Foreword

The Australian Asphalt Pavement Association (AAPA) has prepared this Code of Practice as an aid to promoting best practice in the manufacture, storage, transport, handling and application of polymer modified binders.

A significant difference between Polymer Modified Binders (PMBs) and conventional bitumen is the need for additional care in handling to ensure that effectiveness of the polymer is not reduced by overheating, contamination, or other degradation during storage and transport.

Procedures contained in this Code of Practice are intended to provide assurance to end users of consistent quality of hot PMB materials produced in a controlled manufacturing environment. Field produced crumb rubber mixtures are excluded. Specific requirements for polymer modified bitumen emulsions are also excluded as issues of temperature degradation do not apply to the manufactured product.

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AAPA is a non-profit organisation formed to promote the economic use of asphalt based on sound technical grounds. The Association’s Mission Statement for Research and Development is to ensure the attainment of the optimum level of quality and long-term performance in flexible pavement design, construction and maintenance. The AAPA Technology Committee manages the AAPA R&D Program for Asphalt Research and Technology and works in close cooperation with the Austroads Pavement Reference Group. The research programs are coordinated and complementary.

Reproduction of extracts from this publication may be made subject to due acknowledgement of the source.

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CODE OF PRACTICE:
POLYMER MODIFIED BINDERS

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1. **INTRODUCTION**

This Code of Practice has been prepared by the manufacturers of Polymer Modified Binders (PMBs) to:

- Provide guidelines for the manufacture and handling of hot PMBs.
- Provide assurance to end users of the consistent manufacturing quality of delivered products.
- Reduce the potential for degradation due to incorrect handling or heating during the delivery, storage and application processes.

PMBs generally consist of a blend of road grade bitumen and polymer. In some cases, combining agents and other additives are added to the base bitumen to assist in blending and achievement of particular performance characteristics. In addition to the normal safety, quality and environmental considerations involved in handling hot bituminous materials, the manufacture of PMBs requires:

- Accurate blending of materials and control of manufacture to ensure that the products conform to stated specifications.
- Monitoring and control of temperature at all phases of manufacture, storage, transport and field usage to avoid premature deterioration of polymers at high temperatures.
- Maintaining homogeneity of some mixtures that may segregate in storage.
- Avoiding contamination with other products that may alter performance characteristics of the product.
- Use of compatible procedures for cutting back sprayed seal binders.
- Observing recommended maximum temperatures to avoid fuming.

A number of different organisations may be involved in the manufacture, sampling and testing, transport and application of PMBs. Control throughout the process needs to be coordinated and responsibility accepted by the various organisations.

This guide is intended to be complementary to the following publications:

- AAPA HS&E Guide No 5: Guide to the safe use of SBS
- Austroads Specification Framework for Polymer Modified Binders, AP-T04 (or successor)
- Austroads Guidelines for the Selection and Use of Polymer Modified Binders (in course of preparation)
- Austroads Modified Binder Test Methods
- AAPA Advisory Note 7: Guide to the Selection, Heating and Storage of Binders for Sprayed Sealing and Hot Mixed Asphalt
- Australian Dangerous Goods Code

Other relevant publications include Austroads Guides, Technical Reports and Pavement Work Tips. A full list of references is provided at the end of the document.
2. MANUFACTURE

2.1 General
The manufacturer shall establish, document and maintain a Quality System to ensure that the products supplied conform to the stated specifications. The Quality System shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control the quality of the finished product. A Quality System conforming to the requirements of ISO 9001 and made specific to the requirements of the Austroads Specification Framework for Polymer Modified Binders and the AAPA Guide to the safe use of SBS, is considered to satisfy the above requirements.

The results of inspections, tests or assessments requiring action shall be recorded, as shall any action taken. The action to be taken when control values or criteria are not met shall be recorded and retained for the period specified in the manufacturer's quality procedures.

2.2 Equipment
Testing - all laboratory weighing, measuring and testing equipment shall be calibrated and regularly inspected according to documented procedures, frequencies and criteria.

Manufacturing - all equipment used in the manufacturing process shall be regularly inspected, calibrated and maintained to ensure use, wear or failure does not cause inconsistency in the manufacturing process.

Inspections and maintenance shall be carried out and recorded in accordance with the manufacturer's written procedures, and the records retained for the period defined in the manufacturer's quality procedures.

2.3 Manufacturing process
2.3.1 Overview
A general flow diagram for the process of manufacture of polymer modified binder is shown in Figure 1. Further notes on the requirements for each element of the manufacturing process are described in the following sections.
2.3.2 Bitumen supply and storage

Bitumen is generally supplied in accordance with AS 2008. Systems shall apply to monitoring of quality, e.g supplier certificate of compliance, and storage conditions. Systems shall identify procedures for assessing the influence of changes in source of bitumen materials on the required proportions of other component materials and/or properties of the manufactured polymer modified binder.

2.3.3 Combining agent

Combining agents are generally proprietary products. All combining agents shall comply with the AAPA Guide to the safe use of SBS. Acceptance criteria and storage conditions for combining agents shall be documented.

Most modified binders are sufficiently stable at normal processing and application temperatures (i.e. below 200°C). However, the inclusion of process oils and additives coupled with higher temperatures than normally used with conventional bitumen can produce a noticeable increase in fuming. The manufacturer's recommendations should be followed for each product to ensure fuming is minimised.

It is the responsibility of the manufacturer to exclude the use of ingredients that have known adverse health effects. Similarly it is the responsibility of the user to ensure that all relevant safety precautions are followed as set out in the supplier's MSDS. In any event workers must not be exposed to fume levels in excess of the current appropriate standard.

2.3.4 Polymer

The common generic polymer types used for the manufacture of PMBs specified in the Austroads Framework Specification for Modified Binders are Styrene Butadiene Styrene (SBS), Polybutadiene (PBD), Ethylene Vinyl Acetate (EVA), and Ethylene Methacrylate (EMA). These materials are generally proprietary products that are manufactured to strict quality standards. Experience has shown that a supplier certificate of compliance provides adequate verification of quality.

The acceptance criteria for other incoming raw materials, such as crumb rubber, shall be documented, as shall the inspection scheme for ensuring their conformity. Crumb rubber shall comply with the provisions of the Austroads Framework Specification for Modified Binders.

2.3.5 Pre-blending

Where components are required to be pre-blended, procedures shall be established and documented for proportioning, mixing and storage of the blended material.

2.3.6 Mixing

Component materials must be thoroughly mixed to ensure a homogeneous material. The design of mixing equipment varies considerably depending on the type of polymer modified binder being manufactured. Critical elements, common to all processes, are procedures for proportioning of materials, temperature control, mixing time and conditions, and maintenance and cleanliness of equipment.

2.3.7 Storage of finished product

 Tanks for the storage of finished product should be designed for minimum deterioration in storage, including strict control of temperature, minimal surface area for potential oxidation, and mixing or circulating equipment to ensure that the product remains homogenous in storage. While PMBs are
generally manufactured for immediate delivery, any extended storage must be documented and monitored to ensure product conforms to the specified characteristics.

2.3.8 Testing and release of product
Requirements for product testing and treatment of non-conforming product are outlined in Sections 2.4, 2.6 and 3.2.

2.3.9 Loading gantry
All supply lines throughout the plant, including loading equipment, shall be designed and procedures established so as to avoid contamination during change of product or cleaning of supply lines. The use of oils such as kerosene, diesel, or gas oil for flushing lines shall be avoided. Where lines need to be flushed, it should be done with hot bitumen or finished product. Any oils used for flushing or cleaning of supply lines should be collected and disposed of separately and must not be added to products or components in storage or delivery vehicles.

2.4 Product testing and evaluation
The manufacturer shall establish procedures to ensure that conformance to the specified characteristics is maintained. The means of control are:

a) All PMB characteristics shall be determined using the tests and test frequencies shown in Table 1 or Table 2, as appropriate;
b) Routine control of product quality shall be on a basis of checks, of a type and frequency to be defined and documented, to ensure that properties do not change significantly from those specified.

NOTES:
1. Where testing is required on each batch, a batch is considered to be the quantity of binder produced and stored in one tank once the production run into that tank has been completed. The batch can be considered to remain the same as long as no new production has been added.
2. The manufacture shall establish manufacturing targets for all test properties. Manufacturing targets may be different to specification limits.

2.5 Temperature
The manufacturer shall establish guidelines for the heating and storage of PMBs to avoid fuming or degradation of binders in the manufacturing process, supplier storage, transport, user storage and application. Guidelines shall include the range of application temperatures, the maximum holding time at the maximum application temperature, the recommended storage temperature and the maximum time that materials may be held at the recommended storage temperature.

A summary of manufacturer’s information is published in AAPA Advisory Note 7 - Guide to the Selection, Heating and Storage of Binders for Sprayed Sealing and Hot Mixed Asphalt. Manufacturers shall ensure that agents and users are provided with current guidelines if these have changed since publication pending updating and re-issue of AAPA Advisory Note 7.

2.6 Non-conforming products
The manufacturer shall have written procedures that specify how non-conforming products shall be dealt with. Any such events shall be recorded as they occur and these records shall be kept for the period defined in the manufacturer's written procedures.
3 SAMPLING AND TESTING

3.1 Sampling

All materials shall be sampled in accordance with Austroads Polymer Modified Binder Test Method MBT 01 – Method of sampling polymer modified binders, polymers and crumb rubber.

MBT 01 provides for:

- Sampling of raw materials (polymer and crumb rubber)
- Sampling of PMBs:
  - From bulk storage
  - During loading
  - From rail and road tankers
  - From sprayers
  - From drums.

It is important to ensure that samples collected are truly representative of the material being sampled. The material should be thoroughly circulated prior to sampling to ensure it is homogeneous.

All storage tanks, road tankers and bitumen sprayers used for the storage, transport or spraying of PMBs shall be fitted with a sampling valve to facilitate sampling in accordance with MBT 01. Sampling valves shall be situated in a convenient and safe location for sampling and a permanent platform attached to support the sampling container during filling. The sample container should be placed in a safe location and allowed to cool.

Generally the size of the sample should be about 1L when sampling in the field. The container must be made of metal, new, clean and dry and fitted with a tight fitting lid.

All sampling shall be undertaken by properly trained and qualified personnel. The AAPA Training Module on Sampling of Materials, which is relevant to the new training packages for Civil Construction Certificate III – Bituminous Surfacing, should be used as a guide to national competency training and assessment standards.

Sampling should be accompanied by a visual check for uniformity, texture or unusual odour. Any unusual observation should be recorded on the sample container.

The following information shall be provided with the sample, either on the label or an accompanying form (see MBT01 for full requirements):

- Designation or classification of the material being sampled
- Identification mark
- Name of supplier / manufacturer
- Date, time and location of sampling
- Type, batch number and identifying number of container, vehicle or storage tank from which the sample was taken
- Quantity of bulk material being sampled
- Temperature of material being sampled
- Name of sampler
- Any other comments
Figure 2  Example of sample label

All samples shall be handled in accordance with Austroads Polymer Modified Binder Test Method MBT 02 – *Method for handling polymer modified binders in the laboratory.*

### 3.2 Laboratory Testing

Laboratory testing shall be undertaken in a NATA accredited facility and in accordance with Austroads Polymer Modified Binder Test Methods.

The types of test and minimum frequency of testing shall be in accordance with Tables 1 and 2 of the Austroads Specification Framework for Polymer Modified Binders (AP-T04) or as agreed between the supplier and the purchaser. Minimum testing frequencies specified in AP-T04 are summarised in Tables 1 and 2 below.

#### Table 1. Test Frequency for Polymer Modified Binders for Sprayed Sealing Applications (from APT-04)

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Binder Property</th>
<th>Minimum Testing Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 21 Elastic Recovery, Consistency and Stiffness of PMBs</td>
<td>Consistency at 60°C (Pa.s)</td>
<td>3-monthly (2)</td>
</tr>
<tr>
<td>MBT 21 Elastic Recovery, Consistency and Stiffness of PMBs</td>
<td>Consistency at 45°C (Pa.s)</td>
<td>3-monthly (2)</td>
</tr>
<tr>
<td>MBT 21 Elastic Recovery, Consistency and Stiffness of PMBs</td>
<td>Stiffness at 15°C (kPa)</td>
<td>3-monthly (2)</td>
</tr>
<tr>
<td>MBT 41 Determination of Rubber Content in Crumb Rubber Binders</td>
<td>Rubber Content by analysis (%)</td>
<td>Weekly (3)</td>
</tr>
<tr>
<td>MBT 32 Compressive limit of Polymer Modified Binders</td>
<td>Compression limit at 70°C, 2kg (mm)</td>
<td>3-monthly (3)</td>
</tr>
<tr>
<td>MBT 21 Elastic Recovery, Consistency and Stiffness of PMBs</td>
<td>Elastic Recovery at 60°C, 100s (%)</td>
<td>3-monthly (4)</td>
</tr>
<tr>
<td>MBT 21 Elastic Recovery, Consistency and Stiffness of PMBs</td>
<td>Elastic Recovery at 15°C, 100s (%)</td>
<td>3-monthly (4)</td>
</tr>
<tr>
<td>MBT 24 Toughness of PMBs (ARRB Extensometer)</td>
<td>Toughness at 4°C, 100 mm (N/m)</td>
<td>3-monthly (2)</td>
</tr>
<tr>
<td>MBT 11 Handling Viscosity of PMBs (Brookfield Thermosel)</td>
<td>Viscosity at 165°C (Pa.s)</td>
<td>Each Batch</td>
</tr>
<tr>
<td>MBT 12 Flash Point of Polymer Modified Binders</td>
<td>Flash Point (°C)</td>
<td>Annually</td>
</tr>
<tr>
<td>MBT 03 Pre-treatment &amp; Loss on Heating of Bitumen, Multigrade and Polymer Modified Binders</td>
<td>Loss on heating (% mass)</td>
<td>Annually</td>
</tr>
<tr>
<td>MBT 22 Torsional Recovery of Polymer Modified Binders</td>
<td>Torsional Recovery at 25°C, 30s (%)</td>
<td>Each Batch (5)</td>
</tr>
<tr>
<td>MBT 31 Softening Point of Polymer Modified Binders</td>
<td>Softening point (°C)</td>
<td>Each Batch (5)</td>
</tr>
<tr>
<td>MBT 08 Segregation of Polymer Modified Binders</td>
<td>Segregation (%)</td>
<td>Each Batch (5)</td>
</tr>
<tr>
<td>MBT 09 Ease of Remixing of Polymer Modified Binders</td>
<td>Ease of Remixing (%)</td>
<td>Each Batch</td>
</tr>
<tr>
<td>Other</td>
<td>Other as proposed by supplier</td>
<td>(e.g. Penetration, Ductility Recovery)</td>
</tr>
</tbody>
</table>
Table 2. Test Frequency for Polymer Modified Binders for Asphalt Applications (from APT-04)

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Binder Property</th>
<th>Minimum Testing Frequency (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 21</td>
<td>Elastic Recovery, Consistency and Stiffness of PMBs</td>
<td>Consistency at 60°C (Pa.s)</td>
</tr>
<tr>
<td>MBT 21</td>
<td>Elastic Recovery, Consistency and Stiffness of PMBs</td>
<td>Consistency at 45°C (Pa.s)</td>
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<tr>
<td>MBT 21</td>
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<td>Stiffness at 25°C (kPa)</td>
</tr>
<tr>
<td>MBT 24</td>
<td>Toughness of PMBs (ARRB Extensometer)</td>
<td>Toughness at 4°C, 100 mm (Nm)</td>
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<tr>
<td>MBT 11</td>
<td>Handling Viscosity of PMBs (Brookfield Thermosel)</td>
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</tr>
<tr>
<td>MBT 12</td>
<td>Flash Point of Polymer Modified Binders</td>
<td>Flash Point (°C)</td>
</tr>
<tr>
<td>MBT 05</td>
<td>Pre-treatment &amp; Loss on Heating of Bitumen, Multigrade and Polymer Modified Binders</td>
<td>Loss on heating (% mass)</td>
</tr>
<tr>
<td>MBT 22</td>
<td>Torsional Recovery of Polymer Modified Binders</td>
<td>Torsional Recovery at 25°C, 30s (%)</td>
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<tr>
<td>Other</td>
<td>Other as proposed by supplier</td>
<td>(e.g. Penetration, Ductility Recovery)</td>
</tr>
</tbody>
</table>

Notes to Tables 1 and 2:
1. Testing frequencies provided are suggested minima and will usually apply when product has proven compliance to the stated specification limits. Different testing frequencies may be agreed between the purchaser and the supplier.
2. For sprayed sealing classes S10E and S20E, this minimum testing frequency shall be 1 monthly.
3. Crumb rubber mixtures only.
4. Sprayed sealing classes S25E, S45R and S55R only.
5. Torsional Recovery and Softening Point are used as the “Point of Delivery” control properties.
6. To assist the binder user determine the quantity of added cutter oil required for spraying, the manufacturer must report on the effective concentration and type of process oil used in the formulation of crumb rubber mixtures.

3.3 Tracing Properties of Delivered Materials

Experience and testing has shown that often any non-compliance in specified properties is due to degradation during transport, reheating, cleaning transfer lines and application procedures. From time to time protocols may be established for monitoring the properties of materials at the point of delivery or application. A flow chart of sampling, recording and testing is shown in Figure 2. These procedures may be used:

- As a project for the development and verification of handling protocols. Such projects may be conducted in association with a particular client, (e.g. state road authority).
- To maintain product traceability. In this case field samples are not tested, but held in storage for reference testing for compliance with contract conditions. Samples are generally retained for the duration of the contract defects liability period.

In order to provide adequate traceability, delivery docket for PMBs should generally contain the following information:

- Date
- PMB Grade
- Origin
- Sampling point
- Manufacturing certificate number or batch number
- Customer
- Customer order number, etc.
- Delivery details (delivery point, time and temperature)
• Loading information (date, time, temperature)
• Quantity/Mass of delivery
• Product heating information (heating start time, finish time, total heating time and temperature)
• Delivery date, time and temperature.

Sampling and labelling of samples shall be undertaken in accordance with Section 3.1.

Figure 3  Sample traceability flow chart
3.4  Material Safety Data Sheet (MSDS)

MSDS must comply with WorkSafe Australia Code of Practice: “Preparation of Material Safety Data Sheets”. The supplier arranges the preparation of the MSDS, and it is the primary source of safe handling advice for both blending and application and should:

- Address the safety of both personnel and the physical environment.
- Provide an indication of each class of fumes that may be generated at application temperatures, and the maximum Time Weighted Average (TWA) exposure level of each of the fume groups. Exposure is limited to the lowest maximum TWA value.

The manufacturer/supplier will be liable for the consequences of negligently incorrect information or deliberate omission of known facts.

The user is liable for the consequences of incorrect product use or application techniques, and has an overriding responsibility to ensure that work practices minimise exposure to fumes and contact with product.

4  TRANSPORT, STORAGE AND APPLICATION OF PMBs

4.1  General handling and safety requirements

PMBs are transported and applied hot. Safety and handling procedures that are applicable to hot bituminous materials also apply to PMBs and are described in detail in the Austroads Bitumen Sealing Safety Guide.

Topics that are referred to in the Austroads Guide include:

- Bitumen work hazards
  - skin contact
  - fire and explosion hazard
  - fume and vapour hazard
  - foaming in presence of water
  - checking of handling equipment
  - environmental safety
- Safety of personnel
  - training requirements
  - personal safety equipment
  - personal hazards
  - personal hygiene
- First Aid
  - bitumen burns
  - resuscitation
- Fire fighting
  - fire prevention
  - fire fighting equipment and deployment
- Site arrangements
- Handling, transfer and blending
  - handling
- transfer – loading and pumping
- blending

• Heating
• Cleaning
• Procedures for product changeover
• Sampling from tankers
• Safe handling of packages and drums
• Special requirements for PMBs
• Sealing work.

4.2 Special requirements for PMBs

In addition to the general handling and safety procedures applicable to all bituminous materials, attention shall be paid to those issues that have the potential to cause a reduction in the quality and effectiveness of PMBs. These include:

• Effect of excessive temperatures, extended periods of storage at elevated temperatures, and/or multiple reheating cycles.
• Potential for contamination during change of product in transportation vehicles and storage tanks.
• Potential for contamination with materials used for cleaning and flushing supply lines.
• Potential for some PMB mixtures to segregate in storage.
• Method of reheating, e.g. need to recirculate product while reheating.

As a further confirmation that PMBs have not suffered undue deterioration during transport samples may be required of the product at the point of delivery or immediately prior to use in asphalt mixtures or sprayed sealing work (see Section 3.3).

4.2.1 Temperature

PMBs shall not be heated to, stored or held at temperatures or for periods greater than that recommended by the manufacturer. Holding and storage times shall be calculated as the aggregated sum of all periods following completion of manufacture. Adequate records shall be kept of temperatures, transport, storage and holding times to ensure that the allowable cumulative time is not exceeded (see also Section 4.2.6).

Unless otherwise advised by the manufacturer, AAPA Advisory Note 7 shall be taken as a guide to the maximum application temperature, holding time at maximum application temperature, storage temperature and maximum time at recommended storage temperature.

PMBs shall never be heated to a temperature greater than the recommended maximum application temperature. Generally, only the quantity required for immediate use should be heated to the application temperature and reheating avoided, where practicable.

4.2.2 Moisture

The presence of even small quantities of water can cause foaming and “boil-over” of hot PMB. Care shall be taken to ensure that road tankers, storage tanks or bitumen sprayers are free from water arising from bitumen emulsion products or condensation. A visual check for condensation should always be made where tanks have been out of service for some time.
4.2.3 Cleaning materials

Where possible, flushing of lines and tanks shall be done with the same material as that used as a combining agent in the manufacture of PMBs. Where that is not practicable, diesel or gas oil may be used.

The use of kerosene and similar low boiling point petroleum fractions should be avoided except where PMB is to be used for sprayed sealing as described below. In all other cases, the amount of cleaning material shall be kept to a minimum and drained from tanks and delivery lines for separate disposal in accordance with local requirements. Cleaning materials must never be flushed into binder storage tanks or delivery vehicles.

Kerosene or other types of approved cutter oil used for cleaning delivery lines may be drawn into bitumen sprayers where the PMB is being prepared for spraying. An allowance for the quantity of cutter oil used for cleaning must be made in determining the total quantity of cutter oil to be added.

4.2.4 Segregation

Some PMB types are susceptible to segregation in transport and storage. Manufacturers shall advise users of susceptible materials and provide guidelines for minimising segregation and/or remixing. Users shall adhere to manufacturer’s guidelines where applicable.

4.2.5 Loading of delivery vehicles

Vehicles used to transport PMBs shall be emptied of the previous product to the minimum practical level and be clear of cleaning materials before loading.

Vehicles previously used for delivery of cutback bitumen or bitumen emulsion products shall not be used for the delivery of PMB unless thoroughly cleaned, e.g. at least one load of hot bitumen has been put through the tanker to remove traces of other products. Similarly, traces of PMB should be removed by a series of loads of hot bitumen before delivery of bitumen for bitumen emulsion manufacture and other specialised bitumen uses such as foamed bitumen and the manufacture of aggregate precoating materials. Risk of subsequent product contamination is particularly high when vehicles have been used to transport crumb rubber modified binder. It is recommended that crumb rubber modified binders be transported only in dedicated tankers. Care shall be taken to ensure that tankers that have not been in use for some time are free from condensation.

4.2.6 Reheating during transport

Delivery vehicles can generally transport materials for periods of up to 4 to 6 hours with only a minor loss in temperature, usually no more than about 15°C. Where there is only a small loss in temperature, PMBs may be transferred directly into storage tanks without reheating or, where the PMB is required to be at an application temperature, for example delivery direct to sprayed sealing operations, they may be reheated in the delivery vehicle prior to transfer into the bitumen sprayer.

Where longer transport times and greater loss of temperature are involved, materials should be periodically reheated to ensure that temperature is maintained within the recommended limits. For convenience, this may be done in conjunction with regular rest stops.

The following points should be noted when reheating PMBs:

1. At no time shall the recommended maximum temperature for the material be exceeded and it must never exceed 200°C.
2. Bitumen road tankers or sprayers fitted with open flame burners should never be heated while in motion.
3. Drivers must be in attendance and monitor the process at all times while burners are in operation.
4. To avoid PMB degradation, the rate of heating should be limited to an increase in temperature of not more than 15°C per hour.
5. Tankers must be circulated during heating and for at least 20 minutes after heating and before discharge.
6. Generally, temperature checks should be undertaken every four hours and reheating applied when the temperature drop is greater than 15°C.
7. For crumb rubber modified binders, with 15% or higher rubber content, temperature checks should be made at intervals not exceeding 3 hours and temperature maintained between 185°C and 195°C. Crumb rubber modified binders should be circulated continuously during transport and heating.

4.2.7 Delivery into storage tanks or bitumen sprayers

(a) Asphalt plants and other fixed storage

Where a PMB is placed in a storage tank previously used for straight bitumen, multigrade bitumen or a different grade of PMB, the tank shall be emptied to the minimum practicable level in order to minimise any dilution effect on the polymer content of the delivered PMB. Where the residual contents of a storage tank comprise a different grade of PMB or other modified binder, the manufacturer’s advice shall be sought on any potential incompatibility with the fresh product.

Table 3 provides a guide to the relative risk of a reduction in subsequent performance of products due to contamination from previous tank contents.

<table>
<thead>
<tr>
<th>Previous tank contents</th>
<th>Product being delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cutback bitumen</td>
</tr>
<tr>
<td>Cutback bitumen</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Bitumen emulsion</td>
<td>See note 3</td>
</tr>
<tr>
<td>Bitumen</td>
<td>Medium</td>
</tr>
<tr>
<td>Low modification PMB</td>
<td>Medium</td>
</tr>
<tr>
<td>High modification PMB</td>
<td>Medium</td>
</tr>
<tr>
<td>Crumb rubber bitumen</td>
<td>See Note 4</td>
</tr>
</tbody>
</table>

Notes to Table 3

1. Risk profile:
   - Low – Residual tank contents have a low risk of performance impact on the product being added, for example topping up of modified binder with hot bitumen may enhance rather than detract from normal use of bitumen.
   - Medium – While residual tank contents may not have a major impact on performance of added product, tank levels should generally be reduced to minimum levels before adding new materials.
High – Reduction of tank contents to minimum level is essential. Low levels of contamination may be tolerated but generally not more than 10% of diluting product.

Very high – Contamination could have a serious impact on performance. Preferably, the tank should be completely emptied prior to adding new materials. Where complete emptying is not practicable, risk must be reduced by flushing the tank with a more compatible material or using the tank, for example, with a load or part load of hot bitumen or PMB in an application where the performance properties of the PMB are not critical.

2. Storage of bitumen emulsion in tanks previously used for hot bitumen products usually requires the tank to be completely emptied and cleaned before adding bitumen emulsion.

3. Hot bituminous materials must not be added to tanks previously used for bitumen emulsion unless all traces of moisture have been removed.

4. Care must be used in adding materials to tanks that have been used for storage of crumb rubber modified binder. Usually a series of loads of hot bitumen or hot cutback bitumen are required before use for any other critical application.

(b) Road tankers, mobile storage tanks, and bitumen sprayers used for sprayed sealing work

Road tankers, mobile storage tanks or bitumen sprayers previously used for fluxed or cutback bitumen shall be totally emptied before filling with PMB (see also Section 4.2.5).

4.2.8 Field sampling

Field samples shall be taken at locations and frequencies specified in the Austroads Specification Framework for Modified Binders or as agreed between supplier and purchaser. All sampling and testing shall be done in accordance with the procedures described in Section 3.

Field samples shall be clearly identified to provide traceability from supplier to the point of sampling. Unless otherwise specified or directed, field samples are not required to be tested immediately and shall be stored in sealed containers in a secure location for a minimum period of six months, or for the duration of the contract defects liability period, whichever is the greater. Samples not required for further testing beyond that period may then be discarded.

5 ASPHALT WORK

5.1 General

PMBs for asphalt work shall be transported, transferred and stored in accordance with Section 4.

5.2 Use of PMBs

Modified binders may be used in all types of asphalt. PMB may be used to meet specific requirements and to improve service performance. Appropriate selection of modified binder can provide effective improvement in:
• rut resistance
• fatigue resistance
• aggregate retention
• resistance to high traffic stress (turning movements) and
• increased life of open graded asphalt.

Moderate improvement can also be expected in:
• crack control
• stiffness (possible reduced layer thickness, certain polymer types only)
• moisture sensitivity.
Binder is only one part of an asphalt mix, and therefore the performance properties of any modified binder asphalt will also depend on the aggregate components and mix design.

5.3 Mix Design

5.3.1 Dense Graded Asphalt

The design of dense graded asphalt mixes with modified binder follows standard procedures. Reference should be made to “Selection and Design of Asphalt Mixes: Australian Provisional Guide” (APRG 18). The guide provides detailed notes to the application of test procedures as well as suggested criteria for various performance applications.

The direct substitution of modified binder for bitumen will often result in slightly higher air voids due to reduced workability of more highly modified binders. Typically, around 0.3% extra binder may be required to achieve the same compacted air voids in the same mineral aggregate combination.

Improved durability and increased resistance to fatigue of asphalt mixes can be obtained by the use of modified binders. An addition of an extra, say, 0.5% of binder, without changing aggregate grading, will reduce air voids by up to 1%. The lower air voids may be of no concern, and even desirable, for some applications. The presence of the polymer reduces the tendency for further compaction under traffic or bleeding in hot weather as might occur with higher proportions of conventional bitumen.

5.3.2 Open Graded Mixes

Australian practice has generally been to design open graded mixes based on experience for binder type and content, largely based on field performance. AAPA has developed procedures as a guide to the selection and design of open graded asphalt. (Implementation Guide IG-1, Open Graded Asphalt Design Guide).

5.3.3 Stone Mastic Asphalt

AAPA has developed procedures as a guide to the selection and design of stone mastic asphalt (Implementation Guide IG-4, Stone Mastic Asphalt Design and Application Guide). The guide refers to test procedures for binder drain-off and mix cohesion (abrasion) which will assist in optimising the use of modified binders or other additives.

5.4 Production of asphalt mixes

Asphalt with PMB can be produced in conventional mixing plants, except that the addition of crumb rubber and other selected granular polymers direct to the asphalt mix can only be done in a batch type pugmill mixer.

Asphalt with pre-blended modified binders should be mixed and handled in accordance with the manufacturer’s recommendations. Such recommendations may refer to mixing temperatures, mixing times and specific measures to minimise heat loss during transit.

Addition of polymers (crumb rubber and EVA) direct to the pug mill mixer should also be in accordance with the manufacturer’s recommendations. Increased mixing times may be required. Mixing temperatures for modified binder asphalt should not exceed the recommended temperatures for conventional binders by more than 10°C. Excessive temperatures will cause fuming and may affect segregation and binder drainage.
Table 4  Typical temperatures for placing and compacting dense-graded asphalt

<table>
<thead>
<tr>
<th>Binder Class</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Softening Point (typical)</td>
</tr>
<tr>
<td></td>
<td>(1200 Pa.s)</td>
</tr>
<tr>
<td>Bitumen</td>
<td></td>
</tr>
<tr>
<td>C170</td>
<td>45</td>
</tr>
<tr>
<td>C320</td>
<td>48</td>
</tr>
<tr>
<td>C600</td>
<td>52</td>
</tr>
<tr>
<td>Multi-grade</td>
<td></td>
</tr>
<tr>
<td>M500/170</td>
<td>55</td>
</tr>
<tr>
<td>M1000/320</td>
<td>60</td>
</tr>
<tr>
<td>PMB</td>
<td></td>
</tr>
<tr>
<td>A10E</td>
<td>97</td>
</tr>
<tr>
<td>A15E</td>
<td>94</td>
</tr>
<tr>
<td>A20E</td>
<td>77</td>
</tr>
<tr>
<td>A25E</td>
<td>58</td>
</tr>
<tr>
<td>A30P</td>
<td>66</td>
</tr>
</tbody>
</table>

Notes:
1. Temperatures are typical of relevant binder classes around the midpoint on the classification range.
2. Polymer modified binders may be mixed and compacted at temperatures that represent a slightly higher viscosity than non-modified binders.
3. Fibres can inhibit drainage at higher temperatures.
4. The AAPA Guide to the safe use of SBS permits a maximum of 165°C to avoid fuming.

5.5 Placement and Compaction

Placement and compaction techniques for modified binder asphalt require additional care to achieve the required riding qualities, compaction and surface finish generally specified. To achieve adequate compaction of mixes with modified binders, the mix temperatures needs to be increased only by about 10°C over conventional bitumen in most cases. Loss of workability on cooling will necessitate greater attention to:

- weather conditions;
- timing of operations;
- rolling patterns and techniques;
- scheduling of deliveries (avoid starts and stops);
- joints (minimise);
- handwork (to be avoided);
- prevention of pick-up on rubber tyred rollers (pre-heat).

Some modified binders emit fumes at high temperatures. Such fumes can lead to eye and throat irritation, or even to headaches and nausea. It is important, therefore, to follow the manufacturer’s recommendations with regard to handling conditions as well as to use personal protective clothing and equipment. The AAPA Guide to the safe use of SBS, AAPA Advisory Notes 7 and 14 and APRG Work Tip 13 and Industry training programs address such issues, and provide a guide to Industry best practice. Further guidelines for the use of PMBs in asphalt are provided in the Austroads Guidelines for the Selection and Use of Polymer Modified Binders.
6 SPRAYED SEALING WORK

6.1 General

PMBs for sprayed seal work shall be stored, transported and transferred in accordance with Section 4.

PMBs are used in sprayed seals to:
- improve aggregate retention
- minimise or delay reflection cracking
- minimise risk of bleeding
- reduce water penetration
- improve shear resistance in high traffic situations
- reduce temperature dependence of properties
- allow early brooming of seals
- extend the life of seals.

Any increase in binder cohesion (internal strength) as a result of polymer modification usually is accompanied by a decrease in binder wetting ability and therefore its ability to adhere to, or retain aggregate. These characteristics require modification to field procedures as described in the following section.

6.2 Field procedures

6.2.1 General handling requirements for PMBs

PMBs are generally handled and applied similarly to C170 bitumen using conventional sprayed sealing equipment, but require increased attention to detail and special consideration of the field construction practices to ensure satisfactory adhesion between the binder and the aggregate. PMBs are more viscous and tend to form a “skin” in cooler weather conditions. In addition to normal good practice, the following procedures should be followed:

- The time available to incorporate the aggregate into a PMB is relatively short. The aggregate spreading and rolling operations must be kept as close as possible behind the sprayer. This may necessitate shorter than usual sprayer runs or additional rolling capacity.
- If using a particular class of PMB for the first time it is advisable to check with the manufacturer about any special handling or application requirements.
- For a SAM or SAMI application the pavement and air temperatures need to be above 20°C, and higher still where wind chill is expected to cool the binder quickly after spraying. Wind chill will cause the binder to “skin” more quickly and this will delay, or prevent, wetting and adhesion.

The exception to this is S35E, which may be used at the lower pavement and air temperatures normally accepted for Class 170 work (approx. 15°C), but only where recommended by the manufacturer.

- The presence of moisture in any form must be avoided. Less risk must be taken in changeable weather conditions. Spraying should only be applied to a dry pavement surface and aggregates should be precoated and dry (at most damp). This may require the aggregate stockpile to be covered with waterproof material.

- Warm and dry weather conditions before and after application of the PMB seal are essential. Wet weather up to a week after application may result in the aggregate stripping. Spraying should not be undertaken if wet weather is predicted within several days after application.
• Adhesion agent must be added to the binder in the sprayer no more than half an hour prior to spraying and the load thoroughly circulated. Exceptions may apply to a few specific ‘heat stable’ adhesion agents known to retain effectiveness after several hours at high temperatures. Such materials must only be used in accordance with the supplier’s recommended maximum temperature and storage times.
• The PMB/aggregate/precoating material/adhesion agent system must be evaluated, well in advance of the work, using both the initial adhesion and plate stripping tests. Check with the manufacturer if unsure of the details.
• Cutter oils may be required, but it is essential to determine their compatibility with the PMB being used. The manufacturer’s recommendations should be followed regarding the type and proportion of cutter oil.
• Some of the more viscous PMBs will require the use of larger spray nozzles; e.g. B6 or B8 nozzles depending on binder viscosity, to ensure a uniform transverse binder application.

6.2.2 Classes of PMB and General Cutting Back Requirements
A general guide to the three most common applications of PMBs, and their general cutting back requirements is shown in Table 5.

<table>
<thead>
<tr>
<th>Classes of PMB and their General Application</th>
<th>Comments &amp; Cutting Back Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Stress Seals – (HSS)</strong> May be divided into 2 main applications:</td>
<td></td>
</tr>
<tr>
<td>a) <strong>Aggregate retention</strong> - On high traffic volume/high speed roads, winding alignments, court bowls and returns in sub-division streets S10E, S40R, some proprietary grades of PBD and PE</td>
<td></td>
</tr>
<tr>
<td>b) <strong>High stress service areas</strong> - turning lanes, turning areas and entry/exit for trucks, rural intersections and roundabouts, very tight radius curves The Classes of PMB suitable for SAM treatments may be used for this type of HSS application, but generally at lower rates of application</td>
<td></td>
</tr>
<tr>
<td>May be used with all aggregate sizes, but generally most effective with 10mm and 14mm in single/single seals, and in the first application of a double/double seal Cut back as for Class 170 bitumen.</td>
<td></td>
</tr>
<tr>
<td><strong>Holding Treatments</strong> Generally used on low traffic roads, &lt; 200 v/l/d and at relatively high rates of application S10E</td>
<td></td>
</tr>
<tr>
<td>Used with 10mm and 14mm aggregate Cut back as for normal Class 170 bitumen, but may require up to 2 additional parts of cutter oil in cooler weather conditions</td>
<td></td>
</tr>
<tr>
<td><strong>Strain Alleviating Membranes (SAM)</strong> S15E, S20E (SBS) S35E (PBD) S45R, S50R (Crumb rubber)</td>
<td></td>
</tr>
<tr>
<td>Used with 10mm and 14mm aggregate Cut back as recommended in Work tip 27</td>
<td></td>
</tr>
<tr>
<td><strong>Strain Alleviating Membrane Interlayer (SAMi)</strong> S25E, S30E (SBS) S55R (Crumb rubber)</td>
<td></td>
</tr>
<tr>
<td>Designed to be covered with asphalt within a few days. Undesirable to include any cutter oil, but may add up to a maximum of 2 parts if necessary to wet the aggregate</td>
<td></td>
</tr>
</tbody>
</table>
A summary of the requirements for cutting back of PMBs is provided in APRG/AAPA Pavement Work Tip No. 27 Sprayed Sealing – Cutting Back of Polymer Modified Binders.

Additional notes on cutting back of PMBs and other sprayed sealing construction practices is provided in the Austroads Guidelines for the Selection and Use of Polymer Modified Binders.

6.2.3 Adhesion Agent
In general, hot PMBs are more viscous and cohesive than conventional bitumen and consequently less able initially to wet and adhere to the aggregate particle. Recommended practice therefore is to add extra adhesion agent to promote bonding with the aggregate particles. Normal practice is to double the concentration of adhesion agent compared to conventional bitumen. In most instances this means about 1% of adhesion agent is added, unless it is supplied in a concentrated form. The adhesion agent selected must be compatible with the type of polymer in the binder and the aggregate precoating material.

6.2.4 Aggregate Precoating
Initial adhesion of PMB to the aggregate particles becomes increasingly difficult with increasing concentrations of polymer. It is important, therefore, to only use aggregate that is of good quality, free from dust, and dry, as well as adhering to recommended cutting practice. This applies to all PMB seals, including those applied on lower traffic volume roads.

Aggregate must be adequately precoated, preferably with a bitumen-based precoat that contains about 1% of adhesion agent. This should ensure both effective initial adhesion and longer term retention of the aggregate.

It is not uncommon for PMB seals, using PMB classes with relatively higher polymer contents, to perform satisfactorily in dry and warm weather but lose a considerable portion of the aggregate during the first wet and/or cold weather as a consequence of inadequate precoating and work procedures.

6.3 Crack and Joint Sealing
Routine pavement maintenance practices sometimes require a compound to fill and seal cracks in spray sealed, asphalt or concrete pavements. The aim is to seal the pavement to prevent water ingress from the surface. A typical problem is the thermal contraction and expansion of the pavements with seasonal and diurnal temperature variations. This movement can exceed the resilience of conventional bitumen when used as a crack sealant and reopen the pavement to water ingress.

Polymer modification of bitumen sealants is often utilised to address this problem, and to impart a greater cohesive strength to the sealant at service temperatures.

The availability of polymer modified crack sealant provides an improved performance option. The practitioner must assess whether the enhanced properties are required and provide an economic solution to this problem. In comparison with conventional cationic rapid setting emulsion, the price of polymer modified sealant can range from a modest increment on the basic price to perhaps three times the base price. The price is dependent on the nature of the polymer, its concentration and the manufacturing process involved.

Cracks and joints may be sealed by a variety of techniques including overbanding, blow/rout and fill.
The following general rules for crack sealing techniques apply:

- development of adhesion to the crack walls is probably the most crucial requirement
- adhesion development will vary in accordance with the pavement type (e.g. granular pavements will generally adhere less readily than asphalt pavements)
- the preparation and cleaning of cracks is important
- viscosity of the sealant applied must be appropriate to the crack width and method of application i.e. low viscosity (free flowing) for thin cracks.
- for filling of cracks there must be an appropriate width to depth ratio for the sealant "plug" to be sufficiently keyed and the strain geometry optimised (width to depth ratio of 1:1 to 1:2)
- expected service life is about three years
- if cracks are seasonal, treat during the season when they are widest (usually winter)
- do not open to traffic prematurely
- the high labour cost component in crack sealing must also be kept in mind
- excessive crack sealing can lead to a loss of skid resistance when cracks are closely spaced.

Where crack sealing is considered to be a temporary treatment, conventional cationic rapid set emulsion and sand may sometimes prove an economically effective strategy.

The success of a crack filling and sealant application is largely dependent on the type and extent of preparation. If the preparation is carried out correctly, the success rate of the sealant can be expected to be satisfactory.

Care is required, particularly when using the overbanding technique or when cracks are closely spaced, not to over apply the sealant as it can lead to a loss of skid resistance and/or adversely affect the standard of sprayed seals applied over the treated crack.

The following procedure should be used to ensure good preparation and application practice:

1. Use compressed air to clear out fine detritus from cracks.
2. If necessary, use brushing or other techniques to remove "locked in" detritus.
3. Ensure the crack is dry.
4. Apply a tack/prime coat and/or preheat the pavement as appropriate to the sealant, and as preparation for a surface stripe.
5. Ensure the tack and/or prime coat is fully dry, if recommended by the manufacturer.
6. Apply the sealant with appropriate equipment to meet manufacturer's instructions.
7. Strike off the excess material to provide a striping. Where required, blind the sealant surface with an appropriate sand or grit. When sealing a joint or routed crack with hot pour material, the sealant surface is left lower than the pavement surface to allow for seasonal thermal expansion.
REFERENCES

AAPA (1998) *AAPA SBS Code of Practice*
AAPA (1998) HS&E Guide No 5 *Guide to the safe use of SBS*
AAPA (1998) Advisory Note 14 – *Summary of SBS Bitumen Fume Monitoring Project*
AUSTROADS (2000) Austroads Specification Framework for Polymer Modified Binders, AP-T04 (or successor)
AUSTROADS (200x) *Austroads Guidelines for the Selection and Use of Polymer Modified Binders* (in course of preparation)

AUSTROADS MODIFIED BINDER TEST METHODS:
- MBT 01 – Method of sampling polymer modified binders, polymers and crumb rubber.
- MBT 02 – Protocol for handling polymer modified binders in the laboratory

AS 2809.5 Road tank vehicles for dangerous goods, Part 5: Tankers for bitumen-based products


AAPA Advisory Notes, HS&E Guides, and Austroads/AAPA Work Tips may be accessed and downloaded, free of charge, from the AAPA Web-site at [www.aapa.asn.au](http://www.aapa.asn.au).

APPENDICES

Advisory Note 7
Work Tip 27
MBT01
MBT02.
A general guide to the selection, heating and storage of bituminous binders used in sprayed sealing and hot mixed asphalt applications is provided in the tables on the following pages. Bitumens produced by refining crude petroleum oil and bitumens modified by the addition of polymeric or other similar materials are included. Although the information provided in the table was correct at the time of publication, potential users of bituminous products are advised to contact suppliers for current information and Material Safety Data Sheets prior to using any particular product. While the tabulated storage times and temperatures are considered acceptable, users are strongly advised to store bituminous materials at the lowest practical temperature and for the shortest possible duration.

Modified Binder Classification System

Polymer Modified Binders (PMBs)
(a) The PMB classification system is based on the application of the binder, the minimum Consistency at 60°C and where appropriate, the predominant polymer group represented in the binder.
(b) Binder systems are coded by application as “S” (for sealing classes) or “A” (for asphalt classes).
(c) Polymer groups are coded as “E” (for elastomeric polymer types), “P” (for plastomeric polymer types) or “R” (for granulated crumb rubber materials). Code E includes SBS (styrene-butadiene-styrene), SIS (styrene-isoprene-styrene), SBR (styrene-butadiene rubber), natural rubber, PBD (polybutadiene), chloroprene and other similar polymer types. Code P includes EVA (ethylene vinyl acetate), EMA (ethylene methacrylate), APP (atactic polypropylene), various forms of PE (polyethylene) and other similar polymer types. Code R includes crumbed rubber, usually from old tyres. The binder may be blended in the sprayer immediately prior to use, or it may be pre-blended in a mixing facility. Where the binder is prepared in the field, the code RF is used.

For example, S45R is a sealing class PMB based predominantly on crumb rubber and designated by its minimum Consistency at 60°C (4,000 Pa.s). Similarly, A20E is an elastomeric asphalt class PMB designated by its minimum Consistency at 60°C (8,000 Pa.s).

Multigrade Binders
The Multigrade binder classification system is based on the approach used in AS2008 for unmodified binders. For example, C600/170 is a multigrade binder with high temperature (60°C) properties of C600 bitumen and low temperature properties (penetration at 25°C) of C170 bitumen.

Guide to the Selection of Sprayed Seal Modified Binders

<table>
<thead>
<tr>
<th>Application</th>
<th>Cracking</th>
<th>Traffic</th>
<th>Binder Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Activity</td>
<td>Width / Severity</td>
<td>Site Severity</td>
</tr>
<tr>
<td>SAMI</td>
<td>All</td>
<td>NA</td>
<td>All</td>
</tr>
<tr>
<td>SAM</td>
<td>Slow</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HSS</td>
<td>Severe</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mod</td>
<td>Heavy</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Adequate Binder
## Guide to the Heating and Storage of Binders for Sprayed Sealing

### Note 1:
Adjustments in temperature at the point of spraying may be required to allow for prevailing conditions, such as pavement temperature and wind speed, but must not exceed 200°C. The listed temperature ranges apply to the binder before the addition of any cutter or other additive. For further information refer to Austroads 'Sprayed Sealing Safety Guide'.

### Note 2:
All polymer modified binders must be stirred prior to use and regularly circulated during storage due to possible polymer segregation.

### Note 3:
Longer storage times apply to lower storage temperatures.

### Note 4:
Dilutions can be produced to meet S10E, S15E, S20E and S25E.

### Note 5:
These products require continuous slow agitation during storage.

### Note 6:
Dilution will meet S35E.

### Table: Binder Temperature at Point of Spraying

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Binder Type</th>
<th>PMB Grade</th>
<th>Temperature at Point of Spraying (°C)</th>
<th>Holding Time at Spraying Temperature</th>
<th>Temperature for Medium-term Storage (°C)</th>
<th>Medium-term Storage Time (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BITUMEN TO AS2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP, Shell (WA only)</td>
<td>Class 50</td>
<td></td>
<td>175 – 185</td>
<td>7 days</td>
<td>130 – 150</td>
<td>30 days</td>
</tr>
<tr>
<td>All bitumen suppliers</td>
<td>Class 170, Class 320</td>
<td></td>
<td>175 – 185</td>
<td>7 days</td>
<td>130 – 150</td>
<td>30 days</td>
</tr>
<tr>
<td>SPECIALTY SEALING BINDERS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bituminous Products Pty. Ltd.</td>
<td>Bitulastic SBS S10E</td>
<td>S10E</td>
<td>190 – 200</td>
<td>2 days</td>
<td>130 – 140</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>Bitulastic SBS S15E</td>
<td>S15E</td>
<td>190 – 200</td>
<td>2 days</td>
<td>130 – 140</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>Bitulastic SBS S20E</td>
<td>S20E</td>
<td>190 – 200</td>
<td>2 days</td>
<td>130 – 140</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>Bitulastic SBS S25E</td>
<td>S25E</td>
<td>190 – 200</td>
<td>2 days</td>
<td>130 – 140</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>Bitulastic SBS S30E</td>
<td>S30E</td>
<td>190 – 200</td>
<td>2 days</td>
<td>130 – 140</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>Bitulastic SBS S35E</td>
<td>S35E</td>
<td>190 – 200</td>
<td>2 days</td>
<td>130 – 140</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>Bitulastic Crumb S40R</td>
<td>S40R</td>
<td>190 – 200</td>
<td>3 days</td>
<td>130 – 160</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>Bitulastic Crumb S50R</td>
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**Note 1:** Adjustments in temperature at the point of spraying may be required to allow for prevailing conditions, such as pavement temperature and wind speed, but must not exceed 200°C. The listed temperature ranges apply to the binder before the addition of any cutter or other additive. For further information refer to Austroads 'Sprayed Sealing Safety Guide'.

**Note 2:** All polymer modified binders must be stirred prior to use and regularly circulated during storage due to possible polymer segregation.

**For storage of binders for periods longer than shown, refer to binder manufacturer.**

**Note 3:** Longer storage times apply to lower storage temperatures.

**Note 4:** Dilutions can be produced to meet S10E, S15E, S20E and S25E.

**Note 5:** These products require continuous slow agitation during storage.

**Note 6:** Dilution will meet S35E.

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**Disclaimer:**
Although the information contained in this Advisory Note is believed to be fundamentally correct, the Australian Asphalt Pavement Association does not accept any contractual tortious or other form of liability for its contents or for any consequences arising from its use. Advice should be sought from suppliers prior to handling, applying or storing products outside the recommended ranges.

**Date of Issue:** August 2003
Guide to the Heating and Storage of Binders for Sprayed Sealing

**Note 1:** Adjustments in temperature at the point of spraying may be required to allow for prevailing conditions, such as pavement temperature and wind speed, but must not exceed 200°C. The listed temperature ranges apply to the binder before the addition of any cutter or other additive. For further information refer to Austroads ‘Sprayed Sealing Safety Guide’.

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---

**Guide to the Selection of Asphalt Modified Binders**

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>SERVICE CONDITION</th>
<th>Binder Class</th>
<th>Note 1</th>
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<td>Traffic</td>
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<td>A15E A20E A25E A30P A27R A40R</td>
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- **RUTTING RESISTANCE**
  - Very heavy: High or Medium
  - Heavy: Low

- **RUTTING & FATIGUE**
  - Very heavy to Heavy: Medium

- **OPEN GRADED ASPHALT**
  - Very Heavy to Heavy: High

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**Adequate Binder**

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continued on page 4
### Guide to the Heating and Storage of Binders for Asphalt

#### BITUMEN TO AS2008

- **All bitumen suppliers**
- **BP, Mobil, Shell**

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Asphalt Binder</th>
<th>Austroads PMB Grade</th>
<th>Binder Temperature (°C) at Point of Mixing</th>
<th>Holding Time at Mixing Temperature</th>
<th>Temperature for Medium-term Storage (°C)</th>
<th>Medium-term Storage Time</th>
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#### SPECIALTY ASPHALT BINDERS

- **Bituminous Products Pty., Ltd.**
- **BP Australia Pty., Ltd.**
- **Mobil Oil Australia Ltd.**
- **Pioneer Road Services Pty., Ltd.**
- **SAMI Pty., Ltd.**
- **The Shell Co. of Australia Ltd.**

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Asphalt Binder</th>
<th>Austroads PMB Grade</th>
<th>Binder Temperature (°C) at Point of Mixing</th>
<th>Holding Time at Mixing Temperature</th>
<th>Temperature for Medium-term Storage (°C)</th>
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</table>

**Note 1:** The temperature at the point of mixing and the holding time at mixing temperature refer to the binder prior to its introduction to the mixing process. Adjustments to temperatures at the point of mixing may be required to allow for prevailing conditions such as pavement surface temperature, wind speed, asphalt mix type and haulage distance.

**Note 2:** All polymer modified binders must be stirred prior to use and regularly circulated during storage due to possible polymer segregation. For storage of binders for periods longer than shown, refer to binder manufacturer.

**Note 3:** Longer storage times apply to lower storage temperatures.
Sprayed Sealing - Cutting Back of Polymer Modified Binders

pavement work tips — no. 27

April 2001

INTRODUCTION
This Work Tip is a summary of the Guide to Sprayed Seal Construction/Cutting Practices for PMBs produced by the Austroads PMB Project Group.

It particularly refers to practices that are different to standard Class 170 bitumen and multigrade bitumen binders. A guide to sprayed seal cutting practice for Class 170 bitumen is provided in Work Tip No. 14. Those guidelines may also be applied to multigrade bitumen.

A major difference in using PMBs (Work Tip No 6) in sprayed sealing work, compared to unmodified bitumen, is that increased binder consistency and poorer wetting characteristics make it more difficult to obtain initial aggregate adhesion. Special attention, therefore, is required to be paid to:

- ambient conditions
- condition and precoating of aggregate
- use of adhesion agents
- speed of covering and rolling
- cutting procedures.

AMBIENT CONDITIONS
Both pavement and air temperature should be above 20°C. Particular care must be taken to avoid wind chilling, causing skinning of the surface, or any form of moisture. If conditions are marginal or doubtful, the work should be deferred until more favourable conditions apply.

Care is required in assessing pavement temperature for selection of cutter proportions, taking into account presence of shaded areas and expected weather conditions in the 24 hours or so following completion of the work. When using 8 parts or more of cutter oil, the risk associated with bleeding in subsequent periods of hot to very hot weather should also be considered.

AGGREGATES
To maximise adhesion, aggregates should be precoated with a bitumen based precoat that contains a minimum of 1% adhesion agent. Aggregates must be clean, dry, and of good quality. A guide to precoating of aggregates is provided in Work Tip No. 23.

ADHESION AGENTS
Adhesion agents (generally double the concentration used for unmodified bitumen) should always be added to hot PMBs used in sprayed sealing work (see also Work Tip No. 23).

COVERING AND ROLLING
Aggregates must be promptly applied uniformly at the design rate and rolled without delay. A guide to rolling of cover aggregates is provided in Work Tip No. 24.

CUTTING PROCEDURES
Type of Cutter Oil
Some PMBs, particularly highly modified types and pre-blended crumb rubber mixtures, require oils of particular compatibility or aromaticity. If in doubt, the manufacturer’s requirements should be checked before using any particular cutter oil or flux oil.

Proportion of Cutter Oil
A guide to proportion of cutter oil for PMBs used in Strain Alleviating Membrane (SAM) and High Stress Seal (HSS) applications is provided in Table 1 (see reverse). Variations in the proportion of cutter oil may apply to PMBs used in aggregate retention and Strain Alleviating Membrane Interlayer (SAMI) applications (refer notes to table).

continued on reverse

pavement work tips is produced by AUSTRoads in conjunction with AAPA
Sprayed Sealing - Cutting Back of Polymer Modified Binders

**TABLE 1: Guide to Cutting Practice for PMBs used in SAM and HSS Applications**

(Parts by volume of cutter oil to be added to 100 parts by volume of PMB-measured at 15°C).  

<table>
<thead>
<tr>
<th>Pavement Temperature (^\circ\text{C})</th>
<th>Traffic (veh/lane/day based on AADT)</th>
<th>Traffic</th>
<th>Class of PMB</th>
<th>Traffic</th>
<th>Class of PMB</th>
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<td></td>
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<td>S20E S25E</td>
<td>S35E</td>
<td>S45R (^5, 6)</td>
<td>S55R (^5, 6)</td>
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</tr>
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<td>39 to 45</td>
<td>&lt;1000</td>
<td>Min 2</td>
<td>Min 3</td>
<td>0-2</td>
<td>4-6</td>
<td>6</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>≥1000</td>
<td>Min 2</td>
<td>Min 3</td>
<td>0-2</td>
<td>4-6</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 45</td>
<td>All</td>
<td>Min 2</td>
<td>Min 3</td>
<td>0-2</td>
<td>Min 4</td>
<td>Min 5</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**NOTES:**

1. In SAMI applications, where the seal is to be covered by asphalt within a short period, it is undesirable to include any cutter oil at all. If cutter oil is considered necessary, it should be a maximum of 2 parts of cutter oil to 100 parts of PMB.

2. In aggregate retention applications using lower levels of polymer modification ie. S10E, S40R, and some proprietary blends of PBD, the binder should be cut back as per normal Class 170 bitumen (Work Tip No. 14).

3. Where cutter proportions are added as percentage of total binder, the proportions shown here as parts per 100 parts of PMB may be taken as a reasonable approximation of percentage by volume.

4. Pavement temperature should generally be based on the worst condition, ie. shaded areas.

5. Pre-blended crumb rubber grades may contain process oil used in their manufacture. This oil will most likely reduce the viscosity compared to field blended grades, and may allow a small reduction, say 2 parts, in added cutter oil compared to field produced grades.

6. At high rates of application of binder (greater than say 2 L/m²) the proportion of cutter oil may be reduced by 2 parts.

**REFERENCES**

Work Tip No. 6 – Polymer Modified Binders

Work Tip No. 14 – Sprayed Seal Cutting Practice

Work Tip No. 23 – Sprayed sealing – Aggregate Precoating

Work Tip No. 24 – Sprayed sealing – Rolling of Cover Aggregate


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For more information on any of the construction practices discussed in "pavement work tips", please contact either your local

AUSTROADS

Pavement Reference Group representative or

AAPA —

tel (03) 9853 3595;

fax (03) 9853 3484;

e-mail:

info@aapa.asn.au

A complete list of "pavement work tips" issues is available on AAPA's

web site:

www.aapa.asn.au

Issues may be downloaded using Adobe Acrobat

Reader. Copies may also be obtained from AAPA.

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This edition was prepared by

John Rebecchi in consultation with members of the

National Bituminous Surfacing Research Group.
Method of sampling polymer modified binders, polymers and crumb rubber

PREFACE

This Modified Binder Test Method was prepared by an APRG Working Group on behalf of AUSTROADS. Representatives of AUSTROADS, ARRB Transport Research and Industry through the Australian Asphalt Pavement Association (AAPA) have been involved in the development and review of this test method.

FOREWORD

Specification limits for polymer modified binders (PMBs) have been set on the basis of a representative sample taken at the point of delivery for use and reheated to enable testing in accordance with the test methods set out by AUSTROADS. The adoption of a uniform and practical sampling method will ensure consistent and reliably representative samples are obtained.

METHOD

1 SCOPE

This test method applies to polymer modified binders, polymers and crumb rubber. Materials are sampled according to this protocol to ensure that correct sampling procedures are followed and that test results provide the required information on consignment quality. The purpose of sampling is to enable subsequent testing to:

(a) Represent, as nearly as practicable, an average of a consignment or batch, or
(b) Detect any variation within a consignment or batch.

2 REFERENCED DOCUMENTS

The following documents are referred to in this test method:
AUSTROADS

• MBT 02 Protocol for handling polymer modified binders in the laboratory

3 SAFETY PRECAUTIONS

Strict precautions shall be taken to avoid injury or fire at all times when handling hot bituminous materials, such as bitumen and polymer modified binders. Such precautions include, but are not limited to, the following requirements:

(a) Eye protection, such as safety glasses and/or face shields, shall be worn while sampling.

(b) Heat-resistant gloves, with close-fitting cuffs, and other suitable protective clothing, shall be worn while sampling and sealing containers.

(c) There shall be no smoking while sampling.

(d) Containers shall not be held in the hand while sampling and sealing. Tongs, or some other device, shall be used to hold the containers while the sample is being taken.

(e) The sampler shall, as far as practical, stand above and away from the sampling valve or outlet and on the windward side.

(f) The sample shall be taken slowly and carefully to prevent splashing of the material.

(g) The container shall be placed on a firm, level surface to prevent splashing, dropping or

4 SAMPLING PRECAUTIONS

The following sampling precautions shall be observed:

(a) Care shall be taken to prevent contamination of the samples with solvents, cleaning fluids, or different types of bituminous materials.

(b) Between sampling and testing, the sample shall not be transferred from one container to another if this involves reheating of the sample after cooling, except as specified in MBT 02.

(c) Where a tin is used, the sample container shall be tightly and positively sealed immediately after the sample is taken.

(c) The sample container shall not be submerged in solvent, nor shall it be wiped with a solvent-saturated cloth. Any spilled materials on the outside of the container shall be wiped with a clean dry cloth immediately after the container is sealed.

5 SAMPLE CONTAINERS
Containers for PMB samples shall be clean, dry, nominal 1 L or 2 L capacity, friction-top cans, unless otherwise specified. Dry polymers and crumb rubber samples may be placed in a closed plastic bag. Where the moisture content of a crumb rubber sample is to be determined, the sample shall be placed in a hermetically sealed container.

6 PROCEDURES

6.1 General

Sampling may be carried out at the point of loading, or at the point of delivery, as appropriate.

6.2 Sample size

The size of the sample shall be at least 1 L or 1 kg, unless otherwise specified.

6.3 Sampling of PMBs

(a) Sampling from bulk storage

The procedure shall be as follows:

(i) The material shall be thoroughly mixed and the sample drawn from a sampling cock in the side of the tank.

(ii) The initial material withdrawn (about 4 L) shall be discarded prior to collection of the sample. It is recommended that the product run-off and any product intended to be discarded be returned to the bulk product to avoid contamination of the environment.

(b) Sampling during loading

The procedure shall be as follows:

(i) When rail tankers, road tankers, sprayers or drums are being filled, the material shall be thoroughly mixed prior to loading. Sampling shall be carried out as the material flows through the pipeline.

(ii) When the material is being discharged under pressure, the sample shall be taken from the discharge line by a suitable sampling cock capable of providing a sufficient flow rate, or from the discharge end of a small filling line.

(iii) When the material is being discharged by flowing under gravity, either the procedure described in (ii) above shall be followed, if the pipeline has a rising section completely filled by the outflowing material and provided the pressure is sufficient, or sampling shall be carried out by taking containers-full of material from the outlet, if the pipeline is not completely filled, or the pressure is not great enough.

(iv) The sample shall be taken from near the middle of discharge.

(v) About 4 L of the initial material withdrawn in each increment shall be discarded. It is recommended that the product run-off and any product intended to be discarded be returned to the bulk product to avoid contamination of the environment.
(vi) The sample shall be transferred without delay to the sample container, allowing at least 5 percent ullage, and the container shall be immediately sealed after filling.

(c) Sampling from rail and road tankers

The procedure shall be as follows:

(i) The material shall be thoroughly mixed and the sample drawn from a sampling cock in the delivery line. The sample shall be taken near the middle of the discharge.

(ii) The initial material withdrawn (about 4 L) shall be discarded prior to collection of the sample. It is recommended that the product run-off and any product intended to be discarded be returned to the bulk product to avoid contamination of the environment.

(iii) Where there is no suitable sampling cock available, a sample shall be taken from near the top of the tanker by lowering a weighted sampling can or thief sampling can, as appropriate, into the material.

(iv) The sample shall be transferred without delay to the sample container, allowing at least 5 percent ullage, and the container shall be immediately sealed after filling.

(d) Sampling from sprayers

The procedure shall be as follows:

(i) The contents of the sprayer shall be thoroughly circulated for at least 15 minutes prior to sampling.

(ii) The sample shall be taken either from the spray bar, or by sampling cock, or by using a weighted can or thief sampling can, as appropriate.

(iii) The initial material withdrawn (about 4 L) shall be discarded prior to collection of the sample. It is recommended that the product run-off and any product intended to be discarded be returned to the bulk product to avoid contamination of the environment.

(iv) The sample shall be transferred without delay to the sample container, allowing at least 5 percent ullage, and the container shall be immediately sealed after filling.

(e) Sampling from drums

The procedure shall be as follows:

(i) A number of drums shall be selected at random, with the number being not less than the appropriate number shown in Table 1.

(ii) The contents of each drum selected shall be mixed thoroughly by turning end over end, rolling and stirring with a rod.

(iii) As the stirring rod is withdrawn, it shall be closely examined for the presence of extraneous matter.

(iv) The sample shall be collected by pouring, or by the use of a pump, or by thief sampling can.
(v) Where the material is known to be from a single production run or batch, the samples may be combined and thoroughly mixed to form a bulk sample, from which a sample of about 1 L shall be drawn for testing. In the case of a small consignment, the sizes of samples shall be increased as necessary to yield a combined sample of at least 1 L.

(vi) The consistency of each sample may be determined to detect variations in the material delivered.

6.4 Sampling of polymers and crumb rubber

(a) Sampling of liquids from drums

The procedure shall be as follows:

(i) A number of drums shall be selected at random, with the number being not less than the appropriate number shown in Table 1.

(ii) The contents of each drum selected shall be mixed thoroughly by turning end over end, rolling and stirring with a rod.

(iii) As the stirring rod is withdrawn, it shall be closely examined for the presence of extraneous matter.

(iv) The sample shall be collected by pouring, or by the use of a pump, or by thief sampling can.

(v) Where the material is known to be from a single production run or batch, the samples may be combined and thoroughly mixed to form a bulk sample, from which a sample of about 1 L shall be drawn for testing. In the case of a small consignment, the sizes of samples shall be increased as necessary to yield a combined sample of at least 1 L.

(vi) The consistency of each sample may be determined to detect variations in the material delivered.

(b) Sampling of solids from packs (drums, bags, or other containers)

The procedure shall be as follows:

(i) A number of packs shall be selected at random, with the number being not less than the appropriate number shown in Table 1.

(ii) From each pack, a sample not less than 100 g in mass shall be taken from at least 100 mm below the surface and at least 100 mm from the side of the pack.

(iii) Where the material is known to be from a single production run or batch, the samples may be combined and thoroughly mixed to form a bulk sample, from which a sample of about 1 L shall be drawn for testing. In the case of a small consignment, the sizes of samples shall be increased as necessary to yield a combined sample of at least 1 L.

(iv) The consistency of each sample may be determined to detect variations in the material delivered.
Table 1 - Number of samples

<table>
<thead>
<tr>
<th>Number of drums or packs in consignment</th>
<th>Number of drums or packs to be sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 10</td>
<td>1</td>
</tr>
<tr>
<td>11 - 50</td>
<td>2</td>
</tr>
<tr>
<td>51 - 100</td>
<td>4</td>
</tr>
<tr>
<td>101 - 200</td>
<td>5</td>
</tr>
<tr>
<td>201 - 400</td>
<td>6</td>
</tr>
<tr>
<td>401 - 700</td>
<td>7</td>
</tr>
<tr>
<td>701 - 1000</td>
<td>8</td>
</tr>
<tr>
<td>Over 1000</td>
<td>8 plus 1 for each 500 drums or packs above 1000</td>
</tr>
</tbody>
</table>

7 LABELLING

Samples shall be securely packed for transport to the testing laboratory and shall be clearly identified by markings on the body and lid of the container. The following information shall be shown on the container, or label:

(a) Designation or classification of the material.
(b) Identification mark.
(c) Date and time of sampling.
(d) Sampling temperature.
(e) Further information required for identification of the samples shall be supplied on a separate sampling form. The additional information shall include the following:
   (i) Name of supplier.
   (ii) Place and date of sampling.
   (iii) Quantity of material represented by the sample.
   (iv) Type, batch number and identifying number of container, or vehicle, from which the sample was taken.
   (v) Name of the sampler.
   (vi) If the sampling procedure (especially temperature) was contrary to the manufacturer's recommended procedure and/or industry guidelines.
(vi) If the sampling procedure (especially temperature) was contrary to the manufacturer's recommended procedure and/or industry guidelines.
Protocol for handling polymer modified binders in the laboratory

PREFACE

This test method was prepared by an APRG Working Group on behalf of the AUSTROADS. Representatives of AUSTROADS, ARRB Transport Research and the Australian Asphalt Pavement Association have been involved in the development and review of this test method.

FOREWORD

Polymer modified binders (PMBs) are heat-sensitive materials and may undergo significant changes to their properties as a result of exposure to high temperatures for extended periods where added polymer can be damaged and/or separate from the PMB dispersion. Improper heating of samples can, therefore, affect the properties of PMBs, resulting in sample test results which may not truly represent the characteristics of the original material.

Recent PMB testing experience, particularly with those binders formulated with SBS polymer at concentrations greater than 3 percent suggest that binder handling prior to testing can contribute significantly to measured binder performance. This laboratory handling protocols reflects the range of approaches to binder handling used in Australian laboratories and includes a reference protocol representing agreed best practice. Where SBS modified binders are tested it is strongly recommended that the reference protocol be adopted. This procedure is also recommended where two laboratories report conflicting results with any PMB.

It should also be noted that the estimates of precision reported by AUSTROADS and included in the 2000 release of the test methods were obtained on binders that were handled using the reference protocol. It is expected that testing precision associated with the other protocols will be degraded, particularly between laboratory reproducibility.

METHOD

1. SCOPE

This test method is based on AS 2341.21 and applies to polymer modified binders (PMBs) which are to be tested in accordance with the test methods set out by AUSTROADS.
2. REFERENCED DOCUMENTS

The following documents are referred to in this test method:

**AS**
- 2341  Methods of testing bitumen and related road making products
- 2341.21 Method 21: Sample preparation

**ASTM**
- E 1 Standard specification for ASTM thermometers

**AUSTROADS**
- MBT 01 Method of sampling polymer modified binders, polymers and crumb rubber

3. PRINCIPLE

The objective of this procedure is to ensure that PMB samples, when tested, are representative of the product used in the field. To achieve this, samples undergo a minimum and controlled amount of heating. Three methods have been adopted for heating the materials during sample preparation. Method one uses a hotplate in conjunction with a pre-heating oven and the second method uses a forced convection oven for the complete heating process. The third method uses a strict sample heating, mixing and subdivision protocol to ensure consistent inter-laboratory practices. Method three is described as the reference method and has been used to derive the measures of method precision where given, for various other AUSTROADS MBTs.

4. APPARATUS

4.1 Hotplate Method

The items of apparatus are as follows:

4.1.1 Essential items

The essential items of apparatus are as follows:

(a) *Conditioning oven* - able to maintain a temperature in the range 130 to 180°C with a setpoint accuracy of at least ± 5°C.

(b) *Hotplate* - able to maintain a surface temperature of no higher than 320°C, or 25 kW/m² for hotplates with switched power settings.

(c) *Pre-heating oven* - able to maintain a temperature of 100 ± 10°C. May be fitted with a timer switch.

(d) *Stirrer* – Flat blade spatula, suitable for the containers used.

(e) *Thermometer* - conventional mercury-in-glass, partial immersion thermometer for hotplate use and oven monitoring, accurate to 0.5°C. A suitable thermometer is IP 61 C or ASTM 16C, as specified in ASTM E 1, for use at around 200°C.

(f) *Mechanical Stirrer* with paddle described in Appendix B

4.1.2 Optional items

The optional items of apparatus are as follows:

(a) *Beaker(s)* - 400 mL to fit heating block (or equivalent container), with suitable lid.

(b) *Heating block* - aluminium block, approximately 150 mm diameter, 100 mm high, with a cavity able to accept 400 mL beakers with a clearance up to 0.5 mm.
(c) **Thermoset hotplate** - able to maintain a temperature in the range 135 - 180°C, with a setpoint accuracy of ± 5°C.

(d) **Temperature Controller** - An alternative to the temperature controlled hotplate is described in Appendix C. This system uses a modern oven temperature controller with Pt100 remote temperature sensor. Better temperature control is provided along with a direct temperature readout. No monitoring thermometer is required.

4.2 **Oven Method** The items of apparatus are as follows:

(a) **Forced convection oven** - able to maintain a temperature in the range 130 - 180°C, with a setpoint accuracy better than ± 5°C.

(b) **Mechanical Stirrer** with impeller described in Appendix B

(c) **Stirrer** – Flat blade spatula, suitable for the containers used.

(d) **Temperature probe** - a suitable probe based on a thermocouple or Pt100 used in conjunction with a corresponding readout device, with an accuracy of ± 2°C. Alternatively, a suitable thermometer (or equivalent) may be used.

4.3 **Reference Method** The items of apparatus are as follows:

(a) **Forced convection oven** - able to maintain a temperature in the range 130 - 180°C, with a setpoint accuracy better than ± 5°C.

(b) **Mechanical Stirrer** with impeller described in Appendix B

(c) **Beaker(s)** - 250 - 300 mL sub-sample containers (4 required for a 1 Litre sample)

5. **PROCEDURES**

5.1 **General** PMBs are complex mixtures of polymers and a variety of petroleum products. If handled in accordance with the directions of the suppliers, there should be no significant risk. The hazard of burns with PMBs is greater than with standard bitumens, due to the (normally) higher handling temperatures. It is recommended that notices, describing the action to be taken in the event of bitumen or PMB burns, should be displayed in the laboratory in the areas where bitumen, multigrade and PMBs are handled. A suitable warning could be as follows:

**WARNING: HOT BITUMEN MULTIGRADE & PMBs CAN CAUSE BURNS**

The following precautions should be taken when handling bitumen, multigrade or PMBs:

(a) Eye protection, such as safety glasses and/or face shields, shall be worn when handling hot bitumen, multigrade or PMBs.

(b) Heat-resistant gloves, with close-fitting cuffs, and other suitable protective clothing, shall be worn when handling hot bitumen, multigrade or PMBs.
(c) There shall be no smoking while handling hot bitumen, multigrade or PMBs.

(d) While the material is still cold, loosen the lid of the sample container (invert the can and warm the lid, if necessary), or punch a hole in the lid.

(e) Examine the cold sample for the presence of water. If water is thought to be present, drain most of it out, or blow with clean compressed air to evaporate the free water.

5.2 Sampling

(a) An original sample shall be obtained in accordance with the procedures set out in MBT 01.

Note 1 Samples taken from bulk storage, transport tankers, or during transfer from or into these vessels, shall be treated as original samples.

(b) If the original sample has just been taken and the viscosity is low enough, it can be reduced, after suitable stirring, into sub-samples. These smaller, sub-samples shall be re-heated only once prior to testing.

5.3 HOTPLATE METHOD

When using a hotplate, the procedure should be conducted in a fume cupboard and shall be as follows:

(a) Sample reduction from bulk

The procedure shall be as follows:

(i) Preheat the bulk sample to 100 ± 10°C in the oven.

Note 2 Heating times vary according to oven type, sample size and initial temperature. A minimum of 4 hours is generally required if the samples are larger than 4 L. Samples should not be heated for more than 10 hours at 100°C.

(ii) Place the sample on the hotplate and commence stirring without entraining air. Occasionally, scrape the sides and bottom of the container with the stirrer blade. When the sample is of a uniform consistency, replace the stirrer with the general purpose thermometer.

(iii) When the sample reaches 160°C, divide the bulk sample into sub-samples using smaller containers of 1 L, or less. Remove the bulk sample from the hotplate.

Note 3 At this stage, check the material for any unusual or unexpected physical properties, such as extreme fluidity, cutter odour, or high consistency. If the presence of cutter, or other volatile oil, is suspected, a thin film dish or RTFO treatment bottle may be poured at this stage for further testing (mass loss determination).
(b) **Subsample preparation**

The procedure shall be as follow:

(i) Maintain the conditioning oven at 160°C.

(ii) Pre-heat any required moulds or other test containers as required by the MBT method.

(iii) Heat the subsample until it is 180°C. Heating can be done as follows:

   Note 4 Since the measured properties of PMBs, particularly those modified with SBS polymer can be influenced by their thermal history prior to testing, it is preferable for the sample presented for subsample preparation to be at room temperature.

   (A) Hotplate and heating block (temperature-controlled) Set the thermoset hotplate and heating block to the required temperature and heat the sample in the beaker, covered with a suitable lid. The sample may be left unattended during heating, but shall be stirred gently before pouring. Carry out the pouring or filling operation in Step (iv) within 30 minutes of the sample reaching temperature.

   Note 5 When a mechanical stirrer is used, the impellor speed shall be maintained at a sufficiently low speed so as to avoid cavitation and consequent entrainment of air in the sample. See Figure B2 in Appendix B.

   Note 6 When using the aluminium block, significant temperature differences can occur between the binder sample and the block and hotplate. For reasonable temperature maintenance, the sample temperature in the beaker should be monitored during a typical heating cycle.

   (B) Hotplate (without temperature control) Heat the subsample(s) on the hotplate to the required temperature, while stirring constantly. Carry out the pouring or filling operation, as required in subsequent testing, within 5 minutes of the sample reaching the required temperature.

   Note 7 Do not leave the container on the hotplate without stirring constantly. If the stirring is to be interrupted, transfer the container to a thermally insulating surface until stirring can be resumed.

(iv) Fill the test containers as required by the MBT method.

(v) Discard the heated subsample(s). Do not use them again, or pour them back into the bulk sample.
5.4 OVEN METHOD  When using a forced convection oven, the procedure shall be as follows:

(a)  *Sample reduction from bulk*  The procedure shall be as follows:

(i)  Maintain the oven at 160°C.

(ii) Heat the bulk sample to 160°C, allowing sufficient time to reach this temperature. The temperature is checked using the temperature probe which can be inserted into the sample.

(iii) Remove the sample from the oven and thoroughly stir it for 30 seconds with a spatula without entraining air.

(iv) Divide the bulk sample into sub-samples using smaller containers of 1 L, or less. Remove the bulk sample from the oven.

Note 8 When using the Oven method the bulk sample should be cold before further sample reduction is undertaken. It is preferable that samples not be taken directly from a hot supply and further reduced while hot.

(b)  *Subsample preparation*  The procedure shall be as follows:

(i)  Maintain the oven at a temperature of 180°C.

(ii) Heat the subsample(s) to 180°C.

Note 9 Ensure the correct temperature is reached, using the temperature probe, or heat for the minimum time as determined in Appendix A.

(iii) Remove the subsample(s) from the oven and stir with a mechanical stirrer and suitable paddle for 30 seconds without entraining air. Note 5

(iv) Fill the required test containers.

(v)  Discard the heated subsample(s). Do not use again, or pour back into the bulk sample.

5.5 REFERENCE METHOD

(a)  *Sample reduction from bulk*  The procedure shall be as follows:

(i)  Maintain the oven at 160°C.

(ii) Heat the bulk sample (>2 L) to 160°C, allowing sufficient time to reach this temperature. The temperature is checked using the temperature probe, which can be inserted into the sample. Alternatively, the sample is heated for a minimum period, which has been previously established (according to Appendix A) as being required for the particular sample size being used.

Note 10 When using the Reference method the bulk sample shall be cold before further sample reduction is undertaken. It is essential that samples not be taken directly from a hot supply and further reduced while hot.

(iii) Remove the sample from the oven and thoroughly stir it for 30 seconds with a mechanical stirrer and suitable paddle without entraining air.
(iv) Divide the bulk sample into samples using 1 L containers. These samples can be further divided into sub-samples by the following procedure.

Note 11 At this stage, check the material for any unusual or unexpected physical properties, such as extreme fluidity, cutter odour, or high consistency.

Note 12 If the presence of cutter, or other volatile oil, is suspected, a thin film dish or RTFO bottle may be poured at this stage for further testing (mass loss determination).

(b) **Subsample preparation**

The procedure shall be as follows:

(i) The binders should be provided in 1 L cans (approximately 900 mL net). Check the condition of the sample (water, etc.) and quantity prior to testing.

(ii) Set a forced convection oven to 180° and allow temperature to stabilise.

(iii) Heat the sample tin in the oven for 4 hours at 180°C ±5°C.

(iv) Stir the contents of the tin with a mechanical stirrer and impeller for 30 seconds. Note 5.

(v) After the 30 second stir, quickly pour the binder into the four subsample containers.

(vi) Cover each sub-sample with foil and allow to cool to room temperature. Label the containers 1 to 4 (plus sample designation). Store the sub-samples at room temperature.

(vii) These sub-samples are now ready for re-heating and testing using the appropriate test methods.

6. **REPORT**

The following information shall be reported:

(a) Sample history including the preparation method

(b) The presence of fumes or cutter odour.

(c) The presence of foaming.

(d) Unusually high consistency.
APPENDIX A

(Normative)

HEAT-UP RATE OF SAMPLE IN FORCED CONVECTION OVEN

A1 GENERAL During the preparation of bulk samples for sub-sampling, the minimum time required for a bulk sample to reach 160°C must be known.

In preparing sub-samples for testing, the minimum time required for the particular size of container to attain the filling temperature must be known.

The procedure below shall be carried out, as required, for each size of container used during the forced convection oven sample preparation in this method.

A2 PROCEDURE The procedure shall be as follows:

(a) Insert a thermocouple into the sample as follows:
   (i) Punch a hole through the lid of the container.
   (ii) Fill the container with the sample and secure on the lid.
   (iii) Allow the sample to cool until it is semi-solid.
   (iv) Insert the temperature probe to half the sample depth and secure it.
   (v) Cool the sample to room temperature.

(b) Set the oven to the required temperature, viz. 160°C when using bulk samples, or 180°C when using sub-samples.

(c) When the temperature has stabilised, place the sample in the oven on the shelf normally used for heating bitumen samples. Leave the temperature probe in place and close the door on the wire.

(d) Monitor the temperature with time and establish the minimum time required for the sample container to reach temperature.

(e) Remove the container, cool it to room temperature and repeat Steps (c) and (d).

Note A1: Alternatively, a suitable thermometer can be used in place of the temperature probe.

Note A2: If the laboratory sometimes tests several samples at the one time, the above procedure should also be carried out with the monitored sample surrounded by bitumen-filled dummy containers.

Note A3: Glass beakers and metal containers with cut-off rims will require lids.

A3 RECORDING The following information shall be recorded:

(a) The time required for a particular size of bulk sample container to reach 160°C.

(b) The time required for subsample containers intended to be used to reach 180°C.
APPENDIX B

(Normative)

Mechanical Stirrer and Impeller

B1 GENERAL For sample mixing to be repeatable and reproducible between laboratories, the rotational speed, paddle design and sample container should be adequately defined. By defining the sample size at 1 Litre, and specifying the impeller the geometry of the system is established. The chosen system is described as a low shear rate mixer and is not intended to blend the polymer into the binder. Its purpose is to ensure a homogeneous system for well manufactured binders by overcoming any segregation which may have occurred in the original sample.

B2 EQUIPMENT DEFINITION For the 1997 PMB inter-laboratory precision exercise, a commercial paint stirrer (impeller) was chosen for its availability and simple design. Figure B1 describes the paddle and provides the important dimensions. This impeller (or its equivalent) is recommended. At the time of the precision exercise the paddle described was available from Kmart stores.

The mechanical stirrer is a general purpose laboratory stirrer with variable speeds. The combination of stirrer and paddle with an appropriate rotational speed ensures that during the stirring process, the surface of the sample will be on the verge of forming a vortex. The maintenance of this incipient vortex ensures adequate mixing without the entrapment of air into the sample. Figure B2 describes the ideal mixing condition.

Figure B1. Impeller assembly
(Informative)

Figure B2. Incipient Vortex

Shaft 6 mm diam
250 mm long

30 mm

50 mm

Angle ~ 30 degrees

Vortex must not be turbulent at any stage in the stirring process. Speed of stirrer motor adjusted to point short of air entrapment.
APPENDIX C

(Informative)

Electronic Temperature Controller

C1 GENERAL Sample heating using the temperature controlled hotplate, heating block and thermometer can be difficult to manage both in terms of control precision and temperature stability. The lack of a direct temperature measurement link between the sample and the hotplate is the primary cause of these deficiencies.

C2 EQUIPMENT Several electronic controller manufacturers have released cost effective modules for temperature control in a variety of application. These devices can be seen in recently manufactured laboratory ovens, MATTA test cabinets and Durability ovens and provide a high level of stability through the use of a Platinum resistance (Pt₁₀₀) sensor. Other features are:

- Low noise (Zero crossing) power switching to eliminate interference with other laboratory equipment (computers etc.)
- Direct selection of program temperature set point
- Display of actual sample temperature to 0.1°C (can be calibrated to ensure precision).
- Long term stability

Although not commercially available, the arrangement presented in Figure C1 can be readily assembled. This module can be applied to a variety of temperature control applications and can serve as a temperature monitor without the using the control function.

![Figure C1. Temperature Control Module and Hotplate Assembly](image-url)

180.0

Temperature Controller

Pt100 temperature sensor

Hot Plate
The Australian Asphalt Pavement Association is a non-profit organisation formed to promote the economic use of asphalt and bitumen bound products based on sound technical and commercial grounds.

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