 days” however experience demonstrated this was not sufficient. “28 days” is a consensus between industry and DPTI. Obviously, the longer this is left, the better the long term outcome

South Australian experience with crumb rubber is still quite young. Until work practices and results provide evidence to the contrary, DPTI want blending on site. The definition of “site” is the site where the stockpiles or the bulkers are.

Emulsion seals are very tender during their early life, and are easily damaged by high-speed traffic. If a still “cheesy” resurfaced lane must be opened to traffic to allow work on an adjoining lane to commence, then stop-go traffic control to permit traffic from one direction at a time will also need to be accompanied by a pilot vehicle to lead the platoons through at controlled, slow, speeds.
This clause also means that the last emulsion run of the day may need to be completed early enough to allow at least two hours of daylight and active on-site traffic control to continue.
The application rate of the first coat of a two coat seal is much lower than a single seal design for the same size stone. Thus if the first coat of a two coat seal was left open to traffic overnight, it could be expected to severely strip.

4.2 Aggregate

Hot binders shall not be sprayed if the moisture content of the screenings exceeds 0.8% for non-PMB’s or 0.1% for PMB's as determined in accordance with AS 1289.2.1.1 and AS 1289.2.1.4.

The traditional rule of thumb used to be: ‘Pick up a handful of damp aggregate in one hand, toss the aggregate back, wipe the palm of the damp hand over the back of your other hand. If the back of your other hand also becomes damp, then the aggregate is too wet to use’. This test was then tempered with accumulated local knowledge of how aggregates from different quarries behaved when spread damp. All of this became too hard to word in a specification, so the resulting clause was an attempt to scientifically come to a similar conclusion.

Common sense on site usually means agreement can be made on site without laboratory moisture testing, however this clause would be enforced should site resolution not occur.

4.3 Temperature, Wind and Weather

The acceptable limits for temperature, wind and pavement condition prior to sealing are detailed in Table 4.3.

Pavement temperatures shall be measured in the shade.

Wind speed shall be measured using a wind speed gauge.

TABLE 4.3

Product	Minimum Air/Pavement Temperatures (^{o}C)	Maximum Air/Pavement Temperatures (^{o}C)	Maximum Wind Speed (KPH)	Pavement

Always measure pavement temperatures in the shade, as it is the weakest link, and where stripping will always first commence.

With modern infra red thermometers, the pavement temperature is simply measured where the pavement is in the shade. If there is no natural shade over the job, measure the pavement temperature in your shadow. This ensures that the infrared thermometer measures the heat of the pavement and not reflected heat from the sun.

These maximum wind speeds are DPTI’s current best guess, and further observation and comment on this is needed. A maximum wind speed is basically to allow for the wind chill factor, but in addition if it is too windy the fan of bitumen from each jet will be distorted,

Prime	10/10	None	20	Dry
Primer Binder	10/10	None	30	No free water present
C170	15/15	None	30	Dry
C320	20/20	None	30	Dry
PMB (SBS based)	20/20[1]	None	30	Dry
PMB (PBD based)	15/15	None	30	Dry
Crumb Rubber	17/20[1]	None	30	Dry
Multigrade	15/15	None	30	Dry
Emulsion	5/5	40/70	30	No free water present

Note 1: 15/15 can be applied for SAMI in non-trafficked areas

Air temperatures shall be measured using a thermocouple based temperature device taken 1 metre from the pavement surface. The temperature device shall be positioned:

(a) away from any heat source;

(b) shaded from the sun; and

(c) not protected from the wind.

Until notified otherwise, the only Polymer Modified Binders (PMB) that are PolyButaDiene (PBD) based are Mobil and BP formulations of S35E.

resulting in an uneven application rate. This then leads to patchy stripping and bleeding.

A sprayer run shall not commence if it appears likely that either temperature will fall below 15ºC before completion of all work for that run, including rolling time.

This is particularly important in spring and autumn. When there is not enough residual heat in the pavement, the binder becomes brittle before the aggregate has finished reorientating, and aggregate snaps off resulting in brittle-failure stripping.

The Pavement may be damp, but not wet enough to allow runoff of the emulsion into the side drains. Similarly, emulsions should not be sprayed when rainfall sufficient to cause runoff is expected that afternoon or overnight.

A cutback overspray is sprayed at a higher temperature than a cutback reseal. The binder needs extra viscosity so it can flow down around the shoulders of the “hungry” aggregate beneath it, and fulfil its purpose of sticking the hungry aggregate in place to prevent stripping

5. PROTECTION OF ROAD FIXTURES

The Contractor shall prevent primer, binder, aggregate or other material used on the work from entering or adhering to gratings, hydrants or valve boxes, inspection pit covers, kerbs and other road fixtures. Damage to roadside furniture to be recorded on the daily record sheets to enable costs to be recovered.

Generally achieved in practice by careful placement of heavy duty paper and/or shovel loads of aggregate.

6. CLEANING OF PAVEMENT

The pavement shall be cleaned free of loose material so that primer will be absorbed into the base, or binder adhere to the existing seal, without prilling or being absorbed onto loose material.

The method of cleaning shall ensure that damage to the existing surface is prevented. Steel brooms shall not be used on unsealed base.

The Contractor shall remove all raised pavement markers and pavement bars prior to sealing and undertake any necessary repair to the existing seal. Additional payment will not be made for this activity.

When priming a base course it is also accepted practice to slightly dampen the surface, with a very quick pass of a water truck. This prevents the prime from prilling around surface dust particles, when it should be soaking into the top few millimetres of basecourse.

Steel bristle brooms can be used for cleaning an existing seal prior to a reseal, but not for cleaning bare basecourse.

Removed pavement markers are not to be disposed of within the road reserve.

7. OPERATION OF SPRAYER

The application of primer, primer binder, overspray and binder shall be by means of sprayer(s) currently certified as complying with Austroads Sprayer Calibration Procedures series AGPT/T530 to AGPT/T535. Hand spraying will only be permitted when the use of a mechanical sprayer is not practicable. All sections of road 8 m or less in width and with the same application rate shall be sprayed in one pass. Where the width of the run is greater than the maximum width that the sprayer is calibrated to spray, the Contractor shall include details of how a uniform application of binder across the joint will be achieved in the Quality Plan.

Bitumen impregnated paper shall be used at the start and end of each run to produce a straight line with not gaps or overlap between adjacent runs.

Where binder application rates below0.7 litres per square metre are specified, A3 nozzles or S2 (Austroads AN9) nozzles shall be used.

A copy of the current Sprayer certification certificate for each sprayer should be kept in the sprayer cabin and sighted prior to the first run of every contract, and again for every replacement sprayer. DPTI no longer issues sprayer certificates, they are issued by an independent but NATA Certified service provider. A list of currently Certified sprayers in Australia is maintained on the AAPA web site http:/www.aapa.asn.au
Hand spraying is notoriously un-accurate, usually resulting in far too-heavy an application rate. Its use should be minimised to where wheel paths will not generally travel, such as painted islands and safety-bar layouts.
When a road is sprayed in two half widths, a cold joint occurs at the middle, and this is prone to stripping.
On steep grades where we specify different application rates for uphill and downhill, and the road must be sprayed in two half widths, to prevent wheel path bleeding and stripping. The trade off here is that we then accept that stripping along the cold joint could occur. The use of an end jet would reduce the fanning out of resultant cold bitumen on the pavement.

The minimum of 0.8 L/m2 was reduced to 0.7 L/m2 in 2005 to reflect achievable field practice.

The most commonly used nozzle size is A4 (Austroads AN 18) To spray an application rate lower than 0.7 L/m^2, the forward speed

	required is faster than the sprayer can travel. This problem is overcome by fitting small nozzles with half the rated output (L/min). Check beforehand that the sprayer has been calibrated for A3 or S2 nozzles, in addition to A4. This will be detailed on the Sprayers calibration certificate, carried in the sprayers Cabin. Information on the change-over of Sprayer Nozzles from the Copley numbering system to the Austroads Designation is found at APRG Pavement Work tip No.33 "Sprayed Seals – Selection of Spraying nozzles" issued June 2002, which can be downloaded for free at

8. APPLICATION OF PRIME AND PRIMERSEAL Prior to the application of the prime or primerseal, a **HOLD POINT** shall apply. Release of the hold point will occur when it has been verified that: (a) the surface to be primed or primersealed is suitable, (b) marked guide lines have been set out correctly; and (c) the Contractor is properly prepared to proceed. For unstabilised granular pavements, priming and/or primer sealing shall not be commenced until the moisture content of the top 20 mm of the base is less than 60% of OMC. Where slow absorption of the prime causes interference with traffic or the application of binder, or at an intersection where traffic must cross the new prime, the Contractor shall apply approved cover material evenly over the primed surface. The Contractor shall maintain the surface in a satisfactory condition until the seal coat is applied.	Note that precoating of aggregate for primerseals, is not required. There are already sufficient precoating type agents in the primerbinder. Before placing primes and primerseals, don't forget moisture content and the ball penetration test. Refer to Part 221 This refers to the top 20mm of base course, whereas the 70% OMC referred to above refers to the full basecourse depth. This clause is based on private cars entering their residential addresses. Approved cover material may be crusher dust or washed concreting sand. The 1983 spec advised that any such cover shall not be applied until two hours after the application of the primer

9. APPLICATION OF BINDER Prior to the application of binder a **HOLD POINT** shall apply. Release of the hold point will occur once it has been verified that the pavement surface is suitable for the application of binder and that the Contractor is properly prepared to proceed. A list of approved bitumen adhesion additives is included as Appendix 3. The adhesion agent will only be considered to be active for a period of 10 hours after inclusion into the binder. Class 170 bitumen in a sprayer shall be deemed to be 100:0:0 and a tolerance of + 0.5 parts of cutter shall be allowed for the effect of minor quantities in previous loads, cleaning and the like. Where cutter and/or additives are required to be included in the binder, these shall be added at the site of the works. Cutter shall be added in accordance with Appendix 5. Flux shall not be used unless approved otherwise. Carry over of cutter and adhesion additive content, for spray load calculations, shall not be permitted after overnight storage. The application temperatures for primes, primer binder and binders shall comply with Table 9.	Check there are enough aggregate truckloads to continuously cover the binder before it cools, and there are enough roadworthy rollers ready to cover the full width in one pass. Appendix 3 is updated from time to time at the request and cost of the adhesion agent suppliers. We believe the active ingredient in most adhesion additives only remains active for about 10 hours after it has been added to bitumen "100:0:0" describes the ratios, per 100 parts bitumen, for C170 bitumen : Flux (Industrial Diesel Fuel) : Cutter (Power Kerosene) This format is traditional, but Flux is never called for by DPTI "100:0:0:0" describes the ratios, per 100 parts bitumen, for C170: Flux (IDF) : Cutter (PK) : Approved Adhesion Agent There is no guarantee that cutter or Adhesion Agent added at Adelaide, are still active or present within the binder by the time it reaches a rural site. Overnight storage at warm storage temperatures may drive off the volatile cutter, and neutralise the Adhesion Agent. Their effectiveness by the next day can be ignored. Refer AAPA Advisory Note 7 "Guide to heating and storage of binders for sprayed sealing and hotmix asphalt". This advisory note was updated in August 2003, and is now included as a centre spread in the June 2004 first edition AAPA document "Code of Practice: Manufacture, storage and Handling of Polymer Modified binders", which can be downloaded as a free .pdf from www.aapa.asn.au 185ºC max. for C170 has been specified for at least the last 20 years, and is still specified by most Australian Jurisdictions and by AAPA.

TABLE 9

Product	Minimum Spraying Temp (ºC) Un-cut	Max Re-heating Temp (ºC) Un-cut	Minimum Spraying Temp (ºC) Cut	Max Re-heating Temp (ºC) Cut
Light Prime	15	30	na	na
Medium Prime	40	60	na	na
Primer Binder	95	120	na	na
C170	175	185	Resultant	185

C320	175	185	Resultant	185
PMB	190	200	185	190
Crumb Rubber	190	200	190	200
Multigrade	175	185	Resultant	185
Emulsion	Manufacturers recommendation	90	na	na

**For cut C170, C320 and Multigrade the binder shall be heated to 185ºC, additive and/or cutter added and then sprayed at the resultant temperature*.

The use of alternative products to those nominated in the Quality Plan for binder and precoat shall be subject to approval and the Contractor demonstrating the suitability and compatibility of the products.

PMBs are generally more viscous (thicker) and need to be heated to a higher temperature to enable them to thin and fan properly out of the sprayers nozzles. We specify 195ºC max. AAPA advisory note 7, Note 1, says that PMB temperatures at point of spraying must not exceed 200ºC. If they can't exceed this for the short time they are in the sprayer, then I consider they cant exceed this for the longer times that they are in the Bulker and in storage.

It is acknowledged world wide that SBS binders double their degradation rate for every 10ºC rise in temperature. Therefore, any PMB bulker arriving on site at above 195ºC should be rejected.

If the job is rained out and binder must be stored for a day or more, then lower temperatures, for medium term storage, are quoted in AAPA advisory note 7. Theses should be adhered to.
C170(PMB) is regarded as the most widely used bituminous binder for sprayed sealing in South Australia for those works other that shoulder sealing where C170 predominates

This explains what "resultant" means in Table 9

10. APPLICATION OF STRAIN ALLEVIATING MEMBRANE INTERLAYER

A SAMI seal shall be left exposed for at least 1 day but no more than 7 days, prior to the application of the asphalt overlay. If the SAMI seal is subject to traffic, other than construction vehicles, then an alternative time for the application of the asphalt overlay may be directed.

SAMIs are left exposed to the air to let any volatiles in them evaporate, rather than soften-up the asphalt that will be placed over them.

SAMIs are designed for max membrane thickness, rather than carrying heavy traffic loads (which is what the asphalt is for), so that they need to be covered before the traffic has orientated the aggregate to the point were the SAMIs start to bleed.
If the weather is hot, amount of volatiles are low, and traffic is heavy, the Superintendent may elect to relax the one-day minimum.

Where the temperature of the pavement surface on which the SAMI is to be placed is below 20ºC, the following additional requirements shall apply:

(a) The use of an emulsion binder, or

(b) The use of hot application of binder with hot sealing aggregate.

Often asphalt work occurs outside the spray-sealing season, and minimum temperatures cannot be met.

If the SAMI is not to be trafficked until after the AC has been placed, the Superintendent could relax the minimum temperature, as the potential for stripping, with its associated public safety hazards, does not exist.

SAMI binders may be purchased in Emulsion equivalents (currently sourced from interstate), in which case the minimum pavement & air temps come down to 5^0C (Table 4.3). However, when trafficking be aware of Constraints to Work (clause 4.1).
Another solution may be to heat the aggregate through an asphalt plant and deliver to site, spread and roll whilst still hot. This will reduce the potential for stripping, and has been successfully done.

11. APPLICATION OF AGGREGATE

11.1 Precoating

Precoat may be applied at the quarry or at the stack site. Precoat shall be applied such that at least 80% of each stone's surface is coated. A vibrating screen aggregate loader shall be used where aggregate is precoated at the stack site.

Check that the precoater is distributing precoat evenly across the width of the conveyor belt.
A vibrating screen aggregate loader (shaker deck) is specified because it removes both fines (dust) and oversize (stockpile floor rubble) in addition to giving better precoating coverage.

Precoat shall consist of not less than 30 parts of bitumen to 100 parts of IDF and 1.5 parts approved adhesion agent.

Precoated aggregate may be stockpiled, provided that the Contractor implements approved measures to ensure that contamination does not occur.

Aggregate shall be used within 1 month of precoating.

The methods to eliminate contamination from deleterious material and deterioration of the pre-coated aggregate shall be included in the Quality Plan.

If precoating-in-advance is allowed, ask for this Quality Plan and read it

The Contractor's methods to monitor, manage, mitigate or eliminate pollution or environmental impacts of pre-coated aggregate sites will be included in the Contractor's Environment Management Implementation Plan outlined in Part G50 "Environmental Management Requirements".

11.2 Aggregate Spreading and Rolling

TABLE 11.2

Product	Maximum Cover Time (min)	Minimum Passes over Full Width	Rolling Time
Primerseal	5	4	T
C170	5	4	T
C320	3	6	pave temps < 25ºC: 2T 25ºC < pave temps < 30ºC: 1.5T pave temps > 30ºC: T
PMB (SBS based)	3	6	pave temps < 25ºC: 2T 25ºC < pave temps < 30ºC: 1.5T pave temps > 30ºC: T
PMB (PDB based)	5	4	T
Crumb Rubber	3	6	pave temps < 25ºC: 2T 25ºC < pave temps < 30ºC: 1.5T pave temps > 30ºC: T
Multigrade	5	4	T
Emulsion	Manufacturer's Recommendation	4	T

Until notified otherwise, the only Polymer Modified Binders (PMB) that are PolyButaDiene (PBD) based are Mobil and BP formulations of S35E.

The binder shall be covered with aggregate as soon as practicable. In no case shall this exceed the times given in Table 11.2.

The aggregate covered surface shall be rolled with a minimum contact pressure of 690 kPa over the whole surface.

Rolling shall commence immediately after aggregate spreading has commenced.

Notwithstanding the requirements of this Clause, the minimum number of passes over the full width treated shall be made as per Table 11.2 for all pavement temperatures. Rolling shall continue without interruption until the aggregate is firmly embedded in the binder.

For all binders there shall be sufficient rollers to cover the full width to be sealed with one pass. Roller speeds shall not exceed 5 km/h for the first 2 passes and 15 km/h thereafter.

The rolling time shall be calculated in accordance with Table 11.2 and the requirement below.

A base rolling time per 4 000 litres of binder sprayed shall be calculated by the formula:

$$T = \frac{216}{W}$$

Where T is the time in minutes and W is the total width covered by the rollers in metres.

In 1990 the basic "T" formula was empirically modified by the then Asphalt Engineer to allow for PMBs by introducing a 1.5T and 2T factor. The addition of cutter to PMBs was not allowed at that time, due to the PMBs then available

The most effective time to apply the aggregate is while the binder is still hot, and "aggregate wetting" of the binder occurs. It takes only a couple of minutes for the hot binder to revert to the temperature of the pavement beneath it. As PMBs are more viscous (thicker), they need a higher temperature to soften them up and for aggregate wetting to occur - hence they need to be covered in a quicker time. Some PMBs also form a surface "skin" on cooling, which the aggregate does not penetrate – again, they need to be covered quickly before this happens.

Again, the most effective time to apply the aggregate is while the binder is still hot, and "aggregate wetting" of the binder occur

The unmodified component was specified in 1983, the modified component circa the 1990/91 season. The importance of these minimum passes were confirmed in some 1996 R&D published as: Neaylon, KL, "The Measurement of Aggregate Reorientation in Sprayed Seals using Stereoscopic Microphotogrametery", Roads 96: Joint 18th ARRB Transport Research Conference and Transit New Zealand Transport Symposium, Christchurch, NZ, September 1996.

This requirement was added, initially for PMBs only, circa '90/91 season. Subsequent R&D work in 1996 (quoted above) saw this extended to all binders.

This is the original *Highways Department of SA* rolling formula that has grown over time from proven practice. The original rule of thumb was 90 minutes of rolling per sprayer run (about 1,000 gallons) per each 11 tyred 11-ton roller. On one particular job, due to a mechanical breakdown a 7-ton roller was pressed into service and a site agreement reached to factor up rolling time by 11/7 accordingly. This was later formalised into a rolling formula that could cater any size rollers. The basic formula devised was further soft converted to metric, and is currently specified as T=216/W.

In 1996 rolling practices in SA, Vic, NSW, Qld, and NZ were all different. In an attempt to harmonize practices, the Austroads Pavement Reference Group in 2000 published Pavement Work tip No. 24 "Sprayed sealing – Rolling of Cover Aggregate", DPTI trialled this new method, but concluded that although we had confidence in the reduced rolling that this afforded in warm temperatures, concerns still existed over lowering the amount of rolling in cooler temperatures and in lower traffic levels. Austroads Work Tip 24 method was adopted briefly in this specification only for Pavement temperatures of 30^{0}C and over. It has since been removed due to lack of DPTI & Industry interest/use. It could be reconsidered upon specific company request

12. REMOVAL OF LOOSE AGGREGATE AFTER ROLLING When the binder has hardened to a stage at which no more aggregate can be pushed into it by rolling, or by traffic moving at slow speeds, all loose aggregate shall be removed 900 mm clear of the edge of the seal. Loose aggregate only shall be removed, and without disturbance of the embedded aggregate. The above shall apply to all seals, including the first coat of a double seal. Where the pavement has kerb and gutter, the loose aggregate shall be picked up and removed from the site. Removal of loose aggregate shall commence within 12 hours of the completion of rolling. Prior to removal of loose aggregate after rolling, a **HOLD POINT** shall apply for the purpose of ensuring the binder has properly adhered to the aggregate and pavement. Release of the hold point will occur once it has been verified that the removal of loose aggregate will not damage or have the potential to damage the new seal through the loss of aggregate and loose aggregate does not present a traffic hazard.	

13. PAVING FABRIC Where the use of paving fabric is specified, it shall comply with Part R85 "Supply of Geotextiles" and shall be placed in accordance with the manufacturer's instructions and the following: (a) Public traffic shall not be permitted to travel on the paving fabric until the first layer of the specified seal has been applied; (b) Overlap of the paving fabric shall be between 100 and 150 mm; (c) Paving fabric shall be placed so that the transverse joint between adjacent rolls shall overlap in the direction of traffic; (d) Longitudinal overlap of the fabric shall be placed within 200 mm of the centreline or lane line; (e) The fabric shall be bonded to the pavement with a tack coat sprayed 100 mm wider than the fabric. Appropriate end jets shall be used to ensure the specified tack coat rate is applied across the entire width of fabric; (f) Equipment used to place fabric shall not cause undue migration of the underlying tack coat into the fabric; and (g) Upon completion of placing of fabric and prior to application of binder, the fabric shall be rolled with 4 passes of a pneumatic multi-wheel roller. A certificate of compliance for the paving fabric shall be included with the respective AE Lot data. Seal dimensions specified do not allow for additional binder or fabric required for overlap.	Important practical guidelines that will be of assistance to field personnel are: Materials Technology Section Technical Note No. 22 “Geotextile Reinforced Sprayed Seals”, issued Dec 2000, available from the Supervising Surfacings Engineer; and APRG Pavement Worktip No 25 “Geotextile Reinforced Sprayed Seals”, April 2001, Never use wet or damp Geofabric, as it will not absorb bitumen to the required amount. Paving fabric in South Australia is laid from a framework attached to either a Tractor or Front-End-Loader (Not a Multi tyred roller as is the case in some Eastern States.) Particularly if the FEL has hydraulic steering, the placement of the roll often varies laterally by a large amount. In order to ensure that full width crack retention and waterproofing is achieved, a minimum overlap was specified. The intent is to ensure that at the worst 5% of the join, at least a but joint is achieved. The specified overlap was reduced in 2002/03 to reflect improving work practices. It is common for Geofabric seals to strip over the overlap, especially where the contractor has no procedure to allow for the doubling of binder absorption into fabric at these locations. It is therefore important that the overlap does not occur in a wheel path. It would be better if the contractor had a procedure to allow for the doubling of binder absorption into fabric at these locations. The extra 100mm width, gives the laying front-end-loader a bit of room to wander without affecting the reseal integrity. If end-jets are not used, the overlap must be 250mm This is now believed to be more temperature related than equipment related, but when too much tack coat works to the surface, the fabric sticks to the tyres of passing equipment that then lifts the fabric and tries to tear or stretch it. This clause is based on experience that has been found to work. Refer Table 19. In general, the Certificate must be to Australian Standards and issued by a NATA endorsed laboratory. Refer Clause 6 Test Procedures of Part 275 “Supply of Geotextiles”

14. SURPLUS AND WASTE MATERIALS Waste, including unused contractor supplied aggregate, bitumen, empty containers or other materials remaining after completion of the work shall be removed from the site by the Contractor and the work site shall be left in a neat and tidy condition. Disposal shall be in accordance with the Environment Protection Act. All work shall be conducted in accordance with the DPTI Environmental Code of Practice.	Includes removed Raised Pavement Markers

15. RECORDS OF WORK

The Contractor shall complete the form DPTI 397 "Seal Coat Treatment - Daily Record Sheet", included as Appendix 4, or an approved equivalent, which shall then be certified correct by the Contractor and forwarded by the start of the next working day. Details of all materials applied shall be recorded immediately after each spraying "run".

The Contractor may submit an alternative recording form for acceptance provided that all details required in form DPTI 397 are included.

Note that the Contractor is required to submit documentation in accordance with Part R25 "Supply of Bituminous Materials" and Part R15 "Supply of Pavement Materials" to demonstrate compliance with the Specification.

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There is a problem Nationally with the introduction of point-of-delivery specifications for PMBs, as there is a scarcity of data. DPTI and SA Industry wish to move to a situation where the customer can be reasonably sure of receiving at site the product that was asked for. To work towards this, the following clause was included in the 02/03 season, and will be actively enforced in the successive seasons.

16. APPLICATION TOLERANCES

Materials shall be applied, or added to, within the following tolerances of the specified rate:

(a) Cutter proportions - ± 1.0 parts per 100 parts of bitumen, except that for overspray when cutback is specified the tolerance shall be - ± 1.5 parts per 100 parts of bitumen.

(b) Application of primer, primer binder, binder and overspray shall be within ± 5% of the specified rate. For short bar runs and hand spray work the tolerance shall be ± 20%.

(c) Spreading of aggregate shall be within ± 5% of the specified rate.

(d) The proportion of adhesion additive used in precoat (specified per 100 parts IDF: 30 parts C170: 1.5 parts approved additive) shall be within -0.5 to +1.0 parts.

The longitudinal line followed shall be within 50 mm of that specified for straight runs and 100 mm on curved alignments.

17. TEST PROCEDURES

The Contractor shall use the following test procedures to verify conformance with the Specification:

TEST		TEST PROCEDURE
Moisture Content:	Oven Drying Method	AS 1289.2.1.1
	Microwave Method	AS 1289.2.1.4
Sampling of Soil, Aggregates and Rocks		TP 226
Determination of Aggregate Stripping Value - One Day Plate Stripping Test		TP 705

Laboratory testing of aggregate moisture content is not practical on site and is likely to be only called for to resolve site supervisors differences of opinion.

18. HOLD POINTS

The following is a summary of Hold Points, vide Part 140 "Quality System Requirements", referenced in this Part:

CLAUSE REF	HOLD POINT	RESPONSE TIME

These are maximum response times

2	Submission of Procedures and documentation(if not in Post Tender Submission)	7 days
3.1	Prior to use of sealing aggregates	2 working days
8	Prior to application of prime or primerseal	3 hours
9	Prior to application of binder	3 hours
10	Prior to removal of loose aggregate after rolling	3 hours

19. VERIFICATION REQUIREMENTS AND RECORDS

19.1 Test Records

The Contractor shall undertake the testing specified in this Clause and supply written evidence of compliance with the lot package.

CLAUSE REF.	SUBJECT	PROPERTY	TEST PROCEDURE	TEST FREQUENCY	ACCEPTANCE LIMITS
3 & Part 215	Precoat and Aggregate*	Stripping	TP 705	Annually / Source of Aggregate	Wet: Max 15% Dry: Max 5%
3 & Part 215	Aggregate Properties*	ALD	AS1141.20.1 or AS 1141.20.2	One test per lot	Report Value
3 & Part 215	Aggregate Properties*	Grading	AS 1141.11	One test per lot	Refer Part R15. Appendix 1
3 & Part 215	Aggregate Properties*	Flakiness	TP 241	One test per lot	Refer Part R15. Appendix 1
3 & Part 215	Aggregate Properties*	Misshapen Particles	AS 1141.14	One test per lot	Refer Part R15. Appendix 1
3 & 4.2	Aggregate Properties	Moisture Content	AS 1289.2.1.1 AS 1289.2.1.4	On request	Non-PMB: 0.8%PMB: 0.01%
13 & Part 275	Paving Fabric	Mass per unit area	AS 3706.1	One per lot	Refer Part R75
13 & Part 275	Paving Fabric	Wide Strip tensile strength	AS 3706.2	One per lot	Refer Part R75
13 & Part 275	Paving Fabric	Maximum elongation	AS 3706.2	One per lot	Refer Part R75
13 & Part 275	Paving Fabric	Binder retention rate	ASTM D6140-00	One per lot	Refer Part R75
15	Binder and Aggregate	Application Rate	As recorded on Daily Record Sheet	Per Run	Refer Clause 15 "Tolerances"
8, 9 & Part R25	Supply of Bitumen	Refer Part R25			

* Not applicable for aggregate supplied by the Principal.

19.2 Other Records

The Contractor shall supply the following records:

CLAUSE REF.	SUBJECT	RECORD TO BE PROVIDED
15	Records of Work	DPTI 397 "Seal Coat Treatment - Daily Record Sheet",

20. MEASUREMENT AND PAYMENT

20.1 Measurement

Measurement of Quantities will be based on DPTI 397 "Seal Coat Treatment – Daily Record Sheet" or an approved equivalent.

For two coat seals, measurement will be determined from the area of the first coat.

Measurement of Cutter will be based on the amount used as recorded in the daily record sheets.

Measurement of Paving Fabric will be based on the final surface area covered, with no allowance for the specified overlaps.

20.2 Payment by Schedule of Rates

This sub-clause applies if payment for sprayed bituminous surfacing will be made by Schedule of Rates.

On an individual sprayer run basis, payment will be made at the rates in the Schedule of Rates for the actual quantities of primer, primer binder, overspray and binder prepared and sprayed on the road under this Specification at rates of application specified or ordered and within the tolerances specified.

For individual jobs in this Contract, the unit rates shall apply where the approved proportions and rates are within the ranges set out below for individual jobs. This does not invalidate the total Contract quantities or the limits of accuracy detailed in the Schedule of Rates.

Proportions of components of primer	± 25%
Proportions of flux, cutter in binder	± 100%
Proportion of additive in binder	± 100%
Application rate for primer	± 50%
Application rate for overspray	± 25%
Application rate for binder	± 15%
Application rate for precoating of aggregate	± 50%
Application rate for aggregate spreading	± 10%

20.3 Payment by Lump Sum

This sub-clause applies if payment for sprayed bituminous surfacing will be made by Lump Sum or part thereof.

Where a direction has been issued to adjust the proportions or application rates, the amount paid will be adjusted by an amount determined from the applicable rate in the Schedule of Rates for Variations.

APPLICATION OF SPRAYED BITUMINOUS SURFACING: APPENDIX 1

VOLUME CONVERSION TABLE - BITUMEN EMULSION

HOT LITRES x A = COLD LITRES (15ºC) COLD LITRES x B = HOT LITRES (TºC)

60% BITUMEN EMULSION			70% BITUMEN EMULSION			80% BITUMEN EMULSION		
A	TEMP (TºC)	B	A	TEMP (TºC)	B	A	TEMP (TºC)	B
1.0000	15	1.0000	1.0000	15	1.0000	1.0000	15	1.0000
.9998	16	1.0002	.9977	20	1.0023	.9974	20	1.0026
.9989	18	1.0011	.9951	25	1.0049	.9948	25	1.0052
.9980	20	1.0020	.9924	30	1.0076	.9921	30	1.0079
.9971	22	1.0029	.9899	35	1.0102	.9895	35	1.0106
.9962	24	1.0038	.9872	40	1.0129	.9868	40	1.0134
.9953	26	1.0047	.9840	46	1.0162	.9837	46	1.0166
.9944	28	1.0056	.9830	48	1.0172	.9826	48	1.0177
.9935	30	1.0065	.9819	50	1.0184	.9816	50	1.0187
.9926	32	1.0074	.9809	52	1.0194	.9805	52	1.0199
.9917	34	1.0083	.9798	54	1.0206	.9794	54	1.0210
.9908	36	1.0092	.9788	56	1.0216	.9783	56	1.0222
.9899	38	1.0102	.9777	58	1.0228	.9773	58	1.0232
.9890	40	1.0111	.9767	60	1.0238	.9762	60	1.0244
.9881	42	1.0120	.9752	62	1.0254	.9751	62	1.0255

.9872	44	1.0129	.9746	64	1.0260	.9740	64	1.0267
.9863	46	1.0138	.9736	66	1.0271	.9730	66	1.0277
.9854	18	1.0148	.9725	68	1.0282	.9719	68	1.0289
.9845	50	1.0157	.9715	70	1.0293	.9709	70	1.0300
.9836	52	1.0166	.9704	72	1.0305	.9698	72	1.0311
.9827	54	1.0176	.9693	74	1.0316	.9687	74	1.0323
.9818	56	1.0185	.9683	76	1.0327	.9677	76	1.0334
.9809	58	1.0194	.9672	78	1.0339	.9667	78	1.0344
.9800	60	1.0204	.9662	80	1.0349	.9656	80	1.0356
.9791	62	1.0213	.9651	82	1.0361	.9643	82	1.0370
.9782	64	1.0222	.9640	84	1.0373	.9630	84	1.0384
.9773	66	1.0232	.9630	86	1.0384	.9616	86	1.0399
.9764	68	1.0241	.9619	88	1.0396	.9603	88	1.0413
.9755	70	1.0251	.9608	90	1.0407	.9590	90	1.0427

APPLICATION OF SPRAYED BITUMINOUS SURFACING: APPENDIX 2

VOLUME CONVERSION TABLE – HOT BITUMEN-BASED BINDERS

MULTIPLY BY "A" TO REDUCE VOLUME AT Tº TO VOLUME AT 15º
MULTIPLY BY "B" TO INCREASE VOLUME AT 15ºC TO VOLUME AT Tº

Multiplier A	Temp. ºC T	Multiplier B	Multiplier A	Temp. ºC T	Multiplier B
.9856	38	1.0146	.9356	120	1.0688
.9844	40	1.0158	.9344	122	1.0702
.9831	42	1.0172	.9332	124	1.0716
.9819	44	1.0184	.9320	126	1.0730
.9806	46	1.0198	.9308	128	1.0743
.9794	48	1.0210	.9296	130	1.0757
.9782	50	1.0223	.9284	132	1.0771
.9769	52	1.0236	.9272	134	1.0785
.9757	54	1.0249	.9260	136	1.0799
.9745	56	1.0262	.9249	138	1.0812
.9732	58	1.0275	.9237	140	1.0826
.9720	60	1.0288	.9225	142	1.0840
.9708	62	1.0301	.9213	144	1.0854
.9695	64	1.0315	.9201	146	1.0868
.9683	66	1.0327	.9189	148	1.0883
.9671	68	1.0340	.9178	150	1.0896
.9659	70	1.0353	.9166	152	1.0910
.9646	72	1.0367	.9154	154	1.0924
.9634	74	1.0380	.9142	156	1.0939
.9622	76	1.0393	.9130	158	1.0953
.9610	78	1.0406	.9119	160	1.0966
.9597	80	1.0420	.9107	162	1.0981
.9585	82	1.0433	.9095	164	1.0995
.9573	84	1.0446	.9084	166	1.1009
.9561	86	1.0459	.9072	168	1.1023
.9549	88	1.0472	.9060	170	1.1038
.9537	90	1.0486	.9049	172	1.1051
.9524	92	1.0500	.9037	174	1.1066
.9512	94	1.0513	.9025	176	1.1080
.9500	96	1.0526	.9014	178	1.1094
.9488	98	1.0540	.9002	180	1.1109
.9476	100	1.0553	.8990	182	1.1123
.9464	102	1.0566	.8979	184	1.1137
.9452	104	1.0580	.8967	186	1.1152
.9440	106	1.0593	.8956	188	1.1166
.9428	108	1.0607	.8944	190	1.1181
.9416	110	1.0620	.8933	192	1.1195
.9404	112	1.0634	.8921	194	1.1209
.9392	114	1.0647	.8909	196	1.1224
.9380	116	1.0661	.8898	198	1.1239
.9368	118	1.0675	.8886	200	1.1253

APPLICATION OF SPRAYED BITUMINOUS SURFACING: APPENDIX 3

APPROVED BITUMEN ADHESION ADDITIVES

Megamine NV
Aggr Grip 520LT

APPLICATION OF SPRAYED BITUMINOUS SURFACING: APPENDIX 4

DAILY RECORD SHEET – SEAL COAT TREATMENT

Road Name	A.E. No. /
	Date / /
	Contractor
Type of Work (e.g. prime, seal, reseal, etc)	Sprayed No.

Location of Work (on this sheet) From -Wards (*insert directions*)											
To											
Reference to km Post, Junctions, chainages, etc											
Run No.		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**0**	Totals
Time												
Air Temp ºC												
Surface Temp ºC												
Binder Mix 100/		/	/	/	/	/	/	/	/	/	/	
Added Load (Litres)	Bitumen hot											
	Flux cold											
	Cutter cold											
	Additive											
	Total											
Dipstick Reading	Start											
	Finish											
Litres Sprayed	Hot*											
	Temp ºC											
	Cold*											
	Cutter*											
	Resid Binder*											
Distance From Starting point	Start of run											
	End of run											
Length of spray …….m												
Width of spray ……m												
Side of road												
Area sprayed m^2												
Specified appl. rate *												l/m^2
Specified litres *												
Tolerance ……..*												
Difference ……..*												
Actual appl. Rate …….*												
Aggregate	Source and Size											
	Spec. coverage											m^2/m^3
	Quantity used											
	Act. Coverage											
	Precoat (/)											
Sample Number												

Remarks (alterations to specifications – weather, etc.) No. of Rollers used .....Swept after rolling? Yes/No

.....

.....

DPTI Representative ..... Contractor's Representative .....

APPLICATION OF SPRAYED BITUMINOUS SURFACING: APPENDIX 5

GUIDELINES FOR ADDITION OF CUTTER

Cutter is used to reduce the viscosity of the binder, and enhance the initial wetting of the aggregate.

Following the addition of cutter to the binder, the load should be circulated for at least 15 minutes to ensure a uniform mixture

The amount of cutter required will vary with the pavement temperature and the temperature and traffic conditions in the next few days after application. The Tables show typical cutter addition rates in parts per hundred parts of bitumen

Product	**PAVEMENT TEMPERATURES (ºC)**							
100:0:y Parts Cutter	15 – 20	20 – 25	25 - 30	30 - 35	35 – 40	40 -50	50-60	Over 60
C170	6	5	4	3	2	0	0	
C320	7	6	5	4	3	2	0	0
Multigrade	6	5	4	3	2	1	0	0
S10E	na	6	5	4	3	2	0	0
S15E	na	7	6	5	4	3	2	0
S20E	na	8	7	6	5	4	3	0
S35E (SBS based)	na	6	5	4	3	2	0	0
S35E (PBD based)	4	3	2	1	0	0	0	0
S15RF	na	9	8	7	6	4	4	4
S18RF	na	10	8	9	7	5	5	4
S45R	na	9	8	7	6	4	4	4

The only S35E's that are PolyButaDiene (PBD) based are Mobil and BP formulations, until notified otherwise.

Further changes to the cutter rates may be made on-site to account for:

1. Weather changes prior to completion of rolling: Treat as for likely conditions.
2. Time lapse between temperature measurement and actual spray run: Try to anticipate the actual temperature, and cut accordingly.
3. Age of prime or primer binder (if applicable): If these still contain significant amounts of cutter, the cutting rate may be reduced by 1 part.
4. Two-coat crumb rubber seals require a minimum of 4 parts of cutter in the bottom coat. For all other binders no more than two parts of cutter in the bottom coat is generally required.
5. Traffic conditions: High traffic volumes and masses require less cutter to achieve wetting. Cutter can be reduced by up to 2 parts for roads carrying high volumes and percentages of commercial vehicles (e.g. National Highways), particularly in spray runs completed in the morning, and which will be under traffic control for most of the day. Larger aggregates may require 1 part more cutter to assist wetting where traffic volume is low.
6. Pre-blended crumb rubber grades may contain process oil. This oil will most likely reduce the viscosity of the binder compared to field blended grades; this may allow a reduction of 1-2 parts in the cutting rate.

Wind speed at the time of spraying can affect the rate at which the binder cools. This should be considered when determining the amount of cutter required.

The cutting requirements of PMBs are quite different than that of straight C170. Check to see the requirements for the particular grade PMB that you are using! Don't forget to read points 1 – 6!

This cutting chart is based on work that was undertaken in 1997, and published as: Maccarrone, Neaylon, Clark & Gnanaseelan "The effect of Cutter on the performance of Polymer Modified Sealing Binders", 10th AAPA International Flexible Pavements Conference, Perth, November 1997

Another PMB cutting chart worth trialling - in consultation with the Supervising Surfacings Engineer - is APRG Pavement Work Tip No 27, "Sprayed Sealing – Cutting Back of Polymer Modified Binders",