Bituminous Sprayed Surfacing Manual
Technical Bulletin No 45
The purpose of this Guide is to provide information and guidelines for the application of Bituminous Sprayed Seal Surfacing. The document describes the required materials, processes and equipment used.


This document has been published with the permission of the General Manager - Road System Management VicRoads.

ABOUT VICROADS

VicRoads is the Victorian State Road Authority responsible for the management of the road network, which includes planning, designing, constructing and maintaining roads, managing road use through registered vehicles, licensing drivers and traffic management, and providing information and other road user services.

ABOUT GEOPAVE

GeoPave is an off-budget business unit within VicRoads responsible for developing technical expertise and training in road making materials, geotechnical work and pavement technology. In addition, GeoPave provides an investigation, testing, design and consulting service in these areas of expertise.

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The updating task has been carried out by GeoPave with the assistance of staff from Sprayline, AH Plant, VicRoads and of Industry representatives. Particular thanks go to Sprayline and AH Plant for the use of drawings and photographs.

There are many references available to readers interested in Bituminous Surfacing. Austroads, AAPA, GeoPave and other State Road authorities are valuable sources of Technical Reports, Technical Notes, Worktips and Guideline documents which are readily available.

Sections of the manual contain references to, or discuss aspects of the relationships between VicRoads, GeoPave, Sprayline and AH Plant. It is noted that these may no longer be relevant, however could be considered as typical interactions between a road managers and their contractors when undertaking bituminous sprayed surfacing operations.
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1.1 THE VICTORIAN NETWORK
VicRoads is financially responsible for 22 900 km of roads, 90% of which are surfaced with a sprayed seal. Hot mix asphalt is used on about 2000 km of urban, heavily trafficked roads. In rural areas there are approximately 700 km of unsealed pavements. Only a small proportion of the total road system is surfaced with concrete.

Local government is responsible for a further 138 000 km of public roads in Victoria, 23 000 km of which are in urban areas. In rural areas there are about 20 000 km of surfaced roads, mostly with a sprayed seal. A proportion of urban roads are also surfaced with a sprayed seal making the total length of sprayed sealed roads in Victoria well over 40 000 km.

1.2 ORGANISATION OF SPRAYED SEAL WORK
VicRoads is the manager of only 22 900 km of the road assets referred to above. Delivery of services for construction and maintenance work on the road network is generally performed by contracts managed by VicRoads.

Some of the contract sprayed seal work done for VicRoads is carried out by VicRoads’ contract sealing division, Sprayline. The plant and equipment used by Sprayline in 1998 is provided through a service agreement with AH Plant (originally VicRoads’ Plant Branch). AH Plant is also responsible for development and maintenance of equipment used.

Specialist advice for sprayed seal technology, materials and specifications is provided by GeoPave of VicRoads’ Commercial Services Division.

The procedures described in this manual refer to VicRoads, Sprayline, and other contractors working directly for VicRoads. The procedures are also applicable to other organisations carrying out sprayed seal work.

1.3 TERMINOLOGY
The term sprayed seal, as used in this manual, describes the process of spraying a layer of bituminous binder covered by a single layer of aggregate or stone chips. In its broader context it also includes priming and surface enrichment, where no aggregate cover is used, and multiple applications of binder and aggregate.

In Victoria, the term aggregate is used to describe particles that have been crushed and screened to a uniform size. The word derives from natural stone being formed as an aggregate of different mineral substances to form a solid mass. In other countries the stone particles are often referred to as ‘stone chips’ and the process as ‘chip sealing’.

1.4 SPRAYED SEAL SURFACE PAVEMENTS
1.4.1 Materials
Pavements which are to be spray sealed in rural Victoria are often made up of naturally occurring materials. On the more heavily trafficked roads a manufactured crushed rock can be used as the final layer(s) of material.
To spray seal the top of a pavement, the surface must be smooth, tight and have a uniform texture. This is produced by watering, rolling and grading the top of the pavement. This process is termed preparing the pavement for initial sealing (the first sprayed seal coat).

On top of the prepared pavement surface a sprayed seal is applied. There are various techniques but essentially they are all a sprayed layer of bitumen with aggregate rolled into the bitumen.

Sprayed seals provide a durable, waterproof and a substantially maintenance free surface. As a sprayed seal is very thin it does require regular periodic maintenance to quickly repair tears to the surface and pot holes.

Sprayed seal surfaced pavements can have problems with vehicles that turn very sharply as this action can roll the aggregate and destroy the thin, waterproofing, bituminous layer. Construction of sprayed seals can be in the order of 6 to 12 lane kilometres in a day.

1.4.2 Design of Spray Seals

Basic factors in determining the bitumen application rate of a sprayed seal are:

- size of aggregate
- the absorption of bitumen into the existing pavement
- traffic volumes in a lane
  (the lower the traffic volumes the higher the bitumen application rate, while, the higher the traffic volume the lower the bitumen application rate)
- the type of treatment

The traffic runs on the top of the aggregate and the tyres do not come into contact with the bitumen. A sketch of the basic arrangement of a sprayed seal is shown in Figure 1.4.2.

Figure 1.4.2 Sketch showing tyre contacting the aggregate and clearance to the bitumen
1.4.3 Aggregate

The aggregate is usually one-sized and must be clean and durable. The aggregate is delivered to the site and before being spread onto the bitumen it is screened using an aggregate loader and then precoated with diesel fuel oil (which may contain an adhesion agent).

VicRoads’ aggregate loaders screen the aggregate to remove any fine material, precoat the aggregate (to aid adhesion of the aggregate to the bitumen) and load the aggregate into trucks.

1.4.4 The Process

The pavement surface is initially treated by either:

- primersealing, where a special bitumen mixture is sprayed directly onto the surface and the aggregate rolled into the bitumen, or
- priming then sealing. A prime is a very thin mixture of bitumen, kerosene and other components which is used to wet the surface of the pavement and to soak into the pavement. The seal is achieved by spraying the bitumen (with some minor additives) onto the primed surface and then spreading and rolling the aggregate into the bitumen.

*Figure 1.4.4 Sketch of the sprayed seal sealing process*
1.5 RESEALING

Pavements surfaced with a sprayed seal are normally treated by resealing on a regular basis.

After the pavement has been initially treated it should be resealed every 8 to 14 years as part of a periodic maintenance program.

On occasions, asphalt surfaced pavements are spray sealed to prevent further oxidisation of the surface (and prevent subsequent ravelling), to waterproof a cracked pavement and to improve the skid resistance of the pavement.

Pavements are normally resealed with class 170 bitumen. For heavily trafficked roads 5 parts crumb rubber buffings or small concentrations of other polymer may be added to the bitumen. This helps the bitumen grip the aggregate better and makes the binder more robust.

For damaged roads, VicRoads regularly adds 20 parts crumb rubber buffings or uses polymer modified bitumens (generally 5 to 7% polymer) to improve the effectiveness of the reseal.

For extensively distressed pavements it is often necessary to surface the pavement with a geotextile reinforced sprayed seal. This treatment may use one or two coats of aggregate and it may use Class 170 binder or a polymer modified binder. Geotextile reinforced sprayed seals strengthen the surfacing and provide a more robust waterproofing layer than unreinforced seals.

1.6 ADVANTAGES OF SPRAYED SEAL PAVEMENTS

- Use cheaper local materials
- Use less bitumen than asphalt pavements hence are cheaper
- Provide excellent skid resistance and high macro texture
- May be used as a remedial treatment over asphalt pavements
- Are a quick retreatment.

1.7 DISADVANTAGES OF SPRAYED SEAL PAVEMENTS

- Require more routine maintenance than asphalt
- Require periodic maintenance more frequently than asphalt surfaced pavements (perhaps every 10 years compared with 15 years)
- Are adversely affected when subject to very heavy turning movements
- Are noisy in some circumstances.

Victoria has been able to produce sprayed seal surfacings relatively cheaply and of high quality. This has resulted in an extensive all weather, dust free, sealed road network which has enabled Victoria to transport produce and goods quickly and cheaply.
2.1   GENERAL

2.1.1   Function
In bituminous surfacing work the function of aggregate is to resist abrasion and to transmit the wheel loads to the base pavement materials. The aggregate is held in position by the binder. An aggregate must possess the necessary shape, hardness, toughness, wearing and crushing strength characteristics to withstand the traffic conditions under which it is to be used. The density and type of traffic varies widely over the Victorian road network and therefore many qualities of aggregate can be used successfully. It is usual to obtain the cheapest material which will give the service required.

2.1.2   Materials
Serviceable quality aggregate may be produced from the following material types:

(a) Crushed and screened quarry products.

(b) Gravel and sand materials
   • Wholly crushed and screened gravel
   • Partly crushed and screened gravel
   • Washed and screened gravel
   • Screened gravel
   • Washed and screened sand
   • Screened sand.

(c) Scoria (generally only on shoulders which are only subject to low traffic).

(d) Synthetic materials

2.1.3   Types of Aggregate
The types of aggregate used by VicRoads include:

- Basalt
- Partly crushed and screened river gravel
- Granite
- Quartz Porphyry
- Altered Mudstone
- Micaceous Schist
- Diabase
- Sandstone and Quartz
- Scoria
- Rhyolite
- Quartzite
- Sand
- Diorite
- Hornfels
- Limestone
- Rhyodacite
- Dacite
- Quartz
- Electric blast furnace slag

2.2   AGGREGATE CLASSIFICATION
The quality of an aggregate is classified as A, B or C depending on physical properties.

Aggregate classification provides for the efficient use of available materials and enables an aggregate of adequate quality to be specified for a particular traffic volume and pavement classification. Though an aggregate must remain serviceable for the expected life span of the treatment there is little
advantage in using an aggregate which will outlast the binder by years, particularly if the aggregate cost is high.

The lowest satisfactory classification should be used according to the existing traffic the road carries or will carry towards the end of the design life of the bituminous surface treatment. Where the road is carrying close to the upper traffic limit for a particular class of aggregate, the next highest class should be considered to allow for increases in traffic volumes.

Table 2.2.1 provides a guide to selecting the class of aggregate for sprayed work in relation to the expected traffic volume and situation. It should be noted that there are some highly trafficked areas where aggregates with Polished Stone Values exceeding 48 (the standard for Class A aggregates) are required. Such locations include major freeways.

<table>
<thead>
<tr>
<th>Situation</th>
<th>Class of Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads carrying more than 2000 vehicles per lane per day or more than 200 commercial vehicles per lane per day</td>
<td>A</td>
</tr>
<tr>
<td>Roads carrying 100 to 200 vehicles per lane per day</td>
<td>B</td>
</tr>
<tr>
<td>Roads carrying less than 100 vehicles per lane per day</td>
<td>C</td>
</tr>
</tbody>
</table>

2.3 REQUIREMENTS

2.3.1 Source Rock

(a) Crushed Aggregate

The material from which fully crushed aggregate is produced should be either clean quarried spalls of approved igneous, metamorphic or sedimentary rock, free from bedding planes or lines of weakness which could affect the product, or hard clean gravel. It should be free from clay, organic matter, unsound rock (see Section 2.3.5) and elongated flat particles.

(b) Screened Gravel, Partly Crushed and Screened Gravel

Gravel should be produced by crushing and screening. Sand may be produced by screening only. The material must be free from vegetable matter, clay balls, soil and elongated flat particles.

For crushed or partly crushed gravel at least 75% (by mass) of the particles should have two or more faces produced by crushing.

(c) Soundness of Source Rock

Source material for crushed aggregate shall be considered unsound (refer Definition 2.3.5) if spalls do not meet the relevant requirements listed in Table 2.3.1.
### Table 2.3.1 Source Rock Requirements

<table>
<thead>
<tr>
<th>Rock Type</th>
<th>Degradation Factor Source Rock (min.)</th>
<th>Secondary Mineral Content % (max.)</th>
<th>Texas Ball Mill Value (max.)</th>
<th>Degradation Factor Source Rock (min.)</th>
<th>Secondary Mineral Content %</th>
<th>Texas Ball Mill Source Rock (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACID IGNEOUS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granite</td>
<td>50</td>
<td></td>
<td>35</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adamelite</td>
<td>50</td>
<td></td>
<td>35</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granodiorite</td>
<td>50</td>
<td></td>
<td>35</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granophyre</td>
<td>45</td>
<td></td>
<td>35</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhyolite</td>
<td>45</td>
<td></td>
<td>35</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhyodacite</td>
<td>45</td>
<td></td>
<td>35</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTERMEDIATE IGNEOUS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diorite</td>
<td>45</td>
<td></td>
<td>35</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Porphyry</td>
<td>45</td>
<td></td>
<td>35</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trachyte</td>
<td>50</td>
<td></td>
<td>30</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BASIC IGNEOUS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basaltic Rocks (Basalt, Dolerite, Limburgite)</td>
<td>50</td>
<td>25</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>
1. Size 14 basalt [top left]
2. Size 14 quartz porphyry [top right]
3. Size 14 partly crushed river gravel [middle left]
4. Size 10 scoria [middle right]
5. Size 7 basalt – cubical shape [bottom left]
6. Size 5 diabase – flaky shape [bottom right]
2.3.2 Uniformity

All materials should be of the same grading throughout the period of supply and should be free from segregations of fine and coarse material.

*Figure 2.3.2 Thickness (least dimension) and average least dimension (ALD) of an aggregate*

Aggregate with excellent cubical shape – Low Flakiness Index

Aggregate with poor shape – High Flakiness Index

2.3.3 Cleanliness

The surfaces of the aggregate particles should be clean and free from dust or other coatings which could influence the adhesion of binder to the aggregate.

2.3.4 Wearing Qualities

The suitability of a material for use as an aggregate under various traffic conditions is assessed from the result of the Los Angeles Abrasion Test. The Los Angeles Abrasion Test requires a sample of aggregate and a number of steel balls to be placed in a cylinder. The inside of the cylinder is fitted with a shelf to lift and drop the aggregate and steel balls as it is rotated at a constant speed for a set number of revolutions. The wearing quality of the aggregate is measured by its breakdown during the test. The greater the amount of breakdown the poorer the quality of the aggregate. Table 2.3.4 lists the requirements when the Los Angeles Abrasion Test is used.
### Table 2.3.4  Los Angeles Abrasion Test Value Requirements

<table>
<thead>
<tr>
<th>Rock Type</th>
<th>Los Angeles Abrasion Test Value (max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class A</td>
</tr>
<tr>
<td>ACID IGNEOUS</td>
<td></td>
</tr>
<tr>
<td>Granite</td>
<td>*</td>
</tr>
<tr>
<td>Adamellite</td>
<td>*</td>
</tr>
<tr>
<td>Granodiorite</td>
<td>*</td>
</tr>
<tr>
<td>Granophyre</td>
<td>20</td>
</tr>
<tr>
<td>Rhyolite</td>
<td>20</td>
</tr>
<tr>
<td>Rhyodacite</td>
<td>20</td>
</tr>
<tr>
<td>INTERMEDIATE IGNEOUS</td>
<td></td>
</tr>
<tr>
<td>Diorite</td>
<td>20</td>
</tr>
<tr>
<td>Porphyry</td>
<td>20</td>
</tr>
<tr>
<td>Trachyte</td>
<td>20</td>
</tr>
<tr>
<td>BASIC IGNEOUS</td>
<td></td>
</tr>
<tr>
<td>Basaltic Rocks</td>
<td>20</td>
</tr>
<tr>
<td>(Basalt, Dolerite, Limburgite)</td>
<td></td>
</tr>
<tr>
<td>METAMORPHIC</td>
<td></td>
</tr>
<tr>
<td>Hornfels</td>
<td>20</td>
</tr>
<tr>
<td>Quartzite</td>
<td>20</td>
</tr>
<tr>
<td>Schist</td>
<td>20</td>
</tr>
<tr>
<td>Phyllite</td>
<td>20</td>
</tr>
<tr>
<td>Gneiss</td>
<td>20</td>
</tr>
<tr>
<td>Greenstone</td>
<td>20</td>
</tr>
<tr>
<td>SEDIMENTARY</td>
<td></td>
</tr>
<tr>
<td>River Gravel</td>
<td>*</td>
</tr>
<tr>
<td>Limestone</td>
<td>*</td>
</tr>
<tr>
<td>Scoria</td>
<td>*</td>
</tr>
<tr>
<td>Other Sedimentary Rocks</td>
<td>*</td>
</tr>
</tbody>
</table>

* Not to be used for Class A aggregate

### 2.3.5 Unsound Rock

Unsound rock, whether in the source rock, or as spalls, or as crushed particles, is defined as material which is soft, friable, or composed of clay or weathered rock, or which contains matter which breaks up when alternately wetted and dried or which fails to meet one or more of the requirements specified in Sections 2.3.1 and 2.3.4.

Unsound rock and aggregate of marginal quality is based on that fraction of aggregate retained on a 4.75 mm AS sieve and shall not exceed the values shown in Table 2.3.5.
### Table 2.3.5 Marginal and unsound rock

<table>
<thead>
<tr>
<th>Class of Aggregate</th>
<th>Maximum Permitted Content by Mass (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total of Marginal* and Unsound Rock</td>
</tr>
<tr>
<td></td>
<td>Total Unsound Rock</td>
</tr>
<tr>
<td>A</td>
<td>10</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
</tr>
<tr>
<td>C</td>
<td>20</td>
</tr>
</tbody>
</table>

### 2.3.6 Shape

The shape of an aggregate is important to achieve the best results in bituminous surfacing work. In practice, a quantity of flat particles is always present. The quantity of flat particles in the aggregate is determined by the Flakiness Index test. The Flakiness Index of an aggregate is the percentage by volume (in practice testing and calculations are carried out on a mass basis) of flat particles in the sample. A flat particle is defined as a particle having its least dimension (thickness) less than 0.6 of its mean dimension.

The lower the Flakiness Index for any particular sample the better is its general shape, that is, the nearer are all its particles to cubical shape. Table 2.3.6 lists the maximum permissible Flakiness Index.

### Table 2.3.6 Flakiness Index

<table>
<thead>
<tr>
<th>Class of Aggregate % (max.)</th>
<th>Flakiness Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>30</td>
</tr>
<tr>
<td>B</td>
<td>35</td>
</tr>
<tr>
<td>C</td>
<td>35</td>
</tr>
</tbody>
</table>

* Size 10 one sized aggregate and larger. Flakiness Index and Average Least Dimension (ALD) are usually not measured for aggregates of nominal size smaller than 10mm.

### 2.3.7 Adhesion Values

Adhesion between bitumen and aggregate varies depending on the type of stone and other factors (e.g. dust, moisture etc.). Adhesion values are determined by a laboratory test (VicRoads Test Method RC112.03). Table 2.3.7 lists the requirements for the three classifications of aggregate. (See also Section 2.9.4.)
2.3.7 Aggregate Adhesion Value Requirements

<table>
<thead>
<tr>
<th>Class of Aggregate</th>
<th>Adhesion Value (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial</td>
</tr>
<tr>
<td>A</td>
<td>35</td>
</tr>
<tr>
<td>B</td>
<td>25</td>
</tr>
<tr>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

2.3.8 Polished Stone Value (PSV)

All aggregates tend to polish under traffic. The degree of polishing depends on the nature of the stone, the traffic conditions and the road geometry.

Aggregates are tested in the laboratory to determine their susceptibility to polishing. An aggregate’s resistance to polishing is indicated by its Polished Stone Value (PSV) on a scale of 0 to 100. The higher the PSV the better the aggregate’s resistance to polishing.

It is desirable to use aggregates with high PSVs in critical locations. Such situations may exist because of geometric deficiencies, high traffic volumes, high vehicle speeds, or combinations of these and other factors, e.g. approaches to signalised intersections, roundabouts, school crossings etc.

PSVs from current tests must be used in assessing aggregate sources, as wide variations in PSV for one rock type can occur and the PSV of aggregate from a single source can vary (e.g. different faces being quarried, alterations to crushing and screening arrangements etc.).

Table 2.3.8 lists the requirements for the three classifications of aggregate.

In some situations where extreme polishing conditions occur and a high sideways force coefficient (sfc) is essential, it may be necessary to use an aggregate with a PSV higher than 48.

Such locations include:

- approaches to school and pedestrian crossings
- tight curves, roundabouts
- approaches to signalized intersections, level crossings
- very heavily trafficked highway/freeways.

For these locations it may be necessary to use high PSV aggregates or synthetic aggregates.
### Table 2.3.8 Aggregate Polished Stone Value Requirements

<table>
<thead>
<tr>
<th>Class of Aggregate</th>
<th>Polished Stone Value (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>48</td>
</tr>
<tr>
<td>B and C</td>
<td>No requirement</td>
</tr>
</tbody>
</table>

#### 2.3.9 Luminance Factor (LF)

Light coloured, or high luminance factor (LF) aggregates are used for delineation or to silhouette backgrounds. Examples of such applications would be on the sealed shoulders or emergency stopping lanes of a freeway, adjacent to pedestrian crossings and on the trafficked pavement in shopping centres where pedestrian movements are prevalent.

Such light coloured aggregates, where they are used in heavily trafficked emergency stopping zones, should also possess a high polished stone value (PSV) to promote and maintain a high level of skid resistance, and should also resist abrasion to prevent the pavement being worn down to a smooth textureless surface.

The luminance factor is measured in a laboratory test. In this test, a dish containing the aggregate randomly heaped (the aggregate specimen) is illuminated normal to the surface and viewed with a luminance meter at 45° to the surface. Four readings are taken, the aggregate specimen being rotated through 90° before each reading, and the four luminance readings averaged. A magnesium carbonate block (near perfect diffuser) is then tested in the same manner and the luminance factor is calculated from:

\[
LF (0°, 45°) = \frac{\text{Average luminance reading of aggregate specimen}}{\text{Average luminance of magnesium carbonate block}}
\]

* 0° = angle of illumination and 45° = angle of viewing.

The field luminance test measures light reflected from the road surface at 1° to the height of a driver’s eye. It is an actual luminance reading and no comparison is made with a diffuser. Some typical luminance factor values are given in Table 2.3.9.

The following luminance factor values have been adopted to provide contrasting dark and light coloured surfaces:

- Dark coloured surface – Luminance Factor 0.10 maximum
- Light coloured surface – Luminance Factor 0.15 minimum.

The greater the difference in luminance factor of the aggregates used, the greater the contrast in colour of the respective surface.

Care should be taken in the selection of aggregate such as quartz due to the lack of affinity for bitumen. (Precoating of aggregate is important, refer to Section 16.6.)
Table 2.3.9  Typical Aggregate Luminance Factor Values

<table>
<thead>
<tr>
<th>Material</th>
<th>Luminance Factor (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoria (Mt. Frazer)</td>
<td>0.07</td>
</tr>
<tr>
<td>Vesicular newer basalt (Werribee)</td>
<td>0.03</td>
</tr>
<tr>
<td>Newer basalt</td>
<td>0.07</td>
</tr>
<tr>
<td>Older basalt (Berwick)</td>
<td>0.08</td>
</tr>
<tr>
<td>Rhyolite (Montrose)</td>
<td>0.16</td>
</tr>
<tr>
<td>Granite (Dromana)</td>
<td>0.18</td>
</tr>
<tr>
<td>Rhyodacite (Violet Town)</td>
<td>0.18</td>
</tr>
<tr>
<td>Quartz porphyry (Stawell)</td>
<td>0.24</td>
</tr>
<tr>
<td>River gravel (Seymour)</td>
<td>0.31</td>
</tr>
<tr>
<td>Quartz (Maryborough)</td>
<td>0.37</td>
</tr>
<tr>
<td>Synthetic ceramic aggregate</td>
<td>0.40</td>
</tr>
<tr>
<td>Calcined pyrophyllite</td>
<td>0.61</td>
</tr>
<tr>
<td>Synopal (Danish synthetic aggregate)</td>
<td>0.79</td>
</tr>
<tr>
<td>Magnesium carbonate</td>
<td>1.00</td>
</tr>
</tbody>
</table>

2.4 AGGREGATE GRADING

2.4.1 Types of Grading

The ideal grading for an aggregate used in sprayed seals is one in which all the particles of stone are very close to the one size.

For reasons of economy and practicability some variation from the ideal must be allowed, but the range of grading of any particular nominal size of aggregate should be limited as much as is reasonably possible.

Aggregate is produced in two types of grading:

- One sized (OS)
- Graded.

2.4.2 One Sized Aggregate

(a) Definition

An aggregate of which 60 to 70% by mass of the whole material passes a sieve of a specified size and is retained on a sieve having an opening of 0.7 of the specified size.

(b) Specification

Table 2.4.2 lists the grading requirements for one sized aggregate.

The specification provides for two sets of conditions:

- the ideal at which to aim
- the acceptable variations from the ideal.

An aggregate is known by its nominal size, which is approximately the smallest sieve through which all, or nearly all, the material should pass (85 to 100%).
The acceptable variations from the ideal are set out in three parts:

(i) Specified size

This section sets out the minimum acceptable amount of the ideal sized material. In the case of a one sized material of nominal size 14, this is the material passing the 13.2 mm AS sieve and retained on the 9.5 mm AS sieve.

(ii) Tolerance on oversize

This is the maximum size of material and the maximum amount of oversize which is acceptable.

(iii) Tolerance on undersize

This sets the limits to the maximum amount of small material which is acceptable. The limits are for two sizes for each particular nominal size.

(c) Average Least Dimension (ALD)

The Average Least Dimension of an aggregate is the average of the thickness of all the individual stones, weighted in proportion to the surface areas covered, when the stones lie with their average least dimension near vertical.

The aggregate sample is tested in the laboratory to determine its grading, median size and the Flakiness Index.

The ALD can be determined as follows:

(i) By Calculation (VicRoads preferred method)

Calculate the ALD to the nearest 0.1 mm from the following equation:

$$ALD = \frac{\text{Median Size}}{1.09 + (0.0118 \times \text{Flakiness Index})}$$

(ii) By Nomogram

Determine the ALD, to the nearest 0.1 mm from the nomogram Fig. 2.4.2A.

(iii) Slotted gauge method used by the RTA NSW

(iv) By direct measurement used in New Zealand.

The ALD is important for calculation of the rates of application of binder and aggregate in sprayed work for aggregates of size 10 and larger – see Chapter 14, Design of a Seal Coat.

Under Quality Assurance contracts the aggregate supplier or contractor carries out the sampling and testing of aggregates. It is important that the actual ALD for the aggregates being used be provided rather than historical information about ALDs.
Table 2.4.2  Grading Requirements for One Sized (OS) Aggregates (by mass)

<table>
<thead>
<tr>
<th>Size</th>
<th>Specified Use</th>
<th>Tolerance on Oversize</th>
<th>Tolerance on Undersize</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Passing</td>
<td>Retained</td>
<td>Min (%)</td>
</tr>
<tr>
<td>14 O.S.</td>
<td>13.2</td>
<td>9.50</td>
<td>60</td>
</tr>
<tr>
<td>10 O.S.</td>
<td>9.5</td>
<td>6.70</td>
<td>65</td>
</tr>
<tr>
<td>7 O.S.</td>
<td>6.7</td>
<td>3.35</td>
<td>70</td>
</tr>
<tr>
<td>5 O.S.</td>
<td>4.75</td>
<td>2.36</td>
<td>70</td>
</tr>
<tr>
<td>3 O.S.</td>
<td>3.35</td>
<td>1.70</td>
<td>70</td>
</tr>
<tr>
<td>2 O.S.</td>
<td>2.36</td>
<td>1.18</td>
<td>70</td>
</tr>
</tbody>
</table>
Figure 2.4.2A  Nomogram to determine average least dimension

METHOD: Join A to C. Read Average Least Dimension (ALD) on B.
(d) Use
Only one sized aggregates should be used for sealing and primersealing work.

Figure 2.4.2B illustrates a sprayed seal coat in which a one sized aggregate has been used. The figure alsoendeavours to illustrate why oversize and undersize materials are undesirable.

When a good one sized aggregate is used with the correct quantity of binder, maximum contact and skid resistance is obtained between the tyre and aggregate.

Sprayed seals also provide drainage passages between the aggregate particles allowing the rapid removal of water between the tyre and road surface.

This assists in maintaining skid resistance when the surface is wet – as does tyre tread design, the road crossfall/grade and drainage characteristics.

Figure 2.4.2B Seal Coat – One sized aggregate (diagrammatic)

2.4.3 Graded Aggregate
(a) Definition
In a graded aggregate the object is to obtain a reasonably uniform gradation of sizes between two limits.

(b) Graded Aggregate for Sprayed Work
Graded aggregates should not be used for sprayed work except for the use of sand as described in Section 2.4.4.
2.4.4 Sand

(a) Definition
A sand is the product of rock weathering, generally siliceous, free from appreciable quantities of clay and silt.

(b) Classification
Sands are broadly classified into Class 1, 2 or 3 according to grading.

(c) Specification
(i) Sand Equivalent Value
Sand must have a minimum Sand Equivalent Value of 80.

(ii) Grading
The grading limits are as shown in Table 2.4.4.
It is suggested that when obtaining sand for sprayed work, due consideration be given to the type of material which is likely to be available, and the specification designed accordingly.

The grading in Table 2.4.4 might be used when preparing specifications for the supply of sand for sprayed work.

(d) **Use**

Sands may be used for primersealing and for light sealing work.

Class 1 – Is the most suitable grading
Class 2 – Sands which are finer than Class 1 but have given good results.

Screening a sand with the object of removing excess fines to make it comply with a Class 1 grading is rarely practical.

**Table 2.4.4 Grading Requirements for Sand (by Mass)**

<table>
<thead>
<tr>
<th>Class</th>
<th>Sieve Size AS (mm)</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9.50</td>
<td>4.75</td>
</tr>
<tr>
<td>1</td>
<td>100</td>
<td>85–100</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>85–100</td>
</tr>
</tbody>
</table>

**2.5 SUPPLY OF AGGREGATE**

**2.5.1 General**

(a) It is normal practice for the sealing contractors to provide the aggregate. There are, however, times where VicRoads supplies aggregate to sealing contractors.

These times include where:
- the quantity of aggregate is large and the expected lead time for the contractor to organise crushing etc. would delay the contract, and
- to assist the sealing contractor

Before accepting a tender the supplier must provide objective evidence that the material to be supplied meets the specification.

(b) During Period of Supply

The contractor must check the grading, unsound and marginal stone, flakiness index etc. in accordance with the specification.

**2.5.2 Method of Sampling**

(a) Quarry stockpile: It is difficult to obtain representative samples from a quarry stockpile, especially for sieve analysis testing. Particular care must be taken to follow the method of sampling as detailed in AS 1141.3.1.
(b) Stacksites

(i) General

Sampling from roadside stacksites is not common. The aggregate supply contractor should provide test results from the stockpile in the quarry from which the aggregate came.

If aggregate has not been sampled from the quarry stockpile and tested, it should be sampled from the stacksite and tested in accordance with AS 1141.

(ii) Sampling Using a Shovel

A square mouth shovel can be used for sampling all aggregates if a sampling tube is not available. Portions should be taken from both sides and the top of the stack.

To sample from the sides, remove and discard about 150 mm to 200 mm depth by at least a shovel width from top to bottom and take a portion from the fresh face exposed. From the top of the stack, dig a hole or trench about 150 mm to 200 mm deep, discard the excavated material and take a portion from the fresh face exposed.

(iii) Using a Sampling Tube

A sampling tube is the preferred sampling tool and is suitable for aggregates up to a maximum of size 10 OS (one sized). Insert the tube, with the slot facing downwards, horizontally into the stack. Rotate the tube 180° and withdraw. Collect the material in the tube to form a portion. Take portions at several locations and at various heights on each side along the stack to make up bulk sample quantities as detailed in AS 1141.3.1.

2.5.3 Packaging and Identification of Samples

(a) Containers

Each sample should be packed and sealed into a plastic bag to prevent loss of fines.

(b) Identification

Each sample should be provided with a label giving at least the following information:

(i) Sample number if more than one sample
(ii) Supplier
(iii) Aggregate size
(iv) Aggregate type
(v) Contract/Job number
(vi) Quarry stockpile or roadside stacksite location.
2.6 TESTS

All tests are to be in accordance with the current test methods of VicRoads and appropriate Codes of Practice.

2.7 TESTING REQUIREMENTS

The supply contractor’s laboratories are required to do routine testing on aggregate samples to determine the grading and, if applicable, the Flakiness Index, average least dimension and sound, unsound and marginal rock content in accordance with VicRoads Code of Practice RC/MTD. 500.09 and the specification. The Flakiness Index and average least dimension values must be known for aggregates of size 10 mm and greater to design the rates of application of aggregate and binder in sprayed work.

The test, in accordance with AS 1141, is applied to the various aggregate sizes used as follows:

(a) Size 10 OS and larger – grading, Flakiness Index and average least dimension

(b) Size 7 OS and smaller – grading only

(c) Sand – grading only

2.8 TESTING

For the main tests refer to the VicRoads Standard Specification Section 831 – Aggregates for Sprayed Bituminous Surfacing.

2.9 AGGREGATES WITH UNSATISFACTORY CHARACTERISTICS

2.9.1 Treatment

Aggregates with some unsatisfactory characteristics may still be economical to use if specially treated. The most common problems and effective treatment are described in this section.

2.9.2 Removal of Dust and/or Excess Fines

At times aggregates containing an excess of dust and/or fines are delivered to the stacksites. It may not always be practical or possible to reject this aggregate and have it replaced. An aggregate loader can be used successfully to remove any excess of fines or dust by loading and screening the aggregate when it is dry.

Depending on the quantity of dust or fines it may be necessary to repeat this several times. This operation is costly and is normally charged to the aggregate supply contractor. The option is also available for the supplier to replace the material.

Typically each loading and screening run will reduce the existing high dust content by about 50%.
2.9.3 Porous Aggregate

Certain aggregates have a tendency to absorb part of the binder. The most absorbent aggregates are limestones, quartzite and some chert gravels. These materials are not widely used.

An allowance should be made for the absorption of the binder into the aggregate when a porous aggregate is used in sprayed work and for the associated costs.

When porous aggregates are used on single application sprayed work the aggregate is normally precoated with a cutback bitumen or a bitumen emulsion to fill the surface pores. Precoating may be done at the aggregate plant or at the stacksite. Precoating does not normally remove the need to make some allowance for absorption.

When vesicular aggregates, which occur in some of the newer basalts, are used on sprayed work, it is seldom necessary to make an allowance for absorption. Precoating is also generally not required to fill the surface pores.

As a guide to the allowance for binder absorption for new types of aggregates or existing aggregates where there is concern about the absorption, Austroads has developed a test to give quantitative advice on the absorption allowance. Table 2.9.3 provides the appropriate allowance to be added.

<table>
<thead>
<tr>
<th>Binder Absorption calculated from the Austroads Test %</th>
<th>Absorption Allowance (litres/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;=1</td>
<td>0 to +0.1</td>
</tr>
<tr>
<td>1 to 3</td>
<td>0.1 to 0.3</td>
</tr>
<tr>
<td>&gt;=3</td>
<td>Do not use unless performance is proven</td>
</tr>
</tbody>
</table>

Table 2.9.3 Allowances for binder absorption by aggregate
(Determined using Draft Austroads Test Method)

2.9.4 Poor Adhesion

There is a number of aggregates which, although otherwise satisfactory, have a poor adhesion to the binders used. Some have reasonable adhesion characteristics when dry, but are liable to strip from the binder if they come into contact with water. Stripping can occur some appreciable time after placing or mixing.

Where an aggregate has an initial adhesion value between 25 and 35 and/or a residual adhesion value between 50 and 70, it is desirable to add an adhesion agent to the precoating material, or binder, at all times. If these aggregates are used on roads with high traffic volumes (over 1000 vehicles per day per lane) it is preferable to precoat the aggregate with cutback bitumen or a precoating emulsion at the production plant.
Advice from GeoPave should be sought where an aggregate has an initial adhesion value less than 25 and/or a residual adhesion value less than 50.

If not precoated at a production plant, the following aggregates must be precoated at all times with at least a standard solution of distillate, diesel fuel oil with adhesion agent or precoating emulsion unless there is local knowledge which demonstrates that precoating is detrimental:

- Quartz Gravel
- Crushed Quartz
- Quartzite
- Quartz Porphyry
- Granite

The procedure of precoating aggregates in the field is detailed in Section 16.6.6.

2.10 SYNTHETIC AGGREGATES

A specification for synthetic aggregates is not available but it should meet at least all the requirements of a natural aggregate. Additionally, it should have a high PSV (Polished Stone Value) and resistance to abrasion, be non porous and free from reacting chemicals. It should have good bitumen adhesion and not be affected by solvents. It must also be economically competitive.

Synthetic aggregates have been used for special purposes where it is anticipated they will give better service than any available natural aggregate e.g. at tight curves, School Crossings, Pedestrian Crossings etc., where they can meet all the general properties of the natural aggregate and improve on the skid resistance and safety by having a higher PSV and, perhaps, good luminance properties.

Figures 2.10.1 to 2 are photographs of sprayed seals constructed using aggregate manufactured from electric blast furnace. This particular aggregate had a PSV of 63.

Figure 2.10.3 is a photograph of a calcined bauxite high performance skid resistance treatment. The treatment is manufactured using epoxy or similar binder and 2 to 5 mm calcined bauxite aggregate. The aggregate has a PSV in excess of 75.
Figure 2.10.1  Electric Blast Furnace Slag (first application of a double application)

Figure 2.10.2  High PSV Electric Blast Furnace Slag SEAL (just completed double application sprayed seal – most rolling has not been completed)

Figure 2.10.3  Calcined Bauxite Seal (very high skid resistance)
3.1 GENERAL

3.1.1 Description

(a) Primers

Primers are normally a penetrating slow-hardening material of low viscosity and low surface tension. Cutback bitumen primers are a complete or partial solution of bitumen in cutting oil and, on occasions, flux oil. Bituminous emulsion primers are manufactured from bitumen binder containing cutting and/or flux oils plus other chemicals which have been emulsified into water or the water has been emulsified into the binder (i.e. an inverted emulsion).

Primers are used to:
- penetrate the top of the prepared pavement surface
- bind the surface of the pavement
- provide a uniform surface onto which the initial sprayed seal surface can be applied
- obtain a good interfacial bond between the pavement and the initial sprayed bituminous seal or asphalt.

(b) Primerbinders

Primerbinders were originally developed for use in conditions where there were difficulties using primers, e.g. where the pavement is constructed under high traffic volumes and/or there are cold and damp pavement conditions at the time of sealing and it is necessary for the pavement to be trafficked immediately.

The primerbinders normally used are similar in characteristics to the primers but are less penetrating and more viscous thus leaving a larger proportion of the material on the surface of the pavement to hold and retain covering aggregate.

3.1.2 Selection of Type and Grade

The choice of type of primer or primerbinder depends on suitability, availability and economy.

(a) Primer

The grade and rate of application depends on the type of pavement material, compaction, moisture content, prevailing weather conditions and the life required before the initial bituminous surfacing is applied.

The ability of a primer to penetrate and be absorbed into the pavement varies with the viscosity and this should be such that it will penetrate the surface and be absorbed. Little setting-up should take place before the desired penetration is reached.

Emulsion primers should not ‘break’ or ‘go-off’ before penetrating into the pavement and should take a similar time compared to cutback primers to ‘set-up’.
(b) Primerbinder

The grade and rate of application of a primerbinder depends on the type of pavement material, compaction, moisture content, traffic volume, aggregate size and prevailing weather conditions.

3.1.3 Setting-up

Primers and primerbinders ‘set-up’, that is they thicken and increase in viscosity, which is influenced by:

- reduction in temperature
- loss of the light oils by evaporation for cutback bitumen primer
- breaking of the emulsion and the evaporation of the water and any oils used in the manufacturing process in the case of an emulsion primer or primerseal
- selective absorption of the oils (in the case of a cutback bitumen) by the fines in the pavement material. In the case of an emulsion, by evaporation and the selective absorption of the water.

3.1.4 Types of Primers and Primerbinders

The basic types of primers and primerbinders used are:

- cutback bitumen (most often used)
- bitumen emulsion primer (a specially manufactured emulsion still basically in the development stage)
- bitumen emulsion primerbinder (this may be a specially manufactured emulsion or a standard cationic or anionic emulsion).

On highly absorbent pavement materials, the bitumen used in cutback and emulsion primers and primerbinders may be modified to:

- reduce losses due to absorption (both short and long term)
- reduce the quantity of primer and primerbinder used
- avoid loss of binder in the seal coat applied later. Care is required to ensure that the modified primer/primerbinder achieves some penetration and adhesion with the pavement surface.

3.2 BITUMEN PRIMERS AND PRIMERBINDERS

3.2.1 Production

Cutback bitumen primers and primerbinders are manufactured from refinery-produced bitumen which is cutback (diluted) with petroleum solvents of selected volatility to produce products of various easily worked viscosities. The distillation range of the solvent used determines the curing characteristics and the types that may be made. The cutback primers and primerbinders may be produced at the refinery or in the field to the type and grade required.

Emulsion primers and primerbinders are manufactured to the required specification for the types of material onto which the primer or primerbinder is being placed. These emulsions contain water, bitumen, cutting oils and other chemical emulsifiers. They are complex materials, often specifically tailored for the conditions under which they are to be used. The particular
properties that are modified include breaking time, penetrating ability and temperature of use which all relate to the weather conditions and type of pavement material which is to be treated.

The emulsions can be standard emulsions or inverted emulsions where the water is emulsified into the bituminous material and are further classified in terms of the particle charge as being anionic (−), cationic (+) or non-ionic.

### 3.2.1.1 Primers

(a) Cutback bitumen

The types of cutback bitumen primers produced are:

(i) Rapid curing

(ii) Medium curing

(iii) Slow to medium curing

Generally, the medium and slow to medium curing cutback bitumen primers are used; however, in special circumstances, rapid curing primers may be used.

Rapid curing primers may require the use of high volatility cutting oils such as petrol, turpentine and other proprietary products. These products may require special handling requirements for safety and their use is not recommended without specialist advice being sought.

(b) Bitumen emulsions

Emulsion primers should have low viscosity suitable to penetrate a pavement surface, to coat fine particles, to seal the pores and to assist in bonding the pavement to the subsequent layer.

Emulsion primers should be the non-ionic medium setting (NMS) inverted type, or specialty products. The use of emulsion for priming is still under development, involving special priming emulsions. Specialist advice from GeoPave should be sought before use. (Referenced from RTA NSW Bitumen Emulsion Guide.)

### 3.2.1.2 Primerbinders

The usual type of cutback bitumen primerbinders produced are of the medium curing type. The usual type of emulsion primerbinder is a CRS (cationic rapid setting).

### 3.2.2 Australian Standard Grades

The cutback bitumen primers and primerbinders are divided into several grades by viscosity. The standard grades of medium curing cutback bitumen primers and primerbinders used are shown in the Table 3.2.2.

### 3.2.3 Specification

The properties required of the three standard medium curing cutback bitumen primers and the three primerbinders produced are given in Table 3.2.3.
Table 3.2.2  Standard Grades of Medium Curing Cutback Bitumen Primers and Primerbinders (as specified in Australian Standard 2157).

<table>
<thead>
<tr>
<th>Classification</th>
<th>Viscosity Range Pa.s at 60°C</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very light primer</td>
<td>0.008 to 0.016</td>
<td>AMC 00</td>
</tr>
<tr>
<td>Light primer</td>
<td>0.025 to 0.050</td>
<td>AMC 0</td>
</tr>
<tr>
<td>Heavy primer</td>
<td>0.06 to 0.12</td>
<td>AMC 1</td>
</tr>
<tr>
<td>Very light primerbinder</td>
<td>0.22 to 0.44</td>
<td>AMC 2</td>
</tr>
<tr>
<td>Light primerbinder</td>
<td>0.55 to 1.10</td>
<td>AMC 3</td>
</tr>
<tr>
<td>Heavy primerbinder</td>
<td>2.0 to 4.0</td>
<td>AMC 4</td>
</tr>
</tbody>
</table>

3.2.4 Proprietary Grades

The bitumen supply companies produce special cutback bitumen primers and primerbinders by cutting back refinery residues. These materials are also graded on a viscosity basis and may or may not fully comply with the standard specification for cutback bitumen as shown in Table 3.2.3. The supplier is required to submit their own production specification as a basis for quality control.

The supply companies also produce emulsion primers and primerbinders. AS 1160 specifies the properties of standard bitumen emulsion primerbinders. VicRoads currently does not have a specification for bitumen emulsion primers (which is under development) and so relies on the supplier to meet the manufacturing specification for the particular characteristics required.

The primerbinders also contain an adhesion agent to promote adhesion to the pavement and to the aggregate during cold and/or damp conditions.

3.2.5 Field Produced Grades of Cutback Bitumen

3.2.5.1 Standard Grades of Primers

Cutback bitumen primer may also be produced in the field using Class 170 bitumen, flux oil and cutter. It may be made using a sprayer, road tanker or heater storage tanker but it must be thoroughly mixed to produce a homogeneous material. Failure to mix the components properly will result in an unsatisfactory primer.

(a) The two types of primer that may be produced are:

(i) Medium curing cutback – Table 3.2.5A gives the approximate proportions of Class 170 bitumen and cutter to produce equivalent standard grades as shown in Table 3.2.3.

(ii) Slow to medium curing cutback – Table 3.2.5 B gives the approximate proportions of Class 170 bitumen, flux oil and cutter to produce a slower curing primer to the equivalent grades shown in Table 3.2.3.

(b) Lighter Grades of Primers

A lighter grade primer may be produced by mixing a heavy grade cutback of a lighter grade, or by further fluxing and/or cutting back the heavy grade.
### Table 3.2.3 Properties of Medium Curing Cutback Bitumen Primers and Primerbinders (as specified in Australian Standard 2157)

<table>
<thead>
<tr>
<th>Property</th>
<th>Priming Classes</th>
<th>Primersealing Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AMC 00</td>
<td>AMC 0</td>
</tr>
<tr>
<td>Dynamic Viscosity Pa.s at 60°C</td>
<td>0.008</td>
<td>0.016</td>
</tr>
<tr>
<td>Flash Point °C</td>
<td>38</td>
<td>–</td>
</tr>
<tr>
<td>To 225°C</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>To 260°C</td>
<td>55</td>
<td>90</td>
</tr>
<tr>
<td>To 316°C</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>Residue from distillation to 360°C — Percentage Volume by difference</td>
<td>40</td>
<td>–</td>
</tr>
</tbody>
</table>

* Distillate as percentage by volume of total distillate to 360°C

Note: If the application temperatures are exceeded or if the material suffers prolonged storage at the application temperature, the classification is liable to change.
Table 3.2.5A  Field Produced Equivalent of Medium Curing Cutback Bitumen Primers

<table>
<thead>
<tr>
<th>Grade</th>
<th>Classification</th>
<th>Approximate parts by volume at 15°C</th>
<th>Equivalent % of cutter in mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMC 00</td>
<td>Very Light</td>
<td>100</td>
<td>56</td>
</tr>
<tr>
<td>AMC 0</td>
<td>Light</td>
<td>100</td>
<td>44</td>
</tr>
<tr>
<td>AMC 1</td>
<td>Heavy</td>
<td>100</td>
<td>34</td>
</tr>
</tbody>
</table>

Cutter: Kerosene or Aviation Turbine Fuel type products that comply with AS 3568.

Table 3.2.5B  Field Preparation of Slow to Heavy Curing Cutback Bitumen Primers

<table>
<thead>
<tr>
<th>Classification</th>
<th>Approximate Viscosity Range Pa.s at 60°C</th>
<th>Parts by volume at 15°C</th>
<th>Equivalent % of cutter in mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class 170 Bitumen</td>
<td>Flux Oil</td>
<td>Cutter</td>
</tr>
<tr>
<td>Very Light</td>
<td>0.012 to 0.018</td>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>Light</td>
<td>0.02 to 0.04</td>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>Light to medium</td>
<td>0.03 to 0.06</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Medium</td>
<td>0.06 to 0.10</td>
<td>100</td>
<td>45</td>
</tr>
<tr>
<td>Heavy</td>
<td>0.2 to 0.4</td>
<td>100</td>
<td>30</td>
</tr>
</tbody>
</table>

Flux oil: Diesel Fuel Oil or Distillate type products that comply with AS 3568. Cutter: Kerosene or Aviation Turbine Fuel type products that comply with AS 3568.

When fluxing or cutting back a material which is too heavy the balance between flux oil and cutter must be kept in mind. The flux oil normally used (Distillate or Diesel Fuel Oil) has only about 80% of the cutting value of the normal cutter used (Kerosene or Aviation Turbine Fuel), has a lower penetrative pavement value and sets up more slowly. Excessive quantities of flux oil in the cutback bitumen may result in an unsatisfactory greasy primer.

(c) Heavier Grades of Primers

A heavier grade primer may be produced by mixing the cutback, which is too light, with a heavier grade of cutback or by adding Class 170 bitumen. The bitumen should be heated, or allowed to cool, to about 120 to 130°C and the required quantity, calculated at 15°C, added to the cutback.

When using field-produced slow to medium curing cutbacks, it may be necessary to add some more flux oil or cutter depending on the final grade desired.

(d) Very Heavy Grades of Primer

Some pavement materials are very absorbent and may not be able to be satisfactorily primed with one coat of standard cutback primers. In these cases a very heavy primer is required or a two-application procedure used (see Sections 11.12a and 11.13).
Trials have been undertaken using low concentrations of polymer modified binder or a crumbed rubber modified binder. The aim is to reduce the amount of primer that is absorbed into the pavement thus helping to reduce the amount of binder absorbed during subsequent sealing. These trials have shown promise. These types of primer can be manufactured in the field from chemical or crumbed rubber polymer modified binders or proprietary primers can be purchased from manufacturers.

Alternatively, primersealing using low concentrations of polymer can be considered.

(e) Primerbinders

Cutback bitumen primerbinder may also be produced in the field using Class 170 bitumen, cutter and adhesion agents. It may be made using a sprayer, road tanker or heater storage tanker but must be thoroughly mixed to produce a homogenous material. Failure to mix the components properly will result in an unsatisfactory primerbinder.

Table 3.2.5C gives the approximate proportions of Class 170 bitumen, cutter and adhesion agent required to produce light, medium and heavy primerbinders.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Parts by volume at 15°C</th>
<th>Approximate Viscosity Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class 170 Bitumen</td>
<td>Flux Oil</td>
</tr>
<tr>
<td>Light</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td>Medium</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td>Heavy</td>
<td>100</td>
<td>–</td>
</tr>
</tbody>
</table>

Flux Oil: Distillate or Diesel Fuel Oil
Cutter: Kerosene or Aviation Turbine Fuel
Adhesion Agent: An adhesion agent considered satisfactory by GeoPave.

3.3 DIAGRAMMATIC REPRESENTATION

Figure 3.3 gives a diagrammatic representation of the approximate composition of the most common grades of cutback bitumen primers and primerbinders used.

3.4 BITUMEN EMULSION

Refer to Section 4.4.
3.5 TESTS

Tests are performed in accordance with the methods prescribed in the relevant Australian Standards. The tests prescribed for priming and primersealing materials are for determining:

- Viscosity
- Density
- Distillation
- Water content
- Softening point
- Solubles
- Insolubles
- Flash point.

See Chapter 6 for a description of the most common tests used and their significance.

---

**Figure 3.3 Approximate Composition of Cutback Bitumen Primers and Primer Seals**

<table>
<thead>
<tr>
<th>AMC Grade</th>
<th>Residual Bitumen</th>
<th>Flux oil and/or cutter</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMC00</td>
<td>45</td>
<td>55</td>
</tr>
<tr>
<td>AMC0</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td>AMC1</td>
<td>65</td>
<td>35</td>
</tr>
<tr>
<td>AMC2</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>AMC3</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>AMC4</td>
<td>85</td>
<td>15</td>
</tr>
</tbody>
</table>

NOTE: Composition percentage figures are approximate only
### 3.6 SPRAYING TEMPERATURES

The spraying temperatures for cutback primers and primerbinders must be within the limits as shown in Table 3.6.

<table>
<thead>
<tr>
<th>Type</th>
<th>Grade of Primer/Primerbinder</th>
<th>Spraying Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutback Bitumen</td>
<td>AMC 00</td>
<td>ambient</td>
</tr>
<tr>
<td></td>
<td>AMC 0</td>
<td>35 to 55</td>
</tr>
<tr>
<td></td>
<td>AMC 1</td>
<td>60 to 80</td>
</tr>
<tr>
<td></td>
<td>AMC 2</td>
<td>75 to 100</td>
</tr>
<tr>
<td></td>
<td>AMC 3</td>
<td>95 to 115</td>
</tr>
<tr>
<td></td>
<td>AMC 4</td>
<td>110 to 130</td>
</tr>
<tr>
<td>Field Produced Primerbinder[^1]</td>
<td>Light 100:0:25</td>
<td>115 to 130</td>
</tr>
<tr>
<td></td>
<td>Medium 100:0:20</td>
<td>120 to 135</td>
</tr>
<tr>
<td></td>
<td>Heavy 100:0:15</td>
<td>140 to 155</td>
</tr>
</tbody>
</table>

[^1]: The terminology for describing a cutback binder mixture is Parts of bitumen (always 100): Parts of flux : Parts of cutter.

A mixture described as 100:2:4 represents a mixture manufactured in the proportions 100 parts of bitumen, 2 parts of flux oil and 4 parts of cutter oil. For example, if the mixture started with 2000 litres of bitumen, then 40 litres of flux oil and 80 litres of cutter oil would need to be added and the mixture thoroughly mixed to produce a 100:2:4 mixture. The final mixture in this example would have a volume of 2120 litres.

### 3.7 USAGE

#### 3.7.1 Primers

(a) Cutback Bitumen

On most construction projects the primers most commonly used are cutback bitumen proprietary grades and the field-produced slow to medium curing cutbacks.

(b) Bitumen Emulsion

Bitumen emulsions used for priming and primersealing are specially manufactured emulsions. They normally contain Class 170 binder in water emulsions or inverted emulsions, that is water emulsified into a blended binder. Inverted emulsions have limited availability at present. These materials must perform the same functions as a cutback bitumen primer and primerbinder.

(c) Environmental Issues

Primers take time to cure and can be damaged by being washed off the pavement surface in storms. The washing off of primer can cause significant environmental damage. Care should be taken to ensure that priming is...
- An appropriate treatment at the particular time of year
- Not undertaken if adverse weather is expected during the curing period.

### 3.7.2 Primerbinders

(a) Cutback Bitumen

AMC grade primerbinders, proprietary grades of cutback bitumen primerbinders and field-produced cutback bitumen primerbinders are most commonly used depending on cost and availability.

(b) Bitumen Emulsion

Bitumen emulsions used for primersealing are cationic emulsions or specially manufactured emulsions to suit the materials and conditions for the proposed project. These materials must perform the same functions as a cutback bitumen primerbinder.

For proprietary products refer to the supplier’s instructions and recommendations. It is important to observe recommended temperatures for safety during handling and spraying to ensure materials perform as expected.
4.1 GENERAL

4.1.1 Description

The most common basic material used as a binder for bituminous surfacing work is residual bitumen obtained by processing the residue from the refining of naturally occurring crude oil.

See Figure 4.1.1 for the various petroleum products which are used to produce bitumen binders.

4.1.2 Types of Bitumen Binders

Various grades of bitumen binders are generally prepared and used in one of the following forms:

a) Bitumen

b) Fluxed bitumen

c) Cutback bitumen

d) Bitumen emulsion.

e) Polymer modified bitumen (by the addition of crumbed rubber or other polymer) and which may be cutback or emulsified.

4.1.3 Selection of Type and Grade

The choice of type and grade of binder depends on:

a) The nature of the work

b) Climatic conditions

c) Traffic volumes

d) Composition of traffic (i.e. % commercial vehicles) and loading

e) The condition of the pavement and the type of distress evident in the pavement

f) Type and size of the aggregate used.

For economical reasons, a binder should have as long a life as possible and be resistant to hardening by weathering. To achieve this, the binder used should contain the largest practical proportion of the softest practical grade of bitumen for the service conditions expected.

4.1.4 Bitumen Binder

The bitumen binder used is either Class 170 bitumen or Class 170 bitumen fluxed to a softer grade with or without crumbed rubber or polymer added. This depends on the traffic volume, the size of the covering aggregate, the geometric condition of the pavement and the type of distress in the pavement.
Figure 4.1.1  General Bituminous Materials produced from petroleum crudes (courtesy of the Asphalt Institute)
Harder or softer grades of bitumen are sometimes used for special conditions. Polymer modified binders are used in special circumstances, such as areas subject to high speed traffic and pavements that show signs of distress that would not be rectified by the application of unmodified binders.

4.1.5 Viscosity

The bitumen binders used have certain properties at various temperatures. Viscosity is the main property used to classify the various grades of bitumen (see Section 4.2.3) and gives some indication of the state of the binder at various temperatures. The variation of viscosity of Class 170 bitumen varies with temperature as shown in Table 4.1.5.

Table 4.1.5 Viscosity vs Temperature for Class 170 Bitumen

<table>
<thead>
<tr>
<th>Temperature °C</th>
<th>Viscosity Pa.s</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>100 000</td>
<td>Very viscous, semi solid</td>
</tr>
<tr>
<td>60</td>
<td>170</td>
<td>Classification temperature</td>
</tr>
<tr>
<td>70</td>
<td>50</td>
<td>Heavy liquid</td>
</tr>
<tr>
<td>135</td>
<td>0.4</td>
<td>Spraying viscosity</td>
</tr>
<tr>
<td>185</td>
<td>0.07</td>
<td></td>
</tr>
</tbody>
</table>

See also Figure 4.1.5 Temperature–Viscosity Graph for Class 170 Bitumen.

4.1.6 Methods to Change the Viscosity

The sealing grades of bitumen produced, Class 50 to Class 320 (see Section 4.2.3) and the various polymer modified binders, are very viscous at ambient temperatures and cannot be used in that condition.

To change the viscosity of a bitumen binder into a condition suitable for spraying, one or a combination of these methods may be used:

(a) Application of heat

(b) Fluxing and/or cutting back

(c) Emulsification.

The viscosity of binders at the spraying temperature must be in the range 0.05 to 0.075 Pa.s to enable proper spraying and fanning of the jets of sprayers commonly used in Victoria. To achieve this, the application of heating cutting and/or fluxing are used.

4.1.7 Modified Binders

The viscosity temperature susceptibility and elasticity of standard bitumen is modified by the addition of special materials.

Some materials used are:

(a) Crumb rubber (scrap rubber) which thickens the binder and makes it more elastic

(b) Synthetic elastomers such as SBS, PBD and PBR which thickens the binder and makes it more elastic
Figure 4.1.5  Temperature–Viscosity Graph for Class 170 Bitumen
(c) Synthetic plastomers such as EMA and EVA which thickens the binder and makes it more cohesive

(d) Epoxy resins which create a tough elastic binder that cannot be softened by heating

(e) Gilsonite which increases the stiffness of the bitumen.

The polymers in (a), (b), (c) and (d) above enhance some of the properties of unmodified bitumen (e.g. elasticity, toughness, adhesion, torsional recovery etc.) but they can lower some properties (such as adhesion). The use of plastomer type polymer modified binder (EMA and EVA) is generally confined to hot mix asphalt and not normally used as sprayed seal binders due to the increased stiffness at low temperatures. The effect of polymers depend on the polymer type, its concentration, compatibility with the bitumen and the method of manufacture.

Gilsonite is a naturally occurring asphaltene residue which increases the viscosity of the bitumen. It is used in asphalt work to increase stiffness of asphalt mixes but is not normally used as an additive in sprayed seal work except in some specialised surface correction treatments.

4.2 BITUMEN

4.2.1 Base Crudes

Deposits of crude petroleum occur all over the world in varying quantities and qualities. The world’s most important producing area is the Middle East and it is from this area that suitable heavy crude petroleum is obtained by the Australian refineries to produce bitumen. The crude oil found in Australia is a light crude unsuitable for the production of bitumen.

Bitumen is also found in naturally occurring deposits but these cannot economically compete with refinery-produced bitumen and are not currently used.

4.2.2 Production

Crude oil is a mixture of a large number of individual hydrocarbons, many of them closely related to each other, with a boiling range which extends continuously from far below 0°C to above 300°C, some with residues that coke before they boil. Bitumen is such a residue.

At the refinery the crude oil is distilled by heating, with the lighter fractions evaporating off leaving a residue. This residue is processed to produce a soft bitumen.

Air is then blown through the soft bitumen at a high temperature. The bitumen is oxidised and becomes harder as more air is blown through it. In general, the lower the temperature and the less air used the longer the predicted life of the resulting bitumen.

Distilled soft bitumen and blown harder bitumen may then be combined in varying proportions to produce the grades of bitumen used for roadmaking purposes, though some refineries ‘blow’ straight to grade.

The end product continues to be known as residual bitumen though it should strictly be called a lightly blown bitumen.
4.2.3 Australian Standard Classification

The residual bitumen is classified into grades on the basis of its consistency expressed in terms of viscosity measured at 60°C as shown in Table 4.2.3.

Table 4.2.3 Classification of Residual Bitumen (as specified in Australian Standard 2008)

<table>
<thead>
<tr>
<th>Class</th>
<th>Viscosity Range Pa.s at 60°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>40 to 60</td>
</tr>
<tr>
<td>170</td>
<td>140 to 200</td>
</tr>
<tr>
<td>320</td>
<td>260 to 380</td>
</tr>
<tr>
<td>600</td>
<td>500 to 700</td>
</tr>
</tbody>
</table>

Class 50 is the softest bitumen and Class 320 is the hardest bitumen used for sprayed sealing works. Class 170 is the most commonly used bitumen for sprayed sealing works. Class 600 bitumen is used for the production of asphalt only.

4.2.4 Specification

The standard grades of bitumen supplied to VicRoads is required to conform with the Australian Standard Specification, AS 2008, Residual Bitumen for Pavements, Table 4.2.4, together with the requirement that the bitumen shall take a minimum number of days to reach a critical viscosity when tested by the Australian Standard Test Method 2341.13 – Determination of Durability of Bitumens. This test is designed to identify bitumens which may give poor durability in service. The minimum number of days specified by VicRoads for the two most commonly used grades are:

Class 170–9 days, Class 320–8 days

Table 4.2.4 Properties of Residual Bitumen (as specified in Australian Standard 2008)

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class 50</td>
</tr>
<tr>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Viscosity at 135°C, Pa.s</td>
<td>0.20</td>
</tr>
<tr>
<td>Penetration at 25°C (200 g 60 sec mm minimum)</td>
<td>130</td>
</tr>
<tr>
<td>Density at 15°C, kg/litre</td>
<td>As nominated</td>
</tr>
<tr>
<td>Flash point, °C</td>
<td>250</td>
</tr>
<tr>
<td>Matter insoluble in Toluene, per cent</td>
<td>–</td>
</tr>
<tr>
<td>Durability, days</td>
<td>As specified</td>
</tr>
</tbody>
</table>
4.2.5 Physical Properties

Physical properties of residual bitumen to be considered when heating and handling bitumen are:

(i) Relative Density
(ii) Coefficient of Cubical Expansion (change of volume with heating).

(a) Relative Density
The relative density is normally given as the relative density at 15°C and depends on the origin and hardness of the bitumen.

The relative density of the Class 170 bitumens used in Victoria generally is between 1.02 and 1.04. The relative density is required to be able to convert mass to volume. For convenience the conversions from mass to volume have been tabulated – see Tables 8.3.1 or 16.13.2A.

(b) Coefficient of Cubical Expansion
As with most other materials, bitumen will expand when heated and contract when cooled from a given temperature. The rate of expansion or contraction is fairly uniform and is expressed as the coefficient of cubical expansion. For bitumen the coefficient of cubical expansion varies with the relative density and for the residual bitumens used for roadmaking purposes is between 0.0006 and 0.0007.

For the temperature range in which they are used the average value is 0.00067.

To calculate any changes in volume and/or the corrected volume for changes in temperature the following formula may be used:

\[ V_2 = V_1 \left(1 + A \left(T_2 - T_1\right)\right) \]

where
- \( V_2 \) = volume at temperature \( T_2 \)°C
- \( V_1 \) = volume at temperature \( T_1 \)°C
- \( A \) = coefficient of cubical expansion.

For convenience and accuracy tables have been developed which provide the multiplier to be used to correct volumes for any temperatures between 15°C and 200°C. See Tables 8.5.2, 8.5.3 or Tables 16.13.2D and E.

4.2.6 Mixing Various Grades

Various grades of bitumen may be mixed to produce any grade desired. This is normally done at the refinery but mixing of different bitumen grades on site to produce softer or harder grades in the field is not normally carried out in Victoria because of the difficulty to correctly mix the materials on the approximate proportions to ensure they comply with the Standard Specifications.
4.2.7 Fluxing Bitumen for Sprayed Work

For convenience of handling, Class 170 bitumen is the standard grade generally supplied. When softer grades are required they are produced in the field by adding a low volatility oil as a flux oil. Fluxing is regarded as having a long term effect and the fluxed bitumen is regarded as being the residual binder.

The quantity of flux oil required is based on the traffic volume and the size of aggregate used. The normal quantities of flux oil added are either 2 parts or 4 parts (by volume) per 100 parts of bitumen measured at 15°C.

The material used as flux oil at present is either Distillate or Diesel Fuel Oil (or proprietary products) depending on availability and cost. See Section 5.2 for their specification. The addition of Distillate or Diesel Fuel oil was believed to permanently soften the bitumen, however, current knowledge suggests that this is not the case and that the oil evaporates quicker than originally thought. Class 170 bitumen may be fluxed with heavier oils or greases which may keep the binder softer, longer, although further research in this area is required.

Current practice as described in this manual is still to flux bitumen with Distillate or Diesel Fuel oil. This practice is under review.

Tables have been developed to determine the parts of flux oil required for the particular conditions. See Table 8.7B or Table 16.13.2E.

The viscosities of the residual binders produced by fluxing Class 170 bitumen are shown in Table 4.2.7.

**Table 4.2.7 Field Preparation of Various Grades of Binder Flux Oil – Distillate or Diesel Fuel Oil**

4.2.8 Cutting Back Bitumen for Sprayed Work

For workability and aggregate adhesion it is often necessary to temporarily reduce the viscosity of the bitumen, or fluxed bitumen, in the field. This is achieved by adding a light to medium volatile oil as the cutter. Cutting back is regarded as a temporary effect and the cutter is not regarded as being part of the residual binder.

The quantity of cutter to be added is dependent on the pavement temperature, traffic volume, the size of aggregate used and short and long term weather considerations.
The quantities of cutter added vary from 2 parts to about 20 parts (by volume) per 100 parts of bitumen measured at 15°C. For practical purposes the quantity of cutter is determined in increments of 2 parts per 100 parts of bitumen measured at 15°C.

The material used as cutter at present is either kerosene, high flash point kerosene or Aviation Turbine Fuel depending on availability and cost.

Tables have been developed to determine the parts of cutter required for the particular conditions. See Table 8.7A or Table 16.13.2D.

The approximate viscosities of the field-produced cutback bitumen binders at 60°C are shown in Table 4.2.8 for information.

**Table 4.2.8  Field Produced Cutback Bitumen Binders**

<table>
<thead>
<tr>
<th>Parts of Cutter</th>
<th>Approximate viscosity at 60°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bitumen: Flux Oil 100:0</td>
</tr>
<tr>
<td>0</td>
<td>160</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>8</td>
<td>23</td>
</tr>
<tr>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>14</td>
<td>6.8</td>
</tr>
<tr>
<td>16</td>
<td>4.9</td>
</tr>
<tr>
<td>18</td>
<td>3.6</td>
</tr>
<tr>
<td>20</td>
<td>2.6</td>
</tr>
<tr>
<td>22</td>
<td>2.0</td>
</tr>
<tr>
<td>24</td>
<td>1.6</td>
</tr>
<tr>
<td>26</td>
<td>1.2</td>
</tr>
<tr>
<td>28</td>
<td>0.95</td>
</tr>
<tr>
<td>30</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Note: If the bitumen used has a lower or higher viscosity than 170 Pa.s the cutback produced will have a correspondingly lower or higher viscosity.
4.2.9 Working Temperatures

(a) Class 170 Bitumen

(i) Maximum Temperature

The maximum temperature to which Class 170 bitumen may be heated is 200°C although the maximum spraying temperature should not exceed 185°C. Heating the bitumen in excess of 200°C causes excessive fuming and health risks as well as hardening of the bitumen.

(ii) Sprayed Work

The normal temperature to which bitumen is heated for sprayed work is between 175°C and 185°C in order to be within the specified spraying viscosity limits.

When crumbed rubber is used as an additive, the bitumen may be heated to a maximum of 200°C to enable mixing of the crumb rubber and allow for heat transfer to the cold crumb rubber from the hot bitumen.

(iii) When using polymer modified binders, other than (ii) above, the manufacturer’s recommendations should be followed regarding the heating and storage of the binder.

(b) Fluxed and/or Cutback Bitumen – Sprayed Work

Where the bitumen is fluxed and cut back, as required in the field, the following procedure will ensure that the cutback bitumen produced is at the correct working temperature for spraying:

(i) The temperature of the Class 170 bitumen should be between 180°C and 185°C before any fluxing or cutting back is done

(ii) Add the appropriate quantities of cold flux oil and cutter

(iii) Circulate thoroughly

(iv) Check that the temperature is above the temperature given in Figure 8.6.1 or Figure 16.13.2G

The graph in Figure 8.6.1 (or Figure 16.13.2G) has been produced to check the correct temperature range for reheating and spraying.

See also Section 8.6.1(b) for a method to calculate the correct spraying temperature.

(c) Fluxed and/or Cutback Bitumen – Using AMC Grades

See Table 4.2.8 for the correct working temperatures.
4.3 CUTBACK BITUMEN

4.3.1 Production
Cutback bitumen binders are manufactured from refinery produced bitumen which is cutback (thinned) with petroleum solvents of selected volatility to produce binders of the required viscosity. The distillation range of the solvents used determines the curing characteristics and the types that may be made. They may be produced at refineries or in the field to the type and grade required.

4.3.2 Types
The normal types of cutback bitumen binders produced and used are the medium curing type.

4.3.3 Australian Standard Grades
The cutback bitumen binders are divided into several grades according to viscosity. The standard grades used are shown in Table 4.3.3.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Viscosity Range Pa.s at 60°C</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primersealing</td>
<td>0.22 to 0.44</td>
<td>AMC 2</td>
</tr>
<tr>
<td></td>
<td>0.55 to 1.10</td>
<td>AMC 3</td>
</tr>
<tr>
<td></td>
<td>2.0 to 4.0</td>
<td>AMC 4</td>
</tr>
<tr>
<td>Sealing</td>
<td>5.5 to 11.0</td>
<td>AMC 5</td>
</tr>
<tr>
<td></td>
<td>13.0 to 26.0</td>
<td>AMC 6</td>
</tr>
<tr>
<td></td>
<td>43.0 to 86.0</td>
<td>AMC 7</td>
</tr>
</tbody>
</table>

Table 4.3.3 Standard Grades of Cutback Bitumen Binders (as specified in Australian Standard 2157)

4.3.4 Specification
The properties required of the standard medium curing cutback binders produced are given in Tables 4.3.4 and 4.3.5.

4.3.5 Field Produced Grades
In Victoria, cutback bitumen binders are usually produced in the field using the bitumen, flux oil and cutter depending on the pavement conditions and size of aggregate at the time of spraying. It is contained in a sprayer and must be thoroughly mixed to provide a homogenous material. Failure to mix properly may result in the production of an unsatisfactory cutback bitumen binder.

The types that may be produced are:
(a) Standard Grades
Table 4.3.5 gives the approximate proportions of Class 170 bitumen and cutter to produce equivalent standard grades as shown in Tables 4.3.3 and 4.3.4.
Table 4.3.4 Properties of Medium Curing Cutback Bitumen Binders (As specified in Australian Standard 2157)

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirements and Characteristics</th>
<th>Primersealing</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Scaling Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td></td>
<td>AMC 2</td>
<td>AMC 3</td>
<td>AMC 4</td>
<td>AMC 5</td>
<td>AMC 6</td>
<td>AMC 7</td>
</tr>
<tr>
<td>Flash Point °C</td>
<td></td>
<td>0.22</td>
<td>0.44</td>
<td>0.55</td>
<td>1.1</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Distillation test Distillate as percentage by volume of total distillate to 360°C</td>
<td></td>
<td>38</td>
<td>-</td>
<td>38</td>
<td>-</td>
<td>38</td>
<td>-</td>
</tr>
<tr>
<td>To 190°C</td>
<td></td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>To 225°C</td>
<td></td>
<td>-</td>
<td>40</td>
<td>-</td>
<td>35</td>
<td>-</td>
<td>30</td>
</tr>
<tr>
<td>To 260°C</td>
<td></td>
<td>30</td>
<td>75</td>
<td>20</td>
<td>60</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>To 316°C</td>
<td></td>
<td>70</td>
<td>95</td>
<td>65</td>
<td>90</td>
<td>50</td>
<td>85</td>
</tr>
<tr>
<td>Residue from distillation to 360°C - Percentage Volume by difference</td>
<td></td>
<td>66</td>
<td>-</td>
<td>73</td>
<td>-</td>
<td>79</td>
<td>-</td>
</tr>
<tr>
<td>Tests on Residue from distillation</td>
<td></td>
<td>(a) Dynamic Viscosity Pa.s at 60°C</td>
<td>30</td>
<td>120</td>
<td>30</td>
<td>120</td>
<td>30</td>
</tr>
<tr>
<td>(b) Matter insoluble in Toluene, percent</td>
<td></td>
<td>-</td>
<td>1.0</td>
<td>-</td>
<td>1.0</td>
<td>-</td>
<td>1.0</td>
</tr>
<tr>
<td>Application Temperature °C See Note</td>
<td></td>
<td>75 to 100</td>
<td>95 to 115</td>
<td>110 to 135</td>
<td>120 to 150</td>
<td>135 to 160</td>
<td>150 to 175</td>
</tr>
</tbody>
</table>

Note: If the application temperatures are exceeded or if the material suffers prolonged storage at the application temperature, the classification is liable to change.
(b) VicRoads Field Produced

Tables 4.2.7 and 4.2.8 give the proportions of Class 170 bitumen, flux oil and cutter that may be used to produce a large range of fluxed and/or cutback bitumen binders used for sprayed work. See also Section 8.7 and Section 16.13.2.

(c) Mixing of Standard Grades

Lighter and heavier standard grades may be produced by mixing standard grades of bitumen or by fluxing and/or cutting back.

This procedure is not used by VicRoads on bituminous surfacing sprayed work and the method in (b) above is used to produce the grades required for the work.

Table 4.3.5  Field Produced Equivalent of Medium Curing Cutback Bitumen Binders

<table>
<thead>
<tr>
<th>Grade</th>
<th>Classification</th>
<th>Approximate parts by volume at 15°C</th>
<th>Equivalent % of cutter in mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Class 170 Bitumen</td>
<td>Cutter</td>
</tr>
<tr>
<td>AMC 2</td>
<td>Primersealing</td>
<td>100</td>
<td>37</td>
</tr>
<tr>
<td>AMC 3</td>
<td>Primersealing</td>
<td>100</td>
<td>27</td>
</tr>
<tr>
<td>AMC 4</td>
<td>Primersealing</td>
<td>100</td>
<td>19</td>
</tr>
<tr>
<td>AMC 5</td>
<td>Sealing</td>
<td>100</td>
<td>12</td>
</tr>
<tr>
<td>AMC 6</td>
<td>Sealing</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
<td>AMC 7</td>
<td>Sealing</td>
<td>100</td>
<td>3</td>
</tr>
</tbody>
</table>

Cutter: Kerosene, high flash point kerosene or Aviation Turbine Fuel.

4.3.6 Working Temperatures

The working temperatures for cutback bitumen binders for use in sprayed work are as shown in Tables 4.3.6, 4.3.5 and 4.3.4

Table 4.3.6  Working Temperatures of Cutback Bitumen Binders

<table>
<thead>
<tr>
<th>Grade</th>
<th>Working Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMC 2</td>
<td>75 to 100</td>
</tr>
<tr>
<td>AMC 3</td>
<td>95 to 115</td>
</tr>
<tr>
<td>AMC 4</td>
<td>110 to 135</td>
</tr>
<tr>
<td>AMC 5</td>
<td>120 to 150</td>
</tr>
<tr>
<td>AMC 6</td>
<td>135 to 160</td>
</tr>
<tr>
<td>AMC 7</td>
<td>150 to 175</td>
</tr>
<tr>
<td>VicRoads Field Produced</td>
<td>See Section 4.2.9 &amp; Figures 8.6.1 or 16.13.2G</td>
</tr>
</tbody>
</table>
4.4 BITUMEN EMULSION

4.4.1 Description
Standard bitumen emulsion is a liquid product in which a substantial amount of very finely divided bitumen is suspended in water by means of one or more emulsifying and stabilizing agents. Some speciality emulsions are inverted in that the water is very finely divided and suspended in the bitumen. Inverted emulsions may have the bitumen and the water treated with emulsifying and stabilizing agents.

4.4.2 Types
The nature and type of emulsifying agents control the type of the bitumen emulsion that is produced. Two common types of bitumen emulsion are manufactured for roadmaking purposes:

(a) Anionic – a bitumen emulsion in which the bitumen particles are suspended in water and the bitumen particles are negatively charged

(b) Cationic – a bitumen emulsion in which the bitumen particles are suspended in water and the bitumen particles are positively charged.

Less commonly used emulsions are:

(a) non-ionic emulsions with no charge

(b) inverted emulsions which are emulsions where the water particles are suspended in the bitumen (and the bitumen is positively or negatively charged)

(c) emulsions manufactured from heavily modified bitumen binder. The modified binder can be suspended in water or alternatively have the water suspended in the binder. The binder is modified with proprietary compounds which often include cutting and fluxing oils and polymers.

These emulsions may be used for precoating aggregates and priming, primersealing and sealing pavements.

4.4.3 Composition

(a) Binder
Any of the roadmaking classes of bitumen may be emulsified but the common binder used in Victoria is Class 170 bitumen. In cationic emulsions the binder usually also contains a distillate oil as a stabilizing agent.

Emulsions can also be made from polymer modified binders.

Bitumen emulsion may be produced having a binder content from 25 to 80% but the normal binder contents for sealing works are:

- Anionic emulsion – 60 to 80%
- Cationic emulsion – 60 to 80%.
- Water and emulsifiers make up the balance.
Current practice is to use high binder content (above 67%) emulsions in sprayed sealing works because:

- they are more economical to use than the lower binder content emulsions (i.e. there is less water to transport),
- the sprayed binder film on the road surface is more viscous and less inclined to run when high application rates are required to be sprayed on single application seals.

(b) Water

The water content depends on the binder and emulsifier proportions.

When manufacturing anionic emulsion, soft water only should be used. When manufacturing cationic emulsion, soft or hard water can be used.

(c) Emulsifier

Bitumen emulsion will be unstable unless the bitumen particles are prevented from colliding and sticking together. The emulsion is made stable by adding an emulsifier which creates a layer on the surfaces of the particles. The emulsifiers are usually soaps for anionic emulsion and amines for cationic emulsion, but other compounds may be used.

The proportion of emulsifier affects the stability of the bitumen emulsion and the proportions may be varied to produce emulsions with different stabilities.

The usual content of emulsifier is between 0.5% and 3% depending on the type and stability of emulsion required.

4.4.4 Production

Bitumen emulsion is commonly manufactured using a colloid mill. In a colloid mill the bitumen is subjected to a shearing force by means of two discs or cylinders rotating in opposite directions, or in the same direction at different speeds, with only a small clearance between them. The shearing force from the mill produces fine droplets of bitumen and the size of the droplets can be varied by adjusting the clearance in the mill. The bitumen phase and water plus emulsifier phase, are introduced into the mill together. The mixture from the mill is usually discharged into a holding tank fitted with a mechanical stirrer to prevent sedimentation.

Inverted emulsions are produced in the same manner as conventional emulsions except for different flow rates and the use of different forms of emulsifier.

4.4.5 Australian Standard Grades

The bitumen emulsions are divided into several grades according to the time it takes to break, i.e. the time it takes to form a continuous film of bitumen over the surface to which the emulsion is applied. The standard grades are shown in Table 4.4.5.
Table 4.4.5 **Standard Grades of Bitumen Emulsion (as specified in Australian Standard 1160)**

<table>
<thead>
<tr>
<th>Type of Emulsion</th>
<th>Grade</th>
</tr>
</thead>
</table>
| Anionic          | ARS = rapid setting  
                    AMS = medium setting  
                    ASS = slow setting |
| Cationic         | CRS = rapid setting  
                    AMS = medium setting  
                    CSS = slow setting  
                    CAM = aggregate mixing |

Currently the inverted grades of emulsion manufactured for priming and primersealing are still being developed by the manufacturers and it is necessary to rely on the manufacturer’s specifications for these products. GeoPave can also be contacted to assist in the selection of the appropriate properties of emulsions used for priming and primersealing.

### 4.4.6 Identification

The designation of standard emulsions indicate the standard grades as set out in Section 4.4.5, together with the class of residual bitumen used to manufacture the emulsion.

Examples:

(a) ASS/170 – 60 represents anionic slow setting emulsion 170 = Class 170 with 60% bitumen content.

(b) CRS/170 – 67 represents CRS = cationic rapid setting emulsion 170 = Class 170 with 67% bitumen content.

(c) CRS/170 – 67P represents CRS = cationic rapid setting emulsion 170 = Class 170 with a 67% polymer modified bitumen content.

### 4.4.7 Specification

The properties required of the standard grades of emulsion produced are given in Table 4.4.7.

Currently there is no standard specification for the specialist inverted emulsions used for priming, primersealing and resealing (other than the ARS and CRS emulsions used for primersealing and resealing). Specifications for these materials should be obtained from the manufacturer and advice sought from GeoPave about the use of these materials.

### 4.4.8 Trade Names

Manufacturers produce and market bitumen emulsions which comply with the Australian Standards. Due to the rapid development in emulsion technology, the manufacturers also market special bitumen emulsions which are not covered by Australian Standards. Refer also to Austroads Code of Practice, APRG 7 – Part 3 Bitumen Emulsions.
Table 4.4.7 Properties of Anionic and Cationic Emulsion (As specified in Australian Standard 1160)

<table>
<thead>
<tr>
<th>Property</th>
<th>Anionic type</th>
<th>Cationic type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ARS grade</td>
<td>AMS grade</td>
</tr>
<tr>
<td>pH at 25°C</td>
<td>To be recorded</td>
<td>To be recorded</td>
</tr>
<tr>
<td>Residue from evaporation (minimum percentage by mass)</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Water content (maximum percentage by mass)</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Solvent content (percentage by mass)</td>
<td>2 max.</td>
<td>2 max.</td>
</tr>
<tr>
<td>Consistency at 25°C (degrees Engler) (see Note 1)</td>
<td>3.5 to 8.0</td>
<td>3.5 to 8.0</td>
</tr>
<tr>
<td>Sieve residue (maximum percentage by mass)</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Sedimentation (maximum percentage by mass) (see Note 2)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Stone coating ability and water resistance (percentage of aggregate surface area coated)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Setting time (minutes)</td>
<td>3 max.</td>
<td>4 to 7 min.</td>
</tr>
<tr>
<td>Residue from evaporation: (a) Viscosity at 60°C as percentage of the nominal viscosity of the class of bitumen used</td>
<td>60 to 125</td>
<td>60 to 125</td>
</tr>
<tr>
<td>(b) Matter insoluble in Toluene (maximum percentage by mass)</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

1. By agreement between purchaser and supplier, the requirements for consistency, which merely provide an indication of application properties, may be modified or waived. As bitumen emulsions are non-Newtonian, only empirical flow properties can be determined. Correlation between instruments is possible only by experimental determination with the different instruments on the identical material. If, by agreement, instruments other than the reference instruments are used, the onus is on the testing authority to produce satisfactory, correlating evidence.

2. By agreement between purchaser and supplier, the requirements for settlement may be substituted with requirements based on a simple, indicative test for settling.
4.4.9 Breaking of an Emulsion

A bitumen emulsion is said to ‘break’ when the bitumen and water separate out and the bitumen forms a film on the surfaces to which the emulsion is applied. This can be seen by the emulsion changing from a brown to a black colour.

The two common types of bitumen emulsion produced, break by different actions.

(a) Anionic Emulsion

Anionic emulsion breaks when the water is lost by evaporation or absorption into the surface to which they are applied or when the soap emulsifier is precipitated by hard or acidic water. The breaking of an anionic emulsion is greatly influenced by the prevailing weather conditions.

(b) Cationic Emulsion

Cationic emulsion breaks when the water is lost by evaporation or absorption or when the emulsifier is rendered ineffective. The emulsifier is commonly an amine which has strong adhesion-promoting properties. Because of this, the bitumen will readily adhere to the surface to be coated and this action separates the water from the bitumen and the emulsion breaks. This is based on a chemical reaction and is far less influenced by the weather conditions.

4.4.10 Sedimentation in Storage

(a) Drums

All bitumen emulsion when stored suffers from sedimentation, i.e. the settling of the bitumen droplets to the bottom of the drum. This is usually not serious because it can be easily corrected by agitating the drum periodically, say once a fortnight. Sufficient agitation will be provided by turning the drums once, end over end.

Bitumen emulsion should not be stored for more than about two months. Sedimentation can be reduced by agitating each drum before use, not over ordering, and using the drums as soon as possible.

(b) Bulk storage

Storage of emulsions in bulk is common. Bulk storages are generally fitted with mechanical agitation or stirring and controlled electrical heating. The preferred method is to store emulsions in bulk.

4.4.11 Coagulation in Storage

Coagulation occurs where droplets of the bitumen have joined together to form lumps and strings. Coagulation is a partial or complete breakdown of the emulsion and is serious because it cannot be corrected in the field. The whole of the emulsion in the container is useless.

Coagulation occurs more quickly at low temperatures therefore bitumen emulsion stored should be well protected from frost during storage.
### 4.4.12 Mixing Emulsions

(a) Types of Emulsion

Anionic and cationic emulsion must not be mixed because when they come into contact the emulsions will break due to the attraction of oppositely charged particles. Care is required when changing from one type to another. It is essential to remove all traces of the material last used by flushing out all tanks, hoses etc. with clean water. If the emulsion has broken and a bitumen residue is left in the equipment it may be removed using kerosene or distillate followed by flushing with clean water.

(b) Grades of Emulsion

Because of the nature of bitumen emulsion there is no practical advantage in mixing various grades to produce other grades. Conditions such as weather and type of aggregate used have a far greater influence on the behaviour of an emulsion. To avoid wastage, or if there is a shortage of one grade of material, grades of the same type only may be mixed (i.e. anionic with anionic or cationic with cationic).

If changing from bitumen types (i.e. cutback bitumen to emulsion or visa versa) it is important to clean spraybars and pumps. Inadequate cleaning can result in clogging of pipework and spray bars and, in some cases, explosive type reactions.

### 4.4.13 Diluting Emulsions

Some bitumen emulsions may be diluted with water but this is rare when emulsions are used for sprayed sealing. Dilution of emulsions changes the balance of emulsifier and is not recommended unless absolutely necessary. Normally, dilution is only carried out on the more stable, slow setting grades.

Precautions that need to be followed are:

- The water must be added to the emulsion gradually and stirred in.
- Bitumen emulsion must not be added to the water because the weak concentration formed will break. Any scum which forms after diluting should be removed before the emulsion is used.
- Use clean warm water if possible and check compatibility with the emulsion by testing a small quantity before diluting.
- Only dilute sufficient quantity for immediate use and use as soon as possible after dilution.
- Inverted emulsions cannot be diluted with water.

### 4.4.14 Field Behaviour/curing

It is difficult to predict, from laboratory tests, how a bitumen emulsion will react to the actual working conditions and materials on a particular job. This can only be determined by actual trial on the job.
Bitumen emulsions should achieve results identical to those of cutback bitumen. An emulsion primer is required to soak into and bind the pavement surface and produce a dry, uniform, black, non-absorbent surface, in the same way that cutback bitumen primes perform. An emulsion primerbinder is required to soak into and bind the surface of the pavement yet have sufficient binder remaining to hold the aggregate and waterproof the pavement, in the same way that cutback bitumen primerbinders perform.

4.4.15 Working Temperatures

Bitumen emulsion for sprayed sealing is a liquid product that must be used below 100°C (the boiling temperature of water). The temperature at which the emulsion is sprayed is dependent upon the type of emulsion and the type of jet used in the spray bar. The properties of the emulsion and the manufacturer’s recommendations should be considered when choosing a spraying temperature and the size of jets used in the spray bar.

4.5 DIAGRAMMATIC REPRESENTATION

4.5.1 Cutback Bitumen

Figure 4.5.1 gives a diagrammatic representation of the approximate composition of the standard grades of cutback bitumen binders.

![Approximate composition of cutback bitumen binder](image)

**Figure 4.5.1** Approximate composition of cutback bitumen binder
4.5.2 Bitumen Emulsion

Figure 4.5.2A gives a diagrammatic representation of a bitumen emulsion.

Figure 4.5.2B shows samples of bitumen emulsion magnified approximately 250 times. The usual emulsions produced have a bitumen droplet size between that shown in slide 1 and slide 2.

![Diagrammatic Representation of Bitumen Emulsion](image)

**Figure 4.5.2A Diagrammatic Representation of Bitumen Emulsion**

![Globule Size of Bitumen Emulsion](image)

**Figure 4.5.2B Globule Size of Bitumen Emulsion**

4.6 WORKING TEMPERATURES

4.6.1 Bitumen

See Section 4.2.9.

4.6.2 Cutback Bitumen

See Section 4.2.9 and Table 4.3.6.

4.6.3 Bitumen Emulsion

See Section 4.4.15.
4.7 USAGE

4.7.1 Bitumen

Bitumen is used as the binder, or as the basic material to produce a fluxed/cutback and/or polymer modified binder, in sprayed sealing work.

4.7.2 Cutback Bitumen

The Australian Standard sealing grades AMC5, 6 and 7 are seldom used in Victoria because it is normal practice to produce the required cutback bitumen binder in the field to suit the field conditions at the time.

4.7.3 Bitumen Emulsion/Polymer modified binder emulsion

(a) Anionic – most useful in warm, dry conditions and with clean dry aggregate.

Rapid-setting (Grade ARS) – an emulsion characterized by rapid breaking and suitable for sprayed sealing.

Slow-setting (Grade ASS) – an emulsion with sufficient mechanical and chemical stability for all purposes requiring mixing with aggregate, including those containing large proportions of fines or chemically active materials such as cement or hydrated lime. The grade is also suitable for mixing with water for surface enrichment and dust laying.

(b) Cationic – preferred to anionic emulsion for use in cold and damp conditions and with damp or dry aggregates.

Rapid-setting (Grade CRS) – an emulsion characterized by rapid breaking and suitable for sprayed sealing.

Medium setting (grade CMS) – an emulsion suitable for surface enrichment work.

Slow-setting (Grade CSS) – an emulsion suitable for soil stabilisation work, surface enrichment and dust laying.

Grade CAM – an emulsion containing up to 15% cutter and suitable for mixing with aggregate to produce a cold mix that is also suitable for stockpiling prior to use.

Bituminous materials must be sprayed within the temperature limits specified by the supplier.
5.1 GENERAL
Additives are used to temporarily or permanently alter some of the physical properties of the basic binder material. Various materials may be required and used to alter the binder to make it suitable for a particular job.

(a) Commonly used additives:
• Flux oil
• Cutter oil
• Adhesion agent.

(b) Less commonly used additives:
• Granular crumb rubber
• Polymers with or without carrier oils
• Anti-foaming agent.

5.2 FLUX OIL
5.2.1 Purpose
Flux oils are added to the basic binder to produce softer grades of bitumen in the field. The materials used as flux oils are also suitable as aggregate precoating materials to help improve adhesion between binder and aggregate. Often these materials are further enhanced by using adhesion agents to improve the adhesion between the aggregate and the binder.

5.2.2 Production
Flux oil is a low to medium volatile oil produced from the refining of petroleum crudes and complying with AS 3568 – Cutting Oils For Use in Sprayed Sealing.

5.2.3 Types
The materials used as flux oil are:
• Diesel Fuel Oil (DFO) and proprietary derivatives
• Distillate and proprietary derivatives
• Furnace oil (not used in Victoria).

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1 The fluxing materials used in Victoria are derivatives of diesel fuel oil or distillate and do not permanently produce softer grades of binder as is normally assumed. The use of flux oil is intended to enable the binder to stay softer for a longer period to allow light volumes of traffic to embed the aggregates into the binder during service. Flux oil is only added to bitumen to produce a softer binder, suitable for use on low traffic volume roads.

Recent research has indicated that the assumption that these materials remain in the binder longer than cutter oils may not be correct. Further research in this area is required.
5.2.4 Specification

The technical requirements of flux oil are:
(a) Water content shall not exceed 0.15%
(b) The viscosity must be:
   (i) not greater than 0.01 Pa.s at 5°C
   (ii) not less than 0.001 Pa.s at 50°C
(c) Flash point – minimum of 78°C
(d) The flux oil must not contain material which cannot be passed through a 0.150 mm sieve at 25°C
(e) The flux oil must have the ability to mix with an equal volume of Class 170 bitumen without forming a precipitate.

5.2.5 Tests

The common tests for flux oil are:
(a) Relative Density – to determine the relative density for conversion from mass to volume
(b) Viscosity – to determine the viscosity at 5°C and 50°C
(c) Miscibility – to test its ability to mix with bitumen.
(d) Cleaning Properties – to determine the effectiveness in removing bitumen from spray equipment (tanks, hoses etc.).

5.2.6 Use

The main uses of flux oils are:
(a) Fluxing residual bitumen to softer grades
(b) Precoating of aggregates in sprayed work
(c) Producing field grades of slow to medium curing cutback bitumen primers
(d) Flushing out and cleaning out of bitumen from spray equipment tanks, bitumen hoses etc.

5.3 CUTTER OIL

5.3.1 Purpose

Cutter is used to temporarily reduce the viscosity of a Class 170 or a fluxed bitumen to a viscosity suitable for the prevailing conditions. It may also be used to further reduce the viscosity of cutback bitumen binder.
5.3.2 Production
A medium to light volatile oil produced from the refining of crude petroleum.

5.3.3 Types
The materials used as cutter are:
(a) High Flash Point Kerosene
(b) Aviation Turbine Fuel
(c) High volatility cutters (essential for certain polymer modified binders).

Note: Other cutters are available for special applications. For further advice contact the Manager GeoPave.

5.3.4 Specification
The technical requirements are:
(a) The cutting oil must have a distillation range such that:
   (i) the Initial Boiling Point (IBP) is not below 135°C
   (ii) the Final Boiling Point (FBP) is not above 270°C.
(b) The oil must have the ability to mix with an equal volume of Class 170 bitumen without precipitation.
(c) When this type of material is supplied under contract to VicRoads the supplier is required to submit the name of the product, density, flash point, initial boiling point and final boiling point. Any cutter supplied shall comply with (a) and (b) above and shall not depart by more than 5% from the values nominated by the supplier in their tender.

5.3.5 Tests
The common tests are:
(a) Relative Density – to determine the relative density for conversion from mass to volume.
(b) Miscibility – to test its ability to mix with bitumen.
(c) Cleaning Properties – to determine the effectiveness in removing bitumen from inside tanks, bitumen hoses, spray equipment etc.

5.3.6 Use
Its main uses are:
(a) Cutting back bitumen based binders to a suitable viscosity.
(b) Producing field grades of medium and slow to medium curing cutback bitumen primers and medium primerbinders
(c) Flushing out and cleaning out bitumen from tanks, spray bitumen, hoses, equipment etc.
Note: For some polymer modified binders it is necessary to cut the binder with more aromatic cutters to ensure adequate wetting of the aggregate by the binder.

5.4 ADHESION AGENTS

5.4.1 Purpose
Adhesion agents are used to improve the adhesion between the cutback binder and the aggregate and/or the cutback binder and the existing pavement surface in the presence of moisture. They can be used in the aggregate precoating material, in the binder, or in both.

Cationic bituminous emulsions do not require the addition of an adhesion agent as the emulsifying agents act as adhesion agents.

5.4.2 Production
The adhesion agents used in cutback bituminous surfacing work are usually amines or amine salts of fatty acids. These amine products usually combine the characteristics of both a wetting agent and an anti-stripping agent.

5.4.3 Specification
The adhesion agents used by VicRoads are proprietary products which must fulfil the following technical requirements:

(a) Be soluble in both residual bitumen and the oils used for fluxing and/or precoating.

(b) Be capable of improving adhesion between cutback bitumen and wet or dry mineral aggregate after dissolving in either the bitumen or the oils used for precoating the mineral aggregate or both.

(c) When used in the precoating oils there must be no precipitation of the adhesion agent when the solution is stored for a period of four weeks, or more.

(d) The adhesion agent must not contain any ingredients which, when it is dissolved in the bitumen and used in the field, will:
   (i) cause damage to any equipment
   (ii) be harmful to the bitumen
   (iii) alter the normal mixing and setting qualities of the bitumen.

5.4.4 Tests
Tests are done to determine the effectiveness of the adhesion agent in terms of adhesion, mixing ability and stability. The common tests are:

(a) Adhesion – Test the adhesion of binder to stone in the presence of water. This is done using ten standard types of aggregate with the adhesion agent in the binder or on the aggregate. The results may be reported for each type of aggregate or as an average for all ten.
(b) Miscibility – To test the ability to mix adhesion agents with diesel fuel oil (DFO) or distillate.

(c) Stability at High Temperature – To test the stability of adhesion agents to retain effectiveness after storage in hot bitumen.

(d) Stability in Solution – To test the chemical stability of adhesion agents in solution (i.e. mixed with DFO/distillate) when exposed to air.

5.4.5 Working Temperatures
The adhesion agents used are generally stable in hot bitumen for only a limited period. If a binder containing adhesion agent is kept at normal storage temperatures of 150°C or above for more than 6 hours, or is cooled and reheated, the effectiveness of the adhesion agent will be greatly reduced and the required quantity of adhesion agent should be added again.

5.4.6 Method of Use
Adhesion agents may be dissolved in the binder or in the aggregate precoating material.

The concentrations required for effective use depends on the actual type of adhesion agents used. Unless otherwise instructed, the recommended standard proportions for adhesion agents commonly used are:

(a) In the Precoating Oil
The normal precoating material used is either diesel fuel oil or distillate. Add 1 part of adhesion agent by volume to 100 parts of diesel fuel oil or distillate and mix thoroughly. The mixture may be prepared up to several days before use.

(b) Cutback bitumen precoating
Add 1 part of adhesion agent by volume to 100 parts of cutback mixture.

(c) In the Binder
Add \(\frac{1}{2}\) part by volume to 100 parts of residual binder measured at 15°C. Add shortly before use and circulate thoroughly.

(d) In the Primerbinder
Add 1 part by volume to 100 parts of binder measured at 15°C. Add shortly before use and circulate thoroughly.

In normal practice, adhesion agents are used in the precoating oil as this is the most efficient and economic use of the adhesion agent. For wet aggregates, and aggregates that do not have a high affinity to bitumen, the use of an adhesion agent in the binder as well as in the precoating oil is suggested.
(e) In crumbed rubber modified binder and other PMBs

Add 1 part by volume to 100 parts of binder measured at 15°C. Add shortly before use and circulate thoroughly.

Note: The concentration of adhesion agent may be increased for some types of aggregate and for difficult conditions. In some cases it may be practical to select special adhesion agents for particularly difficult conditions. Advice should be sought from GeoPave when special precoating agents are being considered for use.

5.5 POLYMER MODIFIED BINDERS

5.5.1 Purpose

Polymer modified binders are used in spray sealing to:

- provide a more robust binder than Class 170 bitumen
- to improve crack reflection, waterproofing and aggregate retention properties
- provide a binder that can act as a Strain Alleviating Membrane (SAM), Strain Alleviating Membrane Interlayer (SAMI) or as a high stress seal (HSS).

5.5.2 Production

Polymer modified binders are normally produced in factories or refineries because they require special conditions to enable proper incorporation of the polymer into the binder. Polymers normally require high shear mixing to enable proper incorporation into the bitumen. In some cases the polymer also requires the use of a carrier oil to enable incorporation.

Crumb rubber and EVA (Ethyl Vinyl Acetate) polymer are successfully mixed with bitumen in most sprayers, however such equipment is not suitable for mixing SBS (Styrene Butadiene Styrene) polymers.

5.5.3 Specification


5.5.4 Working Temperatures

Polymer modified binders can degrade at high temperatures causing fuming or breakdown of polymer properties. It is important, therefore, that the manufacturer’s recommendations for working temperatures, storage temperature and length of storage be followed by reference to the manufacturer’s technical literature.

5.5.5 Use

The main purposes for using polymer modified binders is to enhance the properties of bitumen binders. The properties that are improved are robustness, ability to resist cracking, aggregate retention, resistance to temperature and flushing and flexibility. It should be noted that polymer modified binders may improve the properties of strength of the binder to the detriment of adhesion to aggregate.
5.6 CRUMB RUBBER

5.6.1 Purpose

Crumb granulated rubber is a form of polymer added to bitumen and is used to provide a tough, resilient binder which can be applied at heavier than normal rates of application. The use of rubber is aimed to reduce or diminish reflection cracking in the seal coat. It can also assist with the retention of aggregate.

Crumb rubber modified binders are generally made with the addition of either 5 or 20 parts of added crumbed rubber by mass at 15°C. Crumb rubber binders containing 5 parts of rubber are used to provide a tough resilient binder on lightly trafficked roads and to provide improved initial aggregate retention when used in heavily trafficked or high stress locations. Binders containing 5 parts of crumbed rubber also provide minor resistance to reflective and minor structural cracking of heavily trafficked pavements.

Crumb rubber binders containing 20 parts of rubber are used to provide a tough resilient SAM seal on structurally distressed pavements subject to very heavy traffic. On minor roads, 10 to 15 parts of crumbed rubber provides a suitable SAM seal.

Crumb rubber binders containing 25 parts of rubber are used as a SAMI (Strain Alleviating Membrane Interlayer) which is normally covered by asphalt. This type of treatment is used to prevent/reduce reflection cracking of a structurally distressed pavement through an asphalt overlay. If asphalt is to be placed over this type of seal no cutter or minimal cutters should be used and the asphalt placed within two days after the seal. Cutting oils used in sprayed seals can soften the binder used in asphalt causing loss of shape and flushing of the asphalt overlay.

5.6.2 Production

Crumb rubber may be produced by:

(a) mechanical shredding of used rubber tyres
(b) the buffing process used in the preparation of tyres for retreading
(c) crushing tyres frozen with liquid nitrogen (cryogenic process) followed by separation of the rubber granulate from the tyre fabric and screening to size.

Rubber granulate produced by the cryogenic process requires further grinding to produce the rough particle texture desirable for use in bitumen.

5.6.3 Specification

The technical requirements are:

(a) The crumb rubber shall consist mainly of synthetic rubber from car tyres and shall meet the following grading requirement (for Grade 30) shown in Table 5.6.3.
(b) Density

The crumb rubber shall have a maximum bulk density of 350 kg/m³ and a constant relative density to within ± 0.02. (For the crumb rubbers generally supplied the relative density is about 1.15.)

**Table 5.6.3 Particle Size Distribution Requirements of Grade 30 Crumb Rubber**

<table>
<thead>
<tr>
<th>Sieve Size AS (mm)</th>
<th>1.18</th>
<th>0.60</th>
<th>0.15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grading &quot;30&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage Passing (by mass)</td>
<td>100</td>
<td>70 - 100</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

(c) Moisture

The moisture content of the crumb rubber on delivery shall not exceed one percent by mass.

(d) Foreign Matter

The crumb rubber supplied shall be free of all cord, wire, fluff or other deleterious material.

(e) Freedom from Lumps

The material shall be capable of being poured freely from the bags. Any bags containing lumps or conglomerate of particles should be rejected and replaced by the supplier. The use of unsatisfactory material can be dangerous, cause damage to equipment and block jets which results in an unacceptable standard of work.

5.6.4 Tests

The common tests are:

(a) Grading – to determine particle size distribution

(b) Relative Density – to determine uniformity and compliance with specification requirements

(c) Contamination – by visual inspection for fabric, wire etc.

5.6.5 Working Temperatures for Sprayed Work

The bitumen needs to be heated to 200°C to successfully incorporate the granulated rubber into the bitumen. The temperature must not exceed 200°C to avoid degradation of the bitumen, the production of a possibly flammable mixture and to avoid excessive fuming which could be damaging to the health of workers and the environment.

It should be noted that the major proportion of the rubber does not dissolve but remains in suspension.

5.6.6 Use

As there is a high expansion rate when crumb rubber is added to the binder, adequate space should be left in the sprayer before the rubber is added.
The crumb rubber is gradually added to the binder by means of a specially designed rubber (additive) mixing box and the mixture thoroughly circulated to achieve uniform dispersion.

The rubber greatly increases the viscosity of the binder.

A small amount of cutter, plus higher than normal temperatures (190 to 200°C) and bitumen pump revolutions and/or larger spraying jets, are required to achieve uniform distribution on the pavement.

Crumb rubber is regarded as being part of the residual binder.

### 5.7 ANTI-FOAMING AGENTS

#### 5.7.1 Purpose

An anti-foaming agent is used to prevent the chance of ‘boil-overs’ occurring in plant containing bituminous materials and small quantities of water. Boil-over occurs when a sprayer, tanker or heater in which there is water, is filled or partly filled with hot bitumen or when material containing water is heated above the boiling point of water.

Water may accumulate in a tank, pump or spraybar because of condensation over the winter period or when emulsion, which contains water, has been handled or stored in the tank.

#### 5.7.2 Production

Most anti-foaming agents are silicone based and are generally a solution of a small quantity of fluid silicone concentrate and diesel fuel oil or distillate. The silicone concentrate is added to the diesel fuel oil/distillate and the mixture thoroughly stirred.

It is important to measure the quantities carefully as silicone affects the physical properties of bitumen. In the correct proportions the effect is negligible but a high concentration of anti-foam solution could reduce the adhesion properties of the bitumen.

#### 5.7.3 Specification

The basic material commonly used is Dow Corning 200/1000 Fluid (Silicone) concentrate which is blended with diesel fuel oil or distillate to prepare an anti-foam solution.

#### 5.7.4 Test

A test is done using an atomic absorption spectrophotometer to determine the silicone content of the solution.

#### 5.7.5 Use

The anti-foam solution is poured into the tank before any hot bituminous material is loaded. Table 5.7.5 gives the standard proportion of anti-foam solution required to be effective without affecting the physical properties of the bitumen.
Table 5.7.5  Standard Proportions of Bitumen and Anti-Foam Solution

<table>
<thead>
<tr>
<th>Parts by Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen as 15°C</td>
</tr>
<tr>
<td>5000</td>
</tr>
</tbody>
</table>

5.8 PRECOATING MATERIALS

5.8.1 Purpose

The purpose of using precoating materials is to increase the ability of the binder to wet the aggregate and improve adhesion between binder and aggregate.

5.8.2 Types

(a) The precoating material commonly used in rural areas is diesel fuel oil (and proprietary derivatives) which generally contains an adhesion agent.

(b) Other materials which have been used for treating specific aggregates or used in special conditions are:

(i) Cutback bitumen (generally used in urban areas where quarries have the capacity to precoat aggregates)

(ii) Bitumen precoating emulsion (specially formulated)

(iii) Proprietary products.

When using a Polymer Modified Binder (PMB) the preferred precoating agent is a bitumen based material.

5.8.3 Diesel Fuel Oil/Distillate

These are the same materials used as flux oil – see Section 5.2 for details and specification. They may be used with or without added adhesion agent depending on the conditions and type of aggregate.

When using diesel fuel oil/distillate, the aggregate must be precoated just prior to use, as these materials lose most or all of their effect if allowed to dry off the aggregate.

The common method of precoating with diesel fuel oil/distillate (with or without adhesion agent) does give some minor problems when used on roads with very high traffic volumes e.g. in the metropolitan area. The main problem being the time taken for the oil to dry to achieve good adhesion. To minimize this problem, field precoating for work in the urban area and on rural freeways can be done with a light cutback bitumen material similar to that normally used for plant precoating.

An additional potential problem is that DFO is absorbed into the tyres of the trucks used for spreading aggregate and this will soften the rubber and may cause loss of adhesion in wet weather.
5.8.4 Cutback Bitumen

The very light grades of cutback bitumen primers or specially prepared cutback bitumen precoating materials may be used prior to delivery (i.e. plant precoating) or through an aggregate loader in the normal method. See Chapter 3 for specification.

In Victoria these materials are generally only used at quarries for plant precoating. This material is superior to distillate for precoating and is preferred when using a PMB and in urban areas. Precoating should be undertaken well in advance of sealing and the precoating material allowed to dry.

The general requirements are:

(i) viscosity – between 0.003 to 0.020 Pa.s at 60°C

(ii) bitumen content – between 25 and 40% (average is generally about 30%)

(iii) adhesion agent – 1% by volume of mixture.

This material can be used at ambient temperature. Proprietary grades of cutback bitumen precoating materials may or may not comply with the above requirements and GeoPave should be consulted regarding the suitability of any product.

5.8.5 Bitumen Emulsion

Specially formulated bitumen precoating emulsions may be used to precoat aggregates. Bitumen precoating emulsion can be used to precoat aggregate for immediate use or for stockpiling and later use both on site or via a quarry. The preferred method of using emulsion precoat is to precoat in the quarry for later use. GeoPave should be consulted about suitable emulsion precoating materials.

If precoating in the field, some minor modification to the positioning of precoat spray jets in aggregate loaders and their pumping systems may be required.

There is no need to add adhesion agents to bitumen emulsion precoating materials. The emulsifying components in the emulsions are effective adhesion agents.

5.8.6 Proprietary Precoating Materials

There are a number of proprietary precoating materials available from the major oil companies. The supplier should be required to submit their own product specification as a basis for quality control. Some of the products are oil based, some are bitumen based (cutback) and they may or may not contain an adhesion agent but this is usually stated in the manufacturer’s specification.

Some of the proprietary cutback bitumen products are particularly used with aggregates having poor bitumen adhesion characteristics. The precoating is done by the aggregate supplier at the crushing plant and the aggregate supplied precoated to the stacksites. GeoPave should be consulted regarding the suitability of any proprietary product.
The fluxing materials used in Victoria are derivatives of diesel fuel oil or distillate and do not permanently produce softer grades of binder as is normally assumed. The use of flux oil is intended to enable the binder to stay softer for a longer period to allow light volumes of traffic to embed the aggregates into the binder during service. Flux oil is only added to bitumen to produce a softer binder suitable for use on low traffic volume roads.

Recent research has indicated that the assumption that these materials remain in the binder longer than cutter oils may not be correct. Further research in this area is required.
6.1 GENERAL

Primer, primerbinder, bitumen and polymer modified binders are purchased under annual contract. To ensure that the materials comply with the specification regular auditing of suppliers should be conducted.

The routine tests used to determine the suitability of material for the type of work and to ensure that materials supplied to VicRoads works are to specification are as follows:

(a) Tests on Bitumen

- Viscosity
- Softening Point
- Rolling Thin Film Over Test
- Durability
- Density
- Flash Point
- Distillation
- Matter Insoluble in Toluene
- Matter Insoluble in Toluene and Quinoline
- Loss on heating (% mass) max

(b) Tests on emulsion

- Sieve Residue
- Water Content
- Volatile Oil Content
- Sedimentation

(c) Tests on polymer modified binders

- Consistency at 60°C (Pa.s)
- Stiffness at 15°C (kPa)
- Aggregate retention (%)
- Compression limit at 70°C, 2 kg mm (min)
- Elastic Recovery at 60°C and 100s (%) min
- Elastic Recovery at 15°C and 100s (%) min
- Toughness at 4°C and 1m (Nm) min
- Toughness at 4°C and 100mm (Nm) min
- Torsional Recovery at 25°C and 30s (%) min
- Softening point (°C) min
- Ease of remixing (%) max
- Viscosity at 165°C (Pa.s) max
- Flash Point (°C) min
- Loss on heating (% mass) max

References

- VicRoads Standard Specification
- VicRoads Manual of Testing Procedures
- Australian Standard As 2341
### 7.1 GENERAL

Any of the commonly used materials complying with relevant specifications should give safe and satisfactory service provided they are handled and stored correctly. The safe handling and storage methods, as outlined in this chapter should prevent accidents and damage to, or contamination of, the materials used.

Refer also to the Austroads’ *Bitumen Sealing Safety Guide*.

### 7.2 LOADING

#### 7.2.1 Bituminous Materials in Bulk

(a) **Equipment**

When loading or transferring bituminous materials always:

(i) use approved hoses and fittings

(ii) use a strainer on the suction side of the pump. Refer to Auxiliary Equipment, Chapter 22.

(b) **Precautions**

(i) Always ensure that the tank to be loaded and the associated pipework are clean or that they only contain the same material as that to be loaded. This will avoid contamination or spoiling of the material or damage to the containers being filled.

(ii) Do not use naked flames to inspect tank interiors

(iii) Always have someone in attendance during loading and unloading operations

(iv) Always check:

- the quantities to be loaded or unloaded
- that there is space available to allow for heating and/or additives

(v) Check that pipework and hoses are free of obstructions internally and that any valves are operable and in the correct operating position before any loading is started

(vi) Wherever possible transfer material by suction rather than by pumping under pressure. If material must be pumped then use the lowest pumping rate possible to avoid excess pressure, particularly with hot materials.

(vii) Always have the end of any hoses secured by using the proper fittings or by securely tying down the ends if fittings cannot be used.

(viii) Never unload heated materials until at least 20 minutes after heating has stopped
(ix) Do not load cleaning oil, flux oil or cutter into an empty hot tank unless the temperature in the tank is below 100°C

(x) All personnel must wear proper protective clothing. Refer to Austroads’ *Bitumen Sealing Safety Guide* use of personal protective equipment

(xi) Always clean pipework, hoses, strainers etc. after the loading operations are finished to avoid contaminating the material

(xii) Never pump cleaning fluids into a tank until at least 20 minutes after heating has ceased and then only if the bitumen in the tank is at least 300 mm above the heating tubes.

### 7.2.2 Bituminous Materials into Drums

Priming, sealing and mixing grades of cutback bitumen may be produced in the field and drummed and distributed for use in other works. The mixing is usually done using a bitumen road tanker or sprayer and then the material is transferred into 200-litre drums for storage.

*Drums should be clearly marked with the material they contain.*

(a) Precautions

(i) Personnel must wear protective clothing. Refer to the Austroads’ *Bitumen Sealing Safety Guide* for the use of personal protective equipment

(ii) Use clean drums

(iii) Do not mix different types or grades of material

(iv) When filling drums with hot material check that there is no water in the drums before any filling commences. Water would cause a boil over which could cause personal injury to the operator.

(v) Use the proper hose and drum filling attachment

(vi) Mark the drums with the appropriate material identification and safety precautions.

### 7.2.3 Additives

It is essential that additives be fully incorporated by thorough mixing and circulating. It is preferable to place the additive in the material on the suction side of the pump as the pump action will aid mixing.
7.3 HEATING

7.3.1 Bituminous Materials

(a) Equipment

Most bituminous materials used in bituminous surfacing work are handled in bulk and some of the equipment used for heating is also used for storage. The main items for bulk handling are:

- electrically heated fixed storage tanks
- gas and oil fired mobile heater storages.

(b) Maximum Temperatures

The maximum temperatures as indicated for the various materials, in Chapters 3 to 5, must be strictly observed and not exceeded.

(c) Maximum heating rates

Materials may be heated from a solid, semi solid or fluid state but the average rate of heating shall not exceed 40°C Celsius per hour.

If the rate of heating is too high the temperature at the interface of the material and the heater tubes will adversely affect the material and could result in the material exploding and injuring personnel and damaging the heating equipment.

(d) Precautions

See the Austroads’ *Bitumen Sealing Safety Guide*.

7.4 STORAGE

7.4.1 Bituminous Materials in Bulk

(a) Equipment

The main items of equipment used are:

- electrically heated storage tanks
- gas and oil fired heated storage tanks
- gas and oil fired mobile heater storage tankers

For details see Chapter 23, Plant.

(b) Storage

Bitumen and cutback bitumen

Bituminous materials are stored hot in insulated storage tanks to have, readily available, an adequate, economic, supply of materials at or near their working temperatures.
The larger storages are usually for bitumen but cutbacks and other materials are also stored hot in bulk.

When material is stored hot in bulk:

(i) Do not exceed the maximum prescribed temperature for the bitumen or cutback material.

(ii) When the material is required for immediate use keep it within the minimum and maximum temperature e.g. bitumen 175 to 185°C.

(iii) Do not store the materials hot for any length of time if no demand is expected e.g. over a lengthy holiday break or the off season. Prolonged hot storage will drive off the lighter oils and increase the viscosity of the material. It is better to let the material cool and heat it in time for use.

(iv) Materials containing additives such as adhesion agent and/or rubber cannot be stored hot at 150°C or above for more than 8 hours without reducing the effectiveness of the additives.

**Polymer Modified Binders**

Special care needs to be taken when handling polymer modified binders because they can degrade if held at high temperatures, even for relatively short periods. For guidance on the effect of storage time and storage temperature on polymer modified binders refer to the manufacturer’s technical data.

**Bitumen Emulsions**

Bitumen emulsions should be:

(i) Stored in bulk tanks if practical.

(ii) Bulk tanks should be mixed every week or two using a low shear paddle agitator or suitable low shear pump to prevent sedimentation. If stored in drums, the emulsion drums should be turned end on end every week or two to prevent settlement.

(iii) Stored so that their temperature is above freezing (0°C) and below boiling (100°C) otherwise they will break. The usual temperature range is between 15°C and 60°C.

(iv) Checked for compatibility between newly delivered emulsion and the stored emulsion before pumping any material into storage. Emulsions of different types break when mixed and emulsions of the same grade may be chemically different and break when mixed.

(v) Spread a thin layer of kerosene (0.5 litres/m²) on top of emulsion in storage to prevent scum formation.

(Reference: Austroads’ Pavement Research Group/AAPA Pavement Work Tip – No. 2)
(c) Cold Storage

Bituminous materials, except emulsions, may be stored at ambient temperatures without suffering any deterioration. Bitumen emulsions need to be stored under cover in cold climates as freezing may cause the emulsion to break.

(d) Precautions

(i) Storages should be weatherproof

(ii) Label the storages to indicate their contents

(iii) Keep a written stock record of the contents of the storages, hot and cold

(iv) Try and keep the same tanks reserved for the same type of material

(v) Do not mix different types of materials

(vi) Do not mix different grades of the same materials

(vii) Always check on the viscosity of a material at ambient temperatures before placing it in a storage without heating facilities. Maximum viscosity for normal cutback bitumen pumping is in the range 3.5 to 4.5 Pa.s (AMC2 and AMC3 are near this viscosity at temperatures between 20 to 25°C).

(viii) At regular intervals circulate stored materials, such as cutback bitumen and emulsions. These materials should always be circulated before being drawn from the storage for use.

7.4.2 Bituminous Materials in Drums

(a) Method of Storing and Stacking

(i) The standard size drum for petroleum products is of 200 litres capacity

(ii) Drums containing the same materials should be grouped in the same area

(iii) Drums should be stored in a single layer, laid on their side with the bung uppermost

(iv) Drums can be loaded or unloaded via a raised loading ramp to avoid having to manually lift heavy drums. If there is no loading ramp available they should be loaded or unloaded using skids and ropes. In a depot it may be possible to use mechanical equipment for handling drums. Drums containing inflammable liquid may only be handled by mechanical equipment of an approved type.
(iv) Always use the materials in order, i.e. first delivered and stored is first issued and used

(b) Protection

Bituminous materials stored in drums should be stored under cover so as to be protected from the weather to avoid damage and contamination. If this is not possible, order only such quantities as to keep storage time in the open to a minimum. Drums with cutback bitumen should be stacked on their sides to avoid the entry of water. It is particularly important to exclude moisture from materials which require heating before use to minimise the risk of boil-overs occurring.

Bitumen emulsion and bitumen emulsion precoat needs protection from frost because the low temperature will cause the emulsion to break in the drums and thus render it useless. Drums containing bitumen emulsion need to be agitated regularly, say once a fortnight, thus reducing sedimentation\(^1\) and ultimate coagulation.

Each drum of any fluid, cold bituminous material should be agitated before use.

(c) Identification

(i) Standard and proprietary grades of materials supplied under contract have standard markings to identify the material.

(ii) Drums containing field produced materials should always be marked prominently with paint showing the type and grade of material.

7.4.3 Additives

Additives are usually handled as follows:

(a) Adhesion agent – usually in 20-litre drums for convenience of handling – some types also supplied in 10-litre drums. Adhesion agent is also available in 900-litre bulk containers.

(b) Crumb rubber – in bags containing 25 kg net. Crumb rubber is also available in bulk bags of 500 and 1000 kg.

(c) Anti-foam solution – 20-litre drums.

(d) Flux oil and cutter – bulk (generally) or 200-litre drums.

These materials should be stored under cover to avoid contamination with water. Nearly all of these materials are added to hot bitumen and if contaminated with water would give problems and could cause boil-overs.

\(^1\) In standard emulsions, settlement or sedimentation of the bitumen occurs on the bottom of the drum. However, in inverted emulsions the binder may separate and float to the surface and therefore there is no sediment on the bottom of the drum.
7.5 TRANSPORTATION
7.5.1 Bituminous Materials in Bulk
The items of equipment used for transporting bituminous materials bulk are:

(i) Road tankers – insulated and fitted with heating equipment are used for all bituminous materials.
    Road tankers – not insulated and without heating equipment are used for transporting light grades of materials and emulsions. Road tankers without insulation and heating equipment are very rare.

(ii) Fuel trailer tankers – for cutter, flux oil and/or emulsion precoating material.

(iii) Drums – for cutter, flux oil and/or emulsion precoating material.

(iv) Rail tank cars – insulated and fitted with heating equipment are used for transporting bitumen.
    Rail tank cars – not insulated and without heating equipment are used for transporting bitumen cutback primers.

Statutory regulations govern the transport of all materials used in sprayed sealing. These regulations need to be known and adhered too.

7.6 DISPOSAL
The disposal of waste bituminous materials is to be in accordance with the requirements of the Environment Protection Act and other appropriate regulations and bylaws.
8.1 GENERAL

This chapter contains tables and charts to provide:

(a) standard conversion factors for calculations involving materials used in bituminous surfacing work, e.g., mass to volume, volume correction for temperature etc.;

(b) standard proportions of flux oil and cutter to be used in sprayed work, i.e., ‘Fluxing and Cutting Back of Class 170 Bitumen’ tables.

8.2 MASS PER UNIT VOLUME

8.2.1 Aggregate – One Sized

Table 8.2.1 gives the approximate density in tonnes per cubic metre of one sized aggregate, dry and loose as loaded into trucks or bins for the most common types and sizes of aggregate used.

Table 8.2.1 Aggregate – One Sized

<table>
<thead>
<tr>
<th>Type of Aggregate</th>
<th>Approx. Loose Density in Tonnes/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basalt</td>
<td>1.4</td>
</tr>
<tr>
<td>Gravel</td>
<td>1.4</td>
</tr>
<tr>
<td>Granite</td>
<td></td>
</tr>
<tr>
<td>Diabase</td>
<td></td>
</tr>
<tr>
<td>Schist</td>
<td></td>
</tr>
<tr>
<td>Quartz Diorite</td>
<td>1.3</td>
</tr>
<tr>
<td>Quartzite</td>
<td></td>
</tr>
<tr>
<td>Micaceous Schist</td>
<td></td>
</tr>
<tr>
<td>Altered Mudstone</td>
<td></td>
</tr>
<tr>
<td>Quartz Porphyry</td>
<td>1.2</td>
</tr>
<tr>
<td>Limestone</td>
<td>1.2</td>
</tr>
<tr>
<td>Scoria</td>
<td>0.8</td>
</tr>
</tbody>
</table>

8.3 CONVERTING MASS TO VOLUME

8.3.1 Relative Density and Litres/Tonne

The relative density (RD) of a material may be taken as the mass of a volume of that material compared to the mass of an equal volume of fresh water.

The relative densities of bituminous materials are normally given at 15°C.

Using the facts that 1 tonne = 1000 kilogram and that 1 litre of water has a mass of approximately 1 kilogram, the volume of material delivered at 15°C can be calculated from the known mass.

If the relative density is reported at a temperature other than 15°C it must be corrected to the relative density at 15°C – see Table 8.3.1.

Table 8.3.1 gives the average relative density, mass per litre and litres per tonne that may be used for the conversion from mass to volume for bituminous materials and additives.
For materials delivered in standard 200 litre capacity drums the tare weight (ie., empty) of any drum may be taken as 25 kg.

Table 8.3.1  **Relative Density and Litres/Tonne of the Most Commonly Used Materials**

<table>
<thead>
<tr>
<th>Type of Material</th>
<th>Grade</th>
<th>Approximate Average at 15°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Relative Density</td>
</tr>
<tr>
<td>Bitumen</td>
<td></td>
<td>1.040</td>
</tr>
<tr>
<td></td>
<td>Class 170</td>
<td>1.040</td>
</tr>
<tr>
<td></td>
<td>Shell</td>
<td>1.029</td>
</tr>
<tr>
<td></td>
<td>Mobil (Vic)</td>
<td>1.030</td>
</tr>
<tr>
<td></td>
<td>BP</td>
<td>1.029</td>
</tr>
<tr>
<td></td>
<td>Mobil (S.A.)</td>
<td>1.030</td>
</tr>
<tr>
<td>Cutback Bitumen</td>
<td></td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>Standard Grades</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>AMC00</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td>AMC0</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>AMC1</td>
<td>0.96</td>
</tr>
<tr>
<td></td>
<td>AMC2</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>AMC3</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>AMC4</td>
<td>1.00</td>
</tr>
<tr>
<td>Emulsion</td>
<td>All Grades</td>
<td>1.00</td>
</tr>
<tr>
<td>Flux Oil</td>
<td>Diesel Fuel</td>
<td>0.84</td>
</tr>
<tr>
<td></td>
<td>Oil/Distillate</td>
<td>0.84</td>
</tr>
<tr>
<td>Cutter</td>
<td>Kerosine/Aviation</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>Turbine Fuel</td>
<td>0.95</td>
</tr>
<tr>
<td>Adhesion Agent</td>
<td></td>
<td>0.95</td>
</tr>
</tbody>
</table>

8.3.2  **Example**

A nett load of 24.85 tonnes of Mobil (Vic) Class 170 bitumen has been delivered by road tanker at a temperature of 172°C. What is the volume of bitumen delivered measured at 15°C?

(a)  By Relative Density

From Table 8.3.1 the relative density of Mobil (Vic) Class 170 bitumen is 1.04 at 15°C

\[
\text{Volume of bitumen at 15°C} = \frac{24.85 \times 1000}{1.040} = 23894 \text{ litres}
\]

(b)  By Using Litres/Tonne

From Table 8.3.1 the Mobil (Vic) Class 170 bitumen has a volume of 960 litres/tonnes at 15°C

\[
\text{Volume of bitumen at 15°C} = 24.85 \times 960 = 23858 \text{ litres}
\]

The small difference between (a) and (b) can be disregarded as it is due to the rounding of both the relative density and the litres per tonne figures given in the table.
8.4 CONVERTING VOLUME TO MASS

8.4.1 General

Knowing the approximate average density of a material, known volumes can be converted to mass. This is useful where materials are handled in drums or if it is desired to check the volume of material delivered against the weighbridge ticket.

For bituminous surfacing work when material is handled in drums, the nominal capacity of the drums may be taken as 200 litres. This allows space for expansion and freeboard.

8.4.2 Example

A load of cutback is to be delivered by truck. The load consists of:

10 * 200 litre drums of AMC3
5 * 200 litre drums of bitumen emulsion – ARS.

What is the mass per drum of each material?
What is the mass of the load?

Using the kilograms/litre from Table 8.3.1

(a) AMC 3

mass of contents = 200 * 0.98 = 196 kg
mass of drum = 25 kg
Total = 221 kg/drum

(b) Bitumen Emulsion

mass of contents = 200 * 1.00 = 200 kg
mass of drum = 25 kg
Total = 225 kg/drum

(c) Mass of the Load

10 * 221 + 5 * 225 = 3335 kg, (say 3.3 tonnes)

8.5 VOLUME CORRECTION FOR BITUMEN

8.5.1 General

Most materials expand when heated and contract when cooled. To provide a standard point of reference, the quantities and proportions of components and rates of application of primers, primerbinders and binders are all based on their volume at 15°C.

Except for some of the lighter grades of primers most of these materials are handled at temperatures above 15°C and it is thus often necessary to compute volume corrections from higher temperatures to 15°C and from 15°C to higher temperatures.
8.5.2 Bitumen, Fluxed and/or Cutback Bitumen

The following tables have been prepared for volume correction when using road making classes of bitumen where the relative density at 15°C is about 0.966. They may be used also for fluxed and/or cutback bitumen to give volume corrections which are within practical accuracy.

(a) Table 8.5.2 Part A gives the multiplier for calculating the volume of material at a temperature above 15°C to its volume at 15°C.

(b) Table 8.5.2 Part B gives the multiplier for calculating the volume of material at a temperature above 15°C from its volume at 15°C.

(c) Examples

(i) A bitumen road tanker delivers a load of Class 170 bitumen to the roadside. Quantity as measured on the dipstick is 23250 litres at a temperature of 182°C. What is the volume of bitumen delivered measured at 15°C?

From Table 8.5.2 – Part A the multiplier to be used is 0.8990 to correct the volume from 182°C to 15°C.

\[
\text{Volume of bitumen at 15°C} = 23250 \times 0.8990 = 20902 \text{ litres.}
\]

(ii) A quantity of 3800 litres of bitumen at 15°C is to be taken from the road load in (i). What quantity of bitumen needs to be transferred at 182°C to give 3800 litres measured at 15°C? From Table 8.5.2 Part B the multiplier to be used is 1.1123 to correct the volume from 15°C to 182°C.

The volume of bitumen to be transferred at 182°C to give 3800 litres measured at 15°C is:

\[
3800 \times 1.1123 = 4227 \text{ litres.}
\]

(iii) A quantity of 4100 litres of fluxed and cutback binder at 160°C is returned for storage. The composition of the binder is:

| Class 170 bitumen: | 100 parts by volume measured at 15°C |
| Flux oil:          | 4 parts by volume measured at 15°C  |
| Cutter:           | 12 parts by volume measured at 15°C  |
| Total             | 116 parts                          |

What is the quantity of binder delivered and the quantities of the individual components as measured at 15°C?

Using Table 8.5.2 Part A the multiplier to be used is 0.9118 to correct the volume from 160°C to 15°C.
### Table 8.5.2 Volume correction tables bitumen, fluxed and/or cutback bitumen

<table>
<thead>
<tr>
<th>Part A</th>
<th>Part B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TABLE FOR CALCULATING THE VOLUME OF BITUMEN AT A TEMPERATURE 15°C TO ITS VOLUME AT 15°C</strong></td>
<td><strong>VOLUME TABLE FOR CALCULATING THE VOLUME OF BITUMEN AT A TEMPERATURE ABOVE 15°C FROM ITS VOLUME AT 15°C</strong></td>
</tr>
<tr>
<td>Temp °C</td>
<td>Multiplier</td>
</tr>
<tr>
<td>15</td>
<td>1.000</td>
</tr>
<tr>
<td>82</td>
<td>0.9585</td>
</tr>
<tr>
<td>84</td>
<td>0.9573</td>
</tr>
<tr>
<td>16</td>
<td>0.9994</td>
</tr>
<tr>
<td>18</td>
<td>0.9981</td>
</tr>
<tr>
<td>20</td>
<td>0.9969</td>
</tr>
<tr>
<td>22</td>
<td>0.9956</td>
</tr>
<tr>
<td>24</td>
<td>0.9943</td>
</tr>
<tr>
<td>26</td>
<td>0.9931</td>
</tr>
<tr>
<td>28</td>
<td>0.9918</td>
</tr>
<tr>
<td>30</td>
<td>0.9906</td>
</tr>
<tr>
<td>32</td>
<td>0.9894</td>
</tr>
<tr>
<td>34</td>
<td>0.9881</td>
</tr>
<tr>
<td>36</td>
<td>0.9869</td>
</tr>
<tr>
<td>38</td>
<td>0.9856</td>
</tr>
<tr>
<td>40</td>
<td>0.9844</td>
</tr>
<tr>
<td>42</td>
<td>0.9832</td>
</tr>
<tr>
<td>44</td>
<td>0.9819</td>
</tr>
<tr>
<td>46</td>
<td>0.9807</td>
</tr>
<tr>
<td>48</td>
<td>0.9794</td>
</tr>
<tr>
<td>50</td>
<td>0.9782</td>
</tr>
<tr>
<td>52</td>
<td>0.9770</td>
</tr>
<tr>
<td>54</td>
<td>0.9757</td>
</tr>
<tr>
<td>56</td>
<td>0.9745</td>
</tr>
<tr>
<td>58</td>
<td>0.9732</td>
</tr>
<tr>
<td>60</td>
<td>0.9720</td>
</tr>
<tr>
<td>62</td>
<td>0.9708</td>
</tr>
<tr>
<td>64</td>
<td>0.9695</td>
</tr>
<tr>
<td>66</td>
<td>0.9683</td>
</tr>
<tr>
<td>68</td>
<td>0.9670</td>
</tr>
<tr>
<td>70</td>
<td>0.9658</td>
</tr>
<tr>
<td>72</td>
<td>0.9646</td>
</tr>
<tr>
<td>74</td>
<td>0.9634</td>
</tr>
<tr>
<td>76</td>
<td>0.9622</td>
</tr>
<tr>
<td>78</td>
<td>0.9609</td>
</tr>
</tbody>
</table>

Note: These tables do not apply to bitumen emulsions, for these materials see Table 8.5.3. Part A and B.
Volume of binder measured at 15°C = 4100 * 0.9118 = 3738 litres

The quantities of the components measured at 15°C are:

Class 170 bitumen \[\frac{100\times3738}{116} = 3222\text{ litres}\]

Flux oil \[\frac{4\times3738}{116} = 129\text{ litres}\]

Cutter \[\frac{12\times3738}{116} = 387\text{ litres}\]

Total = 3738 litres

### 8.5.3 Bitumen Emulsion

Bitumen emulsion is normally used at ambient temperature and therefore volume correction for temperature is not often necessary except when using higher binder content sprayed seal binders. Where it is necessary to correct for temperature, the procedure outlined in Section 8.5.2 for other bituminous materials can be followed, using the multiplier for bitumen emulsion given in Tables 8.5.3 Part A and 8.5.3 Part B.

#### Table 8.5.3 Volume Correction Tables – Bitumen Emulsion

<table>
<thead>
<tr>
<th>Part A</th>
<th>Part B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table for calculating the volume of bitumen emulsion at a temperature above 15°C to its volume at 15°C</td>
<td>Table for calculating the volume of bitumen emulsion at a temperature above 15°C from its volume at 15°C</td>
</tr>
<tr>
<td>Temperature °C</td>
<td>Multiplier</td>
</tr>
<tr>
<td>----------------</td>
<td>------------</td>
</tr>
<tr>
<td>15</td>
<td>1.000</td>
</tr>
<tr>
<td>20</td>
<td>0.9980</td>
</tr>
<tr>
<td>25</td>
<td>0.9956</td>
</tr>
<tr>
<td>30</td>
<td>0.9935</td>
</tr>
<tr>
<td>35</td>
<td>0.9913</td>
</tr>
<tr>
<td>40</td>
<td>0.9890</td>
</tr>
<tr>
<td>45</td>
<td>0.9868</td>
</tr>
<tr>
<td>50</td>
<td>0.9845</td>
</tr>
<tr>
<td>55</td>
<td>0.9823</td>
</tr>
<tr>
<td>60</td>
<td>0.9800</td>
</tr>
<tr>
<td>65</td>
<td>0.9778</td>
</tr>
<tr>
<td>70</td>
<td>0.9755</td>
</tr>
<tr>
<td>75</td>
<td>0.9733</td>
</tr>
<tr>
<td>80</td>
<td>0.9710</td>
</tr>
<tr>
<td>85</td>
<td>0.9688</td>
</tr>
</tbody>
</table>
8.6 GRAPH FOR CALCULATING SPRAYING TEMPERATURE

8.6.1 Spraying Temperature – Fluxed and/or Cutback Bitumen

(a) General

Figure 8.6.1 provides a graphical means of calculating the correct spraying temperature range for a fluxed and/or cutback bitumen binder.

The graph has been based on the following assumptions:

(i) The temperature of Class 170 bitumen is at an average temperature of 182°C loaded in the sprayer, i.e., midway between the allowable upper and lower limits of 185°C and 178°C respectively.

(ii) The temperature of the additives, flux oil and cutter is at an average temperature of 15°C. A variation of 5°C in the temperature of the material added will have no significant effect on the resultant temperature.

(b) Example

Consider a fluxed and cutback bitumen binder of:

- Class 170 bitumen: 100 parts measured at 15°C
- Flux oil: 4 parts measured at 15°C
- Cutter: 10 parts measured at 15°C

Total 114 parts measured at 15°C

This binder was stored and allowed to cool down.

What is the temperature to which it must be reheated to be at its correct spraying viscosity?

(i) Ascertain which graph line is relevant, according to the number of parts of flux oil. (Refer LEGEND.)

(ii) From point X (parts of cutter) read up vertically to the relevant graph line, this is point Y.

(iii) From point Y, read across horizontally to point Z which indicates the average spraying temperature 161°C.

In place of the graph the spraying temperature may also be calculated using the number of parts and the average temperatures of the components.

No. of parts at 15°C * Average temperature °C

<table>
<thead>
<tr>
<th>Component</th>
<th>Parts</th>
<th>Temperature</th>
<th>Calculation</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen</td>
<td>100</td>
<td>182</td>
<td>100 * 182</td>
<td>18200</td>
</tr>
<tr>
<td>Flux oil</td>
<td>2</td>
<td>15</td>
<td>2 * 15</td>
<td>30</td>
</tr>
<tr>
<td>Cutter</td>
<td>6</td>
<td>15</td>
<td>6 * 15</td>
<td>90</td>
</tr>
<tr>
<td>TOTAL</td>
<td>108</td>
<td></td>
<td></td>
<td>18320</td>
</tr>
</tbody>
</table>

Spraying temperature = \[
\frac{18320}{108} = 169°C
\]
To be near its correct spraying viscosity the fluxed and/or cutback bitumen should be within ±5°C of the calculated temperature, at the time of spraying. A properly prepared fluxed and/or cutback bitumen will normally be near the upper limit, or may slightly exceed it without presenting any problems. A fluxed and/or cutback binder must not be sprayed at a temperature below the lower calculated limit.

Figure 8.6.1  Graph for calculating spraying temperature of fluxed and cutback binder
8.7 FLUXING AND CUTTING BACK TABLES

8.7.1 General

(a) Tables 8.7A and 8.7B are the tables to be used for cutting back and/or fluxing Class 170 bitumen for bituminous surfacing sprayed work. (Also shown as Tables 16.13.2 D and E)

Tables 8.7C is the table to be used for cutting back crumb rubber modified binder. (Also shown as Tables 16.13.2F)

It should be noted that these tables are based on pavement temperature not air temperature as was previously VicRoads practice. Table 8.7A represents a reduction in previous VicRoads cutting practices and is an attempt to minimise the amount of cutter used in sprayed sealing. This philosophy has been adopted by members of Austroads.

The cutting table, Table 8.7A is based on a minimum pavement temperature of 20°C as it is considered the minimum for good practice. Where field conditions dictate that sealing must be carried out below 20°C, a further 2 parts of cutter should be added to the tabulated values for each 5°C or part thereof below 20°C.

In addition, it should be noted that the cutting table 8.7A gives the total recommended amount of cutting and fluxing materials to be added to the binder. If flux oil is necessary, the number of parts of cutter should be reduced by same amount as the parts of flux added.

For example, if for the conditions it is considered that 10 parts of cutting material is necessary but due to the low traffic volumes 4 parts of flux is recommended to be added (via Table 8.7B) then 10 minus 4 = 6 parts of cutting oil should be added.

(b) The parts by volume, measured at 15°C, of flux oil and cutter are based on multiples of two (2). There is no practical value in interpolating to the nearest one (1) part.

(c) The fluxed and/or cutback bitumen binder, when prepared according to these tables, should be at the correct spraying temperature, and of the correct viscosity after it has been sprayed to properly wet the covering aggregate under the varying conditions of air temperature, pavement temperature, wind, traffic etc. To check the viscosity of the binder after spraying refer to 16.4.6(g).

(e) When using these tables for fluxing and/or cutting back Class 170 bitumen the following must be considered:

(i) The temperature of the bitumen when loaded in the sprayer must be between 178°C and 185°C. Before the first load in the morning the sprayer tank should be prewarmed by taking on a load of hot bitumen, maximum temperature 200°C, circulating it and then pumping it back into the storage.

(ii) To avoid the use of extra cutter it may be necessary with lighter rates of application, below 0.90 litres/m², to spray less than a full load of binder in one application.
(iii) The binder sprayed should be covered with aggregate as quickly as possible.

(iv) One roller should operate closely behind an aggregate spreader.

(v) If the binder becomes too viscous (stiff) to wet the aggregate, additional cutter must be added to the next load of binder to be sprayed. This shall only be done when all other precautions listed above have been taken, but have not produced the desired result.

(vi) When in doubt regarding the amount of cutter required it is better to err slightly on the high side by using the next highest figure, e.g., 10 parts in place of 8 parts, or spray only a short section and check the binder – refer to 16.4.6(g).

8.7.2 Condition of Aggregate Precoating

The cutting table uses active or inactive precoating as well as pavement temperature to determine the appropriate amount of cutter to be added to the Class 170 binder. For the purposes of definition:

- active precoating of aggregate is considered to result from precoating with a cutback bitumen or a formulated bitumen emulsion (both in good condition) or moist precoating (i.e., freshly applied or partially dried hydrocarbon based material) of the cover aggregate.

- inactive precoating of an aggregate is considered to be where the aggregate is moist with water or the existing precoating condition of the aggregate is dry or inactive.

Reference: Austroads APRG 97/09(SU), Guide to Sprayed Sealing Cutting Practice

8.7.3 Prevailing and Impending Weather Conditions

When determining the quantity of cutter oil, due consideration should be given to the likely variations in temperature conditions prevailing at the time of the pavement temperature measurement from those normally expected as well as the impending conditions expected in the next few hours after commencement of sealing.

As a general rule, up to 2 additional parts of cutter should be considered during the daily periods when pavement temperatures are falling (e.g., in the late afternoon) and/or during unusually warm days when colder days are to follow. On the other hand, up to 2 parts of cutter oil should be deducted during daily periods when:

- the pavement temperatures are rising (e.g., in the early morning)
- during abnormally cool days in warmer seasons

Pavement temperatures over the next 24 hours or so after sealing may be critical. If the night ground temperature falls to 5°C or below, then significantly more cutter, say up to 4 parts, should be added to avoid aggregate loss and allow the binder to soften on the following days and allow the aggregate particles to flatten into the binder.
When spray runs contain significant areas of shaded pavement further cutting oil should be added according to the shaded pavement temperature. Refer to Section 8.7.4.

Reference: Austroads APRG 97/09(SU), Guide to Sprayed Sealing Cutting Practice

### 8.7.4 Measurement of Pavement Temperature

Pavement temperature is measured with an infrared thermometer. The temperature used to determine the cutting quantity must be representative of a significant portion of the job.

To obtain a representative temperature at least 6 temperature measurements must be taken.

Where the pavement is:

- substantially in the sun (over 90%) the representative average pavement temperature should be estimated from, the average of 2 readings in the shaded area and 4 readings in the unshaded area (i.e., place more emphasis on the shaded area pavement temperature)

- affected by the shade (i.e., greater than 10% of the area) the representative average pavement temperature should be estimated from six readings in the shaded areas

When spray sealing pavements, in warm weather, which are not to be opened to traffic for a period of time (e.g., in cooler conditions) then the amount of cutter added should based the expected temperature at the time of opening as well as the conditions at the time of spraying.

#### Table 8.7A Cutting back of Class 170 Bitumen

<table>
<thead>
<tr>
<th>Pavement Temperature (°C)</th>
<th>Traffic vehicles/ lane/day</th>
<th>Aggregate Size and precat condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Nominal Size of 10mm and larger, actively precated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active precating</td>
</tr>
<tr>
<td>20 to 25</td>
<td>&lt; 100</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>100 to 1500</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>&gt; 1500</td>
<td>4</td>
</tr>
<tr>
<td>26 to 32</td>
<td>&lt; 100</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>100 to 1500</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>&gt; 1500</td>
<td>2</td>
</tr>
<tr>
<td>33 to 38</td>
<td>&lt; 100</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>100 to 1500</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt; 1500</td>
<td>0</td>
</tr>
<tr>
<td>39 to 45</td>
<td>&lt; 100</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>100 to 1500</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>&gt; 1500</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 45</td>
<td>&lt; 100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>100 to 1500</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>&gt; 1500</td>
<td>0</td>
</tr>
</tbody>
</table>

**Note:** A pavement temperature of 20°C is considered the minimum for good practice. Where field conditions dictate that sealing must be carried out below 20°C, a further 2 parts of cutter should be added to the tabulated values for each 5°C or part thereof below 20°C.
### Table 8.7B  Fluxing of Class 170 Bitumen

<table>
<thead>
<tr>
<th>Traffic vehicles/lane/day</th>
<th>Flux of parts per 100 parts of bitumen</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100</td>
<td>4</td>
</tr>
<tr>
<td>100 to 300</td>
<td>2</td>
</tr>
<tr>
<td>&gt;300</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Where Class 170 bitumen is fluxed with flux oil it is recommended that the amount of cutter oil be reduced by a quantity equal to the added flux oil.

### Table 8.7C  Cutting practice for Crumb Rubber Binder

<table>
<thead>
<tr>
<th>Parts of cutter per 100 parts of bitumen by volume at 15°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement Temperature</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>26 to 32°C</td>
</tr>
<tr>
<td>33 to 38°C</td>
</tr>
<tr>
<td>39 to 45°C</td>
</tr>
<tr>
<td>&gt; 45°C</td>
</tr>
</tbody>
</table>

Note: During the manufacturing process of the premixed crumb rubber binder the manufacturer adds an oil to the bitumen which is claimed to help digest the rubber.

It is necessary to take it into account in the cutting practices for crumbed rubber. The oil acts both as a cutter (short term) and a flux (long term) on the viscosity of the bitumen. To take the carrier oil into account it must be considered as a “cutter” only. The supplier must provide details of additives under OH&S requirements.

Crumb rubber modified binders with about 5 parts of rubber should be cutback as for Class 170 bitumen.
Table 8.7D  Cutting practice for Polymer Modified Binders

<table>
<thead>
<tr>
<th>Pavement Temperature</th>
<th>Traffic (v/d based on design traffic)</th>
<th>Class of PMB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>S15E</td>
</tr>
<tr>
<td>20 to 25°C</td>
<td>&lt;1000</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>&gt;1000</td>
<td>6 to 8</td>
</tr>
<tr>
<td>26 to 32°C</td>
<td>&lt;1000</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>&gt;1000</td>
<td>4</td>
</tr>
<tr>
<td>33 to 38°C</td>
<td>&lt;1000</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt;1000</td>
<td>2</td>
</tr>
<tr>
<td>39 to 45°C</td>
<td>&lt;1000</td>
<td>Min 2</td>
</tr>
<tr>
<td></td>
<td>&gt;1000</td>
<td>Min 2</td>
</tr>
<tr>
<td>&gt; 45°C</td>
<td>&lt;1000</td>
<td>Min 2</td>
</tr>
<tr>
<td></td>
<td>&gt;1000</td>
<td>Min 2</td>
</tr>
</tbody>
</table>

Note:  To avoid problems with the asphalt overlay, it is undesirable in SAMI applications to add any cutter oil at all, and the maximum added should not exceed 2 parts/per cent.

- In aggregate retention applications, e.g. S10E and S40R and some proprietary blends of PBD, the binder should be cutback as for Class 170 bitumen
- the cutter type should be appropriate for the polymer type. For example some polymers are not adequately cut using high flash point type cutter normally used by VicRoads and require the use of highly aromatic cutters
- the weather conditions under which polymer modified work is carried out should generally limit the cutter concentration to 4 parts per 100 parts of binder

8.7.5 Examples

(a) Consider a reseal using aggregate which has just been precoated with distillate based precoat, on a highway with a traffic count of 3200 vehicles per lane per day (i.e., 24 hour count). The pavement is substantially unshaded (i.e., over 90% of it is in the sun) and the pavement temperature at the time of doing the work has been measured at 26, 28, 29 and 30°C in the unshaded areas and 23 and 24°C in the shaded areas. It appears that there will be very little change for the next four or five hours.

The pavement temperature for cutting is:

\[(26+28+29+30+23+24)/6 = 27°C\]

From Table 8.7B  Flux oil – Nil
From Table 8.7A  Cutter – 2 parts (i.e., active precoating)
Quantity of bitumen @ 15°C in sprayer = 3850 litres
Quantity of flux oil required – NIL = 0
Quantity of cutter required (3850 * 2/100) = 77 litres
Total quantity of cutback bitumen binder @ 15°C = 3927 litres

(b) Consider example (a) as a reseal being carried out in late April where the night temperature is expected to fall below 5°C.

The pavement temperature is as the example (a) = average 27°C.

From Table 8.7B Flux oil – Nil
From Table 8.7A Cutter – 2 parts (ie., active precoating)
From Clause 8.7.3 add additional 4 parts of cutter for expected night temperature

Quantity of flux oil required – NIL = 0
Quantity of bitumen @ 15°C in sprayer = 3850 litres
Quantity of flux oil required – NIL = 0
Quantity of cutter required (3850 x 6/100) = 231 litres
Total quantity of cutback bitumen binder @ 15°C = 4081 litres

(c) Consider an ITFS (Initial Treatment Final Seal) using size 14 aggregate which was precoated with a bitumen based precoat three months ago. The precoated material is in good condition with minimal additional dust. The road has a traffic count of 280 vehicles per lane per day (24 hour count). The pavement is about 10% in the shade and likely to stay that way or get worse during the remainder of the day due to trees adjacent to the pavement and the movement of the sun. The pavement temperature at the time of doing the work has been measured at 20, 21, 23, 20, 23 and 21°C in the shaded areas. At the time of doing the work the pavement temperature is increasing.

The pavement temperature for cutting should be based on the shaded temperature of the pavement. The pavement temperature can be considered to be (20 + 21 + 23 + 23 + 21 + 21)/6 = 22°C.

The existing precoat is in good condition and has minimal dust so it is considered that the precoating is active because the bitumen based precoat will readily adhere to the sprayed binder, therefore

From Table 8.7B Flux oil – 2 parts
From Table 8.7A Cutter – 6 parts less the 2 parts of flux, ie., 4 parts of cutter (using the 20 to 25°C range from the active precoat range)

Quantity of bitumen @ 15°C in sprayer = 3675 litres
Quantity of flux oil required (3675 * 2/100) = 74 litres
Quantity of cutter required (3675*4/100) litres = 147 litres
Total quantity of cutback bitumen binder @15°C = 3896 litres

(d) Consider example (c) being carried out in late April. The future conditions are likely to be very cold and an additional 2 parts of cutter should be added with no deduction for Flux oil.
From Table 8.7B Flux oil - 2 parts
From Table 8.7A Cutter - 6 plus 2 parts for future weather minus 2 parts for the flux oil = 6 + 2 (weather) -2 (flux) = 6 parts
(using the 20 to 25°C range from the active precoat range and allowing for the future cold conditions over winter)

Quantity of bitumen @ 15°C in sprayer = 3675 litres
Quantity of flux oil required (3675 * 2/100) = 74 litres
Quantity of cutter required (3675*6/100) litres = 221 litres
Total quantity of cutback bitumen binder @15°C = 3970 litres

(e) Consider a reseal using Class 1 sand on a road with a traffic count of about 120 vehicles per day (24 hour count). The pavement is substantially unshaded and the pavement temperature at the time of doing the work averages 22°C (average of 6 readings) and is fairly stable. The aggregate however is very wet and the distillate base precoating material is considered inactive.

Pavement temperature for cutting purposes is 22°C.

From Table 8.7B Flux oil – 4 parts
From Table 8.7A Cutter – 10 parts less the added flux of 4 parts, ie., 6 parts of cutter are to be added

Quantity of bitumen @ 15°C in sprayer = 3550 litres
Quantity of flux oil required (3550*4/100) = 142 litres
Quantity of cutter required (3550 *6/100) = 213 litres
Total quantity of cutback bitumen binder @ 15°C = 3905 litres

8.7.6 Example for Premixed Crumb Rubber Required

(f) Consider a reseal using aggregate which has just been precoated with distillate based precoat, on a highway with a traffic count of 3200 vehicles per lane per day (ie., 24 hour count). The pavement is substantially unshaded (ie., over 90% of it is in the sun) and the pavement temperature at the time of doing the work has been measured at 26, 28, 29 and 30°C in the unshaded areas and 23 and 24°C in the shaded areas. It appears that there will be very little change for the next four or five hours. Because the pavement is substantially cracked the binder to be used is a premixed crumb rubber binder.

The supplier has indicated that the mixture contains 19 tonne of bitumen, 3.8 tonne of crumb rubber and 0.35 tonne of carrier oil.

The pavement temperature for cutting is
\[(26+28+29+30+23+24)/6 = 27°C\]
The bitumen is considered to be 100 parts, therefore the parts of rubber are \( = 3.8 \times \frac{100}{19} = 20 \) parts
The parts of carrier oil are \( = 0.35 \times \frac{100}{19} = 1.8 \) parts

From Table 8.7 B
Flux oil – Nil

From Table 8.7A
Cutter – 8 parts (ie., active precoating) from Table 8.7A but there is already 1.8 parts of carrier, therefore,

Added cutter required is \( = 8 - 1.8 = 6.2 \) parts to be added

Quantity of mixture @ 15°C in sprayer = 3850 litres of mixture

The mixture consists of:
- Bitumen 100 parts
- Rubber 20 parts
- Carrier oil 1.8 parts

The 3850 litres of mixture represents

- Bitumen = \( 3850 \times \frac{100}{100+20+1.8} \) = 3161 litres
- Rubber = \( 3850 \times \frac{20}{100+20+1.8} \) = 632 kilogram
- Bitumen = \( 3850 \times \frac{1.8}{100+20+1.8} \) = 57 litres
- Total = 3850
- Quantity of flux oil required – NIL = 0
- Quantity of cutter required (3850 * 6.2/100) = 239 litres
- Total quantity of cutback crumb rubber bitumen binder @ 15°C = 4089 litres

Reference: Austroads APRG 97/09(SU), Guide to Sprayed Sealing Cutting Practice
9.1 GENERAL
A sprayed bituminous treatment is the term generally used to describe the method of bituminous surfacing where the binder is sprayed onto the prepared road surface and covered with aggregate. It includes spray seals and primerseals. The other treatments are primers and surface enrichments, where no aggregate cover is applied.

9.2 OBJECTIVES
The main objectives when applying a sprayed bituminous surface are to:

(a) provide an economical, durable, skid resistant and non-glare surface on which it is safe and comfortable to travel under all weather conditions

(b) reduce surface moisture reaching the pavement or subgrade

(c) reduce the loss of pavement moisture by evaporation

(d) prevent pavement wear

(e) reduce the effect on the pavement of forces from vehicle impact and wheel-spin

(f) reduce tractive effort and vehicle operating costs

(g) reduce vehicle maintenance costs

(h) reduce road maintenance costs

(i) improve the riding qualities of the pavement

(j) provide a dust free surface.

9.3 CLASSIFICATION OF BITUMINOUS SURFACING
9.3.1 Initial Treatment
Initial treatment is the application of the first bituminous surfacing on a newly constructed or reconstructed prepared pavement. This type of treatment includes:

(a) the priming of the surface and the sprayed seal treatment that is applied to the prime, i.e. a prime and seal treatment

(b) the primerseal that is applied to the prepared pavement surface plus the first sprayed seal treatment that is applied

(c) in some instances, an initial treatment, constructed using pavement materials containing little or no stone, which is a geotextile reinforced sprayed seal (this treatment will be described later).

9.3.2 Retreatment
A retreatment or reseal is the application of a bituminous surfacing over an existing bituminous surface.
A retreatment includes sprayed seals using:

(a) standard binder

(b) polymer modified binders (either using varying proportions of crumb rubber or other polymers)

(c) geotextile or fibre reinforced sprayed seals using unmodified or polymer modified binders and one or two applications of aggregate

(d) multiple application seals using single or multi applications of binder which may be unmodified or modified binder and a multi application of aggregate

(e) surface enrichments.

9.4 SPRAYED WORK

9.4.1 General

The pavements of roads in Victoria are often constructed of naturally occurring gravels, sandstones, limestones, granitic sands or crushed rocks. If untreated, the surfaces of these road pavements are damaged by the actions of traffic, rain and wind. A sprayed seal is a relatively cheap and efficient method of applying a bituminous surfacing to prevent the action of traffic, rain and wind damaging the surface shape of the prepared pavement.

Sprayed work can be broadly subdivided into two groups:

(a) treating the prepared surface of a pavement to provide a waterproof surface on which vehicles can drive

(b) resealing the pavement at periodic intervals to maintain the waterproofing of the pavement.

9.4.2 Treating the Prepared Surface

(a) Dust Laying

The application of a low viscosity, slow curing oil, or diluted bitumen emulsion, to reduce the dust by increasing the mass of the dust particles. This treatment is generally used on access roads.

(b) Priming

The application of a primer of suitable viscosity to a newly constructed or reconstructed prepared pavement surface as a preliminary treatment to hold the pavement and to provide a bituminous surface onto which a sprayed seal can be applied. This enables a good bond to be achieved between the pavement and the seal coat.

(c) Primersealing

The application of a primerbinder of suitable viscosity, covered with aggregate, to a newly constructed prepared pavement to hold and waterproof the pavement. This provides a wearing surface for a longer
time than a primer until a second or final bituminous surfacing of a more permanent nature can be applied.

(d) Surface Enrichment
The light application of a bituminous material to an existing bituminous surface to increase the binder content at the surface and rejuvenate an oxidised bitumen. This is generally applied without aggregate but may use a light cover of small aggregate to minimise delay to traffic.

9.5 SEAL COATS
Seal coats are generally subdivided into two groups, initial treatments and retreatments.

(a) Initial Treatments
An initial treatment is a surfacing on a newly constructed or reconstructed road pavement. This may include more than one seal (i.e. a double application seal) provided this was included in the original treatment design.

The most common forms of initial treatment are:
(i) a primerseal followed by a final seal
(ii) a prime and seal
(iii) prime and light seal followed by a final seal
(iv) a light primerseal or a prime followed by a double application seal (i.e. 14/7).

(b) Retreatment/Reseal
This is a maintenance seal on an existing bituminous surface.

(c) Types of Seal Coats
The two main types of seal coat used on both initial treatment and retreatment/reseal work are:
(i) Single application
A seal coat made up of one application of binder and aggregate.

(ii) Multiple application
A seal coat made up of multiple application of aggregate and often one or two applications of binder. Occasionally multiple application seals consist of three applications of aggregate and two or three applications of binder.

(iii) Geotextile reinforced sprayed seals
Geotextile reinforced sprayed seals are produced by spraying a layer of bitumen onto a pavement (bond coat) then covering this bitumen with a layer of geotextile and lightly rolling. A single or multiple application seal is then applied over the geotextile. The first seal may use a polymer modified binder while the second seal is likely to use unmodified or slightly modified binder.
9.6 ADVERSE FACTORS AFFECTING PERFORMANCE OF SPRAYED SEALS

The degree of success of bituminous surfacing is largely proportional to the control exercised over the quality of materials, the technique of application and the attention given to the design of the seal coat and the preparation of the surface to be treated.

Listed below are the main factors which can adversely affect the quality of sprayed work. Particular attention should be given to these factors when designing the seal coat and during the sealing operation.

Faults in the preparation of the surface are not included, but are discussed later in Chapter 10. Additional information on Faults and Remedies is given in Chapter 20.

(a) Poor Initial Adhesion of the aggregate to the binder.

This may be caused by:

(i) Incorrect design of the seal coat resulting in too light an application of binder for the size and type of aggregate used. This may result from:
   • too low a design rate of binder sprayed onto the road surface
   • too low a surface texture classification
   • no allowance or insufficient provision for binder being absorbed into the surface or aggregate
   • insufficient cutting of the binder for the pavement temperature of the day
   • lack of rolling
   • too low an application rate of aggregate.

(ii) Poor aggregate grading, particularly when an excess of undersized material is present.

(iii) Dirty and/or damp precoated aggregate.

(iv) Aggregate that is too dry. Dust adhering to the surface of the dry aggregate will resist the penetration of the binder to the true surface of the aggregate particles, particularly with emulsion binders.

(v) Aggregate that is too wet. Initial adhesion between the binder and the aggregate is delayed until the surface water has evaporated from the aggregate particles, particularly with aggregates having low affinity for bitumen.

(vi) Lack, or improper precoating, of the aggregate.

(vii) Initial viscosity of the binder too low. If the initial viscosity of the binder is too low it will tend to flow from the high areas to the low areas resulting in a non uniform film of binder. This is often caused by cutting or fluxing the binder too much.

(viii) Initial viscosity of the binder too high. This is caused by adding insufficient cutter (or inappropriate cutter in the case of a PMB) for the conditions and pavement temperature.

(ix) Incorrect grade of binder with regard to the size and type of aggregate used, traffic conditions and/or the prevailing weather conditions.
(x) Unfavourable weather conditions.
(xi) Too heavy an application of aggregate resulting in the aggregate standing proud and being held by insufficient binder (this is also a waste of materials).
(xii) Too light an application of aggregate resulting in windows of binder between aggregate particles where the binder has not been squeezed up and around aggregate particles.
(xiii) Lack of rolling.

(b) Incorrect Materials

Using incorrect materials in relation to the service required of them may lead to the following:

(i) Poor skid resistance due to:
   - aggregate with the incorrect range of polished stone values for the traffic conditions
   - aggregate with excessive flats allowing the binder to rise above the aggregate

   In highly stressed areas such as tight curves, heavily trafficked intersections and pedestrian crossings it may be desirable to specify a higher PSV (polished stone value) aggregate than normally used. Advice from GeoPave should be sought.

(ii) Poor service life due to:
   - aggregate with too low a wear resistance for the traffic conditions
   - aggregate with poor weather resistant properties
   - aggregate with poor adhesion characteristics and a low resistance to stripping from the binder in the presence of water
   - binder which has hardened excessively and lost its ability to retain the aggregate
   - inappropriate cutter type for the polymer modified binder type.

(c) Poor Workmanship

It is essential to pay attention to detail, starting at the design through to the finished job. Accepting a lower standard of work will greatly decrease the useful performance of the sprayed surfacing.

The main factors are:

(i) Poor sweeping and cleaning of the surface to be treated
(ii) Non uniform application of binder, including joints
(iii) Incorrect fluxing and/or cutting back of the binder resulting in an incorrect viscosity for the prevailing working conditions
(iv) Binder temperature being too low when sprayed
(v) Too long a delay between spraying and spreading of the aggregate and/or rolling
(vi) Improper precoating of the aggregate
(vii) Non uniform or too light a rate of spreading of aggregate and failing to spot-up
(viii) Using unsuitable plant
(ix) Poor traffic control
(x) Failing to inspect work after completion.
(d) Poor Maintenance before sprayed sealing
   (i) Failing to patch properly
   (ii) Poor patching techniques
   (iii) Poor pavement shape prior to sealing
   (iv) Excessive crack sealing.

(e) Poor Traffic Control

Poor performance of seals may occur if poor traffic control is exercised during application and immediately thereafter in cases such as where:
   (i) traffic is allowed to use dusty unsealed shoulder, particularly the shoulder on the upwind side while the binder is still uncovered
   (ii) high traffic speeds are permitted during the early life of the work. This will prevent the aggregate settling down and adhering to the binder while the binder is at the correct viscosity to wet and bond to the aggregate.

(f) Lack of Traffic

Lack of traffic may result in a sprayed seal where the aggregate mat is not consolidated properly, i.e. where:
   (i) the aggregate mosaic has not been fully developed by the action of rolling and vehicle traffic
   (ii) the design embedment of the aggregate into the binder has not occurred. With time, this results in the aggregate being unable to embed further into the seal because:
      • dust gets between the binder and the aggregate thus preventing further bonding of the aggregate to the bitumen
      • the binder being hard because it has lost most of the cutting oils and being unable to wet the aggregate and bond onto it.

Lack of embedment, included in the design, is particularly an issue where a seal, designed and constructed for heavy traffic (i.e. low design binder rate and cutting rate), is not subject to design traffic volumes until some time after completion. This particularly applies to roads constructed on new alignments free of traffic. Appropriate actions in such cases are to:
   • apply a primerseal or a prime and a light seal (small size) to protect the pavement and carry construction traffic then apply the final seal immediately before opening
   • defer final seal until after opening to traffic
   • divert normal traffic through the construction works under controlled conditions to properly embed the seal
   • control traffic speeds after opening
   • avoid opening to uncontrolled traffic in cold or wet conditions when the ability of the binder to hold the aggregate is reduced.
(g) Faulty or Incorrect Plant

Using faulty or unsuitable plant for the work affects and lowers the standard of the completed work with a resultant decrease in the useful performance, e.g. using a front end loader instead of an aggregate loader. The aggregate loader has the ability to screen out fine material from the aggregate whereas the front end loader does not have screening capability.

Other problems may include having the spraybar set too high or too low, having incorrect or damaged jets or an incorrectly set spraybar.

(h) Weather

The weather conditions greatly influence sprayed work. Two main weather conditions with adverse effects are:

(i) Sudden changes in temperature
   This could result in loss (stripping) of the aggregate because the binder would be of incorrect viscosity for the changed conditions.

(ii) Rain
   This could cause loss (stripping) of the aggregate because:
   - water delays or prevents adhesion between the binder and the aggregate
   - water emulsifies the binder which could rise above the aggregate and cause aggregate pick-up on the wheels of the traffic and/or the emulsified binder runs off resulting in too light an application of residual binder.

(i) Incorrect Design

Design application rates

Incorrect design of the rates of application of binder will result in an uneconomically low performance bituminous surfacing. Incorrect design of rates of application is most commonly due to incorrect assessment of the traffic.

(i) Too low a rate of application will result in the loss (stripping) of the aggregate over an extended period. Generally the loss of aggregate will be slow, starting with the loss of single stones.

(ii) Too heavy a rate of application will cause the binder to rise above the aggregate (flushing) resulting in poor skid resistance and binder pick-up.

Type of treatment

The incorrect selection of treatment can also result in a sprayed seal that can strip between the wheel paths or flush in the wheel paths. These types of problem are often caused by trying to put too large an aggregate seal on a surface with variable texture. The correct approach is often to:

- pre-spray or locally enrich the coarse areas of the seal to remove textural differences before applying the seal coat
- initially seal the surface with a small sized aggregate (7 mm or
smaller) to make the surface texture more uniform and later in the season, or a number of seasons later, reseal the surface using a larger sized aggregate.
10
Preparation of Surfaces

10.1 INITIAL TREATMENTS

10.1.1 Responsibility

10.1.1.1 General

The construction of a pavement and its preparation for bituminous surfacing is not part of the duties of the Bituminous Surfacing (BS) Contractor. This should have been properly completed in due time before the Surfacing Contractor arrives on the job. The general instructions and information in this chapter are included to present a basis on which to judge whether or not a pavement has been properly prepared and is suitable for treatment.

10.1.1.2 Supervising Engineer

The supervising engineer for the construction work is responsible for the actual preparation of the pavement for priming or primersealing. The supervising engineer should arrange with the BS Contractor for a suitable date to carry out the bituminous surfacing work and confirm or alter the arrangements depending on whether the pavement preparation is satisfactory.

The supervising engineer shall also arrange for the centre-line and start and finish of the work to be marked out on the pavement as a guide for the BS Works Manager.

10.1.1.3 BS Contractor

The Contractor in charge of the bituminous surfacing unit is responsible for:

(i) arranging suitable dates for priming or primersealing the work at the request of the supervising engineer for construction

(ii) inspecting the pavement with a representative from the supervising engineer at least the day before any bituminous surfacing work is programmed in order to accept or reject the standard of work provided

(iii) arranging for the supply of the specified materials, personnel, plant and the designing the rates of application

(iv) preparing details of the actual work carried out.

10.1.1.4 BS Works Manager

The Works Manager in charge of the bituminous surfacing unit is responsible for:

(i) carrying out the actual work according to the instructions and works specification

(ii) inspecting the pavement at the time of doing the bituminous surfacing work and if not satisfied with the standard of preparation should notify the construction engineer immediately, prepare a non-conformance, record in writing concerns and negotiate an appropriate course of action.

10.1.2 Timing of Operation

10.1.2.1 Construction

Soon after a pavement is constructed its surface is usually prepared for bituminous surfacing by grading (if needed), watering and rolling to
produce a tight uniform surface. The surfacing treatment is a primerseal or a prime followed some time later by a seal or asphalt wearing course.

For initial treatment work using a cutback primer it is desirable to have a minimum of two weeks between the completion of the priming and the placing of the seal coat or asphalt course. This will allow sufficient time for the evaporation of the cutter oils which may affect the seal or asphalt. A primer should always be allowed to cure for a short time. Using a heavier grade of primer will extend this time. The time limit should never be so long that the primer has hardened too much or that serious damage is done to the primed surface.

If an emulsion primer is used allow one or two days for the primer to soak in and allow for the evaporation of the water and small quantities of cutter oils.

The use of a primerseal instead of a prime and seal has the advantage of greater flexibility in allowing from about 6 months to 2 years before it is necessary to complete the initial surface treatment.

10.1.2.2 For Preparation and Finishing

There is no substitute for providing the necessary time and effort to properly prepare a pavement and finish the surface before applying the primer or primerseal. The prepared surface of the pavement should be well compacted, uniform in texture and with few, if any, tear or drag marks.

10.1.3 Details of the Work

10.1.3.1 General

The road pavement should be constructed in accordance with the design and construction specification. From the bituminous surfacing point of view the following items should be attended to before commencing an initial treatment.

10.1.3.2 Width of Pavement

Except where the shoulders are capable of carrying the same load as the pavement in all weather conditions, the constructed pavement should be a minimum of 0.6 m wider than the intended bituminous surfacing width.

If the shoulders or adjoining areas are of low strength, this width should be at least 1.0 m. When using porous pavement materials it is desirable to construct the pavement to full formation width or overseal onto prepared shoulders/verge by 300 mm to waterproof and protect the porous pavement materials.

10.1.3.3 Shape

The pavement surface should be constantly checked to obtain the correct cross section and a surface free from bumps, hollows and sudden changes of grade.

10.1.3.4 Compaction

Initial compaction is by pneumatic-tyred, multi-wheel, steel-wheeled vibrating rollers and watering and wherever possible should be followed by further compaction under traffic. Care should be taken to obtain uniformity of compaction across and along the pavement, particularly along the edges and the high sides of curves, by making the traffic use the full pavement width by means of traffic control.
Narrow tracks being compacted by the traffic running in defined wheel paths should be avoided at all times.

During compaction, the pavement surface should be regularly checked for shape and, where necessary, rectified. Whenever fresh pavement material has to be added, the existing pavement material should be scarified to obtain a bond. Thin layers not bonded to the underlying pavement will flake off or break up under the action of traffic after the surfacing has been applied.

10.1.3.5 Moisture Content

(a) For Priming

The cutback or formulated emulsion primers used are of the penetrating type and, depending on the pavement material, may penetrate up to 15 mm into the pavement. A pavement in which the voids are filled with water cannot be filled with primer. The pavement must be surface dry to the depth of penetration.

When priming a very dry pavement, the pavement should be given a light water before priming. This will prevent the primer balling on the dry surface and will improve the penetration of the primer into the dry pavement. This treatment is appropriate whether a cutback or emulsion primer is used.

If using an emulsion primer the emulsion should be checked for compatibility with the pavement materials. Refer to GeoPave for further information on, and testing of pavement material and emulsion primer compatibility.

(b) For Primersealing

The primerbinders used are between a primer and binder in viscosity and are unable to deal with surface dust. The pavement surface should be kept damp but not wet.

Primerbinders may be cutback bitumen, standard emulsions or specially formulated proprietary emulsions.

See Chapter 11 for details on Priming and Chapter 12 for details on Primersealing.

10.1.3.6 Uniformity

To produce high quality bituminous surfacing it is necessary to have a well compacted pavement with uniform moisture content and the surface prepared to a uniform surface texture, free from gouges and ‘hungry’ areas.

10.1.3.7 Riding Qualities

While the pavement surface is being prepared for sealing check the riding quality of the pavement using a normal passenger vehicle in good mechanical condition. The pavement should provide a smooth ride. Any areas not giving a smooth ride should be rectified before priming or primersealing, as a sprayed surface treatment will not correct surface irregularities.
10.1.4 Drainage

10.1.4.1 Purpose

The purpose of drainage is to prevent saturation of the pavement and its foundation by water. Drainage is required to keep the pavement and its foundation dry and firm enough to support, without failure, the wheel loads applied by the traffic.

10.1.4.2 Surface Water Drainage

Saturation by rain is prevented by keeping water from soaking in at the surface, either by quick removal in surface drains and/or by providing an impervious surface. Properly graded table drains and outlets should be provided so that surface water from the pavement and shoulders is removed and discharged into the natural watercourses.

A properly rolled and finished surface will shed most of the water resulting from rainfall with minimal damage.

10.1.4.3 Subsurface Drainage

Certain areas of pavement will at times be found to be continuously wet. This is usually due to water getting into the foundations of the road from underground sources or through a surface which is not waterproof.

The underground water is removed by providing a drainage outlet below the level of the foundation and/or by providing subsurface drains to let out water which may collect in the pavement materials or the boxing under the pavement material.

If the water enters from the surface it is desirable to provide a waterproof surface in addition to the subsurface drainage.

10.1.5 Use of Plant

To ensure that the work is carried out as economically as possible it is necessary that the plant is correctly used and operated and worked at its maximum capacity. To achieve this, proper supervision and setting out of the work is required.

10.1.5.1 Plant Requirements

When preparing a pavement surface for an initial treatment plant should meet the following:

(a) General Requirements

All plant should be in good mechanical condition and used only by trained operators. The fleet of plant used should be balanced so that the pavement compaction and surface preparation is a continuous process of spreading, grading, compacting, watering and preparing the finished surface to a tight, uniform texture suitable for priming or primersealing.
(b) Grader

To produce a smooth riding surface, without irregularities, a grader should:

(i) be operated at speeds below that which cause bouncing, but fast enough to operate efficiently
(ii) have positive control of the blade and the linkages kept in good condition to prevent chattering of the blade
(iii) have a straight edge maintained on the cutting blade. Unevenly worn blades should be replaced before preparation commences
(iv) be able to work a windrow of material across the pavement to assist in the filling of tear marks and creating a uniformly tight surface.

On major projects the grader is often replaced with a paving machine which spreads the pavement materials to line and level using automatic level control or stringlines. Often, after compaction of the pavement materials, the surface of paver laid materials is prepared for sealing by watering and rolling. There is generally no need for additional grading to prepare a paver-laid, crushed rock surface.

(c) Roller

The type of roller used to achieve the required compaction depends on the pavement material used but generally a pneumatic-tyred, multi-wheeled roller, preferably self-propelled, is required to close up the surface pores and to produce an acceptable uniform surface on the pavement. Steel-wheeled rollers may be used on the surfacing to produce fine material which helps tighten up and create a uniformly prepared surface.

(d) Water Tanker

The water tanker should be capable of providing uniform watering across the full width of the spray. The spraying controls should be operable from the operator’s cabin to allow the water to be turned on or off on the run to avoid excessive watering of localized areas, particularly near the start and finish of the work.

10.1.6 Time between Watering and Priming/Primersealing

The major factors which influence the time between watering and priming/primersealing are:

(a) The nature of the pavement material and its surface condition after preparation. Pavement condition from the point of view of priming can be divided into three general groups:

(i) Tightly bonded – Hard and dense when compacted
(ii) Fine (silty soil binder) – Relatively weak and porous when compacted. Fairly porous pavements with medium sized surface pores
(iii) Coarse (sandy soil binder) – Gravels and other pavement materials difficult to compact to a tight, strong surface. Very porous pavements with large surface pores.
(b) The type and volume of traffic

(c) The intensity of watering

(d) The prevailing weather conditions including those just prior to and during preparation

(e) The foundation material and its drainage

(f) The preparation procedures used

(g) The type of primer

Cutback bitumen primers can only be applied to an essentially dry pavement while emulsion primers can be applied to damper pavements.

10.1.7 Common Causes of Poor Performance

Some of the most common causes of pavement deficiencies responsible for failures and/or poor performance of the initial bituminous surfacing are:

(a) Use of unsuitable pavement material

(b) Insufficient pavement thickness

(c) Thin layers of pavement material not bonded to the base

(d) Poorly finished pavement surface due to lack of constant checking of shape and/or poor preparation

(e) Lack of, or uneven, compaction particularly along the edges of the pavement and on the high sides of curves

(f) Poor surface drainage, particularly leaving the shouldering above the edge of the pavement and poor cross sectional shape

(g) Poor subgrade drainage

(h) Dragging or grading of a poor quality material from the shoulders or non-removal of excess fines from the surface

(i) Failure to remove patches of clay worked into the surface and foreign material carried on by the traffic from earth foundations, side roads, shoulders and side tracks

(j) Failure to remove layers or patches of fine slurry from the surface of a limestone pavement

(k) Not properly removing accumulation of fines and/or clay from the surface brought to the top of certain gravels and sands by excessive water

(l) Priming or primersealing the pavement when the pavement materials are too wet.
10.1.8 Pavement Material Requirements

The pavement material used should be in accordance with the specification for the particular job.

Pavement materials outside the job specification should not be used.

10.1.9 Cleaning and Sweeping

It is essential that material carried on from side roads, detours and shoulders, and fines and clay produced during working the material, be completely removed from the surface before priming or primersealing.

The width cleaned should extend at least 0.3 metres outside each edge of the pavement width to be treated.

Sweeping shall be done using both rotary road brooms for the general pavement and hand brooms in areas where a rotary broom cannot operate efficiently.

After cleaning and sweeping the pavement surface should be examined and any clay, scum, or other foreign material still on the surface removed by chipping and/or hand brooming.

10.1.10 Crushed Rock Pavement

10.1.10.1 General Preparation

Figure 10.1.9 A Crushed Rock Pavement Swept, Ready for Priming/Primer sealing
(a) Nature of the material

The material referred to in this section is crushed rock in accordance with VicRoads’ Standard Specification. Reference should also be made to Standard Specification Section 310 – Preparation of Pavement for Sprayed Bituminous Surfacing.

(b) Plant

The plant used for laying, compacting and preparation should be power graders, mechanical spreaders, water tankers, steel-wheeled rollers and pneumatic-tyred, multi-wheeled rollers. Further compaction under traffic is highly desirable.

(c) Spreading

The crushed rock should be spread in uniform layers not exceeding 120 mm compacted depth. The water content of the crushed rock is significant and any additional water required to bring the crushed rock to optimum moisture content should be applied without delay.

(d) Compacting and shaping

It is important that compaction equipment work closely behind the grader. Constant checking of the pavement surface for shape shall be carried out during spreading and compacting. Any segregated patches which show up while the work is in progress should be corrected. Where material is replaced or added it is essential that the whole area and depth be loosened, mixed and put down again to prevent lamination.

During the shaping and compacting stage the crushed rock should be kept at the optimum moisture content. The fleet of compaction equipment should be sufficient to achieve maximum compaction and preparation of the surface for sealing before any serious breakdown of the crushed rock occurs.

10.1.10.2 Maintenance

The pavement should be maintained during the period between the completion of construction and the start of surface preparation for priming/prime-sealing.

Any failures and defects noticed during this period must be removed or corrected.

Maintenance should be carried out by light grading or planing, keeping the pavement damp and rolling with pneumatic-tyred, multi-wheeled rollers. During this period, heavy grading is disastrous – it disturbs the surface resulting in fretting and the formation of heavy mulch or scum. This cannot be incorporated without again scarifying, mixing in additional fines and recompacting the pavement.

10.1.10.3 Priming/Prime-sealing soon after Construction

A short time before priming or prime-sealing is to be commenced the pavement should be finished by light grading, light watering and rolling with pneumatic-tyred, multi-wheeled rollers.
At this stage a light mulch may form on the surface. It is necessary to keep this mulch free of corrugation. Shortly before priming or primersealing the mulch is removed by light grading and/or sweeping.

(a) Priming

For priming, the pavement should be allowed to dry out slowly until it is dry or just damp to a depth of about 5 to 15 mm.

(b) Primersealing

For primersealing, the pavement should be kept damp by watering sufficiently to avoid the formation of surface dust.

10.1.10.4 Priming/Primersealing at a Later Date

If a pavement has been constructed but not sealed for some time after construction, or an existing gravel pavement is to be sealed, the following steps should be carried out to get the pavement surface ready for sealing:

(a) Excavate and fill all failures, bring in extra material to build up low and/or out of shape areas. Bring back and spread over the surface material lying in windrows along the edges and shoulders but do not grade in poor or worn out material, this should be cut to waste.

(b) Water thoroughly

(c) Scarify the full pavement width to a depth of at least 100 mm

(d) Continue watering while grading the full scarified depth from side to side until the material is thoroughly mixed and at about optimum moisture content

(e) Reshape, compact and prepare the surface as set out in Clause 10.1.10.3.

10.1.10.5 Special Conditions

(a) Where it is apparent or suspected that the fines from the pavement material have been lost and the material’s grading has been affected, then samples of the material should be taken and tested before any work is done. If additional fine material is required, care should be taken to select a material of adequate quality. It is important that the fines be spread and mixed uniformly over the road. This will enable a uniform and adequately compacted pavement to be achieved.

(b) If priming or primersealing is delayed for a few days the pavement can be maintained by light grading, watering and rolling with pneumatic-tyred, multi-wheeled rollers. Although this appears costly it is more economical, produces a better standard of work, and causes less interference to the traffic than repreparing the pavement at the last moment.

10.1.11 Gravel and Granitic Sand Pavement

(a) Tightly bonded

These pavements are hard and dense when compacted.

(i) General preparation
Figure 10.1.11.1 A Tightly Bonded Granite Sand Pavement, Swept, Ready for Priming/Primersealing

Figure 10.1.11.2 A Coarse or Loosely Bonded Gravel Pavement, Swept, Ready for Priming/Primersealing

Figure 10.1.11.3 A Gravel Pavement Ready for Sweeping prior to Priming/Primersealing
The preparation of normal gravels, granitic gravels, and granitic sands generally follow the procedure set out in Section 10.1.10 – Crushed Rock Pavement, but the following additional matters should be carefully observed.

(ii) Watering
With these materials, care is necessary as the moisture content approaches saturation, particularly with poor drainage and/or unexpected heavy rain. If under these conditions more water is added, the material will contain more water than the voids can carry and the wheel loads will be transmitted through the water and not through the pavement material, i.e. they become ‘puddeny’.

(iii) Accumulation of Fines and Clay at the Surface
With certain fine gravels, granitic gravels and poor quality granitic sands, watering and working will bring fines and clay to the surface. Where this is evident it is important that the pavement be finished for priming or primersealing as follows:
- The surface should be watered and a cut of sufficient depth made to completely remove all the segregated fines and clay to show a sound, fresh surface. All the cut material must be graded to waste.
- Light grading and rolling with pneumatic-tyred, multi-wheeled rollers should be done while the pavement is drying out.

(iv) Priming
For priming, the pavement surface should be allowed to dry out until it is dry, or at the most damp, to a depth of 5 to 15 mm.

(v) Primersealing
The pavement should be kept damp by watering sufficiently to avoid surface dust forming before primersealing. Although it is necessary for a pavement which is to be primersealed to be damp, it should not contain that much moisture to become unstable when worked by rollers or traffic.

(b) Fine and loose
These pavements are relatively weak and porous when compacted.

(i) General Preparation
The preparation of these gravels follows that set out in Section 10.1.10 – Crushed Rock Pavement except in the case of those gravels with a very high percentage of silty loam binder. Hill gravels may have as much as 35 to 40% of fine material passing a 0.075 mm AS sieve. They present a surface made up largely of very fine material loosely holding larger, usually rounded, pieces in place. When dry, these gravels look like a small quantity of rounded stones in a large quantity of dust.

(ii) Watering
These gravels require more water than a crushed rock or tightly bonded gravel. Care should be taken not to excessively water because this will bring the fines to the top and form a weak crust. If this occurs it is essential that the excess fines are cut and graded to waste before priming/primersealing.

(iii) Holes and Scores Caused by Stones
Hill gravels usually contain a small amount of large hard stones
and during grading the blade will catch these stones and tear scores about the width and depth of the stones. These scores should be patched with fine maintenance premix after priming or primersealing before the final bituminous surfacing is applied.

(iv) Sweeping
A pavement of hill gravel should be broomed lightly, as normal brooming will loosen the surface and produce excessive dust. Some gravels of this type cannot be swept at all.

(v) Priming/Primersealing
The pavement surface should be lightly watered just before applying the primer or primerbinder. The water will help to spread the primer/primerbinder and absorbs it into the surface (see Chapters 11 and 12). It is not unusual to find that the primer has softened the surface. The final bituminous surfacing should not be applied for at least seven days to give the primer a chance to cure, set up, harden and strengthen the top of the pavement.

(c) Coarse or loosely bonded
These are gravels with a sandy soil binder and are difficult to compact to a tight strong surface.

(i) General preparation
The preparation of these gravels follows that set out in Section 10.1.10 – Crushed Rock Pavement but with the following exceptions:

(ii) Compaction
Compaction should be achieved in layers not exceeding about 75 mm in depth with steel-wheeled rollers and pneumatic-tyred, multi-wheeled rollers.

(iii) Watering
It is important that the moisture content be above the optimum. Excessive watering will bring the fines and clay to the surface which will form a weak crust and/or the water may flow through the porous gravel and affect the subgrade.

(iv) Priming/Primersealing
During the finishing operation the pavement should be kept damp but not wet. Just before applying the primer/primerbinder the pavement surface should be heavily watered and all the surface segregation of fines cut to waste. Light grading and rolling with pneumatic-tyred, multi-wheeled rollers should continue until the pavement dries out. The surface can be swept and primed as soon as the pavement is dry or damp to a depth of about 5 to 15 mm and before any ravelling of the surface occurs. It is essential that primersealing be carried out only when the pavement is damp (see Chapters 11 and 12).

(d) Armour-coating
Fine gravel and granitic sand pavements prepared in wet weather will attain greater strength if the surface is armour-coted. See Section 10.1.14(d).

10.1.12 Scoria Pavement

10.1.12.1 General Preparation
The preparation of pavements constructed of scoria follows that set out in Section 10.1.10 – Crushed Rock Pavement, but with the following exceptions:
(a) Construction
Because of the porous nature of scoria, consideration should be given to constructing the pavement to full formation width. The subgrade should be constructed to the finished shape for proper drainage and uniform compaction.

(b) Compaction
It is essential that material is broken into a finely divided state and therefore a grid roller may be used in conjunction with the normal compaction equipment.

(c) Watering
The demand of scoria for water is great and it is important that the pavement be kept saturated during the period of shaping and compacting.

After compaction is achieved it is preferable to continue rolling, with pneumatic-tyred, multi-wheeled rollers, to bring the water to the surface and thus reduce the moisture content to below optimum.

Scoria is very difficult (almost impossible) to prepare if water is limited and it is therefore desirable to carry out preparation in late Spring.

(d) Priming
Sweeping and priming of the pavement should be commenced as soon as finishing is complete. It is important that the pavement be damp only to a depth of about 5 to 15 mm. If the pavement is allowed to dry out completely, ravelling of the surface will generally occur.

(e) Primersealing
Sweeping and primersealing of the pavement should be commenced as soon as finishing is complete and while the pavement surface is still damp. It may be necessary to lightly water the pavement immediately prior to primersealing.

10.1.13 Volcanic Tuff Pavement
The preparation of pavements constructed of volcanic tuff follows that set out in Section 10.1.10 – Crushed Rock Pavement, but with the following exceptions:

(a) Compaction
Compaction should be achieved in layers of approximately 100 mm compacted depth. It is essential that lamination of the pavement layer be prevented from occurring during compaction.

(b) Watering
It is important that the pavement be shaped and compacted dry of optimum moisture content. The surface should then be well watered, rolled with a pneumatic-tyred, multi-wheeled roller and lightly cut if necessary.
(c) Priming

Sweeping and priming of the pavement should be commenced as soon as finishing is complete. It is important that the pavement be damp only to a depth of about 5 to 15 mm.

If the pavement is allowed to dry out completely ravelling of the surface will generally occur.

(d) Primersealing

Sweeping and primersealing of the pavement should be commenced as soon as finishing is complete and while the pavement surface is still damp. It may be necessary to lightly water the pavement immediately prior to primersealing.

10.1.14 Sandstone Pavement

Owing to the nature of the sandstone its preparation generally does not follow that for a crushed rock or gravel.

(a) General Preparation

(i) Nature of the material

The usual sandstones used are relatively soft materials of low tensile strength with poor natural binding qualities. The nominal size used is about 50 mm but large stones up to 150 to 200 mm or more are common in some sandstone pits and need breaking down by rockbuster or grid roller during pavement construction. It is however essential that the sandstone not be broken down too far in the compaction process.

(ii) Spreading

Sandstone cannot be spread in thin layers and should be spread in layers of at least 100 mm compacted depth.

(iii) Compacting and shaping

Steel wheeled rollers are necessary to force the stones into the pavement. To avoid producing excessive loose sand care should be taken not to use too heavy a roller or to work the sandstone unnecessarily.

(b) Special Conditions

Working sandstone presents difficulties which generally do not occur during the handling of crushed rock and the harder gravels. These are mainly:

(i) The grader is likely to grade thin layers of sand into shallow depressions

(ii) Shape regulation must be carried out by the spreading of thick layers of minimum 100 mm consolidated depth

(iii) The sandstone must not be overworked by continuous grading as this may grind away large quantities of the sandstone. Often the larger, harder stones are pulled out creating scores in the surface.
These scores fill with sand and must be cleaned out by hand-brooming before priming or primersealing is carried out.

(iv) The sandstones are porous, sandy and with low binding strength, as a result the demand for water is considerable. During compaction the material should be kept saturated.

(c) Priming/Primersealing

On the completion of shaping and compacting the procedure should be as follows:

(i) Water heavily, saturating the material to a depth below which it is intended to cut

(ii) Cut a thin layer off the whole surface and grade this to waste

(iii) Roll the surface with pneumatic-tyred, multi-wheeled rollers

(iv) While the rolling is in progress lightly grade the surface off again

(v) Sweeping and priming should not be commenced until the pavement has dried out or is damp to a depth of about 5 to 15 mm

(vi) The pavement must be damp before primersealing is commenced (see Chapter 12).

(d) Armour-coating

Pavement strength difficulties associated with sandstone are often overcome by armour-coating the surface of the sandstone pavement with fine crushed rock.

The armour-coating process involves uniformly spreading fine crushed rock over the pavement to a loose depth of approximately 30 mm and lightly tyning the pavement, through the crushed rock, up to a depth of 75 mm. Both materials are then worked until a mixture is obtained which enables the fine crushed rock to be set down.

It is important that during preparation the armour-coating material is not lost from the surface or mixed with excessive fines.

Preparation of the surface for priming/primersealing generally follows that set out in Section 10.1.10 – Crushed Rock Pavement.

10.1.15 Limestone Pavement

Owing to the nature of limestone its preparation does not follow that for other commonly used pavement materials.

(a) General Preparation

(i) Nature of the material

In pavement construction, limestone is generally in the form of a rubble which may contain both soft and/or large hard particles. The more stoney the material the better it is as a pavement material but the more difficult it becomes to produce a smooth surface. The nominal sizes vary from about 25 to 30 mm for the harder material to about 50 to 60 mm for the softer material or larger with very soft material. The larger material can be broken down during construction using steel-wheeled or grid rollers.
(ii) Spreading
Limestone should be spread in layers of at least 75 mm compacted depth.

(iii) Compacting and shaping
Compacting hard limestone is generally more difficult than most other pavement materials and greater attention must be placed on the need for continuous supervision. The softer limestone, or those with a low, hard stone content, are more easily compacted. Limestone pavements should be examined for loose pockets of material, which commonly occur during construction. The loose material should be removed.

(b) Surface Slurry
The greatest problem with the preparation of soft limestone rubble is the failure to completely remove from the surface the scum formed by rain, watering, working and traffic. This scum is quite noticeable on areas affected by seepage and/or when gypsum or marl is present in the limestone. This scum causes the typical smooth, shiny surface appearance after a limestone pavement has been under traffic for some time.

The scum should always be graded off before any priming/primersealing is carried out or any fresh pavement material added. After grading off the scum, it is important that the surface be thoroughly soaked before adding fresh pavement material.

The scum cannot be avoided but it can be reduced by the selection of the pit and/or the material in it. Avoid areas adjacent to gypsum or those running off to marl.

(c) Priming/Primersealing
On the completion of shaping and compacting the procedure should be as follows:

(i) The pavement should be watered and ample time allowed for the water to soak in. When the surface is wet enough to cut easily without disturbance, but not so wet that the traffic slurries the surface, it is in the proper condition to be cut. It is essential that the cut be deep enough to remove all the slurry and a sound fresh surface of limestone exposed. The material must be cut to waste.

(ii) The surface should be rolled with pneumatic-tyred, multi-wheeled rollers to close up the surface pores.

(iii) Sweeping and priming or primersealing should be carried out as soon as possible while the surface is still free of scum. A primer or primerseal must not be applied to a surface which is not free of scum. If only a light scum has formed this may be removed by a light cut, grading the material to waste. Otherwise the full finishing preparation must be carried out again.

(iv) A pavement of soft limestone cannot be left under traffic for any length of time nor will it remain in good condition without watering and working. It should be primed or primersealed as soon as possible after completion.
Priming may be done when the surface has dried out or is only damp to a depth of about 5 to 15 mm.

Primersealing must not be commenced unless the pavement is damp (see Section 12.2).

**Figure 10.1.15 A limestone Pavement, Swept, Ready for Priming/Primersealing**

Note: cracking due to high plasticity index (PI).

### 10.1.16 Stabilised Pavement

(a) At times it is necessary to modify the existing pavement materials. This is done for two main reasons:

   (i) To improve the physical properties of materials to meet requirements such as load bearing capacity, stability under adverse conditions and improve service life

   (ii) To improve the handling and compaction characteristics of difficult materials which are otherwise unsuitable for use as pavement material.

(b) There are many ways of achieving this but the most common are:

   (i) Adding and mixing with other naturally occurring materials. Generally this is to improve the grading

   (ii) Adding lime, cement, slag/lime mixtures

   (iii) Adding bitumen as either cutback bitumen, bitumen emulsion or foamed bitumen.

GeoPave should be consulted to advise on:

- the requirement for stabilisation, the method used and the pavement construction
- the pavement preparation and the type and grade of primer or primerbinder to be used
As stabilised pavements generally provide greater resistance to penetration of primers, a lighter primer or a lower rate of application will be required than would have been the case without stabilisation.

Cutback bitumen primers and primerseals are commonly used on cement stabilised pavements. If emulsion primers and primerseals are being considered their compatibility with the cement stabilised material should be checked.

10.1.7 Concrete Pavement

(a) Either a concrete road pavement or a concrete bridge deck may require a seal to be applied. Usually a concrete surface is smooth and hard and requires no further preparation after construction other than cleaning before treatment.

(b) Priming

The concrete must be thoroughly cleaned of all foreign materials, loose or flaky concrete and dust. The primer needs to be applied only very lightly, just enough to blacken the surface and kill surface dust always present. For this reason no seal coat or asphalt course should be placed on a concrete surface without priming.

(c) Primersealing

Provided the concrete has been cleaned thoroughly a primerseal may be applied directly onto a dry to damp concrete surface. Any free surface water should be removed by brooming as water will delay or prevent a bond between the concrete and the primerseal.

Concrete surfaces that have been primersealed using cutback bitumen should not be asphalted over or have a final seal placed until all of the cutters in the primerseal have evaporated. This is normally 3 to 4 months of summer weather but often 12 months is allowed. Where earlier resurfacing is required, a bitumen emulsion may be used as the primerbinder.

10.2 RETREATMENTS

10.2.1 Responsibility

(a) General

The maintenance of an existing bituminous pavement and its preparation for a retreatment is not part of the duties of the Bituminous Surfacing Contractor. This should have been properly completed in due time before the BS Contractor arrives on the job. The general instructions and information in this chapter are included to present a basis on which to judge whether or not a pavement has been properly prepared and is suitable for treatment.

(b) Supervising Engineer

The supervising engineer for the particular maintenance organization is responsible for the actual preparation of the pavement to an acceptable standard, and should arrange with the BS Contractor for a suitable programme to carry out the bituminous surfacing retreatment
The supervising engineer shall also arrange for the centre line and the start and finish of the work to be marked on the pavement as a guide for the BS Contractor.

(c) OIC BS Unit
The officer in charge of the bituminous surfacing units is responsible for:
(i) arranging a suitable programme to carry out the retreatment work
(ii) inspecting the existing bituminous surfacing at least several weeks before any bituminous surfacing work is programmed and accepting or rejecting the standard of work provided
(iii) arranging for the supply of the necessary materials, personnel, plant and designing the rates of application
(iv) arranging to have the start and finish of reseals and final seals marked out
(v) arranging linemarking of surfaces that are resealed or final sealed.

(d) Bituminous Surfacing Contractor
The Bituminous Surfacing Contractor is responsible for:
(i) carrying out the actual work according to the technical specification for the works
(ii) inspecting the pavement at the time of doing the bituminous surfacing work and if not satisfied with the standard of preparation should notify the Construction Engineer and negotiate an appropriate course of action.

10.2.2 Timing of Operations
(a) General
Each length of road to be retreated should be examined in detail and all the necessary preparation carried out and completed at least six weeks before the bituminous surfacing work is programmed.

Maintenance should include:
• patching (at least six weeks before resealing)
• regulation works (at least three months before sealing)
• grading of shoulders (provided there is not a safety issue, shoulders should not be regraded until 2 weeks after sealing).

(b) Sprayed Work
Regular maintenance and work of a minor nature required to maintain the surface should continue during the six-week period. If any major patching is required within this period, the reseal should be reprogrammed.

Note: It must be stressed that this preparation work must be completed in advance. To rely on the sealing unit to do this is wasteful in terms of manpower and plant available. Preparation carried out at this late stage is useless and will adversely affect the standard of the retreatment in terms of appearance and performance.
10.2.3 Preparation Required

(a) General

A retreatment should not be applied to an existing bituminous surface unless the pavement is sound and capable of carrying the traffic expected during the life of the proposed retreatment. The preparation required for sprayed work and asphalt work is similar but there are some separate major points to be considered.

A reseal does not correct the shape or riding qualities of a pavement nor does it improve its strength. Asphalt regulation will improve the shape, however, it should be done well in advance to allow it to settle down and harden to reduce the possibility of stripping or flushing.

(b) Skin Patching

This is the repairing of shallow breaks and weak areas in the bituminous surface which have not yet developed into the pavement itself. Skin patching may be done by hand or with plant depending on the areas to be covered. The patch should be neat and squared without unsightly dribbles. The rates of application and aggregate used should be such that the patch matches the surrounding surface texture. One of the main problems with this type of treatment is the inability to accurately apply the binder and the tendency to use too heavy an application. This results in unsightly fatty patches.

(c) Repairing Defective Areas

All defective areas should be cut out and replaced with material similar to, or better than, that in the existing pavement. It should be thoroughly compacted and then trafficked for some time. If the area remains stable and shows no further signs of failure it should, if necessary, be corrected for shape and completed. Do not use maintenance premix on large areas where it would be more economical and practical to reconstruct and apply a temporary initial treatment well in advance of the retreatment.

(d) Repairing Potholes

These are usually more than skin deep (10 mm) but not generally more than 150 mm in depth. All the loose material should be removed until a sound surface is reached. The hole should then have the sides cut straight and vertical and the corners squared.

The sides may be vertical but a better result may be obtained with less likelihood of cracking along the edges of the patch if the sides are sloped at about 45°.

Depending on the conditions, the pothole is then filled with pavement material, maintenance premix or preferably hot asphalt where economically available.

With premixed asphalt, the largest size available should be used up to a maximum nominal size of about two-thirds of the depth of the hole.
The patched area should be gritted with clean material to prevent pick-up by the traffic. The surface may need to be finally sealed with a light seal which should waterproof the patch by overlapping onto the original pavement. The final seal should square up the patch.

(e) Repairing Edges

A bituminous surface which has broken away at the edges is repaired by removing all the loose material from the sides. When the edge failure is due to the pavement not being thick enough, the failed areas should be taken out to correct pavement width and depth.

After priming, the edges should then be built up with maintenance premix or preferably hot asphalt where economically available. The repair should be done so that it fits in with the general crossfall and restores the pavement to its proper width. As soon as the edge repairs have been completed the shoulder should be built up to suit.

(f) Repairing Cracks

Pavement cracks should be repaired by filling them with:

(i) cutback bitumen, the grade or type used will depend on the prevailing weather conditions at the time of work. After filling, the crack surface should be covered with clean sharp sand or fine grit;

(ii) bitumen emulsion in place of the cutback;

(iii) bitumen emulsion containing rubber or polymer as an additive. This is preferred when the cracks keep reappearing after using method (i) or (ii);

(iv) bitumen containing crumb rubber or other polymer modified binder when cracks are wider than 5 mm. When pavement cracks are thought to be due to subgrade or pavement failure then the problem area should be dug out and the cause ascertained.

Care should be taken that only the crack is filled and the material not spread on the pavement surface because this will cause fatty patches in the retreatment.

(g) Correcting Shape

When isolated or short depressions result in poor riding quality of the pavement, they should be filled with cold maintenance premix or, preferably, hot asphalt where this is economically available. The surface of the patches should follow the shape of the pavement and be checked with straight edges and boning rods.

The pavement should be swept clean and given a tack coat, either cutback bitumen or bitumen emulsion, before placing the asphalt.

The asphalt may be spread with mechanical spreader, grader or by hand depending on the size of area covered.

With maintenance, premixed asphalt it will be necessary to grit the surface after completion to prevent pick-up.
Note: When the regulation required is extensive and appears to be caused by pavement failure it may be more economical to reconstruct pavement sections as required. These sections may be treated with an initial treatment of a temporary nature well in advance of the retreatment.

Where the existing pavement has an asphalt course of sufficient depth it may be possible, and more economical, to correct the shape by removing the high spots instead of filling the depressions. This may be done using a cold planer.

(h) Correcting Shoving and/or Rutting

Surface waving or shoving usually occurs only at intersections or on long or steep grades where heavy traffic travels slowly in defined wheelpaths.

The irregularities are usually shallow as distinct from the larger deformations caused by subgrade or pavement failure. Unstable material should be removed and replaced with better quality material. When the pavement is stable the surface may be corrected by filling with hot asphalt where available, or cold maintenance premix.

(i) Waterproofing Patches

Patching carried out with maintenance premix should not be covered with a seal coat immediately after patching is completed. The patches should be inspected about two or three weeks later and the decision made then whether a waterproofing seal coat is required. The binder should be cutback bitumen, or bitumen emulsion, and covered with fine grit. Unnecessary or heavy seal coats should not be applied because this will produce fatty black patches.

(j) Removing Fatty Patches

Localised bumps due to fatty patches should be chipped off. Where there are extensive areas of fatty patches these may be removed with a planer (if asphalt) or the use of chemical solvents to soften the bitumen and allow the addition of aggregate (if a sprayed seal).

(k) Providing a Uniform Surface Texture

The existing surface texture of the pavement to be treated greatly influences the design and success of sprayed work but has little influence on plantmix work provided that the other items in this section have been attended to.

The main conditions to be corrected before applying a reseal are:

(i) Ravelling and/or Stripping: Where ravelling or stripping has taken place over extensive areas, usually the surface texture is coarse but uniform and the design of the seal coat will allow for and correct this. Where ravelling or stripping occurs in defined local areas, within the general area to be treated resulting in a non-uniform appearance, these areas should be corrected to provide a surface texture similar to the general surface texture. This is done by sealing the areas concerned or by local surface enrichment. The rate of application of binder and size of aggregate must be such to produce a surface similar in texture to the existing surface. Do not use fine aggregates on existing coarse surfaces and vice versa.
(ii) Patches: Porous open patches will absorb the binder of the reseal and will result in stripping. All premixed asphalt patches should be checked two to three weeks after placing to determine whether a surface seal is required. Again the binder rate of application and aggregate used must be in relation to the existing general surface texture.

(l) Repairing drains and culverts

Clean all drains and culverts and install additional drainage where it is indicated to be necessary by the nature of the pavement failures.

(m) Correcting Shoulders

Build up or cut down the shoulders as required to their correct level and crossfall from the edge of the pavement. All material dragged onto the pavement should be removed. To avoid damaging the seal, shoulders should not be graded or corrected within two weeks of applying a sprayed seal.

10.2.4 Cleaning and Sweeping

The surface should be examined and all mud, scale and other foreign material, not part of the bituminous surface, removed before spraying any tack coat or binder.

Particular care should be given to the edges of the pavement, intersections and any areas adjacent to construction activities, side roads or tracks.

Where necessary, any shouldering material and/or the shoulders must be graded off for a width of at least 0.5 m outside the edges of the pavement to be retreated.

The whole surface shall then be swept with a rotary road broom or suction sweeper and hand brooms.

10.2.5 Linemarking

Sealing over freshly repainted (paint or thermoplastic) pavement markings, especially longitudinal lines on heavily trafficked roads, has resulted in flushing on the marking or loss of adhesion of binder and/or aggregate to the detriment of the appearance of the new seal.

To avoid this, any linemarking should not be repainted within at least two months prior to doing the seal unless it is required for the safety of the traffic.
11.1 GENERAL

11.1.1 Description

Priming is the application of a suitable primer to a prepared pavement as a preliminary treatment to the application of a bituminous surfacing, which may be a sprayed seal or asphalt.

Suitable primers are most commonly cutback bitumen although some proprietary products are also available as bitumen emulsions. As the formulation of emulsion primers is influenced by the type of pavement material, special care needs to be taken in selection and use. To achieve a satisfactory primed surface the compatibility of the emulsion primer with the pavement material is more critical than with a cutback bitumen primer.

11.1.2 Function

The function of priming is to assist in achieving and maintaining an interfacial bond between the pavement and the bituminous surfacing treatment. To achieve this the properties of a primer should enable it:

(a) To deal with surface dust

Road dust is a finely divided, cohesionless material which has little or no adhesion, i.e. it will not stick together nor will it stick strongly to other objects.

Some pavement binding materials have good cohesive qualities when dry but little when wet, eg., clays. When dry their adhesion to the larger stones in the pavement material is low, but when wet it is high. To remove dust when in the wet condition is impractical.

Bitumen binders are materials with strong adhesive characteristics. When applied to free dust the binder will stick to some of the dust and will ball up. The dust will not stick to the pavement material and so no bond occurs.

To be satisfactory, a primer must be capable of penetrating a film of fine material, e.g. the dust or clay, and coat each particle with a strongly adhering film.

(b) To seal surface pores in the pavement material

One of the functions of a bituminous surfacing is to enable the pavement to reach a constant equilibrium moisture content.

With an excess of moisture in the pavement and/or surface, water tends to break the bond between the pavement and the bituminous surfacing. To counteract this a primer should penetrate the pavement and fill the surface voids to provide a seal against water.

For a cutback bitumen primer to achieve the surface penetration the pavement must be dry or only damp for the top 10 mm to 15 mm. A wet pavement in which surface pores are full of water will not allow any penetration of the primer. When applying a prime to a dry pavement the surface of the pavement may need to be moistened to help provide a uniform covering and penetration of the surface.
A bitumen emulsion primer should also penetrate the pavement surface. For an emulsion primer to penetrate the surface, it must be compatible with the material being primed. Before using an emulsion primer it should be checked in the laboratory or in the field to ensure that it can penetrate the pavement material.

(c) To strengthen the pavement near its surface
Some pavement materials, e.g. buckshot gravel or weak sandy materials, have insufficient strength near the surface to resist the forces the pavement will be required to withstand. Under these circumstances the primer is required to deal with dust, fill the surface pores and physically strengthen the pavement near its surface, say for a depth of about 10 to 15 mm.

(d) To waterproof the pavement binding materials
With a clayey, soil-bound gravel, a poor granitic sand or similar material, the primer should waterproof the clay binding material near the pavement’s surface to assist in maintaining pavement surface stability.

A granitic gravel is a material produced from decomposed granite containing feldspars. These feldspars break down into clay and make this material difficult to prime which often results in poor seals.

11.1.3 Requirements for Priming
Where practical, it is standard practice to prime or primerseal all freshly constructed pavements prepared for initial treatment unless a layer of asphalt of more than 100 mm thickness is proposed to be placed. Priming provides some flexibility between the time of completing construction and applying the initial treatment seal. It improves the bond between the pavement and the initial treatment seal and reduces the risk of failure of the treatment.

There are a few pavement materials (coarse strong gravels with a high stone content and a minimum of binding material of a sandy and gritty nature) which do not have any of the properties outlined in Section 11.1.2. When prepared and swept, these present a very clean, coarse, tight, strong stone surface free from dust. This condition allows the binder to come into contact with sufficient clean, strongly held stones to make the deletion of a primer less of a risk.

These pavement materials are not common and as priming always reduces the risk of early failure, it is recommended that priming never be deleted on initial treatment, prime and seal work.

Where the surface needs to be trafficked and the traffic exceeds 400 AADT the alternative of primersealing is recommended as this causes less inconvenience to the travelling public.

11.1.4 Minimum Temperature for Priming
 Primer should not be sprayed when the pavement temperature is below 10°C because at low temperatures the primer will not set up and dry.

11.1.5 Priming Materials
See Chapter 4 for the type and grades of priming materials normally available for use.
11.2 PAVEMENT PREPARATION

11.2.1 General

For priming, the pavement should be prepared as set out in the relevant sections of Chapter 10, Preparation of Surfaces. Proper preparation of the pavement surface is essential to achieve a first class bituminous surfacing. A sprayed treatment will not improve the shape and riding qualities of a pavement.

11.2.2 Condition

A primer should only be applied to a prepared, sound, clean pavement surface. The pavement should be well consolidated, true to line and level, free from dust pockets and laminated layers of pavement material and foreign matter and uniform in surface texture.

For the application of a cutback bitumen primer the surface should have dried out, or be only damp, to a depth of about 5 to 15 mm.

Specially formulated inverted bitumen emulsion primers are manufactured from cutback bitumen and penetrate the pavement in the same manner as standard cutback bitumen primers. They require similar dry or barely damp conditions to cutback bitumen primers.

Conventional bitumen emulsions present difficulty in achieving sufficient penetration and are generally not recommended as primers.

11.2.3 Cleaning

The pavement surface should be cleaned to remove all mulch, carried on material, dirt and dust.

A properly cleaned pavement is one which is free from foreign material and the larger sized stones at the pavement surface are exposed and clean but not loose or dislodged (except with a loosely bonded pavement material). Where the mulch is heavy it should be removed first by light grading. Any scale, hardened mud or foreign material sticking to the surface should be loosened by hand chipping. The cleaning should continue until any material which may prevent the uniform penetration of the primer has been removed.

11.2.4 Sweeping

After cleaning has been completed the pavement surface should be swept with a rotary road broom supplemented by hand brooms where required. The force applied to the broom is dependent on the type and hardness of the pavement material. The force applied should be just enough to only flick off dust etc. without damaging the pavement surface. Some loosely bonded gravels cannot be swept at all but must be lightly watered after final preparation and just before priming. Care should be taken to ensure that dust is not carried back over the top of the broom onto the pavement, or is not blown back across the swept work and that dust nuisance to adjoining properties is kept to a minimum.

Sweeping pavements for priming usually causes a lot of dust. If the dust reduces visibility, the road should be closed during each sweeping run of the broom.
Every surface should be examined for foreign material both before and after sweeping.

11.2.5 Width to be Swept
The pavement should be swept to at least 0.3 m outside the edges of the width to be primed.

11.2.6 Distribution of the Swept-off Material
After the primer has setup any windrows should be graded over the shoulder before the seal coat is applied.
11.2.7 Marking Out

The centre line of the pavement should be established from the construction or survey pegs. This should be done by the Construction Works Manager and the centre line or edge of pavement marked at about 10 m intervals.

If the pavement alignment is not in agreement with the pegs available then the bituminous surfacing must follow the pavement as constructed.

For marking out use either the priming material, water-based paint or spray can. From these marks the Bituminous Surfacing Works Manager can establish guide marks for the sprayer.

11.3 WIDTH TO BE PRIMED

11.3.1 General

Under traffic: Pavements constructed under traffic should normally be primed half width to cause the least possible inconvenience to the travelling public.

The second half width must not be primed until the first half width has dried and is capable of carrying traffic.

Priming may be done full width in one application where traffic is light, a suitable side track or detour is available and the road can be temporarily closed without greatly inconveniencing the public. Care should be taken to ensure that sidetracks adjacent to the primed areas are watered to prevent dust killing the prime.

New alignments: Pavements constructed on new alignments (i.e. not under traffic) should be carried out to minimise the number of longitudinal joints. Care should be taken to ensure longitudinal joins are on lane lines (preferred) or between wheel paths.

11.3.2 Full Width

Where priming can be done full width in one application the primed width should, if practical, extend about 100 mm outside each edge of the proposed bituminous surfacing width. This will provide properly primed unbroken edges for the seal for both staged and ultimate traffic conditions.

11.3.3 Half Width

Where priming can only be done to one half the width of the pavement, the width to be sprayed shall be 100 mm wider than the half width of the proposed seal width. On the first half width, the prime should be sprayed approximately 25 mm over the centre line and about 75 mm outside the edge of the pavement to provide a properly primed unbroken edge for the following seal.

The second half width should overlap the inside edge (centre line) of the first sprayed width of primer by about 50 mm, leaving 75 mm outside the edge of the pavement to provide a properly primed unbroken edge for the following seal. This means that the total primed width is about 150 mm wider (i.e. 75 mm on each side) than the proposed bituminous surfacing width, with a 50 mm overlap on the centre line.

Care should be taken to ensure the overlap is not located on a wheel path.
11.4 RATES OF APPLICATION

11.4.1 General
The selection of the grade of primer and the rate of application is based on the type of pavement material, the degree of compaction, moisture content and the life expected of the primer.

There are no formal design methods to determine the rates of application for priming. Determining the application rate is largely based on the above factors and experience. This section gives some general guidelines to determine suitable rates of application.

If in doubt regarding the correct rate for a particular job, try a small area by hand (perhaps 1 m²) or spray a short section (about 50 m) and observe for about half an hour. This will give some indication of a suitable rate of application of the primer for that job.

This approach is also recommended when using an emulsion primer to check its suitability and compatibility for a pavement material. (Note: Emulsion primers are often unsuitable for cement-treated materials.)

11.4.2 Light Rates

11.4.2.1 Cutback bitumen primer
Light rates of application of primer are generally only required where the seal is to be applied very shortly after the primer, e.g. same day, re-priming worn or damaged primed surfaces or on very dense pavements, e.g. stabilised or concrete.

The primer used is a light grade primer at a rate of application of 0.30 to 0.60 litre/m².

Where conditions favour using light rates of application of priming followed by sealing in the one day, it is necessary to consider possible absorption of some of the binder into the lightly, usually under-primed pavement. Some of the low viscosity cutback primer may also have a cutting back effect on the binder. In such cases it would be necessary to increase the binder rate and decrease the amount of cutter in the binder. This would be based on experience and is difficult to estimate. Rather than use a light primer at a low rate of application to allow early application of the seal coat, it is preferable to use a primerseal.

11.4.2.2 Emulsion primer
Emulsion primers are generally not suitable for light rates of application.

11.4.3 Normal Rates

11.4.3.1 Cutback bitumen primer
With a primer of the correct viscosity for the conditions the normal rate of application should be about 1.0 to 1.1 litres/m² for crushed rock pavements and 0.6 to 0.8 litre/m² for cement-treated crushed rock pavements. This should usually result in a satisfactory, uniformly primed surface.

If it appears that a heavier rate of application is required, it is preferable to use a heavier grade of primer rather than increase the rate of application (sandstones, limestones and other very porous pavements excepted).
Note: Experimental work has been undertaken using polymer modified binder primer to reduce the rate of application of primer. Refer to GeoPave for further information.

The rate of application should be varied according to the compaction of the pavement and the moisture content of the surface. In general, the rate of application should not be less than 0.8 litre/m² nor more than about 1.3 litres/m². Except in special cases, such as cement-treated crushed rock, a rate below 0.8 litre/m² does not adequately prime the surface or fill the pores in the pavement surface and could lead to a stripped seal due to absorption of binder into the surface.

11.4.3.2 Emulsion primer
Typical rates of application for emulsion primers are in the range 1.0 to 1.5 litres/m² (0.5 to 0.8 litre/m² residual binder) depending on the base material. Application rates should be determined by field trials or testing.

11.4.4 High Application Rates
On sandstone, limestone and other very porous pavements the normal rate of application should be about 1.4 to 1.5 litres/m² of a heavy (high viscosity) cutback bitumen primer.

On other pavements a rate of application of 1.3 litre/m² or more indicates the primer is too light and of too low a viscosity. A heavier, more viscous, primer should be used at the normal rate of application.

If it appears that a rate of application in excess of 1.5 litres/m² for a very heavy primer is required, the pavement is unsuitable for priming and will need to be treated by other means, e.g. primersealing.

11.4.5 Applying High Rates of Application
When it is necessary to prime at rates of application in excess of 1.2 to 1.3 litres/m² it is possible that runoff may occur. If it appears that runoff could occur with the high rate of application then the primer must be applied in two applications.

The first application should be sprayed at, or a little higher than, half the total estimated rate of application.

The second application should not be sprayed until the sprayer can work on the first application primer without damaging it. The second rate of application should be determined only after inspecting the result of the first application of primer.

This two-application procedure is the normal method of priming sandstone and limestone pavements.

11.4.6 Very Porous Pavements
If, after priming with a heavy primer, there is still some doubt about the adequacy of the primed surface and it is suspected some of the binder may be absorbed, it is recommended that the following be considered:
(a) apply a light seal, 7 mm, at heavy rates of application and follow this with a larger final seal about 12 months later

(b) use a polymer modified binder in the seal coat to minimise the loss due to absorption.

11.4.7 Softening of a Pavement due to a High Rate of Application

A very high application rate or excess of primer, particularly with a light, low viscosity primer, will, for a short period, soften rather than harden the pavement surface. This is particularly noticeable on gravel with an excess of silty soil binder.

When this occurs, the primed pavement must not be sealed until the primer has cured sufficiently to produce a stable, hard topped pavement.

11.4.8 Priming Concrete Surfaces

Concrete bridge decks and concrete pavement which are to be sealed or asphalted should be primed. The primer should generally be applied at a rate of approximately 0.25 to 0.30 litre/m².

When priming concrete surfaces it is important to consider the compatibility of the compounds that are used to aid the curing of the concrete. Curing compounds that contain waxy materials and chlorinated rubber compounds are known to create problems with priming of the concrete surface. It will be necessary to remove such curing compounds before priming. This can be done using water under high pressure.

11.4.9 Covering Primers

When primer has been sprayed at a heavy rate of application do not immediately cover the primed surface with dust or sand to mop up wet primer in order to shorten the drying time. This is a wasteful practice and generally results in a non uniform, poor standard, primed surface.

Adjust the rates of application so that the primer is dry within the times given as a guide in Section 11.5. If conditions do not allow the normal drying time required, a more suitable process for the conditions would be to primerseal.

In circumstances where only a small portion of the job will be affected by traffic it may be appropriate to lightly cover the prime with sand.

If covering material needs to be applied to mop up excess primer, it should not be spread within the following time limits of spraying the primer:

(a) good weather – 24 hours

(b) cold damp weather – 48 hours.

Only sufficient fine material shall be spread to mop up the excess primer and prevent picking up by the traffic. All loose and excess covering material must be removed before a bituminous surfacing can be applied.
11.5 RATE OF SETUP

11.5.1 Time to Dry

Priming is a matter of experience and no definite rules can be applied regarding the viscosity and rate of application to use.

If the pavement is well covered with primer and a reasonable balance has been achieved between viscosity and rate of application, all the primer should be absorbed and dry within the time limits shown for the weather conditions:

(a) hot weather – 6 to 12 hours
(b) cool weather – 12 to 24 hours
(c) cold or cool and damp weather – 24 to 48 hours.

If a primer dries in less than 6 hours, except in very hot dry weather, then the grade of primer and rates of application should be reviewed, particularly the former if the primer was applied at or near the normal rate of application of 1.0 litre/m². A very poorly compacted and prepared pavement may cause rapid drying.

11.5.2 Time to Cure

All primers must be allowed to dry before any further work is done. Primers can be allowed to harden and polish if constructed under traffic before the bituminous surfacing is applied.

The suggested time limits before applying the bituminous surfacing are:

(a) light to medium primers – minimum one week
(b) heavy primers – minimum two weeks.

11.6 LIFE EXPECTANCY

The life of a primer is influenced by many factors, the major being:

(a) weather conditions
(b) type and conditions of the pavement
(c) nature and volume of traffic
(d) topographic conditions.

For lightly trafficked pavements a correctly applied primer may be expected to have a life without further treatment, other than maintenance, as shown in Table 11.6.

Table 11.6 Life Expectancy of Primed Pavement

<table>
<thead>
<tr>
<th>Grade of Primer</th>
<th>Life Expectancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>2–4 weeks</td>
</tr>
<tr>
<td>Medium</td>
<td>4–6 weeks</td>
</tr>
<tr>
<td>Heavy</td>
<td>6–10 weeks</td>
</tr>
</tbody>
</table>
11.7 UNIFORMITY
The success of a sprayed initial treatment prime and seal on a properly prepared pavement depends on the quality and uniformity of the primed surface.

When priming a road in half widths, conditions may change between the priming of the first and second half widths. This should be taken into account when determining the rates of application for each half width.

Do not allow large overlaps of each spray run onto the previously sprayed primer. This will produce areas with excess primer which will affect the quality of the seal coat.

On lightly trafficked roads of widths of 5.6 m or wider, compaction by the traffic along the outer edges of the pavement is often not as good as on the rest of the pavement. This width may vary from 0.5 m to 0.7 m along each edge. If it is noted that the primer has been absorbed more along the edges, then extra primer should be applied, either by hand or spraying equipment, before the seal coat is applied.

It is more economical to correct a non-uniformly primed surface before sealing by repriming the deficient areas rather than to increase the overall binder rate.

Where the rate of application is a too light on a uniform primed surface, the design of the seal coat may be altered to correct the problem. It can also be corrected by repriming at a light rate of application. The choice will depend on the circumstances.

11.8 MAINTENANCE

11.8.1 After-Care
The main object is to provide a uniformly primed surface. It is most important that the completed primed surface be inspected a few hours after spraying to check on the absorption and rate of drying. In most weather conditions, it should be possible to predict what the quality of the finished primed surface will be after about 4 hours.

Depressions in the pavement holding free primer should be swept out with a bass broom and the free primer allowed to penetrate into the adjoining area.

Areas not completely covered or which have absorbed all the primer should be reprimed by hand such that the final primed surface will be uniform.

Do not cover the primed surface with fine dust or sand to mop up excess primer unless it is essential to do this for the protection of traffic.

11.8.2 Protection
Do not allow traffic onto a primed pavement until the primer is completely dry and strong enough to carry traffic. This provides protection for both the travelling public and the work.

The primed section should be closed to traffic during the drying period.
Figure 11.7.2A  Non uniformly primed surface caused by uneven absorption into the pavement. Deficient areas need to be reprimed before sealing

Figure 11.7.2B  Non uniformly primed surface. Caused by insufficient mixing of primer. (courtesy AAPA)

Figure 11.7.2C  Stripped seal caused by non uniformly primed surface. (Cutback bitumen primer on a sandstone pavement)
Appropriate signs as described in Chapter 21 should be used. Where the traffic has to travel close to the edge of a primed surface, the edge of the primed surface should be marked by signs and traffic cones.

It may be necessary at certain locations to lightly and uniformly grit or sand the primed surface to provide limited access, e.g. crossings. Avoid using dust as it forms a skin, will not sweep off and it hinders adhesion of the seal coat.

11.8.3 Patching

Where areas of the pavement have failed these should be removed and repaired as outlined in Chapter 10, Preparation of Surfaces. Repaired areas should be primed so that the final primed surface is uniform.

Where the surface only is affected, it may be touched up with primer, preferably the same type and grade as used for the job.

Do not repair areas in a primed surface by normal patching techniques using binder and aggregate as a non-uniform surface will result.

11.8.4 Hand priming

Small areas may be primed by hand using dobbling brushes, squeegees or brooms. On larger areas it may be more convenient to use a hand lance with a patrol heater or bitumen sprayer.

When hand priming, care should be taken to uniformly distribute the priming material over the pavement so that the final primed surface is uniform.

11.9 TIGHTLY BONDED SURFACES

11.9.1 General

This group includes pavements which are hard and dense when compacted and when dry are resonant if struck with a heavy implement, e.g. they ring when struck with a pick handle. Included are dense graded crushed rocks, gravels with fine soil binders, granitic sand and other materials which, when properly compacted, present a dense tight surface of low porosity.

11.9.2 Type and Grade of Primer

(a) Type – both cutback bitumen and emulsion primers are suitable

(b) Grade – generally a light primer in the viscosity range:

- cutback bitumen: 0.008 to 0.05 Pa.s at 60°C (see Table 11.17)
- emulsion: refer to the manufacturer’s product information.

11.9.3 Rate of Application

In the range 0.6 to 1.1 litres/m² depending on the degree of compaction and moisture content.

11.10 SURFACES OF MEDIUM POROSITY

11.10.1 General

This group includes pavements which, when compacted and dry, do not ring when struck with a heavy implement but sound somewhat drummy and dead. The pavement materials have a silty soil binder of low strength and
medium porosity. Although these materials can have a fine surface texture they do not compact to a tight and resilient surface.

This group does not include gravels with a high quantity of fine, silty soil binders which require special treatment.

11.10.2 Type and Grade of Primer
(a) Type – cutback bitumen and emulsion primers are suitable
(b) Grade – generally a medium primer in the viscosity range:
   cutback bitumen: 0.025 to 0.05 Pa.s at 60°C (see Table 11.17)
   emulsion: refer to the manufacturer’s product information.

11.10.3 Rate of Application
In the range of 0.8 to 1.1 litres/m² depending on the degree of compaction and moisture content.

11.11 POROUS SURFACES (not including Limestone and Sandstone)
11.11.1 General
This group includes pavements constructed of materials which are deficient in binding material. They may be difficult to compact and present a coarse, weak, open texture of high porosity.

The primer in this case has to seal the large surface pores and strengthen the surface of the pavement.

11.11.2 Type and Grade of Primer
(a) Type – emulsion and cutback bitumen primers are suitable
(b) Grade – generally a heavy to very heavy primer in the viscosity range:
   cutback bitumen: 0.06 to 0.12 Pa.s at 60°C (see Table 11.17)
   emulsion: refer to the manufacturer’s product information.

11.11.3 Rate of Application
In the range 0.9 to 1.3 litres/m² depending on the degree of compaction and moisture content.

11.12 LIMESTONE
11.12.1 General
The usual limestone pavements are very porous and absorb a considerable amount of primer. To fill the surface pores and strengthen the pavement surface a heavy primer at a heavier than normal rate of application is required, usually applied in two applications.

11.12.2 Type and Grade of Primer
(a) Type
   A heavy grade of cutback bitumen primer is the most suitable. Portions of the bitumen in the seal coat may also be absorbed into the pavement even where the surface appears to be well primed. See also Section 14.4.4.3.
(b) Grade

- Preferably a heavy to very heavy primer in the viscosity range 0.10 to 0.30 Pa.s at 60°C
- a medium grade primer for the first application, followed by an application of a heavy cutback bitumen in the viscosity range 0.10 to 0.30 Pa.s at 60°C
- the specially developed proprietary primers.

11.12.3 Rates of Application

The primer should be applied in two applications when it is necessary to:

- get the heavy primer into the pavement at a higher than normal rate of application without loss
- reduce the total amount of absorption, to keep the rate of set up to reasonable limits
- obtain the best prime.

The total rate of application should be about 1.4 to 1.5 litres/m² applied in two fairly even applications, e.g.

1st application: 0.7 to 0.8 litre/m²
2nd application: 0.5 to 0.7 litre/m²

The first application should penetrate and fill the pavement surface pores. The second rate of application should only be determined after the first application has set up and the primed pavement inspected. The second application is intended to provide the coating of primer on the surface.

11.13 SANDSTONE

11.13.1 General

Sandstones vary in quality but most are porous and will absorb a considerable amount of primer. To fill the surface pores and strengthen the pavement surface it is necessary to apply the primer at heavier than normal rates of application. For best results primer should be sprayed in two separate applications.

If the pavement is very dry and dusty it may be necessary to lightly water the surface shortly before spraying the primer. This will assist the penetration of the primer into the pavement and aid in obtaining a uniform cover.

11.13.2 Type and Grade of Primer

(a) Type

Emulsion and cutback bitumen primers are suitable.

(b) Grade

Depending on the nature and condition of the sandstone the first application of primer may be a light to medium or medium to heavy grade to obtain the desired penetration of about 5 mm to 10 mm. The second application would normally be a medium to heavy grade to seal off the surface pores and to provide a uniform coat of primer.
The grades of cutback bitumen primer used are:

1st Application
A light to medium grade cutback primer in the viscosity range 0.02 to 0.05 Pa.s at 60°C
or
A heavy to medium cutback grade primer in the viscosity range 0.05 to 0.25 Pa.s at 60°C.

2nd Application
A medium to heavy grade cutback primer in the viscosity range 0.05 to 0.25 Pa.s at 60°C.

11.13.3 Rates of Application
As with priming limestone, a more satisfactory primed surface is obtained if the primer is applied in two applications.

The total rate of application should be about 1.4 to 1.5 litres/m² applied in two fairly even applications, e.g.
1st application: 0.7 to 0.9 litre/m², 2nd application: 0.5 to 0.7 litre/m².

11.14 VOLCANIC TUFF

11.14.1 General
Volcanic tuff pavements have binding material of low strength, are of medium porosity and appear similar to pavements with surfaces of medium porosity (see Section 11.10).

Volcanic tuff pavements must be kept damp until priming commences to prevent ravelling of the surface. This means a lighter primer than normal for this type of pavement is used and the primer may also tend to sit on the surface with a subsequent increase in the time required to set up and harden.

11.14.2 Type and Grade of Primer
(a) Type
Emulsion and cutback bitumen primers are suitable.

(b) Grade
Very light to light grade of primer in the viscosity range:
cutback bitumen: 0.01 to 0.05 Pa.s at 60°C (see Table 11.17).

11.14.3 Rate of Application
In the range 0.8 to 1.1 litres/m² depending on the degree of compaction and moisture content.
11.15 STABILISED PAVEMENTS

11.15.1 General

Generally, when a pavement material is upgraded by stabilising, a better compacted pavement with a tighter surface results. Because of this, it can be assumed that a stabilised pavement requires a lighter grade and/or rate of application of primer than if the material was not stabilised. This applies more to materials stabilised with lime, cement, bitumen etc. than those upgraded by mixing in other types of pavement materials.

11.15.2 Type and Grade of Primer

(a) Type

Depends upon the unstabilised pavement material and the stabilising material used. Cutback bitumen primers can be assumed to be suitable for all materials but some caution should be exercised when using emulsion primers. Difficulties have been experienced with the use of emulsion primers (and emulsion primerseals) on cement stabilised pavements.

(b) Grade

Generally light to medium grades. Heavy grades of primer would only be used where porous limestones and sandstones are upgraded with sands or crushed rocks.

The normal grades used are those in the viscosity range:

\[
\text{cutback bitumen: } 0.01 \text{ to } 0.05 \text{ Pa.s at } 60^\circ C \text{ (see Table 11.17).}
\]

11.15.3 Rate of Application

Generally within the range 0.5 to 1.0 litre/m² depending on the type of stabilisation, the compaction and moisture content of the pavement.

Unless experienced in priming this type of pavement, the suggested approach is to try a small area, say a few square metres, to determine a suitable rate of application for the job.

11.16 SPECIAL CONDITIONS

11.16.1 General

Pavement materials and conditions which require special attention and treatment are described in the following section.

11.16.2 Pavement Material Containing Salt

Many pavement materials containing salt or built across salt pans, may blister or flake if primed and treated in the normal manner. The higher the salt content the more probable it is that the primer will be affected. The salt may be inherent in the pavement material or could be present in the water used for preparation, which is often the case when using bore water.

If a light primer is applied and has dried, it may be affected by the erupting of many thousands of small areas, leaving the pavement fines puffed up and loose on the surface. Generally, the primed surface also changes colour from black to brown.
When a pavement containing sufficient moisture is primed, the surface pores are filled with primer. As the black surface is warmed by the sun, a rapid rise in water vapour pressure takes place just under the surface. This pushes out the weakly bound fines. The salty water is drawn to the surface and the salt is deposited under the surface of the prime or seal. The salt crystals then absorb further water which causes damage to the prime.

Heavier grades of primer are more successful than light grades and should be applied at higher than normal rates of application.

The seal coat should be applied as soon as the primer has dried to add mass to resist the pressure.

When applying the sprayed seal it is considered preferable to use size 10 or larger aggregate with a heavy rate of application of binder. Consideration should be given to applying a second sprayed surfacing and minimising the use of cutting materials which may assist in drawing the salt to the surface.

**Figure 11.16  Failure of a Primer Due to Salt in the Pavement**

**11.16.3 Granitic Gravel**

Some materials, notably granitic gravel, which contain large quantities of clay, may react in a similar manner to pavements with salt. If primed in the normal manner, the surfaces will puff up and disintegrate into brown dust soon after priming with a light primer.

These materials can be primed and treated successfully using the suggested method for dealing with salt problems.

These materials are often of doubtful quality as a pavement material and are often unsuitable for sealing.
11.16.4 Hill Gravels

Hill gravels may contain as much as 35% to 40% of fine material passing a 0.075 mm AS sieve. They present a loose surface made up of very fine material loosely holding larger, rounded, pieces in place. Pavements constructed of hill gravel can only be very lightly swept, if at all, due to the weak bond. They are usually dusty and need to be watered immediately before priming.
The water will help the primer to spread and be absorbed into the surface.

(a) Type and grade of primer
   Type – emulsion and cutback bitumen primers are suitable
   Grade – very light to light primers in the viscosity range:
   cutback bitumen: 0.01–0.05 Pa.s at 60°C
   bitumen emulsion: refer to the manufacturer’s data sheets.

(b) Rate of application in the range 0.8 to 1.1 litres/m² depending on the compaction and moisture content of the pavement.

11.16.5 Bridge Decks
(a) General
   Where bridges are within a length of road to be primed, the bridge decks, unless covered with an existing bituminous surface, should be treated similarly to the road pavement.

(b) Timber decks
   Should be primed full width with the same primer as used on the road pavement. Normal rate of application would be between 0.5 to 0.8 litre/m².

(c) Concrete decks
   (i) General
      Concrete bridge decks should be primed the same width as the bituminous treatment to be applied.

   (ii) Type and grade of primer
      Both emulsion and cutback bitumen are suitable but because concrete is non absorbent and always has a coating of dust on it, only light grades of primer should be used in order to obtain a uniform cover of primer.
      The normal grades used are:
      cutback bitumen: 0.008 to 0.016 Pa.s at 60°C
      bitumen emulsion: refer to the manufacturer’s data sheets.
      The cutback bitumens available in the above grade may be diluted with up to 20% of cutter to further reduce viscosity.

   (iii) Rates of application
      Cutback bitumen and emulsion – in the range of 0.20 to 0.40 litre/m² with an aim of about 0.25 to 0.30 litre/m².
      Emulsions – in the range of 0.15 to 0.25 litre/m² with an aim of about 0.20 litre/m².
11.16.6 Primer not Setting Up

If a primer is sprayed in dry but cool to cold weather it may appear to become more fluid instead of setting up as normally would be expected.

If the primer is applied to a damp pavement, but one in which the surface pores are free of water for a depth of 10 mm to 15 mm, a light primer will, with sufficient time, penetrate into the surface and set up. If the nights are dry but cold and the days dry but with an air temperature not exceeding about 15°C, the primer instead of setting up during the day will get more fluid. This is due to slight softening of the primer by the day temperature which is not warm enough to set up the primer, and the moisture in the pavement near the surface rising up to the primer. The action of traffic on the primed surface will cause the primer and water to emulsify.

This may be dealt with by lightly and evenly covering the primed surface with a size 5 or smaller grit and rolling with a pneumatic-tyred roller until the binder, water and grit mixture sets up.

11.16.7 Damaged Primed Surface

Should a primed surface be damaged by rain or traffic before it has time to set up, the surface must be reprimed to obtain a uniformly primed surface before the seal coat is applied.

Repriming should not be done until the damaged prime has dried. Unless rain has washed off nearly all of the original primer, repriming should be done using a similar grade of primer at a light rate of application in the range 0.3 to 0.5 litre/m².

It is usually necessary to vary the width sprayed and rate of application along the job in relation to the quantity of primer required to repair the damage.

11.16.8 Dust Laying

Dust laying can be used as a maintenance treatment on an unsurfaced pavement to avoid excessive maintenance, dust nuisance or to prevent loss of pavement material. It may also be used as a temporary treatment on a newly constructed or reconstructed pavement which cannot be prepared for the application of a bituminous surfacing, e.g. lack of finance.

Bitumen emulsion dust laying treatments are described in Chapter 18. Reference may also be made to ARRB Transport Research Special Report 54, Road Dust Control Techniques.

11.17 GUIDE TO TYPE AND GRADE OF PRIMER TO USE

Table 11.17 provides a guide to the type and grade of priming materials and the rates of application to be used on the various types of pavement materials.
Table 11.17  Guide to Type Grade and Rates of Application of Primer to Use with the Most Common Types of Pavement Material

<table>
<thead>
<tr>
<th>Pavement</th>
<th>PRIMER</th>
<th>Viscosity Range</th>
<th>Grade</th>
<th>Rate of Application litre/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tightly Bonded (light primer)</td>
<td>Cutback Bitumen</td>
<td>0.008 to 0.016 Pa.s at 60°C</td>
<td>AMC 00</td>
<td>0.6 to 1.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.025 to 0.050 Pa.s at 60°C</td>
<td>AMC 0</td>
<td></td>
</tr>
<tr>
<td>Medium Porosity (medium primer)</td>
<td>Cutback Bitumen</td>
<td>0.025 to 0.05 Pa.s at 60°C</td>
<td>AMC 0</td>
<td>0.8 to 1.1</td>
</tr>
<tr>
<td>Porous (heavy to very heavy primer)</td>
<td>Cutback Bitumen</td>
<td>0.06 to 0.12 Pa.s at 60°C</td>
<td>AMC 1</td>
<td>0.9 to 1.5</td>
</tr>
<tr>
<td>Limestone (heavy to very heavy primer)</td>
<td>Cutback Bitumen</td>
<td>0.06 to 0.12 Pa.s at 60°C</td>
<td>AMC 1</td>
<td>2 applications: 1.4 to 1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1st at 0.7 to 0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2nd at 0.5 to 0.7</td>
</tr>
<tr>
<td>Sandstone (medium to heavy primer)</td>
<td>Cutback Bitumen</td>
<td>0.025 to 0.05 Pa.s at 60°C</td>
<td>AMC 0</td>
<td>1st at 0.7 to 0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.06 to 0.12 Pa.s at 60°C</td>
<td>AMC 1</td>
<td>2nd at 0.5 to 0.7</td>
</tr>
<tr>
<td>Volcanic Tuff (light primer)</td>
<td>As for tightly bonded</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stabilized (light primer)</td>
<td>Cutback Bitumen</td>
<td>As for tightly bonded but must be used</td>
<td></td>
<td>0.5 to 1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>with caution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hill Gravel (light primer)</td>
<td>As for tightly bonded</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete (very light primer)</td>
<td>Cutback Bitumen</td>
<td>0.008 to 0.016 Pa.s at 60°C</td>
<td>AMC 00</td>
<td>0.2 to 0.4</td>
</tr>
</tbody>
</table>

Note:  
(1) Proprietary grades of primer with viscosity ranges similar to those mentioned above give similar performance.  
(2) There is insufficient experience with emulsion primers to give general advice.
12.1 GENERAL

12.1.1 Description

Primersealing is the application of a suitable primerbinder to a prepared pavement which is then covered with aggregate as a temporary treatment prior to applying the final bituminous surfacing. The primerseal may have a life expectancy of between six months (including a full summer) and two years.

12.1.2 Function

Primersealing is designed to seal a pavement immediately after construction and surface preparation, and to hold the pavement in good condition until the final initial treatment bituminous surfacing can be applied. The binder used for a primerseal is more viscous than a primer and less viscous than a normal binder and is required to act as both a primer and a binder.

Both cutback bitumen and bitumen emulsions can be used for primersealing provided they are of the correct formulation.

12.1.3 Applications

Primerseals may be used at any time of the year but have greater application during the winter months when weather conditions generally are not suitable for normal priming and sealing methods.

Primersealing may be used for the following reasons:

(a) When it is necessary to permit traffic to use the pavement before a normal primer could dry and cure.

(b) To provide a temporary sealed pavement for the traffic on roads under construction during a very busy period, e.g. Christmas or Easter.

(c) To hold sections of pavement on large construction jobs to fit in with the bituminous surfacing programme.

(d) When sealing aggregate meeting the appropriate specification is not available.

(e) When it is desirable to allow a period of time between completing the construction and preparation, and applying the final initial treatment bituminous surfacing, e.g. to rectify expected/anticipated pavement weaknesses and faults.

(f) To enable final sealing to be done in more favourable conditions.

(g) To reduce maintenance costs on pavements where construction has been deferred during the winter months.

(h) Where a very porous pavement requires excessively high rates of application of a heavy grade of primer, or for treating limestone and some very porous sandstones.
12.1.4 Types of Primerseals

(a) Single application

The basic type of primerseal is single application (i.e. a single application of primerbinder followed by a single application of cover aggregate).

In single application primersealing, one application of primerbinder serves the purpose of both primer and binder and is covered with one size of aggregate. This is the most common type of primerseal used in Victoria.

Penetration into the pavement will vary according to the pavement type and condition and is generally not more than 5 mm.

(b) Multiple application

Multiple application primersealing may be done by two methods:

(i) The first application is in the nature of a primer and not covered with aggregate. It is allowed to soak into the pavement and set up before the next application is applied.

This method is useful where the pavement appears non uniform and it is suspected there will be large differential absorption resulting in a non uniform primerseal.

The priming will enable a uniform surface to be obtained. The following application is thus applied to a more uniform surface resulting in a uniformly textured primerseal.

The disadvantage is that the primer must set up and dry and this is difficult in winter. It may be useful in summer, particularly if the pavements are dry and absorbent and difficult to keep damp.

(ii) Multiple applications of primerbinder and aggregate, generally a maximum of two. Useful to extend the life of an existing primerbinder or to provide a more substantial primerseal in areas with high loading, e.g. busy intersections. Often the second application uses an emulsion binder to minimise the amount of cutter, thus minimising future problems in hot weather.

Usually the first application primerseal would be done with size 10 aggregate followed by a primerseal with fine aggregate. The second application should not be applied sooner than one week and could be delayed for three weeks after the first application.

An alternative double application primerseal may involve the use of a small size emulsion primerseal followed, after suitable rolling or trafficking, by a cutback bitumen seal of a larger size to provide a robust multi-layer surfacing.
12.1.5 Traffic
Prime-sealing causes less inconvenience to the travelling public than single application priming. It is recommended that, on roads with traffic volumes of 200 vehicles per lane per day or more, prime-sealing be adopted as standard practice for initial treatment work.

12.1.6 Minimum Temperature for Prime-sealing
Prime-binder should not be sprayed when the pavement temperature is below 5°C. When prime-sealing at temperatures between 5 and 15°C the prime-binder should only be sprayed in short sections and covered with aggregate within 10 minutes.

12.2 PAVEMENT PREPARATION

12.2.1 General
For prime-sealing, the pavement should be prepared as set out in the relevant sections of Chapter 10, Preparation of Surfaces. Proper preparation of the pavement surface is essential to achieve a first class bituminous surfacing. A sprayed treatment will not improve the shape and riding qualities of a pavement or correct surface defects.

12.2.2 Condition
A prime-seal should only be applied to a sound clean pavement. It should be well consolidated, true to line and level, free from dust pockets and laminated layers of pavement material and foreign matter.

Because a prime-binder is more viscous than a primer, it will not penetrate the surface freely and is unable to deal with dust. It is therefore necessary to have the prepared pavement surface damp and free from dust to avoid failure by ‘balling’ of the binder and subsequent excessive maintenance.

A prime-seal may be applied to a very damp pavement with good results provided there is no free surface water, e.g. in the wintertime. A prime-seal should not be placed on an unstable pavement because this may trap the water in the pavement and lead to premature pavement distress. It is recommended that the pavement be allowed to dry back to at least 0.5% below Optimum Moisture Content (OMC) to avoid excessive embedment of the aggregate which may lead to pick-up problems in hot weather.

12.2.3 Cleaning
The pavement surface should be cleaned to remove all mulch, carried on material, dirt and dust.

Where the mulch is heavy it should be removed first by light grading. Any scale, hardened mud or foreign material sticking to the surface should be loosened by hand chipping.

The cleaning should continue until any material which may prevent the uniform penetration of the primer has been removed.

A properly cleaned pavement is one which is free from foreign material and the larger sized stones at the pavement surface are exposed and clean but not loose or dislodged (except with a loosely bonded pavement material).
12.2.4 Sweeping

After cleaning has been completed the pavement should be swept with a rotary road broom supplemented by hand brooms where required. The force applied to the broom is dependent on the type and hardness of the pavement material. The force applied should be just enough to only flick off loose material, without damaging the pavement surface. Some loosely bonded gravels cannot be swept at all.

If the pavement surface is damp it is often also soft and even light brooming will mark the surface. In that case the surface should be allowed to close up under traffic, or by rolling, for a short period after sweeping.

When the pavement is damp there should be little or no dust during sweeping. If the pavement is dry and produces dust it should be lightly watered before sweeping.

Every surface should be examined for foreign material both before and after sweeping.

12.2.5 Width to be Swept

The pavement should be swept to at least 0.3 m outside the edges of the width to be primersealed.

12.2.6 Distribution of the Swept-off Material

If the quantity of material warrants it then the windrows should be graded over the shoulders and rolled before the primerseal is applied. With the pavement kept damp there should be less material swept off than is the case when sweeping for priming when the pavement surface is dry. There is also no dust nuisance when sweeping a damp pavement.

12.2.7 Marking Out

The centreline of the pavement should be established from the construction or survey pegs. This should be done by the construction Works Manager, and the centreline or edge of pavement marked at about 10 m intervals.

If the pavement alignment is not in agreement with the pegs available then the bituminous surfacing must follow the pavement as constructed.

For marking out use either priming material or water based paint of a contrasting colour to the pavement. From these marks the BS Works Manager can establish guide marks for the sprayer.

12.3 WIDTH TO BE PRIMERSEALED

12.3.1 General

Where possible pavements should be primersealed full width in one application.

This may not be possible on multi-lane and/or divided carriageways where the width to be primersealed is larger than the maximum width of 7.5 m to 8 m that can be applied by the sprayer in one application, or where varying rates of application of primerbinder are to be applied on the traffic lanes and/or shoulders.
12.3.2 Full Width
Where a pavement can be primersealed full width in one application the primersealed width should extend, where possible, about 100 mm outside the edges of the proposed final bituminous surfacing width to reduce edge maintenance and provide unbroken edges for the final initial treatment.

12.3.3 Other than Full Width
Where a pavement cannot be primersealed full width in one application then the edge of each width of primerbinder sprayed should overlap the uncovered edge of the previous run of primerbinder by about 50 mm using standard end jets in the spray bar. If other than standard end jets are used, the overlap needs to be increased in order to achieve a uniform full width application of primerbinder. These overlaps and joins should be outside the normal wheelpaths of the traffic.

Where possible, the total width primersealed should extend about 100 mm outside the edges of the proposed final initial treatment.

12.4 PRIMERBINDERS USED
12.4.1 Materials
See Chapter 3 for the types and grades of primerbinder materials normally used in Victoria.

12.4.2 Selection of Type
Both the emulsion and cutback bitumen primerbinders produced are suitable for use with the various pavement materials generally used in road construction in Victoria.

In special circumstances, where it is necessary for the final seal or asphalt course to be applied before a cutback bitumen primerbinder has cured sufficiently, a bitumen emulsion primerbinder should be used to avoid problems due to cutter oil softening the binder in the final treatment. GeoPave can be consulted to assist in determining a suitable treatment.

12.4.3 Selection of Grade
For similar conditions of service the selection of the type/grade of primerbinder is primarily based on the weather conditions at the time of spraying and expected during the first three or four months of the life of the primerseal.

The type and condition of the pavement and material to be primersealed may influence the grade of primerbinder particularly where very porous absorbent pavement materials are involved, e.g. sandstone, limestone.

For practical purposes the grades of the commonly used cutback bitumen and bitumen emulsion primerbinders and the period recommended for use are given in Table 12.4.
Table 12.4  Guide to Selection of Type/Grade of Primerbinder

<table>
<thead>
<tr>
<th>Classification</th>
<th>Viscosity Range Pa.s at 60°C</th>
<th>Time of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light – Medium</td>
<td>1.5 to 3</td>
<td>May to November</td>
</tr>
<tr>
<td>Heavy</td>
<td>4.0 to 7.0</td>
<td>December to April</td>
</tr>
<tr>
<td>Bitumen Emulsion</td>
<td>CRS (60%)</td>
<td>All year but more suited to cool/damp conditions</td>
</tr>
</tbody>
</table>

12.4.4 Handling

(a) Cutback bitumen primerbinder

When handling cutback bitumen primerbinders the following precautions should be observed:

(i) Wherever possible avoid loading into a cold sprayer tank as this will cause the temperature of the primerbinder to drop below the correct spraying temperature. If the sprayer tank is cold, it should be preheated by putting on a hot load of primerbinder or bitumen, circulating it and returning it to storage.

(ii) Cutback bitumen primerbinders must not be heated until required for use. Continual heating or storing at high temperatures will rapidly increase the viscosity and destroy the adhesion qualities. If it is necessary to reheat primerbinders, then the value of the existing adhesion agent must be disregarded and more adhesion agent must be added at the rate of ½ part of adhesion agent to 100 parts of primerbinder by volume measured at 15°C. This should be done in the sprayer for each load sprayed.

(b) Bitumen Emulsion

Standard (60%) bitumen emulsion primerbinders are generally handled at ambient temperatures. Higher binder content emulsions may require heating to generally no more than 60°C. Under no circumstances should emulsions be heated to more than 85°C.

12.5 AGGREGATES USED

12.5.1 Types

The aggregates normally used in sealing work are suitable for use in primersealing (also see Section 2.1.3 for types of aggregates commonly used in Victoria).

12.5.2 Quality

The aggregates used in primersealing should be of similar quality to that required for sealing under the same conditions of service. The wearing quality may be lower because of the shorter life span of primerseals on low traffic roads.
When primersealing on very heavily trafficked roads the quality of the aggregate used in the primerseal should not be lower because of the potential problem with the aggregate being crushed by the strong aggregate in the final seal, resulting in stripping.

12.5.3 Size

A variety of aggregate sizes may be used, varying from sand to size 10. The preferred aggregate gradings are one sized as specified in section 2.4 but graded aggregates may also be used.

The selection of the size of aggregate is primarily based on the traffic volume. The recommended traffic ranges for which the various sizes of aggregate are most suitable are:

- Sand to size 7: < 1200 vehicles/lane/day
- Size 10: > 1200 vehicles/lane/day.

On jobs where traffic is >600 vehicles/lane/day, it is advisable to use size 10 aggregate during very wet or very hot weather to avoid emulsification or pick-up.

Size 10 may be used on lower traffic volumes but this could result in a variable or very ‘hungry’ surface texture. If the final treatment is a sprayed seal this would increase costs and make it difficult to obtain a satisfactory, even textured final seal coat.

It is safer to limit the aggregate to a maximum of size 7 where there are problems in determining a suitable rate of application of primerbinder due to:

- the pavement surface is relatively soft and embedment is likely to result in a reduction in the rate of application of primerbinder exceeding 0.2 litre/m²
- uneven surface texture
- differential compaction and absorption.

12.5.4 Treatment of Aggregate

Cutback bitumen primerbinders normally contain sufficient cutter oil and adhesion agents to aid the wetting and adhesion between the primerbinder and the covering aggregate. Where the aggregate is clean, dry or damp, no aggregate precoating treatment is required.

If the aggregate is dry and dusty the adhesion properties of the primerbinder may not be sufficient to overcome the dust. The aggregate should be cleaned by washing with water, or by precoating it lightly with Diesel Fuel Oil or Distillate to eliminate the dust.

If the primerbinder is bitumen emulsion, no aggregate treatment is necessary where the aggregate is very clean and damp. If the aggregate is dry, or damp but not clean, then the aggregate should be lightly precoated.

Aggregates precoated at the quarry with an emulsion or cutback bitumen or similar product should not require further treatment.
### 12.6 RATES OF APPLICATION

#### 12.6.1 Primerbinder

Primerbinder is applied at a heavier rate of application than that used for a normal binder with the same aggregate size. The rates of application are mainly based on traffic volume and the recommended base rates of application for primerbinder are as given in Table 12.6.1.

**Table 12.6.1 Recommended Base Rates of Application of Primerbinder (litres per square metre)**

<table>
<thead>
<tr>
<th>Aggregate Size</th>
<th>Traffic – vehicles per lane per day</th>
<th>Cutback bitumen*</th>
<th>Bitumen Emulsion*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 150</td>
<td>150 to 1200</td>
<td>&gt; 1200</td>
</tr>
<tr>
<td>Sand, Size 5, Size 7</td>
<td>1.3</td>
<td>1.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Size 10</td>
<td>1.4</td>
<td>1.3</td>
<td>1.2</td>
</tr>
</tbody>
</table>

*The rates of application are based on the volume of the mixture measured at 15°C. This means that with cutback bitumen application rates include the cutter and flux oils, and with bitumen emulsion application rates include the water.*

**CRS 67% is a generally available emulsion.**

These base rates of application do not include any allowance for a ‘hungry’ surface and/or absorption into the pavement or aggregate.

An additional 0.10 to 0.30 litre/m² may need to be sprayed depending upon whether the surface texture and/or absorption allowance is required.

For highly absorptive pavement materials an excessive increase in the rate of application of a light to medium grade of cutback primerbinder may be avoided by using a primerbinder with a higher viscosity or by using bitumen emulsion.

A good primerseal with the correct rate of application for the conditions will initially appear to be filled more than a normal seal coat. It will show that primerbinder is further up the aggregate than a normal seal.

#### 12.6.2 Aggregate

The heavier rates of application of binder make it necessary to spread the aggregate at heavier than normal spreading rates, particularly with the smaller aggregates. This is to avoid pick up of the primerbinder and to ensure that the maximum amount of aggregate is embedded and held by the primerbinder.

As a guide, the rates of application of aggregate are based on the rates for the aggregates as used in sealing work plus an allowance of between 5% and 10%. Table 12.6.2 gives a guide to the rates of application for the various sizes of aggregates used.
Table 12.6.2 Recommended Rates of Application of Aggregate for Primersealing

<table>
<thead>
<tr>
<th>Aggregate Size</th>
<th>Rate of Application m²/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand Size 5</td>
<td>130 to 150</td>
</tr>
<tr>
<td>Sand Size 7</td>
<td>110 to 130</td>
</tr>
</tbody>
</table>

12.7 PRACTICE

12.7.1 Weather

The grade of cutback primerbinder should be selected having regard to the weather conditions, see Table 12.4.

In hot weather the primerbinder may take considerable time to set-up. If possible, avoid primersealing when the temperature is 30°C or higher. If a primerbinder does not set-up on a hot day, it is possible to cool the primerseal by watering lightly, taking care not to over-water as this will emulsify the primerbinder.

The type and grade of bitumen emulsion primerbinder should be determined after trialing the compatibility of the emulsion with the pavement materials and the manufacturer’s recommendations. In very hot conditions, above 35 to 40°C, the emulsion may ‘skin’ and may not wet the aggregate nor set-up until the temperature falls.

12.7.2 Aggregate Spreading

The primerbinder should be covered with aggregate as quickly as possible, particularly when primersealing in cool or cold weather.

Immediately after spreading and initial compaction, the aggregate shall be broom dragged to provide a uniform cover.

When using bitumen emulsion as the primerbinder with a size 10 mm aggregate, a ‘rack-in’ coat of a small aggregate may be required to provide mechanical stability while the primerbinder cures and develops strength.

12.7.3 Rolling

At least two self-propelled, pneumatic-tyred, multi-wheeled rollers should be used, with one roller following closely behind the spreaders. If primersealing more than 25,000 m²/day, additional rollers may be required, particularly in cooler conditions.

With the racking-in technique the first layer of aggregate should be rolled for at least half an hour before spreading the rack in coat and rolling it.

12.7.4 Traffic Control

Traffic control is most important during the first 4 to 6 hours of the life of primerseal, particularly on heavily trafficked roads in adverse conditions. In cold and/or wet weather it takes more time for the primerbinder to wet and adhere to the aggregate. In very hot weather it takes more time for cutback primer-binder to set-up sufficiently to retain the aggregate. Traffic control is most important with bitumen emulsion which takes longer to fully cure and set-up.
12.8 MAINTENANCE

12.8.1 After-Care

After-care is most important to achieve a satisfactory primerseal. Primersealing should be avoided on Fridays or the day before public holidays, if practical.

Primerseals should be kept under observation for at least one week after completion. If the primerseal was laid in cold weather the lighter oils may not have evaporated and the primerseal should be inspected during the first few hot days as it could bleed and might require gritting to prevent pick-up and damage.

If it rains within 48 hours after completion, the fresh primerbinder may emulsify and rise above the top of the aggregate. (In some cases this may also occur up to one week after primersealing.) If this happens the primerseal will have to be closed to traffic, or if this is not practical, covered with a small aggregate for as long as is necessary to keep the tyres from picking up the primerseal. Do not use fine sand as this will fill the voids and may cause instability and pick-up in the next period of warm to hot weather.

12.8.2 General

With all primerseals, the depth of penetration and the thickness of the mat provided is only small. To avoid damage to the pavement, continuous regular inspection and maintenance is required.

The maintenance shall not be allowed to go beyond the stage of small holes. These can be repaired by hand dabbing with primer followed by an application of a light maintenance cutback bitumen binder and fine aggregate.

Larger patches caused by pavement failures should be dug out, replaced and primed and sealed or primersealed using the same aggregate as used in the original primerseal. Some thought must be given to the binder materials used bearing in mind the life-span of the primerseal and the type of final treatment to be applied.

12.9 LIFE EXPECTANCY

The life of a primerbinder depends on many factors, the main ones being:

(a) type and grade of primerbinder
(b) type of pavement material
(c) general climatic conditions
(d) nature and volume of traffic
(e) rate of application
(f) type and size of aggregate
(g) topographic conditions.
With a suitable primerbinder for the conditions, the average life that can be expected of a primerseal without further treatment, other than maintenance, is as shown in Table 12.9.

**Table 12.9  Life Expectancy of a Primerbinder**

<table>
<thead>
<tr>
<th>Type of Primerbinder</th>
<th>Grade</th>
<th>Life Expectancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen Emulsion</td>
<td>All</td>
<td>12 to 36 months</td>
</tr>
<tr>
<td>Cutback Bitumen</td>
<td>Medium</td>
<td>3 to 18 months</td>
</tr>
<tr>
<td></td>
<td>Heavy</td>
<td>12 to 36 months</td>
</tr>
</tbody>
</table>

Primerseals should be inspected regularly to determine when retreatment is required. A primerseal needs retreatment when the primerbinder is nearly or fully oxidised. This can be determined by using a screwdriver to pry out pieces of aggregate and examining the primerbinder. It is fully oxidised when the binder appears dull and brittle.

Another indication that the primerbinder may be near the end of its life is when the primerseal develops small holes and fine cracks. A primerseal in this condition should present no problem when applying another primerseal or the final treatment, e.g. seal coat or asphalt overlay.

**12.10 SPECIAL CONDITIONS**

A primerseal should not be covered by a final seal while the cutback primerbinder is still fresh and lively as this will lock in the lighter oils and cause fatty or bleeding wheel tracks, particularly with seal coats. As an approximate guide, the minimum time between primersealing and final sealing should be 3 months if primersealing is done at the beginning of the summer and 6 months if primersealing is done during winter.

When it is necessary for the final seal or asphalt course to be applied before a cutback bitumen primerbinder would have cured sufficiently, a bitumen emulsion primerbinder should be used.

Primerseals that have been constructed but not trafficked for a period of time, perhaps 3 months, may strip when subject to traffic, especially in cold weather. Where a primerseal (or a seal) has been applied to a road which is not open to traffic at the time, e.g. freeway construction, ensure that the opening to traffic does not happen during a cold, wet period as stripping of the primerseal is likely to occur.

This stripping may be due to:

- the aggregate not being fully embedded into the binder at the time of initial rolling
- the binder losing some of the cutting oils and thus not wetting the aggregate to create adhesion between the aggregate and the binder
- dust creating a skin on the binder preventing further wetting and embedment of the aggregate.
13.1 GENERAL

13.1.1 Description
Sprayed sealing is a method of applying a bituminous surfacing where a binder is sprayed onto a prepared pavement surface (e.g. a prime or an existing sprayed seal surface) and covered with aggregate.

A sprayed seal may be used on both initial treatment and retreatment work on all types of roads.

13.1.2 Functions
The main functions of a seal coat are:
(a) to protect the pavement and subgrade from damage by the weather, mainly from water
(b) to provide a low maintenance wearing surface
(c) to provide an economical, durable, skid resistant and non-glare surface on which it is safe and comfortable to travel in the normally expected weather conditions.

13.1.3 Application
A seal coat may be applied to:
• a primed surface
• a primersealed surface
• an existing bituminous surface, e.g. sprayed seal or asphalt.

Sealing is used for one or more of the following reasons:
(a) To seal a new or existing pavement surface against the entrance of moisture and air
(b) To provide an anti skid texture where an existing bituminous surface is smooth or slippery
(c) To enliven a dry or weathered bituminous surface and improve wear resistance
(d) To improve the road surface luminosity or night visibility by using light coloured aggregates
(e) Delineation for traffic guidance by using contrasting aggregate colours on shoulders, traffic lanes and traffic islands.

13.1.4 Effect of Weather
Weather has a major influence on the success of sprayed seals and therefore sealing work is generally done during the better weather conditions in the period October to May. In the drier, warmer areas of Victoria the season may extend from September to June.
13.1.5 Minimum Temperature for Sealing
Binder should not be sprayed when the air temperature is below 15°C because of the difficulty of achieving satisfactory adhesion between the binder and the aggregate at low temperatures.

In emergencies or special circumstances spraying at temperatures between 10°C to 15°C may be carried out.

For bitumen-crumb rubber and other polymer modified binder work the minimum desirable pavement temperature for spraying is 20°C. Bitumen-crumb rubber binder and other polymer modified binders may be sprayed at air temperatures between 15°C to 20°C but the risks of the seal stripping and/or fatting up during the first hot weather will be substantially increased.

13.1.6 Binder Materials
See Chapter 3 and 4 for the types and grades of binder materials normally used in Victoria.

13.2 TYPE OF SEALS
13.2.1 General
The main types of sprayed seal coats that may be used are:

(a) Single application
(b) Multiple application
(c) Two aggregate seals
(d) Geotextile reinforced sprayed seals (with one or two coats of aggregate).

13.2.2 Single Application Seals
A single application seal is one application of binder covered by one application of one size of aggregate. This type of seal coat is used on nearly all of the sprayed sealing work carried out in Victoria.

13.2.3 Multiple Application Seals
A multiple application seal is more than one application of binder with each application of binder covered by one application of one size of aggregate.

Multiple application work in Victoria rarely exceeds two applications of binder and aggregate. As a general rule the aggregate in the second application should be about half or less of the nominal size of aggregate in the first application, e.g. size 20 and size 7 or, size 14 and size 7 or a size 10 and size 5 or 7.

The main uses for multiple application seals are:

(a) To provide a robust sprayed seal coat in areas of high loading and stress, e.g. intersections, steep and/or hilly country, very cold conditions etc.

(b) To use a soft or brittle aggregate, e.g. soft limestone, under conditions for which it is not suited on a single application seal, but where it may be the economic procedure compared to importing a harder, more expensive aggregate.
(c) To use a large aggregate, size 14 or 16, which has poor adhesion characteristics.

(d) For work using bitumen emulsion as the binder at rates of application exceeding 1.2 to 1.5 litres/m².

(e) On initial treatment work where it is desirable to provide a heavy layer of binder (i.e. requiring a large aggregate) but because of consideration for pedestrians and such it is necessary to provide a reasonably smooth, fine textured surface, e.g. parking areas, town streets.

(f) To attain longer life.

(g) Noise reduction in urban areas.

This type of seal coat is used on sealing work carried out in snow country, some new freeways and retreatments on highly stressed highways.

13.2.4 Two Aggregate Seals

The two aggregate type seal is one application of binder followed by two applications of aggregate. The aggregate is usually of two sizes, the second application being the smaller aggregate of about half the nominal size of the larger aggregate, or smaller, e.g. size 14 and size 7.

Usually the only time a second layer of aggregate is applied without binder is:

- to assist in racking-in a larger aggregate at high stress locations, e.g. intersections
- to rack-in and hold a tender emulsion seal
- to repair bleeding seals, see Chapter 20, Failures and Remedies.

This type of seal is often used when:

(a) Carrying out a large size emulsion seal. The second layer of aggregate is used to anchor or rack-in between the larger aggregate to lock it into place.

(b) At high stress locations such as intersections to lock the larger aggregate into place. The rack-in coat reduces the risk of traffic rolling or turning over the coarse aggregate particles while the binder is still fluid. As there is very little contact between the rack-in aggregate and binder, only a small amount of it remains in the final seal.

13.3 SPECIAL TREATMENTS

13.3.1 Cutback Bitumen Reseals (Primerbinder)

Cutback bitumen reseals, which are cutback significantly more than normal, have been used to treat the effects of reflective cracking in an existing bituminous surface.

The cutback binder may be commercially produced Primerbinders, Medium Curing Cutback Bitumen, or field produced Cutback Bitumen containing an adhesion agent.
The types of cutback used are those where the composition is between 100 to 14 and 100 to 25 parts of bitumen and cutter, with 0.5 to 1% of adhesion agent added. The basis of this treatment is that the increased fluidity of the binder will penetrate or fill the cracks, thus waterproofing the pavement. The treatment is applicable to emergency reseals carried out in winter to arrest the deterioration of a badly cracked pavement. The treatment involves the risk of the additional cutter causing flushing problems in summer.

The recommended rates of application of binder for this type of treatment are shown in Table 13.3.

**Table 13.3 Recommended Application Rates**

<table>
<thead>
<tr>
<th>Aggregate Size</th>
<th>Traffic – vehicles per lane per day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 150</td>
</tr>
<tr>
<td>Sand, Size 5, Size 7</td>
<td>1.3 litres/m²</td>
</tr>
<tr>
<td>Size 10</td>
<td>1.4 litres/m²</td>
</tr>
</tbody>
</table>

The above rates of application do not include any allowance for surface texture or absorption but these should be allowed for in the normal manner.

The treatment is of a temporary nature having an expected life of 2 to 3 years and should then be followed by a normal sprayed reseal or asphalt retreatment.

Note: This type of treatment may be replaced by the use of emulsion sealing techniques in appropriate locations.

**13.3.2 Bitumen Crumb Rubber Seals (High Stress Seals and Strain Alleviating Membranes)**

(a) General

Since 1975 VicRoads, with the co-operation of the VicRoads Regions, GeoPave and the ARRB TR, has been using and developing the use of bitumen crumb rubber seals (BCRS) to extend the serviceable life of distressed pavements.

(b) Purpose

Granular crumb rubber is added to the normal bitumen, Class 170, to provide a tough, resilient binder which can be applied at heavier than normal rates of application to aid in the suppression of reflection cracking and/or to cope with difficult traffic situations. Crumb rubber is normally added to bitumen at a rate of 5 or 20 parts of rubber to 100 parts of bitumen.

High Stress Seals (HSS) have 5 parts of crumb rubber added to the binder. These are used in high stress situations where improved aggregate retention and a more elastic binder are required.

Strain Alleviating Membrane (SAM) seals have 20 parts of crumb rubber added to the binder. They are placed in high stress situations to reduce or suppress reflection cracking from pavements containing structural and/or environmental cracking.
(c) Appearance

In order to achieve the reduction or suppression of reflection cracking on heavily trafficked roads it is necessary to use 20 parts of crumb rubber to 100 parts of bitumen and to use heavier than normal rates of application of binder and this will result in a surface slightly more black in appearance than with normal seals. There is, however, little tendency for any picking up of the binder, or of binder being carried onto other surfaces by vehicle tyres.

In order to improve the retention of aggregate to binder for all traffic ranges and to provide a low level of suppression of reflection cracking for low traffic ranges, it is necessary to use 5 parts of crumb rubber to 100 parts of bitumen. The 5 parts of crumb rubber binder provides a stiffer binder than standard bitumen and although slightly heavier application rates than normal are often used, the appearance of the sealed surfacing is similar to a standard seal.

(d) Rates of Application

See Section 14.7.1 for the practical combinations of crumb rubber and Class 170 bitumen, their main uses and the factors used to design the rates of application. For a SAM, the recommended minimum application rate is 1.5 litres/m².

(e) Aggregate Size

Size 10 or 14 aggregate should be used depending on type of work, traffic, location, etc.

Size 7 aggregate should not be used with 20 parts of crumb rubber modified binder as it is too small to give the necessary heavier rates of application of binder. Size 7 mm aggregate can be used with 5 parts of crumbed rubber modified binder to provide a better adhesion and a stiffer binder for use on shoulders and residential streets.

13.3.3 Strain Alleviating Membrane Interlayer Bitumen Crumbed Rubber Seals

13.3.3.1 General

Strain Alleviating Membrane Interlayer (SAMI) seals are a form of bitumen crumb rubber seals that normally:

(a) are manufactured using 25 parts of crumb rubber instead of 20 parts

(b) are covered with an asphalt layer shortly after application of the seal

(c) fill a higher proportion of the voids in the aggregate mat

13.3.3.2 Purpose

The purpose of a SAMI bitumen crumb rubber seal is to act as a Strain Absorbing Membrane Interlayer to resist the propagation of reflective cracking from the underlying pavement through the asphalt surfacing.
13.3.3 Rates of Application
The rate of application of binder for a SAMI bitumen crumb rubber seal is sufficient to fill a basic voids factor of 0.16. For a SAMI, the recommended minimum application rate is 1.8 litres/m².

13.3.4 Use of Cutter
If cutter is used in a SAMI it can soften the binder in the asphalt and cause flushing and rutting. Cutter should not be used in a SAMI unless the pavement temperature renders it essential to achieve adhesion of the aggregate.

13.3.5 Aggregate Size
Size 10 or 14 mm aggregate can be used although 10mm is more common. Size 7 mm aggregate is not used as it is too small to enable sufficient binder to be applied to have the strain absorbing membrane interlayer effect.

13.3.4 Polymer Modified Binder Sprayed Seals (HSS, SAM and SAMI)
There are many, commercially available, polymer modified binders other than crumbed rubber. These binders are used as HSS, SAM and SAMI treatments to perform the same functions as described in Section 13.3.2 and 13.3.3 above.

See Section 14.8 for additional information.

13.3.5 Geotextile Reinforced Sprayed Seals
13.3.5.1 General
Geotextile reinforced sprayed seals have been used in Victoria for many years to rehabilitate distressed pavements. They are currently the most effective sprayed sealing technique for treating badly cracked and distressed pavements (bound and unbound pavements), particularly where the crack movements are slow, for example, as caused by environmental factors.

13.3.5.2 Types
The two common types of geotextile reinforced seal are:
(a) single coat (often using a modified binder)
(b) double coat (using modified or unmodified binder in the first spray of binder and slightly or unmodified binder in the second layer).

Another variation in the use of a geotextile sprayed seal is similar to the common treatments (a) and (b) above except that the treatment is covered with an ultra thin asphalt or open graded asphalt. These treatments are often used with a thin asphalt regulation layer.

13.3.5.3 Method of Application
Geotextile reinforced sprayed seals are produced by spraying a layer of bitumen onto a pavement to create a bond coat. This layer of bitumen is then covered with a layer of geotextile and lightly rolled. Special care should be taken on hot days because the bond coat readily permeates the geotextile and
can stick to the wheels of the roller or sprayer and wrap around the wheels. A single or double seal is then applied over the fabric. It may contain a polymer modified binder.

Geotextile reinforced sprayed sealing treatments, in common with all sprayed sealing techniques, do not affect the shape or ride of the pavement. They can be applied on top of a regulation treatment (of slurry or asphalt).

**13.3.5.4 Rate of Application**

A method for the design of geotextile sprayed seals is still being developed. The factors that appear to affect the application rates are as follows:

- traffic volumes and traffic composition
- geotextile type and weight
- aggregate sizes
- type of binder.

Reference should be made to VicRoads GeoPave Technical Note 14 and General Report No. 95/1 – Geotextile Reinforced Sprayed Surfacing by Henk van Deuren and John Esnouf. See also Section 14.8.

**13.3.5.5 Aggregate Size**

In the first application of aggregate, Size 10 or 14 mm (most common) aggregates should be used to enable sufficient quantity of binder to be applied to resist reflective cracking and allow sufficient margin for judgement in estimating application rates. If a second application of binder and aggregate is used, it is normal to use an aggregate about half the size of the first aggregate, i.e. a size 5 if size 10 mm was used first or size 7 if size 14 mm aggregate was used first.

**13.3.5.6 Type of Geotextile**

There is a large choice of geotextiles available for use in sprayed bituminous seals. Non-woven, needle-punched fabrics are preferred as they perform better than woven ones (they have more uniform elongation, better resistance to tearing and superior bitumen/fabric adhesion). The most common types of geotextiles used for bituminous sprayed seals are:

- Polyester: Polysters are the most suitable because their melting point is typically 250°C; they absorb only small amounts of water; are less sensitive to ultra violet light than polypropylene; and are suitable for all applications including polymer modified binders. The polyester is porous so it retains sufficient bitumen to perform the waterproofing function and is not affected by hydrocarbons in the bitumen.
- Polypropylene: Polypropylene may be used, providing the bitumen temperatures do not approach or exceed 175°C, which is the softening/melting point of this material. Signs of the effect of heat include shrinkage or melting along the edges of the polypropylene after hot bitumen has been applied. This type of geotextile has been used successfully with emulsion binders.
13.3.5.7 Grades of Geotextile
(a) For sealing applications a minimum geotextile fabric grade of 140 g/m² is used for aggregate sizes of 10 and 14 mm. For seals on expansive clays or untreated soft pavements or with stone sizes larger than 14 mm, heavier grades of geotextile should be used to minimise the potential of puncturing the material.

(b) For primersealing applications on gravel shoulders, bicycle paths and low trafficked roads a minimum geotextile fabric grade of 180 g/m² should be used.

13.3.6 Surface Enrichment Seals
These are types of sprayed work which are used to waterproof or extend the life of an existing bituminous surface by means of an application of binder without a covering of aggregate.

These are used where the binder of an existing bituminous surfacing is at or near the end of its life but the surface is otherwise still in good condition. The main use is on existing bituminous surfacings with large aggregates.

They are cheaper to apply but have a shorter life than normal type seal coats. See Section 13.7.

13.3.7 Dust Laying
Dust laying can be used as a maintenance treatment on an unsurfaced pavement to avoid excessive maintenance, dust nuisance or to prevent loss of pavement material. It may also be used as a temporary treatment on a newly constructed or reconstructed pavement which cannot be prepared for the application of a bituminous surfacing.

Bitumen emulsion dust laying treatments are described in Chapter 18.

13.3.8 Slurry Sealing/Microsurfacing
Slurry sealing is not a sprayed treatment but is the application of a mixture of bitumen emulsion, fine graded aggregate and/or mineral filler, in the form of a slurry to an existing bituminous surface by means of a mechanical spreader or squeegee.

A slurry seal is a useful way to provide a uniform surface texture on existing bituminous surfacings which have coarse aggregates and/or have a non-uniform surface with a greatly varying texture.

Microsurfacing is similar to slurry surfacing except that a polymer modified emulsion is used and this enables a thicker layer to be placed.

Note: Unless these surfaces have been trafficked and weathered for a significant period of time, it is difficult to determine the appropriate allowances in the design of the sprayed seal. Surfaces that have been recently patched or overlaid are also difficult to determine the appropriate design allowances.
13.3.9 Foam Bitumen Sealing

Foam bitumen sealing is similar to normal sealing, except that water is added to the bitumen, in a purpose-built sprayer, and this causes the bitumen to foam, i.e. expand. The cover aggregate is then incorporated into the expanded bitumen before it subsides. The process eliminates the need for cutting oils, and can be very useful on heavily trafficked roads where early high strength binder is essential.

13.3.10 Fibre-Glass Reinforced Emulsion Sprayed Seal

This technology is currently marketed under the trade name Fibredec.

A fibre reinforced seal usually uses a polymer modified emulsion. The process uses a purpose-built sprayer which, with a single pass:

- sprays binder onto the pavement
- cuts the required amount of fibreglass to length, and blows this onto the first layer of binder, fibres are cut to length, and can be 50 mm and up to 90 mm in length
- sprays a second layer of binder over the cut fibres.

The bitumen and fibre layers are immediately covered with a lightly spread aggregate (say a 14 mm) being locked into place using a racked-in size 5 or 7 mm aggregate.

13.3.11 Pavement Material Containing Salt

Many pavement materials which contain salt or are built across salt pans may, under certain conditions of moisture and temperature, blister if primed and treated in the normal manner, see Section 11.16.2.

The seal coat should be applied as soon as the primer has dried to add mass to the treatment, to retain it in place and to provide an impermeable surface.

It has been demonstrated that a size 10 or larger aggregate, with a heavy rate of application of binder for the conditions, has provided a successful treatment. On occasions, to ensure that the surface is impermeable and that there is sufficient weight of material, it may be necessary to provide a third or fourth sprayed seal. In carrying out these seals it may be beneficial to eliminate or minimise the use of cutters as the cutters may assist the hydroscopic process of depositing the salt at the pavement/seal interface.

13.3.12 Porous Limestone and Sandstone Pavements

Limestone pavements and some of the more porous sandstone pavements require the use of heavy primers and/or two application procedures. See Sections 11.12 and 11.13.

The application of binder, where the final seal uses a 10 mm or 14 mm aggregate, should be made as heavy as possible for the conditions. There remains the possibility that a certain amount of the binder could be very slowly absorbed and the seals should be inspected regularly – once a year.
If binder absorption is modest then surface enrichment may be an effective and economic treatment.

If binder absorption is excessive then possible alternative treatments are:
(a) apply a primerseal, with size 5 or 7 aggregate, followed by a final seal the following season
(b) apply a size 5 or 7 initial treatment prime and seal, with a high binder rate of application for the conditions, and reseal with a larger aggregate 2 to 3 years later.

13.4 PAVEMENT PREPARATION

13.4.1 General
The pavements should be prepared as set out in the relevant sections of Chapter 10, Preparation of Surfaces. Priming or primersealing should be as set out in Chapters 11 and 12 respectively.

Proper preparation of the pavement surface is essential to achieve a good quality, even textured seal coat. Any pavement distress, lack of width, poor shape and riding qualities must be corrected before the seal coat is applied. A sprayed seal does not strengthen a pavement nor will it improve shape and riding qualities.

13.4.2 Condition
A seal coat should only be applied to a sound clean dry surface. This may be a primed, primersealed or existing bituminous surface.

A seal coat must not be applied to a damp or wet surface because moisture will be trapped and prevent bond between the binder and the pavement surface.

13.4.3 Cleaning
The pavement surface should be cleaned to remove all mud, carried on material, dirt and dust. Any scale, hardened mud or foreign material sticking to the surface should be removed by hand chipping or grading well ahead of applying the seal coat.

The cleaning should continue until any material which may prevent the adhesion of the seal coat to the surface has been removed.

13.4.4 Sweeping
After cleaning has been completed the surface should be swept with a rotary road broom or suction sweeper, supplemented by hand brooms where required. Final sweeping should be done shortly before spraying the binder in order to apply the binder to as clean a pavement as possible.

If the pavement is wet, sweeping with a rotary broom may help remove the excess water and reduce the time taken for the surface to dry. Rollers and traffic will also help to dry out the surface.

After the surface has dried it should be re-examined and, if necessary, swept again before spraying the binder.
13.4.5 Width to be Swept
The pavement surface should be swept across the full width to at least 0.3 m, if possible, outside the edges of the width to be sealed.

13.4.6 Distribution of the Swept-Off Material
If the quantity of material warrants it, and this should not be often, the windrows should be swept over the shoulders if possible or removed (e.g. where there is kerb and channel) before applying the seal coat.

The edges of the surface to be sealed should be inspected after grading or removing the windrows and any dirt or dust removed by further sweeping before spraying the binder.

13.4.7 Marking Out
Using a sealing unit is very expensive so it should be delayed as little as possible. It is more economical to organise and do the marking out, ahead of the sealing unit, rather than to have personnel from the BS unit marking out.

Marking out for sprayed sealing work should be organised by the contractors/purchasers/engineers responsible for the section to be sealed.

If possible, particularly on larger jobs, it is preferable to have the engineering survey crew do the marking out.

On some work, particularly intersections and areas of traffic channelisation, it is not always feasible to mark ahead because of the difficulty in deciding the method of work. This sort of work is best organized to be marked out by the contractor and construction personnel on the day the work is done. The minimum amount of marking should be the centreline spotted at about 10 m intervals.

The centre of the seal width should be determined from the overall width and the line of best fit marked.

Do not mark off one edge only, or a striped centreline which may or may not be the actual centre of the seal width. Do not perpetuate previous errors.

The marks should be made with water based paint of a contrasting colour to the existing surface.

13.5 Width to be Sealed

13.5.1 Full Width
Where possible pavements should be sealed full width in one application. Depending on conditions the normal cut off point where it becomes difficult to seal full width, without unduly delaying the traffic, is about 1500 vehicles/day/lane and on roads with higher traffic volumes consideration must be given to seal in half or lane widths.

Full width sealing may not be possible on multi-lane and/or divided carriageways where the width may be greater than the maximum possible spraying width of 7.5 m or where varying rates of application of binder are to be applied across the traffic lanes.
Winding roads, widths of 5.6 m and greater, with numerous short radius curves must be sealed half width to avoid non-uniform application rates across the pavement.

13.5.2 Other than Full Width

Where a pavement cannot be sealed in one application then the edge of each width of binder sprayed should overlap the uncovered edge of the previous run of binder by about 50 mm. These overlaps and joins should be outside the normal wheelpaths of the traffic and if practical coincide with the traffic lane markings.

When spraying binders containing 20 parts of crumb rubber, or binders highly modified with other polymer types, it may be necessary to limit the width of spray to ensure a uniform lateral distribution of the viscous binder.

In these cases the minimum overlap should also be 50 mm as described above (assuming end jets are used). This overlap should be located on lane lines, it should never be located under a wheel path.

13.6 MAINTENANCE

13.6.1 After-Care

A sprayed seal coat is susceptible to damage by the weather and traffic early in its life, particularly the first four hours. The seal should always be inspected the next day during backrolling and again in the next few days if there are sudden extreme weather changes. In particular, this inspection is required if the work was done on a cool day and the binder contained 8 parts or more of cutter.

Fast traffic can damage a seal coat in its early life and, whenever needed, traffic control should be used to reduce the speed of vehicles. This will protect the new works until the binder has set-up and the aggregate is well embedded and adhering to the binder.

Early inspection will reveal any problems. At that stage they may only be minor and easily remedied. If undetected they may create a hazard to the public and be more difficult and expensive to repair.

Loose aggregate from whip-off should be removed from the roadway as soon as possible to minimise damage to vehicles, particularly windsreen damage.

13.6.2 General

To obtain maximum life and benefit from a seal coat, normal maintenance should apply from early in its life. Grading of shoulders should not be done until the seal is at least two weeks old and the binder has set-up. Any such work done shortly after sealing could lead to stripping of the aggregate along the edges due to dust or the aggregate dislodged by the grader itself.
13.7 LIFE EXPECTANCY

The life expectancy of a sprayed seal depends to a large degree on conditions such as the weather, traffic, binder type and grade, aggregate size and type etc. The average life that can be expected for single application seals without further treatment, other than normal maintenance, is as shown:

Table 13.7 Life Expectancy of Treatments

<table>
<thead>
<tr>
<th>Type of Binder</th>
<th>Aggregate (One size)</th>
<th>Life Expectancy in Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 170 Bitumen, Fluxed and/or Cutback Class 170 Bitumen</td>
<td>Size 5, sand</td>
<td>5 – 7</td>
</tr>
<tr>
<td></td>
<td>Size 7</td>
<td>6 – 8</td>
</tr>
<tr>
<td></td>
<td>Size 10</td>
<td>7 – 10</td>
</tr>
<tr>
<td></td>
<td>Size 14</td>
<td>8 – 12</td>
</tr>
<tr>
<td>As above including PMBs</td>
<td>Geotextile reinforced sprayed seals</td>
<td>9 – 14*</td>
</tr>
</tbody>
</table>

Note: The life of a sealing treatment is affected by the condition of the pavement prior to sealing, previous and future maintenance and traffic. This is particularly the case with PMB seals and geotextile reinforced sprayed seals which are often placed on pavements in poor condition.

* Geotextile reinforced sprayed seals are often placed on severely distressed pavements and consequently less life than indicated may occur due to the pre-existing pavement distress.
14.1 GENERAL
The success or otherwise of a sprayed seal depends on many factors some of which are beyond the direct control of the designer. The most important factor that can be controlled is the design of the seal coat which includes selection of:

(a) the type and size of aggregate
(b) the type and grade of binder
(c) the rates of application of binder and aggregate
(d) special treatments such as reinforcement with geotextile

14.1.1 Single Application Seals, Size 10 mm or Larger
The critical design influence on the success of a single coat seal is the rate of application of binder and aggregate in relation to the traffic volumes.

The design of seal coats by VicRoads is based on Hanson’s method, VicRoads experience and the Austroads method (1990) – see Section 14.4. The rates of application of binder and aggregate have been amended and updated to suit locally occurring materials and conditions and standard tables and charts developed.

14.1.2 Single Application Seals, Size 7 mm or Smaller
The design of rates of application of binder and aggregate using 7 mm or small aggregate is based on experience – see Section 14.5.

14.1.3 Multiple Application Seals
The design of the rates of application of binder and aggregate for multiple application seals is a mixture of the design of a single application seal for the first application and experience or field trials to determine the rates for the following applications – see Section 14.6.

14.1.4 Polymer Modified Binder (PMB) Seals
The three basic types of polymer modified spray seal are as follows:

- HSS (High Strength Seal) which is a modified binder seal for the retention of aggregate on high traffic, high stress situations. This is designed similarly to a normal sprayed seal except that the binder application rate may be increased by up to 10%.
- SAM (Strain Alleviating Membrane) seal. Design is similar to a normal seal except that binder application rates are higher to utilise the more viscous binder and achieve a thicker layer. This is achieved by using a PMB factor with the standard design.
- SAMI (Strain Alleviating Membrane Interlayer) seal. Heavier rates of application of binder than a SAM are required but a similar design approach is used. A SAMI seal, which acts as an interlayer to reduce or suppress reflective cracking, is always covered by an asphalt overlay. The design of rates of application of binder are dependent on the treatment type and type of binder – see Section 14.7.
14.1.5 Design of Geotextile Reinforced Sprayed Seals

The design is currently based on the design method for single and multiple applications seals with an allowance for binder to be absorbed in the geotextile, plus experience – see Section 14.8.

14.1.6 Average Base Rates of Application of Binder and Aggregate

For general information only, Table 14.1.6 sets out the average base rates of application of binder and aggregate when using the most common one sized aggregates (eg., basalt) on single application work under normal conditions. These figures must only be used as a guide for planning and estimates and not to design the final rates of application. This must be done for each individual job as set out in Sections 14.4 to 14.7.

The rates in the table include average adjustments for void factors but do not include any allowance for surface texture, embedment or absorption. The table is not for design purposes.

Table 14.1.6 Average base rates of application of binder and aggregate for one sized aggregates used in single application work

<table>
<thead>
<tr>
<th>Aggregate (one sized)</th>
<th>Binder (L/100m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Nominal size</td>
<td>Typical ALD in mm</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>8.3</td>
</tr>
<tr>
<td>10</td>
<td>5.8</td>
</tr>
<tr>
<td>7</td>
<td>NA</td>
</tr>
<tr>
<td>5 and smaller</td>
<td>NA</td>
</tr>
</tbody>
</table>

Rate of Application of binder is measured by volume at 15°C.

14.2 SIZE OF TREATMENT

The nominal aggregate size chosen should be related to the conditions of the particular work and should be the best possible compromise for the various conditions to provide the most economic treatment. This does not always mean using the largest aggregate.

14.2.1 Maximum Size

The maximum size of aggregate used should normally not exceed the following:

(a) single application work – size 14

(b) multiple application work – size 20

The common sizes used in Victoria are 7, 10 and 14mm aggregates. Aggregates smaller than 7 mm are only used on low trafficked roads. Aggregates of 20 mm size and larger are rarely used except in double application work.
14.2.2 Recommended Size

Any of the nominal aggregate sizes between sand and size 20 (refer to Section 14.2.1 above) may be used on either an initial treatment or retreatment sealing work provided the aggregates comply with the relevant specification and requirements – see Chapter 2 – Aggregate.

14.2.3 Initial Treatment

Where the work is an initial treatment prime and seal, the aim is to provide the strongest seal coat economically possible and this is achieved by using the larger aggregates.

To determine a suitable economic aggregate size for an initial treatment single application work the following should be considered:

(a) Nature and Volume of Traffic, Both Now and in The Near Future.

A road with very little traffic at present could be subjected to a lot of traffic in the near future or vice versa. As a general rule the aggregate sizes shown in Table 14.2.3 give economic service.

<table>
<thead>
<tr>
<th>Traffic</th>
<th>Aggregate Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>very light to light traffic</td>
<td>maximum size 10 mm</td>
</tr>
<tr>
<td>i.e. &lt;300 v/l/d</td>
<td></td>
</tr>
<tr>
<td>light to medium traffic</td>
<td>maximum size 14 mm</td>
</tr>
<tr>
<td>i.e. 300 to 1200 v/l/d</td>
<td></td>
</tr>
<tr>
<td>heavy traffic</td>
<td>minimum size 10 mm</td>
</tr>
<tr>
<td>i.e. &gt;12000 v/l/d</td>
<td>maximum size 14 mm</td>
</tr>
</tbody>
</table>

(b) Life Expected from the Treatment

Is it of a temporary nature or to last as long as possible? See Section 13.7 for average life expectancy of single application seal coats.

(c) Nature of the Pavement Material

On a dense, smooth uniform pavement the recommended maximum size may be used to obtain a strong seal coat with maximum life expectancy.

On a material such as hill gravel, which would present a coarse open surface, a size 10 or size 7 may be the maximum size which will provide a smooth satisfactory seal coat.

If the pavement material contains salt or the pavement is across salt pans the primer may be affected by the salt (see Chapters 10 and 12) and size 10 or preferably size 14 aggregate should be used to provide a heavy treatment to overcome this problem.
(d) Condition of the Pavement

On a pavement constructed of soft or weak material, into which an aggregate might be forced by the traffic, the aggregate size should be limited to a maximum of size 10 or preferably a size 7 or sand to provide a layer of more than one stone in thickness.

This can be regarded as a temporary treatment to provide a uniform strong surface for a final seal treatment with larger aggregate a few years later. The same may be achieved with a primerseal followed by a final seal.

In the case of widening of an existing pavement, or reconstructing short sections, the aggregate used should be of similar size and type to the existing aggregate to provide a uniform surface for future resealing of the full width widened pavement.

(e) Nature of the Aggregate

A soft or absorbent aggregate may require the choice of a larger size or special treatment compared to a better quality aggregate, to obtain the same service life, eg., size 14 compared to a size 10.

(f) Availability of Aggregate Sizes

The choice could be to use a smaller or larger size than desirable in order to avoid expensive delays to the sealing programme and excessive maintenance and/or damage to the primed/primersealed pavement. Generally this is more critical with a primed pavement, primed with a short life primer.

(g) Nature of the Terrain

It is much more difficult to hold and retain large aggregates compared to smaller aggregates in adverse conditions such as winding roads, forest areas where the pavement is heavily shaded, etc.

Crumb rubber in the binder or a lightly polymer modified binder will assist initial adhesion of aggregate in adverse conditions as set out above. Larger aggregates require higher rates of application of binder (for the same conditions) and in hilly country this will result in higher run-off of binder. In hilly country or any steep incline this could result in insufficient binder remaining to hold the aggregate.

(h) Location, ie., Urban or Rural

Noise and comfort of pedestrians etc., may dictate the maximum size that can be conveniently used. The removal of aggregate whipped-off by traffic may also be a problem.
14.2.4 Maintenance Reseals

To determine a suitable economic aggregate size for single application resealing work the following should be considered:

(a) Nature and volume of the traffic, both now and in the near future.

On an existing bituminous surface the aggregate size selection is not as strongly influenced by the traffic volume. As a general rule the maximum size should be restricted to size 10 on low volume traffic roads, i.e., 300 vehicle/lane/days.

For roads with traffic volumes greater than 100 vehicles/lane/day, the minimum aggregate size used should be size 7, preferably size 10, because smaller aggregate sizes would generally result in a smooth, lower skid resistant surface.

(b) Life Expected from the Pavement

If the existing pavement has only a limited expected life before reconstruction is required then the aggregate size should be limited accordingly – see Section 13.7.

If the pavement is sound the aggregate size should be such to provide the most economical treatment considering the initial cost and future cost/problems caused by an inappropriate initial choice.

(c) Surface Texture of the Existing Surface

This is one of the most important factors in choosing the aggregate size. When a failure occurs in resealing it is often due to resealing with the wrong aggregate size for the existing surface and generally the aggregate used has been too large.

As a general rule an existing seal coat with large size aggregate (say size 14) will be too coarse and hungry to be resealed successfully using another large aggregate. Normally a smaller aggregate than the existing size aggregate should be used. This would enable a larger size aggregate to be used on the next reseal.

If an existing surface has used a size 7 mm seal or smaller it is normal practice to reseal with:

- a size 7 mm seal if the traffic volumes were low, although a 10 mm seal could be considered
- a size 10 mm or 14 mm seal if the traffic volumes were high enough to require this size seal. If the existing surface is a smooth worn uniform asphalt or seal coat the larger aggregates may be used for the reseal

The above also applies in choosing the aggregate size for a final seal over a primerscal.
The less uniform and coarser the existing surface the smaller the aggregate that should be used (down to size 5). It is advisable not to use aggregate smaller than size 7 on roads having a traffic volume of 1200 vehicles/lane/day or more except to create a uniform surface texture or to pin-down a sprayed seal. On lower traffic volume roads the major consideration for using size 7 or smaller would be cost and availability because the reseal performance and life would be similar.

(d) Nature of the Aggregate

A soft or absorbent aggregate may require the choice of a larger size or special treatment compared to a better quality aggregate, to obtain the same service life.

(e) Availability of Aggregate Sizes

With resealing, any delay in obtaining the aggregate is usually not critical from the point of view of maintenance but could be with regard to the sealing programme. If for some reason it is necessary to obtain an aggregate other than that originally proposed it is desirable to choose a smaller rather than a larger aggregate. It may give a shorter life but should result in a more uniformly textured reseal and less likelihood of failure, in the future, due to stripping.

(f) Nature of the Terrain

As for initial treatments, see Section 14.2.3(g).

(g) Location

As for initial treatments, see Section 14.2.3(h).

14.2.5 Use of large size aggregates

It is generally undesirable and uneconomical to use a size 14 (or larger) aggregate for single application work where any of the following conditions apply:

(a) If it is suspected the shape of the pavement will deform in the first three or four years after sealing

(b) If the work will be given an asphalt wearing course early in its life, say 2 to 3 years

(c) On a very winding alignment with a large number of small radius curves

(d) On treatments on roads with light traffic volumes (< 300 v/l/d)

(e) On an initial treatment on a soft and weak pavement material into which the aggregate might be forced and partially embedded by the traffic

(f) On a reseal where the surface texture is coarse and a surface texture allowance would need to be 0.5 litres/m² or more for a size 10 or 14 aggregate

(g) Where the aggregate is of poor grading (ie., insufficiently one sized) or contains a lot of flats, ie., 30% or more.
14.3 BACKGROUND OF RATES OF APPLICATION OF BINDER

14.3.1 General

In the early days of sprayed bituminous surfacing the determination of rates of application of binder and aggregate was on an empirical basis and this resulted in variable, and often poor standard sprayed seals. In 1935 Mr. F. M. Hanson of New Zealand developed a method to determine the rates of application of binder and aggregate for single application work using the average least dimension (ALD) of the aggregate. This method was adopted by the then Country Roads Board (now VicRoads) and was used successfully with amendments made from time to time to adapt to changing conditions, mainly traffic related.

The basic premise of the Hanson/CRB modified method was that a successful sprayed seal would be obtained if a certain portion of the air voids in the compacted mat of aggregate were filled with bitumen. The portion of the air voids filled with bitumen was inversely related to the traffic, i.e., the higher the traffic the lower the proportion of voids filled with bitumen and conversely the lower the traffic the higher the proportion of the voids that had to be filled with bitumen.

The design method presented in this manual is based on Austroads research into the behaviour of sprayed seals with some additional guidance based on CRB/RCA/VicRoads experience. The design method gives results very similar to the VicRoads traditional seal design method, except at very high traffic ranges and very low traffic ranges. The Austroads method in high traffic ranges produces slightly lower application rates and higher application rates for very low traffic ranges. The VicRoads method tended to slightly over estimate the amount of binder required in the high traffic ranges (greater than 4000 vehicles/lane/day) and under estimate the amount of binder in the low to very low traffic ranges (less than 300 vehicles/lane/day).
This method is based on the Austroads method (1990) and Austroads experimental works involving:

(a) detailed experimental data and observations from experienced personnel

(b) experimental data showing that:

(i) the total voids in a sprayed seal mat after about 2 years of trafficking are generally in the range 45 to 58%. For practical purposes the total voids in the completed sprayed seal mat are taken as 50%

(ii) the Basic Voids Factor (proportion of the total volume of the mat that needs to be filled with bitumen) is related to the traffic volume via Table 14.4.2

(c) there needs to be adjustments to the Basic Voids Factor for:

(i) the shape of the aggregate (Flakiness Index)
(ii) proportion of commercial vehicles
(iii) conditions of trafficking such as where the sprayed seal is used as a shoulder, passing lane
(iv) the road geometry of the site

(d) there needs to be allowances in the design for:

(i) the texture (hungriness) of the existing surface on which the new sprayed seal is placed
(ii) possible binder absorption into the aggregate used and the original surface
(iii) possible aggregate embedment into the existing surfacing

(e) aggregate is spread shoulder to shoulder in a tight mosaic and is, at least initially, able to move and adjust its position so that the aggregate lies relatively flat with the ALD relatively in a vertical direction. The method does not assume that ALD of the aggregate in the completed mat is vertical, but that the layer thickness may be 15 to 25% greater than the ALD.

(f) using aggregate complying with the specification for a one sized aggregate and with a nominal size of 10mm or greater.

The end result of the sprayed seal process should be a single layer of aggregate where the lower half of the aggregate is firmly embedded in a bitumen binder while the upper half is free of binder to provide a well textured, skid resistant surface. The binder also provides a continuous film which waterproofs the underlying surface.

A minor variation can occur with fine aggregates (less than 7 mm) and sands where some particles are completely immersed in binder resulting in a seal which is more than one aggregate particle thick.
14.4  RATES OF APPLICATION OF BINDER – SINGLE APPLICATION WORK

14.4.1 General

This section covers the design of single application spray seals using aggregates of 10 mm or larger nominal size aggregate. The design of spray seals using aggregates of 7 mm nominal size and smaller is covered in Section 14.5.

In determining the rate of application of binder for a sprayed seal, the objective is a compromise between the conflicting demands of a waterproof seal, long life, a skid resistant surface and economy.

As a general rule this compromise is achieved if sufficient binder is provided to fill between about one half and two thirds of the height of the aggregate in a compacted mat of well shaped one sized aggregate.

The theoretical approach to design is that the total volume of the sprayed seal mat, including aggregate and void space between the aggregates, is represented by the ALD of the aggregate and that the proportion of that volume that needs to be occupied by binder, in order to hold the aggregate is place, is determined by multiplying the design voids factor by the ALD. The binder volume is fundamentally a function of the amount of compaction provided by the different traffic volumes (Basic Voids Factor) to which minor adjustments are made for aggregate shape, particular mixes of heavy and light traffic and road geometry conditions. Further allowances need to be made for surface texture, absorption and embedment to arrive at a design application rate.

Rate of application of residual binder (litre/m$^2$) = ALD * (Bvf - A$_1$) ± A$_2$

where:

- **ALD** = Average Least Dimension of the aggregate
- **Bvf** = Basic Voids Factor representing the proportion of the mat that needs to be filled with bitumen to result in a durable seal with suitable texture to provide for skid resistance
- **A$_1$** = adjustments that can directly be related to the ALD of the aggregate, i.e., due to very high percentages of commercial vehicles, aggregate shape and geometry
- **A$_2$** = allowances that relate to absorption, surface texture of the original surface, embedment and local factors

Table 14.4.2 indicates the proportions to be used for various ranges of traffic and types of aggregate.

Using the Basic Voids Factor from Table 14.4.2, applying the void adjustment factors and multiplying by the ALD of the aggregate gives the base rate of application of binder in litres/m$^2$. To the base rate of application must be added (or subtracted) the allowances that relate to surface texture (Section 14.4.4.2), absorption (Sections 14.4.4.3, and 14.4.4.4), embedment (Section 14.4.4.5) and any local factors.
Table 14.4.2  A Basic Voids Factor for determining the Proportion of mat to be Filled with Residual Binder*  
(Single application sprayed work)(Litres/m²/mm)

<table>
<thead>
<tr>
<th>Type of One Sized Aggregate</th>
<th>Basic Voids Factor (Proportion of mat to be filled with residual binder)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Traffic - Vehicles per day per lane</td>
</tr>
<tr>
<td></td>
<td>&lt; 50</td>
</tr>
<tr>
<td>Group 1  Basalt Dacite</td>
<td>0.23</td>
</tr>
<tr>
<td>Diabase Dolerite Sandstone &amp; quartz &amp; slate</td>
<td>0.24</td>
</tr>
<tr>
<td>Group 2  Granite Hornfels</td>
<td>0.24</td>
</tr>
<tr>
<td>Limburgite Mudstone</td>
<td>0.24</td>
</tr>
<tr>
<td>Nevadite Quartzite</td>
<td>0.24</td>
</tr>
<tr>
<td>Rhyodacite Sandstone</td>
<td>0.24</td>
</tr>
<tr>
<td>Micaceous Schist Slate</td>
<td>0.24</td>
</tr>
<tr>
<td>Toscanaite Scoria (one size)</td>
<td>0.24</td>
</tr>
<tr>
<td>Quartz porpyry Shale</td>
<td>0.24</td>
</tr>
<tr>
<td>Group 3  River Gravel Quartz Gravel</td>
<td>0.24</td>
</tr>
</tbody>
</table>
14.4.2 Determining the Basic Voids Factor (Bvf)

The Basic Voids Factor should be determined from the Table 14.4.2

Table 14.4.2 provides slightly different Basic Voids Factors for three different groups of aggregates. Group 1 aggregates are those from sources providing particularly good quality sealing aggregates with high hardness and good bitumen adhesion characteristics.

Group 2 aggregates are those from sources that can also provide good quality sealing aggregates but may require slightly more binder due to lesser hardness or lower bitumen adhesion characteristics than Group 1.

Group 3 aggregates are those from sources that, due to either lower hardness, rounded shape or poorer adhesion characteristics, should only be used in lower traffic situations and with increased binder applications to reduce the risk of stripping.

14.4.3 Void Adjustments, A1 (litres/m²/mm)

14.4.3.1 Shape of aggregate

The design process assumes an aggregate with a flakiness index in the range 20 to 35%. If aggregates with a more cubical shape are used, a correction needs to be made for the additional binder that is required to hold the aggregate. Table 14.4.3.1 gives the void adjustment factor considered necessary to correct the Basic Voids Factor for better shaped aggregates.

<table>
<thead>
<tr>
<th>Flakiness Index</th>
<th>Adjustment to voids factor (litres/m²/mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;20%</td>
<td>No adjustment necessary</td>
</tr>
<tr>
<td>15 to 20%</td>
<td>Add 0.01</td>
</tr>
<tr>
<td>Less than 15%</td>
<td>Add 0.01 to 0.02</td>
</tr>
</tbody>
</table>

Table 14.4.3.1 Void adjustment factors for aggregate shape (litres/m²/mm)

14.4.3.2 Adjustment related to commercial vehicles and geometry

The Basic Voids Factors assume a normal mix of light vehicles and commercial traffic (5 to 15%) and normal traffic flow conditions.

Cases where the voids factor, and hence the design application rate, should be reduced include:

- where the commercial traffic is higher than normal (5 to 15%)
- where there is extra loading associated with slow moving traffic in climbing lanes and intersections subject to stop/start conditions
- where there is (additional) trafficking due to narrower lanes or a narrow bridge producing higher traffic loadings

Cases where the voids factor, and hence the design application rate, should be increased include:

- where the commercial traffic is lower than normal (ie., less than 5%)
- where there is inconsistent, low traffic loadings such as shoulders of highway and freeways
where overtaking lanes and fast lanes of freeways are generally used by cars only and very few commercial vehicles. (Note: the design method assumes 5 to 15% commercial vehicles, this rarely occurs on overtaking lanes and rural freeways or highways).

Table 14.4.3.2 provides guidance on the void adjustment factors to be used for commercial vehicle, traffic speed and geometry considerations.

**Table 14.4.3.2 Void Adjustment Factors Relating to Traffic and Geometry Factors (Litres/m²/mm)**

<table>
<thead>
<tr>
<th>Traffic Effect</th>
<th>Adjustment to the voids factor (Litres/m²/mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Vehicles: &lt; 5%</td>
<td>0.01</td>
</tr>
<tr>
<td>Commercial Vehicles: 5 to 15%</td>
<td>No adjustment</td>
</tr>
<tr>
<td>Commercial Vehicles: 15 to 30%</td>
<td>-0.01</td>
</tr>
<tr>
<td>Commercial Vehicles: &gt; 30%</td>
<td>-0.02</td>
</tr>
<tr>
<td>Slow moving traffic on climbing lanes</td>
<td>-0.01</td>
</tr>
<tr>
<td>Fast moving cars only on overtaking lanes of rural freeway</td>
<td>+0.01</td>
</tr>
<tr>
<td>Non Trafficked area such as shoulders or median</td>
<td>+0.02</td>
</tr>
</tbody>
</table>

Note: The above effects are cumulative and where more than one factor applies the adjustments must be added.

### 14.4.4 Application Rate Allowance, A₂ (litres/m²)

#### 14.4.4.1 General

Where appropriate, allowances to the base rate of application shall be made for:

- surface texture
- absorption into the existing pavement
- absorption into the aggregate
- embedment or penetration of the aggregate into the pavement materials

These allowances are discussed further below.

#### 14.4.4.2 Surface Texture Allowance

The basic rate of the application of the binder is based on a seal being applied to a smooth surface without any texture depth and into which there will be no absorption of any of the binder.

In order to make allowance in the rate of application of binder a classification of the existing surface is necessary. This classification must take into account for that binder which may be required to coat or be lost around an existing surface or gained from the existing surface. In most cases, other than a flushed surface, this classification is done by measuring the texture depth of the existing surface and determining the appropriate allowance based on the size of the existing and proposed surface seals.

This applies to both initial treatments and retreatments. The surface classification should be done in the main wheel tracks because that is where
the aggregate will receive its full compaction although some allowance needs to be made for the surface classification between the wheel paths.

The allowance for surface classification depends to a large extent on the size of the aggregate. For the same texture depth the allowance would be greater for a size 14 aggregate than for a small aggregate such as size 7 which may fit in the voids of the existing surface.

The method of determining the allowance for surface texture is as follows:

- determine the size or type of the existing surfacing
- carry out a sand patch test, determine the diameter of the sand patch and hence the surface texture of the surface at that location
- carry out a number of sand patch tests to determine an average surface texture depth
- using the graph in Figure 14.4.4.2 for the correct existing surface type and the proposed surfacing size to determine the appropriate surface texture allowance.

Sufficient sand patch testing should be undertaken to reliably determine the representative texture in the wheel paths and between the wheel paths.

For practical purposes the allowances are made in increments of 0.1 litre/m².

The normal surface classification allowance on a well primed pavement would be from 0.1 litre/m² to about 0.2 litre/m² for most pavement materials.

Hill gravels may require a higher allowance of say 0.3 litre/m². If an allowance above this is required for size 10 or size 14 aggregate then consideration should be given to using a smaller aggregate like size 7mm.

With reseals and final seals the surface texture may result in an allowance up to 0.50 litre/m². If this allowance is needed for aggregates of size 14 or size 10mm size then consideration should be given to using a smaller aggregate. For this reason it is always important to determine the surface texture allowance for reseals and final seals before letting a contract or ordering the intended aggregate in case the aggregate size is too large or in other cases a small aggregate is proposed where a larger aggregate could be economically used.

When classifying a primerseal which still has a lively primerbinder, some caution should be exercised in the allowance made. A lively primerseal could allow some embedment of the aggregate and effect the new binder of the next seal by either cutting it or actually providing some extra binder. For these reasons a lower than normal (say 0.10 litre/m² less) allowance should be made than if the primerbinder was fully oxidised and the primerseal had the same texture depth.

If the existing surfacing is full or flushed the application rate of binder may need to be reduced. This reduction is estimated. The allowance is generally in the range minus 0.1 to 0.2 litres/m².

When determining the allowance for texture both wheelpaths need to be considered and a compromise reached. More emphasis should be placed on the texture in the wheel path but between the wheelpaths should not be
Figure 14.4.4.2 Surface Texture Allowances

- Asphalt Surface
- Existing Seal

<table>
<thead>
<tr>
<th>Diameter of Sand Patch (mm) (Volume = 50.0cc)</th>
<th>Allowance For Surface Texture (Litre/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>140</td>
<td>0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8</td>
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<tr>
<td>340</td>
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</tbody>
</table>

- Use Smaller Aggregate if appropriate
forgotten. If the difference in texture between the textures in the wheelpaths and between the wheelpaths would result in an application rate that is more than 20% different it is advisable to:

(i) consider using a smaller aggregate, say a 7 mm nominal size or small aggregate, to provide a more uniform surface texture
(ii) consider using a slurry seal to uniform the surface
(iii) consider pre spraying (or local surface enrichment) between the wheel paths (ie the hungry areas) to make allowance for the different textures.

14.4.4.3 Absorption of Part of the Binder into the Surface to be Treated

This allowance is quite distinct from the surface texture and an additional absorption allowance may apply to all types of surfaces whether they are fine or coarse. The allowance made varies but in most cases usually 0.10 litre/m² is sufficient.

Absorption allowances may apply to the following:

(i) A primed surface
   Experience has shown that an absorption allowance may need to be made for limestone and sandstone pavements because of the long term absorption by these types of pavement materials. Applying excess primer will not solve the problem without creating other worse problems such as flushing or excessive time for the primer to dry and cure. In the north western portion of the State an allowance of 0.1 to 0.2 litre/m² for absorption should always be made for limestone and carefully considered for sandstone pavements.

   Poorly or inadequately primed surfaces will usually also absorb binder. In low traffic areas only (< 600 vehicles/lane/day) rather than allow for absorption in the design of the seal coat it is better practice, if possible, to lightly reprimed the pavement as this will be more economical and reduce the risk of future stripping. In circumstances where repriming is not possible an estimate of the absorption is required. This will generally be in the range 0.2 to 0.3 litres/m².

(ii) A primersealed surface
   It appears that some absorption of the binder may take place when applying the final seal over a primerseal in which the primerbinder has nearly completely oxidised. This should be kept in mind when inspecting primerseals due for a final seal. A typical allowance in this case 0.10 litre/m².

   In the case of a lively primerseal, it may be necessary to reduce the application rate to allow a reduction in the application rate for contributions from the binder of the ‘lively’ primerseal and possible embedment into the primerseal. A typical allowance is a deduction 0.1 litre/m².

(iii) An existing bituminous surface or smooth surface.
This may be either a seal coat, asphalt or concrete. This does not often apply to an existing seal coat but may apply to an asphalt or concrete which may have a relatively smooth surface texture while still having voids which may take binder and cannot be adequately determined with the sand patch method. A typical allowance is an addition of 0.1 to 0.2 litre/m².

14.4.4.4 *Absorption of Part of the Binder into the Aggregate*

An absorption allowance of 0.10 litre/m² may need to be considered when using aggregates which may absorb some of the binder. Typical aggregates this may apply to are:

- Limestone
- Scoria
- Quartzite

This allowance need not be made when these aggregates are precoated with precoating material (such as cutback bitumen or a bitumen emulsion) which coats and seals off the surfaces of the aggregate particles. If the existing surface to be treated is a seal coat with one of the above aggregates, not specially precoated when applied, and a considerable proportion of aggregate is exposed (eg., a hungry surface) then some consideration should also be given to making some additional allowance for absorption of the new binder into the old aggregate.

As a guide to the allowance for binder absorption for new types of aggregates or existing aggregates where there is concern about the absorption, Austroads has developed a test to give quantitative advice on the absorption allowance. Table 14.4.4.4 provides the appropriate allowance to be added.

*Table 14.4.4.4 Allowances for binder Absorption by Aggregate*

<table>
<thead>
<tr>
<th>Binder Absorption calculated from the Austroads Test (%)</th>
<th>Absorption Allowance (litres/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1</td>
<td>0 to +0.1</td>
</tr>
<tr>
<td>&gt; 1 to 3</td>
<td>0.1 to 0.3</td>
</tr>
<tr>
<td>&gt; 3</td>
<td>Do not use unless performance is proven</td>
</tr>
</tbody>
</table>

14.4.4.5 *Embedment/Penetration of the Aggregate into the Existing Surface*

This may occur on initial treatments where the primed pavement is soft, a fresh primerseal, or a soft or weak asphalt. It rarely occurs on an existing seal unless it has excess binder up well up around the aggregate (see Section 14.4.4.2) and the aggregate will press into this.

This again is a matter of experience and some deduction must be made for the effective loss in the depth of the traffic compacted mat. Usually an allowance of 0.10 litre/m² should be sufficient however further guidance can be obtained from Figure 14.4.4.5. This figure relates ball embedment results and traffic volumes to the deduction in binder application rate.
In Victoria, the typical ball embedment results are:

- zero to 3mm for primerseals
- 3 to 5mm for soft limestones and sandstones
- 5 to 8mm for very soft pavements

In Victoria, most softer pavement materials are used on low traffic roads so deductions for embedment are rarely more than 0.2 litres/m². An exception to this occurs when placing a seal on fresh or soft asphalt or fresh premixed asphalt.

Note: Ball embedment results of less than 1mm result in zero allowance for embedments.

If it is suspected a considerable amount of penetration will take place it would be more satisfactory to use a small aggregate, such as size 7 or 5, to provide a layer more than one stone thick.

**Figure 14.4.4.5 Ball Embedment allowances**

14.4.4.6 Local Factors

(a) General

The design method presented here covers all appropriate allowances commonly made by VicRoads to ensure that sprayed seals perform satisfactorily.

There may be justifiable factors that practitioners have found necessary in their local area to make allowances. Practitioners should only add to the binder application rates when their experience has demonstrated the need. This should not be based on isolated jobs.
Figures 14.4.4.5A, B, C, & D  Ball Imbedment Test

Refer Austroads Design Method
(b) Optimising durability or surface texture

There is a traditional concern about the binder application rates required to produce a sprayed seal that will result in:

- good surface texture and result in a waterproof pavement with a good life
- a seal with slightly less surface texture and a longer life because more binder has been used

Practitioners may choose to increase the durability of their sprayed seal at the risk of reduced surface texture, hence a potential reduction in the long term skid resistance. They may wish to increase the binder application rate by 0.1 litres/m² for traffic ranges less than 600 v/l/d. It would be unwise to arbitrarily use this local allowance where the traffic is in excess of 600 vehicles/lane/d, as this would increase the risk of excess binder causing flushing.

14.4.4.7 Minimum binder application rate

Where adjustments and allowances have been made for embedment and heavy traffic it is necessary to check that the design binder application rate is sufficient to hold the aggregate in the short term until the traffic has worked the binder up around the aggregate and embedment has occurred.

To prevent short term stripping it is necessary that the Design Rate of application of binder (at 15°C) is not less than 0.10*ALD (litre/m²). If a lower binder application rate was designed it may be necessary to review the type of treatment, e.g., use of a larger aggregate or applying a preliminary surface correction treatment.

Note: The minimum binder application rate for a PMB seal becomes 0.10*ALD*PMB factor (litre/m²).

14.4.5 Determining Base Rate of Binder Application Tables

Table 14.4.5 – Rate of Binder application for sprayed seals has been developed to determine the Base Rates of application of binder for the various traffic volumes, likely void adjustments and covering a range of ALDs, from 3.6 mm to 10.0 mm, in increments of 0.4 mm. Base rates should be determined using the ALD interpolated to the nearest 0.1 mm.

Note: Allowances need to be added to these base rates to determine the design rate of application.

The rate of application of the residual binder is based on the volume measured at the standard temperature of 15°C.
Table 14.4.5A Base Rate of Binder application for sprayed seals

<table>
<thead>
<tr>
<th>ALD mm</th>
<th>Traffic Range (Basic Voids Factor ≤ 50 (Bvf = 0.23))</th>
<th></th>
<th>Traffic Range (Basic Voids Factor 50 to 100 (Bvf = 0.21))</th>
<th></th>
<th>Traffic Range (Basic Voids Factor 100 to 150 (Bvf = 0.19))</th>
<th></th>
</tr>
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<td>Void adjustment factor</td>
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### Table 14.4.5B Base Rate of Binder application for sprayed seals

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<th>ALD in mm</th>
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<th>ALD in mm</th>
<th>Traffic Range 300 to 600 (Bvf = 0.15)</th>
<th>Void adjustment factor</th>
<th>ALD in mm</th>
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### Table 14.4.5C  Base Rate of Binder application for sprayed seals

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<th>ALD in mm</th>
<th>Traffic Range (Basic Voids Factor) 1200 to 2400 (BvF = 0.12)</th>
<th>ALD in mm</th>
<th>Traffic Range 2400 to 4800 (BvF = 0.11)</th>
<th>ALD in mm</th>
<th>Traffic Range &gt;4800 (BvF = 0.10)</th>
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</table>
14.5  RATES OF APPLICATION OF BINDER FOR 7 MM AGGREGATE OR SMALLER

Because of the shape of these aggregates and the fact that normally the seal coat is more than one stone in thickness for these small aggregates, the design method for these aggregates is based on:

- the standard base rates given in Table 14.5, which do not require void adjustment corrections
- allowances for texture, absorption into the aggregate and existing pavement and embedment. These allowances are made in accordance with should be determined in accordance with Section 14.4.4 and added in the normal manner.

If a size 7 aggregate appears to be large and/or cubical, the ALD should be determined to check the rate of application using the procedure in Section 14.4. If the base rate of application determined is higher than the rate above then the higher rate should be used.

Table 14.5  Base rates for binder application for 7mm aggregate or smaller

<table>
<thead>
<tr>
<th>Traffic Volume in vehicles/day/lane</th>
<th>Basic binder application rate (litres/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7mm</td>
</tr>
<tr>
<td>&lt; 100</td>
<td>0.8</td>
</tr>
<tr>
<td>100 to 600</td>
<td>0.7</td>
</tr>
<tr>
<td>600 to 1200</td>
<td>0.6</td>
</tr>
<tr>
<td>&gt; 1200</td>
<td>0.5</td>
</tr>
</tbody>
</table>

14.6  RATES OF APPLICATION OF BINDER – MULTIPLE APPLICATION WORK

14.6.1  General

Any multiple application work done by the VicRoads is normally two applications of both binder and aggregate. These two forms of multiple application work are distinguished by the time between the first and second application of binder and aggregate. The two basic types are:

- where both applications of binder and aggregate occur together, ie., within the same day or very soon afterwards
- where the second application of binder and aggregate occurs sometime after the first application of binder and aggregate, ie., separated by two or more weeks.

A third form of multiple application work involves an application of binder and aggregate followed by a second application of aggregate. The second application of aggregate does not involve an application of binder and only a small portion of the aggregate is expected to stay in place in the long term. The second application of aggregate is often referred to as a rack-in coat.
<table>
<thead>
<tr>
<th>First Application</th>
<th>Basic Voids Factor, Proportion of the mat in the traffic compacted aggregate to be filled with residual binder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Aggregate</td>
<td>TRAFFIC - vehicles per lane per day</td>
</tr>
<tr>
<td></td>
<td>&lt; 150</td>
</tr>
<tr>
<td>Size 10</td>
<td>Size 14 or larger</td>
</tr>
<tr>
<td>Basalt Dacite</td>
<td>0.18</td>
</tr>
<tr>
<td>Diabase Dolerite</td>
<td></td>
</tr>
<tr>
<td>Sandstone &amp; quartz &amp; slate</td>
<td></td>
</tr>
<tr>
<td>Other than Above</td>
<td>0.20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second Application</th>
<th>Residual binder first application - rates**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Aggregate</td>
<td>Residual binder second application rates (litre per square metre)***</td>
</tr>
<tr>
<td></td>
<td>Size 3 and sand</td>
</tr>
<tr>
<td>Group 1</td>
<td>Basalt Dacite Diabase Dolerite Sandstone &amp; quartz &amp; slate</td>
</tr>
<tr>
<td>Other Aggregate</td>
<td>Other than above</td>
</tr>
</tbody>
</table>

* Residual Binder is bitumen plus polymer (rubber or other polymer) plus any flux oil used, measured by volume at 15°C and does not include any cutter that might be used.

** The rate of application of residual binder of the first application of binder is determined from the average least dimension (ALD) of the aggregate multiplied by the design voids factor (which are based on Basic Voids Factor and adjustments to the voids factor (Section 14.4.3) plus allowances (Section 14.4.4).

*** No allowance for surface texture is to be added to these rates of application.

Note: The second application of binder and aggregate should not be applied until the first application has been adequately rolled and the surplus aggregate removed.
14.6.2 Both Applications Together

The following procedure applies to design of two application seals where the second application is to follow the first application immediately or within a short period.

The design of the first application is similar to a single application seal coat but with special consideration given to the Basic Voids Factor (proportion of the mat to be filled with binder) and the spread rate of aggregate. The spread rate of aggregate is normally slightly less than the rate used for single application sprayed seals.

The second application is designed from experience.

Table 14.6 – Two Application Seals, Basic Voids Factor in the traffic compacted mat to be Filled for First Application and Recommended Rate of Application for Second Application gives the Basic Voids Factor (proportion of the mat to be filled with binder) for the first application and gives the rates of application for the second application. The Basic Voids Factor used for the first application needs to be adjusted to allow for the Flakiness Index, geometry and commercial vehicle considerations however the total binder application rate should be checked to ensure stripping is prevented. Other information such as surface texture, absorption allowances etc., is also required to complete the design of the first application. Allowances are included in the second application given in the table. The rate of application for the aggregate is designed to be slightly less than the rate for single application work.

14.6.3 Applications Some Time Apart

Where both applications of binder and aggregate do not occur together as described in 14.6.2 then each application should be designed individually in accordance with the procedure for single application work.

Special care needs to be made for the surface texture allowance for the design of the second application of binder because the fresh binder, which may contain cutter as well, may ultimately permit the design surface texture to reduce if there was more time between the first and second applications. A deduction in the surface texture allowance of 0.1 to 0.3 litres/m² may be appropriate.

14.6.4 Single Application Followed by a Rack-in Coat

This form of double application seal is designed as a single application sprayed seal in accordance with Section 14.4 and the second application of aggregate is applied after the first application of aggregate is adequately rolled and any surplus aggregate removed. The second application of aggregate is normally spread at 80 to 90% of the normal aggregate spread rate for the size of aggregate. This is because aggregates do not form a mosaic like a normal seal but fit between the voids of the larger aggregates.
14.7 BITUMEN-CRUMB RUBBER AND OTHER PMB SEALS

14.7.1 Recommended Crumb Rubber/Bitumen Combinations

Table 14.7A lists the recommended practical combinations of crumb rubber and Class 170 bitumen and their main uses.

14.7.2 Rates of Application of Polymer Modified Binder

The rate of application of polymer modified binder for a HSS or SAM seal is calculated from the normal design method as follows:

(i) Modified Binder Base rate = normal design base rate x PMB factor (litres/m²)

(ii) Allowances = as for a normal seal coat design (litres/m²)

(iii) Design rate of application = (i) ± (ii) litres/m² (this is rounded off to the nearest 0.10 litres/m² – See Section 14.13, example No. 8)

**Table 14.7A Recommended Combinations of Crumb Rubber and Class 170 Bitumen**

<table>
<thead>
<tr>
<th>Type of treatment</th>
<th>Parts of crumb rubber per 100 parts of bitumen (by mass)</th>
<th>Recommended Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Stress Seal (HSS)</td>
<td>5 parts (4.8% by mass)</td>
<td>To be used mainly initial retention of the aggregate in difficult traffic situations</td>
</tr>
<tr>
<td>Stress alleviating membrane (SAM)</td>
<td>20 parts (17% approx. by mass)</td>
<td>To be used mainly where fine to medium cracks (up to about 5mm) exist in the pavement</td>
</tr>
<tr>
<td>Stress alleviating membrane interlayer (SAM)</td>
<td>25 parts (20% approx. by mass)</td>
<td>To be used on badly cracked but basically structurally sound pavements, after filling major cracks with a rubberised binder and major patching of the pavement as necessary, to eliminate or reduce reflection cracking. Also used as a Stress Alleviating Membrane Interlayer beneath an asphalt surface.</td>
</tr>
</tbody>
</table>

The polymer modified binder factor is a factor that allows for additional binder for waterproofing purposes plus the different orientation of the aggregates that occurs in a polymer modified binder sprayed seal when compared with a Class 170 binder seal.

The value of the PMB factor depends upon the:

- type of polymer
- traffic volumes
- the loading type acting on the sprayed seal

Table 14.7B lists the PMB factors currently used by VicRoads.
In the design of polymer modified sprayed seals containing crumb rubber or other polymers, the residual binder is composed of bitumen plus crumb rubber or other polymer plus combining oils. Combining oils or processing oils used premixed factory produced crumb rubber blends are considered as cutting oils. Cutting oils and adhesion agents are not considered to be part of the residual binder in polymer modified binders manufactured from rubber or other polymers.

14.7.3 Sprayed Seals Designed as Strain Alleviating Membrane Interlayers (SAMIs)

The Basic Voids Factor adopted for the design of SAMI seals is 0.16. This will result in a basic application rate which provides a thick layer of binder to resist or retard the reflection of cracks from the underlying surface through the asphalt layer placed over the SAMI seal.

The rates of application of the residual binder are calculated similarly to the normal design method as follows:

(i) **Base rate** = $0.16 \times \text{ALD} \times \text{PMB factor (litres/m}^2\text{)}$
(ii) **Allowances** = as for a normal seal coat design (litres/m$^2$)
(iii) **Design rate of application** = (i) ± (ii) litre/m$^2$
    (this is rounded off to the nearest 0.10 litre/m$^2$ – see Section 14.13, example No. 8)

Table 14.7B lists the BCRS and other PMB factors to be used.

**Table 14.7B PMB Factors to Determine the Rates of Application of Binder**

<table>
<thead>
<tr>
<th>Traffic Volume (vehicle/lane/day)</th>
<th>Type of seal</th>
<th>Equivalent parts of crumb rubber</th>
<th>PMB Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crumb rubber based polymer modified binder</td>
</tr>
<tr>
<td>All traffic</td>
<td>HSS</td>
<td>5 parts/100 parts of bitumen</td>
<td>1.0 to 1.1, i.e. additional 0.10 to 0.20 litre/m$^2$ over normal design rate</td>
</tr>
<tr>
<td>&lt; 500</td>
<td>SAM Seal</td>
<td>20 to 25 parts/100 parts of bitumen</td>
<td>1.7 to 2.0</td>
</tr>
<tr>
<td>500 to 3000</td>
<td></td>
<td></td>
<td>1.6 to 1.8</td>
</tr>
<tr>
<td>3000 to 5000</td>
<td></td>
<td></td>
<td>1.5 to 1.7</td>
</tr>
<tr>
<td>5000 to 8000</td>
<td></td>
<td></td>
<td>1.4 to 1.6</td>
</tr>
<tr>
<td>&gt; 8000</td>
<td></td>
<td></td>
<td>1.3 to 1.5</td>
</tr>
</tbody>
</table>

SBS = Styrene Butadiene Styrene  
PMB = Polybutadiene

Note: In order to prevent flushing up in high volume turning movement areas, braking and/or acceleration areas and heavily trafficked intersections, application rates should be reduced in these areas by at least 0.3 litre/m$^2$ for Bitumen Crumb Rubber Seals (BCRS) and 0.2 litre/m$^2$ for SBS and PBD based polymers. When reducing the application rate for intersections etc the application rate should not be below 0.10*Polymer Factor*ALD.
In the design of SAMI seals containing crumb rubber or other polymer, the residual binder is composed of bitumen and crumb rubber or other polymer. Cutting oils and adhesion agents are not considered to be part of the residual SAMI seals should only be constructed using Size 10 or 14 mm aggregates. Size 7 mm aggregate is not used as it is too small to enable sufficient binder to be applied to have the strain alleviating membrane interlayer affect.

**Figure 14.7.1** Bitumen crumb rubber seal (20 parts of crumb rubber) with size 10 aggregate over a cracked but stable pavement. Age 12 months

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### 14.8 SPRAYED SEALS USING GEOTEXTILE REINFORCING

The design of geotextile sprayed seals is under development. The current design is undertaken by a process of experience and using the current design methods to determine the base rate for single application, double application and PMB design methods plus normal allowances (except as detailed below) plus allowance for the geotextile.

The current allowances are as follows:

- for lightly trafficked rural roads, all normal allowances plus additional 0.9 to 1.1 litres per square metre for the geotextile (140 g per square metre)
- for heavily trafficked urban roads, little or no surface texture allowance plus other allowances if necessary, plus an additional
  - (i) 0.6 to 0.7 litres per square metre for the geotextile (140 g per square metre) for double application work, or
  - (ii) 0.8 to 1.0 litres per square metre for the geotextile (140 g per square metre) for single application work.

Figure 14.4.4.3A attached gives typical application rates while Figure 14.4.4.3B shows the typical laying sequence for a geotextile reinforced sprayed seal.

Note: Single application geotextile spray seals are unusual in the urban area unless they are to be overlayed with an asphalt (normally ultra thin asphalt). Single application PMB geotextile reinforced spray seals have been used in the rural area in essentially straight alignments without intersections.
14.9 RATES OF APPLICATION OF AGGREGATE

14.9.1 General

When using a good quality, one sized stone of 10 mm or larger nominal size the final cover of aggregate held by the binder will be only one stone thick.

Under normal operating conditions it is not possible to spread the nett quantity of aggregate required and it is not possible to avoid whip-off due to traffic. The loss due to whip-off will vary, depending on type of binder, grading and size of the aggregate, prevailing weather, spreading equipment and speed and volume of traffic. Fast traffic soon after spreading causes most of the whip-off. In practice the loss due to whip-off can be taken as being between 2% for size 20 and 10% for size 7 aggregate.

For sprayed work using standard binders VicRoads uses the following formula to determine the basic rate of application of aggregate:

\[ \text{Aggregate Application Rate} = \frac{900}{\text{ALD}} \text{ m}^2/\text{m}^3 \]

The above formula does not include any allowance for the traditional whip-off from a sealed surface which occurs generally within days of carrying out a sprayed seal. The formula does however include an allowance for loss of aggregate that is not part of a layer one stone thick and may have initially been held by partial contact with bitumen. Austroads analysis of sprayed seals suggests that the aggregate held in place after two years may be as low as (1100 divided by ALD). To initially spread at this low application rate is not practical because additional aggregate is required to achieve a shoulder to shoulder aggregate mosaic in the seal.

Table 14.9.1 – One Sized Aggregate – Rates of Application for Single Application Sprayed Work sets out the recommended rates of application in square metres per cubic metre (loose) to the nearest five square metres for aggregates with ALDs between 3.6 mm and 12.0 mm in increments of 0.2 mm. It also indicates the amount of whip-off included.

The application rates of aggregate for binders using polymer modified binder (crumb rubber and other polymers) SAM seals are heavier than the rates mentioned above. See Section 14.9.5.

14.9.2 Determination of Rates of Application of Aggregate for Single Application Work

The rate of application of aggregate for single application seals is essentially governed by the ALD of the aggregate although the application rate is marginally influenced by the shape of the aggregate, rate of application of binder, volume of traffic and the existing surface.

(a) For Size 10 and Larger (applicable to single application work and the first application of multiple application work.).

Table 14.9.1 provides aggregate application rates for ALD of aggregates from 3.6 to 10.0 in 0.2mm increments. The aggregate application rate have been calculated for a spread rate of 850 to 900 divided by the ALD plus the stated percentage allowance for whip-off. The aggregate application rate should be interpolated to the ALD of the aggregate being used to the nearest 0.1mm.
(b) For Size 7 and Smaller (applicable to single application work, and the second application of multiple application work.)

For size 7 and smaller the ALD is not determined because there is no limit set on the flakiness index and generally the seal coat has more than one layer thickness of stone with these aggregates.

The recommended rates of application of aggregates are given in Table 14.9.2.

**Table 14.9.1 One Sized Aggregate – Rates of Application for Single Application Sprayed Work**

<table>
<thead>
<tr>
<th>ALD mm</th>
<th>Application rate (loose) m³/m³</th>
<th>Allowance for whip off included in application rate</th>
<th>ALD mm</th>
<th>Application rate (loose) m³/m³</th>
<th>Allowance for whip off included in application rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6</td>
<td>215</td>
<td>10 %</td>
<td>7.8</td>
<td>105</td>
<td>4%</td>
</tr>
<tr>
<td>3.8</td>
<td>205</td>
<td></td>
<td>8.0</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>195</td>
<td></td>
<td>8.2</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>185</td>
<td></td>
<td>8.4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>175</td>
<td></td>
<td>8.6</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>4.6</td>
<td>170</td>
<td></td>
<td>8.8</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>4.8</td>
<td>165</td>
<td></td>
<td>9.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>160</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>155</td>
<td>8%</td>
<td>9.2</td>
<td>90</td>
<td>3%</td>
</tr>
<tr>
<td>5.4</td>
<td>150</td>
<td></td>
<td>9.4</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>5.6</td>
<td>145</td>
<td></td>
<td>9.6</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>5.8</td>
<td>140</td>
<td></td>
<td>9.8</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td>135</td>
<td></td>
<td>10.0</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>130</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.4</td>
<td>125</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.6</td>
<td>125</td>
<td>6%</td>
<td>10.5</td>
<td>80</td>
<td>2%</td>
</tr>
<tr>
<td>6.8</td>
<td>120</td>
<td></td>
<td>11.0</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>7.0</td>
<td>115</td>
<td></td>
<td>12.0</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>7.2</td>
<td>115</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.4</td>
<td>110</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.6</td>
<td>110</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When obtaining aggregate, the normal allowance shall be made for loss incurred at the stack, etc.

**Table 14.9.2 Application Rates for 7mm and Smaller Aggregates**

<table>
<thead>
<tr>
<th>Size of Aggregate</th>
<th>Single Application</th>
<th>Second Application in a two application seal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size 7</td>
<td>between 150 to 160 m³/m³</td>
<td>between 170 to 180 m³/m³</td>
</tr>
<tr>
<td>Size 3 and 5</td>
<td>between 180 to 160 m³/m³</td>
<td>between 200 to 210 m³/m³</td>
</tr>
<tr>
<td>Sand</td>
<td>approximately 200 m³/m³</td>
<td>approximately 220 m³/m³</td>
</tr>
</tbody>
</table>
If the size 7 aggregate appears large or is oversized (by the grading) an ALD could be useful to determine if the rate of application is below the recommended limit. If so, the rate of application as determined by the ALD (Table 14.9.1) should be used.

14.9.3 Determination of Rates of Application of Aggregate for Multiple Application Work
Application rates of aggregate for the first application of a multiple application may be up to 5 to 10% lighter than that given in Table 14.9.1. Application rates of aggregate for the second application of a multiple application is given Table 14.9.2.

14.9.4 High Strength Seals (HSS)
The aggregate application rate for a High Strength Seal (HSS) is the same as the rates given in Table 14.9.1.

14.9.5 SAM and SAMI Seals
Because the binder used in bitumen crumb rubber and other polymer modified binder sealing is more viscous than normally used the aggregate particles tend not to be able to align themselves as in normal seals and tend to stand proud. To support the aggregate particles in this position it is necessary to use heavier than normal rates of application of binder and spread the aggregate heavier than normal.

Generally for a SAM seal an additional 5 to 10% of aggregate is required compared to normal work as given in Table 14.9.1.

Generally for a SAMI seal the aggregate spread rate is slightly lower (5 to 10%) than for normal sealing works because the seal will be covered with asphalt and it is desirable that there be no excess aggregate to be removed prior to placing asphalt.

14.9.6 Geotextile Reinforced Sprayed Seal
The rates of application of aggregate for a geotextile reinforced sprayed seal are the same as for single or multiple application sprayed seals.
Figure 14.4.3A Guidelines for selection of geotextile treatment types. (The bitumen application rates given are an example only)
Figure 14.8B  Typical Laying Sequence for a geotextile reinforced sprayed seal

TYPICAL LAYING SEQUENCE FOR A GEOTEXTILE DOUBLE SEAL

100 mm

7 mm aggregate
Bitumen 0.5 l/m²

7 mm aggregate
Bitumen 0.5 l/m²

14 mm aggregate
Bitumen 1.6 l/m²
Geotextile

14 mm aggregate
Bitumen 1.6 l/m²
Geotextile
Bond coat 0.6 l/m²

EXISTING ROAD PAVEMENT

The overlap of the geotextile join does not have to be located on the centre or lane line

TYPICAL LAYING SEQUENCE FOR A GEOTEXTILE SINGLE SEAL

100 mm

14 mm aggregate
Bitumen 1.6 l/m²
Geotextile

14 mm aggregate
Bitumen 1.6 l/m²
Geotextile
Bond coat 0.6 l/m²

EXISTING ROAD PAVEMENT

The overlap of the geotextile join should be located on the centre or lane line

Note: The bitumen application rates given are an example only
14.10 SELECTION OF BINDER

14.10.1 Requirements

The function of the binder is to hold the aggregate in place and the seal coat as a whole to the pavement. Therefore there must be a bond between the binder and both the aggregate and the pavement.

The binder must be able to withstand shock and be self healing, and must have sufficient ductility, adhesion and tensile strength at both high and low pavement temperatures (70°C to < 5°C approx.) to hold the aggregate in place under the prevailing conditions.

14.10.2 Selection of Type and Grade

(a) General

For economy, a binder should have as long a life as possible. To achieve this, a seal containing the largest possible proportion of bitumen and of the softest possible grade for the service conditions expected, should be used.

(b) Normal Sealing Conditions

On most of the sprayed work carried out in Victoria the basic binder normally used is Class 170 bitumen or Class 170 bitumen fluxed to a softer grade as required for the traffic conditions. Refer to Chapter 4 for specification and details.

(c) Special Conditions

(i) Retention

In adverse conditions where it is difficult to achieve a strong bond between the normal binder and the aggregate it may be necessary to modify the binder if it is undesirable to reduce the aggregate size. This applies to conditions such as high volume, high speed traffic (e.g., urban highways and freeways), very winding alignments producing high loadings and a delay of say more than one week between applying the seal coat under light traffic and opening it to its normal higher volume of traffic – say 1200 v/l/d or more (e.g., a deviation not opened to traffic until fully completed). In these cases the basic binder may be modified to improve its retention properties and temperature susceptibility by the addition of crumb rubber or other polymer at a suitable concentration. This is quite separate and distinct from improving adhesion between binder and aggregate using adhesion agent.

With crumb rubber the standard proportion is 5 parts of crumb rubber by mass to 100 parts of Class 170 bitumen measured at 15°C.

The rates of application of binder and aggregate are designed as for a normal seal coat with allowances for additional binder and aggregate as indicated in Sections 14.7 and 14.9.5.
(ii) Cracked pavements
Where the existing bituminous surfacing is badly crazed and cracked the cracks will, after a short time, reflect through into the new seal coat using normal binder. This is because the normal binder is not resilient and elastic enough.

Thus the waterproofing quality of the new seal has been greatly reduced or destroyed. This may be overcome to some extent by using a light cutback bitumen (primer binder) reseal followed by a normal seal coat within 2 or 3 years (see Section 13.3.1); or preferably, if the weather conditions are suitable, by modifying the normal binder with rubber in the form of crumb rubber (see Section 13.3) or other polymer which will provide a tough resilient binder applied at heavier than normal rates of application. This process is well developed and Austroads Framework Specification for Polymer Modified Binders, AP-TO4, June 2000, should be consulted to assist in the specification and selection of the appropriate binders.

For the practical combinations of crumb rubber and Class 170 bitumen, their main uses and the appropriate polymer factors for both crumb rubber and other polymer modified bitumen (see Section 14.7).

14.10.3 Residual Binder
Residual binder is bitumen plus any rubber or other polymer plus any flux oil, measured by volume at 15°C. Residual binder does not include any cutter that might be used because this will ultimately not remain in the binder.

14.10.4 Fluxing
(a) General
Fluxing oil is classed as having a long term effect and is regarded as being part of the binder.

(b) Class 170 Bitumen
Table 16.13.3B or Table 8.7.5B give the proportions of flux oil to be added to 100 parts of Class 170 bitumen, measured by volume at 15°C, for various traffic volumes with the types and sizes of aggregate normally used.

(c) Class 170 Bitumen modified with crumb rubber and other polymer modifiers.
Bitumen crumb rubber and other polymer modifiers binders should only be fluxed in accordance with the ‘cutter charts’ when traffic volumes are low.

To aid and promote adhesion between the viscous bitumen-crumb rubber mixture and the aggregate, adhesion agent must always be added to the binder in the sprayer. To aid and promote adhesion between the binder of polymer modified binders and the aggregate, adhesion agent is always added unless the manufacturer recommends otherwise.
Recommended quantity of adhesion agent is 1 part per 100 parts of binder for the normal strength adhesion agents generally used.

14.10.5 Cutting Back

(a) General

Cutting back is for improving the adhesion of aggregate to the binder and workability of the binder and is regarded as a temporary effect.

The quantity of cutter to be added should not be decided until just before spraying the load of binder.

Any cutter added is not regarded as being part of the residual binder.

(b) Class 170 Binder

Table 16.13.2D or Table 8.7A give the proportions of cutter to be added to 100 parts of Class 170 bitumen, measured by volume at 15°C, for the pavement temperature for various traffic volumes with the normal range of aggregate sizes used.

(c) Binder Modified With Crumb Rubber

Table 16.13.2F or Table 8.7C give the proportion of cutter to be added to 100 parts of Class 170 bitumen, measured by volume at 15°C, where the binder is modified by the addition of crumb rubber.

Note: The proportion of cutter to be added is based on field produced crumbed rubber mixtures. If premixed crumbed rubber is used the manufacture must supply information about the components of the mixture. The proportion of cutter to be added to premixed crumbed rubber must deduct any combining oils or fluxes deducted from the proportions given in Table 8.7C or Table 16.13.2F.

(d) Polymer modified binders other than crumb rubber

Polymer modified binders (other than crumb rubber) should be cut in accordance with the manufacturers directions or Table 8.7A with the following provisions:

- the minimum amount of cutter to be added shall be 2 parts per 100 parts of binder
- the cutter type should be appropriate for the polymer type. For example some polymers are not adequately cut using high flash point type cutter normally used by VicRoads and require the use of highly aromatic cutters
- the weather conditions under which polymer modified work is carried out should generally limit the cutter concentration to 4 parts per 100 parts of binder.

14.10.6 Sprayed Film Thickness of Binder

As a matter of interest, the thickness of a sprayed film of residual binder that is sprayed onto a flat road surface at various rates of application is setout in Table 14.10.6. This thickness is not the same as the binder thickness present in the mosaic of a sprayed seal as the binder has been displaced by aggregate and squeezed up between the aggregate particles. The normal thickness of binder in between aggregate particles is half to two thirds the ALD of the aggregate.
Table 14.10.6  Film Thickness of Binder on a flat road surface for Various Rates of Application

<table>
<thead>
<tr>
<th>Rate of Application</th>
<th>Film Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>litre/m²</td>
<td>mm</td>
</tr>
<tr>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>0.80</td>
<td>0.80</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>1.20</td>
<td>1.20</td>
</tr>
<tr>
<td>1.40</td>
<td>1.40</td>
</tr>
<tr>
<td>1.60</td>
<td>1.60</td>
</tr>
<tr>
<td>1.80</td>
<td>1.80</td>
</tr>
<tr>
<td>2.00</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Note: The rate of application of residual binder is measured by volume at 15°C. The relative density of the residual binder is taken as being 1.00 at 15°C. The volume of 1 litre of residual binder is taken as being 1,000,000 mm³ at 15°C.

14.11 SELECTION OF AGGREGATE

14.11.1 Requirements

The function of aggregate is to resist abrasion and to transmit the wheel loads to the base. The aggregate is kept in position by the binder.

The aggregate should possess the necessary hardness, toughness, wearing and crushing strength to withstand the type of traffic conditions expected. As the volumes and types of traffic vary widely, many qualities of aggregate can be used successfully. It is usual to obtain the cheapest material which will give the service required.

14.11.2 Type

All of the types of aggregate listed in Table 14.4.2 – Basic Voids Factor for determining the Proportion of mat to be Filled with Binder (Single Application Sprayed Work) may be used. If a synthetic aggregate or type of aggregate not listed is proposed to be used, the proportion of the mat to be filled and any other special treatment required needs to be determined.

The quality and cleanliness of the aggregate is more critical with BCRS and other polymer modified binder work than with normal sealing work. Only good quality aggregates complying with the specification should be used. Limestone and soft granites should not be used on BCRS and other polymer modified binder work.

14.11.3 Classification

Aggregate is classified depending on physical properties (see Section 2.2). This classification should be used to specify an aggregate with adequate quality for the service conditions expected.

Using an aggregate of a classification lower than desirable for the particular job will generally result in a shorter service life of the seal.
14.11.4 Grading

The design of a seal coat is based on using one sized aggregates and every effort should be made to obtain only aggregates complying with the specification for one sized aggregate (see Section 2.4). The only exception to this is the use of a graded size 5 and sand.

If a size 7 aggregate or larger does not comply with the grading and percentage flats specification, the question of whether it may be used successfully depends on its deviation from the specification, its size and the traffic volume and type of road it is to be used on.

If these aggregates are only slightly outside the specification for oversize and specified size they could be used, with caution, and the rates of application designed as normal based on their ALD.

Aggregates which are out of specification should not be used on busy roads, say more than 600 vehicles/lane/day, but with caution may be used on roads with light traffic volumes although the final result will not be as good as with a one sized aggregate complying with the specification. Preferably the aggregate should be replaced with aggregate complying with the specification. The effect of using an out of specification aggregate in a seal is worse with the larger aggregates, size 10 and 14, than with the smaller aggregates.

If the only part of the grading not complying with the specification is the dust, i.e., passing a 2.36 mm AS sieve, then within limits the aggregate loader may be used to dry screen the aggregate and remove this prior to doing the work. See Section 16.5.7.

Figure 2.4.2B diagrammatically illustrates the effect of oversize, specified size and under size aggregate particles in a seal coat.

14.11.5 Precoating

All aggregate should be precoated before it is used on sealing work. This is to improve wettability and adhesion with the binder and allows the use of a more viscous binder which will set up quicker and provide faster retention of the covering aggregate. When precoating is carried out in the field, the precoating material is generally Diesel Fuel Oil/Distillate with or without additives depending on conditions or bitumen emulsion precoating material. When precoating is carried out in a quarry, the precoating material is normally a cutback bitumen or bitumen emulsion precoating material.

See Section 5.8 for materials used and Section 16.6 for precoating rates and procedures.

For BCRS and other polymer modified binder work, it is preferable that aggregate is precoated with a bitumen based approved product, i.e., cutback bitumen or an appropriately formulated bitumen emulsion. Where bitumen based precoating is not available, the aggregate must be precoated at least with Diesel Fuel Oil/Distillate containing adhesion agent and should be slightly over precoated compared to normal sealing work.
14.11.6 Average Least Dimension and Flakiness Index of the Aggregate-Size 10 and Larger

The Average Least Dimension (ALD) and the Flakiness Index (FI) of size 10 mm and larger aggregate is determined from the aggregate samples by the supply contractor using the VicRoads standard test method as detailed in Code of Practice RC/MTD 500.09.

Because of the small size the ALD and FI are not normally measured or calculated on size 7 mm and smaller aggregates. Refer to Section 14.5 for additional information.

14.12 DESIGN TRAFFIC CONSIDERATIONS

14.12.1 General

Traffic volume has a direct bearing on the Basic Voids Factor (proportion of the mat to be filled) and thus the rate of application of binder. It is therefore important that an accurate traffic count be used to design the rate of application. In addition, the proportion of the commercial vehicles in the traffic count is important.

The normal traffic count provided is the total volume of traffic (ie., AADT) so it is therefore necessary to determine the vehicle count per day per lane. For most highways and main roads this is available from VicRoads or Municipal records. If not available, it will be necessary for the client organisation to arrange for a manual traffic count or to install an automatic traffic counter for a few days.

If the only traffic count available is a 12 hour count (7:00 a.m. to 7:00 p.m.) then for most work, other than in built up areas, a reasonable approximation is to multiply the 12 hour count by 1.2 to estimate the 24 hour count. It should however be noted that some freeways/ highways/ main roads have a high proportion of traffic using them at night so care should be used when converting 12 hour counts to 24 hour counts. In some locations the factor can be 1.8 or higher.

On multi lane carriageways it is necessary to know the proportion of the traffic using each lane. This is more accurately obtained by having an actual traffic count for each lane of the carriageway. This applies mainly to freeways, duplicated highways and heavily trafficked roads in the Melbourne Metropolitan and Provincial Cities Geelong, Ballarat, Bendigo, etc., for example, 2 or 3 lane carriageways on duplicated roads or 2 or 3 lane single carriageways.

On duplicated two lane carriageway rural highways it is recommended that the actual traffic count for each lane be taken. If it is not practical to separately count the traffic in each lane, it has been found that a satisfactory approximation is to take about 70 to 80% of the total traffic using the outer lane and about 20 to 30% using the inner lane.

Table 14.4.2 shows Basic Voids Factors (the proportion of the mat to be filled) for various ranges of traffic volumes. The traffic ranges are based on vehicles per lane per day.
Failure to correct the traffic counts will result in binder filling too high or too low a proportion of the mat, and therefore an incorrect base rate of application of residual binder, for the conditions.

14.12.2 Commercial Vehicles
The number or proportion of commercial vehicles should normally be obtained as part of the traffic counting undertaken by VicRoads or Municipalities (refer to 14.12.1).

14.12.3 Special Conditions
If the work is near wheat silos, showgrounds, race tracks, detours etc., it is important to determine the influence these may have on the normal traffic count and when this occurs.

A sudden large temporary increase in the traffic volume, eg., on a show day or wheat carting season, early in the life of the seal, say within one month of the work being done, will compact the aggregate further and may affect the proportion of the mat to be filled with bitumen (ie., Basic Voids Factor) to the extent that the binder may rise above the aggregate, particularly in areas where the normal traffic count is low, ie., less than 100 vehicles/lane/day. Preferably the work should be deferred until such time as the traffic count will be normal for a period of say a month.

There are jobs where the seal coat may be placed and subjected to only light or no traffic for some time before being subjected to the normal traffic, eg. large construction jobs not opened to traffic until fully completed. This may or may not affect the proportion of the mat required to be filled with bitumen depending on the time limit between doing the work and subjecting it to its full traffic.

There is risk of stripping if a seal coat is not trafficked for some time. This occurs because traffic is required to fully bed aggregate into the bitumen. In addition dust has often caused a film on top of the binder and the binder, having lost some of its wetting properties because cut has evaporated, is less able to wet and grip the aggregate.

In other cases an existing busy road may have its traffic volume drastically reduced in the near future, eg., a temporary deviation. Designing the rates of application for the high traffic count will result in a shortened life if soon after the traffic is greatly reduced. It may be preferable to delay the treatment until this occurs.

If unsure of the effect of these conditions on the rate of application of binder and/or the performance of the seal coat, GeoPave should be consulted.
14.13 EXAMPLES AND TABLES

14.13.1 General

The following examples are provided as a guide to determining the rates of application of residual binder and aggregate from the standard tables for various types of work, traffic volumes and aggregate types and sizes.

The examples provided are:

(a) Single Application Work

Example No. 1, Reseal–930 v/l/d – size 14 OS granite
Example No. 2, ITP & S–380 v/d (12 hour count) – size 10 OS quartz porphyry
Example No. 3, Reseal–210 v/l/d – size 10 OS river gravel
Example No. 4, Reseal–40 v/d (24 hour count) – size 7 OS basalt
Example No. 5, ITFS–2620 v/l/d – size 14 OS basalt
Example No. 6, Reseal–4100 v/l/d (multi lane carriageway) including crumb rubber in the binder – size 10 OS basalt
Example No. 7, Reseal – individual traffic counts on a multi lane carriageway – size 14 OS basalt
Example No. 8, (BCRS) Reseal–11000 v/d – size 14 basalt

(b) Multiple Application Work

Example No. 9, ITFS–345 vpd – size 20 and size 7 OS river gravel

14.13.2 Single Application Work

14.13.2.1 Example No. 1

(a) Job Details

Type of work – Reseal
Traffic – 930 v/l/d
Aggregate  size 14 OS granite
median size 10.9 mm
flakiness index  20.9%
ALD  8.2 mm
Existing surface – a size 7 granite seal, some minor cracking, surface texture is 0.8mm.
Insignificant ball embedment is measured and no absorption is expected into the existing surface or into the aggregate.

(b) Rate of Application of Residual Binder

See Binder Application Rate Check Sheet 14.1

(c) Rate of Application of Aggregate

(From Table 14.13). The rate of application of aggregate for an ALD of 8.2 mm = 100 to 110 m²/m³

(d) Fluxing and/or Cutting Back

From Table 16.13.2E (or Table 8.7B)

For size 14 aggregate no flux oil is required with 930 v/l/d and the residual binder will be Class 170 bitumen. The amount of cutter required will depend on the pavement temperature at the time the work.
**Binder Application Rate Check Sheet 14.1**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate size</td>
<td>14 mm basalt 8.2 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic (Table 14.4.2)</td>
<td>Basic Voids Factor</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td><strong>ADJUSTMENT AGGREGATE FACTORS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape - FI (Table 14.4.3.1)</td>
<td>20.9</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Commercial vehicles</td>
<td>(see 14.3.2)</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Passing lanes (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Untrafficked areas (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Grade of pavement (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>TOTAL:</td>
<td></td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Design Voids Factor</td>
<td></td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Basic application rate</td>
<td>(ALD * VF)</td>
<td>1.23</td>
<td></td>
</tr>
<tr>
<td>Polymer modified binder factor</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ALLOWANCES</strong></td>
<td>VALUE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing surface</td>
<td>7 mm seal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface texture</td>
<td>1.25 mm +0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absorption</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>aggregate</td>
<td>NA</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>existing binder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>existing asphalt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Embedment (Ball penetration value)</td>
<td>NA</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Total allowances</td>
<td></td>
<td>0.3 litres/m²</td>
<td></td>
</tr>
<tr>
<td>Other factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design binder application rate</td>
<td>0.3 + 1.23 = 1.63 litre/m²</td>
<td>ADOPTED APPLICATION RATE litres/m²</td>
<td></td>
</tr>
<tr>
<td><strong>STRIPPING CHECKS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stripping check of construction</td>
<td>0.10 * ALD</td>
<td>0.82</td>
<td></td>
</tr>
</tbody>
</table>

Note: All rates of application of residual binder are measured by volume 15°C is done.
14.13.2.2 Example 2

(a) Job Details Type of work – ITPS & S

Traffic – 380 vpd (12 hour count) (Commercial vehicles 10%)

Geometry – No steep grades

Aggregate size l0 OS quartzporphyry

- median size 7.9 mm
- flakiness index 21.9%
- ALD 5.9 mm

Existing surface – primed sandstone pavement starting to look a little dry, uniform texture

Allowances

- surface texture 0.2 litres/m²
- pavement absorption 0.2 litres/m² (a very dry primed surface)
- aggregate absorption expected to be zero

Ball embedment results indicate an average embedment of 3mm.

(b) Rate of Application of Residual Binder

The traffic count provided is for 12 hours and the design is based on a 24 hour count. Take 120% as a reasonable approximation. Therefore the 24 hour traffic count is 1.2*380 = 460 vpd (ie., 230 v/l/d thus in the 150 to 300 traffic range).

See Binder Application Rate Check Sheet 14.2.

(c) Rate of Application Of Aggregate

From Table 14.13

The rate of application of aggregate for an ALD of 5.9 mm = 140 to 150 m²/m³

(d) Fluxing and/or Cutting Back

From Table 8.7B or (Table 16.13.2E)

For size 10 aggregate 2 parts of flux oil are required with 230 v/l/d and the residual binder will be Class 170 bitumen + flux oil. The amount of cutter required will depend on the pavement temperature at the time the work is done.
### Binder Application Rate Check Sheet 14.2

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate size type</td>
<td>10 mm Quartz porphyry 5.9 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic (Table 14.4.2)</td>
<td>Basic Voids Factor</td>
<td>0.18</td>
<td>Quartzporphy is in group 2</td>
</tr>
<tr>
<td>230 vfl/d</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADJUSTMENT AGGREGATE FACTORS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape - FI (Table 14.4.3.1)</td>
<td>2.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial vehicles</td>
<td>20%</td>
<td>-0.00</td>
<td></td>
</tr>
<tr>
<td>Passing lanes (see 14.4.3.2)</td>
<td>NA</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Untrafficked area (see 14.4.3.2)</td>
<td>NA</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Grade A pavement (see 14.4.3.2)</td>
<td>NA</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>10.01</td>
<td></td>
</tr>
<tr>
<td>Design Voids Factor</td>
<td></td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>Basic application rate</td>
<td>(ALD * VF)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Polymer modified binder factor</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ALLOWANCES

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing surface</td>
<td>7 mm seal</td>
</tr>
<tr>
<td>Surface texture</td>
<td>1.25 mm +0.2</td>
</tr>
<tr>
<td>Absorption aggregate existing binder</td>
<td>NA 0.0</td>
</tr>
<tr>
<td>Absorption aggregate existing asphalt</td>
<td>NA 0.0</td>
</tr>
<tr>
<td>Embedment (Ball penetration value)</td>
<td>Average 3mm 0.0</td>
</tr>
<tr>
<td>Total allowances</td>
<td>0.2 litres/m²</td>
</tr>
<tr>
<td>Other factors</td>
<td>0.2 + 1.00 = 1.20 litre/m² ADOPTE'd APPLICATION RATE litres/m²</td>
</tr>
</tbody>
</table>

### STRIPPING CHECKS

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stripping check of construction</td>
<td>0.10 * ALD 0.59</td>
</tr>
</tbody>
</table>

1.20
14.13.2.3 Example No. 3

(a) Job Details

Type of work – Reseal
Traffic – 500 v/l/d (24 hour count one direction)
(Commercial vehicles 4%)
Aggregate size 10 OS partly crushed river gravel (PCRG)
  median size 8.1 mm
  flakiness index 16.6%
  ALD 6.3 mm
Existing surface – a size 7 mudstone seal, fairly course with considerable texture depth (average 1.3mm), well patched.
Absorption
  None expected into aggregate
  Some expected into dry mudstone aggregate surface

(b) Rate of Application of Residual Binder

See Binder Application Rate Check Sheet 14.3

(c) Rate of Application of Aggregate

From Table 14.13

The rate of application of aggregate for an ALD of 6.3 mm
= 125 to 130 m²/m³

(d) Fluxing and/or Cutting Back

From Table 16.13.2E (or Table 8.7B) for size 10 aggregate no flux oil is required with 500 v/l/d and the residual binder will be Class 170 bitumen. The amount of cutter required will depend on the pavement temperature at the time the work is done.
Binder Application Rate Check Sheet 14.3

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate size type</td>
<td>10 mm PC River Gravel 6.3 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic (Table 14.4.2)</td>
<td>Basic Voids Factor</td>
<td>0.12</td>
<td>PC River Gravel is in group 3</td>
</tr>
</tbody>
</table>

**ADJUSTMENT AGGREGATE FACTORS**

<table>
<thead>
<tr>
<th>Shape - FI (Table 14.4.3.1)</th>
<th>Commercial vehicles</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>16.6%</td>
<td>4%</td>
<td>0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Passing lanes (see 14.4.3.2)</th>
<th>Untrafficked areas (see 14.4.3.2)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>NA</td>
<td>0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade of pavement (see 14.4.3.2)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**TOTAL**

<table>
<thead>
<tr>
<th>Design Voids Factor</th>
<th>0.01</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Basic application rate (ALD + VF)</th>
<th>1.07</th>
</tr>
</thead>
</table>

Polymer modified binder factor | NA |

**ALLOWANCES**

<table>
<thead>
<tr>
<th>Existing surface</th>
<th>Surface texture</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7 mm seal</td>
<td>1.3 mm</td>
<td>+0.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Absorption aggregate existing binder existing asphalt</th>
<th>Allow into existing M/S</th>
<th>+0.1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Embedment (Ball penetration value)</th>
<th>Average 4 mm</th>
<th>+0.1</th>
</tr>
</thead>
</table>

Total allowances | 0.5 litres/m² |

Other factors

<table>
<thead>
<tr>
<th>Design binder application rate</th>
<th>0.5 + 1.07 = 1.57 litre/m²</th>
</tr>
</thead>
</table>

**STRIPPING CHECKS**

<table>
<thead>
<tr>
<th>Stripping check of construction</th>
<th>0.10 * ALD</th>
<th>0.63</th>
</tr>
</thead>
</table>

ADOPTED APPLICATION RATE litres/m² | 1.60 |
14.13.2.4 Example No. 4

(a) Job Details

Type of work – Reseal
Traffic – 1540 v/d (24 hour) or 770 v/l/d
Aggregate size 7 0S basalt.
Existing surface – coarse hungry size 14 basalt seal with great texture depth (2.3mm average), some cracking and crazing.

(b) Rate of Application of Residual Binder

From 25.6.1
For size 7 aggregate the determination of ABL is not considered necessary. For 770 v/l/d the accepted standard base rate of application of residual binder = 0.60 litres/m² (Table 14.5)

Allowances
Absorption NA
Surface texture (2.3mm) +0.4 litres/m²
Traffic No Adjustment
Rate of application of residual binder = 0.60 + 0.40 = 1.0 litres/m²

(c) Rate of Application of aggregate From 14.9.1

The accepted standard rate of application for size 7 aggregate = 150 to 160 m³/m³

(d) Fluxing and/or Cutting Back

From Table 16.13.3E (or Table 8.7.5B)

For size 7 aggregate no flux oil is required with 770 v/l/d and the residual binder will be Class 170 bitumen.

The amount of cutter required will depend on the pavement temperature at the time the work is done.
14.13.2.5 Example No. 5

(a) Job Details

Type of work – Initial Treatment Final Seal (ITFS)
Traffic – 1310 v/l/d (25% commercial vehicles)
Aggregate size 14 OS basalt
  median size 11.0 mm
  flakiness index 15.9%
  ALD 8.6 mm
Existing surface – a primerseal with size 10 basalt aggregate – in good condition with the primerbinder nearly completely oxidised – would absorb some of the binder (estimate 0.1 litres/m²), surface texture (0.8mm).

(b) Rate of Application of Residual Binder

See Binder Application Checksheet 14.5

(c) Rate of Application of Aggregate

From Table 14.13

The rate of application of aggregate for an ALD of 8.6 mm = 95 to 100m²/m³

(d) Fluxing and/or Cutting Back

From Table 16.13.2E (or Table 8.7B)

For size 14 no flux oil is required with 1310 v/l/d and the residual binder will be Class 170 bitumen. The amount of cutter required will depend on the pavement temperature at the time the work is done.
### Binder Application Rate Check Sheet 14.5

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate size type ALD</td>
<td>14 mm basalt 8.6 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic (Table 14.4.2) 1310 vfl/d</td>
<td>Basic Voids Factor</td>
<td>0.12</td>
<td>0.12 Basalt is in group</td>
</tr>
</tbody>
</table>

#### ADJUSTMENT AGGREGATE FACTORS

- **Shape - FI (Table 14.4.3.1)** 15.9
- **Commercial vehicles** 25% -0.01
- **Passing lanes (see 14.4.3.2)** 3% 0.00
- **Untrafficked areas (see 14.4.3.2)** 0.00
- **Grade of pavement (see 14.4.3.2)** NA 0.00

**TOTAL:** -0.01

- **Design Voids Factor** 0.11
- **Basic application rate (ALD * VF)** 0.95

| Polymer modified binder factor | NA |

#### ALLOWANCES VALUE

- **Existing surface** 7 mm seal
- **Surface texture** 0.8 mm +0.2
- **Absorption of aggregate existing binder existing asphalt** NA 0.0
- **Embedment (Ball penetration value)** Average 0.5 mm 0.0

**Total allowances** 0.2 litres/m²

#### Other factors

| Design binder application rate          | 0.2 + 0.95 = 1.15 litre/m² |

#### STRIPPING CHECKS

| Stripping check of construction | 0.10 * ALD | 0.86 | 1.1 |

Binder Application Rate Check Sheet 14.5

Withdrawn - Refer Austroads Design Method
14.13.2.6 Example No. 6

(a) Job Details

Type of work – Reseal on a four lane, divided carriageway highway. Because of the volume and nature of the traffic 5 parts of crumb rubber is to be incorporated in the binder.

Traffic – 2050 vpd (in the carriageway) (Commercials 20%)
Aggregate size 10 OS basalt
- median size – 7.8 mm
- flakiness index – 10.0%
- ALD – 6.5 mm

Existing surface – an existing size 10 mm asphalt surface generally in good condition. Allowance for surface texture – outer or slow lane 0.2 litres/m² (because it is old and dry), inner or fast lane 0.3 litres/m² (more open than the slow lane)

(b) Rate of Application of Residual Binder

The traffic needs to be in vehicles per lane per day. Because of the nature of the traffic the split between the slow lane and the fast lane is 70%:30%. Therefore the traffic volume of the slow lane is 0.7*2050 = 1435 v/l/d while the traffic in the fast lane is 0.3*2050 = 715 v/l/d

As most commercial vehicles stay in the slow lane the percentage of commercials in the slow lane is about 0.2*2050/1435 = 28%. The percentage of commercials in the fast lane is likely to be in the ‘less than 5% range’.

See Binder Application Rate Check Sheets 14.6A and 14.6B.

(c) Rate of Application of Aggregate

This is not dependent on the traffic and will be the same for both lanes. From Table 14.13

The rate of application of aggregate for an ALD of 6.6 mm = 120 to 130 m²/m³

(d) Fluxing and/or Cutting Back

From Table 16.13.2E (or Table 8.7B)

For size 10 aggregate no flux oil is required with either 1435 v/l/d or 715 v/l/d. In this case the residual binder will be Class 170 bitumen.

From Table 16.13.2D (or Table 8.7A)

The amount of cutter required will depend on the pavement temperature at the time the work is done.
**Binder Application Rate Check Sheet 14.6A**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate size type ALD</td>
<td>10 mm basalt 6.5 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic (Table 14.4.2) 1435 v/f/d</td>
<td>Basic Voids Factor</td>
<td>0.4</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Result is in group 1</td>
</tr>
<tr>
<td>ADJUSTMENT AGGREGATE FACTORS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape - FI (Table 14.4.3.1)</td>
<td>10.0</td>
<td>+0.6</td>
<td></td>
</tr>
<tr>
<td>Commercial vehicles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passing lanes (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Untrafficked areas (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Grade of pavement (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>TOTAL:</td>
<td></td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Design Voids Factor</td>
<td></td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td>Basic application rate (ALD * VF)</td>
<td></td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>Polymer modified binder factor Factor</td>
<td>Use 1.1</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>ALLOWANCES</td>
<td>VALUE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing surface</td>
<td>Asphalt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface texture</td>
<td>0.6 mm</td>
<td>+0.2</td>
<td></td>
</tr>
<tr>
<td>Absorption aggregate existing binder</td>
<td>0.2 litres/m²</td>
<td>+0.2</td>
<td></td>
</tr>
<tr>
<td>existing asphalt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Embedment (Ball penetration value)</td>
<td>Average 0.5 mm</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Total allowances</td>
<td>0.4 litres/m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design binder application rate</td>
<td>0.4 + 0.86 = 1.26 litres/m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STRIPPING CHECKS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stripping check of construction</td>
<td>0.10 * ALD* PMB factor</td>
<td>0.8</td>
<td>Adopt 1.3 for the slow lane</td>
</tr>
</tbody>
</table>

**Notes:**
- Binder Application Rate Check Sheet 14.6A
- Withdrawn - Refer Austroads Design Method
### Binder Application Rate Check Sheet 14.6B

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate size type ALD</td>
<td>10 mm basalt 6.5 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic (Table 14.4.2) 715 v/ld</td>
<td>Basic Void Factor</td>
<td>0.13</td>
<td>Basalt is in group 1</td>
</tr>
</tbody>
</table>

#### ADJUSTMENT AGGREGATE FACTORS

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape - FI (Table 14.4.3.1)</td>
<td>10.0</td>
<td>+0.01</td>
</tr>
<tr>
<td>Commercial vehicles</td>
<td>&lt;5%</td>
<td>+0.01</td>
</tr>
<tr>
<td>Passing lanes (see 14.4.2)</td>
<td>NA</td>
<td>0.00</td>
</tr>
<tr>
<td>Untrafficked areas (see 14.4.2)</td>
<td>NA</td>
<td>0.00</td>
</tr>
<tr>
<td>Granular pavement (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>0.02</td>
</tr>
</tbody>
</table>

#### ALLOWANCES

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Polymer modified binder factor</td>
<td>Factor Use 1.1</td>
<td>1.07</td>
</tr>
</tbody>
</table>

#### Existing surface

<table>
<thead>
<tr>
<th></th>
<th>Asphalt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface texture</td>
<td>0.6 mm</td>
</tr>
<tr>
<td>Absorption aggregate existing binder existing asphalt</td>
<td>0.3 litres/m²</td>
</tr>
<tr>
<td>Embedment (Ball penetration value)</td>
<td>Average 0.5 mm</td>
</tr>
<tr>
<td>Total allowances</td>
<td></td>
</tr>
</tbody>
</table>

#### Other factors

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Design binder application rate</td>
<td>0.6 + 1.07 = 1.67 litre/m²</td>
<td>ADOPTED APPLICATION RATE litres/m²</td>
</tr>
</tbody>
</table>

#### STRIPPING CHECKS

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stripping check of construction</td>
<td>0.10 * ALD + PMB factor</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
14.13.2.7 Example No. 7

(a) Job Details

Type of work – Reseal on two lanes of the northbound carriageway only of a four lane divided carriageway road.
Traffic (actual lane counts) – Outer lane: 5726 v/l/d (24 hour count)
Inner lane: 2300 v/l/d (24 hour count) (20% commercials)
Aggregate size 14 OS basalt plant precoated with cutback bitumen.
median size 10.2 mm
flakiness index 21.7%
ALD 7.6 mm
Existing surface – size 10 asphalt worn smooth but otherwise in good condition,
Surface texture – Outer lane: 0.3 mm, Inner lane: 0.7 mm

(b) Rate of Application of Residual Binder

See Rate of Application of Binder Check Sheets 14.7A and 14.7B.

(c) Rate of Application of Aggregate

This is not dependent on the traffic and will be the same for both lanes.
From Table 14.9.1.

The rate of application of aggregate for an ALD of 7.6 mm
= 105 to 115 m²/m³

(d) Fluxing and/or Cutting Back

From Table 16.13.2E (or Table 8.7B) no flux oil is required with for the traffic volumes under consideration.

The amount of cutter required will depend on the pavement temperature at the time the work is done.
### Binder Application Rate Check Sheet 14.7A

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aggregate size type ALD</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic (Table 14.4.2) 5726 v/kl</td>
<td>Basic Voids Factor</td>
<td>0.10</td>
<td>Basalt is in group 1</td>
</tr>
<tr>
<td><strong>ADJUSTMENT AGGREGATE FACTORS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape - FL (Table 14.4.3.1)</td>
<td>21.7</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Commercial vehicles</td>
<td>20%</td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td>Passing lanes (see 14.4.2)</td>
<td></td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Untrafficked sections (see 14.4.5.1)</td>
<td>NA</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Graded surfacement (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td></td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td><strong>Polymer modified binder factor</strong></td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ALLOWANCES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing surface</td>
<td>Asphalt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface texture</td>
<td>0.3 mm</td>
<td>+0.1</td>
<td></td>
</tr>
<tr>
<td>Absorption aggregate existing binder existing asphalt</td>
<td>0.1 l/m²</td>
<td>+0.1</td>
<td></td>
</tr>
<tr>
<td>Embedment (Ball penetration value)</td>
<td>NA</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Total allowances</td>
<td></td>
<td>0.2 litres/m²</td>
<td></td>
</tr>
<tr>
<td><strong>Other factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design binder application rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>STRIPPING CHECKS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stripping check of construction</td>
<td>0.10 * ALD</td>
<td>0.76</td>
<td></td>
</tr>
</tbody>
</table>
## Binder Application Rate Check Sheet 14.7B

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate size type ALD</td>
<td>10 mm basalt 6.5 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic (Table 14.4.2) 715 v/klm</td>
<td>Basic Voids Factor</td>
<td>0.12</td>
<td>0.10 Basalt is in group 1</td>
</tr>
</tbody>
</table>

### ADJUSTMENT AGGREGATE FACTORS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape - Fl (Table 14.4.3.1)</td>
<td>21.7</td>
<td>0.00</td>
</tr>
<tr>
<td>Commercial vehicles</td>
<td></td>
<td>1.01</td>
</tr>
<tr>
<td>Passing lanes (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
</tr>
<tr>
<td>Untrafficked areas (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
</tr>
<tr>
<td>Grade of pavement (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>Design Voids Factor</td>
<td>-0.01</td>
</tr>
<tr>
<td></td>
<td>Basic application rate (ALD * VF)</td>
<td>0.91</td>
</tr>
</tbody>
</table>

| Polymer modified binder factor | NA                                      |

### ALLOWANCES

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing surface</td>
<td>Asphalt</td>
<td></td>
</tr>
<tr>
<td>Surface texture</td>
<td>0.7 mm</td>
<td>+0.2</td>
</tr>
<tr>
<td>Absorption aggregate existing binder existing asphalt</td>
<td>0.1 l/m²</td>
<td>+0.1</td>
</tr>
<tr>
<td>Embedment (Ball penetration value)</td>
<td>Average 0.5 mm</td>
<td>0.0</td>
</tr>
<tr>
<td>Total allowances</td>
<td>0.3 litres/m²</td>
<td></td>
</tr>
</tbody>
</table>

| Other factors               |               |       |
| Design binder application rate | 0.3 + 0.91 = 1.21 litre/m² | Adopted APPLICATION RATE litres/m² |

### STRIPPING CHECKS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stripping check of construction</td>
<td>0.10 * ALD</td>
<td>0.76</td>
</tr>
</tbody>
</table>
**14.13.2.8 Example No. 8**

(a) Job Details

Type of work – Reseal on a busy highway. The pavement is sound but has some large well patched longitudinal cracks as well as a large number of fine random cracks. Because of the heavy traffic and the cracking, 20 parts of crumb rubber polymer modified binder is proposed. Traffic – approximately 11000 vpd (12 hour count two way traffic) (10% commercials)

Aggregate size 14 0S basalt (plant precoated with Cutback bitumen)

- median size 11.0 mm
- flakiness index 18%
- ALD 8.6 mm

Existing surface – an existing size 10 asphalt, surface texture is 0.7 mm and embedment is expected. Embedment hammer results indicate a 1.5 mm average embedment.

(b) Rate of Application of Residual Binder

The traffic figures are two way 12 hour counts and must be converted to one way, 24 hour counts. For this highway, which is not used a lot at night the 12 hour to 24 hour conversion factor is approximately 1.2. The traffic uses the highway equally in both directions so the two way to one way conversion factor is 0.5. Therefore traffic on one carriageway is

\[ 1.2 \times 0.5 \times 11000 = 6600 \text{ vpd on the carriageway} \]

The split of traffic between the slow and fast lanes is 80% to 20%. Therefore the design traffic in the slow lane is 5280 v/l/d and in the fast lane 1320 v/l/d.

See Binder Application Rate Checklists 14.8A and 14.8B

(c) Rate of Application of Aggregate

This is not dependent on the traffic and will be the same for both lanes.

The rate of application of aggregate for an ALD of 8.6 mm

\[ = 90 \text{ to } 100 \text{ m}^2/\text{m}^3 \]

(d) Fluxing and/or Cutting Back

From Table 16.13.2E (or Table 8.7.5B)

For size 14 aggregate no flux oil is required with either 5280 v/l/d or 1320 v/l/d. In this case the residual binder will be Class 170 bitumen with 20 parts of crumb rubber.

The amount of cutter required will depend on the pavement temperature at the time the work is done.
### Binder Application Rate Check Sheet 14.8A

**Item** | **Description** | **Value** | **Comment**
---|---|---|---
Aggregate size type ALD | 14 mm basalt 8.6 mm | | Basalt is in group 1
Traffic (Table 14.4.2) 5280 v/l/d | Basic Voids Factor | 0.10 | Consider rounding up

**ADJUSTMENT AGGREGATE FACTORS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape - FI (Table 14.4.3.1)</td>
<td>16.0</td>
<td>0.00</td>
</tr>
<tr>
<td>Commercial vehicles</td>
<td>20%</td>
<td>0.00</td>
</tr>
<tr>
<td>Passing lanes (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
</tr>
<tr>
<td>Untrafficked areas (see 14.4.3.2)</td>
<td>NA</td>
<td>0.00</td>
</tr>
<tr>
<td>Grade of pavement 14.4.3.2</td>
<td>NA</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL:</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Design Voids Factor</td>
<td></td>
<td>0.09</td>
</tr>
<tr>
<td>Basic application rate (ALD * VF)</td>
<td></td>
<td>0.77</td>
</tr>
<tr>
<td>Polymer modified binder factor</td>
<td>Factor</td>
<td>Use 1.5</td>
</tr>
</tbody>
</table>

**ALLOWANCES**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing surface</td>
<td>Asphalt</td>
</tr>
<tr>
<td>Surface texture</td>
<td>0.3 mm</td>
</tr>
<tr>
<td>Absorption aggregate existing binder existing asphalt</td>
<td>0.1 l/m²</td>
</tr>
<tr>
<td>Embedment (Ball penetration value) Average 1.5 mm</td>
<td></td>
</tr>
<tr>
<td>Total allowances</td>
<td></td>
</tr>
<tr>
<td>Other factors</td>
<td></td>
</tr>
<tr>
<td>Design binder application rate</td>
<td></td>
</tr>
<tr>
<td>ADOPTED APPLICATION RATE litres/m²</td>
<td></td>
</tr>
</tbody>
</table>

**STRIPPING CHECKS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stripping check of construction</td>
<td>0.10 * ALD + PMB factor</td>
</tr>
<tr>
<td></td>
<td>1.29</td>
</tr>
</tbody>
</table>

Adopt 1.3 for the slow lane
### Binder Application Rate Check Sheet 14.8B

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate size type ALD</td>
<td>14 mm basalt 8.6 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic (Table 14.4.2) 1320 v/dl</td>
<td>Basic Voids Factor 0.12</td>
<td>0.12</td>
<td>Basalt is in group 1</td>
</tr>
</tbody>
</table>

#### ADJUSTMENT AGGREGATE FACTORS

| Shape - FI (Table 14.4.3.1) | 1.00 | 1.00 | Consider rounding up |
| Commercial vehicles | 20% | -0.01 | |
| Passing lanes (see 14.4.3.1) | | | |
| Untrafficked areas (see 14.4.3.2) | 0.00 | | |
| Grade of pavement (see 14.4.3.2) | NA | 0.00 | |
| TOTAL | | +0.01 | |
| Design Voids Factor | 013 | | |
| Basic application rate (ALD + VF) | 1.12 | | |
| Polymer modified binder factor Factor | Use 1.7 | 1.9 | Cancels out round up |

#### ALLOWANCES

| Existing surface | Asphalt | |
| Surface texture | 0.3 mm | +0.1 |
| Absorption aggregate existing binder existing asphalt | 0.1 l/m² | 0.0 |
| Embedment (Ball penetration value) | Average 1.5 mm | -0.1 |

| Total allowances | +0.1 litres/m² |

Other factors

| Design binder application rate | 0.1 + 1.9 = 2.0 litre/m² | ADOPTED APPLICATION RATE litres/m² |

#### STRIPPING CHECKS

| Stripping check of construction | 0.10 * ALD * PMB factor | 1.29 | Adopt 2.0 for the slow lane |
14.13.3 Multiple (2) Application Work

14.13.3.1 Example No. 9

(a) Job Details

Type of work – ITFS on very winding road with steep grades, for this reason a two application seal is proposed.
Traffic – 200 v/l/d (24 hour, one way count) with 31% commercials
Aggregate size 20 mm 0S partly crushed river gravel
median size 15.2 mm
flakiness index 17.1%
ALD 11.8 mm
size 7 mm 0S partly crushed river gravel
size 7 0S, other details are not applicable.
Existing surface – a size 7 primerseal – in good condition with the primerbinder still showing some life – surface texture 0.7mm.

(b) Rate of Application of Residual Binder

(1) Size 20 Aggregate (First application)
See Rate of Application of Binder Checksheet 14.9

(2) Size 7 Aggregate (Second application)

From Table 14.9.2.

Rate of application of residual binder = 0.60 litres/m² (for group 1) or 0.7 litres/m² (‘other’ group) (No allowance applicable.)

(c) Rate of Application of Aggregate

(i) Size 20 Aggregate (First application) From the equation in Section 14.9.1 and allowing for 3% whip-off the rate of application of aggregate for an ALD for 11.8 mm is 70 to 75 m²/m³

(ii) Size 7 Aggregate (Second application)

From 14.13.

The accepted standard rate of application for size 7 aggregate = 170 to 180 m²/m³

(d) Fluxing and/or Cutting Back

(i) Size 20 Aggregate (First application)
From Table 16.13.2E (or Table 8.7B) 2 parts of flux oil is suggested with 200 v/l/d and the residual binder will be Class 170 bitumen + flux oil. The amount of cutter required will depend on the pavement temperature at the time the work is done.

(ii) Size 7 Aggregate (Second application)
From Table 16.13.2E (or Table 8.7B), for size 7 aggregate 2 parts of flux oil are required with 200 v/l/d and the residual binder will be Class 170 bitumen + flux oil. The amount of cutter required will depend on the pavement temperature at the time the work is done.
### Binder Application Rate Check Sheet 14.9

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate size type ALD</td>
<td>20 mm PC Gravel 11.8 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic (Table 14.6) 200 v/d</td>
<td>Basic Voids Factor</td>
<td>0.15</td>
<td>Two applications. Group - others</td>
</tr>
</tbody>
</table>

### ADJUSTMENT AGGREGATE FACTORS

| Shape - FL (Table 14.4.3.1) | 17.1 | Consider rounding up |
| Commercial vehicles | 31% | 0.02 |
| Passing lanes (see 14.4.3.2) | NA | 0.00 |
| Untraficked areas (see 14.4.3.2) | NA | 0.00 |
| Grade of pavement (see 14.4.3.2) | 0.00 or -0.01 | 0.00 in flat areas -0.01 in steep areas |
| **TOTAL** | | -0.02 or -0.03 |
| Design Voids Factor | 0.13 or 0.12 |
| Basic application rate (ALD * VF) | 1.53 or 1.42 |

| Polymer modified binder factor | Factor | NA | NA |

### ALLOWANCES

| Existing surface | Seal 7 mm | |
| Surface texture | 0.7 mm | +0.2 |
| Absorption aggregate existing binder existing asphalt | NA | 0.0 |
| Embedment (Ball penetration value) | Average 1.5 mm | 0.0 |
| **Total allowances** | | +0.2 litres/m² |

### Other factors

| Design binder application rate | 0.2 + 1.53 or 1.42 = 1.73 or 1.62 litres/m² |

### STRIPPING CHECKS

| Stripping check of construction | 0.10 * ALD | 1.18 |

Adopt 1.7 on the flat areas and 1.6 on the grades
15.1 GENERAL
Sprayed work is a specialised operation involving specialised equipment operated by a team of trained personnel.

Each Bituminous Surfacing Unit (BS Unit) is mobile, self-contained and readily able to move from one location to another.

15.2 PRIMING/PRIMERSEALING UNIT
Units do not generally operate a unit exclusively for priming/primersealing and this work is undertaken by the sealing units when economically practical or the work is contracted out.

The following is considered to be a reasonable complement for a unit engaged mainly on priming and primersealing work:

15.2.1 Personnel
1 Works Manager
1 Sprayer driver/operator
1 Road tanker driver
1 Aggregate loader driver (primersealing only)
1 Aggregate spreader operator (primersealing only)
2 Truck drivers (priming 1 only, primersealing 2)
1 Roller driver (primersealing only)
1 Road broom operator.

Priming – minimum number 4
Primersealing – minimum number 8.

The above numbers assume that traffic control, including signing, is provided by the organisation responsible for the construction work.

15.2.2 Plant
1 Bitumen sprayer
1 Bitumen road tanker
1 Rotary road broom
Trucks (priming 1 only, primersealing 2)
Aggregates loader (primersealing only)
Self-propelled, pneumatic-tyred, multi-wheeled roller (primersealing only)
1 Motor vehicle (for the Works Manager)
2 Box spreaders – 2.6 m.

Because they generally operate from central depots, items of plant, such as heaters, heater storages and storage tanks are available on site part-time or full-time as required.

15.3 SEALING UNIT
The number of crew required with a sealing unit will vary to some extent depending on the common type of work, size of job, whether the unit operates from a central depot or motel/hotel central to the work.

The following is a recommended minimum complement for a sealing unit operating from a central depot and engaged principally on the most common type of work and size of job.
15.3.1 Personnel

(a) Personnel

1 Works Manager
1 Assistant Works Manager
1 Road tanker operator
1 Fuel/preclean truck drivers
2 Sprayer driver/operator
1 Aggregate loader operator
2 Traffic controllers
1 Broom operator
1 Sign truck operator/paper handler
2 Roller operators
3 Truck operators

(b) Other Personnel

Additional personnel are usually required for:

(i) work involving high traffic volumes
(ii) extensive papering
(iii) urban work with many intersections requiring traffic control
(iv) freeway work requiring an extra sprayer for economy because of the varying rates of application applicable to that type of work
(v) BCRS work requiring an extra sprayer to keep up production.

15.3.2 Plant

1 Bitumen sprayer
1 Road tanker
1 Aggregate loader
3 Box spreaders 2.6 m and associated trucks
1 Rotary road broom
2 Self-propelled, pneumatic-tyred, multi-wheeled rollers
1 Sign truck
1 Motor vehicle (for Overseer)
1 Fuel tanker trailer units
3 Trucks (9 to 10 m³ capacity).

This should be sufficient if the unit works from a central depot or a central site.

When engaged on bitumen crumb rubber work (BCRS) using concentrations of 20 parts or more of crumbed rubber, it is recommended that a second sprayer be used to reduce loss of output due to the extra time taken for loading and the extra time for mixing to achieve the desired reaction.
16.1 GENERAL

16.1.1 Communication

(a) Within VicRoads

   For an organisation the size of VicRoads to function efficiently it is essential to have good communication and records. Communication regarding bituminous surfacing is mostly achieved by the use of standard forms, circulars and reports often stored in electronic format using Lotus Notes and contract specifications. It is important that all forms are utilised and properly completed to provide all relevant information on the work. Within VicRoads there is a relatively large turnover of personnel and thus memory is of little value whereas properly completed forms provide long term accurate information.

(b) With Other Clients/Contracts

   The Superintendent is to receive copies of all the relevant forms and contract requirements before commencing works (e.g., traffic management plans, design application rates, etc.).

   It is most important that the BS Works Manager informs and checks with the Client/Superintending Officer, by phone or visit, at least the day before work commences.

16.1.2 Inspections

(a) Regional Providers/Purchasers

   The Regional Providers/Purchasers should inspect all the work before any specification of sealing works is prepared in order to determine:

   - the proposed treatment type, i.e., binder type, aggregate size
   - the classification of the surface texture (to enable the selection of an appropriate default design rate of binder application)
   - if any remedial treatment is necessary, i.e., crack sealing, patching, surface regulation or grading of shoulders is necessary

   On initial treatment work if the pavement material is known, it may be possible to form an opinion as to the type of primer required. The surface texture cannot be determined until after the pavement has been primed.

   It is important that jobs are inspected well in advance of the BS Unit in order to prepare a final programme of works which will keep lost time to a minimum. For contract and other work it is desirable that the Superintendent or representative should be present at these initial inspections.

(b) BS Works Manager

   The BS Works Manager should always inspect the job before moving the crew and plant to the site. The inspection should compare the conditions on the ground with those shown in the instructions for the work/contract documents.

   The following should be checked:
(i) Aggregate
Is the quantity sufficient to complete the job when spread at the design rate of application? Is the aggregate as described in the instructions?

Is it uniform in shape and size?

Is it dirty or are there excess fines?

If there are excess fines, or if the instructions say that screening is necessary, arrange that the aggregate is screened by the aggregate loader well in advance, or the material replaced by the aggregate supplier.

If necessary re-screen twice to remove excess fines.

(ii) Initial Treatments
Is the pavement uniformly consolidated, well prepared, correctly shaped, and free from corrugations and potholes?

Remember sprayed work will not improve the shape or riding qualities.

Is the priming material suitable for the pavement material?

If the surface is primed, is it uniformly primed, smooth or hungry etc., or does it require any special allowances for absorption of part of the binder, etc?

(iii) Retreatments
Is the patching satisfactory, i.e., are the patches well compacted, sealed and are they set-up and hard? Is the surface texture of the patch similar to the surrounding existing surface?

Is the pavement of reasonably uniform texture? If it is not, how should the surface be divided into sprayer runs for the various rates of application to obtain a uniform seal coat.

Is the surface classification in agreement with the surface texture indicated on the instructions?

(iv) Should The Work Proceed
If the standard of the surface is not acceptable the BS Works Manager should immediately report to the BS Area Manager for further instructions.

16.1.3 Workmanship

To obtain a first class seal coat it is important to pay attention to detail at all times. The following are important points to keep in mind doing sprayed work:

(a) A first class job is the primary objective, output is second and cost third.
Generally an efficient BS Unit produces first class work at a low cost.

(b) Spare no effort to produce a good, sound, clean looking job.

(c) Do not sacrifice good workmanship and proper procedure by taking short cuts just to increase output.

(d) Attend to faulty work immediately. Don’t delay or ignore fault work because the earlier it is attended to generally the simpler and less costly the remedy.

(e) Teamwork is essential to achieve a good job.

(f) For work done near the end of the day ensure the correct amount of cutter is used, adequate rolling is given and sufficient traffic control and signs and/or lighting are provided. Don’t leave the job to the mercy of the weather and/or the traffic.

(g) The last load should be sprayed and covered by 3.00 pm on Fridays and on days before local and public holidays.

Race meetings and special local events should be considered when programming work.

(h) On very heavily trafficked roads or roads leading to tourist areas it is undesirable to do sprayed work on Fridays or the day before a public holiday.

(i) Avoid unsightly blemishes on new or existing work, eg. bitumen or bitumen emulsion on kerbs, bridge handrails etc., or by oil leaks from plant and trucks on the surface.

16.2 SWEEPING

16.2.1 Safety When Sweeping

Prior to commencing sweeping, the appropriate and necessary warning signs shall be placed in advance of the area being swept so that they are clearly visible to the travelling public (see Chapter 21 – Provision for Traffic).

When a rotary road broom, while sweeping, creates dust to reduce visibility to such an extent that the broom and traffic are obscured, traffic control must be used and all traffic stopped during each sweeping run.

In urban areas, suction cleaners may be used to clean pavements. This causes less interference and creates less dust than a rotary road broom.

Rotary road brooms fitted with flashing lights which should be used when sweeping.
16.2.2 General Instructions

These instructions generally refer to sweeping with a rotary road broom but should be kept in mind and observed where applicable for a suction cleaner:

(a) Before any bituminous surfacing work is done the existing pavement surface must be properly cleaned.

(b) It is essential to remove all loose and/or foreign material adhering to the surface.

(c) If possible all sweeping should extend at least 0.3 m outside the edges of the width to be sprayed.

(d) Before sweeping is started, the BS Works Manager should inspect the surface to see if any handwork or special cleaning treatment is required. Do not expect a rotary road broom or suction cleaner to remove hard material, this should be removed with a grader and/or hand chipping. After such work the rotary road broom or suction cleaner shall be used for the final clean up.

(e) Carefully regulate the pressure and speed of the rotary road broom on a surface. The bristles should exert the minimum necessary pressure on the pavement so that the material to be removed is flicked off. Do not use the rotary road broom as a grader.

   Observe the direction of the wind, if any, and if the wind is blowing across the road start sweeping on the windward side and work across the surface with the wind. If the wind is blowing along the road, always sweep with the wind.

(f) If sealing in half or lane widths, the direction of sweeping shall be away from completed work. Sweeping must never be directed towards a newly completed seal because the dust will “kill” the adhesive qualities of the binder and cause stripping.

(g) If the amount of material to be swept off is more than normal, start preliminary sweeping the day (or days) before.

(h) When using the suction cleaner be careful to regulate the height of the
hood and the suction to prevent damage to thin bituminous surfacings such as initial treatment primerseals. Do not stop the cleaner without first raising the suction hood or stopping the suction.

16.3 LOADING THE BITUMEN SPRAYER

16.3.1 The Loading Site

The most common method of supplying bitumen to the job site is with contract bitumen road tankers operating from a central depot or refinery. The sprayer is loaded from the road tankers at some convenient site along the job.

The sprayer should be able to travel to the loading site without any delay immediately at the end of each sprayer run. Generally the site is somewhere close to the end of the job to keep the travelling time as short as possible. In urban areas it may be more difficult to find a convenient site.

The site should have good access and should be large enough to allow loading and fluxing and/or cutting back to be done in safety. The flux oil/cutter loading point should be at least 30 m away from the bitumen loading point.

16.3.2 Bitumen Sprayer Operation

For the operational functions of Sprayline’s bitumen sprayers refer to section 23.2 for preliminary guidance and to the appropriate operator’s manual for complete instructions.

16.3.3 Standard Instructions

When loading sprayers with primer, primerbinder or bitumen, flux oil and/or cutter, it is essential to follow correct procedures for reasons of safety, to produce a uniform material and avoid difficulties such as the bitumen pump jamming, etc.

(a) During loading, the sprayer, with the driver’s door wide open, shall be placed in such a position and left in a condition that it can be driven off at a moments notice from the loading site without any interference. The Sprayer Driver should be prepared to start and drive off immediately if there is a mishap during loading and if safe to do so.

(b) Place the plant so that the wind blows any fumes away from any possible hot spots such as the engine exhausts or hot heating tubes. Be very careful on calm humid days when the fumes will not disperse and will accumulate at ground level.

(c) Smoking or naked flames shall not be allowed within 15m of the loading point.

(d) Always check the quantity and type of material left in the sprayer tank before loading any material.

(e) When first loading a sprayer or when changing types of material, eg., Bitumen emulsion to bitumen, make sure the spraybar, tank, pipes, pump, valves, hoses and screens are clean or cleaned before loading any material. Special care should be taken to ensure that the spraybar is cleaned out and all traces of water removed to avoid a ‘boil-over’.
(f) Using the sprayer pump only, the required quantity of material shall be loaded by suction into the sprayer from the bitumen road tanker, or other type of storage/supply, through an in-line strainer and standard hose or a standard strainer and two standard hoses.

(g) All hose fittings should be tightened with the C-spanner before any material is transferred.

(h) The control valves must be on fill.

(i) The Road Tanker Driver shall be near the supply control valves and be ready to instantly cut off the supply.

(j) The Sprayer Driver should control the pump shaft speed and the control valves at the start of the loading.

(k) The bitumen pump shaft speed should be between 400 and 500 rpm during loading.

(l) The bitumen pump must not be run dry for any length of time. The bearings in this type of pump are generally lubricated only by the material being pumped.

(m) Before spraying, all materials must be circulated for at least 20 minutes after loading has been completed. This may include the time taken to travel from the site to the job and the time required for setting up the spray bar. Circulating should be done with a pump shaft speed of about 400 to 500 rpm, and the control valves on ‘circulate’.

Sprayers with a capacity larger than 6000 litres may require a longer circulation time to adequately circulate and mix materials.

(n) The quantities of flux oil and/or cutter required must be calculated at the corrected temperature of 15°C. All quantities loaded shall be measured accurately and the final load checked by dipping. All materials and quantities loaded must be recorded.

Caution: Emulsions contain water and even after cleaning some moisture may still be present in the tank but this should not be a problem with primers as they are used at temperatures below 100°C. If a ‘hot’ (over 100°C) bituminous material such as a primemix is to be loaded shortly after, this should be done with caution as frothing and rapid expansion of the hot material will occur which may cause a ‘boil over’. After using emulsions and thoroughly cleaning, the spray tank should only be filled with bitumen and the bitumen thoroughly circulated. The hoses and spray bar should be especially carefully cleaned as, in these confined areas, moisture coming into contact with hot bitumen can cause rapid expansion resulting in an explosive effect causing damage to the plant and may cause injury to personnel.

Disposal of any waste material must be in accordance with the requirements of the Environment Protection Authority.
16.3.4 Equipment Required

When loading a sprayer the following equipment must be used:

(a) Approved metal hoses and fittings (for safety)

(b) A standard screening box or in-line strainer placed on the suction side of the pump to prevent jamming of the bitumen pump and/or blocking of jets by contaminants when spraying.

16.3.5 Primer

(a) General

The most common priming material used is cutback bitumen, although specially formulated bitumen emulsions primers are becoming available for selected uses. These primers are not compatible and must not be mixed. Before changing from one type to another the hoses, strainers, pump and tank must be thoroughly cleaned as follows:

- Bitumen emulsion – cutter only
- Cutback bitumen – may use flux oil or cutter for cleaning

Primers are loaded as per standard instructions (Section 16.3.3). In the case of field produced cutback bitumen primers the procedure shall be similar as for fluxing and/or cutting back bitumen.

(b) Bitumen Emulsion

After loading bitumen emulsion the hoses and strainer should be cleaned out using cutting oil, or if emulsions are to be used again, water may be used.

If cutback bitumen is to be used next in the sprayer, about 10 to 15 litres of cutter should be sufficient and may be drawn into the tank without unduly diluting the next load of cutback bitumen or stored for further use.
If bitumen emulsion is to be used next in the sprayer load, about 10 to 15 litres of cutter or water should be sufficient to clean the hoses and strainer. The water may be drawn into the tank without unduly diluting the next load of bitumen emulsion while the cutter can be stored for further use for a cutback bitumen used at below 100°C.

(c) Cutback Bitumen

After loading cutback bitumen primers the cleaning out may be done using flux oil and/or cutter. About 10 to 15 litres should be sufficient and may be drawn into the tank without unduly diluting the load of cutback bitumen primer, or run into a drum for further use.

16.3.6 Primerbinder

The primerbinders used at present are mainly cutback bitumen and should be loaded as per standard instructions (Section 16.3.3).

After loading, the hoses and strainer should be cleaned out with about 10 litres of cutter which may be drawn into the tank or run into a drum for further use.

After cleaning the hoses etc., the load must be circulated for at least 20 minutes before spraying.

If the primerbinder is a bitumen emulsion it should be handled as for Section 16.3.5(b) above.

16.3.7 Bitumen

Bitumen shall be loaded as per standard instructions (Section 16.3.3). If the bitumen is to be fluxed and/or cutback refer to Section 16.3.8.

If the binder is bitumen without any flux oil or cutter the hoses and strainer must be cleaned with flux oil and/or cutter which is not allowed to be drawn into the tank but must be run into a drum for further use.

16.3.8 Fluxing and Cutting Back Bitumen

(a) Determining Quantity of Flux Oil Required

The amount of flux oil is dependent on the size and type of aggregate used and the volume of traffic. The proportion of flux oil to be added to 100 parts of Class 170 bitumen, measured by volume at 15°C, is indicated in the current fluxing and cutting back tables in Section 8.7 and Section 16.13.2.

(b) Determining Quantity of Cutter Required

The amount of cutter required is dependent mainly on the pavement temperature, traffic volume and aggregate size.

The proportion of cutter to be added to 100 parts of Class 170 bitumen, measured by volume at 15°C, is to be determined using the fluxing and cutting back tables. Experience and judgement are required in deciding the correct temperature range to be used.
Proper cutting back to meet the prevailing working conditions is essential to achieve good adhesion between the binder and the aggregate and for this reason each load should be considered separately and be cut back at the job site shortly before spraying.

When determining the amount of cutter the following must be considered:

(i) Pavement temperature shall be measured with an infrared thermometer in a shaded area exposed to the wind and representative of the area to be sprayed.
(ii) Besides pavement temperature also take into account whether all or part of the section to be sprayed is in the sun or shade, the air temperature and wind speed.
(iii) The condition and type of aggregate.
(iv) Nature and volume of the traffic.
(v) When in doubt regarding the quantity of cutter required it is better to add slightly too much than too little. If the binder is cut back too much the traffic speed can be controlled or the traffic detoured until the binder has set up and is strong enough to retain the aggregate.
(vi) Always provide for the worst expected conditions.

For further information on cutting back and fluxing, prevailing and future weather conditions and the determination of a representative average pavement temperature refer to Section 8.7.

(c) Loading Procedure

When the required quantity of bitumen has been loaded and the bitumen supply shut off, clean out the hose, strainer and pump by flushing with about 10 to 15 litres of cutter/flux oil into the sprayer. The quantity added must be deducted from the required total quantity of cutter/flux oil.

With the control valves on fill and the bypass closed, reduce the pump shaft revolutions, uncouple the transfer hose and drive the sprayer to the fuel trailer tanker which must be situated at least 100 m from the bitumen storage.

Flux oil and cutter are usually transported in fuel trailer tankers which are fitted with a flow meter for measuring the quantities required. These meters were originally designed to operate under pressure and if subjected to too much suction will not record accurately. For this reason the pump shaft speed should be kept down to about 150 to 250 rpm when pumping on flux oil or cutter using these meters to record the quantities.

At the trailer tanker the required quantity of cutter is pumped on followed by the remaining quantity of flux oil required. After the flux oil has been loaded the fluxed and cutback bitumen shall be circulated for at least 20 minutes before spraying.

When loading in bulk from the fuel trailer tanker use the special transfer hose with standard fittings. Quantities are given by the meters on the fuel tanker. These meters should be checked monthly for accuracy by dipping the fuel tanker.
When loading from 200 litre drums use the special transfer hose with standard fittings and calibrated drum attachment to measure the quantity taken from each drum. A calibrated dipstick may also be used. The quantities should be checked by dipping the sprayer load.

Note: Be careful when loading from drums as water may be present. Always check for water using special water finding paste before loading the drum’s contents into the hot load in the sprayer.

16.3.9 Fluxing The Bitumen Only

(a) Determining Quantity of Flux Oil Required

Refer to Section 16.3.8(a)

(b) Loading Procedure

After the required quantity of bitumen has been loaded, the hoses, strainer and pump should be cleaned by loading about 10 to 15 litres of flux oil. The remaining quantity of the required flux oil is then loaded at the fuel trailer tanker – see Section 16.3.8(c). After the flux oil has been loaded the material must be circulated for at least 20 minutes before spraying.

16.3.10 Cutting Back the Bitumen Only

(a) Determining Quantity of Cutter Required

Refer to Section 16.3.8(b)

(b) Loading Procedure

After the required quantity of bitumen has been loaded, the hoses, strainer and pump should be cleaned out by loading about 10 to 15 litres of cutter.

The remaining quantity of the required cutter is then loaded at the fuel trailer tanker – see Section 16.3.8(c).

After the cutter has been loaded the material must be circulated for at least 20 minutes before spraying.

16.3.11 Additives

(a) Adhesion Agent – As a Fluid

Before loading adhesion agent, the material must be mixed thoroughly by either shaking the drum or by stirring.

It should then be loaded using the special transfer hose supplied with standard fittings.

The standard proportion, unless otherwise advised, is ½ litre of adhesion agent to 100 litres of bitumen by volume, measured at 15°C.

Most of the adhesion agent supplied is in thick fluid form at ambient temperatures and will pour from the standard 20 litre containers or flow
from bulk containers. As an alternative, when a transfer hose is not available, it may be added via the cleaning oil box on the bitumen road tanker or heater storage tanker, or via the cleaning oil loading funnel on the sprayer.

The measured quantity of adhesion agent should be added while the bitumen is being loaded as per standard instructions, so that it is being mixed with the bitumen as it goes through the pump to aid dispersion and mixing. Care must be taken to avoid splashing materials.

Adhesion agent shall not be poured into the tank via the manhole.

If adhesion agent will not pour from the drum it may be warmed to make it fluid or it can be made fluid by mixing with cutter. If adhesion agent is mixed with cutter the quantity of cutter incorporated with the adhesion agent must be taken into account when loading the required quantity of cutter.

(d) Crumb Rubber

Because the bitumen and crumb rubber froth up when mixed and loaded, the quantity of bitumen should be kept to about 3,600 litre hot in the 4,500 litre sprayer (or 4300 litres in a 5200 litre sprayer).

Crumb rubber is loaded using a special mixing box, inline strainer and standard hoses. The in-line strainer must be at the bitumen supply end because the bitumen crumb rubber mixture will not pass through the strainer.

To aid with mixing, at least 500 litres of bitumen must be in the sprayer before any crumb rubber is added.

The bitumen is run at a slow rate and the crumb rubber is added by allowing it to flow slowly from the bag into the hopper of the mixing box. The mixture then passes through the pump into the sprayer. The main precautions are to break up lumps of rubber and avoid adding crumb rubber too quickly as this may block the inlet pipe or pump causing a flow over of bitumen into the hopper.

A satisfactory mixing rate is about 1 bag (25 kg) of crumb rubber to 100 to 150 litres of bitumen. After the required amount of crumb rubber has been added the slide in the hopper should be closed and the rate of bitumen supply increased, to minimise heat loss, until the required amount has been loaded.

After loading, the hoses, box and strainer may be cleaned as normal with cutter which must be deducted from the required total if pumped into the sprayer. The remaining cutter is then loaded as set out in 16.3.8(c).

If cutting is not required, the hoses, box and strainer should be cleaned with cutter which must be run into a drum for further use.
When using bitumen-crumb rubber mixtures with high crumb rubber concentrations (eg., 15 parts or more), the temperature of the Class 170 bitumen should be raised to about 200°C before adding any crumb rubber. This is to ensure the desired reaction occurs and to partially offset the drop in temperature and increase in viscosity of the binder.

16.3.12 Temperature Corrections

All calculations involving bituminous materials and additives must be done with the volumes corrected to the standard temperature of 15°C.

16.3.13 Measuring Quantities

(a) Standard Procedures

All quantities of material loaded in the sprayer tank must be checked by dipping the sprayer tank with the calibrated dipstick provided or measurement by weight. To obtain meaningful accurate figures the following procedure should be adopted:

(i) the sprayer should be parked on level ground and preferably the same location should be used for each dip at the loading site
(ii) the circulating spraybar should be emptied by sucking back into the tank
(iii) the pump should be stopped to let the froth subside and let the material settle after circulating. The dip should not be taken until a few minutes after stopping the pump
(iv) the dipstick should be withdrawn and the calibrated face wiped clean with a clean piece of rag or waste
(v) lower the dipstick slowly until it is seated on its suspension point. It should then be quickly but smoothly withdrawn and the reading taken
(vi) record the temperature of the material to apply the volume correction factor.

Small variations must be expected when measuring by dipstick and temperature. The volume of material at 15°C calculated from its mass is generally more reliable than the volume obtained by dipstick readings.

(b) Bitumen Crumb Rubber Work

Field produced bitumen crumb rubber mixtures with concentrations of 15 parts of crumb rubber, or more, froth up and the sprayer dip stick cannot be used to accurately record the quantities of materials loaded.

To obtain meaningful figures the following procedure shall be adopted:

(i) record the temperature of the bitumen in the road tanker each sprayer load to apply the volume correction factor.
(ii) record the quantity of bitumen loaded into the sprayer using the road tanker dipstick. Calculate the quantity of bitumen required in multiples of 100 litres eg., 3,200 litres hot.

(iii) calculate the quantity of rubber required and then load to the nearest number of full bags, ie., multiples of 25 kg, and recalculate the actual parts of rubber.

(iv) calculate quantity of adhesion agent required (1% by volume) and actually add to the next nearest full drum ie., multiples of 20 litre.

(v) when loading cutter from the fuel trailer tankers set the sprayer pump revolutions between 150 to 250 rpm to ensure the flowmeter will record accurately – refer Section 16.3.8(c).

16.3.14 Calculations

The above procedures apply also to binder containing crumb rubber at a concentration of 5 parts. Refer to Section 16.13 for examples of loading a sprayer including volume correction, fluxing and cutting back bitumen and incorporating additives.

16.4 SPRAYING

16.4.1 General

Sprayline’s bitumen sprayers have been designed to be operated by either one or two operators depending on the model of sprayer.

All spraying functions can be controlled from the cabin and there is no need to have an operator on the rear platform during the spraying operation.

The sprayer crew may be the driver only or the driver and a forward speed controller which is normally the Assistant Works Manager. They are responsible for the safe operation of the sprayer, setting up the spraybar and control valves and the calculations for the materials, area sprayed and applications rates.

The duties are generally split as follows:

(a) Driver only - all functions

(b) Driver and Assistant Works Manager:

• Driver – steering correct line, on – off, setting up of the valves and controls, pump speed

• Assistant Works Manager – calculations, operating and controlling the forward speed.
16.4.2 Standard Instructions

(a) General

- Always check the length and width to be sprayed
- Mark out for the sprayer
- Always check the number and setting of the jets in the spraybar are appropriate for the width to be sprayed and the type of work
- Always use paper at the start of each sprayer run, at the end of each day’s work and at the end of each job
- Use paper and/or end shields to avoid splashing on half width work and to protect kerbs, handrails, manholes etc.
- Ensure that all fuel tanks contain sufficient fuel
- Before running a load, check the temperature of the material. If it is in the correct temperature range spray the load, if not, reheat the material
- Dip the contents of the sprayer on level ground, record quantities and temperatures
- Check rates of application for each load sprayed;
- Remember to correct the forward speed for cutter where applicable
- At the start of the season or after an overhaul, the first job should be on a lightly trafficked road to check the accuracy of the sprayer because the rates of application in that instance are not as critical compared to a road with high traffic volumes
- At the start of the season or after an overhaul the control valves should be adjusted, with the tank full of hot bitumen, before any work is done
- If the bitumen pump is changed it may be necessary to amend the pump shaft speed shown on the spraying table to maintain the correct output
- If the bitumeterhead/distance measuring equipment is changed a new spraying table will have to be prepared
- To obtain a uniform lateral application of material the spraying overlap on longitudinal joins should be about 50 mm, provided end jets are used
- Check the fifth wheel (if fitted) for cleanliness and remove any build up of material which will affect its accuracy
- Always carry a copy of the current spraying table in the primemover cabin. Do not use any table other than the latest table provided
- Regularly check the accuracy of the fifth wheel and bitumeter head against a measured distance of say 500 m. If there are any problems arrange for it to be repaired/replacement
- Before any spraying is done the material in the sprayer tank shall be circulated for at least 20 minutes after loading
- If the work is not ready when the sprayer arrives the Sprayer Driver must remain with the sprayer while the load is circulating
- If material has to be heated in the sprayer, it is not to be sprayed until the burner has been extinguished for at least twenty minutes. If this procedure is not followed there is a considerable risk of the fumes igniting on contact with the hot burner tubes
The direction of spraying should be selected so that the wind is across or against the direction of spraying for safety and visibility.

Always control traffic with flagmen when setting up the sprayer and during spraying.

When sealing and primersealing during cold weather limit the length of spray by splitting the loads in the sprayer to one-half or one-third – see Table 16.4.16.

(b) Setting Up the Guide Rod

Line up the guide rod consistent with the markings on the ground, normally 0.6 m to the right of centre of the sprayer, and consistent with the width of the spraybar being used. Set the height so that the chain just touches the ground.

Test check the setting before use, particularly where spraying half width or close to obstructions.

Carelessness in setting up the guide rod will result in poor longitudinal alignment at joins.

(c) Setting up the circulating spraybar

The spraybar extensions should be lowered and the sprayer square to the direction of spraying.

As far as possible have the spraybar should set up to give an equal spraying width on either side.

For widening work, remove as many extensions to the bar as is practical and for improved vision use a slightly offset spraybar, generally the right hand side.

All spraybar extensions are branded either LHS or RHS – ensure that they are fitted correctly.

For uniform lateral distribution the jets are spaced at a distance of 100 mm centre to centre. When fixing extensions to the main bar always check that the distance between the last jet on the main bar and the first jet on the extension is 100 mm.

The number of jets required for a width of spray can be determined from the spraying table. Use only A4 intermediate jets and one EA4 end jet at each end of the spraying width. For example,

- when the full width to be sprayed is 5.6 m, the total number of jets required is 54, ie., 52 ‘A4’ jets and 2 ‘EA4’ jets
- when the full width to be sprayed is 9.0 m but only half width can be sprayed at a time
- Using end jets at both ends of the spraybar, a bar width of 4.5 and 4.6 m should be used (allows for 50 mm overlap and an additional overspray of 50 mm on each side), from the spraying table, Figure 23.2.5, the total number of jets required is 43 (or 44), ie., 41(or40) ‘A4’ jets and 2 ‘EA4’ jets
- If using an end jet on the outside edge of the pavement and an intermediate jet in the centreline of the pavement an overlap of 300 mm overlap is required. This however is not a desirable practice but, if essential, can be used.
Photograph 16.4.2A  Jets fitted correctly in manifold. Note ‘R’ on ‘EA4’ end jet on RHS of spraybar

Photograph 16.4.2B  Jets fitted correctly in spraybar. Note the difference in slot size and angle of intermediate ‘A4’ jets and ‘EA4’ end jet on RHS of spraybar

Photograph 16.4.2C  Result of a blocked jet. Before allowing traffic on the new seal the uncoated areas should be neatly repaired by hand spraying the binder and covering with precoated aggregate
When spraying half widths the preferred method is to use end jets at both ends of the spraybar and overlap by 50 mm.

When fixing the jets in the spraybar, screw them tightly into the bar and set the intermediate jets with the face stamped ‘A4’ visible and parallel to the centreline of the spraybar. The right hand side end jet should be set with the face stamped ‘R’ visible and parallel with the centreline of the spraybar. The left hand end jet should be set similarly with the face stamped ‘L’ visible and parallel to the centreline of the spraybar.

When the spraybar has been lowered into place and viewed from the rear of the sprayer the end jet ‘L’ should be on the left and the end jet ‘R’ on the right hand side. The end type spraying jet shall always be used and only in the position described above. See Section 22.7.3.

On a crowned pavement the end jets on each side of the spraybar shall be at the same height above the surface of the pavement, and the face of the jet at the crown of the road shall be 250 mm above the surface of the pavement when the sprayer is loaded.

A spraybar which is set too high is not as serious as one which is set too low.

(d) Care of the Spraybar and Jets

When not in use spraybar extensions should be stored correctly to avoid damage and kept clean.

Avoid damage to the spraybar by careless driving and if unsure of clearances do a check run at slow speed before actually spraying. (This is particularly important when extensions to the spraybar are attached and the pavement surface is variable.)

Jets are made to very accurate tolerances and minor damage to the jet slot, such as a burr or nick, will affect the distribution and discharge of material sprayed – be careful when handling and setting them with a spanner.

Keep spare jets in a tin of kerosine but do not drop the jets into the tin and do not string them on pieces of wire as this will damage the slot in the jets.

A blocked jet should be removed from the bar and be replaced with a clean jet. The blocked jet should be soaked in kerosine for some time and any remaining material removed without damaging the slot of the jet.

Care must be taken not to damage the bar and or jets when driving across table drains etc.

When travelling along a new seal the aggregate particles will flick up and hit the jets, particularly on the fixed centre section. These jets should be regularly checked for damage and replaced as required.
All jets should be checked with an appropriate gauge and the jets replaces if it is found that the slot is outside the accepted tolerance. From experience up to about 25 to 30% of the jets need replacing each season due to wear and/or damage.

(e) Running a Load

The following procedure is common to spraying the normally used materials and assumes that the work is ready and all necessary materials on site, the run marked, the sprayer loaded with the material and being circulated through the spraybar, the quantity and temperature checked and recorded, the forward speed worked out and the spraybar is made up to the correct width.

The Traffic Control should be in position, the appropriate signs erected to allowing the traffic to be stopped.

Drive the sprayer to the starting position. Allow enough distance to enable the sprayer to reach the correct forward speed and be on correct alignment when crossing the starting paper.

The Sprayer Driver lowers the spraybar extensions and sets up the guide rod in the correct position, moves the control valves to the correct position and sets the pump shaft speed to the correct speed for the number of jets in the bar. This figure is obtained from the spraying table.

Where fitted, the 5th wheel is lowered into position by the Assistant Works Manager or Sprayer Driver.

Ensure that the required quantity of covering aggregate is on site before proceeding further.

Lower the spraybar extensions into position.

If all is in order, arrange for the traffic to be stopped.

Place the starting paper in position, and keep it in place with precoated aggregate.

The Sprayer Driver should indicate when ready to commence, and when instructed, start the sprayer moving and to get into the appropriate gear for the forward speed required. As the sprayer passes over the starting paper it should be on correct alignment and be running in the appropriate gear at the correct forward speed. The Sprayer Driver shall press the spraybar ‘ON’ button on the control panel and as the material starts to spray the Assistant Works Manager/Works Manager shall start the trip meter on the bitumeter head.

If any fault is visible after spraying has started, such as blocked jets, leaks in the spraybar, poor fanning of the jets, poor lateral distribution etc., the Sprayer Driver shall immediately press the ‘OFF’ button on the control panel and spraying shall cease until the fault has been corrected. The procedure for stopping spraying at the end of a run is outlined below. When spraying is restarted the procedure is as for the start of a new load.
During the sprayer run, the Sprayer Driver and Assistant Works Manager should watch the end jets for correct alignment of the sprayer. The Driver shall steer the sprayer to obtain the correct alignment at the spraybar end.

The end of the load is indicated when cut-off papers at the end of the run are reached or the pressure falls indicating only little material is remaining in the tank. As soon as this occurs the Sprayer Driver should press the ‘OFF’ button and the spraybar will ‘cut-off’ and turn off the trip meter. At this stage any bitumen in the sprayer will be circulated through the recirculating spraybar and the pump revolutions can be reduced.

At the end of a run the sprayer may be stopped on paper.

If the fifth wheel is fitted, immediately the sprayer stops at the end of the run, and before reversing, Assistant Works Manager or Sprayer Driver (whoever ran the load) must lift the fifth wheel to its traveling position to avoid damage to the wheel or bitumeter head. The Sprayer Driver raises the spraybar extensions and folds the guide rod into the traveling position. The distance (length) of the spray run must be recorded.

The sprayer should be dipped on level ground or in the same position as the first dip for that load and the reading and temperature recorded. If the sprayer was emptied the dipstick may not give a reading.

All sprayers retain at least 100 litres but in some circumstances 200 litres or more could be retained in the sprayer. Allowance for this material should be made before putting on the next load.

If no further spraying is to be done within a short time the pump, tank etc. should be cleaned out.

16.4.3 Equipment

(a) Operation

For the operational functions of Sprayline’s bitumen sprayers refer to Section 23.2.

(b) Faulty Equipment

If a pump shaft speed indicator, pressure gauge, distance measuring equipment, bitumeter head or pump on a sprayer becomes faulty, or the sprayer is not spraying in accordance with the spraying table, the BS Works Manager shall immediately notify AH Plant (or the appropriate owner) so that repair or replacement can be arranged.

16.4.4 Primer

(a) Primer should be sprayed in accordance with the standard instructions for spraying.

(b) Always check the instructions with the field conditions to ensure that the priming material provided is suitable for use with the pavement material and the conditions.
(c) Priming is now mainly confined to roads with lower traffic volumes. As a general rule the following spraying widths should be adopted to cause minimum delay and inconvenience to the traffic:

(i) Less than 250 v/l/d – spray full width
(ii) More than 250+ v/l/d – spray half width (up to a maximum of 3.7 m)

If there is a proper sidetrack or detour to divert the traffic onto, or the work is not under traffic then primer may be sprayed full width.

Priming pavements under traffic in the urban area is very unusual as it causes great inconvenience to the Public. Normal practice is to primerseal pavements constructed in these areas.

(d) Primer should, if possible, be sprayed wider than the width of the following initial treatment bituminous surfacing. The minimum recommended additional width is one extra jet both sides (ie., 100 mm outside each edge).

(e) If priming half widths on curves with enough superelevation to cause run off of the primer then prime the high side first. This will allow any run off to soak into the unprimed pavement and avoid black fatty streaks appearing through a seal coat.

(f) Primer may only be sprayed if the pavement temperature is at least 10°C or above.

(g) Primer should not be sprayed if immediate rain is threatening or predicted with 48 hours.

(h) To achieve a uniformly primed surface primer must not be overlapped over the end of the previous load. Starting paper must be used at the start of each load. The last load of the day or at the end of a job shall be finished on paper to avoid unsightly dribbles.

If primer is overlapped at the start or finish of a load or for other reasons it should be swept by hand and distributed over a large area or swept off the pavement.

(i) About four hours after spraying the primed surface should be inspected and any pools of primer etc., should be distributed. Any hungry areas deficient in primer should be spotted up.

The most common priming materials are cutback bitumens although especially formulated emulsion bitumens can be used – see Chapter 13 Primers and Primerbinders. At the time of spraying the temperature of the priming material shall be within the limits shown in Table 16.4.10A.

It should be noted that when field produced cutback bitumen primers are made using Class 170 bitumen at the standard temperature range of 180 to 185°C the temperature of the cutback bitumen exceeds the maxima shown in Table 16.4.10A. They may be sprayed as normal at this temperature but if not used and allowed to cool, the material must not be re-heated in excess of the maximum temperature shown in Table 16.4.10A.
(j) The rate of application may be determined by using the rates suggested in Chapter 3 'Priming' adjusted based on experience and the service required of the primer. A suitable rate of application can be determined by spraying a short section, say 30 m, or by treating by hand a small area of say 1 m², and observing the primer for about half an hour.

(k) Cutback bitumen primer should only be sprayed on dry or surface damp only pavement surfaces except in the case of certain pavement materials (see Section 10.1 Preparation – For Initial Treatments and Section 11.16 Priming – Special Conditions).

(l) The forward speed required for various rates of application can be determined directly from the spraying table and is applicable to all types of cutback bitumen priming materials used by VicRoads.

If a bitumen emulsion primer is used then the forward speed of the sprayer may need to be adjusted depending on the viscosity of the emulsion and whether jets other than A4 are used.

16.4.5 Primerbinder

(a) Primerbinders should be sprayed in accordance with the standard instructions for spraying.

(b) Primerbinder may only be sprayed if the pavement temperature is at least 5°C or above.

(c) When the pavement temperature is between 5 and 15°C the primerbinder should be sprayed in short sections, see Table 16.4.6 – Maximum Quantity of Binder to be Sprayed in One Application, so that all the primerbinder sprayed is covered with aggregate within 10 minutes.

(d) Primerbinder shall not be sprayed if rain is threatening.

(e) Primerbinder should only be sprayed on a dust free, damp pavement. If using primerbinder in resealing it may be sprayed on a damp (not wet) or dry, dust free surface.

(f) Primerbinder should be sprayed full width where possible. As a general rule the following spraying widths should be adopted to cause minimum delay and inconvenience to the traffic.

(i) Urban
   Less than 1000 v/l/d – spray full width (maximum 7.5 m). More than 1000 v/l/d – spray half widths or lane widths (up to a maximum of 3.7 m)

(ii) Rural
   Less than 1500 v/l/d – spray full width (maximum 7.5 m). More than 1500 v/l/d – spray half widths or lane widths (up to a maximum of 3.7 m).

(g) Primerbinder should, if possible, be sprayed wider than the width of the following final initial treatment bituminous surfacing. The minimum recommended additional width is one extra jet (ie., 100 mm).
(h) If it is necessary to store the primerbinder at high temperatures or it needs to be reheated, the value of the adhesion agent in the primerbinder must be disregarded and more adhesion agent added at the rate of ½ part of adhesion agent to 100 parts of primerbinder by volume measured at 15°C. This should be done in the sprayer for each load just prior to spraying and the load circulated for 20 minutes.

(i) The most commonly used primerbinder materials are cutback bitumen – see Chapter 3 “Primers and Primerbinders.” At the time of spraying the temperature of the primerbinder material must be within the limits shown in Table 16.4.10A. It should be noted that when field produced cutback bitumen primerbinders are made using Class 170 bitumen at the standard temperature range of 180 to 185°C, that the temperature of the cutback bitumen may exceed the maxima shown in Table 16.4.10A.

They may be sprayed as normal at this temperature but, if not used and allowed to cool, the material must not be reheated in excess of the maximum temperature shown in Table 16.4.10A.

Emulsion primerbinders must be sprayed at the temperature recommended by the supplier.

(j) The forward speeds required for various rates of application can be read directly from the spraying table and are applicable to all types of cutback primersealing materials used by VicRoads. The forward speed therefore does not have to be corrected for any light oils in the cutback primerbinder material.

If a bitumen emulsion primer is used then the forward speed of the sprayer may need to be adjusted depending on the viscosity of the emulsion and whether jets other than ‘A4’ are used.

16.4.6 Binder

(a) Binder, with or without additives, except PMBs, and field produced crumb rubber modified binder should be sprayed in accordance with the standard instructions for spraying.

(b) For binders containing crumb rubber or other PMBs a minimum pavement temperature 20°C is recommended. Preferably the pavement temperature should be above 25°C.

(c) Binder should not be sprayed if rain is threatening and the primer may runoff and cause significant environmental damage.

(d) Binder shall only be sprayed onto a dry, dust free surface.

(e) For cutback bitumen sealing proper wetting and adhesion of the aggregate by the binder depends largely on covering with aggregate and initial rolling before the binder gets cold and too viscous. This occurs quickly and the action required to guard against this is to limit the area of binder sprayed – see Table 16.4.6 for the recommended maximum quantities for various pavement temperature ranges, rates of application, aggregate size and road width.
The viscosity to be aimed for shall be that required to achieve wetting and adhesion of all the aggregate spread on the binder within the recommended time limit.

For emulsion bitumen sealing proper wetting and adhesion of the aggregate by the emulsion depends on covering the binder with aggregate before the binder cools too much and breaks. This can occur quickly and similar precautions to those applicable to cutback bitumen sealing are appropriate.

(g) Where necessary, check the suitability of the cutback binder viscosity for each load as follows:

(i) After spraying and immediately before spreading drop several representative pieces of the covering aggregate on to the sprayed binder from a height of approximately 25 to 30 mm. Do not throw, press or push the aggregate to improve adhesion but drop the pieces freely

(ii) Allow the aggregate to remain there for one minute, then cleanly and carefully pickup each piece of aggregate and examine for wetting and adhesion by the binder

(iii) The ability of the binder to wet and achieve adhesion with the last of the aggregate being spread on the sprayed binder should be checked. Thus just prior to spreading the last of the aggregate the above test should be done also

(iv) If the binder is at the correct viscosity for the prevailing conditions the binder will be found to have adhered to the pieces of aggregate

Figure 16.4.6A Drop a piece of precoated aggregate onto binder from height of about 25 to 30 mm

Figure 16.4.6B Remove piece of aggregate after one minute – note stringers of binder indicating correct viscosity for the conditions and good wetting of the aggregate
and coated the aggregate face in contact with a thick black film. If there is little or no adhesion this means the binder is too viscous and further cutting back is required.

(v) If there is adhesion but the film of cutback binder is very thin or brown this indicates the binder is not viscous enough and means that too much cutter has been used for the conditions.

(vi) If owing to low air temperatures or other conditions the quantity of cutter required for correct viscosity of the binder becomes excessive, the quantity of binder sprayed shall be reduced by splitting the load of binder. Refer to Table 16.4.6.

In times of low pavement temperature the length of a sprayer run should be reduced. This generally applies to cool mornings and afternoons of an otherwise warm day.

In the case of an emulsion, the binder will be found to have adhered to the pieces of aggregate and coated the aggregate face in contact with a thick black film. If there is little or no adhesion and the film is very thin or brown this may indicate that the binder has not broken completely and further rolling and traffic control is necessary.

(h) To avoid longitudinal joins binder should be sprayed full width where possible. As a general rule the following maximum spraying widths should be adopted to cause minimum inconvenience and delay to the traffic:

(i) Urban
   Less than 1000 v/l/d – spray full width (maximum 7.5 m)
   More than 1000 v/l/d – spray half widths or lane widths (up to a maximum of 3.7 m)

(ii) Rural
   Less than 1500 v/l/d – spray full width (maximum 7.5 m)
   More than 1500 v/l/d – spray half widths or lane widths (up to a maximum of 3.7 m. The additional width of a shoulder, not affecting traffic, may also be included.)

If spraying in half or lane widths the longitudinal joins should, if possible, be positioned to coincide with the traffic lane markings.

(i) On existing seals (or primerseals) do not start or end a run on existing transverse joins as this may cause bumps.

   On multiple application work stagger the starts and stops of each following application over the preceding application, to keep the seal free of bumps at transverse joins.

(k) Always start on paper. To obtain neat invisible joins it is desirable to also stop on paper at the end of each run. This should ensure that the correct rate of application is achieved for the full length of the spray and avoids overlap of binder.

If not finishing on paper the end of the run must be squared off and cut back a few centimetres (with a square-mouth shovel) to where the full
application of binder finished, before placing the paper for the next sprayer run.

The last load of the day or end of the job shall always be finished on paper to eliminate unsightly drips and pick up by the traffic and ensure a neat straight finish square to the centre line of the pavement.

(1) Sufficient aggregate must be loaded and available on site to cover the proposed area to be sprayed before any binder is sprayed.

(m) All binder sprayed should be covered within the times as set out in Table 16.4.6 to minimise the risk of stripping.

(n) If the aggregate stacksite or bitumen loading site is along the job, work away from it or leave a gap and spray it last. This avoids having the trucks and plant turning on the new work and spoiling the appearance.

(o) The forward speed required for various rates of application of bitumen binder can be read directly from the spraying table.

The forward speed has to be corrected for all cutter in cutback bitumen, or water present in the bitumen emulsion in all works other than priming and primersealing.

Because of variations in viscosity of bitumen crumb rubber mixtures it may be necessary to alter the bitumen pump shaft revolutions and/or the calculated forward speed by speeds of up to ±15 m/min to obtain the desired rates of application of residual binder.

**Table 16.4.6 Recommended Maximum Covering Time to Cover Binder with Aggregate**

<table>
<thead>
<tr>
<th>Pavement Temperature</th>
<th>Maximum Covering Time</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cutback binder (including crumbed rubber modified binders)</td>
<td>Emulsion binder</td>
</tr>
<tr>
<td>15 to 20°C</td>
<td>10 minutes</td>
<td>20 minutes</td>
</tr>
<tr>
<td>20 to 25°C</td>
<td>15 minutes</td>
<td>15 minutes</td>
</tr>
<tr>
<td>25+˚C</td>
<td>20 minutes</td>
<td>10 minutes</td>
</tr>
</tbody>
</table>

No correction needs to be made for crumbled rubber, other polymers or flux oil in the binder as these are considered to be part of the residual binder. If premixed crumb rubber is used, any carrier oil must be treated as cutter, and

- the cutting concentration reduced by the quantity of carrier oil; and
- the forward speed adjusted by treating the total of the carrier oil and cutter as cutter.
At the time of spraying, the temperature of the binder must be within the correct limits. This is normally achieved if the sprayer is loaded as per instructions, see Standard Instructions in Section 16.3.3.

The correct spraying temperature range for fluxed and/or cutback binder can be calculated using Fig. 8.6.1 or Figure 16.13.2G.

16.4.7 Binder Containing Additives

Binder containing additives should be sprayed in accordance with the standard spraying instructions Section 16.3.3 and spraying instructions for binder Section 16.4.2 and the additional instructions set out in this section.

The following additional instructions apply to the additives normally used:

(a) Adhesion Agents

When adhesion agent has been added to hot binder and the binder is not used the same day, the adhesion agent shall be considered to have lost all its value after that day.

Adhesion agent is not considered to be part of the residual binder.

(b) Rubber – As Crumb Rubber

(i) General

Crumb rubber should only be used in warm to hot weather in order to keep the total amount of cutter as low as possible. The recommended minimum pavement temperature for using crumb rubber is 20°C.

It is not advisable to spray binder with crumb rubber in cold or adverse weather conditions as the additional cutter required increases the risk of the binder flushing up next summer. The cold conditions also increase the risk of stripping of the aggregate as it is difficult to achieve adhesion between the viscous binder and the aggregate.

A guide to the amount of cutter required is obtained from Table 16.13.2F – Cutting Back of Class 170 Bitumen Containing Crumb Rubber. Adding the correct amount of cutter is still largely a matter of experience and it is desirable that the amount of cutter added is sufficient to minimise streaking and ensure correct lateral distribution of the binder.

Bitumen crumb rubber mixtures are sprayed in accordance with the appropriate standard instructions plus the instructions in (ii).

(ii) 5 Parts of Crumb Rubber

Bitumen crumb rubber mixtures with concentrations of 5 parts of crumb rubber can be sprayed as per the standard instructions using standard ‘A4’ and ‘EA4’ spraying jets.

(iii) 15 or more part of Crumb Rubber

With good quality 30 mesh crumbed rubber suitably digested, the use of standard A4 and EA4 jets has been found to be adequate, but larger jets may be used.
To ensure a uniform distribution with the viscous binder from the spraybar it may be necessary to limit the width of spray and/or increase the pump shaft speed.

When spraying bitumen crumb rubber mixtures with concentrations of 15 parts of crumb rubber or more the very viscous nature of the bitumen crumb rubber mixture can lead to blocked spraybars and spraying jets.

When spraying with the larger jets the spraying widths are limited generally to about 5 metres.

(c) Other Polymers

The common polymer modified binders are normally sprayed using standard jets as for Class 170 bitumen.

16.4.8 Bitumen Emulsion

Emulsion binders do not require the addition of additives in the field. As part of the emulsification process, emulsion binders contain materials which act as adhesion agents therefore it is not necessary to add any additional adhesion agents.

It is not possible to add polymer modifiers to emulsions in the field so if the properties of a polymer are required, it is necessary to have the polymer incorporated as part of the emulsion manufacture.

On occasions it may be necessary dilute the emulsion with water. This is unusual, however if necessary the quality of the water should be suitable. Water containing salts and chemicals may affect the emulsion.

High binder content emulsions or polymer modified binder emulsions may require the use of large jets and spray widths may have to be limited.

16.4.9 Hand Spraying

(a) Priming

Hand spraying shall be kept to a minimum but it may be useful to touch up small areas deficient in primer to provide a uniformly primed surface.

(b) Primersealing and Sealing

Hand spraying shall be kept to a minimum. Plan the work so that hand spraying is limited to areas where there is little or no traffic because of the difficulty of obtaining a uniform correct rate of application.

Hand spraying should be done last and aggregate already spread protected by protective paper to avoid spoiling the appearance by splashes.

Areas to be hand sprayed should be done with straight edges and squared up where possible.
Hand spraying should be done as uniformly as possible without overlapping.

(c) Hand spraying Binder Containing Crumb Rubber

Binder containing crumb rubber at concentrations of 15 parts or more **must not** be sprayed through a hand lance.

The very viscous binder requires high pressures (a dangerous practice) and can easily block the hand lance hose which is difficult to clean out.

For hand spraying in these conditions it is recommended to save handwork to the end of the day, or job, and use binder containing 5 parts of rubber only which will hand spray similar to normal binder.

(d) Hand spraying Procedure

Use only the standard approved hose and hand lance. Use only one jet in the hand lance, usually an ‘A4’ should be suitable.

If hand spraying is necessary the following spraying instructions shall be followed to keep pressures to a minimum and provide a safe working method:

(i) Attach the hand spray hose securely to the transfer port of the sprayer

(ii) Close the hand spray on/off tap

(iii) Set the suction valve and the delivery valve to circulate

(iv) Set the bitumen pump shaft speed at approximately 100 rpm

(v) Circulate the binder in the sprayer tank

(vi) Open the transfer valve

(vii) Start spraying through the hand lance

(viii) If the pressure is insufficient for spraying, slowly turn the control valve from circulate to transfer until satisfactory output is obtained.

On completion of the work the tank shall be completely isolated, after which the hand spray equipment shall be drained of material and thoroughly cleaned by passing flux oil or cutter through the whole of the equipment.

Note: Disposal of the waste material must be in accordance with the requirements of the Environment Protection Authority.

16.4.10 Spraying Temperatures

(a) General

The temperature and viscosity of the materials during spraying is very important in relation to its safe handling, performance and rate of application.
Excessive temperature increases the fuming and may damage the binder. It will temporarily reduce the viscosity of the materials to the extent that the calibration test figures, shown in the Spraying Table, will not apply and the material will be sprayed at too heavy a rate of application. Material too cold means that the material is too viscous and this will result in improper fanning of the spray jets, non uniform lateral distribution (ie. streaking of the material) and low rates of application.

With primerbinder and binder incorrect temperatures or incorrect cutter quantities may result in stripping of the aggregate:

- When the binder is too thin (too much cutting) it is not viscous enough to retain aggregate
- When the binder is too thick (due to it being too cold or too little cutter) it will not wet and achieve adhesion with the aggregate.

(b) Primer and Primerbinder

Table 16.4.10A gives the recommended spraying temperature range for the commonly used primers and primerbinders.

(c) Binders

Figure 16.13G (also shown as Fig. 8.6.1 in Chapter 8) is a graph for calculating the spraying temperature for field produced fluxed and cutback binder.

The spraying temperature can also be calculated mathematically, see Section 8.6.1(b).

(d) Binders Containing Crumb Rubber

Table 16.4.10B gives the recommended spraying temperature range for the commonly used practical combinations of crumb rubber and Class 170 bitumen, fluxed and/or cutback as required.

16.4.11 Rates of Application

(a) Primer

The rates of application of primer should be determined based on experience with the particular priming and pavement materials and the recommended rates of application set out in Chapter 3 – Priming. The design should be submitted to the Superintendent of Contract works for agreement or information.
Table 16.4.10A Recommended Spraying Temperatures – Primers and Primerbinders

<table>
<thead>
<tr>
<th>Type</th>
<th>Grade</th>
<th>Spraying Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutback Bitumen</td>
<td>AMC 00</td>
<td>ambient</td>
</tr>
<tr>
<td></td>
<td>AMC 0</td>
<td>35 to 55</td>
</tr>
<tr>
<td></td>
<td>AMC 1</td>
<td>60 to 80</td>
</tr>
<tr>
<td></td>
<td>AMC 2</td>
<td>75 to 100</td>
</tr>
<tr>
<td></td>
<td>AMC 3</td>
<td>95 to 115</td>
</tr>
<tr>
<td></td>
<td>AMC 4</td>
<td>110 to 130</td>
</tr>
<tr>
<td>Field Produced Primerbinder</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Light-Medium 100:0:20</td>
<td>120 to 135</td>
</tr>
<tr>
<td></td>
<td>Heavy 100:0:15</td>
<td>140 to 155</td>
</tr>
<tr>
<td>Commercially produced PMB's</td>
<td>Refer to the manufacturer's directions</td>
<td></td>
</tr>
<tr>
<td>Emulsions</td>
<td>Refer to the manufacturer's directions</td>
<td></td>
</tr>
</tbody>
</table>

The upper limit of temperature shown must not be exceeded.

Table 16.4.10B Binder Containing Crumb Rubber

(b) Primerbinder

<table>
<thead>
<tr>
<th>Parts of crumb rubber per 100 parts of Class 170 bitumen, by mass</th>
<th>Spraying Temperature Range °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>As for normal fluxed and/or cutback bitumen</td>
</tr>
<tr>
<td>20</td>
<td>180 to 200</td>
</tr>
<tr>
<td>25</td>
<td>200 (Maximum)</td>
</tr>
</tbody>
</table>

The rates of application of primerbinder should be determined based on the recommended rates in Table 12.6.1 and appropriate allowances. The design should be submitted to the Superintendent of Contract works for agreement or information.

(c) Binder

The rates of application of binder shall be determined based on the information in Chapter 14 - Design of a Seal Coat. The design should be submitted to the Superintendent of Contract works for agreement or information.
(d) Altering Rates of Application

It is recommended that the BS Works Manager have authority to alter the design rates of application if the conditions in the field warrant this. This alteration should be limited to alter the rates by ± 0.1 litre/m², for any alteration outside these limits the BS Works Manager must consult the BS Area Manager and the client.

If an alteration is made, the reason should be shown on the appropriate Daily Work Return Form.

(e) Spraying Table

There is a spraying table issued for each bitumen sprayer. (see Figure 23.2.5). It indicates the following information necessary to spray material at the various practical rates of application that can be achieved by sprayers:

- The pump shaft speed in revs per minute (Table A – Pump Shaft Speed)
- The forward speed scale reading for primer, primerbinder and binder (Table D – Scale reading)
- The correction factor to correct the recorded distance to actual distance (Table C – Distance) Rates of application are based on volumes measured at 15°C
- The forward speeds shown on the spraying table make an allowance for the spraying temperature correction required for primers, primerbinders and binders.

(f) Calculating The Forward Speed

(i) Primer and Primerbinder

The forward speed scale reading required for a particular rate of application can be read directly from the spraying table and no corrections are required.

(ii) Binder

The simple and preferred method is to use the parts of the materials, by volume, measured at 15°C, which make up the binder. See Section 16.13 for examples.

The forward speed scale reading required for a particular rate of application of residual binder can be read directly from the spraying table.

Cutter in the binder is not considered part of the residual binder and a reduction in the forward speed of the sprayer must be made when spraying cutback binder. Similarly a reduction in the forward speed must be made when spraying bitumen emulsion to allow for the water in the binder.
The common methods of calculating the correct forward speed scale reading for a particular residual binder rate of application when spraying a fluxed and/or cutback bitumen are:

By parts measured at 15°C:
\[
\text{corrected forward speed} = \frac{\text{parts of (bitumen + flux oil)}}{\text{parts of (bitumen + flux oil + cutter)}} \times \text{table speed} \quad \text{metre/minute}
\]

By quantity measured at 15°C:
\[
\text{corrected forward speed} = \frac{\text{litres of (bitumen + flux oil)}}{\text{litres of (bitumen + flux oil + cutter)}} \times \text{table speed} \quad \text{metre/minute}
\]

(iii) Binder Containing Crumb Rubber

Using “A4” and “EA4” jets the method of calculating the correct forward speed scale reading for a residual binder rate of application when spraying a binder containing crumb rubber, fluxed and cutback as required, is:

By parts measured at 15°C:
\[
\text{corrected forward speed} = \frac{\text{parts of (bitumen + crumb rubber + flux oil)}}{\text{parts of (bitumen + crumb rubber + flux oil + cutter)}} \times \text{table speed} \quad \text{metre/minute}
\]

Because of variations in viscosity of bitumen crumb rubber mixtures and other polymers it may be necessary to alter the bitumen pump shaft revolutions and/or the calculated forward speed by speeds of up to ± 15 m/min to obtain the desired rates of application of residual binder, i.e., bitumen plus crumb rubber plus flux oil, if any.

(iv) Other PMBs

The method of calculating the correct forward speed scale reading for a residual binder rate of application when spraying a binder containing polymers (other than crumb rubber), fluxed and cutback as required, is:

By parts measured at 15°C:
\[
\text{corrected forward speed} = \frac{\text{parts of (binder \{including polymer\} + flux oil)}}{\text{parts of (binder \{including polymer\} + flux oil + cutter)}} \times \text{table speed} \quad \text{metre/minute}
\]

Because of the viscosity of polymer modified binders (other than crumb rubber) it may be necessary to alter the bitumen pump shaft revolutions and/or the calculated forward speed by speeds of up to ± 10 m/min to obtain the desired rates of application of residual binder, i.e. bitumen plus polymer plus flux oil, if any.

(v) Bitumen Emulsion

Using ‘A4’ and ‘EA4’ jets the method of calculating the correct forward speed scale reading for a residual binder rate of application when spraying a bitumen emulsion (which contains water) is:
By parts measured at 15°C:

\[
\text{corrected forward speed} = \text{table speed} \times \frac{\text{parts of (bitumen)}}{\text{parts of (bitumen + water)}} \text{ metres/minute}
\]

Note: An emulsion containing 60% bitumen and 40% water is represented, in parts format, as 100 parts of bitumen and 67 parts of water.

Because of the nature and viscosity of emulsions it may be necessary to make further minor adjustments to the bitumen pump shaft revolutions and/or the calculated forward speed to achieve the design rate of application.

(vi) Binder Containing Adhesion Agent

Adhesion agent is added in only small proportions (< 1%) and is normally disregarded in the calculations for correcting the sprayer forward speed.

(g) Accuracy

With an experienced crew, and if the correct procedures are used and the sprayer is mechanically functioning correctly the accuracy obtainable in the rates of application is generally within 0.05 litre/m² of the desired rate of application eg. Desired rate of application of 1.20 litre/m² then the actual rate of application obtained should be within 1.15 to 1.25 litre/m².

With binders containing crumb rubber of concentrations of 15 parts or more, other PMBs and emulsions the accuracy is more like ±0.10 litre/m² from the desired rate of application.

It is more difficult to obtain accuracy on short runs than it is when spraying full loads due to the accuracy of dipping the load and its influence on the overall accuracy when spraying only small quantities.

Always check the rates of application for each run or load sprayed. If in error check the calculations first. Minor corrections to the forward speed of the sprayer may be necessary to obtain the desired rate of application.

It may not be possible to obtain the desired rates of application due to the following:

- the pump is worn or was changed
- the material being sprayed is at the incorrect viscosity (correct spraying viscosity is in the range 0.05 to 0.08 Pa.s except for PMBs)
- the pump shaft speeds are too low to obtain the correct flow rate
- there are restrictions in the valves and pipes
- using incorrect or faulty jets
- any of the instruments are faulty
- the dip stick suspension point has been altered or the dip stick has been damaged.
16.4.12 Use of Protective Paper

(a) Protective paper is available in two grades:
   Heavy – grammage 215 Kraft paper. (215 grams per square metre.)
   For use as starting and finishing papers and protection of structures,
   etc., where a full application of the material is sprayed on the paper.

   Medium – grammage 85 Kraft paper (85 grams per square metre.)
   Used for protection from splashing of material only, eg. such as kerbs, 
   handrails etc.

(b) Sizes of Paper

   Protective paper is available in two widths of rolls referred to as Full 
   width and Half width rolls.

   Heavy paper – Full width, 1.14 m wide, 80 m long.
   Medium paper – Half width only, 0.57 m wide, 200 m long.

(c) Starting Papers

   Protective paper must be used at the start of every load and shall be of 
   sufficient width to enable the Sprayer Driver to achieve the correct 
   pressure and proper fanning of jets across the full width of the spraybar 
   before the sprayed material passes off the paper.

   Starting paper shall be placed at right angles to the centreline of the 
   road unless, for any reason, the finishing line of the preceding load is 
   not at right angles, eg. at intersections.

   Generally a full width paper (1.14 m) is required. The Sprayer Driver 
   shall make every effort to start the spraying as close as possible to the 
   rear edge of each set of starting papers.

   Do not lay the starting paper until the aggregate spread on the 
   preceding load has been squared off and cut back to where the full 
   application of material finished.

(d) Finishing Papers

   Protective paper shall be used at the end of each day’s work and at the 
   end of every job to ensure a clean finish to the work.

   Finishing paper should be laid at right angles to the centreline of the 
   road to square up the work unless, for some reason, the work does not 
   finish at right angles, e.g., intersections.

   The sprayer shall cut off and stop with the spraybar over the paper.

(e) Protection of Structures etc.

   Use paper to fully protect bridge handrails, kerbing, manholes, 
   signposts or any structure which will be affected by the splashes of the 
   sprayed material. Generally the medium grade of paper should be
adequate and is easier to handle than the heavy grade. Protective paper for protection of kerbs should be held in place with aggregate or bricks, nails etc. Do not use dusty material.

Light grades of plastic may be more suitable than paper protecting structures or bridge parapets/ rails, particularly if it does not need to be removed between priming and sealing.

**Figure 16.4.12A, B & C**  Procedures for paper laying

**STEP 1 : Procedures before laying paper when primersealing and sealing**

<table>
<thead>
<tr>
<th>Previously sprayed area</th>
<th>Area to be sprayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprayer direction</td>
<td></td>
</tr>
<tr>
<td>a. Sweep all loose material to side of road</td>
<td></td>
</tr>
<tr>
<td>b. Cut back to where full application of binder ended</td>
<td></td>
</tr>
</tbody>
</table>

**STEP 2 : Correct method of laying starting paper**

<table>
<thead>
<tr>
<th>Previously sprayed area</th>
<th>Area to be sprayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprayer direction</td>
<td></td>
</tr>
<tr>
<td>10 to 20 mm lap over clean straight edge</td>
<td></td>
</tr>
</tbody>
</table>

**Step 3: Correct method of finishing paper**

<table>
<thead>
<tr>
<th>Last area sprayed</th>
<th>Area not to be sprayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprayer direction</td>
<td></td>
</tr>
<tr>
<td>End of day’s work</td>
<td></td>
</tr>
</tbody>
</table>

Note: When sealing or primersealing, papers should only be held down using aggregate
(f) At junctions and intersection where the roads often vary in width along their length, plan the work and use ample paper to make maximum use of the sprayer and keep hand spraying to a minimum. For an example on papering an intersection see Fig 16.4.12 D,E and F.

Spraying and spreading should be along the main lines of the traffic flow.

When hand lancing at the end of a section of road, eg wings tapers, paper should be used to protect the adjoining road pavement and also give a good clean finish.

(g) Disposal of Protective Paper

All starting and finishing papers should be folded neatly and stacked along the road. If necessary they should be weighted down to prevent being blown about by wind.

All other papers shall be removed as soon as they are no longer required and also stacked neatly as above.

At the end of each day’s work all paper shall be collected and disposed at an approved garbage landfill operation.

Note: Protective paper is not to be burned at any time either at the roadside or the tip. Refer to Section 9.2.3.

*Figure 16.4.12D*
16.4.13 Marking Out

(a) General

Mark out for every sprayer run to ensure that the sprayed work is in the correct location and of neat appearance on longitudinal joins and along the edges. Do not follow existing edges, kerbs etc. The position of the guideline marks varies according to the width to be sprayed, whether half or full width work and depending on the particular sprayer doing the work. The most common marking out is 600 mm to the right of the centre of the width sprayed, for work other than widening.

Guideline marks should be placed so that the sprayer driver can sight along the guide rod, which on most sprayers is directly in front of the driver’s position, 600 mm to the right of the centre of the sprayer.

Mark out so that the spraying is central about the centreline of the pavement for each sprayer run. For widening mark out to spray so that the jets are on the right hand side of the sprayer to allow the sprayer driver to observe the outside edge for line. This will allow the sprayer to
travel on the existing pavement spraying against the direction of travel to
give a smoother ride and more uniform line.

Provide marks, say 2 or 3 at least, before the starting papers and past
the finishing papers to provide the sprayer driver with a line to spray to
at the start and finish of the run. Failure to do this often results in poor
longitudinal alignment at joints.

Always check the correctness of the marking out by looking for sharp
deviations in the marked line, particularly on curves.

The marked line should curve smoothly on varying alignments.

Marking out should be done in advance of the arrival of the BS unit to
eliminate waiting time. Where possible the BS Area Manager should
arrange with the appropriate Superintendent’s Representative to have
the work marked out well in advance. Preferably this marking should
be to allow spraying in both directions or otherwise away from the
stacksite.

The minimum marking that should be provided is the pavement
centreline or edge.

When marking out, use a tape in good condition.

(b) Priming/Primersealing

The pavement edge or centreline must be provided by the construction
supervisor. Always check any guide marks provided to ensure the
sprayer will run to the correct line.

*Figure 16.4.13 Examples of one method of papering part of an
intersection to minimise hand spraying and confine it to
areas with little or no traffic*
Where the pavement is widened on curves, mark this out so that the spraying follows the inside of the curve, not the outside. Space the guideline marks at about 10m intervals, using primer or water based paint. **Do not** use stones or other markers.

If the primer is applied in two applications the work should be marked out each time.

(c) Sealing

Always check any guide marks provided to ensure the sprayer will run to the correct line.

Do not perpetuate previous errors. Mark out according to the correct centreline of primed/primersealed pavement or width of existing sealed or asphalt surface.

Determine the centreline by measuring and lining out.

Do not use traffic linemarkings as the centreline or edge for working because often it is not the actual centre of the pavement surfacing.

Space the guideline marks at about 10m intervals, using water based paint or a spray can with paint of contrasting colour to the existing surfacing. **Do not** use stones or other markers.

Do not use one pavement edge as a guide for spraying.

16.4.14 Quantity of Binder to be Sprayed in One Application

The success of a seal coat depends to a large degree on the adhesion achieved between the binder and the covering aggregate. A major factor in the ability of a binder to wet an aggregate and achieve adhesion is its viscosity. This viscosity is, among other things, dependent on the binder temperature and the amount of cutting back.

When sprayed on a pavement surface, the binder temperature drops very quickly resulting in a rapid increase in viscosity, with subsequent decrease in its ability to wet aggregate. The lower the air and pavement temperatures the quicker the drop in binder temperature.

This is compensated for by cutting back the binder, but there is a limit to the amount of cutter that can be added to achieve both wetting and adhesion to the aggregate at lower temperatures.

For colder temperatures it is desirable to comply with the covering times in Table 16.4.6. This can be achieved by shortening the sprayer runs. It is more desirable and effective to avoid adding large amounts of cutter by reducing the time between spraying the load of binder and completion of covering that load with aggregate. Refer to Section 16.4.6(m) for recommended time limits to cover a load of binder.

When the recommended maximum quantity to be sprayed is less than a full load, a full load should be carried in the sprayer wherever possible to minimise heat loss.
In all cases where the quantities are less than a full load the recommended sprayed quantity of binder shall be covered with aggregate before more binder is sprayed. The sprayer can wait by the roadside during the covering operation or return to the loading site to top up the load depending on the recommended maximum quantity and the size of the sprayer.

16.5   LOADING AGGREGATE

16.5.1  Stacksites

For efficient and economical loading and safety, aggregate stacksites should be selected with care.

16.5.2  Equipment

(a) Sealing

The aggregate spreading trucks must always be loaded using purpose built aggregate loaders which will enable:

- The aggregate to be loaded cleanly from the stacksite
- Any dust and excess fines to be screened out
- Uniform precoating of the aggregate
- Ease of levelling of the aggregate in the truck body.

Front End Loaders (FEL) are not acceptable for loading aggregate.

(b) Primersealing

It is preferable to use an aggregate loader if one is available but a front end loader may be used, with care to avoid picking up foreign material, because the aggregate is usually not precoated and the aggregate grading and screening is not as critical as with sealing.

(c) Operation

For operational details of an aggregate loader refer to Section 23.5.

16.5.3  Standard Instructions

(a) Always use an aggregate loader to load, screen and/or precoat aggregate from stacksites for use on sealing work.

(b) Level the scraper blade so that it cleans up the aggregate but does not load foreign matter, eg., grass, dirt or other materials.

(c) Use the loader efficiently by making each cut through the aggregate stack as even in quantity as possible. With the loaders it should be possible to load aggregate stacked to the recommended templates, in two even cuts.

(d) Leave the aggregate stack squared off, do not leave long narrow wind rows which will interfere with future stacking of aggregate.

(e) Overhead clearance required is about 4 metres, therefore care is required with overhead obstructions, telephone and cable TV wires and particularly electricity cables for the safety of the operator. If in doubt regarding the safety of the site contact the BS Area Manager.
(f) Use a screen appropriate for the size of aggregate being loaded.

(g) Adjust the loading speed and rate, to suit the conditions and to avoid overloading the screens and conveyor.

(h) Place the loader in such a position that during loading any dust is blown away from the operator and the already precoated aggregate. When loading in a cross wind try to load the trucks on the upwind side of the loader.

(i) Operators shall have a clear view while operating the aggregate loader.

The correct position is to stand at the operating controls to have a clear view of the scraper plate, spirals, aggregate precoating and the trucks etc.

(j) Always empty the trommel before stopping but do not let it run for more than a few minutes without a load, as this will cause excessive wear on its rollers.

(k) Keep the loader flights in the trommel free from accumulated dust to maintain an efficient loading rate. Inspect and clean daily if necessary.

(l) Check the rollers on the conveyor to ensure they run freely and do not restrict the conveyor belt speed and as a result the aggregate discharge rate.

(m) Keep the precoating jets clean, both internally and externally. They are designed to cut-off cleanly when the pressure drops below about 75 kPa to minimise wastage and spillage of precoating material.

(n) To ensure a uniform rate of precoating use the jets to wet the trommel etc., before first loading aggregate at the start of each day or after a break long enough to dry the trommel interior (eg., after a lunch break).

The rate of application may be adjusted by operating one, two or three of the pre-coating jets as required.

(o) To obtain the rated discharge normal pressure setting for the precoating jets in the trommel is about 250 to 300 kPa. The maximum pressure is about 400 kPa, but higher than normal pressure will result in excessive atomisation of the spray with a corresponding decline in the efficiency of the precoating.

(p) If the aggregate being loaded does not require precoating, eg. when using aggregate precoated at a central plant or when removing excess fines by dry screening, do not run the gear pump but disconnect it, as running it dry will cause excessive wear or failure.

(q) For efficient operation of pumps it is essential that all joints in hoses etc., are airtight.

(r) The aggregate spreading trucks should be loaded evenly.

(s) The aggregate should always be struck off to water level so that the quantity of aggregate in the truck is an even and of known quantity. This is necessary to avoid overloading and to determine rates of application of aggregate to an acceptable limit of accuracy.
Figures 16.5.3A & B  Aggregate loading – very tight site

Figures 16.5.3C & D  Aggregate loading – plenty of room
It is desirable to paint the water level capacity of the truck on both sides of the truck body so that it can be easily read by the aggregate loader operator to record the quantities loaded and the rate of precoating material applied.

16.5.4 Screen Sizes

Table 16.5.4 gives the standard screens that should be used with aggregate loaders to screen out undersized materials and dust without significantly affecting grading and the ALD of the one sized aggregate during loading and/or screening.

Table 16.5.4 Screen Size to be Used for the Loading of Sealing Aggregate

<table>
<thead>
<tr>
<th>Screens</th>
<th>Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aperture (mm)</td>
<td>Wire diameter (mm)</td>
</tr>
<tr>
<td>9</td>
<td>2.5</td>
</tr>
<tr>
<td>6.3</td>
<td>2.5</td>
</tr>
<tr>
<td>3.15</td>
<td>1.6</td>
</tr>
<tr>
<td>Blank (steel plates)</td>
<td></td>
</tr>
</tbody>
</table>

Using too large a screen size for the size of aggregate being loaded could significantly alter the grading and ALD and this will affect the design of the rates of application.

Using too small a screen could result in insufficient screening because the screen will block with fines.
For aggregates of size 5 and smaller and sand, screening is not required and the screens should be blanked off with the steel plates.

If any of the recommended standard screens provided are not satisfactory the BS Area Manager should be consulted before another screen size is adopted.

16.5.5 Loading Rate
The design maximum loading rate of an aggregate loader is about 2.5 cubic metres per minute. The normal loading and precoating rate is about 1.5 to 2 m³/min and this should not be exceeded because it will overload the trommel screen, and will result in insufficient screening as well as insufficient and non-uniform precoating of the aggregate.

16.5.6 Recording Quantities
To provide accurate contractual information and to provide useful records for future reference and estimating purposes, the BS Works Manager should arrange for the following quantities to be measured and recorded at the end of each day’s work, and at the end of each job:

(a) Quantity at the stacksite
(b) Quantity loaded into the aggregate spreading trucks
(c) Quantity returned from the job to the stacksite
(d) Quantity left at the stacksite
(e) An allowance for the amount of aggregate wastage, ie., undersized, due to stacksite conditions, etc., usually this is between 2 and 5% of the original stacksite quantity
(f) Quantity of precoating material used
(g) Rate of precoating in litres/m³

The quantity measured by truck volume and the quantity measured in the stack should agree within a few cubic metres. If there is a discrepancy the quantity measured in the stack would be more accurate than the quantity measured by truck volume.

The average rate of application of the precoating material (litre/m³) should be obtained by dividing the litres of precoating material used by the cubic metres of aggregate loaded and precoated, not just by the quantity of aggregate spread on the job.

16.5.7 Screening of Aggregates
At times aggregate delivered to a stacksite, stacked for a long time, or stacked in a dusty location etc., maybe outside the grading specification by an amount which will affect the quality of the seal coat and thus requires treatment before use.

If the aggregates are out of specification in the ‘Undersize’ only, then an economic method of removing the excess fines is to screen the aggregate
with an aggregate loader some time before it is required for use. The aggregate must be screened dry and should be restacked neatly to allow economic loading at a later date.

The aggregate should be stacked away from the screening operation so that fines being screened out do not re-contaminate the screened aggregate.

Using the appropriate size screen for the particular aggregate, see Table 16.5.4, and loading and screening the aggregate ‘dry’, the aggregate loader could be expected to remove about half of these fines. The maximum amount removed would be approximately 3% of the total aggregate for screening. Screening wet or damp aggregate will achieve little or no removal of fines.

An aggregate loader and two trucks for restacking at the same site could be expected to load and screen about 300 m³ in a normal working day.

Normally it should only require one dry screening with a maximum of two, to bring the excess fines down to an acceptable level. If more rescreenings are required the rescreening cost is likely to be uneconomic.

The aggregate loader cannot be used to screen out oversize material or improve the grading for the specified size without excess wastage.

Aggregate which has been screened by an aggregate loader may need to be resampled and tested before use on the road.

16.6 PRECOATING AGGREGATE

16.6.1 General

All aggregate shall be precoated before it is used in sealing work. This is to improve wettability and adhesion with the binder. In cutback bitumen sealing precoating allows the use of a more viscous binder which will set up quicker and provide faster retention of the covering aggregate. The precoating material may be light oil (with or without a bitumen component) or cutback bitumen with or without adhesion agent or a specially formulated precoating emulsion.

16.6.2 Equipment Used to Precoat in the Field

An aggregate loader is always used for loading of sealing aggregates from stacksites. To allow aggregate to be precoated during the normal loading cycle, the aggregate loader is fitted with a system which sprays the aggregate in the trommel. The precoating system is made up of:

- A spraying head
- Control valves and pressure gauge
- Pump
- Pipework and filters
- Flowmeter

The spraying head consists of three spraying nozzles fitted to diaphragm check valves. Two of these can be shut off so that either 1, 2 or 3 nozzles can be used according to the quantity of material required. In addition the nozzle discharge can be varied by adjusting the operating pressure.
The precoating jets must be kept clean, both internally and externally. They are designed to cut-off cleanly when the pressure drops below about 75 kPa to minimise wastage and spillage of precoating material.

The nozzles give a flat spray pattern. At about 280 kPa two of the nozzles have a rated capacity of 7 litres/min. each, and the third one 4.5 litre/min. giving a maximum capacity of about 18 litres/min.

For distillate base precoating materials the spraying head is located at the inlet end of the trommel, on the right-hand side adjacent to the bucket elevator head.

The spraying nozzles should be directed to a point approximately three quarters of the way along the trommel screen, at between 7 and 8 o’clock as seen from the operator’s position.

For specially formulated emulsion precoating materials alternative arrangements and positions for the spraying nozzles may be needed. At this stage no guidance can be given regarding the most appropriate position for the spraying nozzles.

The correct positioning is very important to achieve initial dry screening and to wet and coat the aggregate at a point where sufficient rolling action of the aggregate takes place to uniformly and completely coat the aggregate particles before discharge.

The control valves and pressure gauge are located on the operator’s platform. The control valve has a bypass position and spray position. In the spray position, a relief valve maintains the preset pressure setting.

To obtain the rated discharge normal pressure setting for the precoating jets in the trommel is about 250 to 300 kPa. The maximum pressure is about 400 kPa, but using higher than normal pressure will result in excessive atomisation of the spray with a corresponding decline in the efficiency of the precoating.

Larger capacity spraying nozzles are available for spraying heavier precoating materials such as precoating emulsion and cutback bitumen.

The flowmeter is used to record the quantities sprayed through the nozzles and is provided to allow easy and accurate recording of the quantity of precoating material applied per cubic metre of aggregate loaded.

If the aggregate being loaded does not required precoating, eg., when using aggregate precoated at a central plant or when removing excess fines by dry screening, do not run the gear pump but disconnect it, as running it dry will cause excessive wear or failure.

For efficient operation of pumps it is essential that all joints in hoses are airtight.
16.6.3 Standard Instructions

These instructions refer to the normal precoating with diesel fuel oil/distillate with or without adhesion agent, cutback bitumen or specially formulated emulsion precoat.

(a) Aggregates shall be precoated by spraying with specially formulated emulsion precoat or a solution of one part by volume of adhesion agent per 100 parts of diesel fuel oil or distillate or a cutback bitumen in the following cases:

(i) When the aggregate is quartz gravel, crushed quartz, quartzite, quartz porphyry or granite

(ii) All aggregates which are damp provided complete and uniform precoating is achieved, otherwise the adhesion agent should be added to the binder

(b) All other aggregates are to be precoated by spraying them with specially formulated emulsion precoat or diesel fuel oil or distillate or specially formulated bitumen emulsion precoat only, except in special cases where the instruction is to precoat with other materials.

(c) The quantity of precoating material used should be sufficient to uniformly coat each aggregate particle without ‘over oiling or over coating’. After precoating and loading into the aggregate spreading trucks the aggregate should present a completely coated emulsion or oil damp surface. No free emulsion or oil should be present, only enough precoat should be used to adequately deal with any dust and/or film of fine material on the aggregate.

To ensure a uniform rate of precoating use the jets to wet the trommel, etc., before first loading aggregate at the start of each day or after a break long enough to dry the trommel interior (eg., after a lunch break).

(d) Large excess of precoating must be avoided as it will result in fluxing of the binder and generally unsightly black patches on the finished seal coat or sticky aggregates which pick-up.

(e) Depending on conditions operate either 1, 2 or 3 jets and adjust the loading rate such that all aggregate is uniformly precoated.

(f) If using a distillate based precoating material, do not precoat and load aggregate if it is known the aggregate is going to remain in the truck for some time longer than normal before spreading, ie. just prior to the lunch break. Particularly in hot weather the top part of the load will dry out reducing the effectiveness of the precoating. This could result in partial stripping of the load of aggregate spread.

The performance of specially formulated bitumen emulsion precoat is not affected if it dries out over a lunch break.

16.6.4 Precoating Materials

Refer to Chapter 5 – Additives and Aggregate Precoating Materials for the various types of aggregate precoating materials available.
16.6.5 Special Conditions

(a) Precoating with Cutback Bitumen/specially formulated Bitumen Emulsions.

Aggregates which are precoated with cutback bitumen or similar product, should generally be precoated about 4 to 6 weeks before being used. This is to let the material set up to avoid pick up by the wheels of the traffic and fluxing of the binder.

Specially formulated precoating emulsions may also be used for precoating. Trials have shown that aggregates precoated with these emulsions perform equally well if quarry precoated and left to stand for some time or precoated in an aggregate loader and used immediately. The use of a low binder content (15–30%) emulsion for the precoating of aggregates has many advantages such as wet aggregate can be precoated, precoated aggregate can be left in field or quarry stacksites for a long time without further treatments having to be applied prior to sealing operations and there is no leaching of the precoat into the surrounding environment at the stack site. (R&D Project 635, Internal Report No. 96–1 and 97–1.)

Precoating of the aggregate can be undertaken at either the stack site or more preferably the quarry using a pugmill or similar equipment.

Because of the more viscous nature of these precoating materials the standard spraying nozzles will need to be replaced with larger capacity nozzles.

When precoating with these more viscous materials, the trommel loader flights and conveyor belt may need more frequent cleaning than normal to maintain efficient loading.

When precoated in advance at the stacksite it should be restacked neatly to allow economic and efficient loading at the time of use.

Aggregates precoated with emulsion or cutback bitumen and left in stacks should be satisfactory for use for several months without further treatment. If used at a later date and the precoated aggregate has become contaminated with dust or is damp with water, it may be precoated with Diesel Fuel Oil/Distillate, with or without adhesion agent, or adhesion agent used in the binder, in accordance with the standard instructions.

In addition to observing the normal requirements for a stacksite, care is required to ensure any precoat does not run off or is washed off by rain as this may harm vegetation near the stacksite.

(b) Precoating with Proprietary Precoating Materials

There are several types of proprietary precoating materials available ranging from Diesel Fuel Oil/ Distillate based to cutback bitumen.

When using any one of these materials for precoating, the procedure to be followed is either as in (a) or (b) depending on the nature of the material. If in doubt consult the supplier.
16.6.6 Rates of Application

The rate of application of precoating material will vary with the nature and type of aggregate and its condition. A smooth, hard surfaced, non porous, clean aggregate will require less material to achieve a uniform cover than a rough surfaced aggregate of similar size.

Because of the larger surface area to be wetted a small size aggregate will require a heavier rate of application than a larger sized aggregate of the same stone.

Aggregates which have been precoated with emulsion or cutback bitumen and stacked for a long time will have dried out completely and may have become covered with dust. If required, these aggregates may be re-precoated with Diesel Fuel Oil/Distillate as per standard instructions. Generally the rate of application of precoating required will be similar or a little less than is required for a smooth aggregate.

A dusty, dry aggregate will also require a heavier rate of application than a clean, dry aggregate of the same type and size.

As a general indication the rates of application should be as follows:

(a) For Diesel Fuel Oil/Distillate see Table 16.6.6 – Approximate Rates of Application of Precoating with Diesel Fuel Oil/Distillate which sets out the rates recommended for various types and conditions of aggregate.

Table 16.6.6 Guide to Rates of Application of Precoating with Diesel Fuel Oil/Distillate (litres per cubic metre)

<table>
<thead>
<tr>
<th>Nominal Size of Aggregate</th>
<th>Aggregate Condition Before Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry</td>
</tr>
<tr>
<td></td>
<td>Rough hard</td>
</tr>
<tr>
<td>Size 14 or larger</td>
<td>7 - 9</td>
</tr>
<tr>
<td>Size 10, 7 and 5</td>
<td>8 - 10</td>
</tr>
<tr>
<td>Sand - Coarse</td>
<td>9 - 12</td>
</tr>
<tr>
<td>Sand - Fine</td>
<td>10 - 14</td>
</tr>
</tbody>
</table>

Note: The above rates of application also apply when using adhesion agent in the Diesel Fuel Oil/Distillate. At this stage in the development of specially formulated emulsion precoating limited guidance can be given on expected precoating rates. Precoating rates using emulsions appear to be similar to or slightly higher than for DFO/distillate based products.

(b) For cutback bitumen, between 15 to 30 litres per m$^3$ depending on viscosity of material and type of aggregate being precoated.
For specially formulated emulsion precoats, rates similar too or slightly higher than given in Table 16.6.6

The actual rate of application can only be decided for each aggregate as it is being loaded and precoated and should be such that each aggregate particle is completely and uniformly covered without excess material.

16.7 SPREADING AGGREGATE

16.7.1 General

Spreading the covering aggregate is a very important phase of sprayed work and can make all the difference between a successful high performance seal coat and a failure. To produce a good quality seal in normal conditions the Class 170 binder and crumbed rubber modified binder must be covered with aggregate and initially rolled within ten minutes of being sprayed and less in adverse conditions – refer Table 16.4.6. Polymer modified binders (including crumbed rubber) may need to be covered and initially rolled in less than 10 minutes and less in adverse conditions.

16.7.2 Equipment

(a) Sealing

On sealing work the covering aggregate is placed using a box spreader, which is a truck mounted unit. These spreader boxes are operated by a hand held remote control to minimise the risks to operators. It can be operated from the cabin of the spreader truck and obviate the need for having a spreader box runner for each truck.

(b) Primersealing

Generally box spreaders are used as described in (a) above.

(c) Spreading Speed

The actual speed of spreading which can be achieved depends on the condition of the spreader, the aggregate spreading truck, the existing surface, the size of aggregate being spread, etc.

With box spreaders, the discharge rate is not mechanically linked to the road speed and it is most important to have the aggregate spreading trucks achieve a uniform spreading speed to obtain an acceptable uniform rate of application of aggregate.

With the common types of truck used, the acceptable spreading speed is in the range 60 to 90 metres/minute.

16.7.3 Standard Instructions

(a) All the aggregate required to cover the area of binder to be sprayed should be onsite, loaded in the aggregate spreading trucks, before any binder is sprayed.

When traveling to and from a stacksite to the work site care must be taken that loose aggregate is not spilled from the truck body or spreader as it may cause windscreen damage and/or paint damage to vehicles.
Figure 16.6  Aggregate Precoating

1. Size 14 basalt aggregate before (LHS) and after (RHS) recoating with distillate only – rate approx 8 l/m²

2. Size 7 quartzite aggregate before (LHS) and after (RHS) precoating with distillate containing 1% by volume of adhesion agent – rate approx 1 l/m²
(b) Spreading shall start as soon as possible after spraying has started. Therefore remove the starting paper as quickly as possible after the sprayer has passed off the paper taking care to fold the paper neatly and place it out of the way off the road.

(c) Select the spreading width to enable covering to be done in the least number of passes and without requiring changes of width during the spreading process.

(d) Use the gates in the spreader to select the width. Minimum normal spreading width is the width from outside of tyre to outside of tyre of the spreading truck, plus an allowance of say 50 to 100 mm.

(e) Spreading should be done at a steady, safe speed to provide a uniform rate of application – see Section 16.7.2.

(f) Immediately corrugations appear in the aggregate just spread, spreading shall be stopped and the spreader and truck moved forward of the affected area. The spreader should be checked, and adjusted if necessary, before spreading is continued. Corrugations must be removed with the drag broom as soon as possible.

(g) During spreading the spreader operators must watch for blockages and non uniform spreading. Any blockages should be removed immediately.

(h) The BS Works Manager or Assistant Works Manager should check the rate of application at regular intervals during a day’s work and each time the type and/or size of aggregate is changed. The spreading should be adjusted carefully to give the correct rate of application which is enough to cover the binder with a uniform layer of aggregate one stone thick when packed tightly together.

If the aggregate has been correctly sampled, the actual spreading rate should be close to the design rate of application of aggregate plus an allowance for whip off.

(i) The appearance of the spread aggregate under the truck wheels is a guide to the correct rate of application. The binder should just be visible through the spread aggregate.

(j) Regularly check the rate of application of the aggregate for correctness and uniformity.

(k) Be careful not to underspread or overspread aggregate because this will cause stripping. Overspreading will cause breakdown of the aggregate causing fines which may lead to loss of aggregate or flushing. It is also wasteful and maybe dangerous to traffic. Under spreading will cause stripping because the excess voids in the aggregate will result in the binder not rising high enough to hold the aggregate particles securely in place.

Refer to Chapter 14 Design of a Seal Coat regarding the spread rate for the particular aggregate ALD.

(l) Watch for the accumulation of dust and fines in the truck bodies and spreader hoppers. Regularly clean the spreaders.
(m) Where the total width requires more than one spreading width always start spreading on the downwind side of the road or against the wind to avoid any dust being blown on to the uncovered binder. Where a narrow width is left to be covered the spread width of the box spreader can be adjusted. This should be done by spreading closely behind the main spreaders, ie. cover all the binder as soon as possible, don’t wait until the main spreader has finished its run.

When spreading narrow widths it is desirable not to have the wheels on the truck run on the shoulder as there may be overspray (and pavement materials) that stick to the wheel and dust may be created which affects the seal. If a truck has to use the shoulder it should not be allowed on the new work until the tyres are cleaned. This problem can be reduced by using the splash shields on the sprayer. Any narrow width should be left along the outside edges, not the centre.

(n) If the aggregate is size 10 or smaller it shall be drag broomed immediately after spreading and initial compaction. This will even up inequalities of spread (more common with the smaller aggregates) and helps to move the aggregate into a position with the least dimension vertical. Size 14 aggregate should normally not require drag brooming if spread correctly.

(o) Lack of uniformity due to spillage from trucks or spreaders, overlapping or misses at joins or other causes should be removed by hand brooming immediately following spreading. Aggregate must not be swept in from the outside edge because this will bring in dust which could ‘kill’ the binder and cause stripping.

(p) The spreader operators should look for problem areas with the binder, such as missed areas at the start or finish, blocked jets, etc. Such areas should not be covered with aggregate, or should be marked so that the aggregate can be swept off and the area treated as required before the job is completed.

(q) On busy roads, say 1000+ v/l/d, one width of aggregate should be spread the full length of the sprayer run to prevent delay to the traffic.

This will provide a better alternative then letting traffic run along a shoulder where there is generally a danger of dust being blown on the uncovered binder which may result in stripping and / or the overspray being picked up by vehicle tyres.

(r) When working half widths or lane widths and each run is covered separately about 50mm of the binder should be left uncovered along the edge to be overlapped on the following sprayer run if standard end jets are used. If endjets are not used there may be at least 300 mm overlap.

(s) The spreaders must always be emptied and cleaned out when changing from one type and/or size of aggregate to another and they should be emptied and cleaned at the end of each day.

Aggregate remaining in the truck or spreader must not be spread on the finished seal or existing pavement as this will cause aggregate
breakdown and fill the voids with fines and dust causing stripping, and will also increase the possibility of broken windscreens.

Leftover aggregate remaining should be returned to the stacksite.

(t) Aggregate spreading trucks and other equipment must not turn on newly spread and rolled aggregate because they will dislodge the aggregate and spoil the appearance by turning over the aggregate.

Turning should be done off the ends of the work taking care not to carry mud, etc. onto the new work.

16.7.4 Time Interval Between Precoating and Spreading

(a) DFO/Distillate and derivatives

This section refers to aggregate being precoated with DFO/Distillate
and derivative products (with or without adhesion agent) as it is being loaded for use.

The precoating material is used to promote adhesion between the aggregate and the binder and this is only achieved if the aggregate is damp with precoating oil. The effectiveness of the oil is lost as it dries. The higher the air temperature the quicker the aggregate dries, particularly the top layer. Thus it is important to keep the time interval between precoating and spreading to a minimum.

The effectiveness of oil precoating lasts only about one hour from the time of precoating and loading in the aggregate spreading trucks. Thus the trucks should not be loaded just prior to the lunch break or any other known break which will cause the precoating to dry off in the aggregate in the trucks. This applies particularly when the air temperature exceeds 25°C.

If possible, reduce the drying effect by parking loaded trucks in the shade while waiting for the remaining total required quantity of aggregate to be loaded.

If the precoating oil has dried the load of aggregate should be returned to the stacksite for future use and the truck reloaded with freshly precoated aggregate. If necessary the returned load may be reloaded and precoated as normal.

For this reason aggregate spreaders should also be emptied during the last run before the lunch break or end of the day to prevent aggregate drying out in the hopper.

Any aggregate spreading truck which is partially emptied should be returned to the stacksite and reloaded if the waiting time is more than half an hour before spreading the remainder of the load. To reduce truck changeover time on the spreaders it is good practice to start each spreading cycle with only fully loaded trucks.

Aggregate on which the oil precoating has dried will probably not adhere to the binder, and will be stripped off, and must not be used. The BS Works Manager should check the precoating on every truck load just prior to the sprayer being ready to spray its load.

In warm weather a thin layer of aggregate on top of the load will partially dry out. This is offset by the rolling and tumbling action during the tipping in the spreader hopper and actual spreading, where this very small quantity will be distributed through the rest of the aggregate and be partially recoated by contact with the other damp stones.

Note: The above does not apply to aggregate precoated in advance with bitumen emulsion or cutback bitumen precoating materials. Drying out is not a problem because the bitumen coating on the aggregate readily adheres to the sprayed binder. If this aggregate has been re-precoated with DFO/Distillate, then the above instruction apply. Refer to Section 16.6.6.
Figure 16.7.4A, B & C
Aggregate spreading using automatic
opening spreader boxes
16.7.5 Rates of Application of Aggregate

(a) Sealing

The design rates of application of the aggregate are as shown in the table below. These rates should be used as a guide only, because the actual rates of application achieved are governed entirely by the obtaining of an effective aggregate cover on the binder.

The design rate of application is dependent on the ALD and, to a minor extent, traffic volumes. The design rates of application should be close to the actual rates of application if the aggregate was sampled and tested correctly.

If the ALD is not known the average rates of application that may be used, as an initial guide, are as shown in Table 16.7.5.

(b) Sealing with PMB’s

When applying a SAM or SAMI, the aggregate needs to be applied 5 to 10% heavier than for a standard seal coat. See Table 14.9.1. For a HSS seal the aggregate is spread as for a normal seal.

(c) Primersealing

Because primerbinder is applied at heavier than normal rates of application (compared to a binder), the aggregate is required to be applied heavier than with sealing work.

As a guide, the rates of application are based on the rates for the aggregates in sealing work plus an allowance of between 5% and 10%, see Table 16.7.5.

Figure 16.7.5 1. Appearance before rolling of size 10 basalt aggregate spread at correct rate of application

2. Appearance after two phases of SPPTMW roller (Most of the aggregate has turned with the least dimension vertical and packed closer together)
Note:: These rates of application are guide only and must not be used in place of rates calculated in accordance with the procedures given in Chapter 14 which would be more accurate.

### 16.7.6 Variations from the Design Rates

(a) **Sealing**

As stated in Section 16.7.5 the actual rates should not vary greatly from the design rates.

In practice the expected variation from the design rate of application is about ± 10 m²/m³, with a maximum of 15 m²/m³. If the actual rate of application of the aggregate differs by more than 10 m²/m³ from the design rate the BS Works Manager should check the calculations, the size of the aggregate actually used, the quantity, actual area covered, etc. For variations of over 10 m²/m³ the BS Works Manager should provide some explanation on the appropriate Daily Work Return. One common reason for the variation is that the design of the seal coat was altered due to changed conditions eg., C170 to PMBs.

(b) **Primersealing**

Because the rates of application are not based on a layer of aggregate one stone thick and hence cannot be designed as accurately as in sealing work, the normal expected practical variation from the design rates would be 10 m²/m³ with a maximum of up to 20 m²/m³ depending on the actual shape of the aggregate.

### 16.7.7 Examples

Refer to Section 16.13 for examples on calculating precoating rates and aggregate spreading rates.

### 16.7.8 Spotting Up

Some spotting up is nearly always required, particularly on winding alignments and restricted areas where small areas, such as along spread aggregate joints, may not be covered with aggregate or are deficient in the cover of aggregate spread.
These areas should be spotted up closely behind the spreaders. Care should be taken in spotting up and only enough aggregate used to cover the area without overspreading.

Spotting up can be done by hand by the spreader crew or separately by a man hand spreading from one of the aggregate trucks following.

If a large area has been generally under spread it should be spotted up using the spreaders but taking care, as it is very difficult to not end up overspreading.

16.7.9 Hand Spreading

Other than for spotting up, hand spreading should be kept to a minimum because of the difficulty in obtaining a uniform aggregate cover.

Aggregate spreading should be organised so that hand spreading is confined to areas where there is little or no traffic. Hand spread aggregate shall be smoothed out with handbrooms.

When spreading aggregate by hand, the aggregate should be shaken off the shovel so that it falls onto the binder (as is the case with mechanical spreading). Do not broadcast the aggregate because this will result in a non uniform aggregate cover which is unsightly.

16.7.10 Brooming

(a) Hand brooming

There may be aggregate spillages from the trucks or spreaders or overlap along spreading joints. Any small areas missed may be covered by brooming adjacent aggregate onto them and/or by spotting up. Aggregate must not be swept in from the outside edges because this will bring in dust which could ‘kill’ the binder and lead to stripping.

(b) Drag Brooming

(i) Sealing

Immediately after spreading and initial compaction all aggregate of size 7 or smaller shall be drag broomed to provide an even cover and prevent the formation of corrugations and fatty areas.

Sealing work with size 10 or larger aggregate does not normally require drag brooming if the aggregate is spread correctly. If the aggregate is uneven, non-uniform or irregular for any reason, it should be drag broomed immediately after spreading and initial compaction, taking care to not dislodge the aggregate particles from the binder.

(ii) Primersealing

Immediately after spreading and initial compaction the aggregate shall be drag broomed to provide a uniform cover.

(iii) Instructions

Aggregate may be drag broomed using the drag broom fitted to a rotary broom or SPPTMW roller. The aggregate should be drag
broomed the full width of the spread aggregate starting in the
centre and working towards each edge. Aggregate should not be
broomed in from the edges because this will drag in dust etc., and
will create a hazardous windrow in the centre of the pavement.

To avoid damage to a freshly spread and compacted seal coat the
minimum pressure necessary to move the loose aggregate should be
applied. It is preferable to make several passes at minimum pressure
rather than one pass at increased pressure. Correct pressure is applied
if the broom bristles are only slightly bent.

To obtain maximum use and even drag brooming, the drag brooms shall
periodically be turned end for end to ensure even wear. The broom
shall be replaced when the bristles are between 50 and 60 mm in length.

16.7.11 Aggregate Spreading Patterns
Binder shall be covered with aggregate as quickly as possible. Refer to
Table 16.4.6 – Recommended Maximum Covering Time to Cover Binder
with Aggregate.

To keep within the specified maximum covering time all aggregate
spreading should be planned carefully, particularly on restricted areas such
as large intersections with traffic islands, city streets etc. Spraying and
spreading should both be along the main lines of traffic flow with handwork
restricted to minor areas.

16.8 ROLLING OF AGGREGATE
16.8.1 Purpose
The covering aggregate is rolled to:

(a) Press the aggregate particles into the binder

(b) Move the aggregate particles so that their least dimension is near
vertical. This is to reduce the air voids and force the binder up into the
mat of aggregate particles

(c) Achieve mechanical interlock between the aggregate particles.

16.8.2 Equipment
(a) Self Propelled Pneumatic Tyred Multi Wheel (SPPTMW) Rollers

These are the most suitable rollers for use on sprayed work and shall be
used at all times. This type of roller can roll closely behind the
spreaders and can reverse direction without turning. All BS units on
sealing work are allocated at least two SPPTMW rollers for normal
production works. The units may require additional rollers if carrying
out high production work.

Field trials have proven that it is not necessary to have this type of roller
ballasted to achieve the desired initial orientation and packing of the
aggregate particles.
(b) Steel wheel rollers

Steel wheel rollers are not used because they tend to break down the aggregate and do not arrange the aggregate particles in their correct position with their least dimension vertical. They ride on the high points only and thus provide non-uniform pressing of the aggregate into the binder.

(c) Operation

For operational details of the self propelled pneumatic tyred multi-wheel rollers refer to Section 23.7.

16.8.3 Standard Instructions

(a) It is important that the aggregate is rolled before the binder becomes cold and too viscous to achieve proper wetting and adhesion. Therefore rolling must follow as close as practical behind the spreader(s).

(b) Rolling should be continuous during the day and rollers should not be left idle, eg., between sprayer loads, but must be used at every opportunity.

Consideration should be given to continuous rolling during lunch breaks, etc. by using spare operators and/or staggering the normal operators’ lunch hour to have a minimum of one roller working at all times.

(c) The full width of the spread aggregate must be rolled.

(d) On medium to high traffic roads the traffic will provide additional rolling and after initial rolling, the rollers should concentrate on the non or low traffic areas. Traffic provides useful additional rolling if their speed is controlled. Therefore to ensure adequate compaction and orientation of the aggregate particles, more roller time is required on low traffic roads compared to medium – high traffic roads.

(e) Rolling, with drag brooming if necessary, should continue until the aggregate has been well embedded in the binder and a uniform surface is obtained.

(f) Aggregate must be rolled for at least the time given in Table 16.8.3 after being spread, particularly the last aggregate spread for the day.

(f) Rollers must be stopped and started smoothly to avoid skidding the wheels which will tear and damage the new work.

(g) Traffic should not be allowed onto the new work until the aggregate has had at least one pass with the roller.

(h) When the work is opened to traffic the roller operator must observe the traffic lanes and travel in the correct direction on the appropriate side of the road.

On roads with one way traffic rolling may be done against the direction of the traffic provided the width being rolled is closed to traffic, eg., one lane out of two or three.
Table 16.8.3 Minimum Rolling Requirements per hour per roller
(Area covered per roller hour ie., 1 roller for 1 hour)

<table>
<thead>
<tr>
<th>Aggregate Size</th>
<th>Traffic Volume Vehicles/lane/day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;300</td>
</tr>
<tr>
<td>5 and 7 mm</td>
<td>4000 m²</td>
</tr>
<tr>
<td>10 mm</td>
<td>3000 m²</td>
</tr>
<tr>
<td>14 mm</td>
<td>2500 m²</td>
</tr>
</tbody>
</table>

16.8.4 Rolling Wet Aggregate

The amount of rolling should be reduced while the aggregate is wet but rolling in accordance with the standard instructions should be carried out as soon as the aggregate dries. Additional rolling will be required to bed aggregate that was spread when wet.

Traffic must be kept to a minimum speed during this period because adhesion between the binder and aggregate is not fully achieved until the aggregate dries out and the water has evaporated.

16.8.5 Rolling in Wet Weather

If it rains during or soon after spreading the aggregate the rolling must be watched very closely. The water will emulsify the binder and there is a danger that rolling will force the emulsified binder up above the aggregate particles causing pickup and damage to the new seal.

If necessary rolling should be stopped, and traffic kept off the new seal if possible, until the aggregate dries out enough to enable adhesion to take place with the binder. Rolling should then be carried out in accordance with the standard instructions.
16.8.6 Rolling Speed

The initial pass should be at a slower speed but subsequently passes should be at rolling speeds between 15 and 25 kph to achieve compaction and move the aggregate particles to their correct position.

16.8.7 Number of Rollers

The amount of rolling necessary will vary with the area covered, size of aggregate and the traffic conditions. Table 16.8.3 gives an indication of normal roller requirements. These requirements are normally met by contractors sealing units using two rollers working continuously with the spreaders. The number of rollers required for the day’s work can be calculated from the Table 16.8.3. In cool weather, 15 to 20°C, the area per roller hour should be reduced by about 10%. This means 3 rollers may be required in cooler conditions. All rolling should be completed before leaving the site.

16.8.8 Backrolling

On deviations constructed without traffic it is necessary to backroll for a number of days using several rollers. The weather on days when back rolling is proposed should be warm to assist in bedding down the aggregates.

16.8.9 Method of Rolling

One roller should closely follow each spreader and the other roller (or rollers) further back, rolling earlier work.

Rolling must be done along the direction of the main traffic flow starting at the edges and working towards the centre. For the first roller passes, rolling shall be done without overlapping in order to roll all the aggregate as quickly as possible after spreading.

After the surface has been covered once, rolling shall proceed by overlapping each preceding pass by about one-third of the effective roller width.

Rolling shall be continuous and the full width of the seal should receive an equal number of roller passes.

On roads with two way traffic, rollers should normally not follow each other but should work in opposite directions and may be used to advantage to help control the speed of the traffic by leading the traffic through.

On roads with one way traffic, i.e., divided roads, it may be preferable to have the rollers following each other to minimise interference to the traffic but the full spread width must be covered with an equal number of passes.

When practical, the BS Works Manager should manage the traffic to assist in the rolling of seals, e.g., the use of cones and other traffic control devices to direct traffic onto shoulders so that they are thoroughly rolled and the moving of the cones and traffic control devices so that the full width may be rolled.
16.9 REMOVING LOOSE AGGREGATE

16.9.1 General

Aggregate spread rates are not sufficiently accurate to prevent whip-off. The whip-off can be a safety hazard to the traffic particularly with the larger size aggregates (e.g., size 14) on roads with high volume and/or high speed traffic. The main problem is broken windscreens, paint damage and possible loss of control of the vehicle and workers being hit by flying stones.

The BS Works Manager should inspect the work and arrange for the removal of any whip-off which may be dangerous and/or could cause problems. Loose aggregate on the surface may also crush itself and the aggregate in the seal due to the grinding action of traffic causing aggregate breakdown, fines and dust which may upset the proportion of voids in the mat, causing flushing and/or partial stripping.

As soon as the binder has hardened to the stage at which no more stones can be pressed into it and adhere, all loose aggregate must be removed from the surface of the seal in accordance with the requirements set out in VicRoads standard specification. On busy roads careful removal of most of the loose aggregate is required to be done on the day of sealing with the remainder being allowed to be removed the day after the work is completed.

16.9.2 Using a Rotary Road Broom

The broom should be set with less pressure than for normal sweeping. The broom should have a new or near new refill with long bristles which will provide a flicking action to remove the loose aggregate off the surface onto the shoulders or into the channels.

Sweeping should be started in the centre of the pavement and progress to the edges. A very small windrow only should be allowed to build up – make several light passes rather than one heavy one.

Depending on the location (and the job specification), the broomed off aggregate can be left on the shoulders well clear of the edge of the seal or must be picked up and carted to a convenient site.

With a rotary road broom it is preferable to have a roller following to ensure that any disturbed aggregate is rolled back into place.

16.9.3 Using a Suction Cleaner

Where the aggregate must be removed in medium to high traffic locations it is preferable to use a suction cleaner to pick up the whip-off and transport it to a convenient site.

Care must be taken that the aggregate is removed by suction only.

A suction cleaner should not be stopped with full suction operating as this will lift and damage the seal (particularly at the edges of the seal).

If the suction cleaner used has brooms to aid the suction, care must be taken to ensure that the brooms do not dislodge the aggregate. Generally the aggregate recovered by the suction cleaner is not suitable for re-use as sealing aggregate.
16.9.4 Traffic Control

Traffic control must be exercised for the safety of the operation. Traffic control is required when the rotary road broom is working but the suction cleaner which is fitted with warning lights and signs, can normally work alone with only signs needed to warn the traffic.

16.10 PROTECTION OF THE WORK

16.10.1 General

In its early life, sprayed work is susceptible to damage by traffic, even if the work is completed in good weather conditions. The first four hours are critical and the first forty-eight hours are very important. Therefore the BS Works Manager should take all possible precautions during the first 48 hours, and longer if necessary, until the work can stand up to the normal traffic conditions.

16.10.2 Inspections

The BS Works Manager should inspect completed work at least the next morning after completion. The inspection should assess whether the binder has set up and is strong enough to retain the covering aggregate. Traffic control must be continued as long as is necessary to achieve this.

On Fridays and before public holidays, work should be stopped earlier than normal to allow adequate rolling and time for the binder to cure and set up. The job should then be inspected after the weekend or holidays.

The earlier any problem or distress is detected, the easier and less costly it is to remedy. The BS Area Manager should be advised of any problems and/or actions taken to protect both the traffic and the work. If required the BS Area Manager/Works Manager shall arrange for the necessary men and/or equipment to work overtime weekends and/or holidays to protect the travelling public and/or the work.

Any known problem areas should be recorded on the Daily Work Return. A non-conformance should be filled out if a problem arises.

16.10.3 Half Width or Lane Width Working

When working in half widths or lane widths all traffic shall be kept off the new work until at least initial rolling, usually 2 passes and any necessary drag brooming has been completed.

Controlled traffic may then be allowed on the work and the next lane treated etc. The roller can be used to lead the traffic through and control the speed on the worksite.

16.10.4 Full Width Working

Where a sidetrack is not available, controlled traffic may be allowed through on one half or lane width as soon as spreading and initial rolling has been completed. The roller can be used to lead the traffic through and control the speed.

Uncontrolled traffic shall not be permitted on the new work until initial rolling, drag brooming and some final rolling has been completed.
16.10.5 Traffic Control

(a) Volume of Traffic

The greater the volume of traffic and the larger and heavier the vehicles, the greater the effect on the work. It is essential to exercise traffic control at all times but it is most important on roads carrying a high volume of traffic because damage can occur in a shorter time and will be more severe than on roads carrying less traffic.

(b) Speed

During the first few hours life of new work, high speed traffic can and usually does do serious damage and is a danger to personnel and the public. On the other hand slow speed traffic provides very good additional pneumatic tyred rolling.

On roads with high traffic volumes the control of the traffic speed, and protection of the work and personnel, is very difficult. To reduce damage and obtain as much pneumatic tyred rolling as possible it is most important to exercise proper traffic control.

Under present legislation, VicRoads has power to restrict traffic speed on roads during construction works. The speed limits are enforceable by the Police. This power is also available to the municipalities for roads under municipal control. This Regulation provides a means of enforcing traffic speed control but should only be used where necessary.

Refer to Chapter 21 – Provision for Traffic

(c) Excluding Traffic

If traffic is causing damage to the work then where possible, traffic should be excluded from the work until conditions improve or repairs have been carried out and the traffic can run over the work without causing further damage.

(d) Warning Signs

When working on restricted widths, eg., half width or lane width, both the work and the traffic shall be protected by using the appropriate warning signs and devices.

It is the BS Works Manager’s responsibility to ensure that the necessary signs and equipment are available to exercise full traffic control as required by the conditions. Refer to Chapter 21 – Provision for Traffic.

16.10.6 Time of Working

(a) Hot Weather

In hot weather it may take longer for the binder to set up and attain enough strength to retain the aggregate. This applies particularly to primerbinders. If this occurs traffic control must be used until the binder has set up sufficiently to withstand normal traffic conditions.
In extreme cases cooling the binder down with light watering may aid the rate of set up. This is not a recommended procedure as it could cause stripping and it is preferable to exclude the traffic from the work.

(b) Cold Weather

In cold weather the load in the sprayer should be split and the quantity of binder sprayed reduced so that it can be covered with aggregate before the binder gets too cold and viscous to achieve wetting and adhesion to the aggregate.

Refer to Table 16.4.14 which sets out the recommended maximum quantity of residual binder and/or length of road to be sprayed in one application in cooler weather.

(c) Weekends, Public Holidays, etc.

Consideration should be given to programming the work to avoid sprayed work on busy roads on Fridays and days before public holidays etc. This will greatly reduce the risk of damage by traffic and avoid the problem of organising men and plant for traffic control.

If work is to be done on these days then binder should not be sprayed after about 2.00 pm to allow adequate rolling before work ceases for the day. This work should be inspected by the BS Works Manager as soon as possible after the break, ie., Monday or first day of work after the holiday.

16.10.7 Humid or Wet Weather

(a) Obtaining Adhesion

Humid weather combined with damp or wet aggregate is a most difficult condition under which to achieve adhesion between the binder and the aggregate. This is further aggravated by fast and/or heavy traffic.

The following general instructions apply to sprayed work done in humid or wet weather.

(i) If a damp or wet aggregate is used traffic should not be allowed onto the work until the aggregate has dried. The use of adhesion agent will aid the removal of water from the aggregate but not from the work. This can only happen by natural drying. If traffic is to be allowed on the work, the speed should be kept down to 20 to 30 kph by traffic control.

(ii) If rain, dew or mist should fall on work before the aggregate has dried and adhesion is obtained, traffic shall be kept off the work, ie. by side track or detour. If this is not possible traffic shall be kept off as much of the work as is possible. Back rolling shall start again as soon as the aggregate has dried out and before traffic is allowed on to the work. If during the above, traffic has to be let on to the work its speed should be kept as low as practicable.
(iii) When humid weather prevails, or rain is likely, adhesion agent should be used in the binder in addition to normal precoating instructions for the conditions and type of aggregate.

(iv) In humid weather, or if rain is likely that night, rolling of the last load for the day shall be continued longer than normal until adhesion between the binder and aggregate has been achieved.

(v) In humid weather, or if rain is likely, work should be restricted to roads with low traffic volumes if possible because this is less likely to present problems.

(vi) If there is a choice among the low traffic work choose the work on which aggregate with better adhesion qualities are used (eg., basalt versus quartz gravel) and/or the work with the smaller size of aggregate (eg., size 7 versus size 10).

(b) Precautions with High Volume and/or High Speed Traffic

If work is to be done on roads with high traffic volumes and/or high speed, and humid weather prevails or rain is likely, the following precautions should be taken:

(i) adopt half width or lane width working

(ii) keep traffic off the work until adhesion between the binder and the aggregate has been obtained and the binder has set up enough to retain the aggregate

16.11 PROTECTION OF STRUCTURES, ETC

16.11.1 General

It is essential at all times to protect structures, kerbs and channels, buildings, signs, etc., from the splash and wind carried spray when spraying primer, primerbinder or binder.

With proper job pre-planning very little or no output will be lost due to time spent on papering for protection.

Any kerbs and channels, structures, etc., which are splashed will suffer in appearance and will remain unsightly for years. Smooth surfaces, such as on signs, metal, glass, etc., if splashed should be cleaned as soon as possible using kerosine followed if necessary by soap and water.

16.11.2 Bridge Handrails, Kerbs, etc

Whenever spraying over a bridge deck, end shields shall be used on both ends of the spraybar.

If the spraying is to be done close to the kerbs then these should be covered with protective paper or light grade of plastic.

If there is a cross wind blowing and there is a danger to the down wind handrails etc. being marked by splashes or spray, protective paper must be used or the work deferred.
Any bridge deck joints shall be covered by a strip of paper to protect the working joint from bitumen and aggregate. Protective paper should be removed as soon as the work has been completed over the bridge.

16.11.3 Manholes, Fire Plugs, etc

Before starting any work, particularly in built-up areas, the surface to be treated shall be inspected to determine the location of any cover boxes over stopcocks on water mains, gas mains etc., bench marks and manhole covers over sewers, drains, power and telephone cables.

The location of any manholes etc., shall be marked and they shall be covered with paper held down with aggregate. After the work is completed the paper shall be removed and the manholes etc., left clean and visible.

16.11.4 Kerbs, Kerb and Channel

Kerbs and kerb and channels shall be fully protected with paper which is held down securely by aggregate, bricks, wire clips, etc. It is particularly important with channels to provide a barrier against drainage by ensuring the paper is held down flat on the channel and/or using any swept off material as a barrier as well.

Half width medium grade paper is the most suitable.

Any side entry pits and other pits shall be protected from being filled with swept-off material and/or aggregate.

Protective paper (and the material used to hold it in place) shall be removed as soon as the work is completed.

Although the paper protects the kerbs and/or channels it is good practice to minimise overspray by using the end shields on the spraybar.

The practice of using only end shields to protect kerbs and channels is not a good one because it does not entirely eliminate splashing the kerbs and channels. Irregularities in the channel or road may make the shield ‘jump’ reducing its effectiveness.

With good organising the time taken to paper kerbs and channels should not interfere with output and this is the recommended method for protection.

16.11.5 Traffic Markings

(a) Linemarking

All marking must be marked with temporary delineators known as stick and stomps or flip flops to provide guidance for traffic until linemarking is reinstated.

(b) Raised Pavement Markers

Raised pavement markers can be removed before carrying out sealing works. After completion of the sprayed sealing works raised new pavement markers should be placed.
Figure 16.11A  Protecting a bridge parapet using half width medium grade protective paper

Figure 16.11B  Protecting a building using full width heavy grade protective paper

Figure 16.11C  Protecting a bridge deck expansion joint using full width, heavy grade protective paper. Note that in this case the joint coincides with the end of the sprayer run and end of the work
(c) **Barrier Lines, etc.**

The start and finish of barrier lines and lateral position should be clearly and safely marked in advance of the work, e.g., at the same time as when marking out, so that their correct position is easily relocated after the work has been completed.

### 16.11.6 Properties

(a) **Houses, Offices, Fences, etc.**

Care should be taken to ensure that any properties such as houses, offices, fences, etc. are not marked by splashes or windblown spray. If necessary the work should be deferred until the weather conditions are suitable.

(b) **Cars, etc.**

If sprayed work is to be done in areas used for car parking, such as city streets, arrangements should be made in advance with local council officers to restrict parking to keep parked cars from obstructing the work and possibly being marked.

### 16.12 PROVISION FOR TRAFFIC

Traffic control, signs, etc. shall be in accordance with the instructions in Chapter 21 – Provision for Traffic.

### 16.13 EXAMPLES, TABLES AND GRAPHS

#### 16.13.1 General

The following examples are provided as a guide to the calculations which are normally required in the general type of sealing work done by BS units. The basic calculation procedures apply also to priming and primersealing work.

#### 16.13.2 Tables and Graphs

The tables and graphs are shown also in Chapter 8 but for convenience have been grouped together with the examples in this Chapter.

The tables and graphs provided, including the references to their location in Chapter 8 are:

- **Table 16.13.2A** – Relative Density and Litres/Tonne – also as Table 8.3.1
- **Table 16.13.2B** – Volume Correction Tables (Bitumen, Fluxed and/or cutback bitumen) – also as Table 8.5.2 Parts A and B
- **Table 16.13.2C** – Volume Correction Tables (Bitumen emulsion) - also as Table 8.5.3 Parts A and B
- **Table 16.13.2D** – Cutting back of Class 170 bitumen – also as Table 8.7A
- **Table 16.13.2E** – Fluxing of Class 170 bitumen – also as Table 8.7B
- **Table 16.13.2F** – Cutting Back of Class 170 Bitumen containing
16.13.3 Examples

The following examples are provided as a guide to the calculations generally required in the daily operations of a BS unit. The examples provided are:

- Example No. 1 – Converting mass to volume
- Example No. 2 – Volume correction
- Example No. 3 – Calculations for Fluxed and/or Cutback binder
- Example No. 5 – Calculations for Fluxed and/or Cutback binder including Adhesion Agent
- Example No. 6 – Calculations for Fluxing and Cutting Back a part load in a bitumen sprayer
- Example No. 7 – Calculations for Fluxed and/or Cutback binder containing Crumb Rubber
- Example No. 8 – Calculations for Cutback Bitumen Primerbinder
- Example No 9 – Field produced Primerbinder
- Example No 10 – Calculations for Sealing using PMB (SBS Polymer)

Example No. 1 – Converting Mass to Volume

A Road Tanker of Class 170 bitumen from Mobil has been delivered to the rail siding and the weighbridge ticket shows that the mass of the load of bitumen delivered is 23.70 tonnes. This must be converted to litres at 15°C.

From Table 16.13.2A
Class 170 bitumen ex Mobil = 960 litres/tonne at 15°C
Quantity in the R. Tanker = 23.70 * 960
= 22,752 litres at 15°C

Example No. 2 – Volume Correction

The Class 170 bitumen in the Road Tanker has been heated to the allowable maximum of 185°C and a load is to be taken off by a bitumen sprayer.

After transfer, the load in the bitumen sprayer is 5,850 litres, measured on the dipstick, at a temperature of 182°C. This must be converted to litres at 15°C.

From Table 16.13.2B the multiplier to correct from 182°C to 15°C is 0.8990.

Therefore the quantity at 15°C = 5,850 * 0.8990
= 5,259 litres.

Example No. 3 – Calculations for Fluxed and/or Cutback Binder

Instructions for a proposed reseal are as follows:

Length of work = 1.8 kilometres
Width of work = 5.6 metres
Rate of application of binder = 1.3 litres/m²
Traffic – 250 v/l/d
Fluxing – 2 parts
Aggregate – size 10 basalt but is moist due to substantial recent rains.
Rate of application – 140 m²/m³
The pavement temperature at the time of spraying the load – 22°C

(a) Loading the Bitumen Sprayer

The quantity of Class 170 bitumen transferred from the bitumen road tanker to the bitumen sprayer, as measured on the dipstick, is 4,875 litres at 178°C.

This quantity must be converted to the quantity at 15°C. From Table 16.13.2B the multiplier to correct from 178°C to 15°C is 0.9014.

The quantity of bitumen at 15°C
\[ 4,875 \times 0.9014 = 4,393 \text{ litres} \]

Quantity of Flux oil: From Table 16.13.2E (or Table 8.7B) for traffic in the range 100 to 300 v/l/d 2 parts are suggested
\[ 4,393 \times \left( \frac{2}{100} \right) = 87.9 \text{ say 88 litres} \]

Quantity of cutter: From Table 16.13.2D (or Table 8.7A) the total cutter required for size 10 aggregate where the precoat is inactive due to moist aggregate, traffic of 250 v/l/d and a pavement temperature of 22°C is 8 parts per 100 parts of bitumen at 15°C. Considering that 2 parts of flux oil are to be added this leaves 6 parts of cutter oil to be added.
\[ \text{Cutter } 4,393 \times \left( \frac{6}{100} \right) = 263.6 \text{ say 264 litres} \]

(b) Checking the Temperature of the Load

The temperature of the fluxed and cutback binder should be checked after the materials have been circulated for 20 minutes.

From Figure 16.13.2G (or Figure 8.6.1) the minimum temperature of the material should be about 169°C.

(c) Checking the Quantity in the Bitumen Sprayer

A check should be made of the quantity by dipping the load after the materials have been circulated for at least 20 minutes. This dip can also serve as the dip for the start of the sprayer run, unless there is a long delay which may cause a drop in the temperature of the material.

In this case the total quantity loaded into the bitumen sprayer is:
\[ 4393 + 88 + 264 = 4,745 \text{ litres at } 15°C \]

This must be corrected to the temperature of the material, after circulation, to provide a check for the dipstick reading.
The temperature of the fluxed and cutback bitumen is 169°C

From Table 16.13.2B the multiplier to correct from 15°C to 169°C is 1.103

Therefore the quantity is:

\[ 4,745 \times 1.103 = 5,234 \text{ litres at } 169°C \]

Depending on the accuracy of the dip the measured quantity in the sprayer at this temperature would be expected to be within ± 50 litres of the above quantity.

(d) Number of Jets

From Figure 23.2.5 the number of jets required to spray a width of 5.6 metres = 54 jets, including 2 end jets.

(e) Forward Speed

From Figure 23.2.5 the forward speed for the desired rate of application of binder of 1.30 litre/m² is 128 m/min. This forward speed scale reading must be corrected to allow for the cutter in the cutback binder.

\[
\text{Forward speed} = \frac{\text{parts of (bitumen + flux oil)}}{\text{parts of (bitumen + flux oil + cutter)}} \times \text{scale reading}
\]

\[
= \frac{100 + 2}{100 + 2 + 6} \times 128
\]

\[= 121 \text{ m/min} \]

(f) Actual Work Done

Length of spray run = 600 metres as recorded on the bitumeter head of sprayer 29 F 707. From Figure 23.2.5 the correction factor for distance is 0.996.

Actual distance sprayed = 600 \times 0.996 = 597.6 say 598 m.

Area sprayed = length \times width
= 598 \times 5.6 = 3,347 m²

The spraying details are as follows:

- Dip start – 5,217 litres
- Dip finish – 50 litres
- Hot cutback sprayed – 5,167 litres
- Spray temperature – 164°C

Quantity of cutback sprayed at 15°C = 5,167 \times 0.9095 = 4,699 litres
Quantity of residual binder sprayed $= \frac{100+2}{100+2+6} \ast 4,699$

$= 4,438 \text{ litres at } 15\degree C.$

Rate of application of residual $= \frac{\text{binder quantity of residual binder at } 15\degree C}{\text{area sprayed (m}^2\text{)}}$

$= \frac{4,438}{3,347}$

$= 1.32 \text{ litres/m}^2 \text{ (design } = 1.3 \text{ litres/m}^2 \text{)}$

Rate of application of aggregate

Quantity of aggregate used was 3 truck loads of 8.0 m$^3$ each = 24m$^3$

Rate of application of aggregate $= \frac{\text{area sprayed (m}^2\text{)}}{\text{quantity of aggregate (m}^3\text{)}}$

$= \frac{3347}{24} = 139 \text{ m}^2/\text{m}^3 \text{ (design: 140 m}^2/\text{m}^3\text{)}$

Example No. 4 – Calculations for Fluxed and/or Cutback Binder including Adhesion Agent

Adhesion agent is normally supplied in 20 litre drums (19 kg).

The normal addition is ½ % by volume to 100 parts of bitumen at 15\degree C for class 170 binder.

This is ½ litre per 100 litres of bitumen at 15\degree C or 10 litres (½ drum) per 2000 litres of bitumen at 15\degree C.

Adhesion agent is disregarded in further calculations regarding fluxing, cutting back, forward speed and rates of application.

Example No. 5 – Calculations for Fluxing and Cutting Back a Part Load in a Bitumen Sprayer

At completion of a job a bitumen sprayer is left with a part load of a fluxed and cutback binder which is to be used on the next job.

Details of the load left in the bitumen sprayer are:

Composition: Bitumen – 100 parts by volume at 15\degree C
Flux oil – 2 parts by volume at 15\degree C
Cutter – 8 parts by volume at 15\degree C
Adhesion agent – ½ part by volume at 15\degree C
The volume is 1,250 litre, measured on the dipstick, at a temperature of 170\degree C.
This must be reduced to its volume at 15°C.
From Table 8.5.2 Part B the multiplier to correct from 170°C to 15°C is 0.9060.
The quantity of cutback at 15°C is = 1250 * 0.9060 = 1,133 litre

Quantity of bitumen at 15°C = (100/110.5) * 1,133 litres = 1,025 litres
Quantity of flux oil at 15°C = (2/110.5) * 1,133 litres = 21 litres
Quantity of cutter at 15°C = (8/110.5) * 1,133 litres = 82 litres
Quantity of adhesion agent = (0.5/110.5) * 1,133 litres = 5 litres

TOTAL = 1,133 litres

The binder required for the next job is:
- Bitumen – 100 parts
- Flux oil – 4 parts
- Cutter – 6 parts
- Adhesion agent – ½ part

The new load has to be about 6,000 litres of residual binder at 15°C.

Based on 6,000 litre of bitumen at 15°C the following total quantities are required:
- Bitumen 6,000 litres
- Flux oil (4/100) * 6000 = 240 litres
- Cutter (6/100) * 6000 = 360 litres
- Adhesion agent (0.5/100) * 6000 = 30 litres

<table>
<thead>
<tr>
<th></th>
<th>Required total quantity at 15°C (litres)</th>
<th>Existing quantities on bitumen sprayer at 15°C (litres)</th>
<th>Quantity to be added at 15°C (litres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen</td>
<td>6000</td>
<td>1025</td>
<td>4975</td>
</tr>
<tr>
<td>Flux oil</td>
<td>240</td>
<td>21</td>
<td>219</td>
</tr>
<tr>
<td>Cutter</td>
<td>360</td>
<td>82</td>
<td>278</td>
</tr>
<tr>
<td>Adhesion agent</td>
<td>30</td>
<td>5</td>
<td>20 (drum)</td>
</tr>
</tbody>
</table>

Table 16.13.3A Quantity of material to be added to tanker
Example No. 6 – Calculations for Fluxed and/or Cutback Binder containing Crumb Rubber

Instructions for a proposed bitumen crumb rubber reseal over a cracked pavement are as follows:

- Length of work – 2.7 kilometres
- Width of work – 2 * 3.7 m lanes + 1 * 2.5 m parking lane = 9.9 metres
- Rates of application of binder
  – through lanes Quantity to be added at 15°C (litres) – 1.9 litres/m²
  – parking lane – 2.5 litres/m²
- Crumb rubber content – 20 parts
- Traffic (12 hour count) – approx. 1100 v/l/d
- Aggregate (plant precoated with cutback bitumen) – size 14 basalt
- Rate of application of aggregate – 90 to 100 m²/m³

Note: The actual width of the lanes in 3.5m, the additional 200mm is to allow for vehicles overhanging the marked edge line.
Pavement temperature at the time of doing the work is about 26°C and increasing slowly with an expected top pavement temperature of 32°C.

(a) Loading the Bitumen Sprayer (4500 litre – Sprayer No.29 F 706)

Assume the bitumen sprayer has just returned from spraying a load and the quantity of material left is 450 litre, measured on the dipstick, at 172°C. This quantity has to be corrected to 15°C and the components calculated separately before topping up the sprayer.

The load consisted of:

- Class 170 bitumen – 100 parts by volume at 15°C
- Flux oil – Nil parts by volume
- Cutter – 4 parts by volume
- Crumb rubber – 20 parts by mass
- Adhesion agent – 1 part by volume at 15°C

From Table 16.13.2B Part A (or Table 8.5.2 Part A) the multiplier to correct from 172°C to 15°C is 0.9048.

The quantity of material at 15°C = 450 * 0.9048 = 407 litre

The approximate quantities of the components are:

Quantity of bitumen at 15°C = \((100/124) * 407\) = 328 litre
Quantity of cutter at 15°C = \((4/124) * 407\) = 13 litre
Quantity of crumb rubber = \((20/124) * 407\) = 66 kg
Quantity of adhesion agent = \((1/124) * 407\) = 3 litre

Because of the frothing of the bitumen crumb rubber mixture the quantity of hot bitumen loaded into the bitumen sprayer should be limited to about 3,600 litre to reduce the possibility of an overflow occurring. In this case it is decided to add 3,300 litre of hot bitumen measured on the dipstick of the tanker.

Temperature 200°C

Quantity of bitumen at 15°C. From Table 16.13.2B (or Table 8.5.2 Part A) the multiplier to correct from 200°C to 15°C is 0.8886.

Quantity of bitumen at 15°C = \(3,300 * 0.8886\) = 2932 litre

Parts of crumb rubber required = 20 parts by mass

Assuming 1 litre of Class 170 bitumen at 15°C has a mass of 1 kilogram

Quantity of crumb rubber required = \(2,932 * (20/100)\) = 586 kg

At 25 kg net per bag this equals 586kg = 23.46 bags

It is desirable to load crumb rubber in multiples of full bags so in this case 23 bags would be loaded. i.e., 575 kg

Cutter – cutter required is 4 parts

Quantity of cutter at 15°C = \(2932 * (4/100)\) = 117 litres
Adhesion agent required is approx 1 part

Quantity of adhesion agent at 15°C = 2932 * (1/100) = 29 litres

In practice 1½ 20 litre drums would be added, i.e., 30 litres

Total load – the total quantities in the sprayer at 15°C are shown in Table 16.13.8

The material must be circulated for 40 minutes after all the rubber has been added in order to obtain the desired reaction.

(b) Temperature of the Load

After circulating for 45 minutes the temperature of the load should be about 180 to 185°C. If it is below 175°C the load should be reheated to about 185°C.

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount in sprayer</th>
<th>Amount added</th>
<th>Total amount</th>
<th>Actual parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen (litres)</td>
<td>328</td>
<td>2932</td>
<td>3260</td>
<td>100</td>
</tr>
<tr>
<td>Flux Oil</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cutter (litres)</td>
<td>13</td>
<td>117</td>
<td>130</td>
<td>4</td>
</tr>
<tr>
<td>Crumb Rubber (kg)</td>
<td>66</td>
<td>575</td>
<td>641</td>
<td>19.7</td>
</tr>
<tr>
<td>Adhesion Agent (litres)</td>
<td>3</td>
<td>30</td>
<td>33</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Table 16.13.8 Quantities in Sprayer**

(c) Checking the Quantity in the Bitumen Sprayer

Because of the varying expansion and frothing of the bitumen crumb rubber mixture the dip is not accurate. The load should be dipped immediately prior to spraying for use in calculating the rate of application. Generally the dip should be similar for loads of similar quantities and circulating times. The dip will also decrease from the time of loading to spraying and can be expected to decrease with larger circulating times for similar loads, e.g., longer circulating over lunch time.

(d) Number of Jets Required

With 20 parts of crumb rubber the maximum width that can be sprayed is 7.6 m and 2.6 m for the parking lane to provide the required 50 mm overlap on each join. For this example consider the width of 7.6 m.

From Figure 23.2.5 the number of jets required is 74 jets, including 2 end jets.

(e) Pump Shaft Revolutions

From Figure 23.2.5 for 74 jets:
Pump shaft speed – 605 rpm

For 20 parts of crumbed rubber: From experience increase in pump shaft revolutions – 10 to 20 rpm because crumb rubber polymer modified binder has a high viscosity, say pump speed 620 rpm.

(f) Forward Speed

From Figure 23.2.5 the forward speed for the desired rate of application of binder of 1.9 litre/m² is 84 m/min. This must be corrected for the parts of cutter in the binder.

\[
\text{Forward speed} = \frac{\text{parts of (bitumen + crumb rubber + flux oil)}}{\text{parts of (bitumen + flux oil + crumb rubber + cutter)}} \times \text{scale reading}
\]

\[
= \frac{(100 + 20 + 0)}{(100 + 20 + 4)} \times 84 = 81 \text{ m/min}
\]

(g) Actual Work Done

Length of spray run = 240 m was recorded on the bitumeter head of sprayer 29 F 707

From Figure 23.2.5 the correction factor is 0.982

Actual distance sprayed = 240 * 0.982 = 236 m

Area = length * width = 236 * 7.6 = 1794 m²

Spraying details are as follows:

- Dip start – 4650 litres
- Dip finish – 400 litres
- Hot material sprayed – 4250 litres
- Spray temperature – 182°C

Because of the inaccuracy of dipping bitumen crumb rubber mixtures, it is preferable to calculate the quantity of binder remaining in the sprayer, as measured at 15°C, and deduct this from the quantity of total binder at the start to obtain the quantity sprayed. This will reduce errors and provide a more reliable indication of the rate of application sprayed.

- Quantity of material in sprayer – 400 litres
- Temperature – 182°C
- Quantity of material in sprayer at 15°C = 400 * 0.8990 = 360 litres
- Quantity of binder in sprayer at 15°C = Bitumen + Rubber

\[
= 360 \times (120/124) = 348 \text{ litres}
\]

- Quantity of binder in sprayer at start = 3901 of residual binder
- Quantity of residual binder in sprayer at finish = 346 litres 15°C
- Quantity of residual binder sprayed = 3553 litres at 15°C
Rate of application of residual binder =
\[
\frac{\text{quantity of residual binder sprayed at 15 °C (litre)}}{\text{area sprayed (m}^2\text{)}}
\]
\[
= \frac{3553}{1794} = 1.98 \text{ litres/m}^2 \text{ (design: 1.9 litres/m}^2\text{)}
\]
(This appears a bit high, calculations should be rechecked, if OK, check distance calibration or increase pump revolutions per minutes.)

Rate of application of aggregate
Quantity of aggregate used was 2 truck loads of 9 m\(^3\) each = 18 m\(^3\)
\[
\text{Rate of application of aggregate } = \frac{\text{quantity of aggregate m}^3}{\text{area sprayed (m}^2\text{)}}
\]
\[
= \frac{1794}{18} = 100 \text{ m}^2/\text{m}^3
\text{ (design: 100 to 115 m}^2/\text{m}^3\text{)}
\]

Example No. 8 – Calculations for a Cutback Bitumen Primerbinder

Instructions for a proposed primerseal are as follows:

- Length of work – 2.5 kilometres
- Width of work – 7.4 metres
- Rate of application of primerbinder – 1.4 l/m\(^2\)
- Traffic (12 hour count) – 735 vpd
- Aggregate – size 10 quartz porphyry
- Rate of application – 130 to 140 m\(^2\)/m\(^3\)

The pavement temperature at the time of doing the work is about 17°C.

(a) Loading the Bitumen Sprayer

A proprietary cutback bitumen primerbinder is delivered by road tanker.

The quantity of primerbinder loaded into the bitumen sprayer is 4,325 litres, as measured on the dipstick, at 130°C.

This must be converted to the quantity at 15°C.

From Table 16.13B Part A (or Table 8.5.2 Part A) the multiplier to correct from 130°C to 15°C is 0.9296.

Quantity of primerbinder at 15°C \[= 4,325 \times 0.9296 = 4,021 \text{ litres}\]

(b) Number of Jets

The width of the bituminous surfacing is to be 7.4 m. For primersealing it is recommended that this width be increased by at least one extra jet, ie., width of spray = 7.5 m.
From Figure 23.2.5 the number of jets required to spray a width of 7.5 metres = 73 jets, including 2 end jets.

(c) Pump Shaft Speed for 73 jets:

Pump shaft speed – 597 revolutions per minute

(d) Forward Speed

From Figure 23.2.5 the forward speed for the desired rate of application of primerbinder of 1.40 litre/m² is 118 m/min. The forward speed scale reading does not have to be corrected for primerbinders and primers, where it does for cutback bitumen and for emulsions.

(e) Actual Work Done

Length of spray run = 378 metres as recorded on the bitumeter head.

From Figure 23.2.5 the correction factor for distance is 0.982.

Actual distance sprayed = 378 * 0.982 = 371 m

Area sprayed = length * width = 371 * 7.5 = 2782 m².

The spraying details are as follows:

- Dip start = 4325 litres
- Dip finish = 50 litres
- Hot cutback sprayed = 4275 litres
- Spray temperature = 130°C
- Quantity of primerbinder sprayed at 15°C = 4275 * 0.9296 = 3974 litres

Rate of application of primerbinder = \( \frac{\text{area sprayed (m}^2\text{)}}{\text{quantity of primerbinder at 15°C (litre)}} \)

= \( \frac{3974}{2782} \) = 1.43 l/m²

(design 1.4 l/m²)

Rate of application of aggregate

Quantity of aggregate used was:

- 2 truck loads of 10 m³ each = 20 m³
- 2/3 of a truck load of 6 m³ = 4 m³

Total = 24 m³

Rate of application of aggregate = \( \frac{\text{quantity of aggregate (m}^3\text{)}}{\text{area sprayed (m}^2\text{)}} \)

= \( \frac{2782}{24} \) = 116 m²/m³

(design 130 to 140 m²/m³)
Note: This rate is bit heavy which will result in crushing of the excessive aggregate and a dangerous situation. It needs to be reduced on the next run.

**Example No 9 – Field produced Primerbinder**

To make up a heavy primerbinder in the field say 100/0/15/1.

Length of job = 400 meters  
Width of work = 6.2 meters (actual sprayed width = 6.3m)  
Binder rate of application = 1.40 l/m²

Quantity of Class 170 bitumen in the sprayer = 3700 litres  
Temperature of bitumen = 170°C

Quantity of Class 170 @ 15°C = 3700 * 0.9060 = 3352 litres

Quantity to add to sprayer

- Bitumen @ 15°C = 3352 litres  
- Flux (3352*0/100) = Nil  
- Cutter (3352*15/100) = 503 litres  
- Adhesion Agent (3352*1/100) = 34 litres  
- TOTAL = 3889 litres

(e) Actual Work Done

Length of spray run = 402 metres as recorded on the bitumeter head

From Figure 23.2.5 the correction factor for distance is 0.982

Actual distance sprayed = 402 * 0.982 = 395 m

Area sprayed = length * width = 395 * 6.3 = 2489 m²

Note: Always spray primerseals 100 mm wider than actual width

The spraying details are as follows:

- Dip start = 3900 litres  
- Dip finish = 500 litres  
- Hot cutback sprayed = 3725 litres  
- Spray temperature = 140°C  
- Quantity of primerbinder sprayed at 15°C = 3725 * 0.9236 = 3440 litres.

Rate of Application of primerbinder = \[
\frac{\text{litres of primerbinder at 15°C}}{\text{area sprayed (m²)}}
\]

= (3440/2489)  
= 1.38 l/m² (design 1.4 l/m²)
Example No 10 – Calculations for Sealing using PMB (SBS Polymer)

Instructions for a proposed Polymer Modified Seal are as follows:

- Length of work = 205 metres
- Width of work = 6.8 metres
- Rate of application of primerbinder = 2.20 l/m²
- Traffic = 80 v/l/d
- Aggregate = size 10 basalt
- Rate of application = 140 to 150 m²/m³

The pavement temperature at the time of doing the work is about 34°C

(a) Loading the Bitumen Sprayer

Quantity of Modified binder in sprayer = 3800 litres
Temperature of binder – 180°C
Quantity of PMB @ 15°C = 3800* 0.9002 = 3421 litres

Quantity to add to sprayer

- PMB BinderBitumen @ 15°C = 3421 litres
- Flux (3421*4/100) = 137 litres
- Adhesion Agent (3421*1/100) = 34 litres
- TOTAL = 3592 litres at 15°C

(b) Number of Jets Required

With polymer modified binder the full width can be sprayed

For this example the width is 6.8 m

From Figure 23.2.5 the number of jets required is 66 jets, including 2 end jets

(c) Pump Shaft Revolutions

From Figure 23.2.5 for 66 jets:

Pump shaft speed – 542 rpm

(d) Forward Speed

From Figure 23.2.5 the forward speed for the desired rate of application of binder of 2.20 litre/m² is 74 m/min. This must be corrected for the parts of cutter in the binder.

\[
\text{Forward speed} = \frac{\text{parts of binder}}{\text{parts of binder + cutter}} \times \text{scale reading}
\]
(e) Actual Work Done

Length of spray run = 210 metres as recorded on the bitumeter head of sprayer 29 F 706

From Figure 23.2.5 the correction factor is 0.982.

Actual distance sprayed = 210 * 0.982 = 206 m

Area = length * width = 206 * 6.8 = 1401 m²

Spraying details are as follows:
- Dip start = 4030 litres
- Dip finish = 500 litres
- Hot material sprayed = 3530 litres
- Spray temperature = 182°C

Quantity of material @ 15°C = Hot quantity sprayed * 182°C * 0.8990

= 3530 * 0.8990 = 3173 litres @ 15°C

Quantity of residual binder sprayed = 3173 litres at 15°C

Rate of application of residual binder = \frac{\text{litres of residual binder sprayed at 15°C}}{\text{area sprayed (m²)}}

= \frac{3173}{1401} = 2.26 \text{ litre/m²}

(designed: 2.20 l/m²)
### Table 16.13.2A Relative Density and Litres/Tonne of the Most Commonly Used Materials

<table>
<thead>
<tr>
<th>Type of Material</th>
<th>Grade</th>
<th>Approximate Average at 15°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Relative Density</td>
</tr>
<tr>
<td>Bitumen</td>
<td>Class 170</td>
<td>1.040</td>
</tr>
<tr>
<td></td>
<td>Shell</td>
<td>1.040</td>
</tr>
<tr>
<td></td>
<td>Mobil (VIC)</td>
<td>1.029</td>
</tr>
<tr>
<td></td>
<td>BP</td>
<td>1.030</td>
</tr>
<tr>
<td></td>
<td>Mobil (SA)</td>
<td>1.030</td>
</tr>
<tr>
<td>Cutback Bitumen</td>
<td>Standard Grades</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AMC 00</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>AMC 0</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td>AMC 1</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>AMC 2</td>
<td>0.96</td>
</tr>
<tr>
<td></td>
<td>AMC 3</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>AMC 4</td>
<td>1.00</td>
</tr>
<tr>
<td>Bitumen Emulsion</td>
<td>All grades</td>
<td>1.00</td>
</tr>
<tr>
<td>Flux Oil</td>
<td>Diesel Fuel</td>
<td>0.84</td>
</tr>
<tr>
<td></td>
<td>Oil/Distillate</td>
<td></td>
</tr>
<tr>
<td>Cutter</td>
<td>Kerosine/Aviation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turbine Fuel</td>
<td>0.78</td>
</tr>
<tr>
<td>Adhesion Agent</td>
<td></td>
<td>0.95</td>
</tr>
</tbody>
</table>
### Table 16.13.2B Volume Correction Tables Bitumen, Fluxed and/or Cutback Bitumen

<table>
<thead>
<tr>
<th>Part A</th>
<th>Part B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table for calculating the volume of bitumen at a temperature 15°C to its volume at 15°C</td>
<td>Volume table for calculating the volume of bitumen at a temperature above 15°C from its volume at 15°C</td>
</tr>
<tr>
<td><strong>Temp°C</strong></td>
<td><strong>Multiplier</strong></td>
</tr>
<tr>
<td>15</td>
<td>1.000</td>
</tr>
<tr>
<td>82</td>
<td>0.9565</td>
</tr>
<tr>
<td>94</td>
<td>0.9373</td>
</tr>
<tr>
<td>16</td>
<td>0.9994</td>
</tr>
<tr>
<td>18</td>
<td>0.9813</td>
</tr>
<tr>
<td>20</td>
<td>0.9699</td>
</tr>
<tr>
<td>22</td>
<td>0.9595</td>
</tr>
<tr>
<td>24</td>
<td>0.9493</td>
</tr>
<tr>
<td>26</td>
<td>0.9391</td>
</tr>
<tr>
<td>28</td>
<td>0.9299</td>
</tr>
<tr>
<td>30</td>
<td>0.9206</td>
</tr>
<tr>
<td>32</td>
<td>0.9114</td>
</tr>
<tr>
<td>34</td>
<td>0.9022</td>
</tr>
<tr>
<td>36</td>
<td>0.8931</td>
</tr>
<tr>
<td>38</td>
<td>0.8840</td>
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<tr>
<td>40</td>
<td>0.8754</td>
</tr>
<tr>
<td>42</td>
<td>0.8673</td>
</tr>
<tr>
<td>44</td>
<td>0.8591</td>
</tr>
<tr>
<td>46</td>
<td>0.8510</td>
</tr>
<tr>
<td>48</td>
<td>0.8430</td>
</tr>
<tr>
<td>50</td>
<td>0.8352</td>
</tr>
<tr>
<td>52</td>
<td>0.8275</td>
</tr>
<tr>
<td>54</td>
<td>0.8199</td>
</tr>
<tr>
<td>56</td>
<td>0.8125</td>
</tr>
<tr>
<td>58</td>
<td>0.8051</td>
</tr>
<tr>
<td>60</td>
<td>0.7978</td>
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<td>62</td>
<td>0.7906</td>
</tr>
<tr>
<td>64</td>
<td>0.7835</td>
</tr>
<tr>
<td>66</td>
<td>0.7764</td>
</tr>
<tr>
<td>68</td>
<td>0.7693</td>
</tr>
<tr>
<td>70</td>
<td>0.7623</td>
</tr>
<tr>
<td>72</td>
<td>0.7552</td>
</tr>
<tr>
<td>74</td>
<td>0.7482</td>
</tr>
<tr>
<td>76</td>
<td>0.7412</td>
</tr>
<tr>
<td>78</td>
<td>0.7342</td>
</tr>
</tbody>
</table>

Note: These tables do not apply to bitumen emulsions, for these materials see Table 16.13.2C, Parts A and B.
Table 16.13.2C Volume Correction Tables Bitumen Emulsion

<table>
<thead>
<tr>
<th>Temperature°C</th>
<th>Multiplier</th>
<th>Temperature°C</th>
<th>Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>1.000</td>
<td>15</td>
<td>1.000</td>
</tr>
<tr>
<td>20</td>
<td>0.9980</td>
<td>20</td>
<td>1.0020</td>
</tr>
<tr>
<td>25</td>
<td>0.9956</td>
<td>25</td>
<td>1.0043</td>
</tr>
<tr>
<td>30</td>
<td>0.9935</td>
<td>30</td>
<td>1.0065</td>
</tr>
<tr>
<td>35</td>
<td>0.9913</td>
<td>35</td>
<td>1.0088</td>
</tr>
<tr>
<td>40</td>
<td>0.9890</td>
<td>40</td>
<td>1.0111</td>
</tr>
<tr>
<td>45</td>
<td>0.9868</td>
<td>45</td>
<td>1.0134</td>
</tr>
<tr>
<td>50</td>
<td>0.9845</td>
<td>50</td>
<td>1.0157</td>
</tr>
<tr>
<td>55</td>
<td>0.9823</td>
<td>55</td>
<td>1.0181</td>
</tr>
<tr>
<td>60</td>
<td>0.9800</td>
<td>60</td>
<td>1.0204</td>
</tr>
<tr>
<td>65</td>
<td>0.9778</td>
<td>65</td>
<td>1.0228</td>
</tr>
<tr>
<td>70</td>
<td>0.9755</td>
<td>70</td>
<td>1.0251</td>
</tr>
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<td>75</td>
<td>0.9733</td>
<td>75</td>
<td>1.0274</td>
</tr>
<tr>
<td>80</td>
<td>0.9710</td>
<td>80</td>
<td>1.0297</td>
</tr>
<tr>
<td>85</td>
<td>0.9688</td>
<td>85</td>
<td>1.0320</td>
</tr>
</tbody>
</table>
### Table 16.13.2D  Cutting back of Class 170 Bitumen
(in parts by volume of cutter oil to be added to
100 parts by volume of bitumen at 15°C)

<table>
<thead>
<tr>
<th>Pavement Temperature (°C)</th>
<th>Traffic (vehicles/lane/day)</th>
<th>Aggregate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Nominal Size of 10 mm and larger, actively precoated</td>
<td>Nominal Size of 7 mm or less, actively precoated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active precoating</td>
<td>Inactive precoating and/or moist aggregate</td>
</tr>
<tr>
<td>20 to 25</td>
<td>&lt; 100</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>100 to 1500</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>&gt; 1500</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>26 to 32</td>
<td>&lt; 100</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>100 to 1500</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>&gt; 1500</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>33 to 38</td>
<td>&lt; 100</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>100 to 1500</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>&gt; 1500</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>39 to 45</td>
<td>&lt; 100</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>100 to 1500</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt; 1500</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 45</td>
<td>&lt; 100</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>100 to 1500</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt; 1500</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

### Table 16.13.2E  Fluxing of Class 170 Bitumen
(in parts by volume of fluxing oil to be added to
100 parts by volume of bitumen at 15°C)

<table>
<thead>
<tr>
<th>Traffic (vehicles/lane/day)</th>
<th>Flux oil (parts per 100 parts of bitumen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100</td>
<td>4</td>
</tr>
<tr>
<td>100 to 300</td>
<td>2</td>
</tr>
<tr>
<td>&gt; 300</td>
<td>0</td>
</tr>
</tbody>
</table>

**Note:** Where Class 170 bitumen is fluxed with flux oil (complying with AS3568) it is recommended that amount of the cutter oil be reduced by the quantity of added flux oil.

1 (Reference: AUSTROADS APRG 97/09(SU), Guide to prayed Sealing Cutting Practice)

2 For pavement temperature below 20°C add 2 parts of cutter oil for each 5°C interval decrease below 20°C
### Table 16.13.2F Cutting Practice for Crumb Rubber Binder

<table>
<thead>
<tr>
<th>Pavement Temperature</th>
<th>Site mixed crumb rubber</th>
<th>Premixed crumb rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than 1000 vpd/lane</td>
<td>Greater than 1000 vpd/lane</td>
</tr>
<tr>
<td>26 to 32°C</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>10 minus added</td>
<td>8 minus added</td>
</tr>
<tr>
<td></td>
<td>suspension oil</td>
<td>suspension oil</td>
</tr>
<tr>
<td>33 to 38°C</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>8 minus added</td>
<td>6 minus added</td>
</tr>
<tr>
<td></td>
<td>suspension oil</td>
<td>suspension oil</td>
</tr>
<tr>
<td>39 to 45°C</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>6 minus added</td>
<td>4 minus added</td>
</tr>
<tr>
<td></td>
<td>suspension oil</td>
<td>suspension oil</td>
</tr>
<tr>
<td>&gt; 45°C</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>4 minus added</td>
<td>4 minus added</td>
</tr>
<tr>
<td></td>
<td>suspension oil</td>
<td>suspension oil</td>
</tr>
</tbody>
</table>

Note: (1) During the manufacturing process of the premixed crumb rubber binder the manufacturer adds an oil to the bitumen which is claimed to help digest the rubber. It is necessary to take it into account in the cutting practices for crumbed rubber. The oil acts both as a cutter (short term) and a flux (long term) on the viscosity of the bitumen. To take the carrier oil into account it must be considered as a ‘cutter’ only. The supplier must provide details of additives under OH&S requirements.

Note: (2) Polymer modified binders (other than crumb rubber) should be cut in accordance with the manufacturers directions or Table 8.7.5D with the following provisions:

- the minimum amount of cutter to be added shall be 2 parts per 100 parts of binder.
- the cutter type should be appropriate for the polymer type. For example some polymers are not adequately cut using high flash point type cutter normally used by VicRoads and require the use of highly aromatic cutters.
- the weather conditions under which polymer modified work is carried out should generally limit the cutter concentration to 4 parts per 100 parts of binder.
Figure 16.13.2G Graph for calculating spraying temperature of fluxed and cutback binder
17.1 GENERAL
This chapter considers the use of the following additives:

- adhesion agents as used in cutback bitumen spray sealing.
- crumb rubber.

17.2 ADHESION AGENTS
17.2.1 General
(a) Material
For the type and specification of adhesion agents used by VicRoads refer to Section 5.4.

(b) Aim
There are three general aims when using adhesion agents:

(i) To improve the natural adhesion conditions

(ii) To promote wetting of the aggregate by the binder

(iii) To decrease the influence of water at the aggregate/binder interface.

The use of adhesion agents is not intended to replace normal procedures when a good quality, clean, dry aggregate is used under good working conditions or be a substitute for good sealing practice.

Adhesion agents are used to improve the degree of wetting of the aggregate by the binder and increase adhesion, thus reducing the chance of the aggregate stripping.

Adhesion agents are not required for:

- precoating with specially formulated bitumen emulsion as the emulsion contains an adhesion agent as the emulsifier.

- aggregates precoated in a quarry using a bitumen based precoat provided it is reasonably fresh and in good condition, because adhesion agents are included in the precoat and the bitumen based precoats have superior adhesion.

Adhesion agents are generally only used with aggregates precoated in the field using distillate based precoating materials.

(c) When Adhesion Agents are Used
Adhesion agents are of value with certain types of aggregate and for work done under conditions when the adhesion obtained in the normal way would not be satisfactory. Using an adhesion agent does not guarantee adhesion, it only assists by improving the surface conditions at the aggregate/binder interface.
Adhesion agents are usually used under the following conditions:

(i) When using aggregates with a poor affinity for bitumen

(ii) When the aggregate used is damp

(iii) In humid and/or showery weather conditions.

For (i) and (ii) refer to the standard instructions regarding precoating of aggregate. Section 16.6.6.

Adhesion agents are expensive and every care should be taken to avoid waste or unnecessary use.

(d) Method of Use

Laboratory tests have shown that in sprayed work the most effective method of using adhesion agent is to use it in the aggregate precoating material, provided a complete and uniform coating is achieved. However, with wet, or wet and dirty aggregate, it is not possible to achieve a complete and uniform coating. In that case it is more beneficial to add the adhesion agent to the binder.

(e) Warning

The use of an adhesion agent to improve adhesion conditions between the aggregate and the binder must only be regarded as an aid in overcoming difficult conditions. Using an adhesion agent must not be regarded as a cure-all or as an excuse for carrying out work under unfavourable conditions which could have been avoided.

(f) Handling

(i) Gloves and eye protection must be worn by personnel at all times when handling adhesion agents

(ii) Adhesion agents should be thoroughly agitated in their containers before use. When emptied, the interior of the container should be inspected for sediment. Any signs of sediment should be reported immediately to the manufacturer for appropriate action.

17.2.2 Adhesion Agent in the Aggregate Precoating Material

(a) Conditions for Use

Aggregates should be precoated by spraying with a solution of Diesel Fuel Oil/Distillate and adhesion agent in the following cases:

(i) When the aggregate is quartz gravel, crushed quartz, quartzite, quartz porphyry or granite

(ii) All aggregates which are damp or wet and/or dirty provided complete precoating is achieved. (Otherwise it should be added to the binder – see Section 17.2.3.)
This does not apply to aggregates precoated with emulsion precoating material or cutback bitumen precoat unless it has been precoated for some time, perhaps 3 months or more, and the effectiveness of that precoating has been reduced.

(b) **Strength**

The practical quantity of adhesion agents normally used is approximately 1% and this is achieved by adding 1 part by volume of adhesion agent to 100 parts of Diesel Fuel Oil/Distillate.

(c) **Method of Mixing**

Diesel Fuel Oil/Distillate: The adhesion agent solution for precoating aggregates can be prepared by mixing the adhesion agent and the Diesel Fuel Oil/Distillate together in fuel trailer tankers, sprayers, road tankers or heaters.

Place the required quantity of Diesel Fuel Oil/Distillate in the mixing unit and gradually add the required quantity of adhesion agent (1 litre of adhesion agent for every 100 litre of Diesel Fuel Oil/Distillate).

Under cold conditions it might be necessary to warm the adhesion agent and mix it with a small quantity of warm Diesel Fuel Oil/Distillate and then add this to the balance of the Diesel Fuel Oil/Distillate to promote thorough intermixing.

A hot tank on a sprayer or road tanker is helpful but the temperature inside the tank must be below 100°C when drawing in the Diesel Fuel Oil/Distillate. Alternatively the cold oil may be heated to about 100°C and then the warmed adhesion agent gradually added. One convenient method of heating the adhesion agent is to suspend the 20- or 40 litre drums in the Diesel Fuel Oil/Distillate while this is being heated.

The mixture should be circulated for at least 20 minutes when mixed in a fuel trailer tanker or sprayer, i.e. quantities of about 4000 to 5000 litres or less. It should be circulated for at least 50 minutes when mixed in a road tanker or heater storage tanker, i.e. quantities between 5000 and 10 000 litres. The pump shaft speed should be about 400 to 450 rpm to achieve sufficient circulation.

Precoating materials containing adhesion agent should be regularly agitated to prevent segregation of the adhesion agent and the precoating material.

Cutback bitumen precoating materials come mixed with adhesion agent added at a concentration of approximately 1% and no additional adhesion agent needs to be added. The cutback bitumen must be handled similarly to DFO/distillate and does not require heating.

**Note:** Formulated bitumen emulsion precoating material comes mixed and requires no special treatment other than being placed in a clean tank and occasional circulation of the material to prevent breaking. If the material is not placed in a clean tank with clean carrier lines it may break and clog up machinery and lines.
In the manufacturing process the bitumen emulsion precoating material uses emulsifiers which are similar to standard adhesion agents. It is, therefore, not necessary to add adhesion agent to bitumen emulsions that have been formulated for use as precoating materials.

(d) Rates of Application for Precoating Aggregates

The Bituminous Surfacing Contractor must ensure that the quantity of precoating material used is sufficient to uniformly and completely coat each stone without over-oiling.

The quantity is generally between 5 and 15 litres per m$^3$ depending on the type and condition of the aggregate. See Table 16.6.6 for the recommended rates of application.

(e) Fluxing Bitumen

Diesel Fuel Oil/Distillate containing adhesion agent should not be used for fluxing bitumen. The very small amount of adhesion agent is of no benefit and is a waste of an expensive material.

(f) Settlement

Any sign of breaking/settlement of the bitumen emulsion precoating material or the adhesion agent in the Diesel Fuel Oil/Distillate drums or bulk trailer tanker should be reported immediately to the manufacturer for appropriate action.

17.2.3 Adhesion Agent in the Cutback Bitumen Binder

(a) Conditions for Use

Adhesion agent shall be added to cutback bitumen binder in the following circumstances:

(i) Damp pavement and showery conditions (prevailing or expected) associated with high humidity.

This applies in all cases including where the aggregate has been precoated with material containing adhesion agent, e.g. when using quartz as set out in Section 17.2.2 (a) (i).

(ii) When using wet aggregate

This applies to all aggregates regardless of whether the aggregate itself is precoated or not.

The above conditions for use apply to both normal and modified bitumen binders.

(b) Strength

The standard proportion of adhesion agent to add to the binder is approximately ½ part by volume to 100 parts of residual binder measured at 15°C.
(c) Method of Adding

Adhesion agent shall be added to the sprayer shortly before use. Before loading adhesion agent from a standard 20 litre drum, the material must be mixed thoroughly by either shaking the drum or stirring.

It should then be loaded by suction using the special transfer hose with standard fittings.

Most of the adhesion agent supplied is in thick fluid form at ambient temperatures and will pour from the standard 20 litre containers or bulk containers. The measured quantity of adhesion agent should be added while the bitumen is being loaded as per standard instructions so that it is being mixed with the bitumen as it goes through the pump to aid dispersion and mixing. See Section 16.3.10.

If the adhesion agent will not pour from the drum it may be warmed to make it fluid or it can be made fluid by mixing with cutter. If the adhesion agent is mixed with cutter the quantity of cutter loaded with the adhesion agent must be taken into account when loading the required quantity of cutter. After adding, the mixture should be circulated for at least 20 minutes with a pump shaft speed of about 450 rpm.

(d) Working Temperature

The adhesion agents normally used are stable in hot bitumen for only a limited period. If a binder containing adhesion agent is kept at normal working temperature (about 150°C or more) for more than 6 hours, or the material is allowed to cool and reheated the next day or at a later date, the effectiveness of the adhesion agent will be greatly reduced and the required quantity of adhesion agent should be added again to the sprayer shortly before use.

17.2.4 Adhesion Agent in Cutback Bitumen Primerbinder

(a) Conditions for Use

Because of the nature of the work, a cutback bitumen primerbinder must contain an adhesion agent. Commercially produced, proprietary cutback bitumen primerbinders bought under contract normally have adhesion agent incorporated as part of the specification. AMC grades of cutback bitumen do not contain adhesion agent and therefore it must be added in the field.

If the primerbinder is a field-produced cutback bitumen, or an AMC 3 or AMC 4, then the adhesion agent must be added to the sprayer shortly before use.

(b) Strength

Generally, primersealing is done under difficult conditions and the amount of adhesion agent used is higher than in normal sealing work.

The standard proportion of adhesion agent to add to the cutback bitumen primerbinder is approximately 1 part, by volume, to 100 parts of primerbinder measured at 15°C.
(c) Method of Adding

The method of adding is as described in Section 17.2.3(c).

(d) Working Temperature

The adhesion agents normally used are stable in hot bitumen for only a limited period (about 4–6 hours).

If a primerbinder containing adhesion agent is stored at or near its working temperature (110 to 150°C) for more than 6 hours, or the material is allowed to cool and is reheated the next day or at a later date, the effectiveness of the adhesion agent will be greatly reduced and the required quantity of adhesion agent should be added again to the sprayer shortly before use.

This applies to both commercially produced and field produced cutback bitumen primerbinders.

17.2.5 Adhesion Agent in Binder Containing Crumb Rubber and Other Polymers

(a) Conditions for Use

To promote wetting of the aggregate by the viscous bitumen crumb rubber mixture and other polymers, adhesion agent must always be added to the binder in the sprayer.

(b) Strength

Because of the viscous nature of the binder, particularly with the higher concentrations of crumb rubber or other polymers, the proportion of adhesion agent required is higher than with normal binders.

The proportion of adhesion agent to add is 1 part, by volume, to 100 parts of Class 170 bitumen or PMB binder measured at 15°C.

(c) Method of Adding

The method of adding is as described in Section 17.2.3(c).

(d) Working Temperature

The adhesion agents normally used are stable in hot bitumen for only a limited period. If a bitumen crumb rubber mixture or other polymer containing adhesion agent is kept at normal working temperature (about 180°C or more) for more than 6 hours, or the material reheated the next day or at a later date, the effectiveness of the adhesion agent will be greatly reduced and the required quantity of adhesion agent should be added again to the sprayer shortly before use.
17.3 POLYMER MODIFIED BINDERS

17.3.1 Crumb Rubber in The Binder

(a) Application

(i) Purpose

Crumb rubber is added to Class 170 bitumen to provide a tough, resilient binder to aid in the suppression of reflection cracking in the seal coat and/or to cope with difficult traffic situations.

(ii) Recommended crumb rubber/bitumen combinations

Table 14.7A lists the practical combinations of crumb rubber and Class 170 bitumen and their main uses.

(b) Appearance

In order to achieve the reduction or suppression of reflection cracking it is necessary to use heavier than normal rates of application of binder and this will result in a surface black in appearance compared with normal seals. It is, therefore, desirable on heavily trafficked roads to have ready access to fine aggregate (size 5) to cover areas which might flush in hot weather.

(c) Residual Binder

(i) Definition of Residual Binder

Residual binder in BCRS (Bitumen Crumb Rubber Seal) work is bitumen plus the crumb rubber plus any flux oil, measured at 15°C, and does NOT include cutter.

(ii) Factors Used to Calculate Rates of Application of Binder

The rates of application of the residual binder are calculated from the normal standard design method as follows:

1. Base rate of application = normal design base rate * Polymer (BCRS) factor (litre/m²)

2. Allowances = as for normal seal coat design (litre/m²)

3. Rate of application = (1) + (2) (litres/m² rounded to the nearest 0.1).

The BCRS polymer factors take into account the parts of crumb rubber and the traffic volume.

The factors recommended are listed in Table 14.7B.

(ii) Fluxing

Fluxing of crumb rubber modified binders should only be considered for very low traffic ranges. See the recommended cutting and fluxing charts in Chapter 8 – Tables and Charts.
(e) Supply and Storage

(i) Supply

Crumb rubber is supplied to Sprayline under an annual contract.

Crumb rubber is supplied in bags containing 25 kg net or in bulk bags (500 and 1000 kg).

(ii) Type of Rubber

Crumb rubber is generally a mixture of synthetic (car tyres) and natural rubber (truck tyres) in a ratio of 80% to 20%. The size of crumb rubber used by VicRoads is 30 mesh and finer. Crumb rubbers finer than 30 mesh can mix and spray better but are considered to have handling problems due to the very fine particles. The coarser size of crumb rubber, 16 mesh, does not mix and spray as readily and is more likely to block jets and is not generally used by VicRoads.

(iii) Storage

Crumb rubber should be stored in a dry building, preferably on above-floor storage. Small quantities of moisture (above 1%) will lead to foaming problems when the crumb rubber is added to the hot bitumen in the sprayer. Moisture will also cause the rubber to form ‘lumps’ in storage and this causes problems in the handling and loading into the mixing box.

(f) Aggregate

(i) Size

Size 10 or 14 aggregate should be used depending on type of work, traffic, location etc. Size 7 aggregate should not be used as it is too small to permit the heavier binder application rate necessary to suppress cracking.

(ii) Quality

The quality and cleanliness of the aggregate is more critical with BCRS work than with normal sealing work. Only good quality aggregates complying with the specification should be used. Limestone and soft granites should not be used on BCRS work.

If scoria aggregate is proposed, special care must be taken that only the hardest, cleanest scoria available is used.

(iii) Precoating

For work on roads with high traffic volumes, i.e. over 1200 v/l/d, it is preferable that aggregate is precoated at the production plant with a bitumen based product.

Where precoating at a plant is not available, the aggregate must be precoated at least with a bitumen emulsion precoating material or Diesel Fuel Oil/Distillate and should be slightly over-precoated compared to normal sealing work.
(iv) Rate of Application

Because of the heavier than normal rates of application of binder, aggregate needs to be spread heavier. Generally an additional 10% of aggregate is required compared to normal sealing work. See Section 14.9 for design of rates of application.

(g) Field Procedures

(i) Plant

The VicRoads bitumen sprayers can be used with standard procedures when only 5 parts of crumb rubber are added to the binder. When more than 5 parts of crumb rubber is added, it is necessary to use higher spraying temperatures and/or larger jets as set out in 16.4.10(B).

(ii) Quantities

Because the bitumen and crumb rubber froth up when mixed and loaded, the quantity of bitumen should be kept to about 3600 litres in a 4500-litre sprayer and 4500 litres in a 5200-litre sprayer.

(iii) Loading the Sprayer

The crumb rubber is added by allowing it to flow from the bag or bulk hopper into a special mixing box through which the bitumen is flowing, and then the mixture passes through the pump into the sprayer. To aid with mixing, at least 500 litres of bitumen must be in the sprayer tank before any crumb rubber is added.

To obtain a satisfactory bitumen–crumb rubber mixture, the mixture must be circulated for a minimum of 45 minutes after adding the last of the crumb rubber to the sprayer. That is, circulate bitumen, crumb rubber mixture for at least 25 minutes, then cut and/or flux and add adhesion agent to the load and circulate for a further 20 minutes as per normal procedures.

(iv) Cutting Back

Table 16.13.2F (also Table 8.7C) gives the parts of cutter to be added to the bitumen–crumb rubber mixtures for all aggregate sizes.

(v) Reaction Time

To obtain a satisfactory bitumen–crumb rubber mixture the mixture must be circulated for a minimum of 45 minutes after adding the last of the crumb rubber to the sprayer.

(vi) Adhesion Agent

To promote adhesion between the viscous bitumen–crumb rubber mixture and the aggregate, adhesion agent must always be added to the binder in the sprayer. The recommended quantity is approximately 1 part per 100 parts of Class 170 bitumen by volume at 15°C.

(vii) Minimum Pavement Temperature

The ideal minimum pavement temperature for spraying bitumen–
crumb rubber, containing 15 or more parts of rubber, is 20°C. However, bitumen–crumb rubber may be sprayed at pavement temperatures between 15°C to 20°C with great care. This practice should be avoided if at all practical and the work deferred until conditions are more favourable and the pavement temperature is above 20°C.

The minimum desirable pavement temperature for spraying binder containing 5 parts of crumb rubber is the same as Class 170 binder.

(viii) Spraying Widths
To ensure a uniform distribution of binder containing 15 or more parts of crumb rubber from the spraybar it is necessary to limit the width of spray.

The very viscous nature of the bitumen–crumb rubber mixture can lead to blocked spraybars and spraying jets.

(ix) Forward Speed
The crumb rubber is regarded as part of the binder, therefore, there is no need to adjust the forward speed except for the amount of cutter in the binder. See Section 16.13.3 for an example.

(h) Spreading Aggregate
Aggregate must be spread as quickly as possible and the maximum time for covering is 10 minutes because it is more difficult to obtain adhesion with the more viscous and tough binder containing 15 parts or more of rubber.

(i) Rolling
For a successful treatment the spread aggregate must be rolled into the binder as quickly as possible with adequate rollers to obtain good adhesion between binder and aggregate and to ensure the aggregate will be pushed into the binder before it cools and becomes too viscous. Experience has shown that once the binder has cooled its rubbery nature prevents further aggregate embedment.

(ii) Safety
Because of the higher temperatures involved it is necessary to pay particular attention to the safety practices normally prescribed for use when handling hot materials.

(k) Storage
Binder with crumb rubber must not be kept at elevated temperatures and should be sprayed within two hours after mixing, if possible. If it is to be kept for a longer period it must be allowed to cool and reheat gently on the day of use. Adhesion agent must be added again and further cutter may also be required.

It is undesirable to store the crumb rubber modified binder.
When bitumen–crumb rubber mixtures are reheated for use, adhesion agent must be added to the sprayer – refer to (vi) above.

(i) After Care

It is essential that recently completed BCRS jobs be kept under close observation during periods of hot weather for up to 12 months after completion. If it appears that there could be a flushing problem immediate arrangements should be made to have the job gritted, desirably with a good quality size 5 grit.

17.3.2 Premixed Crumb Rubber

In recent years, industry has been supplying premixed crumb rubber modified binder. This material is supplied in tanker loads and can be transported to most locations in Victoria.

As part of the manufacturing process the product may have some carrier oils added to aid in the mixing process. These carrier oils need to be considered when determining the cutting and fluxing of the binder before spraying onto the pavement. The carrier oils are generally heavier than diesel fuel oil and will affect the viscosity of the binder for a significant time (i.e. longer than flux oils). If the premixed crumb rubber binder is being used on:

• a low trafficked road the carrier oils can be considered to act as a flux oil

• a high trafficked road the carrier oils should be considered to replace some of the cutting oils. Clearly a carrier oil does not act in the same way as a cutting oil so it is necessary to carefully review and minimise cutting when using premixed crumb rubber modified binder. Special care should be taken when using premixed crumb rubber on high trafficked roads as the lower viscosity residual binder (containing carrier oil) may flush more easily than binders not containing carrier oils.

17.3.3 Other PMBs

(a) Application

The purpose of a polymer modified binder is to provide a tough, resilient binder to aid in the suppression of reflection cracking in the seal coat and/or to cope with difficult traffic situations.

(c) Residual Binder

The residual polymer modified binder is the binder as supplied, premixed by the manufacturer, or the bitumen plus the polymer if mixed on site, measured at 15°C, and does not include cutter.

Note: Mixing of polymers on site, other than crumb rubber, is unusual unless there is specialist mixing equipment on site.

(i) Factors used to calculate rates of application of the polymer modified binder

The rates of application of polymer modified binder are calculated from the normal standard design method as follows:
(1) Base rate of application = normal design base rate* Polymer factor (litre/m²)

(2) Allowances = as for normal seal coat design (litre/m²)

(3) Rate of application = (1) + (2)

(litres/m² rounded to the nearest 0.1)

The polymer factors take into account the type of polymer and the traffic volume.

The factors recommended are listed in Table 14.7B.

(ii) Fluxing

Fluxing of polymer modified binders is not recommended.

(e) Supply and Storage

Some of the properties of polymer modified binders can be very sensitive to storage (and cartage) temperatures. Users should refer to the manufacturer’s instructions for further information on the supply, storage and handling properties of PMBs.

(f) Aggregate

Refer to the discussion under Section 17.3.1(f).

(g) Field Procedures

Users should refer to the manufacturer’s instructions for further information on the field procedures for using PMBs.

(i) Cutting Back

Polymer modified binders (other than crumb rubber) should be cut in accordance with the manufacturer’s directions or Table 8.7A with the following provisions:

- The minimum amount of cutter to be added shall be 2 parts per 100 parts of binder.
- The cutter type should be appropriate for the polymer type. For example *some* polymers are not adequately cut using high flash point type cutter normally used and require the use of highly aromatic cutters.
- The weather conditions under which polymer modified work is carried out should generally limit the cutter concentration to 4 parts per 100 parts of binder.

(ii) Reaction Time

If a polymer modified binder is mixed on site the manufacturer’s directions on mixing time should be followed.

(iii) Adhesion Agent

To promote adhesion between the viscous polymer modified binder
and the aggregate, adhesion agent must always be added to the
binder in the sprayer. The recommended quantity is approximately
1 part per 100 parts of polymer modified binder by volume at 15°C.

(iv) Minimum Pavement Temperature

The ideal minimum pavement temperature for polymer modified
binders is 20°C. However, PMBs may be sprayed at pavement
temperatures between 15°C to 20°C with great care. This practice
should be avoided if at all practical and the work deferred until
conditions are more favourable and the pavement temperature is
above 20°C.

(h) Spreading Aggregate

Refer to the comments in Section 17.3.1(h).

(k) Storage

Polymer modified binder must not be kept at elevated temperatures and
should be sprayed as soon as practical after delivery. If it is to be kept
for a longer period it must be allowed to cool and be reheated gently on
the day of use. Adhesion agent must be added again and further cutter
may also be required. The manufacturer’s directions for storage of
PMB must be adhered to.

When polymer modified binders are reheated for use, adhesion agent
must be added to the sprayer. Refer to Section 17.3.1(g)(vi).

(i) After Care

It is essential that recently completed polymer modified binder jobs be
kept under close observation during periods of hot weather for up to 12
months after completion.
18.1 GENERAL
Dust laying may be used on unsealed roads to reduce maintenance, reduce dust nuisance or prevent loss of pavement materials. It can also be used as a temporary treatment on a newly constructed or reconstructed pavement which cannot be prepared for the application of a bituminous surfacing, e.g. lack of finance, no aggregate available etc.

Dust laying is most commonly achieved by wetting the dust particles with a diluted bitumen emulsion as described in this Chapter. Other chemical dust suppressants may also be used. For a detailed study of dust suppressant performance, reference should be made to ARRB Transport Research Special Report 54, “Road Dust Control Techniques”.

18.2 CONDITIONS OF USE
Dust laying techniques can be useful in unmade private streets or any area where dust would be objectionable. These techniques should generally only be used on roads with relatively low traffic volumes, i.e. average less than 100 vpd.

This method may provide a more economical means of maintaining the surface than by watering, grading and rolling.

Potholes may form and these should be repaired as soon as possible to prevent further damage.

18.3 PROCEDURE USING BITUMEN EMULSION
18.3.1 Material
(a) Mixture
A suitable material is obtained by diluting slow setting, anionic, bitumen emulsion with water. The proportion required varies from about 4 parts of water to 1 part emulsion to about 12 of water to 1 emulsion, depending on the road pavement condition and the equipment used to apply the mixture. A wetting agent is also required to aid wetting of the dust particles and increase the effectiveness of the material.

A typical mixture suitable for applying with the normal water sprayer is:
- 2500 litres of water
- 200 litres of slow setting anionic bitumen emulsion
- 2 litres of wetting agent – such as Teepol or Comprox.

(b) Preparation
Place a small quantity of water in the tank, sufficient to cover the bottom, and then add the emulsion. The remainder of the water should then be added. This should preferably be done through a pipe with its outlet below the surface of the liquid to minimize frothing. At the same time, the wetting agent should be added. The materials must be thoroughly mixed by circulating or agitation by stirring and/or moving the water sprayer backwards and forwards.
The material should be used shortly after preparation to avoid settling and/or breaking which could block the equipment.

General precautions regarding handling of emulsions apply.

18.3.2 Road Surface Condition
For maximum effect the pavement should be compacted and swept free of all dust. Preferably the surface should be damp rather than dry to promote an even coverage. The process will work on a dusty pavement but will be less effective and will require more applications.

18.3.3 Rate of Application
Approximate rate of application of the mixture is about 0.8 to 1.0 litre/m². Traffic should be kept off until the surface is dry, generally about 2 to 3 hours, to prevent pick up.

18.3.4 Plant
For general works the plant required would be a normal construction watertanker with a spray bar or an emulsion sprayer for the higher concentrations of emulsion.

Small areas could be done by hand from drums.

18.3.5 Life Expectancy
Life expectancy is about 2 to 3 days for the initial application. The application may be repeated and several applications will result in a dark brown surface which will have a lasting effect. The expected period between applications after the second application will depend on the pavement condition, weather and traffic but should be of the order of 3 to 4 weeks minimum up to 3 to 4 months.
19.1 DESCRIPTION
A surface enrichment is the application of a binder to an existing bituminous surfacing without using a covering aggregate. The binder is generally either a cutback bitumen or bitumen emulsion.

This type of treatment may be an economical alternative to a normal type reseal on low traffic roads (for pavements carrying <100 vpd) in suitable conditions.

The cost of this work is cheaper but the life is shorter than for a normal single application reseal. An average life of 5 years can be expected for a surface enrichment.

The treatment may be repeated several times providing sufficient texture depth remains after each treatment.

Figure 19.1 Hungry coarse seal coat before (left) and after (right) applying a surface enrichment at a rate of application of 0.7 litre/m² of cutback bitumen (100-0-20).

19.2 CONDITIONS OF USE
A surface enrichment may be an economic treatment for the following conditions:

(a) Preventative Maintenance
   Prolonging the life of an existing bituminous surfacing when the binder is near the end of its life but is otherwise still in good condition with a reasonable depth of aggregate exposed. Generally, applies to seals with large aggregates, e.g. size 10 or larger with texture depths of 1.5 mm or greater.

(b) Waterproofing a previous bituminous surfacing providing there is sufficient texture depth.

(c) Pinning down aggregate on a relatively new seal coat when the aggregate is being stripped due to too light an application of binder.
Could be caused by incorrect design, absorption of the binder, error in application etc.

(d) Treating a bituminous surfacing with a lot of very fine cracks shortly before applying a normal reseal. This could occur also with primerseals and may be done before applying the final seal.

(e) Where there is a problem with adhesion and/or absorption with the aggregate in the existing bituminous surfacing.

19.3 MATERIALS

19.3.1 Choice

Whether a cutback bitumen or a bitumen emulsion is used depends on the type of spraying plant available and the availability and cost of the materials. There are also proprietary products available for this type of treatment.

The material used must be fluid enough (i.e. low enough viscosity) to run down into the voids between the aggregate to maximise the effectiveness of the treatment.

Surface enrichment may also be applied as ‘foam’ bitumen. In the foam process, a small quantity of water and foaming agent are added to hot Class 170 bitumen as it is sprayed. The water vapour trapped in the bitumen provides a temporary increase in the volume and fluidity of the bitumen enabling it to flow into the voids between the aggregate. On cooling, the binder becomes straight bitumen, hence there is no curing period. Foam bitumen is supplied using specialist equipment operating as a proprietary process.

19.3.2 Cutback Bitumen

The basic binder used is Class 170 bitumen cutback as required for the weather conditions and the type of surface. A surface with smooth aggregate would give better run-off than one with a rough textured aggregate.

The following is presented as a guide to the amount of cutter required:

<table>
<thead>
<tr>
<th>Pavement temperature in °C</th>
<th>Parts of cutter per 100 parts of Class 170 bitumen</th>
</tr>
</thead>
<tbody>
<tr>
<td>by volume at 15°C</td>
<td></td>
</tr>
<tr>
<td>15 to 20</td>
<td>30</td>
</tr>
<tr>
<td>20 to 25</td>
<td>25</td>
</tr>
<tr>
<td>25 to 30</td>
<td>20</td>
</tr>
<tr>
<td>30+</td>
<td>15</td>
</tr>
</tbody>
</table>

Cutter: Kerosene or Aviation Turbine Fuel

If in doubt regarding the proportion of cutter required it is better to add too much than too little. Too viscous a binder may result in a streaky appearance at the low rates of application normally used and the binder may not run down between the aggregate into the interstices where it is required.
19.3.3 Bitumen Emulsion

The bitumen emulsions used are the standard grades of either anionic or cationic emulsion (except CAM) made from Class 170 bitumen. The choice of type and grade depends on the weather conditions at the time of doing the work but generally medium- or slow-setting grades are used.

The emulsion should be diluted, if required, to reduce the viscosity.

As a guide the minimum dilution that should be used is 1 part of bitumen emulsion to 1 part of water. An undiluted emulsion may not flow into the voids as freely as diluted emulsion.

Figure 19.3A  Emulsion enrichment 0.6 l/m² residual, texture prior 2.5 mm

Figure 19.3B  Surface after 2 months enrichment residual texture 1.0 mm

19.4 RATES OF APPLICATION

The rates of application vary with the texture depth of the bituminous surfacing to be treated. The aim is to provide sufficient binder to be effective in prolonging the life of the existing surface without causing too much of a reduction in the texture depth which could cause skid resistance problems.
The general aim is to provide a residual binder rate of application of 0.5 to 0.8 litre/m² at 15°C, i.e. bitumen only, not including the cutter in cutback bitumen or the water in the emulsion.

If in doubt, a small section should be sprayed and from this an appropriate rate of application determined.

It is preferable to spray several light applications of a low viscosity material than one heavy application. The several light applications would cause less delay to the traffic and provide a better overall result.

19.5 TIME OF WORKING
Because the binder is not covered with aggregate the traffic must be kept off until the binder has set-up and dried. To keep the delay to a minimum, surface enrichment treatments should be applied during the better, drier and warmer, weather conditions, i.e. November to March.

19.6 PLANT
19.6.1 For Cutback Bitumen
The cutback binder must be sprayed by a calibrated bitumen sprayer in good operating order.

19.6.2 For Bitumen Emulsion
Bitumen emulsion, undiluted or diluted with water, may be sprayed with a suitable calibrated bitumen sprayer.

When loading bitumen emulsion and diluting with water, the procedures as set out in Section 19.3.3 should be followed.

19.7 PAVEMENT PREPARATION
The existing bituminous surfacing should be prepared as for a normal reseal as set out in Chapter 10, Preparation of Surfaces.

19.8 PROVISION FOR TRAFFIC
The binder will take probably a minimum of four hours to set-up and dry enough to let traffic use it without causing pick-up. Preferably, the traffic should be kept off until the next day or as long as required. Therefore, a suitable detour must be provided or the surface should be treated in half widths.

The binder will pool in hollows and these areas will take longer to set-up, cure and dry particularly when using bitumen emulsion. These areas should be checked, using a screwdriver as a probe, and the binder condition assessed before opening to traffic, particularly if rain is threatening in the next few hours. The treatment may be lightly gritted if the binder is not fully cured to minimise pick-up.

Care must also be taken if it rains shortly after application or when first opened to traffic. The water may emulsify the binder or cause stripping and this may cause pick-up by the traffic. The area should be closed to traffic if possible or otherwise the area should be gritted or sanded and the traffic allowed to use it with adequate traffic control.
20.1 COMMON CAUSES

The aim of bituminous surfacing work is to produce high quality economic work without a single failure. Failures do occur, although the length of sealing work which fails is only a very minor percentage (less than 1%) of the total length of work done each year. Most problems occur during the early and late months of the BS (Bituminous Surfacing) season when working in less favourable or adverse weather conditions.

As an aid to help reduce or eliminate sprayed work failures, the most common causes contributing to failures are listed below:

20.1.1 General

- Condition of the surface to be treated
- Improper sweeping
- Incorrect treatment for the condition
- Incorrect grade and viscosity of binder
- Cold binder
- Delays in covering the binder
- Incorrect fluxing and/or cutting back
- Incorrectly designed and/or applied rates of application
- Deficiencies in uniformity of sprayer distribution
- Poor sprayer operation
- Aggregate condition
- Poor and/or incorrect aggregate precoating
- Careless spreading of aggregate (over- or under-spreading)
- Failure to spot up
- Inadequate rolling
- Inadequate traffic control
- Weather conditions
- Inadequate after-care treatment

20.1.2 Initial Treatment Work

- Poor pavement preparation
- Incorrect type of primer
- Incorrect grade and viscosity of primer/primerbinder
- Primer not allowed to properly cure
- Insufficient primer/primerbinder
- Badly maintained primed/primersealed surface
- Absorption of binder into primed/primersealed pavement
- Using too large an aggregate on a rough textured stoney pavement (e.g. hill gravels) or on a soft pavement (e.g. sandstone)

20.1.3 Retreatment (also Final Seals on primersealed pavements)

- Inadequate preparation
- Non-uniform surface texture
- Patching not done far enough in advance
- Failure to seal-off open patches
- Incorrect classification of surface texture, resulting in incorrect rates of application of binder (usually insufficient)
- Size of aggregate too large in relation to texture of the surface being treated
20.2 CORRECTING PROBLEMS AND FAILURES

20.2.1 General

The following provides some guidelines on how to deal with some of the most common problems/failures that occur.

It is most important that the work is given adequate after-care to identify problems and/or failures as early as possible in the life of the treatment.

Problems and/or failures should be immediately reported to the BS Contractor to allow remedial action to be undertaken as soon as possible.

20.2.2 Priming

(a) Excess Primer

Excess primer can be easily dealt with while it is still wet. It can be covered with sand or grit, which in effect, provides a longer wearing surface than a normal primer. The treatment should be allowed to cure properly, which takes longer than normal, before applying the seal.

Another method is to carefully sweep off the excess primer while still wet. Care must be taken to avoid contaminating or dirtying kerbs and channels, property, vehicles etc. The rotary road broom will get very dirty and will need to be cleaned while the primer is still damp.

(b) Deficient Primer

It is often more convenient and economical to lightly reprime a pavement than to increase the rate of application of binder in the seal coat.

The primer is sprayed in the normal manner and should be a light grade of primer applied at a light rate of application.

(c) Non-uniform Primed Surface

Due to non-uniform material, compaction etc. a pavement may finish with a non-uniform primed surface due to differential penetration and/or absorption.

Small areas should be touched up by hand-spraying and large areas by using the sprayer. If necessary, the full width may be given a very light application of primer to produce a uniform surface after the hungry areas have been touched up separately and allowed to dry long enough to prevent run-off occurring.

This treatment may also be used on primed surfaces where the primer has worn thin in localised areas or widths, e.g. wheel tracks, resulting in a non-uniformly primed surface.
20.2.3 Primersealing

(a) Excess Primerbinder

The main forms of corrective treatment are:

(i) If the primerbinder is still soft enough, spread and roll more aggregate to bring the aggregate up above the top of the primerbinder. In some cases the use of high volatility cutter (chemical solvents) treatments to ‘wet’ the aggregate and permit the incorporation of additional aggregate can be considered.

(ii) If this does not work, apply a second primerseal with the rate of application reduced to allow for the excess in the first application. The use of an emulsion binder may assist in reducing the quantity of ‘cutter’ in the composite binder, hence reducing the possibility of flushing in the future.

(iii) If the primerbinder is not picking-up and the situation is not hazardous, then on a warm to hot day when the primerbinder becomes lively again, spread and roll more aggregate into the primerbinder. The ‘wettability’ of a cutback bitumen primerbinder may be improved by spraying a very light application of cutter just before applying the aggregate.

Do not apply the final seal earlier than normal in order to cover up the smooth primerseal, because the excess primerbinder will still be lively and cause fluxing/cutting of the binder in the new seal. This will result in an unsatisfactory full or slick seal coat with poor skid resistance qualities.

(b) Deficient Primerbinder

A primerseal with a low binder content will have a shorter than normal life. If the deficiency is such that aggregate is being lost, remedial action will be required.

If size 7 or smaller aggregate was used, a second primerseal or a seal should be applied over the first using the same or small sized aggregate. Consideration should be given to using an emulsion to reduce the risk of flushing.

If size 10 aggregate was used, a second primerseal with a smaller aggregate should be applied or alternatively, if the conditions permit, it may be quicker and cheaper to apply a surface enrichment. This would generally only be possible on roads with low traffic volumes.

(c) Pick-up

Primerseals laid in cold weather should be watched carefully when subsequent warm weather is expected, as the primerbinder may bleed on the first few hot days.
Figure 20.2A  Blocked jet

Figure 20.2B & C  Stripping due to lack of binder
Figure 20.2D  Seal joint bleeding. Not enough thought in spraying procedure

Figure 20.2E  Job not complete, no paper, ran out of binder

Figure 20.2F  Finish of job, no paper used
Figure 20.2G  Stripping on the edge of seal caused by insufficient binder due to not using an end jet

Figure 20.2H  Stripping due to lack of rolling and poor traffic control
If bleeding occurs, the primerseal should be covered with as much size 5 or 7 aggregate as is necessary until the primerbinder no longer appears on the surface. The fine aggregate should be broom dragged to work the maximum amount of aggregate into the primerbinder and to avoid corrugations forming.

If aggregate is not available and the primerbinder is being picked up by the tyres in hot weather, a quick, temporary solution is to cool the primerbinder by watering lightly.

Pick-up may also occur if it rains shortly after the primerseal is applied and the primerbinder is emulsified and comes to the top. Aggregate should be spread on the primerseal to a sufficient depth to keep the tyres from the emulsified binder. Up to size 10 may be used depending on the existing primerseal and depth of aggregate required.

20.2.4 Sealing

(a) Excess Binder

The main forms of corrective treatment are:

(i) If the binder is still soft enough, spread and roll more aggregate into the binder.

(ii) If the binder is not picking up and the situation is not dangerous, then on a warm to hot day (25 °C +) when the binder softens, spread and roll more aggregate into it. The ‘wettability’ and adhesion may be improved by precoating the aggregate with cutback bitumen (quarry precoated), Diesel Fuel Oi/Distillate or a suitably formulated emulsion precoat and wetting the binder with cutter just before applying the aggregate. This procedure will generally only work if the binder is less than 12 months old.

The use of high volatility cutters (chemical solvent) treatments may be used to improve the wetting of the surface of the binder. This will enable better incorporation of the aggregate into the excess binder. High volatility cutters appear to be successful with many binders, however, other specialist solvent treatments appear to be more successful with older, harder binders.

(iii) If (i) and (ii) above are not applicable or do not work then a reseal should be applied. This should be done using size 7 or 10 mm aggregate with light rates of application to allow for the existing excess binder. More aggregate may be rolled into any areas where binder shows through again. This should result in a uniform surface suitable for a further reseal when required.

Note: These treatments may need to be repeated many times, particularly if the location has been sprayed seal many times and contains many “layers” of fresh binder.
(b) Deficient Binder

A seal coat deficient in binder will have a shorter than normal life. If aggregate is being lost remedial action will be required.

(c) Stripping of Aggregate

(i) Loss of Adhesion Due to Water

If, soon after sealing, the aggregate is stripping because of moisture on the aggregate or rain, the traffic should be excluded if possible and the water allowed to evaporate. When drying, it may be rolled and slow controlled traffic allowed on it after some adhesion has taken place. The work should be controlled until it has dried out and the binder has set-up.

(ii) Stripping Due to Deficiency in Binder

Partial Stripping: If a size 10 or larger aggregate was used in the seal coat, it may be possible to apply a surface enrichment on roads with low traffic volumes. If necessary, a light reseal with a suitable smaller aggregate and light rates of application may be applied to pin-down the aggregate and prevent stripping. Cutback and emulsion binders are suitable for this treatment.

Total Stripping: If all the aggregate strips off leaving a slippery dangerous surface, resealing will be necessary.

(iii) Stripping Due to General Lack of Adhesion

If the aggregate continues to strip, the exposed binder may present a dangerous situation and will need to be treated with a reseal to pin-down the aggregate in the original seal.

If it is not dangerous and the binder is less than 12 months old, then on the first warm to hot day (25°C +), when the binder softens, spread and roll more aggregate into it.

The ‘wettability’ and adhesion may be improved by precoating the aggregate with cutback bitumen, a formulated emulsion precoat or Diesel Fuel Oil/Distillate and wetting the exposed binder with cutter just before applying the aggregate. The size of aggregate used will depend on the amount of stripping and the quantity of binder left. Maximum size would be size 10 mm on seals with larger aggregates, with the best result being obtained when using a size 7 mm.

If this is not effective, the work will have to be resealed with a suitably sized aggregate and due allowance made for the existing exposed binder. If treated early enough when only a small amount of the aggregate has stripped, a light reseal only is required, just sufficient to pin-down the aggregate.
21.1 GENERAL

21.1.1 Aim of Traffic Control

The aim of traffic control is to provide and maintain safe conditions of travel; to present the least inconvenience to the public (both motorists and pedestrians); and at the same time provide safety for personnel, plant and the new work. For details refer to *VicRoads’ Worksite Traffic Management Code of Practice*.

Standard Australia “Field guide for traffic control at works on roads – Bituminous surfacing works”, SAA HB 81.6-1998, contains typical traffic management arrangements for bituminous surfacing operations.

21.1.2 Authority

Under the Transport Act, VicRoads has powers and responsibilities with regard to the construction and maintenance of certain classes of roads. Highway authorities can place signs, devices and/or traffic controllers at roadwork sites for the purpose of warning and guiding the traffic, under the Road Safety (Traffic) Regulations. VicRoads also has the authority to consent to changes to speed limits on sites.

The power to consent the use of speed limits is delegated to Section Leaders in the VicRoads Regional Offices. This power is not delegated to officers in Sprayline or other surfacing contractors. Permission to use speed limits must be applied for, and obtained, from the appropriate VicRoads Officer.

21.1.3 Responsibilities

It is the responsibility of the Bituminous Surfacing Contractor to provide and maintain a safe place for workers and the safe passage for traffic through the works area during the bituminous surfacing operations, regardless of the Authority responsible for the particular road.

21.1.4 Signs and Devices

In order for the signs to be effective they must be kept in legible and serviceable condition. They should be situated so that they are clearly visible to approaching motorists (and pedestrians) and are of a type (and legend) appropriate for the conditions.

Signs should only be used as required and must be covered or removed as soon as they are no longer applicable to the prevailing road conditions at any time. This particularly applies to temporary roadwork speed limit signs which must be removed or covered when not needed.

21.1.5 Method of Working

The method of working should be chosen after due consideration of how the standard of work and the traffic will be affected, e.g. half width work versus full width, spreading patterns, rolling patterns etc.
21.2 PROVISION OF SIGNS AND WARNING DEVICES

21.2.1 General
On standard sprayed sealing works the necessary signs are generally provided by the Sealing Crew.

21.2.2 Other Works
(a) Sealing and Primersealing by Sealing Crew Units

The sealing crew generally provides all the necessary signs.

(b) Priming/Primersealing Work

This depends to some extent on the contract specification for the works and local arrangement but because the priming/primersealing gang usually has a limited number of people, it is often not practical to supply and erect all the signs. On major projects and other new construction, priming or primersealing may be performed by subcontract in which case the main contractor or constructing authority may undertake to supply all the necessary signs for actual working conditions and organize barriers, removal of signs at a later date, and provide the subsequent signs necessary after completion of each day’s work to protect the public and/or the work.

21.2.3 Other Authorities
Usually similar arrangements to (b).

21.3 GENERAL SIGNS AND WARNING DEVICES TO BE CARRIED

21.3.1 General
Table 21.3.2 provides a guide to the standard signs and devices that Sealing Crews should have available for immediate use as required.

The actual number of each sign required will vary with the conditions under which most of the work is done, e.g. high or low traffic volumes, amount of linemarking, etc.

21.3.2 Provision of Signs and Devices
The necessary standard signs and devices are available for purchase at selected sign manufacturers. The special plywood or plastic non-returnable reminder signs are:

or
### Table 21.3.2 Recommended Minimum Number of Standard Signs and Devices Required with BS Units

<table>
<thead>
<tr>
<th>VicRoads Classification Number</th>
<th>Sign Type</th>
<th>Priming Unit</th>
<th>Primersetting Unit</th>
<th>Sealing Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-V103</td>
<td>Roadwork Ahead/End Roadwork</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>GW284/19</td>
<td>Road Surfacing</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>T2-5</td>
<td>Part Road Closed</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>T1-3</td>
<td>Road Plant Ahead</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>T2-V106</td>
<td>Road Plant Working in Dust</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>T1-18</td>
<td>Prepare to Stop</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>T2-25</td>
<td>Trucks (crossing or entering)</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>T1-5</td>
<td>Worker Symbol</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>T2-V105</td>
<td>Possible Delay 15 Minutes</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>T3-3</td>
<td>Slippery (metal)</td>
<td>–</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>T3-3</td>
<td>Slippery (plastic)</td>
<td>–</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>T3-9</td>
<td>Loose Stones</td>
<td>–</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>W8-2</td>
<td>&quot;X&quot; km/h</td>
<td>–</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>T3-1</td>
<td>Wet Tar</td>
<td>6</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>R6-8</td>
<td>Stop-Slow Bats (450 mm)</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Traffic Cones (450 mm) Bipods for the above signs</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Transceivers</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>T3-12</td>
<td>No Lines, Do not overtake unless safe</td>
<td>–</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

### 21.4 WORKING ARRANGEMENTS

#### 21.4.1 General Method of Working

(a) Low Traffic Volumes – less than 600 v/l/d

Where necessary the traffic may be detoured, side tracked or be allowed to travel on a restricted width of the road. The time should be kept to a minimum but may include night time, e.g. when priming a road and the primer requires time to dry properly and set-up so that traffic can safely travel on it.

(b) High Traffic Volumes – more than 600 v/l/d

When the traffic volume is in the order of 600 vehicles per lane per day or more, sprayed work shall be organized to ensure that the full pavement width is available to the travelling public between sunset and sunrise.
On initial treatment work, the preferred treatment is a primerseal. Primerbinder should be applied not later than mid afternoon so as to allow time for adequate compaction of the aggregate before sunset and before unrestricted use by the public.

In cases of emergency or problems with work, adopt the procedures set out in (a) above.

When applying a seal, whether it be an initial treatment or a retreatment, binder should not be sprayed after about 4.00 p.m. so as to permit adequate compaction of the aggregate before sunset and unrestricted use by the public. Rolling of aggregate shall be thorough and shall be done systematically for 2 to 4 hours and slow controlled traffic may be allowed during this time. Every effort shall be made to ensure that the work does not fail with consequent possible damage to vehicles and injury to the travelling public.

Adverse weather conditions greatly increase the danger of possible failures in the work and therefore greater care should be taken. Work should be avoided on busy roads on days of high humidity or when wet weather threatens. Work should be avoided on roads carrying large volumes of traffic due to local shows, race meetings etc.

21.5 REMOVING SIGNS

21.5.1 General

Signs should be removed or covered as soon as they are no longer applicable to the conditions. Some of the signs will need to be left for several days or longer.

21.5.2 Warning Signs – Priming Works

Warning signs shall not be removed from construction sites after priming (and sanding where necessary) of the pavement, but shall be left in position until the sealing has been completed.

Sealing is part of the construction and the work is still in progress until the sealing is complete.

21.5.3 Symbolic Skidding Car and Broken Windscreen

An ample number of signs must be displayed along the full length of the work and be left in position until all loose aggregate has been removed.

21.6 ROADS WHERE LINEMARKING IS OBLITERATED

21.6.1 General

Temporary signs shall be used as set out below to warn motorists of the absence of linemarking on new road surfaces.

21.6.2 Placing Signs

The BS Contractor shall arrange for the signs to be placed in position on completion of surfacing operations.
21.6.3 Removing Signs

Usually the linemarking crew remove the signs when linemarking is completed.

The BS Unit should make arrangements to collect the signs when linemarking is completed.

21.6.4 Location of Linemarking

The start and finish of any linemarking, such as barrier lines, should be prominently marked before any of the linemarking is covered by the bituminous surfacing operation. This will allow easy replacement of the markings in the correct location. The responsibility for marking the location of linemarking and for marking the pavement so that lines can be replaced depends upon the particular contract requirement, it should not, however, be overlooked.

It is usual for Temporary Raised Reflective Pavement Markers to be placed prior to resealing to provide lane definition and guidance of traffic until linemarking is reinstated.

21.6.5 Replacement of Linemarking

As soon as possible after the bituminous surfacing is completed, the linemarking should be respotted.

Remarking should be done as soon as possible thereafter.

21.7 POLICE ASSISTANCE

At some areas where traffic control proves to be extremely difficult it may be desirable to request the local Police to aid with traffic control.
22.1 GENERAL

22.1.1 Description

Auxiliary equipment consists of specialized items of equipment required in the daily operation of a BS Unit.

22.1.2 Control

In VicRoads, Sprayline arranges the maintenance, replacement, evaluation and design of auxiliary equipment in association with AH Plant.

22.1.3 Items included

*Table 22.1.3 List of Items Included in Auxiliary Equipment*

<table>
<thead>
<tr>
<th>Brooms Rotary Refills - Plastic</th>
<th>Strainers - Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brooms Rotary Refills - Plastic</td>
<td>Strainers - Standard</td>
</tr>
<tr>
<td>Hoses - Adhesion Agent Loading</td>
<td>Mixing Boxes - Special for BCSR</td>
</tr>
<tr>
<td>Hoses - Bitumen various lengths</td>
<td>Spanners - Jet</td>
</tr>
<tr>
<td>Hoses - Bitumen Drumming</td>
<td>Spraying Jets - Copley</td>
</tr>
<tr>
<td>Hoses - Hand Spraying Lance</td>
<td>Thermometers - Bitumen - Long Stem</td>
</tr>
<tr>
<td>Infra red thermometer</td>
<td></td>
</tr>
</tbody>
</table>

22.2 ROTARY ROAD BROOM REFILLS

22.2.1 Plastic

(a) General

The most commonly used material is polypropylene. This may be fitted to either of two types of broom core, viz. a wire cable bound core or a wind on core.

(b) Fitting

The filled core can be readily fitted to a rotary road broom in the field.

22.2.2 Steel Wire

(a) General

The initial cost of steel wire refills is high but when fitted and used correctly they have a long economical life.

(b) Issue

Steel wire refills are issued packed in boxes. A full set is made up of 46 No. wire bristle segments and 45 No. spacers packed as follows:

- 1 box with 45 No. spacers
- 2 boxes with 23 No. wire bristle segments each.
(c) Fitting

Steel wire refills are normally fitted in the BS depots but can be fitted in the field if suitable handling equipment is available. The steel wire bristle segments and spacers shall be mounted alternately on the broom core starting with a wire bristle segment and finishing with a spacer on the end from which the end plate has been removed.

The drive lug on each segment shall be located one quarter of a turn in advance of the previous lug to distribute the pressure on the four longitudinal battens on the broom core.

The segments and spacers shall be assembled together as tightly as possible, but shall not be compressed by undue force just to fit the full set on the core.

With some cores it may be found that some segments and spacers are surplus and these should be stored for later use.

The used segments and spacers are scrap value only and can be disposed of as rubbish.

(d) Reversing the Core

After the wire refill has been in use for some time and is approximately one quarter worn, the broom core shall be reversed to avoid a permanent set in the wire bristles. This procedure shall be repeated at regular intervals to avoid the possibility of loss of efficiency and reduction in life of the wire bristles.

22.2.3 Hoses – Adhesion Agent Loading

For safety and ease of operation, a special hose has been developed to load adhesion agent directly from the container by suction into the bitumen sprayer using the sprayer pump as it is loading bitumen.

The loading hose consists of a short length of 38 mm diameter pipe joined onto a 38 mm diameter reinforced plastic hose with a standard hose fitting on the other end. Total length is about 2 metres.

22.3 HOSES BITUMEN

22.3.1 Description

The standard hose used by Sprayline is a 65 mm diameter type 650 high pressure flexible metallic hose fitted with nut and tail couplings at each end, as per Australian Standard AS 2475.

Hoses are supplied in three standard lengths:

• 2.5m and 4 m for general use with tankers
• sprayers 6 m for general use at bulk depots
22.3.2 Use

Bituminous materials shall only be pumped through hoses when the couplings at each end are screwed on tightly to standard cone couplings. This should be done with the standard ‘C’ spanner.

The delivery end of a hose must never be hand held or left free while pumping bituminous materials.

Unserviceable hoses must not be used. They should be clearly marked and returned to the BS Units depot for repair and/or replacement.

22.3.3 Special Hoses

For safety all materials must be transferred by suction where possible. In some cases, e.g. the electrically heated bulk bitumen storage tanks, material will have to be pumped against a head and for this purpose special hoses are available with modified fittings to provide a greater margin of safety. The special hoses are marked with a tag to indicate their purpose.

22.3.4 Fittings

Fittings available for use with hoses are (see Figure 22.3.4):

(a) Hose Plug

To be fitted in each end of hoses carried on a road tanker to prevent the entry of dirt and stones while the hose is not in use. Do not use rags or waste for this purpose.

(b) Hose Joiner

A double threaded joiner is available to temporarily join two standard length hoses into one long hose.

If the longer hose is required permanently the required length hose should be purchased.

22.3.5 Bitumen Drumming

A bitumen drumming hose is a 38 mm diameter type 650 high pressure flexible metallic hose fitted with quick action valve and is used to transfer bulk materials into 200 drums.

22.3.6 Maintenance

(a) In the Field

Bitumen hoses should be checked once a week.

Hoses shall be kept clean inside and outside. The inside can be kept clean during normal loading operations by following the correct loading procedure. The outside can be best kept clean by using a clean ‘dobbing’ brush and kerosine while the hose is warm, eg., during the loading operation.
Figure 22.3.4A  Bitumen hose fitting, general view

Figure 22.3.4B  Bitumen hose fitting, cut away view

Figure 22.3.4C  Bitumen hose joiner
Hoses can also be cleaned by ‘soaking’ in distillate or kerosine for some time, say 12 hours or more.

Hoses must not be ‘burnt’ by the application of heat from naked flames (eg., gas burner) because this will destroy the packing causing the hose to leak and thus render it unsafe and therefore unfit for use.

Repairing hoses and fittings is a specialized task and this must only be carried out by a properly qualified contractor. Unserviceable hoses must also be repaired by a qualified contractor or replaced.

(b) Checking of hoses and fittings

All hoses should be checked, the fittings repacked if required and then pressure tested for leaks. Any leaks detected in the field should, for safety, be marked at the time by clearly damaging the hose at the leaks, eg., with an axe, to ensure small leaks do not go undetected during the overhaul. This could occur because the hoses are pressure tested with cold water which may not show leaks which are visible with hot materials.

22.4 LANCE – HAND SPRAYING UNIT

22.4.1 Description

The lance hand spraying unit is a spraying attachment for spraying in areas not suited to using the spraybar. The unit consists of a length of pipe fitted with an on-off tap, generally one Copley A4 jet, and connected to the sprayer by a length of special high pressure heat resistant rubber hose with a standard bitumen hose fitting for securely attaching to the sprayer transfer port. The hose is supplied in lengths of 6 m.

22.4.2 Use

Use of the lance hand spraying unit shall be kept to a minimum. It is extremely difficult to attain a uniform and correct rate of application and hand spraying should be limited to areas of little or no traffic. Heavily modified PMBs, which are generally very viscous and used at high temperatures must not be sprayed through a hand lance.

For the correct procedure on hand spraying refer to Section 16.4.9.

22.4.3 Maintenance

The tightness and operation of the on-off tap and the condition of the hose and fittings should be checked regularly.

After each use, the lance and hose must be drained of material and thoroughly cleaned by passing cleaning oil through the whole length of the equipment.

Damaged or unserviceable hoses must be disposed of and a replacement ordered.
22.5 STRAINERS AND MIXING BOXES

22.5.1 Standard in-line Strainer

The standard strainer is a lightweight aluminium, cylindrical shape, in-line strainer. This is connected directly to one end to the tanker supply outlet, and the bitumen hose to the other end.

It is easily dismantled to give access to the wire straining basket.

22.5.2 Large Strainer

The large strainer is a steel cylindrical container mounted on a flat circular base and has a standard size inlet and outlet for connection to bitumen hoses. It is fitted with a removable clamped lid to give access to the wire straining basket and to allow additives to be added to the binder during loading, eg., adhesion agent.

It is mainly used at bulk depots.

Figure 22.5A In line strainer

Figure 22.5B In line strainer disassembled
22.5.3 Mixing Box for Crumb Rubber

(a) Description

VicRoads rubber box is designed to provide an in-line continuous mixing of crumb rubber and bitumen.

To provide a continuous flow of crumb rubber the hopper is fitted with an auger, driven by a 12 volt electric motor, via sprocket and chain.

The auger drive ratio has been predetermined to add rubber at the appropriate flow rate for 20 parts, and must not be altered.

A pointer in the inspection hatch in the in-line bitumen inlet, has been set at a predetermined rate to the auger flow, and this should also not be altered.

(b) Safety

The motor must only be driven with a 12 volt DC source. A higher voltage will damage the motor, and 240V AC will present danger to the operators.

The grate in the hopper must be in the down position during the loading operation.

(c) Setting up

Temperature of the bitumen prior to loading (mixing) should be 200°C.

Preheat the sprayer with 2000 to 3000 litres of bitumen for 15 minutes.
Set up the tanker, sprayer and rubber box on a level clean area. Care should be taken that the area is free of loose stones and sticks etc. as these could jam the pump and/or the auger. Use an old tarp on the ground to prevent foreign material from entering the mixing box.

Connect the power cable to a 12 volt source (DC) ensuring connections are correct (ie., + to +, - to -) or the auger will be turning against the flow of the rubber.

*Figure 22.5.3A  Rubber box 12 volt*

*Figure 22.5.3B  Bulk rubber container, includes weigh cells for calculation of material used*
(d) Quantities

Crumb rubber is added to the mixing box using single bags or via a bulk crumb rubber hopper.

When using single bags, count out the number of bags of rubber (to the nearest bag) for the calculated quantity (kg) of rubber required. When using the bulk crumb rubber hopper, the rate of addition and the quantity of crumbed rubber augered into the bitumen is controlled by scales and electronic controls.

It is necessary to dip the required amount of bitumen from the tanker, as foaming and bulking occurring in the sprayer is not consistent and will lead to inaccuracies.

The ideal load is about 4000 litre as mixing and reheating (if required) can be achieved in reasonable time.

(e) Loading of the sprayer

Load about 500 litre of bitumen onto the sprayer, then reduce the flow of bitumen until the bitumen flow just touches the pointer in the inspection hatch of the bitumen line.

Turn on the switch to start the 12 volt motor and start to load the hopper with rubber, the opening at the bottom of the hopper should be about ¾ open.

The flow of bitumen and rubber should be monitored during loading. The ideal flow of material is 25 kg of rubber per 100 litre of bitumen.

(f) Digestion time

When loading is completed the material on the sprayer should be circulated for at 30 minutes to allow the rubber to digest and ensure the full reaction is obtained as a modified binder.

The required amount of cutter, usually 2 parts more than normal and adhesion agent (1 part per 100 parts of bitumen) is added to the mixed material and the load should be circulated for another 20 minutes.

(g) Spraying of bitumen crumb rubber

The ideal spraying temperature of bitumen crumb rubber is 170 to 180°C. It may be necessary to reheat after loading, this can be done during the digestion time.

Aggregate should preferably be precoated with a bitumen based product. If this is not available it must be precoated with at least distillate on the day.

Spreading of the aggregate should be as close as possible to the sprayer (within safe limits).

Rolling of aggregate as close as possible to the cover truck to ensure the particles are pressed into the more viscous modified binder.
(h) Cleaning equipment

All hoses and the bitumen line of the rubber box should be cleaned with cutter when loading is completed.

When spraying of the load is finished the spray bar should be flushed clean.

At the end of the day the sprayer (pump and tank) should be cleaned in the normal way.

The rubber box auger is fitted with sealed bearings, care should be taken that extreme heat from gas torches do not make contact.

Lubricate the chain with oil every 2 months. Place end caps onto the hose fittings on the bitumen line to prevent damage during transport.

A special mixing box is used for adding crumb rubber in the field. The open topped hopper is fitted with an electrically driven auger (12 volt motor) to aid the flow of rubber. A grate is fitted on top for safety and to help break up and rubber lumps.

A sliding gate is fitted to control the rate of flow of the rubber into the bitumen.

The hopper is fitted onto a frame which carries the mixing chamber, and safety opening, and pipe work to connect to the in and outflow bitumen hoses.

For safety, the sliding gate must be closed when loading the remaining bitumen after the required quantity of crumb rubber has been loaded.

(i) Crumb Rubber in bulk

VicRoads uses bulk rubber bins designed to eliminate the task of manual handling the 25kg bags of crumb rubber and speed up the mixing time.

Using bulk rubber bins:

- reduces of people required to make crumb rubber modified binder
- are more accurate because the weighing and dispensing of crumb rubber is electronically controlled
- have built in safety features

22.5.4 Use of Strainers

(a) Strainers

A strainer must be used at all times when transferring bituminous materials under suction, eg., storage to road tanker, road tanker to sprayer, etc.

Strainers must not be used when pumping bituminous material under pressure.
(b) Mixing Boxes

The special mixing boxes are to be used whenever mixing crumb rubber and bitumen in the field.

22.5.5 Maintenance

Strainers and mixing boxes must be kept clean inside and outside.

The wire strainers should be checked and replaced if there are any defects which would reduce their screening efficiency, eg., holes in the wire, blocked areas, etc. The wire strainer may be cleaned using kerosine.

If any leaks develop, the strainers and/or mixing boxes should be replacement requested. The location of any leaks should be marked after cleaning.

22.6 RAIL TANK CAR COUPLINGS – BITUMEN

A short length of pipe, about 76mm diameter with a bend of about 110 degrees fitted on one end with a special swivel nut to connect directly onto the outlet valve of the Rail Tank Car (RTC), and fitted with a standard fitting on the other end to connect onto a standard bitumen hose.

For safety, a bleed-off valve is fitted to check that the RTC valve has been shut off properly and the line is empty before unscrewing the hose.

22.7 SPRAYING JETS

22.7.1 Description

The spraying jets used are ‘Copley’ type slotted jets machined out of brass. The jets supplied are A4 jets and their corresponding EA4 end jets. Other jets may only be used such as S2 and B8 jets on appropriate jobs.

22.7.2 Discharge Rates

The spraying table issued by VicRoads is based on the jets having the following discharge rate:

(a) Copley A4-18 litres per minute  
(b) Copley EA4-36 litres per minute

The other jets that may be used are:

(c) Copley B8-36 litres per minute  
(d) Copley S2-9 litres per minute  
(e) B6-27 litres per minute

Corrections will need to be made to the Forward Speed when using these jets.

22.7.3 Setting of Jets

Copley A4 jets must be used throughout the spraybar except for the last jet at each end which shall be Copley EA4 end jets at all times unless the bar is fitted with a special ‘taper’ spraybar system in which case the EA4 jet may be omitted when spraying tapers.

Intermediate A4 jets are to be fitted so that the slots are at an angle of 30 degrees to the centerline of the spray bar. This is achieved when the faces marked ‘A4’ can be seen when viewed from the rear of the sprayer and are parallel to the centerline of the spraybar.
Each EA4 end jet shall be fitted correctly to ensure that the slot is at an angle of 45 degrees to the centerline of the spraybar and the widest part of the slot is on the outside of the width of spray. The end jets are set at the required angle in the spray bar when the face marked ‘L’ on the left end and ‘R’ on the right end, when viewed from the rear of the sprayer, can be seen and are parallel to the centerline of the spraybar. (See photographs 16.4.2A and 16.4.2B.)

The angle of the jets in relation to the spraybar is critical for uniform transverse distribution of the sprayed material, particularly for end jets.

When marking two or more sprayer runs side by side, it is essential to overlap the material sprayed on the previous run by 50 mm. This is due to the lower application rate normally obtained on the outer 50 mm of the width of spray.

Figure 22.7.3B diagrammatically shows the correct setting of the jets in the spraybar and a typical transverse distribution.

**Figure 22.7.3A  Copley jets**

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### 22.7.4 Maintenance

#### (a) In the Field

Copley jets are made to very fine tolerances and a slight knock on the face or a burr etc., can affect the clear opening of the slot. This may upset the proper fanning or discharge rate and ruin the uniform transverse distribution.

Jets may be carried in a small tin of kerosine to keep them clean.

Jets shall not be strung on a piece of wire or dropped into a tin.

If the slot is blocked it may only be cleaned with a match or similar soft wood to prevent damage. **Do not** use a nail, screwdriver, etc.

#### (b) Inspection of Jets

Jets should be checked visually and tested with a special gauge at the end of each season for any signs of damage and wear. Damaged or worn jets are discarded and replaced with new jets. On average 25 to 30% of jets need to be replaced each season.

The jet should be marked so that the year the jet was last checked can be readily identified.
Figure 22.7.3B  Arrangement ‘Copley’ type jets in a spraybar fitted to a bitumen sprayer
22.7.5 **Jet Spanner**

Care is needed to set the jets correctly in the bar and not damage the spraying slots. A special 'Jet Spanner' is available as part of Auxiliary Equipment to enable all jets to be set in the bar with a minimum risk of damage. Some sprayers have been fitted with specially designed pneumatic spanners to fit the jets correctly and without damage.

22.8 **SPREADERS – BOX**

22.8.1 **Description**

The box spreader is a simple type of aggregate spreader. It consists of a truck mounted spreader box constructed of mild steel plate and fitted with sliding doors which can be opened and closed together or independently by means of hand operated control levers or remote control.

The remote control allows the operator to operate the spreader without having to be next to the truck at the rear wheels. This development has made the operation of the box spreader less arduous and prevents back strains as well as improving the safety of the aggregate spreading operation with greatly reduced risk of injury caused by the spreading truck and other traffic on the pavement.

The box spreaders are 2.6m wide and fitted with 8 equal width sliding doors giving a spread width varying from 200mm to 2600mm.

22.8.2 **Use**

The maximum size of aggregate spread with box spreaders should not exceed size 14.

Unless operators are skilled, it may be difficult to obtain uniform spreading and therefore aggregate spread with box spreaders should be broom dragged to even out irregularities and areas of non uniform spreading.

22.8.3 **Maintenance**

The spreader should be maintained so that the sliding doors move freely and equally when operating together in order to provide uniform lateral spreading. The doors must close properly to ensure a clean cut off.

Any box spreader in the field not spreading satisfactorily should be returned and a replacement obtained.
22.9 THERMOMETERS – BITUMEN – LONG STEM

22.9.1 Description
The long stem thermometer is a hand held mercury filled circular dial thermometer having a standard scale range of 0° to 230°C in increments of 2°C.

This is mounted on a steel stem about 700 mm long containing the probe. The normal maximum working temperature for class 170 bitumen; viz. 185°C is indicated with a red line for easy reference.

The expected accuracy of a carefully handled long stem thermometer is about ±2°C.

22.9.2 Use
Long stem thermometers are used to check the temperature of hot bituminous materials in equipment not fitted with thermometers and/or to check the accuracy of fitted standard thermometers.

The probe of the thermometer is placed in the hot material and the stem must be moved about gently. As the cool stem comes in contact with the material, a skin will form which must be given some time and agitation to dissolve allowing thermometer to indicate the actual temperature of the material. Failure to do this will result in a false, lower reading.

Long stem thermometers must be handled with care. Dropping the thermometer or rough handling, ie. loose in the back of a utility, will result in upsetting the calibration giving incorrect temperature readings.

22.9.3 Maintenance
The only maintenance required in the field is careful handling and keeping the steel stem and instrument clean.
A long stem thermometer suspected or proven of giving incorrect readings must be returned to the BS Units depot and a replacement arranged.

Repairing and calibrating a long stem thermometer is a specialist task done by qualified technicians.

\textit{Figure 22.9} Dial gauge, long stem thermometer. \textit{Note red line at }185^\circ C\textit{ to indicate normal maximum temperature for bitumen}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{long_stem_thermometer.png}
\caption{Dial gauge, long stem thermometer. Note red line at 185°C to indicate normal maximum temperature for bitumen}
\end{figure}

\section*{22.10 INFRARED THERMOMETER}
Hand held infra red thermometers are used to determine the pavement temperature. The thermometers are pointed at the pavement and the trigger is pulled. The temperature of the pavement is instantly shown on the digital display.

\section*{22.11 GEOTEXTILE DISPENSING FRAME}
Geotextiles have been placed on pavements in many ways beginning by hand placing small patches on early jobs, to current practices where 300 metre rolls are placed using a special laying frame to dispense the fabric.

The most suitable frame used by VicRoads to date consists of a fairly simple frame attached to the front of a self propelled multi-wheeled roller. (See photo attached for a general view of this system).

Some advantages of the frame are as follows:

- the large number of wheels on the roller gives an even tension across the width of the roll producing a smooth, wrinkle free mat.
- because the frame is close to the ground the effects of wind billowing the fabric are greatly reduced.
- the roller immediately impregnates the freshly sprayed bitumen bond coat into the (usually only 1 or 2 additional roller passes are required to achieve a good uniform bond).
the roller is an item of plant already within the sealing crew and only requires simple brackets attached to it to enable the frame to be mounted. If other rollers on the job have similar brackets attached then a back up is immediately available in the case of a breakdown.

rollers give the operator excellent vision and because of their relatively slow steering enable fabric to be placed very accurately and wrinkle free even around curves.

The type of dispensing frame used by VicRoads has been continually improved over the years to enable rolls to be changed very quickly and various widths to be placed. Outputs of up to 40,000 m² have been achieved in a day using one frame, and 20,000 m² is readily achieved.

Other methods of placing geotextiles have included dispensing frames attached to small maintenance tractor/loaders, large construction loaders, and small trucks. All have been used successfully and the vehicle chosen to carry the dispensing frame can be adapted to suit equipment on site. However very heavy, quick steering, or vehicles fitted with large treaded tyres are best avoided.

Figure 22.11  Laying geotextile
23.1 GENERAL

23.1.1 Introduction

VicRoads/Sprayline operate a relatively large fleet of mobile plant and equipment which is supplied under contract by AH Plant. This fleet is a mixture of specialized VicRoads and AH Plant designed items, e.g. bitumen sprayers, bitumen road tankers and standard commercially available items, e.g. tip trucks. AH Plant now constructs specially designed and manufactured equipment to VicRoads/Sprayline’s operational requirements.

The high standard of sprayed work achieved by VicRoads/Sprayline’s BS units is partly due to the practice of developing specialized plant, with the assistance of, and in consultation with AH Plant, to give the best results rather than lowering the standard of work to suit existing available plant.

Figure 23.1A  Spraying bitumen

Figure 23.1B  Spreading aggregate
23.1.2 Type of Plant

The basic items of equipment used in bituminous surfacing sprayed work are:

(a) Bitumen sprayers
(b) Bitumen road tankers
(c) Heater storage tankers
(d) Aggregate loader
(e) Trucks
(f) Aggregate spreaders
(g) Rollers
(h) Rotary road brooms
(i) Fuel trailer tankers
(j) Auxiliary equipment – see Chapter 22
(k) Miscellaneous items

23.1.3 Operation

All plant and equipment shall only be operated by personnel with current and valid licences in accordance with the standard instructions of VicRoads/ Sprayline and the owner of the plant, AH Plant.

23.1.4 Towing

Before assigning a truck to tow any item of bituminous surfacing plant, the BS Works Manager shall check that an appropriate current licence or permit has been obtained.

The BS Works Manager shall also satisfy himself that the vehicle is in good order, properly equipped as described below and suitably loaded so that the rear wheels have sufficient traction and braking capability to handle the particular item in the conditions anticipated for the journey.

To prevent costly repairs to plant and possible danger to the public and their vehicles, all drivers of vehicles towing plant operated by VicRoads shall ensure that all wheels on the towed plant are fitted correctly and that all wheelnuts are tight before towing commences.

All trucks attached to bituminous surfacing units and/or employed to tow bituminous surfacing plant shall be equipped to operate the dual line system of air brakes and to activate the stop lights etc., on the towed vehicle, and shall be fitted with approved hooks onto which shall be attached the safety chains fitted to the plant to be towed.

Bituminous surfacing plant shall never be towed by a vehicle not fitted to take safety chains, or which has unsatisfactory steering or unsatisfactory brakes.
Drivers of vehicles towing plant should always ensure that the electrical and braking systems on the trailer are connected to the towing vehicle and working correctly. Any sign of loss of trailer braking efficiency shall be immediately reported to the nearest service centre to enable the appropriate action to be taken to repair, adjust or replace the unit.

Safety chains shall be hooked onto the truck and the lock fitted securely in the towing pin.

All tyres on towed plant shall be inflated correctly and checked with a tyre gauge.

During long runs, towed plant shall be checked at least every 100 km for overheated brakes or bearings, disconnected safety chains, brake connections, electrical connections, wheel studs, condition of the tyres etc.

Additional care shall be exercised when plant is being towed on down grades.

23.1.5 Servicing

The BS Works Manager is responsible to see that plant and equipment under is serviced in accordance with the servicing as specified on the plant.

A BS unit’s operations shall not be stopped just to permit servicing of plant. Servicing shall be done before or after normal working hours or when the plant is not working, e.g. on a wet day.

23.1.6 Maintenance

Preventative maintenance by regular servicing avoids or reduces breakdowns and delays.

The plant operator shall inform the BS Works Manager and the nearest AH Plant Service Centre Workshop Manager of any defects or problems affecting the plant items. If the unit is distant from the workshop, the AH Plant Service Centre may arrange to have minor faults repaired at a local garage. Major faults are to be reported to the AH Plant representative at the local workshop and Sprayline’s BS Area Manager.

23.1.7 Cleaning

(a) General

It is easier to clean plant and equipment regularly, once a day, once a week etc., rather than leave it until the end of the bitumen spraying season.

All bitumen handling equipment is best cleaned while it is still warm. Cleaning oil must not be used to clean a tank immediately after it is emptied of bitumen. The tank must not be flushed until the temperature inside has dropped to below 100°C.

The quantity of cleaning oil used must be kept to a minimum to reduce the problem of disposing of the used oil. Used cleaning oil may be
reused as cutting oil or fluxing oil (as appropriate). Alternatively, it must be disposed of properly in accordance with the requirements of the Environment Protection Authority.

At the end of the bitumen spraying season all plant and equipment must be cleaned thoroughly before it is returned to the BS Unit’s depot or returned to the nearest AH Plant Service Centre for routine maintenance.

(b) Bitumen sprayers

For the efficient operation of bitumen sprayers it is essential that the sprayer is kept clean internally and externally and the cabin of the prime mover is kept clean and tidy.

The sprayer should be cleaned during regular servicing and while not actually travelling or spraying, e.g. when circulating a load.

The pump, valves and inside the tank should be cleaned at the end of each day’s work. The pump should be left filled with cleaning oil except when next spraying bitumen emulsion. Refer to Figures 23.2.13K to 23.2.13O for details on the cleaning operation for bitumen sprayers.

The interior of the sprayer tank is to be inspected and cleaned, if necessary, at weekly intervals to ensure there is no build-up of unwanted material.

The overflow pipe shall be inspected at weekly intervals and any build-up of material removed. Blocked overflow pipes will create problems with loading the sprayer and may be a danger to sprayer personnel and the operations.

At the end of the season, or when going in for overhaul, the bitumen sprayer should be thoroughly cleaned.

(c) Bitumen road tankers

Road tankers attached to sealing units are generally used for the transport of bitumen only and this may cause some build-up inside the tank.

Loads of cutback bitumen, e.g. primerbinder, or primer, will aid in keeping the interior free of build-up.

The pump, valves and tank interior should be cleaned at the end of each day’s work. The pump should be left filled with cleaning oil.

The interior of the tank should be inspected weekly and cleaned, if necessary, to avoid unwanted build-up of material.

There have been problems with blocked circulating pipes. These should be inspected regularly, e.g. monthly, and any build-up material removed. Failure to keep the circulating pipe clean will mean increased
pressures in the system, a lack of proper mixing of materials and non-uniform heating. The dump valve should be inspected regularly and any build-up removed to avoid blockage of the valve.

(d) 26,000-litre heater storages

These are generally not emptied every day and this may cause some build-up inside the tank. The pump and valves should be cleaned at the end of each day’s work. The pump should be left filled with cleaning oil.

At the end of each bitumen spraying season the heater storage shall be thoroughly cleaned. If manual cleaning is necessary the following two methods have been found useful:

(i) Fill the tank with water and add about 20 litres of liquid detergent such as Comprox or Teepol. This mixture should be boiled for one or two days and then disposed of or it may be used again for cleaning other items.

(ii) Fill the tank with cleaning oil and let it stand for several weeks. This should loosen most of the build-up inside the tank. The material should be circulated using a strainer to collect the rubbish. The cleaning oil may be re-used for cleaning other items or for cut bitumen.

If the fumes inside the tank need to be dispersed, the tank should be filled with water and detergent, and this should be boiled.

(iii) As with road tankers, the circulating pipe must be inspected regularly and build-up of material removed.

(e) Electrically heated storage tanks

These should be emptied at the end of the BS season and the interior scraped clean manually. As an aid, water with liquid detergent may be used first to soften the build-up by boiling. This hot water may be used to aid with the cleaning of other items such as heater storages.

The filling pipe should be inspected regularly and any build-up of bitumen removed.

(g) Precautions to be taken when entering tanks

Personnel should not enter bitumen sprayers, bitumen road tankers and heater storages or any other confined space without taking the appropriate precautions as required by the Occupational Health and Safety Act and regulations.

23.2 BITUMEN SPRAYERS

23.2.1 Description

The bitumen sprayers provided under contract to VicRoads/Sprayline are rigid chassis or semi-trailer type units consisting of a commercially available truck as a primemover and a unit built in accordance with VicRoads’ operational specification.
The bitumen sprayers generally comply with the requirements for bitumen sprayers as set out in the National Association of Australian State Road Authorities’ publication (AustRoads) ‘Specification for Mechanical Sprayers of Bituminous Materials’.

The basic features are:

(a) The Primemover

This is a two-axle, forward control truck fitted with the following equipment for use as a bitumen sprayer primemover:

(i) guide rod

(ii) distance measuring equipment (fifth wheel, radar or drive axle counter) and bitumeter head

(iii) electronic controls for pump speed and forward speed

(iv) hydrostatic motor to drive the bitumen pump.

(b) The spraying unit

The bitumen spraying unit is a steel tank (either as a tank on a prime mover or as a trailer unit) and is fitted with the following equipment:

(i) bitumen pump

(ii) necessary pipework, valves, gauges and instruments to control the four main functions of loading, circulating, spraying and heating

(iii) heating system

(iv) dipstick

(v) circulating spraybar

(vi) insulation.

The bitumen sprayers have been designed to be operated by a crew of one or two with each member of the crew being responsible for only one major task during the spraying of a load.

23.2.2 Size

The size of the bitumen sprayer is based on the nominal capacity of the sprayer tank. The nominal capacity is the average maximum quantity of binder, as measured at 15°C, which the sprayer tank can hold allowing about 20% extra capacity for expansion for heating and the average amounts of flux oil and cutter added on normal sealing work. The sizes of bitumen sprayers are:

(a) 4500 litres nominal capacity with a gross capacity about 5400 litres

(b) 5200 litres nominal capacity with a gross capacity about 6000 litres.
23.2.3 Calibration

(a) General

To obtain a satisfactory standard of sprayed work it is essential that the bituminous materials are applied uniformly at the design rates of application.

The desired application rate is obtained by accurately controlling the spraybar output and the forward speed of the sprayer. The spraybar output is maintained at a constant volume per unit width of spraybar so that the rate of application is a function of the forward speed of the sprayer. To maintain accuracy the bitumen sprayers are tested and calibrated after each major overhaul or repairs to the pump, valves or spraybar.

(b) Spraybar Output

In the bitumen sprayer the spraybar output is controlled by the pump revolutions and output. The bitumen pump speed is set to give the required output and, hence, an accurate constant discharge.

Bitumen sprayers are calibrated for spraybar discharge by measuring the actual output against the required output for each width of spray, normally between 0.6 m and 7.5 m, and recording the pressure and pump revolutions required to give the required output (18 litres per minute for A4 and 36 litres per minute for EA4 jets). The maximum allowable variation between the total actual rated output and required output is ± 1.25%.
The procedure used is to check the output by spraying a test fluid having a viscosity similar to the spraying viscosity of bituminous materials. The test fluid used has a viscosity of 0.07 Pa.s at 25°C. Starting with the largest width of spraybar (7.5 m and 73 jets), the fluid is sprayed at a predetermined bitumen pump revolutions for 60 seconds and the actual output measured accurately. If the output is not satisfactory the run is repeated using different pump revolutions until a satisfactory output is achieved. The process is repeated with the width of spray being progressively reduced down to the width of 0.6 m.

During each discharge test run the lateral distribution is also checked.

Figure 23.2.4  Control panel, 6000-litre Mathews Sprayer

(c) Forward Speed

Forward speed is measured by means of distance measuring equipment (fifth wheel, radar or drive axle counter) which records distance in metres and forward speed in metre/minute.

The distance measuring equipment is calibrated by running over a measured distance at uniform predetermined forward speeds. The actual speed is calculated and a graph plotted showing the indicated scale speed against the actual speed. From this graph the scale speed required for any actual speed can then be read off.
23.2.5 Bituminous Surfacing Spraying Table (Figure 23.2.5)

The bituminous surfacing spraying table is prepared for each sprayer tested and calibrated. Only the current table must be used or incorrect rates of application will result.

The table provides the following information:

(a) Application rate versus Forward Speed (for primer, primerbinder and binder)

(b) Shaft Speed versus Bar Width and corresponding number of jets

(c) Actual distance to Indicated Distance Scale factor.

23.2.6 Spraybar

The spraybars fitted to sprayers are a recirculating bar which is permanently attached to the machine. This bar is designed with pivoting extension arms at each end which can be fitted with a maximum of 3 No.*6 jets and 1 No.*3 jet extensions in any appropriate combination, dependent on the spray width.

Figure 23.2.6 View of circulating spraybar

23.2.7 Bitumen Pump

(a) General

Bitumen pumps fitted to VicRoads’ sprayers are of two types. Sprayers of VicRoads/AH Plant manufacture are fitted with Kinney rotating plunger pumps. Other sprayers are fitted with gear pumps. Both pump types provide positive displacement with a fixed volume per revolution.
**VIC ROADS**

**Bituminous Surfacing Spraying Table**

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<th>A H PLANT</th>
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**Spraying Table**

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<th>Pump</th>
<th>bar/tank circulate kpa</th>
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**Note:** This spraying table is based on using Copley A4 and EA4 jets at 100.00 mm centres.
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</table>

The distance indicator reads: 1018 metres per kilometer.

Actual distance run equals indicated distance multiplied by: 0.982

Indicated distance equals actual distance divided by: 0.982

Note: This Table has been prepared for VicRoads by Australian Plant Hire and Service
Any queries or problems regarding this chart or sprayer
Contact: Australian Plant Hire and Service
Allan Jones  Telephone 03 9881 7378

No allowance has been made for any cutter used in the binder

NOTE: The figures given are indications only, and it is the responsibility of the owner to make any necessary adjustments to obtain the rate of application as instructed.
(b) Kinney Pump

The Kinney SD 666 pump used on VicRoads’ sprayers has a rated output of approximately 2.3 litres (0.5 gallon) per revolution.

The Kinney pump is a twin rotating plunger, positive displacement pump. The bearings are lubricated by the material being pumped and the pump should not be run dry or too long without material. Cold material, such as cutter, may seize the pump if it is pumped immediately after hot bitumen. If at all possible, flux oil should be used after pumping hot bitumen.

The safe maximum pump shaft speed is 700 rpm and this should not be exceeded unless a higher pump speed is required to achieve the correct output – refer to Table A on the ‘Bituminous Surfacing Spraying Table’ – Figure 23.2.5.

Figure 23.2.7A & B Kinney pump external (left) and internal view (right). Note lubricating pipes

(c) Gear Pump

Gear pumps are used on bitumen sprayers of other suppliers. The pump is a non-surge herringbone type gear pump mounted at the rear of the sprayer and driven by a hydraulic motor. The herringbone gears provide a uniform flow of material without pulsing. To provide adequate capacity the pumps have two chambers with a single inlet and outlet.

The rated output of the two-chamber gear pump used in these sprayers is approximately 2.6 litres per revolution.

Bitumen emulsions can be pumped through gear pumps.
(d) Pump Drive

On the sprayers the pump is driven from a hydrostatic drive. This system does not require shear pins and provides a variable pump shaft speed ranging from 0 to 700 rpm.

**Figure 23.2.7C & D**  
*Gear pump, interior and exterior. Note the drive shaft*

---

**23.2.8 Control Valves**

The sprayers have two valves which provide for the operations of filling, circulating, transferring, draining and isolating the tank from the pump.

When a sprayer has been overhauled the suction and delivery valves are adjusted prior to the sprayer being calibrated. However, before any work is done with the sprayer, it is essential that the adjustment of the valves be checked when the *first hot load* of material is placed in the sprayer.

The BS Works Manager should arrange with the nearest AH Plant Service Centre Workshop Manager for a fitter to be made available to check the adjustment in the presence of the Sprayer Operator.

The valves should be adjusted so that an even, firm action is required to turn the valve control wheels.

If the suction and/or delivery valves are repaired or replaced during the season the valve adjustment should be checked again when the next hot load is placed in the sprayer.

If any further valve adjustments are required during the season they must always be done with the sprayer containing a hot load.

If the valves are not correctly adjusted this can result in leaking valves, blocked pipework and/or jets, damaged valves, and incorrect rates of application.
23.2.9 Gauges

(a) Pump Shaft Revolution Indicator

On all bitumen sprayers, the pump shaft revolution indicator is either a standard automotive tachometer electrically operated or a digital tachometer.

(b) Temperature Gauges

These are used to indicate the temperature of the material in the sprayer tank. These are a mercury operated gauge with a circular scale range of 0 to 230°C. The normal maximum working temperature for Class 170 bitumen, 185°C, is indicated with a red line for safe and easy reading (see Figure 22.9).

The sprayers are equipped with two temperature gauges, one reading the temperature of the tank contents and the other reading the temperature of material in the pump and pipework. The two should give the same or similar readings once the material has been properly circulated. Faulty or incorrect gauges must be replaced.
23.2.10 Distance measuring/forward speed equipment (fifth wheel, radar or drive axle counter)

The bitumeter head is located in the cabin fitted to the console. It is driven by means of a small gearbox and cable from the distance measuring equipment. The bitumeter head has a circular scale from 0 to 500 m/min in increments of 5 m/min. A red coloured adjustable pointer is used to set the scale reading required and the indicator needle is matched to this to achieve an accurate, uniform forward speed.

The accuracy of the distance measuring equipment (fifth wheel, radar or drive axle counter) should be regularly checked by running over an accurately measured distance, say 500 m. Digital type forward speed/measuring devices are fitted to some sprayers.

23.2.11 Faulty Gauges

When a pump shaft speed revolution indicator, distance measuring equipment or bitumeter head on a sprayer becomes faulty or the sprayer is not spraying in accordance with the spraying table, the BS Works Manager shall immediately notify the BS Area Manager who shall in turn immediately notify the Manager Plant and Linemarking.

It is essential that the BS Area Manager be informed so that arrangements can be made to have the sprayer checked in the field and, if necessary, returned to the depot for re-calibration.

Calibrated sets of a bitumeter head and fifth wheels are now readily available and these can be installed and the spraying table amended in the field.

If required, the Manager Plant Services will arrange for a replacement sprayer to be obtained.

A temperature gauge that is faulty or giving an incorrect reading should be replaced as soon as possible.

23.2.12 Equipment

The items listed in Table 23.2.12A, whether or not in use, shall be carried on the bitumen sprayer at all times.

A bitumen sprayer shall be transferred with all these items or a written statement explaining any deficiency must be provided with the machine.
The items listed in Table 23.2.12B shall be carried on the sprayer at all times during the spraying season:

Table 23.2.12B  Equipment to be carried during the spraying season on a bitumen sprayer

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<tr>
<td>Fire extinguisher – 9 litre foam</td>
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<tr>
<td>Knapsack and spray pumps</td>
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<td>Shovels</td>
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<td>Spanner – hose</td>
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<tr>
<td>Spanner – jet</td>
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<td>Gloves bitumen (pair)</td>
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<td>100</td>
</tr>
<tr>
<td>Jets – Copley EA4</td>
<td>10</td>
</tr>
<tr>
<td>Plugs – 12.7 mm (¼&quot;)</td>
<td>24</td>
</tr>
<tr>
<td>Spraybar extension gaskets</td>
<td>10</td>
</tr>
</tbody>
</table>
23.2.13 General Operation Bitumen Sprayers

The following list and drawings show the general arrangements of all current model 4500-litre bitumen sprayers together with the valve setting for the various operational functions.

(a) General arrangement bitumen sprayers nos. 29–F and B–........
    Fig. 23.2.13A General Arrangement of Sprayer Prime Mover
    Fig. 23.2.13B General Arrangement of Sprayer Tank

(b) Filling
    Fig. 23.2.13C

(c) Bar circulating
    Fig. 23.2.13D

(d) Spraying
    Fig. 23.2.13E

(e) Suck back
    Fig. 23.2.13F

(f) Circulating and heating
    Fig. 23.2.13G

(g) Transferring from sprayer to heater or tanker
    Fig. 23.2.13H

(h) Transferring externally (tank isolated)
    Fig. 23.2.13I

(i) Holding loads for long periods
    Fig. 23.2.13J

(j) Cleaning sprayer tank and pump
    Fig. 23.2.13K

(k) Cleaning sprayer – pump only (tank isolated)
    Fig. 23.2.13L

(l) Cleaning sprayer tank and pump
    Fig. 23.2.13M

(m) Cleaning bar and jets
    Fig. 23.2.13N

(n) Cleaning pump and bars
    Fig. 23.2.13O

(o) Hand lancing
    Fig. 23.2.13P

Note: The drawings showing operational functions are for general information. Operators should refer to the appropriate Operating Manuals (AH Plant or other hire company’s) for complete instructions on the particular sprayer type.
Legend for Figure 23.2.13A

1. Sprayer operating controls
2. Tank and pump temperature gauges
3. Guide rod
4. Bitometer head and fifth wheel assembly
5. Not used
6. Engine speed hand throttle
7. Hydraulic reservoir
Figure 23.2.13B  General arrangement of sprayer tank

Legend to Figure 23.2.13B

1  Tanker manhole
2  Screen
3  Operator’s tank platform assembly
4  Bitumen tank thermometer
5  Cleaning oil tank
6  Fill and transfer valves, ports & caps
7  Jet carrier
8  Tool box
9  Liquid petroleum gas withdrawal bottles
10 Dipstick
11 Valve controls
12 LPG vaporiser pressure relief
13 Overflow drip tray
14 Cleaning oil measuring tank funnel
15 Gas burner
16 Gas tube flues
17 Gas burner LPG pressure gauge
18 LPG pressure regulator
19 LPG stop valve
20 End shield
21 Spray curtain (windshield)
22 Hand pouring hose
23 Combustion chamber slide cover
24 Paper rack
25 Measuring tank valve switch
Figure 23.2.13C  Filling

FILLING A SPRAYER TANK

SUCTION VALVE IN **FILL** (CLOSED)
DELIVERY VALVE IN **CIRCULATE** (FILL)
Figure 23.2.13D  Bar circulating

BAR CIRCULATING

SUCTION VALVE IN CIRCULATE
DELIVERY VALVE IN SPRAY
PUMP SET AT 400 TO 500 RPM
**Figure 23.2.13E**  
Spraying

**SPRAYING**

SUCTION VALVE IN CIRCULATE  
DELIVERY VALVE IN SPRAY  
PUMP SPEED: AS PER SPRAYING TABLE
Figure 23.2.13F  Suck back

SUCK BACK

SUCTION VALVE IN CUTOFF
DELIVERY VALVE IN CIRCULATE
PUMP SPEED SHOULD NOT EXCEED 700 RPM
Figure 23.2.13G  Circulating and heating

CIRCULATING AND HEATING

SUCTION VALVE IN CIRCULATE
DELIVERY VALVE IN CIRCULATE
PUMP SET AT 400 - 500 RPM
Figure 23.2.13H  Transfer to heater or tanker

TRANSFER TO HEATER OR TANKER

SUCTION VALVE
FILLING VALVE

BITUMEN PUMP

DELIVERY VALVE

CLOSED

AIR CYLINDER

DELIVERY VALVE

SUCTION VALVE IN CIRCULATE
DELIVERY VALVE IN TRANSFER
Figure 23.2.131  Transferring externally (tank isolated)

TRANSFER TO HEATER OR TANKER

SUCTION VALVE IN FILL (CLOSED)
DELIVERY VALVE IN TRANSFER
Figure 23.2.13J  Holding loads for long periods

HOLDING LOADS FOR A LONG PERIOD

SUCTION VALVE IN FILL (CLOSED)
DELIVERY VALVE IN TRANSFER
Figure 23.2.13K  Cleaning sprayer tank and pump
Figure 23.2.13L  Cleaning sprayer pump only

CLEANING SPRAYER PUMP ONLY FUNCTION

SUCTION VALVE IN FILL (CLOSED)
DELIVERY VALVE IN TRANSFER
PUMP SET AT 80 - 100 RPM
Figure 23.2.13M  Cleaning sprayer tank and pump

CLEANING SPRAYER TANK AND PUMP

SUCTION VALVE IN FILL (CLOSED)
DELIVERY VALVE IN SPRAY
PUMP SET AT APPROXIMATELY 500 RPM
Figure 23.2.13N  Cleaning bars and jets

CLEANING BAR AND JETS

SUCTION VALVE IN FILL (CLOSED)
DELIVERY VALVE IN SPRAY
Figure 23.2.13O  Cleaning pump and bars

CLEANING PUMP AND BAR

SUCTION VALVE IN FILL (CLOSED)
DELIVERY VALVE IN SPRAY

STORAGE CONTAINER
Figure 23.2.13P  Hand spraying

CLEANING SPRAYER TANK AND PUMP

SUCTION VALVE IN CIRCULATE
DELIVERY VALVE HALF OPEN TO CIRCULATE
PUMP SET AT 200 RPM
23.2.14 Bitumen Road Tanker

The bitumen road tanker is a semi-trailer unit fitted with an integral chassis steel tank mounted on a tri-axle trailer and the prime mover engine drives the pump via a hydrostatic drive. It is fitted with the following:

(a) Hydraulically driven bitumen pump (off the prime mover motor)

(b) Necessary pipework, valves and instruments to control the main functions of loading, unloading, circulating and heating

(c) Heating system

(d) Dipstick

(e) Insulation.

The capacity is 24 000 to 26 000 litres.

Figures 23.2.17 A&B Bitumen road tankers
23.2.15 Bitumen Pump
The bitumen pump is a positive displacement gear pump for the 24 000- to 26 000-litre bitumen tankers.

23.2.16 Temperature Gauges
There are two gauges used to indicate the temperature of the material in the tank. They are the standard type temperature gauge calibrated from 0 to 230°C as fitted to the bitumen sprayers – see Section 23.2.9(b), and have a red line at 185°C indicating the normal maximum temperature for bitumen.

23.2.17 Unloading
The road tanker should be on reasonably level ground during unloading. The material should be transferred to other bitumen road tankers or heater storage tankers using the pumping equipment belonging to the other item of plant.

When unloading into a fixed storage tank the road tanker should use the pumping engine on the road tanker (i.e. by transferring by suction).

To ensure complete draining of the tank keep the outlet end lower than the front when emptying. If necessary use the chocks provided to raise the front of the tank.

23.2.18 Operation – Bitumen Road Tanker
Figure 23.2.18 shows the general arrangement together with the tanker control valve settings for the various operational functions.

*Figure 23.2.18*
### Table 23.2.18 Operation and control valve settings for bitumen road tankers

<table>
<thead>
<tr>
<th>Operation</th>
<th>Valves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Outlet</td>
</tr>
<tr>
<td>To fill tank (using pump)</td>
<td>Shut</td>
</tr>
<tr>
<td>When travelling</td>
<td>Shut</td>
</tr>
<tr>
<td>To circulate load</td>
<td>Open</td>
</tr>
<tr>
<td>To unload tank – own pump</td>
<td>Open</td>
</tr>
<tr>
<td>To flush pump and tank</td>
<td>Open</td>
</tr>
<tr>
<td>To drain pump and tank</td>
<td>Open</td>
</tr>
<tr>
<td>To flush pump</td>
<td>Shut</td>
</tr>
<tr>
<td>To drain pump</td>
<td>Shut</td>
</tr>
<tr>
<td>To unload tank by suction</td>
<td>Open</td>
</tr>
<tr>
<td>Separate outlet not via pump</td>
<td>Open</td>
</tr>
</tbody>
</table>

### 23.2.19 Heating

(a) General

VicRoads’ bitumen road tankers are equipped with a heating system designed to maintain or slowly increase the temperature of hot bituminous materials. They are not designed to be operated as heater/storage tankers.

(b) Type of Heating Equipment

The larger road tankers, 24 000- to 26 000-litre, are fitted with two burner tubes each fitted with a low pressure gas fired burner.

See Section 23.4.4 for details on their operation.

(c) Use of Heating Equipment

See Section 23.4 for details on the use of heating equipment.

(d) Minimum Quantities

The minimum quantity, as measured on the dipstick, is indicated on the unit on a plate located near the burners.

### 23.2.20 Electric Bulk Storages – 36 000- and 56 000-litre capacity

(a) General

The establishment of various fixed location bulk bitumen depots presented a need for larger capacity heater storage units. As a result, fixed electrically heated storage tanks were built with sufficient capacity to accept one, full rail tank car load of bulk bitumen.
(b) Description

The heater storage tank is a heavily insulated cylindrical steel tank supported in the horizontal position by three legs on concrete foundations. The main features are:

(i) the steel tank shell
(ii) the supporting legs
(iii) the heating tubes and elements
(iv) the pipework for filling, emptying, draining and overflow
(v) the insulation and external cladding
(vi) the control cabinet
(vii) the volume indicator
(viii) the high and low level switches
(ix) the ladders and platform over the tank for access to the dipstick and manhole.

The tanks require an external pumping unit for filling and emptying. Normally a fixed pumping installation is provided in the form of an electrically driven Kinney bitumen pump.

(c) Capacity

The nominal capacity is 36 000 or 52 000 litres of bitumen measured at 15°C. The tank capacity is about 40 000 or 58 000 litres.

(d) Heating

Heating is by means of electric elements operating at night on off-peak electricity rates. The temperature of the bitumen is controlled thermostatically between 180°C and 190°C. The heating is automatic and a warning system is provided to warn the attendant of any malfunctions. It is not necessary to be in continuous attendance at the tank during heating as is the case with oil- or gas-fired heaters.

The heating system is primarily designed to maintain bitumen at the desired temperature of 180°C to 190°C, although it will raise the temperature at a low heating rate.

Because of the heavy insulation, the tanks have a very low heat loss and it is not necessary to heat every night when there is little or no requirement for bitumen, e.g. Christmas close-down. For economy and to avoid holding the bitumen at high temperature for a long period, which may have adverse effects, the following procedure is recommended:

(i) holding periods of up to 1 week – heat the bitumen only the night prior to requiring bitumen
(ii) holding periods of 1 week to 1 month – heat the bitumen regularly once a week and on the night prior to requiring bitumen
(iii) holding periods over 1 month – let the bitumen cool down and bring back up to temperature slowly and carefully over a period of perhaps 3 days prior to requiring bitumen.
23.3 RAIL TANK CARS

23.3.1 General

Rail tank cars are provided by the contract supplier as part of the conditions of the supply and delivery contract for materials in bulk. They may be owned by the supplier or by the railway authority. The rail tank cars are used to supply bitumen and other materials in bulk to BS units and municipalities via a number of railway sidings.

23.3.2 Description

The rail tank car is a large steel cylindrical tank mounted horizontally on a steel frame fitted with railway owned rolling gear.

The majority of rail tank cars are used to supply bulk bitumen and these are insulated and fitted with heating tubes. A number of rail tank cars are used to supply priming materials which do not require heating. These tanks are not insulated.

Figure 23.3.1 Bitumen rail tank car

The main features are:
- the tank assembly
- the frame and wheels
- the heating tubes
- the thermometers
• the control valve
• the dipstick.

23.3.3 Capacity

(a) Bulk bitumen – the major oil companies supplying bulk bitumen provide rail tank cars which supply loads between 33 000 and 40 000 litres at 15°C.

(b) Priming materials – normal loads supplied are about 40 000 litres at 15°C.

23.3.4 Loading

Rail tank cars are loaded at the contractor’s works or at a convenient nearby siding.

23.3.5 Unloading

As soon as a rail tank car is positioned for unloading, a red flag and a ‘Tank Car Unloading’ sign shall be placed at each end of the rail tank car. The sign must be placed on the track so that it can be read as the rail tank car is approached along the track.

Rail tank cars are unloaded into bitumen road tankers or bitumen sprayers using the pumping equipment of the unit being loaded.

At bulk bitumen depots, the rail tank cars are unloaded into heater storage tanks.

A rail tank car should be unloaded as quickly as possible and every effort must be made to ensure that it is completely emptied.

23.3.6 Heating

(a) General

The rail tank cars are fitted with burner tubes at each end of the tank. The number of tubes fitted depends on the type and make of rail tank car but are generally either 4 tubes or 6 tubes, i.e. 2 at each end or 3 at each end.

(b) Type of Heating Equipment

The heating equipment used are oil fired low pressure burners. The burners do not remain on the rail tank car but are part of the equipment supplied with the mobile rail tank car heating units – see Section 23.3.7.

See Section 23.4.3 for details on the operation of low pressure burners.

(c) Use of Heating Equipment

See Section 23.4 for details on the use of heating equipment.

Note: The bitumen is not circulated during heating.
(d) Rate of Heating

The burners on a rail tank car shall not be operated continuously until the three thermometers register similar temperatures to indicate the bitumen in the tank is at a uniform temperature and consistency.

The maximum heating rate allowed is one which will not increase the temperature by more than:

- bitumen – average 40°C per hour
- cutback bitumen – average 30°C per hour.

(e) Minimum Quantities for Heating

The minimum quantity that is allowed to be heated varies between rail tank cars. The minimum quantities are indicated on each end of the tank and these must be strictly observed.

23.3.7 Rail Tank Car (RTC) Heating Units

Rail tank car heating units are supplied by the contract suppliers as part of the necessary equipment of a rail tank car.

The heating unit which is fitted in a two-wheel trailer comprises fuel supply tank, air blower and fuel pump driven by a small petrol or diesel engine. Included with the unit are the oil burners and the necessary air and oil hoses to supply air and oil to the burners when heating.

In some bulk bitumen depots, the engine has been replaced with an electric motor for quieter operation.

23.4 USE OF GAS AND OIL FIRED HEATING EQUIPMENT

23.4.1 General

(a) The operator shall be in attendance whenever the heating equipment is in use and for a period of at least 20 minutes after the burners have been turned off.

(b) Heating equipment shall not be used during any of the following operations:

- loading
- unloading
- spraying
- travelling.

(c) If the material being heated cannot be pumped, heating must be carried out for only short periods until the material becomes ready and can be circulated. This is to avoid excessive heat around the burner tube(s). As soon as the material is ready it must be circulated with the bitumen pump running at between 400 and 500 rpm while heating is taking place and for 20 minutes after the burners are turned off.

(d) If the material being heated is below 90°C at the time heating is started, careful attention should be paid to the possibility of a boilover caused by
the presence of water in the material (indicated by bubbling and gurgling noises during heating).

If this is noted, heat should be slowly applied and the material held at a temperature of about 90°C and if possible vigorously circulated until the water has evaporated.

(e) Heating shall always take place away from other items of plant or inflammable materials.

(f) Burners should always be turned off before the material reaches the maximum temperature. The latent heat in the burner tubes etc., will generally raise the temperature about another 3 to 5°C after the burner is stopped.

**23.4.2 Procedure for Operating High Pressure Oil Fired Burners**

(a) Starting the Burner

(i) Drain any water from the air receiver tank

Note: Before removing the drain plug ensure that the air pressure is released.

(ii) Engage compressor drive dog-clutch before starting pumping engine. Use only clean diesel fuel oil or distillate

(iv) Remove the smoke stack cover and open the valve controlling the smoke stack air ejector (if fitted)

(v) Open the burner air valve to a pressure of 40 to 50 kPa

(vi) Hold a lit oil-soaked flare, or preferably a gas torch, under the burner jet so that the flow of air forces the flame into the combustion chamber and slowly open the oil valve until the oil ignites

(vii) Adjust both air and oil control valves to give a moderate size flame and allow this to burn for a few minutes

(viii) Continue raising the air pressure and increasing the oil supply until an air pressure of between 350 and 400 kPa is reached and the oil is burning steadily

(ix) Adjust the fuel oil control valve to give a faint trace of dark smoke from the stack.

(b) Stopping the Burner

(i) Turn off the oil supply to the burner

(ii) Allow the air to flow until the oil mist ceases to be blown from the burner and the fumes in the burner tube have been dispersed

(iii) Turn off the air supply to the burner
(iv) Turn off the air to the smoke stack ejector

(v) Replace the smoke stack cover

(vi) Stop engine and disengage compress or drive

(vii) Continue to circulate the material in the tank for a further 20 minutes to allow the heating tubes in the sprayer to cool down to the temperature of the material in the tank.

(c) Necessary Adjustments

(i) Keep the oil and air valve packing glands tight to overcome any tendency for the adjustment of these valves being upset by vibration

(ii) Keep the oil strainer clean

(iii) Keep the oil burner nozzle free from dirt and coke

(iv) See that the locking nut on the burner body is tight. This nut maintains the adjustment between the position of the air nozzle and the hole through which the oil is drawn.

23.4.3 Procedure for Operating Low Pressure Oil Fired Burners

(a) Starting the Burner

(i) Engage blower drive dog-clutch before starting pumping engine. (This may not apply to RTC heating units with fluid drive coupling.)

(ii) Use only clean diesel fuel oil or distillate

(iii) Remove the smoke stack cover, uncover the entrance to the combustion chamber and place the burner in the operating position

(iv) Set the air valve in the full open position and allow the air to blow through the burner tube for several minutes

(v) Set the air control valve at the closed position. This allows a small flow of air

(vi) Hold a lit oil-soaked flare, or preferably a gas torch, under the burner so that the flow of air forces the flame into the combustion chamber

(vii) Open the oil control valve until the oil ignites

(viii) Adjust both air and oil control valves to give a moderate sized flame and allow this to burn for a few minutes before increasing the flow of oil and air

(ix) Fully open the air valve and adjust the fuel oil control valve to give a faint trace of dark smoke from the stack.
Note:  Too much oil causes black smoke. Too little oil gives smokeless combustion over a very wide range with little or no visual evidence of the resultant wasted heat until, in the most extreme cases, whitish smoke is formed and this can be explosive. This condition must be avoided.

(b) Stopping the Burner
   (i) Turn off the oil control valve
   (ii) Allow the air to flow until the oil mist ceases to be blown from the burner and the fumes in the burner tube have dispersed
   (iii) Turn off the air control valve and removes slag (if any) from the burner tube
   (iv) Replace the smoke stack cover
   (v) Close off the entrance to the combustion chamber to avoid a draught through the burner tubes, with consequent loss of temperature, and to protect the tip of the burner from the heat of the combustion chamber
   (vi) Stop engine and disengage blower drive
   (vii) Continue to circulate the material in the tank for a further 20 minutes to allow the heating tubes to cool down to the temperature of the material in the tank.

23.4.4 Procedure for Operating Liquid Petroleum (LP) Gas Burners on Bitumen Sprayers

(a) Starting the Burner
   (i) Ensure that a cylinder has been properly connected to the system and is of the liquid withdrawal type
   (ii) When using 4500- or 5200-litre sprayers ascertain the direction of the wind and then arrange the flue elbow outlets to face downwind and lock them in this position. Reposition the flue if a change of wind direction occurs. On other equipment remove the stack cover.
   (iii) Open the slide cover over the burner tube inlet
   (iv) Fully unscrew the pressure regulator
   (v) Fully open the stop valve
   (vi) On 4500-litre sprayers wind the handle of the magneto which produces a spark in the spark plug located at the front end of the burner. This will ignite the gas burner.

If the gas does not ignite within 10 seconds, close the stop valve and check that the magneto and spark plug are working. Wait 10 minutes for dispersal of the unburnt gas which is now in the flame duct. After 10 minutes repeat step (v).
On other equipment use a gas torch to ignite the gas burner.

When the gas has ignited, screw the pressure regulator clockwise until the desired burning rate is attained.

Note: The LP gas fuelled heating system on the 4500- and 5200-litre bitumen sprayer has been designed primarily for heating bituminous material which will generally be at a temperature between 150°C and 180°C.

In this temperature range, the vaporizer mounted on the front end of the tank obtains enough heat from the material in the tank to completely vaporize the liquid gas.

When the tank contents are significantly colder, i.e. 40°C to 100°C, the vaporizer will not be capable of vaporizing the liquid gas at the required demand of the burner.

When this happens, the output from the vaporizer will be a mixture of liquid and vapour and the resultant combustion, although safe, will be rich and unsatisfactory. This condition is indicated by a yellow flame and should not be allowed to continue as it results in the deposition of soot in the flame duct.

The situation can be avoided by unscrewing the pressure regulator which will reduce the burner rate and the demand for vapour. The regulator should be kept on this setting until normal burning is restored.

(b) Stopping the Burner
   
   (i) To stop heating, close the stop valve, but do not alter the regulator setting. The flame will continue burning for some time until the gas in this section of the line is exhausted.

   (ii) Close the combustion chamber slide cover.

   (iii) Continue to circulate the material in the tank for a further 20 minutes to allow the heating tubes to cool down to the temperature of the material in the tank.

   (iv) If travelling, while circulating the load in a 4500-litre sprayer, the flue outlets should be turned to face the rear of the sprayer and locked in position.

   (v) If fitted, replace stack cover.

23.4.5 Procedure for Operating LP Gas Burners on Bitumen Road Tankers

This applies to the gasburners fitted to the 24 000- to 26 000-litre road tankers.

(a) Starting the Burner

   (i) Ensure that a cylinder has been properly connected to the system and is of the liquid withdrawal type.

   (ii) Remove the stack cover and the slide cover over the burner tube inlet.
(iii) Make sure that the burner control valve, located adjacent to the burner, is closed (clockwise)

(iv) Open the stop valve on the selected cylinder very slowly (anti-clockwise) in order to prevent the closing of the excess flow valve (both cylinder hose fittings incorporate an excess flow valve for safety in the event of a hose or line failure)

(v) Adjust the pressure regulator to approximately 350 kPa setting on the gauge (clockwise rotation of the knob increases pressure setting)

(vi) Open the burner control valve (anti-clockwise) while holding a gas torch close to the end of the burner near the fire tube.

After ignition, slowly increase the opening of the burner control valve to obtain the burning rate desired.

(b) Stopping the Burner

(i) Close the valve on the LPG cylinder tightly (clockwise)

(ii) Wait until the flame is extinguished, then close the burner control valve (clockwise)

(iii) Replace stack cover and slide plate.

Note: The gas supply and LP gas burners on bitumen road tankers are currently being modified. AH Plant will rewrite the procedures for that system and issue operators with revised Operating Manuals.

23.5 AGGREGATE LOADERS

23.5.1 Description

Aggregate loaders are a special purpose designed and built bucket loader mounted on a commercially available rigid chassis truck.

The main features are:

- the loading spirals and scraper blade
- the bucket elevator
- the trommel screen
- the conveyor belt
- the operator’s platform
- the auxiliary engine
- the precoating system
- the truck cabin and chassis.

They are used on all VicRoads’ sealing work to load, screen and precoat the aggregate in one operation from the stack sites into the aggregate spreading trucks.
23.5.2 Operation
For general operation of the aggregate loaders refer to Operator’s Handbook – Aggregate Loader.

23.5.3 Loading
The maximum loading rate is about 2 m³/minute. The normal loading rate should be about 1.5 to 2 m³/minute to obtain adequate screening and uniform precoating.

The loader flights in the raff wheel of the trommel should be kept free from accumulated dust and fine aggregate to maintain the loading rate. Regular checks should also be made to ensure that the conveyor rollers run freely.

Use the tilt rams at the rear to level the scraper blade so that the aggregate is loaded cleanly without foreign matter such as dirt or grass.

Always empty the bucket elevator, trommel and conveyor belt before stopping. Failure to do this will result in overloading the drive train when restarting. Do not let the trommel run empty for more than a few minutes without a load, as this will cause over speeding and excessive wear on the rollers.

The auxiliary engine must be started with the drive train disengaged to avoid overloading.

Normal pressure setting for the precoating jets in the trommel is about 250 to 300 kPa with a maximum pressure of 400 kPa.

Disconnect the gear pump whenever it is not required for use during loading operations, because running it dry will cause excessive wear or failure.

Because of the load distribution, the travelling speed should be kept down to about 60 km/h and care must be taken on curves and embankments.
Figures 23.6 A, B & C  Rotary road broom
23.6 ROTARY ROAD BROOMS

23.6.1 Description

The rotary road brooms are based on previously designed and built VicRoads Plant Branch (now AH Plant) equipment. The units consist of a towed steel chassis on one axle fitted with a revolving broom core which is mechanically driven by the rear road wheels or an auxiliary engine. The broom core frame is pivoted so that it can swivel from side to side and is adjustable in height.

The height of the core above the surface of the pavement and the angle is controlled by a mechanical or hydraulic linkage depending on the model of rotary road broom and is operated by remote control from the cabin of the truck towing the rotary road broom.

To reduce bouncing and ensure uniform contact pressure with the pavement the frame is not fitted with a suspension, but the necessary flexibility is provided by using tyres with relatively low pressures (about 70 kPa).

The main features are:

- the broom frame and wheels
- the broom core and cowl
- the auxiliary engine plus hydrostatic drive
- the lifting mechanism
- flashing amber lights for safety during sweeping operations.

The broom core may be either a plastic or steel wire core, see Section 22.2 for details. Some of these brooms also have a drag broom attachment fitted at the rear of the broom core frame.

23.6.2 Sweeping

The broom core drive shall be disengaged at the end of each sweeping run so that when turning or towing the rotary road broom, the broom core does not revolve.

The broom core shall be lifted at the end of each run so that the bristles are clear of the pavement surface.

The correct method of sweeping is to apply the minimum pressure of the bristles on the pavement which will flick the dust etc. off the surface. Do not try to use the broom as a grader.

23.6.3 Towing

(a) The drive to the broom core must be disengaged.

(b) The broom core shall be lifted to the travelling position and the safety pin fitted. This is to prevent damage by keeping the mass of the broom core off the height control mechanism during travelling.

(c) Because brooms are unsprung and the tyres run at low pressure the broom must not be towed at fast speeds. Special care must be taken on uneven pavement surfaces.
23.7 SELF-PROPELLED, PNEUMATIC-TYRED, MULTI-WHEELED (SPPTMW) ROLLERS

23.7.1 Description
The SPPTMW rollers are commercially available rollers. They consist basically of a steel body capable of being ballasted with water or sand etc., mounted on a front and rear set of smooth or limited groove tyres, with flat treads and squared edges, placed to give overlap of the wheel paths of the front and rear wheels. This ensures a complete coverage over the full width of the roller in one pass.

The roller is powered by a diesel engine driving the rear wheels and is fitted with a cabin and dual control for better operator visibility.

The most common rollers used have a total of 11 wheels, 5 front and 6 rear, and a weight of about 11 tonne (unballasted).

On sprayed work it is not essential to use ballasted rollers.

*Figure 23.7 Multi-wheeled roller*

23.7.2 Travelling
(a) Extreme care must always be exercised when travelling, as under certain conditions rollers may be slightly unstable and with the tyres used, especially when affected by precoating oil, make stopping and turning on smooth or wet roads hazardous.

(b) Most of the wear, particularly on the transmission, occurs when rollers are travelling between jobs, due to the constant hard driving. The roller must be stopped immediately if there are signs of the transmission oil overheating. If jobs are more than one hour travelling apart, it is advisable to transport the rollers. Special six-wheel trailers are available for this.

23.7.3 Towing Trailer and Roller
The following special conditions shall apply to the towing of six-wheeled
articulated trailers loaded with self-propelled, multi-wheeled rollers:
(a) These units shall be towed only by a large truck (minimum tare 8.5 tonnes), or equivalent vehicle
(b) Self-propelled, multi-wheeled rollers when transported in this manner must be completely unballasted

23.8 FUEL TRAILER TANKERS/FUEL BULKERS OR TANKERS

23.8.1 Description
(a) The fuel trailer tankers consist of one or two steel cylindrical tanks mounted on a steel chassis with either 2 or 3 single axles depending on the design and capacity.

The single tank trailers are mainly used for bulk transport for aggregate precoating oil.

The two tanks, or dual compartment tank, trailers are mainly used for bulk transport of flux oil and cutter for use with the bitumen sprayer. They are fitted with a flow meter to record the quantity of material being loaded. The pipework is so designed that only either flux oil or cutter can be loaded at the one time.

These fuel trailer tankers have been designed and built to comply with the Dangerous Goods Act for transporting hazardous materials.

(b) Fuel bulkers or tankers
   Description
   These are either a solid chassis or articulated type fitted with purpose built tanks. The tanks have the ability to carry various products as they have several compartments. Capacity varies from 6000 litres to 30 000 litres.

   These units must comply with the Dangerous Goods Act for transporting hazardous materials.

23.8.2 Flowmeter
Flowmeters are designed to operate mainly under pressure but in normal sprayed work operation, the bitumen sprayer loads its flux oil and/or cutter by suction. To avoid damage to the flowmeter mechanism and to obtain accurate recording of the quantities, minimum suction must be applied. The bitumen pump should not exceed 300 rpm when loading flux oil and/or cutter via a flowmeter.

The flowmeter should be checked monthly for accuracy.

23.8.3 Towing
(a) The vehicle and driver come under the jurisdiction of the Inflammable Liquids Act and Regulations – Dangerous Goods Act.
(b) Fuel trailers should be towed only by a large truck.

Figure 23.8  36 000-litre fuel tanker

23.9  HIGHWAY SUCTION CLEANER

The highway suction cleaner used on sprayed work was specially designed for VicRoads to quickly remove, by suction only, aggregate whip-off from roads with high traffic volumes in order to reduce broken windscreens and seal failures. It may also be used on normal maintenance cleaning.

The highway suction cleaner is a mobile self-contained unit which consists of a suction unit and closed hopper mounted on a large truck.

The main features are:

- the truck chassis, cabin and controls
- the auxiliary engine and fan
- the suction hood – 2.5 m wide
- the hopper – approximately 4 m³ capacity
- the filter bag system.

Loose aggregate is removed using suction only and stored in the hopper until the hopper is filled. The unit then travels to the nearest available dump site where the aggregate is tipped off.

In dry conditions, dust nuisance is controlled by using the filter bag system located in the hopper. In damp or wet conditions, little or no dust is created during working and the filter bag system is bypassed.
23.10 TRUCKS

Large trucks with a single steering axle, tandem driving axles and fitted with a 9 to 10 m³ capacity tipping body are used. These trucks can safely tow roller carriers, fuel trailer tankers and heater storages.
23.11 DIMENSIONS AND MASS OF PLANT ITEMS

Table 23.11 lists the approximate overall dimensions and mass of the items of plant commonly used or towed.

Table 23.11  Approximate Overall Dimensions and Mass of Plant Commonly Used or Towed

<table>
<thead>
<tr>
<th>Plant</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Height (m)</th>
<th>Tare (kg)</th>
<th>Gross (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen road tanker – 24 000 to 26 000 litre</td>
<td>15.00</td>
<td>2.50</td>
<td>3.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bitumen sprayer – 4 500 litre</td>
<td>8.00</td>
<td>2.50</td>
<td>3.45</td>
<td>11950</td>
<td>20000</td>
</tr>
<tr>
<td>Bitumen sprayer – 5 200 litre</td>
<td>8.00</td>
<td>2.50</td>
<td>3.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregate Loader</td>
<td>8.40</td>
<td>2.30</td>
<td>3.30</td>
<td>8560</td>
<td>–</td>
</tr>
<tr>
<td>Rotary Road Broom</td>
<td>5.50</td>
<td>2.50</td>
<td>1.55</td>
<td>1780</td>
<td>–</td>
</tr>
<tr>
<td>SPMW Roller</td>
<td>4.50</td>
<td>2.10</td>
<td>3.10</td>
<td>5900</td>
<td>15 000</td>
</tr>
<tr>
<td>SPMW Roller Carrier</td>
<td>8.85</td>
<td>2.50</td>
<td>1.30</td>
<td>3610</td>
<td>13 800</td>
</tr>
<tr>
<td>Fuel Trailer Tanker</td>
<td>7.35</td>
<td>2.40</td>
<td>2.55</td>
<td>3000</td>
<td>7500</td>
</tr>
<tr>
<td>Truck – Various types</td>
<td>6.75 to 7.25</td>
<td>2.35 to 2.50</td>
<td>2.10 to 2.80</td>
<td>3150 to 9510</td>
<td>6 550 to 21 000</td>
</tr>
</tbody>
</table>