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Technical Direction – TD 00018:2021

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Title: Dense graded asphalt containing high percentages of reclaimed asphalt pavement

This technical direction is issued by the Asset Management Branch (AMB) as a supplement to TfNSW QA Specification R116 *Heavy Duty Dense Graded Asphalt*, edition 9, revision 2, 2021. The purpose of this technical direction is to provide direction on the management and use of high percentages of reclaimed asphalt pavement (RAP) material in dense graded asphalt.

The audience for this technical direction includes:

- asphalt industry
- asset managers
- maintenance planners
- pavement designers.

1 Background

Maximising the use of reclaimed asphalt pavement (RAP) into asphalt mixes provides a sustainable platform for the Australian asphalt industry into the future. The use of RAP in asphalt mixes around Australia is now standard practice due to benefits associated with reductions in the consumption of virgin resources such as aggregates and bitumen, reducing material wastage, and reductions in overall cost. This technical direction adopts an improved procedure for material characterisation and blending methodology from Austroads project TT1817 (Austroads, 2013, 2015 and 2016). Additionally, TfNSW conducted a study to characterise the NSW RAP source, and found that the research findings were suitable for use in NSW. Implementation of the collective findings in this technical direction will provide a pathway

for greater proportions of RAP to be used in NSW while minimising the risk of in-service performance issues.

2 Scope

The aim of this technical direction is to provide a mechanism for asphalt Contractor on how to demonstrate the suitability of dense graded asphalt mixes containing RAP content between 15% and 50%. The technical direction applies as a supplement to and should be read in conjunction with TfNSW QA Specification R116 including an asphalt Contractor's capability to meet both viscosity and binder content requirements for a blend of virgin and RAP binder. Asphalt mixes incorporating RAP should be designed with the intent to align with performance properties comparable to asphalt mixes without RAP.

This technical direction does not fully address all other considerations needed to be made by the asphalt Contractor in ensuring the dense graded asphalt will perform satisfactory in-service. This technical direction also requires other aspects relating to the management of RAP to be in accordance with the Australian Flexible Pavement Association (AfPA) (previously AAPA) *Reclaimed Asphalt Pavement (RAP) Management Plan* (2018) and TfNSW QA Specification 3153 *Reclaimed Asphalt Pavement Material*.

The pavement design of flexible pavements containing high RAP dense graded asphalt mixes is not covered under this technical direction. Refer to TfNSW *Supplement to Austroads Guide to Pavement Technology Part 2: Pavement Structural Design*, 2018.

3 Approval process for higher RAP content dense graded asphalt mixes

As per the requirements of R116 Clause 2.2.1 (c), the asphalt Contractor may incorporate RAP material in dense graded asphalt. Under this technical direction, TfNSW allows the incorporation of up to 50% RAP into dense graded asphalt mixes for other than wearing course asphalt layers. Before using RAP in dense graded asphalt mixes, each asphalt mix design shall be reviewed by TfNSW and approved on the "Register of Transport for NSW Asphalt Mixes", <https://roads-waterways.transport.nsw.gov.au/documents/business-industry/partners-and-suppliers/register-of-materials/asphalt-register.pdf>. In addition to all other TfNSW R116 mix design submission requirements, the Contractor shall submit documentation which demonstrates the Contractor's ability to consistently process RAP to a homogenous state prior to use and satisfactory for incorporation into dense graded asphalt production.

The approval of high RAP dense graded asphalt mixes under this technical direction adopts a RAP approval level approach adapted from that specified in TfNSW R116. The approval levels set out in Table R116.4 are superseded by new approval levels as set out in Table 1A and Table 1B. The new approval levels which may be granted for high RAP asphalt mixes are denoted as 2+, 2W+, 3+, 4+, and 5+.

Mix design documentation relating to this technical direction shall be submitted at least one month before the nominated mix is proposed to be placed. All other requirements as specified in TfNSW R116 Clause 2.3 for the nominated mix design submission shall also be met.

Table 1A – RAP approval levels, other than wearing course

RAP Approval Level ⁽¹⁾	Maximum amount of RAP ⁽²⁾	Required Testing ⁽³⁾
1P	Table R116.4	Table R116.4
1	15%	Section A
2+	25%	Section B
3+	35%	Section C
4+	40%	Section D
5+	50%	Section E

Table 1B – RAP approval levels, wearing course

RAP Approval Level ⁽¹⁾	Maximum amount of RAP ⁽²⁾	Required Testing ⁽³⁾
1PW	Table R116.4	Table R116.4
1W	15%	Section A
2W+	20%	Section B

Notes to Tables 1A and 1B:

“P” denotes polymer modified binder (PMB), “W” denotes wearing course.

(1) Refer Clause 1.3.1, TfNSW R116 for definitions of “RAP Approval Level”.

(2) Maximum amount of RAP material allowable in asphalt mix for the particular RAP approval level, expressed as a percentage by mass of the total mix.

(3) Clauses in Annexure R116/F Ed9 Rev1 shall be complied with, hold point in this Annexure still applies. Table R116/F.1 is superseded by Table 4 under this Technical Direction.

Given that RAP is obtained from many different sources, regular monitoring and testing shall be undertaken to ensure adequate consistency and known quality prior to incorporation into dense graded asphalt production. Asphalt Contractors shall have a RAP management plan clearly detailing the processing of RAP materials, stockpile management, and ongoing RAP testing verification and monitoring during asphalt manufacturing. This plan shall also meet the requirements established in the AfPA (AAPA) *Reclaimed Asphalt Pavement (RAP) Management Plan* (2018) and this technical direction. RAP material shall also meet additional requirements of TfNSW QA Specification 3153 *Reclaimed Asphalt Pavement Material* for the purposes of processing and stockpiling of RAP materials prior to incorporation in the asphalt manufacturing process.

The requirements in the previous paragraph are auditable at the point of mix design submission and at any time during the production and placement of high RAP dense graded asphalt mixes.

When applying for higher RAP content mixes, either Method A or Method B may be used in the management of the binder blend viscosity. However, for dense graded asphalt mixes which contain greater than 30% RAP or for any mixes containing rejuvenating oils, Method A shall not be used. For RAP approval level 3+ (Table 1A), 31-35% RAP mixes, Method B shall be used.

4 Management of binder blend viscosity

The Contractor shall demonstrate an ability to manage the viscosity of blended virgin and RAP bitumen within suitable limits when producing dense graded asphalt. This information shall be provided at the time of mix design submission for TfNSW review. The process for management of binder blend viscosity shall include one of the following two processes:

- Method A - Adjustment of virgin binder class using blend viscosity (up to and including 30% RAP).
- Method B - Varying mix constituents (both binder class and % RAP) to achieve a nominated binder viscosity.

The method selected will depend on each individual asphalt mix design and asphalt Contractor’s preference. However, the asphalt Contractor shall clearly demonstrate their ability to adhere to one of the two methods. The demonstrated ability shall be documented in both the Contractor’s RAP management and quality management plans.

4.1 Method A – Using virgin binder class to adjust blend viscosity (maximum 30% RAP)

Method A can be used for the adjustment of blended binder viscosity by adding specific classes of virgin (added) binder. This method may be used for all mixes containing up to and including 30% RAP, providing the RAP characteristics are within the limits specified in Table 2A and Table 2B. The suitability of this method depends on the individual asphalt Contractor’s RAP source characteristics (the total RAP binder content, grading and viscosity). Table 2A and Table 2B have been developed to account for NSW RAP sourced from road pavements. For all other cases, Method B shall be used.

Table 2A – Virgin binder class selection for dense graded asphalt mixes containing RAP, other than wearing course

Maximum amount of RAP⁽¹⁾	15%	25%	30%
RAP binder content	4.7 ± 0.5%	4.7 ± 0.5%	4.7 ± 0.5%
Binder class to be used for adjustment – Design binder type: C450	C450	C320	C240

Maximum amount of RAP⁽¹⁾	15%	25%	30%
Binder class to be used for adjustment – Design binder type: C600	C600	C450	C320

Table 2B – Virgin binder class selection for dense graded asphalt mixes containing RAP, wearing course ⁽²⁾

Maximum amount of RAP⁽¹⁾	15%	20%
RAP binder content	4.7 ± 0.5%	4.7 ± 0.5%
Binder class to be used for adjustment – Design binder type: C450	C450	C320
Binder class to be used for adjustment – Design binder type: C600	N/A	N/A

Notes to Tables 2A and 2B:

(1) When assessed in accordance with AGPT-T192, binder viscosity shall be no lower than 3,000 Pa.s and no higher than 50,000 Pa.s.

(2) Adjustment of binder class for dense graded asphalt mixes containing polymer modified binders is not permitted.

When using Method A, it is the Contractor’s responsibility to manage inherent variability of the RAP source and ensure that the RAP characteristics are suitable for use under Table 2A and Table 2B. Where the RAP source no longer meets the requirements of use permitted under Table 2A and Table 2B the Contractor may do one or both of the following:

- reprocess the non-conforming RAP
- submit a new mix submission for approval to use RAP in asphalt designed with Method B.

Failure to meet the requirements for mixes supplied under Method A will result in the removal of registration of the asphalt mix under this technical direction. The Contractor shall demonstrate appropriate RMP (RAP management plan) and QMP (quality management plan) in place through the re-submission process.

For dense graded asphalt mixes which contain greater than 30% RAP and/or for any mixes containing rejuvenating oils, Method A shall not be used.

4.2 Method B – Varying mix constituents to achieve a nominated binder viscosity (maximum 50% RAP)

The use of Method B is suitable for dense graded asphalt mixes which contain up to and including 50% RAP and in circumstances where the RAP source characteristics are determined to lie outside limitations of Table 2A and Table 2B. This may include very hard or soft RAP

binder and/or RAP that has an unusually high or low binder content as well as RAP containing the presence of polymer modified and other alternative binders. A lower binder content than indicated in Table 2A and Table 2B may also be observed where a Contractor wishes to use a coarser RAP source as a constituent material in their dense graded asphalt mix design.

In order to properly manage the binder blend viscosity, the binder content and viscosity of the RAP shall be fully evaluated first and then on an ongoing basis.

The Contractor shall nominate how they will vary the specified added binder type in order to optimise resultant mix properties. The appropriate target blend viscosity requirements for Method B are provided below in Table 3 using Austroads test method AGPT-T193.

Table 3 – Target blend viscosity at 60 °C using AGPT-T193

Design binder class specified	Target binder blend viscosity at 60 °C (Pa.s)
C450	450 - 680
C600	600 - 880

Table 3 outlines the blend viscosity at 60 °C which shall be targeted at all times by the Contractor during production. In order to achieve consistency and compliance, adjustment is required to be made to one or more of the following:

- percentage of RAP
- virgin binder class used
- percentage of rejuvenating oil.

Predictive calculations for blended binder viscosity are made using the nominated (target) blend viscosity, proportion and viscosity of virgin and RAP binder included in the blend mix. An evaluation of the binder content and viscosity at 60 °C is required for the four most recent RAP stockpile results. Each mix shall be reviewed on a plant specific basis and any new plant shall require a new submission to be completed. For all new RAP stockpiles, a re-evaluation of RAP binder content and viscosity shall be undertaken. Where Method B is to be used, a placement trial shall also be conducted and nominated in Annexure A of TfNSW R116.

4.2.1 Selection and use of rejuvenating oils

Rejuvenators are low-viscosity products designed to restore the properties of the RAP binder and to improve the properties of the asphalt mixture containing RAP. An ideal petroleum based rejuvenator not only restores the mechanical properties of the bitumen, but also corrects the chemical composition of the aged bitumen.

Rejuvenating oils may be used to manage blend viscosity to comply with the limits provided in Table 3.

Currently, petroleum based rejuvenating oils are typically used in the management of blend viscosity due to their effectiveness in replacing lost chemical components in RAP binder. However, non-petroleum based rejuvenation oils may be used and the Contractor should consult with TfNSW Pavements and Materials Science Units to demonstrate effectiveness as a rejuvenator. Further development into effectiveness of various non-petroleum based oils to correct the chemical composition of RAP binder is being investigated.

For each nominated rejuvenation oil, the Contractor shall submit to the Principal the following details:

- a. source of raw material
- b. method of incorporation into asphalt manufacturing
- c. evidence that proposed source and method are suitable for the required quantity of oil to produce a homogeneous and consistent quality of high RAP dense graded mix
- d. nominated properties to be provided are:
 1. viscosity @ 60 °C in accordance with AS/NZS 2341.2 (report only)
 2. density @ 15 °C in accordance with AS 2341.6 or AS 2341.7 (report only)
 3. flash point in accordance with AS 2106.2 or AS/NZS 2106.1 or ASTM D93 or IP 170 or ISO 13736; Minimum 230 °C
 4. in the case of petroleum based rejuvenator, chemical composition by SARA analysis (saturate, aromatics, resins and asphaltenes) (report only) or by carbon type (aromatics, naphthenics and paraffins) (report only)
 5. in the case of a non-petroleum based rejuvenator, description of the oil, the physical and chemical properties describing its effectiveness (report only)
- e. safe work method statement
- f. material safety data sheet and assessment of carcinogenic risk.

The oil shall be compatible with the binder used in the asphalt mix. Long term stability of the oil shall be demonstrated by the Contractor. The quantity of rejuvenating oil being used in asphalt production shall be supported by calculations (AGPT-T193) and verified by the Contractor on a continual basis.

Specialist advice should be sought from TfNSW Pavements and Materials Science Units.

5 Amendment to Annexure R116/F – RAP Approval level progression

Table 4 supersedes R116, Table F.1 in full.

Table 4 – RAP level progression criteria

Submission type	Testing	Frequency
Section A	(a) Particle size distribution of RAP aggregate washed in solvent and tested in accordance with AS 1141.11 or AS 2891.3.1 (b) Binder content of RAP in accordance with AS 2891.3.1	At the time of nominated mix submission and one per 500 tonnes or part thereof used in asphalt production.
	(c) Quality of RAP aggregate washed in solvent to comply with TfNSW 3153 (d) Moisture content of RAP in accordance with AS 2891.10 (e) Visual monitoring of incoming RAP by a person experienced in the process	At the time of nominated mix submission and as per TfNSW 3153
	(f) Binder recovery of RAP in accordance to either AGPT-T191 or ASTM D5404 (g) Dynamic viscosity at 60 °C of recovered RAP binder in accordance with either AGPT-T192 or AS 2341.3	At time of nominated mix design submission, thereafter every 3 months.
	Section B	All testing required in Section A, plus:
(a) Resilient modulus of asphalt containing RAP in accordance with AS 2891.13.1 (b) Deformation resistance measured by wheel tracking depth of asphalt containing RAP in accordance with AGPT-T231		Every 2 years and at change in nominated mix design
(c) Binder recovery of RAP in accordance to either AGPT-T191 or ASTM D5404 (d) Dynamic viscosity at 60 °C of recovered RAP binder in accordance with either AGPT-T192 or AS 2341.3		Every processed RAP lot or once every 1 week, whichever is the less frequent.

Submission type	Testing	Frequency
Section C	All testing required as per Section A and B, plus:	Testing frequency as per Section A and B
	(a) Beam fatigue of asphalt containing RAP in accordance with AGPT-T274. (b) Flexural Stiffness Master Curve in accordance with AGPT-T274	Once every 2 years and at change in nominated mix design
Section D	All testing required as per Section A, B and C, plus:	Testing frequency as per Section A, B and C
	Properties of the rejuvenation oil	Once every delivery of oil
	(a) Optimisation testing to establish the mix design based on ongoing testing of RAP (formal calculations to be submitted in accordance with AGPT-T193 every 6 months, refer to Table 3). The Contractor shall document in their RMP how variations in RAP viscosity and RAP binder content will be managed so that the viscosity and binder content of the asphalt mix stays within the acceptable limits. (b) Project locations shall be provided by the asphalt Contractor on a yearly basis for inclusion into TfNSW RAMS asset management database. Ongoing approval for any high RAP dense graded asphalt mixes shall be subject to satisfactory field performance at these locations. (c) Samples upon request of plant mix shall be sent to TfNSW Russell Vale Laboratory for additional testing	Once every 1 years and at change in nominated mix design
Section E	All testing required as per Section A, B, C and D plus consult with TfNSW Pavements and Materials Science Units:	Testing frequency as per Section A, B, C and D

Submission type	Testing	Frequency
	a) Chemical analysis by SARA analysis of the RAP binder. b) The Contractor shall evaluate the properties (both high and low temperature) of the rejuvenated RAP including laboratory ageing protocol.	Once every 2 years and/or change in mix design.

6 For more information

For further information the following references should be consulted:

- AfPA (AAPA) 2018. *Reclaimed Asphalt Pavement (RAP) Management Plan*, Version 1.0, 12 June 2018.
- Austroads 2013. *Maximising the Re-use of Reclaimed Asphalt Pavement: Binder Blend Characterisation*, AP-T245-13, Austroads, Sydney.
- Austroads 2015. *Maximising the Re-use of Reclaimed Asphalt Pavement: Outcomes of Year Two - RAP Mix Design*, AP-T286-15, Austroads, Sydney.
- Austroads 2016. *Maximising the Use of Reclaimed Asphalt Pavement in Asphalt Mix Design: Field Validation*. AP-R517-16, Austroads, Sydney.
- NAPA 2015. *Best Practices for RAP and RAS Management*, Quality Improvement Series 129, National Asphalt Pavement Association, Lanham.
- RMS 2012. *Test method T542, Identification of tar or pitch in asphalt*.
- TfNSW 2020. *QA Specification R116 Heavy Duty Dense Graded Asphalt*, Edition 9 Revision 1, Transport for NSW.
- TfNSW 2020. *QA Specification 3153 Reclaimed Asphalt Pavement Material*, Edition 1 Revision 1, Transport for NSW.

Authorisation:

Approved by
Director Corridor Infrastructure & Engineering, Asset Management Branch

TRANSPORT FOR NSW (TfNSW)

QA SPECIFICATION R116

HEAVY DUTY DENSE GRADED ASPHALT

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REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 8/Rev 0		New edition, covering only dense graded asphalt. Open graded asphalt moved to new spec R119.	GM, IC	19.05.11
Ed 8/Rev 1	1.1 2.2.2(b) 4.5	Performance period of asphalt clarified. Definition of “Filler-Binder Ratio” added. Ride quality measurement clarified to be in accordance with T188 (quarter-car model).	GM, IC (W Stalder)	24.06.11
Ed 8/Rev 2	Annex A	Second table amended with respect to ride quality measurement.	GM, IC (M Andrew)	24.01.12
Ed 8/Rev 3	Global 1.1 1.3.6 1.4.2 2.1.6(a) 2.2.1(c) 2.3.1 2.4.2 3.3	AS 2891.7.1 added as alternative test method to AS 2891.7.3. No of heavy vehicles per lane-day replaced by ESA. Period where asphalt must not ravel, rut, etc increased to 24 months. Provision for reduced frequency of testing added. “ESA” and “PMB” added to Abbreviations. References to specs 3259 or 3269 removed. Clause on RAP rewritten to improve clarity. New category of RAP Approval Level “1P” and “1PW” added. Time period when tests related to nominated mix submission are carried out, changed to 1 month. Conditions for varying constituent proportions in nominated mix amended. PQP to include method of achieving required compaction.	GM, IC	11.06.13

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 8/Rev 3 (cont'd)	3.8 3.9 4.1.1 4.1.2 Annex M	Accuracy of thermometer changed to $\pm 2^{\circ}\text{C}$. Provision added for reduced application rate of tackcoat due to underlying pavement material such as primerseal or seal. Asphalt layers ≤ 30 mm thickness not to be tested for insitu air voids. Up to 5 mm reduction to core layer thickness permitted. Tech Direction for use of rhyolite aggregate updated.		
Ed 8/Rev 4	2.2.1 2.2.1(g) 2.3 2.3.2 3.3 3.9 4.1.2 4.4.2	Retitled "Proportions of Constituent Materials". Maximum proportion of additive in warm mix asphalt specified in Table 4 instead of in text. Subsequent tables renumbered. Sub-heading inserted to form new sub-clause 2.3.1. Subsequent sub-clause renumbered. Retitled "Submission of Nominated Mix Design". Retitled "Method of Placement". Requirement for tackcoat to be intact at commencement of asphalt placement added. AS 2891.7.1 added as alternative test method to AS 2891.7.3. Maximum deviation from straightedge of surface shape 12 months after completion specified in Table 10 instead of in Clause 1.1.	GM, IC	15.07.13
Ed 8/Rev 5	2.1.3.2 2.2.1	Requirement for granulated glass aggregate to be washed added. Proportion of granulated glass aggregate in asphalt clarified.	MCQ	24.05.19
Ed 8/Rev 6	Global	References to "Roads and Maritime Services" or "RMS" changed to "Transport for NSW" or "TfNSW" respectively.	DCS	22.06.20
Ed 9/Rev 0	Global Guide Notes 1.1	Clauses rearranged and reworded to improve clarity. New guide note, cross referring to CQTD 2013/001, on problem caused by tackcoat. Previous clauses 1.1 and 1.2 consolidated under clause 1.1. Subsequent clauses renumbered. Requirements for asphalt performance after 24 months, moved to clause 5.1.	EDCS	28.07.20

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 9/Rev 0 (cont'd)	1.2.4	Previously sub-clause 1.3.4. Submission of RAP Management Plan moved to clause 2.1.4.		
	1.2.5	Standard clause on frequency of testing added, combining previous sub-clauses 1.3.6 and 5.3.1. Previous sub-clause 1.3.5 deleted as it is superfluous.		
	1.2.7	New sub-clause on guide documents, which was previously part of clause 1.3.4. AAPA Guide IG-3 moved here from previous clause 5.4.		
	1.3	Previously clause 1.4. Some definitions moved here from elsewhere in R116.		
	2.1	Heading added to form new sub-clause 2.1.1. Subsequent sub-clauses renumbered.		
	2.1.2	Statement added that rhyolite aggregates must comply with Annex E1.		
	2.1.4 (a)	Previously sub-clause 2.1.3.1 on RAP, incorporating parts of previous sub-clauses 1.3.4 and 2.2.1 (c). Additional requirements for RAP Approval Levels 3 and 4 amended.		
	2.1.5	Previous listed requirements for filler, viz voids in dry compacted filler and MBV, tabulated under new Table 1 and clarified to be on total (combined) filler. Subsequent tables renumbered.		
	2.1.7 (b)	Use of warm mix asphalt additive clarified.		
	2.1.9	New sub-clause on sampling and testing of constituent materials, cross referred to Annex L.		
	2.2	Heading title changed.		
	2.2.1 (b)	Table 3 (previously Table 2) – table notes changed to main text. Requirement to demonstrate that volumetric proportions are consistent with intent, deleted.		
	2.2.1 (c)	Table 4 (previously Table 3) reformatted, Performance Period deleted or reduced for RAP Approval Levels 2, 3 and 2W.		
	2.2.2	Previous listed requirements for volumetric and mechanical properties tabulated under new Table 6. Subsequent tables renumbered.		
	2.2.2, Annex L	Test methods T660 and T662 replaced by AS 2891.10 and AS 2891.2.2 respectively.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 9/Rev 0 (cont'd)	2.2.3	New sub-clause stating that design of mixes containing rhyolite must comply with Annex E2.		
	2.3.1	Requirement that submitted nominated mix design is contract specific deleted. Statement added that submitted mix design, once approved, will be listed on the Register of Asphalt Mixes, and alternative provided to use mix already listed on the Register.		
	2.3.2	New sub-clause on production trial, incorporating previous clause 2.3.2 (c).		
	2.3.3	Previously sub-clause 2.3.2. Individual clauses reshuffled.		
	2.3.3 (b)	Combined aggregate density, including calculations, added to list of items to be submitted.		
	2.3.3 (c)	Production trial requirements moved elsewhere, as this sub-clause item covers mix design submission details; replaced by test results from production trial.		
	2.3.4	Previously sub-clause 2.3.2 on test report validity periods. Validity period for high RAP content mixes increased to 3 months.		
	2.3.5	New sub-clause for Hold Point. Hold Point release validity period increased to 24 months.		
	2.4.1	Consolidating previous sub-clauses 2.4.1 and 2.4.2.1.		
	2.4.2	Incorporating previous sub-clause 2.4.2.2.		
	2.4.6	New sub-clause stating that production of mixes containing rhyolite aggregates must comply with Annex E3.		
	2.4.7	Previously sub-clause 2.4.6 on sampling and testing during production, incorporating part of Clause 5.		
	3.1.1	Previously 1 st para of clause 3.4, on provision for traffic.		
	3.1.2	Previously clause 3.2 on surface preparation.		
	3.1.3	Previously clause 3.5 on protection of road and services fixtures.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 9/Rev 0 (cont'd)	3.2	Previously clause 3.9 on tackcoat. Headings added to form new sub-clauses 3.2.1 to 3.2.5. Statement on determination of required volume of tackcoat moved here from under Pay Item P1.		
	3.3	Previously clause 3.7 on temperature and weather conditions. Headings added to form new sub-clauses 3.3.1 and 3.3.2.		
	3.3.2	Minimum temperature for paving using ordinary bitumen lowered to 8°C; minimum temperature using PMB correspondingly reduced.		
	3.4.1	Incorporating 1 st para of previous clause 3.1 and sub-clause 4.1.1.		
	3.4.2	New sub-clause incorporating part of previous clause 3.3, on equipment and method of placement.		
	3.4.3	New sub-clause incorporating part of previous clause 3.3, on MTV requirements. Storage and remixing requirements of MTV amended.		
	3.4.4	New sub-clause incorporating part of previous clause 3.3, on echelon paving. Paving run layout requirements clarified.		
	3.5	Previously clause 3.8 on paving and compaction temperatures. Headings added to form new sub-clauses 3.5.1 to 3.5.3.		
	3.5.2	Requirement to carry out daily verification of infrared thermometer accuracy deleted.		
	3.6	Difference between “course” and “layer” moved to clause 1.3.		
	3.6.1	New sub-clause on course thickness incorporating part of previous sub-clause 4.2.1 and 1 st para of item (b) of same clause.		
	3.6.2	Combining previous clause 3.6 and sub-clause 3.6.1.		
	3.6.3	Previously sub-clause 3.6.2; heading title changed to “nonconforming layer thicknesses”.		
	3.7	Combining previous clauses 3.10 and 3.12 to form new clause on joints.		
	3.7.1	New sub-clause on joint locations, incorporating part of previous clause 3.10.		
	3.7.2	New sub-clause on procedure for joint construction, incorporating part of previous clause 3.10.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 9/Rev 0 (cont'd)	3.7.3	New sub-clause on temporary ramps at joints, incorporating part of previous clause 3.12.		
	3.7.4	New sub-clause on tie-ins to existing pavements, incorporating part of previous clause 3.12.		
	3.8	Previously clause 3.11 on trial section, retitled. Headings added to form new sub-clauses 3.8.1 to 3.8.6.		
	3.9	Combining 2 nd para of previous clauses 3.4 and 3.1 on protection of work.		
	4	New clause on sampling and testing of placed asphalt, incorporating parts of previous clauses 4 and 5.		
	4.1.1	New sub-clause on sampling and testing frequency, incorporating previous clause 5.2.		
	4.1.2	New sub-clause on Lots and sub-Lots, incorporating 1 st para of previous clause 4.1.2, previous sub-clause 5.3.2 and 2 nd para of previous clause 5.2. Division of nonconforming Lot into sub-Lots clarified.		
	4.1.3	New sub-clause on samples for Principal, incorporating last 2 para of previous clause 5.2.		
	4.2	Previously clause 4.1 on determination of insitu air voids. Placing requirements moved to clause 3.4.1. Conformity criteria moved to clause 5.3.		
	4.2.1	Mention of “reference density” omitted.		
	4.2.2	Density offset determination requirements added.		
	4.3	Previously clause 4.2 on determination of course thickness. Placing requirements moved to clause 3.6.1. Conformity criteria moved to clause 5.4.		
	4.3.1	Determination of course thickness required only where specified in Annex A.		
	4.3.2	New sub-clause on determination of course thickness from cores.		
	4.3.3	New sub-clause on determination of course thickness by survey. Survey for product conformity requirements cross referred to spec G71.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 9/Rev 0 (cont'd)	4.4	Previously clause 4.3 on determination of course position. Conformity criteria moved to clause 5.5.		
	4.5	Previously clause 4.4 on determination of surface shape. Conformity criteria moved to clause 5.6.		
	4.6	Previously clause 4.5 on determination of ride quality. Conformity criteria moved to clause 5.7.		
	4.7	Previously sub-clause 5.3.3, on time for submission of test results.		
	4.8	New clause on restoration of core holes.		
	5	New clause on conformity.		
	5.1	New clause incorporating part of previous clause 1.1.		
	5.2	Incorporating part of previous clause 5.1, on homogeneity.		
	5.3	New clause on conformity criteria for insitu air voids, incorporating part of previous clause 4.1		
	5.4	New clause on conformity criteria for course thickness, incorporating part of previous clause 4.2.		
	5.5	New clause on conformity criteria for course position, incorporating part of previous clause 4.3.		
	5.6	New clause on conformity criteria for surface shape, incorporating part of previous clause 4.4. Location of test clarified to include across traffic lanes.		
	5.7	New clause on conformity criteria for ride quality, incorporating part of previous clause 4.5.		
	5.8	New clause on treatment of nonconformities.		
	5.8.1	New sub-clause, incorporating part of previous clauses 4.3.2 and 4.4.2. Discrepancy on when to carry out rectification corrected.		
	5.8.2	New sub-clause incorporating part of previous sub-clause 5.1, on acceptance of non-homogenous placed asphalt.		
	5.8.3, 5.8.4	New sub-clauses incorporating previous sub-clause B2.2, on acceptance of nonconforming work.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 9/Rev 0 (cont'd)	5.8.5	New sub-clause incorporating part of previous clause 5.5, on rectification or replacement of nonconforming asphalt. Statement added that Principal is not bound to accept any proposals for acceptance of nonconforming Lots.		
	5.8.6	New sub-clause incorporating part of previous sub-clause B2.1.		
	Annex A	Guidance notes amended. Table A.1 reformatted. Determination of course thickness added to Table A.2. Previous provision to list pay items which will be measured by area changed to item in Table A.2.		
	Annex B	Previous conflicting requirement on measurement of tackcoat quantity rectified. Pay Item P1 description for tackcoat amended.		
	Annex E	New annex on requirements for rhyolite aggregates (previously in TD 2013/02).		
	Annex F1	Previously part of clause 2.2.1 (c), on RAP approval level progression requirements. Previous Annex F becomes Annex F2.		
	Annex K	Previously Annex E, on calculations of characteristic values. “MD” definition amended.		
	Annex L	Frequency of testing rearranged in following order: constituent materials, production asphalt, placing process and placed asphalt. Table L.2 – items relating to mix design submission deleted. Frequency for filler moved here from spec 3211. Frequency changed for air voids at 350 cycles, and moisture content. Table L.5 – Frequency for - course position cross referred to spec G71; - longitudinal joint changed to 1 every 20 m.		
Annex M	Referenced documents updated.			
Ed 9/Rev 1	Annex L	Table L.2 – Frequency of testing stated clarified to be for total filler used in asphalt production.	MCQ	10.09.20
Ed 9/Rev 2	1.2.3, Annex C	References to Annexure Q/E removed.	SMCSp	16.09.21
	Annex A	Table A.1 – Word “course” added to “intermediate” and “corrective”, to be consistent with the rest of the table.		

GUIDE NOTES (Not Part of Contract Document)

Clause 2.1.2 Coarse Aggregates

This specification calls up Materials Specification TfNSW 3152, and Annexure 3152/A which must be completed to specify the Minimum PAFV.

Clause 3.2 Tackcoat

CQTD 2013/001, which highlights the problem during construction of the seal or primerseal peeling off under the paver tyres due to the application of tackcoat, provides some guidance on when tackcoat should not be applied. Note however that the clause references to R116 in CQTD 2013/001 are those of the previous edition of R116, and are no longer correct when read in relation to this edition.

CQTD 2013/001 may be downloaded from the intranet at:

http://home.rms.nsw.gov.au/dts/cserv/os/original/tdconstructionquality/cqtd_2013_001.pdf



Transport
for NSW

QA SPECIFICATION R116

HEAVY DUTY DENSE GRADED ASPHALT

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VERSION FOR: DATE:

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FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from TfNSW Specification R116 Edition 9 Revision 1.

All revisions to the previous version (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

PROJECT SPECIFIC CHANGES

Any project specific changes are indicated in the following manner:

- (a) Text which is additional to the base document and which is included in the Specification is shown in bold italics e.g. ***Additional Text***.
- (b) Text which has been deleted from the base document and which is not included in the Specification is shown struck out e.g. ~~Deleted Text~~.

TfNSW QA SPECIFICATION R116

HEAVY DUTY DENSE GRADED ASPHALT

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for heavy duty dense graded asphalt for use in:

- (a) heavy duty pavement types;
- (b) high stress locations such as stop/start locations, traffic lights, roundabouts, climbing lanes, etc.

The asphalt may contain recycled material, and can be manufactured using either conventional or warm mix asphalt technology.

The requirements include:

- (i) design of asphalt mix(es);
- (ii) production and transport of asphalt;
- (iii) application of tackcoat;
- (iv) placement and compaction of asphalt;
- (v) inspection and testing necessary to demonstrate that the quality requirements of this Specification have been achieved.

1.2 STRUCTURE OF THE SPECIFICATION

This Specification includes a series of annexures that detail additional requirements.

1.2.1 Project Specific Requirements

Project specific details of work are shown in Annexure R116/A.

1.2.2 Measurement and Payment

The method of measurement and payment is detailed in Annexure R116/B.

1.2.3 Schedules of HOLD POINTS and Identified Records

The schedules in Annexure R116/C list the **HOLD POINTS** that must be observed. Refer to Specification TfNSW Q for definition of **HOLD POINTS**.

The records listed in Annexure R116/C are **Identified Records** for the purposes of TfNSW Q.

1.2.4 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure R116/D and must be implemented.

In all cases where this Specification refers to the manufacturer's recommendations, these must be included in the PROJECT QUALITY PLAN.

1.2.5 Frequency of Testing

The Inspection and Test Plan must nominate the proposed frequency of testing to verify conformity of the item, which must not be less than the frequency specified in Annexure R116/L. Where a minimum frequency is not specified, nominate an appropriate frequency. Frequency of testing must conform to the requirements of TfNSW Q.

You may propose to the Principal a reduced minimum frequency of testing. The proposal must be supported by a statistical analysis verifying consistent process capability and product characteristics. The Principal may vary or restore the specified minimum frequency of testing, either provisionally or permanently, at any time.

1.2.6 Referenced Documents

Unless otherwise specified, the applicable issue of a referenced document, other than a TfNSW Specification, is the issue current at the date one week before the closing date for tenders, or where no issue is current at that date, the most recent issue.

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure R116/M.

1.2.7 Guide Documents

Use the following documents as a guide when undertaking the Works:

- (a) AAPA Implementation Guide No.3 "Asphalt Plant Process Control Guide" (IG-3);
- (b) AS 2150 "Hot mix asphalt - A guide to good practice";
- (c) Austroads AGPT04B "Guide to Pavement Technology Part 4B: Asphalt".

1.3 DEFINITIONS AND ACRONYMS

1.3.1 Definitions

The terms "you" and "your" mean "the Contractor" and "the Contractor's" respectively.

Unless stated otherwise, all references in this Specification to the term "asphalt" mean "heavy duty dense graded asphalt".

"Total filler" in asphalt is the combined fraction of fines produced from the crushing of aggregates and any added filler which passes the 75 µm AS sieve.

An asphalt course may comprise one or more layers.

"RAP Approval Level" is the level designation which corresponds to the maximum amount of reclaimed asphalt pavement (RAP) material which can be used in an asphalt mix design (refer Table R116.4).

"Performance Period" is the period (in number of years) of proven past performance of a mix incorporating the maximum amount of RAP material corresponding to the RAP Approval Level.

A "shift" is a period of continuous work not exceeding 12 hours.

References to the term “Lot(s)” in Clauses 4.6 and 5.7 mean “Lot(s)” with in relation to ride quality.

Other definitions are in accordance with the Glossary of Austroads Terms.

1.3.2 Acronyms

The following acronyms apply to this Specification:

AAPA	Australian Asphalt Pavement Association
AC	Dense graded asphalt
IRI	International Roughness Index
MTV	Material Transfer Vehicle
MBV	Methylene Blue Value
NATA	National Association of Testing Authorities
PAFV	Polished Aggregate Friction Value
PMB	Polymer Modified Binder
RAP	Reclaimed asphalt pavement (material)
TSR	Tensile Strength Ratio
VMA	Voids in Mineral Aggregate

2 SUPPLY OF ASPHALT

2.1 CONSTITUENT MATERIALS

2.1.1 General

All constituent materials used in the manufacture of asphalt must comply with the requirements of this Specification, and maintain a uniform appearance, for the duration of the Contract.

2.1.2 Coarse Aggregate

Coarse aggregate must comply with Specification TfNSW 3152.

When aggregates are specified to be from a specific source or type, or with a high PAFV or other special characteristics, 100% of the coarse aggregate (by mass) in the asphalt must comply with all the requirements specified under this Clause.

Rhyolite aggregates must comply with Annexure R116/E1.

2.1.3 Fine Aggregate

Fine aggregate must comply with TfNSW 3152.

2.1.4 Recycled Materials

(a) Reclaimed Asphalt Pavement (RAP) Material

RAP material must comply with Specification TfNSW 3153.

If using RAP material, submit a RAP Management Plan as part of your PROJECT QUALITY PLAN which addresses the requirements of this Specification and comply with “Reclaimed Asphalt Pavement (RAP) Management Plan” published by AAPA.

Where the RAP material is used under RAP Approval Levels 3 and 4 (refer Clause 2.2.1 (c)), the following additional requirements apply:

- (i) Processed RAP material must be screened to remove oversize particles before fractionating into single or multiple fractions (coarse and fine) and then metered into the asphalt mixing process;
- (ii) A statement must be provided in your RAP Management Plan on how you propose to ensure that the processed RAP material within a stockpile is graded and fractionated.

(b) Granulated Glass Aggregate

Granulated glass aggregate must comply with Specification TfNSW 3154 and be washed prior to use.

2.1.5 Filler

Added filler must conform to Specification TfNSW 3211.

Total filler (refer Clause 1.3.1 for definition of “total filler”) in the asphalt must conform to TfNSW 3211 and Table R116.1.

Table R116.1 – Total (Combined) Filler Requirements

Property	Unit	Test Method	Acceptance Criteria
Voids in dry compacted filler	%	AS/NZS 1141.17	≥ 40
Methylene blue value ⁽¹⁾	mg/g	TfNSW T659	≤ 10

Note:

⁽¹⁾ MBV value of total filler, but excluding hydrated lime.

2.1.6 Binder

Binder used for the Works must be of the class specified in Annexure R116/A.

You may propose for approval by the Principal the use of an alternative class of binder if the asphalt contains either:

- (a) RAP material in excess of 15%; and/or
- (b) warm mix asphalt additive.

The binder must comply with Specifications TfNSW 3252 or TfNSW 3253 as appropriate for the class of binder specified. Provide documentary evidence of the binder conformity for asphalt used in the Works in accordance with TfNSW 3252 or TfNSW 3253.

2.1.7 Additives

(a) Bitumen Adhesion Agent

Bitumen adhesion agent may be added to improve the resistance of the asphalt's propensity to stripping.

(b) Warm Mix Asphalt Additive

Warm mix asphalt additive may be added to asphalt, for purposes such as to reduce the asphalt manufacturing temperature and/or to improve workability during the paving and compaction operations, particularly during cool weather paving.

2.1.8 Bitumen Emulsion Tackcoat

Bitumen emulsion for use as a tackcoat must be CRS/170-60 complying with AS 1160, unless otherwise approved by the Principal.

2.1.9 Sampling and Testing of Constituent Materials

The frequency of sampling and testing for constituent materials must be in accordance with Annexure R116/L.

2.2 DESIGN OF ASPHALT MIX

2.2.1 Proportions of Constituent Materials

(a) Combined Particle Size Distribution of Aggregate

The combined particle size distribution of aggregates in the asphalt, when determined in accordance with AS/NZS 2891.3.1, must conform to Table R116.2.

Table R116.2 – Combined Particle Size Distribution Limits, Different Nominal Size of Asphalt

AS Sieve Size	Combined Particle Size Distribution Passing Limits (% by mass)					
	Nominal Size of Asphalt (Asphalt Designation)					
	5 mm (AC5)	7 mm (AC7)	10 mm (AC10)	14 mm (AC14)	20 mm (AC20)	28 mm (AC28)
53.0 mm	–	–	–	–	–	–
37.5 mm	–	–	–	–	–	100
26.5 mm	–	–	–	–	100	80 – 98
19.0 mm	–	–	–	100	80 – 98	#
13.2 mm	–	–	100	80 – 98	65 – 93	50 – 80
9.50 mm	–	100	80 – 98	#	#	#
6.70 mm	100	80 – 98	65 – 90	55 – 80	45 – 70	35 – 60
4.75 mm	80 – 98	#	#	#	#	#
2.36 mm	50 – 80	45 – 65	35 – 65	25 – 45	20 – 40	15 – 40
1.18 mm	#	#	#	#	#	#
600 µm	15 – 45	15 – 40	15 – 35	10 – 30	5 – 25	5 – 25
300 µm	#	#	#	#	#	#

AS Sieve Size	Combined Particle Size Distribution Passing Limits (% by mass)					
	Nominal Size of Asphalt (Asphalt Designation)					
	5 mm (AC5)	7 mm (AC7)	10 mm (AC10)	14 mm (AC14)	20 mm (AC20)	28 mm (AC28)
150 µm	#	#	#	#	#	#
75 µm	3 – 11	3 – 11	3 – 11	2 – 8	2 – 8	2 – 7

Note: Where the particle size distribution is shown as “#”, state the values of the Particle Size Distribution limits in your nominated mix design submission and in the trial and production mixes reporting.

(b) Binder

The proportion of binder in the asphalt, expressed as a percentage by mass of the total mix, must comply with Table R116.3.

Table R116.3 – Binder Content, Different Nominal Size of Asphalt

Property	Nominal Size of Asphalt (Asphalt Designation)					
	5 mm (AC5)	7 mm (AC7)	10 mm (AC10)	14 mm (AC14)	20 mm (AC20)	28 mm (AC28)
Binder content (% by mass of total mix)	5.6 – 6.8	5.4 – 6.6	5.1 – 6.4	4.8 – 6.2	4.6 – 6.1	4.0 – 5.8

The binder content ranges specified in Table R116.3 are applicable to commonly used natural sources of aggregates and sands for a known range of densities. If you propose to use constituent materials of substantially different density, you may propose for approval by the Principal the use of an alternative binder content that does not conform to the above.

Determine the binder content in accordance with AS/NZS 2891.3.1.

(c) Reclaimed Asphalt Pavement Material

You may incorporate RAP material in asphalt for use in the wearing and other courses, up to the maximum limits shown in Table R116.4. The amount of RAP material in the asphalt mix must not exceed the percentages shown in Table R116.4 for the RAP Approval Level at which you have been approved.

Table R116.4 – Maximum Amount of RAP Material in Asphalt and their Prerequisites

RAP Approval Level ⁽¹⁾	Other than Wearing Courses			RAP Approval Level ⁽¹⁾	Wearing Course		
	Maximum Amount of RAP ⁽²⁾	Testing (Refer Table R116/F.1) ⁽³⁾	Performance Period ⁽¹⁾		Maximum Amount of RAP ⁽²⁾	Testing (Refer Table R116/F.1) ⁽³⁾	Performance Period ⁽¹⁾
1P	10%	Section A	N/A	1PW	10%	Section A	N/A
1	15%	Section A	N/A	1W	15%	Section A	N/A
2	25%	Section B	N/A	2W	20%	Section B	2 years
3	30%	Section C	2 years				
4	40%	Section C	5 years				

Notes: “P” denotes PMB “W” denotes wearing course

- (1) Refer Clause 1.3.1 for definitions of “RAP Approval Level” and “Performance Period”.
- (2) Maximum amount of RAP material allowable in asphalt mix for the particular RAP Approval Level, expressed as a percentage by mass of total mix.
- (3) Testing specified in Annexure R116/F must be complied with. Testing requirements as per Sections A, B and C are detailed in Table R116/F.1.

Warm mix asphalt may contain RAP material.

(d) Granulated Glass Aggregate

Asphalt may contain a proportion of washed granulated glass aggregate not exceeding:

- (i) **wearing course:** 2.5% by mass of total mix;
- (ii) **other than wearing course:** 10% by mass of total mix.

(e) Hydrated Lime

The amount of hydrated lime in the asphalt must not be less than 1.5% by mass of total aggregate.

(f) Adhesion Agent

Asphalt may contain bitumen adhesion agent not exceeding 1.0% by mass of binder.

(g) Warm Mix Asphalt Additive

The maximum proportion of additive in the asphalt must comply with Table R116.5.

Table R116.5 – Maximum Proportion of Additive in Warm Mix Asphalt

Additive	Maximum Proportion
Wax	2.0% by mass of binder
Surfactants	Nominated by Contractor
Water (either added directly or in the form of water containing crystals)	0.06% by mass of the total mix

2.2.2 Volumetric and Mechanical Properties

The asphalt mix design must comply with the volumetric and mechanical properties shown in Table R116.6.

Table R116.6 – Volumetric and Mechanical Properties

Property	Unit	Test Method	Acceptance Criteria
Voids in mineral aggregate (VMA) at 120 cycles	%	AS/NZS 2891.2.2, AS/NZS 2891.7.1 or AS/NZS 2891.7.3, AS/NZS 2891.8, AS/NZS 2891.9.2	Table R116.7
Air voids in laboratory compacted mix, at 120 cycles ⁽¹⁾	%		$\geq 3.0, \leq 6.0$
at 350 cycles ^(1,2)			≥ 2.0
Filler-binder ratio ⁽³⁾	%	AS/NZS 2891.3.1	$\geq 0.8, \leq 1.2$
Binder film index ⁽²⁾	μm	AG:PT/T237 or AS/NZS 2891.8	> 7.5
Moisture content ⁽⁴⁾	%	AS/NZS 2891.10	< 0.5
Resilient modulus ⁽⁵⁾	MPa	AS/NZS 2891.13.1	Report ⁽⁶⁾
Deformation resistance, measured by wheel tracking depth ⁽⁷⁾	mm	AG:PT/T231	Report
Moisture sensitivity, measured by Tensile Strength Ratio (TSR)	%	AG:PT/T232 or TfNSW T640	≥ 80
Average tensile strength of freeze/thaw group	kPa		> 600

Notes: Report = no conformity criteria exist, but test results must be reported

⁽¹⁾ Number of cycles of compaction required for AS/NZS 2891.2.2.

⁽²⁾ Not applicable for AC5.

⁽³⁾ Measured as ratio of percentage passing 75 μm AS sieve by mass of total aggregate (“filler”) to percentage of binder by mass of total mix (“binder”).

⁽⁴⁾ Applies to all mixes produced in a drum plant, or containing a warm mix asphalt additive, or containing RAP.

⁽⁵⁾ Applies to asphalt containing warm mix asphalt additive, or if specified as required in Annexure R116/A, or if required for RAP Approval Level progression (refer Annexure R116/F).

⁽⁶⁾ Report also number of cycles to compact it to $5.0 \pm 0.5\%$ air voids.

⁽⁷⁾ Applies to asphalt containing in excess of 20% RAP material, or containing warm mix asphalt additive, or if specified as required in Annexure R116/A.

Table R116.7 – Voids in Mineral Aggregate (VMA)

Property	Unit	Nominal Size of Asphalt (Asphalt Designation)					
		5 mm (AC5)	7 mm (AC7)	10 mm (AC10)	14 mm (AC14)	20 mm (AC20)	28 mm (AC28)
VMA	(%)	≥ 17	≥ 17	≥ 16	≥ 15	≥ 14	≥ 13

2.2.3 Mixes Containing Rhyolite Aggregates

Design of asphalt mixes containing rhyolite aggregates must comply with Annexure R116/E2.

2.3 NOMINATED MIX DESIGN

2.3.1 General

Submit to the Principal for approval one nominated mix design for each asphalt mix specified in Annexure R116/A.

The submitted nominated mix design is:

- (a) materials specific, and substitution of constituent materials during production is not permitted;
- (b) design specific, and variation to the design nominated mix submission is not permitted;
- (c) asphalt plant specific, and except for component maintenance, changes in the components, configuration and/or location of the plant is not permitted.

For each new establishment of an asphalt plant, submit a full nominated mix design.

Once approved, the mix will be listed on the “Register of Transport for NSW Asphalt Mixes”, available at:

<http://www.rms.nsw.gov.au/documents/business-industry/partners-and-suppliers/register-of-materials/asphalt-register.pdf>.

Alternatively, instead of submitting a new nominated mix, you may propose to use a mix which is already listed on the “Register of Transport for NSW Asphalt Mixes”.

2.3.2 Production Trial

As part of your nominated mix design submission process, conduct a production trial to demonstrate conformity of the nominated mix.

All production trial tests on each nominated mix must be from one trial batch. The tests on the constituent materials must represent the materials used in this trial batch.

2.3.3 Nominated Mix Design Submission Details

The nominated mix design submission must include the following details:

(a) Constituent Materials

- (i) Coarse and fine aggregates: source, geological type. Aggregate of a different type or quality, even if from the same quarry face or from within the same quarry, will be regarded as from a different source.
- (ii) Added filler: type, grade and source.
- (iii) Binder: source, class or grade.
- (iv) Recycled materials:
 - RAP material: effective binder content (i.e. the portion that is considered to contribute to the binder content of the asphalt mix design) and recovered viscosity of binder.
 - granulated glass aggregate: source.
- (v) Additives: type, source, trade name and manufacturer’s recommendations.
- (vi) Bitumen emulsion tackcoat: source, class of bitumen, any bitumen modification.

(b) Mix Design

For each nominated mix design:

- (i) Proportion of each constituent by percentage of mass of total mix.
- (ii) Nominated values and allowable tolerances for each requirement specified in Clause 2.2, where applicable.
- (iii) Combined aggregate density, including calculations showing how this is determined.
- (iv) If using RAP material, the RAP Approval Level for which you are approved to use.
- (v) Type and identification number of the asphalt manufacturing plant, and mix identification.
- (vi) Temperature at which the asphalt is manufactured.

(c) Production Trial

Test results from the production trial in accordance with Clause 2.3.2.

(d) Warm Mix Asphalt Additives

If using warm mix asphalt additives, provide details of the additive(s) in your nominated mix design submission.

Clearly state in your submission:

- (i) any proposed amendments to the mix design procedure, operational processes and/or test methods as a result of the inclusion of a warm mix asphalt additive;
- (ii) classification of the warm mix asphalt additive.

Include evidence acceptable to the Principal that the additive is suitably designed and has proven performance for the purpose described in this Specification.

The nominated mix design will be rejected if the nature, intended purpose and dosage of the warm mix asphalt additive are not clear in your nominated mix design submission.

(e) Signed Statement

A signed statement certifying that each nominated mix, the associated production trial mix, and all constituents meet the requirements of Clauses 2.1 and 2.2. The statement must include NATA endorsed test results for all specified tests. Attach a copy of your completed verification checklist.

2.3.4 Test Report Validity Periods

Unless specified otherwise, all asphalt and binder tests relating to the nominated mix design submission must not be older than one month prior to the date of submission to the Principal.

For high RAP content asphalt mixes, wheel tracking and beam fatigue tests relating to the submission must not be older than three months prior to the date of submission to the Principal.

All other tests relating to the submission must not be older than 6 months prior to the date of submission to the Principal.

All phases of any particular test must be performed at the same laboratory.

2.3.5 Hold Point

HOLD POINT

Process Held:	Placing of the nominated mix(es).
Submission Details:	Documents as detailed in Clause 2.3.3 at least 7 working days before the nominated mix(es) is (are) proposed to be placed.
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point. This Hold Point release is valid for a maximum period of 24 months.

2.4 PRODUCTION OF ASPHALT

2.4.1 Method of Production

Your adopted method of production must:

- (a) control the process and target the nominated mix design;
- (b) supply a homogeneous and consistent product at the nominated manufacturing temperature.

You may vary the proportion of each constituent for the purpose of process control, provided that:

- (i) the asphalt produced remains uniform and of consistent quality, and subject to the production tolerances specified in Clause 2.4.2;
- (ii) the proportion of RAP does not exceed the RAP Approval Level in Table R116.4 for which you have been approved.

2.4.2 Production Tolerances

The actual combined particle size distribution and actual binder content may vary from their nominated values within the limits shown in Table R116.8, provided that the actual values also remain within the limits of Tables R116.2 and R116.3 respectively.

Table R116.8 – Production Tolerances

Description	Tolerance (% by mass)
Permissible variation to nominated values during production, for each mix size:	
Combined particle size distribution (AS sieve) ^(1, 3)	
4.75 mm and larger	± 7
2.36 mm	± 5
1.18 mm	± 5
600 µm	± 4
300 µm	± 4
150 µm	± 2.5
75 µm	± 1.5
Binder content ^(2, 3)	± 0.3

Notes:

- (1) % by mass of total aggregate.
(2) % by mass of total mix.
(3) Determined in accordance with AS/NZS 2891.3.1.

2.4.3 Asphalt Manufacturing Plant

Operate the asphalt manufacturing plant with adequate production process controls to produce asphalt of a consistent quality and conforming to the requirements of this Specification. The production control system must produce auditable records of key process parameters including individual aggregate and filler feed rates/batch masses, binder application rate/batch mass and various process temperatures.

Implement a documented procedure in the PROJECT QUALITY PLAN for the management and control of the moisture content of each constituent aggregate material.

Disperse uniformly throughout the mix any added RAP materials such that there is no apparent variability or temperature segregation in the mix.

The asphalt manufacturing plant must have sufficient capacity to supply asphalt for continuous operation of the paver.

2.4.4 Storage and Handling**(a) Binder**

Include in the PROJECT QUALITY PLAN the procedures for acquisition, storage and handling of binder which identify and prevent segregation and/or contamination of the binder.

Heating and storage of binder must comply with the temperature and time limits set out in Advisory Note 7 published by AAPA.

At the asphalt manufacturing plant, binder supplied in accordance with TfNSW 3252 must be recirculated in delivery and/or storage tanks to a uniform consistency immediately prior to its use in the manufacturing process.

(b) Asphalt

Asphalt which does not contain RAP material may be retained in hot storage silos for a period not exceeding 24 hours. You may propose for approval by the Principal a longer period, based on effective temperature management and oxidation suppression systems.

Asphalt mixes containing RAP materials may be retained in a purpose designed storage system which has been demonstrated to cause no deterioration in the stored asphalt, for a period not exceeding 24 hours, subject to the approval of the Principal.

2.4.5 Manufacturing Temperatures

Control the temperatures of constituent materials in response to suitable thermometer elements placed in the flow of materials from the drier, and in the binder storage system or binder supply line. Thermometer must be readable and accurate to within $\pm 2^{\circ}\text{C}$.

Measure and record the temperature of the asphalt when:

- (a) asphalt leaves the pugmill or mixing drum; or
- (b) asphalt is being discharged from the hot storage bin(s); or
- (c) in the delivery vehicles, prior to them leaving the plant.

The temperature of asphalt must not at any time in the process exceed 175°C .

Include in the PROJECT QUALITY PLAN details of the project specific process temperatures and the frequency of recording.

2.4.6 Mixes Containing Rhyolite Aggregates

Asphalt mixes containing rhyolite aggregates must comply with Annexure R116/E3.

2.4.7 Sampling and Testing During Production

Verify conformity with the Specification by sampling and testing, and maintain records of your process control during asphalt production.

The frequency of sampling and testing must be in accordance with Annexure R116/L.

Take asphalt samples in accordance with AS/NZS 2891.1.1.

2.5 TRANSPORT OF ASPHALT

Transport of asphalt must be in accordance with AS 2150.

Include in the PROJECT QUALITY PLAN the method of application and control of release agent to ensure a uniform, light coating of the vehicle's tray without ponding of surplus release agent.

Facilitate continuous operation of the paving train by providing sufficient transport capacity and ensuring efficient on-site management of asphalt deliveries.

3 PLACING ASPHALT

3.1 GENERAL

3.1.1 Provision for Traffic

Provide for traffic in accordance with the requirements of Specification TfNSW G10 when carrying out asphalt paving.

3.1.2 Surface Preparation

Prepare the surface to be paved in accordance with AS 2150, including removal of raised extruded thermoplastic road markings and raised pavement markers.

3.1.3 Protection of Road and Services Fixtures

Implement measures to prevent asphalt or other material used on the work from entering or adhering to grates, hydrants or valve boxes, service covers, bridge joints and other road fixtures.

Immediately after the asphalt has been placed, clean and remove all waste asphalt adhering to road and services fixtures.

3.2 TACKCOAT

3.2.1 Existing Surface Condition

The existing surface must be clean, dry and free from loose material, prior to application of the tackcoat.

3.2.2 Application Rate

Apply the tackcoat evenly at a rate of between 0.15 and 0.30 litres of residual bitumen per square metre, ensuring that it is effectively bonded to the surface. For joints and chases, double the application rate.

Nominate in writing to the Principal your proposed tackcoat application rate prior to applying the tackcoat.

Determine the required volume by multiplying the nominated application rate of residual bitumen by the specified area of the surface to be tackcoated, including the faces of joints, kerbs and other structures.

3.2.3 Reduced Application Rate

You may propose in writing to the Principal a reduced application rate for the tackcoat, for reasons arising from the existing underlying surface material. Support your proposal by examples of previous cases where this has been done, including locations and insitu material types and the current pavement performance.

3.2.4 Daily Record

Provide to the Principal a signed daily record of the average tackcoat application rate applied to each Lot. Report the tackcoat application rate in terms of residual bitumen and state the percentage dilution of the tackcoat used during spraying.

3.2.5 Condition of Tackcoat at Commencement of Asphalt Placement

The tackcoat must be intact at the commencement of asphalt placement.

3.3 TEMPERATURE AND WEATHER CONDITIONS

3.3.1 Temperature and Wind Velocity Measurement

Measure and record the temperature of the surface to be paved, and wind velocity at the point of asphalt placing. Document the method and frequency of measurement and recording in the PROJECT QUALITY PLAN.

3.3.2 Conditions Suitable for Placing Asphalt

Do not commence or continue placing asphalt containing binder complying with TfNSW 3253 if the temperature of the surface to be paved over, measured at existing surface level, is less than 8°C where the nominal size of asphalt is less than 20 mm, or less than 5°C where the nominal size of asphalt is 20 mm or greater, for a zero wind speed.

These minimum temperatures are increased by 5°C for asphalt containing binder complying with TfNSW 3252.

These minimum temperatures are increased by a further 5°C for each 5 kph of wind speed above zero; however the minimum temperatures must not exceed 30°C.

Do not place tackcoat and/or asphalt when the surface is wet, and/or when wet weather appears imminent.

3.4 METHOD OF PLACEMENT

3.4.1 General

Your method of placing and finishing the asphalt must:

- (a) produce a homogeneous product with a tightly bound surface;
- (b) achieve a uniform bond to the surface below;
- (c) achieve the finished pavement properties, specified in Clause 5, within the specified tolerances.

Compact uniformly each layer of asphalt to achieve insitu air voids requirements before placing the next layer.

3.4.2 Equipment and Method

Place the asphalt using a self-propelled paver with the ability to be operated with automatic grade control and automatic joint matching facility.

Hand placement of asphalt is only permitted for minor corrections of the existing surface and in areas where placement with a paver is impractical.

Include in the PROJECT QUALITY PLAN the method of achieving conforming compaction, including roller type, number of passes and rolling pattern.

3.4.3 Material Transfer Vehicle

If so specified in Annexure R116/A, use a Material Transfer Vehicle (MTV) in your paving operations to receive asphalt from the delivery vehicles and transfer the asphalt to the paver.

The MTV must be a self-propelled machine with independent controls and demonstrated capability to minimise temperature variation and material segregation. It must be equipped with:

- (a) a receiving hopper compatible with delivery vehicles;
- (b) conveying mechanisms capable of delivering asphalt to the paver at a minimum rate to suit the paving output;
- (c) sufficient power output from the motor to operate with full load on grades up to 6% and travel in tandem with the paver, either directly in front or in an offset position;
- (d) capacity to store and remix asphalt if the time between loading the delivery vehicles at the asphalt plant and unloading at the Site is equal to or greater than 1.5 hours, or when the temperature of the surface to be paved is below the minimum specified in Clause 3.3.

The MTV must discharge into a holding bin in the paver hopper.

3.4.4 Echelon Paving

If so specified in Annexure R116/A, place the asphalt by echelon paving using a minimum of two pavers operating continuously in tandem. Plan the paving run layout, and the location of the hot joint between the two mats placed by the tandem pavers, to minimise the risk of cold joints developing within trafficked lanes, unless otherwise approved by the Principal.

3.5 PAVING AND COMPACTION TEMPERATURES

3.5.1 General

Include in the PROJECT QUALITY PLAN the temperatures at which asphalt can be placed and compacted to achieve the insitu air void requirements specified in Clause 5.3.

HOLD POINT

Process Held:	Commencement of paving using the nominated mix(es), including trial section (refer Clause 3.8).
Submission Details:	If not previously submitted, details of the following: <ul style="list-style-type: none">(a) minimum temperature at which asphalt will be delivered to the paver;(b) minimum temperature at which initial compaction of the asphalt can still commence;(c) method of temperature measurement.
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

3.5.2 Thermometer

Measure the asphalt temperature using a hand held or machine mounted infrared thermometer, which is readable and accurate to within $\pm 2^{\circ}\text{C}$, either at the point of discharge from a tipper truck or at the distribution auger on the paver.

Carry out a daily check of the correlation factor of the hand held infrared thermometer, and at any other time upon the request of the Principal.

3.5.3 Temperature Variation

Do not incorporate in the Works asphalt that exhibits a temperature variation within the batch, unless it has been remixed to a consistent and adequate temperature for placing and compaction.

3.6 COURSE AND LAYER THICKNESSES

3.6.1 Course Thickness

The specified course thickness is detailed in Annexure R116/A, or shown on the Drawings.

Control the course thickness by maintaining the design levels during placing and the surface shape requirements specified in Clause 5.6.

3.6.2 Layer Thickness

Where a course comprises more than one layer, and the layer thicknesses have not been specified on the Drawings, nominate the thickness of each layer in your PROJECT QUALITY PLAN.

The nominated thickness of a layer of asphalt must be between 3.0 to 5.0 times the nominal mix size.

3.6.3 Nonconforming Layer Thicknesses

For corrective courses and tie-ins to an existing pavement, you may propose for approval by the Principal to place layers in thicknesses that does not conform to the specified thickness requirements of Clause 3.6.2.

HOLD POINT

Process Held:	Placing of asphalt in layer thicknesses that does not conform to specified layer thicknesses.
Submission Details:	Details of the following: (a) nominated layer thicknesses which does not conform to specified thicknesses; (b) work methods capable of producing a dense homogeneous layer at these thicknesses; (c) areas affected, and evidence that these areas are the absolute minimum necessary.
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

3.7 JOINTS

3.7.1 Locations

Longitudinal joints must be:

- (a) offset by 150 mm from the joint in the underlying layers;
- (b) located within 150 mm of the line of change in crossfall;
- (c) coincident with final traffic markings, unless otherwise approved by the Principal.

Transverse joints must be:

- (i) located at a minimum of 25 m apart;
- (ii) offset by a minimum of 1 m from the joint in the underlying layer;
- (iii) formed at the commencement of each paving run;
- (iv) formed when a delay in paving causes asphalt temperature to fall below the initial compaction temperature nominated in Clause 3.5.

3.7.2 Procedure

Include in your PROJECT QUALITY PLAN the procedure for the construction of joints. Your procedure must maximise joint density and include mechanised edge compaction or mechanised edge trimming details.

Hand tamping of edges is permitted where the use of a machine is impractical. Do not spread excess material resulting from hand preparation of edges on the surface of the work.

Remove all loose, cracked and/or boney material at the edge of a paved asphalt mat prior to placing the adjacent mat. Do not incorporate asphalt resulting from clean-up of process trimmings in the Works.

Finish each joint with a smooth, planar surface coinciding with the surface of the rest of the mat and satisfying the surface shape requirements specified in Clause 5.6.

3.7.3 Temporary Ramps at Joints

Construct temporary ramps at joints for safe trafficking of the work either by placement of asphalt complying with this Specification, or by cold milling the existing or new asphalt layer to form the ramp, as appropriate for the application.

The length and grade of temporary ramps must be equivalent to those specified for treatment at edges and structures described in Specification TfNSW R101.

3.7.4 Tie-ins to Existing Pavements

Construct permanent tie-ins to existing pavement by placement of asphalt complying with this Specification.

3.8 TRIAL SECTION

3.8.1 General

If so specified in Annexure R116/A, and prior to commencement of paving of the Works, construct a separate trial section using the plant and personnel proposed for the work for each nominated mix.

3.8.2 Location

Each trial section must be located remote from the Works, unless otherwise approved by the Principal. Limit the size of the trial section to the production which can be achieved in one shift (refer Clause 1.3.1 for definition of “shift”).

3.8.3 Conformity Requirements

Design the trial to implement all the procedures described in your PROJECT QUALITY PLAN and demonstrate conformity with the Specification in respect of:

- (a) homogeneity;
- (b) insitu air voids;
- (c) course thickness;
- (d) course position;
- (e) surface shape;
- (f) joint quality;
- (g) ride quality, where specified.

3.8.4 New Trial Section

If there are nonconformities in the trial section, or when the Principal determines that a previous trial is not representative of the materials, asphalt mix proportions, temperature, plant, rate of output and/or method of placement, carry out paving of a new trial section.

3.8.5 Nonconformities

Where a trial section forms part of the Works, manage all nonconformity in respect of materials, process and finished pavement properties in accordance with Clause 5.8.

3.8.6 Hold Point

HOLD POINT	
Process Held:	Commencement of paving at locations other than trial section.
Submission Details:	Verification checklist and all relevant test results from the trial section demonstrating conformity to the specified requirements, at least 3 working days prior.
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

3.9 PROTECTION OF WORK

Protect the asphalt until it has been fully compacted and cooled sufficiently to carry traffic without damage to the work.

Do not induce rapid cooling in the asphalt surface by application of water at any stage in the process, including preparation for trafficking.

4 SAMPLING AND TESTING OF PLACED ASPHALT

4.1 GENERAL

4.1.1 Frequency of Sampling and Testing

Frequency of sampling and testing of placed asphalt must be in accordance with Annexure R116/L.

Show in the PROJECT QUALITY PLAN your method of determining the sampling locations, sampling and testing frequencies and associated test methods.

4.1.2 Lot and Sub-Lot

Carry out compaction control on Lots using statistical techniques as specified in TfNSW Q.

The maximum Lot size must conform to TfNSW Q.

A Lot which is nonconforming may be divided into sub-Lots to exclude sections of the Lot which are conforming.

For the purpose of determining the quantity of nonconforming placed asphalt, the boundaries of a sub-Lots represented by a single tested sample will be the midpoints between the sample point in question, and adjacent sample points.

4.1.3 Samples for the Principal

When the Principal requests loose asphalt samples for testing, riffle and/or quarter the samples.

Deliver all samples, including core samples, in sealed and labelled containers.

4.2 DETERMINATION OF INSITU AIR VOIDS

4.2.1 General

Do not test asphalt layers less than or equal to 30 mm thickness for insitu air voids.

Calculate the characteristic values of insitu air voids in accordance with Annexure R116/K1.

4.2.2 Determination of Bulk Density

Determine the bulk density (BD) from either one of the following methods, but do not use the nuclear density gauge method (see item (b) below) when steel reinforcement exists within 300 mm of the surface of the layer:

(a) Cores

Take cores in accordance with AS 2891.1.2.

When trimming, do not reduce the core layer thickness by more than 5 mm.

Determine the bulk density of cores taken in accordance with AS/NZS 2891.9.2.

(b) Nuclear density gauge

Take measurements in accordance with AS/NZS 2891.14.2 and AS/NZS 2891.14.3.

Determine the bulk density of cores taken for density offset calculations in accordance with AS/NZS 2891.9.2.

Determine the density offset separately for every change in nominated mix and specified layer thickness. Verify that the applied density offset is still valid wherever there is a change in site characteristics, such as underlying surface roughness, composition of underlying layer and density of underlying layer.

Report the density offset on all test reports.

4.3 DETERMINATION OF COURSE THICKNESS

4.3.1 General

Determine course thickness where so specified in Annexure R116/A.

4.3.2 From Cores

Determine the characteristic values and average value of thickness of the Lot using statistical techniques as specified in TfNSW Q from cores taken in accordance with AS 2891.1.2. The cores may be the same as those taken for determination of air voids (refer Clause 4.2), but the core layer thickness is determined prior to trimming of the core.

Where the asphalt is placed in one or more layers to form a single course, determine the course thickness by adding the average thickness from cores of the lower and upper layers.

For the purpose of determining the course thickness from cores, the core diameter can be less than 95 mm and the test specimen may comprise more than one layer.

Calculate the maximum and minimum characteristic values of thickness for the Lot in accordance with Annexure R116/K2.

4.3.3 By Survey

Carry out surveys for product conformity in accordance with Specification TfNSW G71 Clause 5.3.3.

The average compacted course thickness of each Lot calculated from surveys must be consistent with the average compacted course thickness of the respective Lot determined from cores.

Include in your PROJECT QUALITY PLAN the statistical technique for verifying the consistency of the results.

4.4 DETERMINATION OF COURSE POSITION

4.4.1 Finished Surface Levels Not Specified

Where finished surface levels are not specified, determine the course position of each Lot by reference to existing pavement surface and road fixtures.

4.4.2 Finished Surface Levels Specified

Where finished surface levels are specified, measure the course position of each Lot by survey in accordance with TfNSW Q and TfNSW G71 Clause 5.3.3.

4.4.3 Survey Location for Determining Course Position

The survey location of any point on the surface of a course for level determination must be located within 25 mm from the corresponding point determined from the Drawings.

4.5 DETERMINATION OF SURFACE SHAPE

4.5.1 General

Determine and report the surface shape in accordance with Test Method TfNSW T183.

The maximum Lot size must be in accordance with TfNSW Q but extended to include the adjacent longitudinal joints, transverse joints and tie-ins.

4.5.2 Prior to Placing Overlying Course

Prior to placing the next overlying course, determine the surface shape in accordance with Clause 4.5.1. Deal with any conformities in accordance with Clause 5.8.1.

4.6 DETERMINATION OF RIDE QUALITY

4.6.1 General

If specified in Annexure R116/A, determine the ride quality from measurements of the longitudinal profile taken by a vehicular laser profilometer, where the ride quality is the International Roughness Index (IRI_s) determined in accordance with Test Method TfNSW T188.

For this purpose, the Lot is a section within the test lane as defined in the Test Method.

Where the Works comprise a single layer of asphalt placed over a pavement constructed by others, determine and report the ride quality of the existing surface prior to commencement.

The Lots of the existing surface selected must coincide as much as practicable with the Lots of the finished work.

4.6.2 Inspection and Test Plan

Develop an Inspection and Test Plan (ITP) for ride quality that meets the requirements of the Specification. Define the Lots (for ride quality) and the start and end locations for testing in your ITP.

4.6.3 Accreditation Certificates

Provide the Principal with copies of the TfNSW Accreditation Certificates for each proposed vehicular laser profilometer driver and operator.

4.7 TIME FOR SUBMISSION OF TEST RESULTS

Submit to the Principal test reports for:

- (a) combined particle size distribution, binder content and air voids in laboratory compacted mix – within one working day of placing the asphalt;
- (b) insitu air voids, course thickness and course shape – within three working days of placing the asphalt.

4.8 RESTORATION OF CORE HOLES

4.8.1 Materials

Materials used for restoration of core holes must be a bituminous mix, and may be installed either hot or cold in accordance with the product manufacturer's recommendations and suitable for the intended purpose.

Hot dense graded asphalt may be used, provided that the normal hot asphalt temperatures required during transport and placement are maintained throughout the entire process.

Normal cold mix asphalt, and materials which have significantly different stiffness and thermal response to the asphalt (e.g. concrete), must not be used.

Proprietary purpose-designed products may be used to reinstate core holes, subject to the approval of the Principal.

4.8.2 Core Hole Preparation

Prior to their backfilling, prepare the core holes by removing any dirt inside, then brush, sponge and/or vacuum the core hole clean and allow it to dry.

Apply by brush or spray, a heavy coating of rapid set bitumen emulsion or similar material, to the sides and floor of the core hole. Allow the coating material to break or cure prior to placing the fill material.

4.8.3 Core Hole Backfilling

Fill the core holes without segregation or contamination of the fill material in layers not exceeding 50 mm.

Compact each layer without crushing the aggregate particles, using suitable compaction equipment such as motorised hammer, plate compactor, and/or hand tampers.

The finish top surface of the backfill material must not be below the level of the existing pavement.

5 CONFORMITY

5.1 GENERAL

During the first 24 months after the Actual Completion Date:

- (a) the placed asphalt must not ravel, rut, shove, strip or bleed; and
- (b) the wearing course for the first 12 months must comply with the surface shape requirements specified in Table R116.12.

5.2 HOMOGENEITY

Placed asphalt must be homogeneous in appearance, and must not exhibit segregation, cracking, ravelling, bony or fatty material, or have been damaged during construction.

5.3 INSITU AIR VOIDS

The characteristic values of insitu air voids for a Lot must be within the limits shown in Table R116.9.

Table R116.9 – Insitu Air Voids Requirements

Layer Type	Characteristic Values of Insitu Air Voids	
	Lower Limit	Upper Limit
Specified layer thickness:		
> 30 mm and < 50 mm	3.0%	8.0%
≥ 50 mm	3.0%	7.0%

5.4 COURSE THICKNESS

5.4.1 Finished Surface Levels Not Specified

Where the course is a single layer and is placed over an existing pavement constructed by others, the average compacted course thickness for each Lot must be within the tolerances specified in Table R116.10 for the nominal size of asphalt.

Where the course is placed over one or more layers which have been placed by you, the characteristic values of the course thickness for the Lot must be within the tolerances specified in Table R116.10 for the nominal size of asphalt.

Where the asphalt is placed in one or more layers to form a single course, the course thickness calculated in accordance with Clause 4.3.1 must be within the tolerances specified in Table R116.10 for the nominal size of asphalt.

Table R116.10 – Allowable Tolerances for Course Thickness

Nominal Size of Asphalt (mm)	Tolerances (mm)
5	-0 / +5
7	-0 / +5
10	-0 / +6
14	-0 / +8
20	-0 / +10
28	-0 / +12

5.4.2 Finished Surface Levels Specified

The course thickness is deemed to conform if the asphalt course surface levels conform under Clause 5.5.1 (refer also Clause 3.6.1).

The average compacted course thickness of each Lot of the wearing course must be within 10% of the specified course thickness.

5.5 COURSE POSITION

5.5.1 General

The actual surface levels of the placed asphalt course as determined by survey must not deviate from the design levels by more than the tolerances shown in Table R116.11.

Table R116.11 – Course Surface Level Tolerances

Course	Tolerances (mm)
Wearing course	-0 / +10
Top Intermediate course	-5 / +10
Other Intermediate Courses	-10 / +10
Corrective course	-15 / +10

Note: Minus (-) is below design level and plus (+) is above design level.

5.5.2 Matching Existing Surface Levels

Where the new asphalt wearing course is required to match the surface levels of an existing road structure (e.g. tie-in to existing pavement or bridge joints, pavement gutter, utility access point, etc), construct the pavement such that its surface levels match the surface levels of the existing road structure and its surface does not pond water.

Dispositions for nonconformity must be approved before a subsequent course is placed.

5.6 SURFACE SHAPE

The surface of the course including longitudinal and transverse joints must not pond water.

The surface shape of the course within and across traffic lanes must not deviate from the bottom of the straightedge (refer Clause 4.5) laid in any direction by more than the tolerances shown in Table R116.12.

Table R116.12 – Maximum Deviation From Straightedge (mm)

Course	Through Carriageway < 70 kph Traffic Speed, Ramps and Roundabouts	Through Carriageway ≥ 70 kph Traffic Speed
Immediately after placing		
Corrective course	15	10
Intermediate course	10	5
Wearing course	5	3
Prior to placing overlying layer⁽¹⁾		
Corrective course	18	13
Intermediate course	13	8
12 months after placing		
Wearing course	8	6

Notes

⁽¹⁾ If longer than 1 month after placing.

5.7 RIDE QUALITY

The surface of the wearing course must have a smooth longitudinal profile.

When:

- (a) construction of the underlying pavement forms part of the Contract; or
- (b) the course comprises more than one layer of asphalt, including any corrective course, placed over a pavement constructed by others; or
- (c) the aim of the asphalt paving work is to improve the ride quality;

the ride quality of each Lot must not exceed an IRI_S of 1.56 m/km.

Where a single layer of asphalt is placed over pavement constructed by others, the ride quality of each Lot must not exceed the IRI_{Sa} values determined as follows (refer Clause 4.6):

$$IRI_{Sa} = 0.2 + (0.6 \times IRI_{Sb}), \text{ but not less than } 1.56 \text{ m/km}$$

where: IRI_{Sa} is the IRI_S after placing the asphalt layer (m/km)

IRI_{Sb} is the IRI_S before placing the asphalt layer (m/km)

5.8 TREATMENT OF NONCONFORMITIES

5.8.1 General

Where a Lot is nonconforming, submit to the Principal a Nonconformity Report and your proposed disposition for the Lot.

Dispositions for nonconformity of a placed layer must be approved and implemented before a subsequent layer is placed.

Where the surface shape of a surface to be paved has deviations from a straightedge exceeding the maximum deviations stated in Clause 5.6, carry out rectification of those areas before the subsequent layer is placed, unless directed otherwise by the Principal.

5.8.2 Non-homogeneous Work

You may propose to the Principal that placed asphalt which is non-homogeneous and/or contains segregated material be accepted. Any such proposal must be in writing and must:

- (a) state the technical reasons for acceptance;
- (b) show that the asphalt comply with the remaining requirements of the Specification;
- (c) sets out the extent of the nonconforming sub-Lots, taking into account any risk to the ride quality and future performance of the pavement structure.

5.8.3 Nonconforming Particle Size Distribution, Binder Content, Insitu Air Voids and Ride Quality

You may propose to the Principal in writing that Lots that are nonconforming with respect to combined particle size distribution, binder content, insitu air voids and ride quality be accepted with the pre-determined deductions specified in Annexure R116/B2, but subject to the limitations stated in Annexure R116/B2.

5.8.4 Nonconforming Tensile Strength Ratio and Filler-Binder Ratio

You may propose to the Principal in writing that Lots which are nonconforming with respect to tensile strength ratio and filler-binder ratio be accepted, subject to the limitations stated in Annexure R116/B2.

If accepted by the Principal, implement the measures specified in Annexure R116/B2.

5.8.5 Rectification and Replacement

Notwithstanding Clauses 5.8.2 to 5.8.4, the Principal is not bound to accept any proposals for acceptance of nonconforming Lots.

Nonconforming Lots which are not accepted must be either rectified or replaced.

HOLD POINT

Process Held: Rectification or replacement of a nonconforming Lot.

Submission Details: Nonconformity Report and details of your proposal to rectify or replace the Lot.

Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

5.8.6 Cost of Rectification

The cost of rectifying, or removal and replacement, of nonconforming Lots, including any restoration work to any underlying or adjacent surface or structure which becomes necessary as a result of such rectification or replacement, will be borne by you.

ANNEXURE R116/A – PROJECT SPECIFIC REQUIREMENTS

Refer to Clause 1.2.1.

*NOTES TO TENDER DOCUMENTER: (Delete this boxed text after customising Annexure R116/A)**Complete Table R116/A.1 below by filling in the required details.**Where the pavement design details are shown on the Drawings, delete the table in its entirety and replace it with “As shown on the Drawings”. Retain the heading “Table R116/A.1 ...” to provide the context.**Where the pavement design details are not shown on the Drawings, and there are multiple pavement designs, extend Table R116/A.1 as required to show the details of each pavement design.***Table R116/A.1 – Pavement Design Details**

Course	Layer	Nominal Size of Asphalt (mm)	Class of Binder	Specified Thickness (mm)
Wearing course				
Intermediate course	Layer 1			
	Layer 2			
	Layer 3			
	Layer 4			
Corrective course	Layer 1			
	Layer 2			

*NOTES TO TENDER DOCUMENTER: (Delete this boxed text after customising Annexure R116/A)**Complete Table R116/A.2 below by deleting whichever option is not applicable.**For the item under Clause 4.3.1, determination of course thickness is not required for work involving re-sheeting after milling.***Table R116/A.2 – Other Requirements**

Clause	Description	Requirement
2.2.2	Testing required for:	
	- Resilient modulus	Yes / No
	- Wheel tracking depth (as measure of deformation resistance)	Yes / No
3.4.3	Material Transfer Vehicle required for:	
	- Wearing course	Yes / No
	- Intermediate course	Yes / No

Clause	Description	Requirement
3.4.4	Placing by echelon paving required for:	
	- Wearing course	Yes / No
	- Intermediate course	Yes / No
3.8.1	Trial section required	Yes / No
4.3.1	Determination of course thickness required	Yes / No
4.6.1	Measurement of ride quality required for:	
	- Existing pavement	Yes / No
	- Finished pavement	Yes / No
Annex B1	Measurement of asphalt quantity for payment purposes by	Mass / Area

Other Project Specific Requirements:

<i>List here other project specific requirements.</i>

ANNEXURE R116/B – MEASUREMENT AND PAYMENT AND DISPOSITION OF NONCONFORMITIES

Refer to Clause 1.2.2.

B1 MEASUREMENT AND PAYMENT

Payment will be made for all costs associated with completing the work detailed in this Specification in accordance with the following Pay Items.

Where no specific pay items are provided for a particular item of work, the costs associated with that item of work are deemed to be included in the rates and prices generally for the Work Under the Contract.

Unless otherwise specified, a lump sum price for any of these items will not be accepted.

Measurement for payment of asphalt is either by mass or by area, specified in Table R116/A.2 in Annexure R116/A.

(a) Measurement by Mass

Where the quantity of asphalt for payment purposes is measured by mass, the unit of measurement is the “tonne”.

The Principal may approve measurement by batch weights using certified scales. The quantity of asphalt in place in the final work must be mutually agreed using the TfNSW Contract Quantity Agreement Sheet using the tally of the weigh bridge docket of delivered asphalt less the quantity of asphalt not incorporated in the Works.

Truck weighbridge dockets must be issued at a weighbridge certified by the NSW Office of Fair Trading and collected at the point of delivery.

(b) Measurement by Area

Where the quantity of asphalt for payment purposes is measured by area, the unit of measurement is the “square metre”.

The area will be determined from the dimensions shown on the Drawings or by measurements on site if not shown on the Drawings.

Pay Item R116P1 – Tackcoat

The rate must cover all costs associated with the application of the tackcoat in accordance with Clause 3.2, including supply of material and preparation of the surface to be paved.

The quantity of tackcoat for payment purposes is measured by volume and the unit of measurement is the “litre” of residual bitumen. The volume of residual bitumen is determined by applying a factor to the volume of bitumen used as obtained from sprayer tanker dippings.

Pay Item R116P2 – Heavy Duty Dense Asphalt in Corrective Courses

R116P2.1 5 mm Nominal Size

R116P2.2 7 mm Nominal Size

R116P2.3 10 mm Nominal Size

R116P2.4 14 mm Nominal Size

R116P2.5 20 mm Nominal Size

Pay Item R116P3 – Heavy Duty Dense Asphalt in Intermediate Courses

R116P3.1 10 mm Nominal Size

R116P3.2 14 mm Nominal Size

R116P3.3 20 mm Nominal Size

R116P3.4 28 mm Nominal Size

Pay Item R116P4 – Heavy Duty Dense Asphalt in Wearing Courses

R116P4.1 5 mm Nominal Size

R116P4.2 7 mm Nominal Size

R116P4.3 10 mm Nominal Size

R116P4.4 14 mm Nominal Size

**Pay Item R116P5 – Heavy Duty Dense Asphalt Over Existing Pavement
(Levels Not Specified)**

R116P5.1 5 mm Nominal Size

R116P5.2 7 mm Nominal Size

R116P5.3 10 mm Nominal Size

R116P5.4 14 mm Nominal Size

**Pay Item R116P6 – Heavy Duty Dense Asphalt Over Existing Pavement
(Levels Specified)**

R116P6.1 5 mm Nominal Size

R116P6.2 7 mm Nominal Size

R116P6.3 10 mm Nominal Size

R116P6.4 14 mm Nominal Size

Pay Item R116P7 – Deductions and Incentives in accordance with Annexure R116/B2

R116P7.1 Deductions

R116P7.2 Incentives

Deductions and incentives under Pay Item R116P7 are not subject to rise and fall adjustments.

Pay Item R116P8 – Miscellaneous Items**R116P8.1** Resilient Modulus Test**R116P8.2** Wheel Tracking Test

Pay Item R116P8 is only applicable if the above tests are specified to be required in Annexure R116/A. Provide separate rates for each nominated mix.

B2 DISPOSITION OF NONCONFORMITIES

Refer Clause 5.8.

The deduction is applied to the schedule rate for the quantity of nonconforming asphalt in the Lot (or sub-Lot) represented by the test sample(s) and recorded against Pay Item R116P7.1.

B2.1 Combined Particle Size Distribution and Binder Content

Lots which are nonconforming with respect to combined particle size distribution and binder content will not be accepted under the following circumstances:

- (a) where the measured value is more than twice the production tolerance specified in Table R116.8 (refer Clause 2.4.2);
- (b) where the cumulative deductions for each nonconformity with respect to combined particle size and binder content exceed 20%.

For other cases, the deductions shown in Table R116/B.1 will be applied to those nonconforming Lots with respect to combined particle size distribution and binder content which are accepted by the Principal.

Table R116/B.1 – Deductions for Nonconforming Combined Particle Size Distribution and Binder Content⁽¹⁾

Description	Production Tolerance Exceedance⁽²⁾	Deductions (in % of Schedule Rate)
Combined particle size distribution (AS sieve)		
Pass 37.5 mm	Each 2% or part thereof	1%
Pass 26.5 mm	Each 2% or part thereof	1%
Pass 19.0 mm	Each 2% or part thereof	1%
Pass 13.2 mm	Each 2% or part thereof	1%
Pass 9.50 mm	Each 2% or part thereof	1%
Pass 6.70 mm	Each 2% or part thereof	1%
Pass 4.75 mm	Each 2% or part thereof	1%
Pass 2.36 mm	Each 1% or part thereof	1%
Pass 1.18 mm	Each 1% or part thereof	1%
Pass 600 µm	Each 1% or part thereof	1%
Pass 300 µm	Each 1% or part thereof	2%

Description	Production Tolerance Exceedance ⁽²⁾	Deductions (in % of Schedule Rate)
Pass 150 µm	Each 0.5% or part thereof	2%
Pass 75 µm	Each 0.5% or part thereof	2%
Binder content		
20 mm asphalt or smaller	Each 0.1% or part thereof	3%
28 mm and 40 mm asphalt	Each 0.1% or part thereof	2%

Notes:

- (1) Refer Clause 2.4.2 and Table R116.8 for production tolerances.
- (2) For combined particle size distribution: % by mass of total aggregate.
For binder content: % by mass of total asphalt mix.

B2.2 Insitu Air Voids

Lots which are nonconforming with respect to insitu air voids will not be accepted when the maximum characteristic value of insitu air voids exceeds the specified upper limit in Table R116.9 by more than 1.5%.

For other cases, the deductions shown in Table R116/B.2 will be applied to those nonconforming Lots with respect to characteristic insitu air voids which are accepted by the Principal.

Table R116/B.2 – Deductions for Nonconforming Insitu Air Voids

Exceedance of Specified Upper Limit	Deduction (in % of Schedule Rate)
< 0.5%	5%
0.5% – 1.0%	30%
1.1% – 1.5%	50%
> 1.5%	Reject

B2.3 Tensile Strength Ratio

Lots which are nonconforming with respect to Tensile Strength Ratio (TSR) will not be accepted when TSR < 70% and air voids in laboratory compacted mix is nonconforming.

For other cases, comply with Table R116/B.3.

Table R116/B.3 – Requirements for Nonconforming TSR

Condition	Requirements
TSR ≥ 70%, ≤ 80%, and	
(a) previous result ≥ 80%	(i) Promptly implement corrective action, and (ii) Test after implementing corrective action and report results within 4 working days
(b) previous result < 80%	Observe Hold Point

Condition	Requirements
TSR < 70%	Observe Hold Point
Tests not carried out at required frequency, or Test results not reported within specified timeframe, or Corrective action not promptly implemented	Observe Hold Point

Note: For all cases of nonconformity, any reduced minimum frequency of testing reverts back to the specified minimum frequency in Annexure R116/L.

Where a HOLD POINT is required to be observed, investigate the causes of the nonconformity, and propose corrective action to prevent recurrence of future nonconformity.

HOLD POINT

Process Held: Further production of the nominated mix.

Submission Details: (a) Proposed corrective action to achieve conformity.
(b) Test results for insitu air voids and all properties specified in Clause 2.2 of the nonconforming Lot.

Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point, and will advise whether the nonconforming Lot can be accepted.

Do not recommence production of the asphalt until the corrective action has been implemented. Test after implementing corrective action and report results within 4 working days of the resumption of production.

B2.4 Filler-Binder Ratio

Lots which are nonconforming with respect to filler-binder ratio will not be accepted when:

- (a) either the binder content or percentage of aggregate passing 75 µm AS sieve are nonconforming, or
- (b) the individual test result exceeds the design filler-binder ratio of the nominated mix by more than 0.4.

For other cases, the nonconforming Lots may be accepted but corrective action must be implemented at or prior to the following occurrences (with respect to the control chart):

- (i) five points of a five-point rolling mean which are consecutively at above, or consecutively at below, the design filler-binder ratio;
- (ii) five points within a five-point rolling range which are consecutively increasing.

Report immediately the binder film index of all Lots with filler-binder ratio of 1.4 and above.

B2.5 Ride Quality

Lots which are nonconforming with respect to ride quality will not be accepted when the ride quality exceeds the specified limit by more than 0.80 m/km.

For other cases, the deductions shown in Table R116/B.4 will be applied to those nonconforming Lots with respect to ride quality which are accepted by the Principal.

Table R116/B.4 – Deductions for Ride Quality

Exceedance of Specified Limit (m/km)	Deduction (in % of Schedule Rate)
< 0.25	2%
0.25 – 0.43	4%
0.44 – 0.61	8%
0.62 – 0.80	16%

B3 INCENTIVES

If a Lot of wearing course conforms to all requirements of this Specification, and the ride quality is conforming for all three adjacent Lots (for ride quality) in all directions, you may propose to the Principal in writing that pre-determined increases to the schedule rate be applied in accordance with Table R116/B.5 as incentives for improved ride quality of the wearing course.

Table R116/B.5 – Incentives for Ride Quality

Ride Quality Below Specified Limit (m/km)	Incentive (in % of Schedule Rate)
< 0.44	0%
0.44 – 0.61	1%
0.62 – 0.80	2%
> 0.80	3%

The increase is applied as incentive to the schedule rate for the quantity of asphalt in the Lot represented by the test results and recorded against Pay Item R116P7.2.

ANNEXURE R116/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.3.

C1 SCHEDULE OF HOLD POINTS

Clause	Description
2.3.5	Submission of nominated mix design details
3.5.1	Submission of paving and compaction temperature details to achieve conformity
3.6.3	Placing of asphalt in nonconforming layer thicknesses
3.8.6	Submission of verification checklists and test results from trial section
5.8.5	Submission of Nonconformity Report and proposed dispositions
Annex B.2.3	Submission of test results for insitu air voids and other properties, and proposed corrective actions
Annex F	Progression to higher RAP Level

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of TfNSW Q.

Clause	Description of Identified Record
2.1.4 (a)	RAP Management Plan
2.1.6	Documentary evidence of binder conformity for asphalt used in the Works
2.3.3	Nominated mix design details
2.4.3, 2.4.5	Asphalt manufacturing process parameters including process temperatures
3.2.4	Daily record of average tackcoat application rate in each Lot
3.3.1	Surface temperature and weather conditions at time of paving
3.5	Asphalt temperature at time of initial compaction
3.8	Verification checklist and all listed test reports of trial section for each combination of materials, mix proportions, equipment, rate of paving and methods for placement, compaction and finishing

ANNEXURE R116/D – PLANNING DOCUMENTS

Refer to Clause 1.2.4. The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. Review the requirements of this Specification and others included in the Contract to determine additional documentation requirements.

Clause	Planning Documents
2.1	For each constituent material, Lot/stockpile sizes, method of defining each Lot and allocating a unique Lot Number
	Handling and storage of each constituent material
	Nominated particle size distribution and tolerances
2.3	Development and authorisation of nominated mix submission
2.4	For each nominated mix, method of defining each Lot and allocating a unique Lot Number
	Calibration of the asphalt manufacturing plant, including all weigh scales, flowmeters and thermometers
	Storage and handling of binder, including identification and prevention of segregation and/or contamination
	Process control, including plant operating instructions, key temperature targets and records, and response to process control charts
	Control of plant feed proportions, including regular checks on grading and moisture content
	Daily asphalt manufacturing plan to ensure timely and uninterrupted progress on site
2.5	Loading, delivery and unloading procedures that maintain adequate mix temperature and do not interrupt progress of the paving train
	Method of application and control of release agent
3	For each paving and related activity, method of defining each Lot and allocating a unique Lot Number
	Process control for surface preparation, tackcoating, placing asphalt, joint construction, compaction and clean up, including plant operating instructions, key temperature targets and records, patterns for paving and compaction operations, and process monitoring
3.3	Measurement and recording of pavement temperatures and weather conditions
3.4	Allocation of appropriate plant and equipment, including backup in case of breakdown
	Rolling pattern, including roller type and number of passes
3.5	Paving and compaction temperatures
	Calibration of all thermometers and other measuring equipment
3.6.2	Nominated layer thicknesses where not specified on the Drawings
3.7	Procedure for construction joints
3.8	Design, execution and quality verification of trial section
4	Inspection and test plan, including methods and frequencies of sampling, methods and frequencies of testing, verification checklists, and timeframe for submission of test results

ANNEXURE R116/E – USE OF RHYOLITE AGGREGATES IN SKID RESISTANT MIXES

Rhyolite aggregates are currently sourced from Gosforth (near Maitland) in NSW, and are used in skid resistant asphalt mixes.

E1 PHYSICAL PROPERTIES

E1.1 General

Rhyolite aggregates must comply with TfNSW 3152, and the following additional requirements or exceptions under the Clauses E1.2 to E1.4.

E1.2 Polished Aggregate Friction Value

Refer also Clause 2.1.2.

Where rhyolite aggregate is used for its high Polished Aggregate Friction Value, 100% of the coarse aggregates in the asphalt must be rhyolite aggregate.

Rhyolite crusher dust must not be used in the mix.

E1.3 Wet/Dry Strength Variation

Where the wet/dry strength variation exceeds the specified maximum value of 35%, seek advice and approval from the TfNSW Pavements Unit on the use of the rhyolite aggregates.

E1.4 Water Absorption

Water absorption of between 3% and 6%, which occurs in rhyolite aggregates from Gosforth and exceeds the maximum of 2.5% specified in TfNSW 3152, is acceptable but subject to the requirement under Clause E2.5.

E2 MIX DESIGN

E2.1 General

Design of asphalt mixes containing rhyolite aggregates must comply with Clauses 2.2 and 2.3, and the following additional requirements under Clauses E2.2 to E2.5.

E2.2 Air Voids in Laboratory Compacted Mix

(a) Laboratory compacted mix

Refer also Clause 2.2.2.

Air void testing must be done on samples with 80 cycles of gyratory compaction, rather than that stated in Table R116.6.

(b) Production trial

Refer also Clause 2.3.2.

Air void testing must be done on samples with 80 and 350 cycles of gyratory compaction.

E2.3 Oven Conditioning of Asphalt Samples

Where oven conditioning of samples of asphalt containing rhyolite is required by a test method, the conditioning period must be equivalent to the sum total of the estimated storage time (if applicable) plus the haulage time to the job site plus 30 minutes, or a minimum of 1 hour, whichever is the greater.

E2.4 Use of Hydrated Lime

Use of hydrated lime as a constituent material in the asphalt is optional, but the higher dry compacted voids (DCV) of hydrated lime must be considered in the mix design, as this may adversely impact the workability of the mix.

E2.5 Allowance for Higher Binder Absorption

Carry out your mix design using the volumetric principles in AS 2891.8.

Make allowance in the mix design for the higher rate of absorption of binder into the rhyolite aggregate during manufacture and transport.

E3 PRODUCTION

E3.1 General

Asphalt mixes containing rhyolite aggregates must comply with Clause 2.4, and the following additional requirements under Clauses E3.2 and E3.3.

E3.2 Water Absorption

Monitor the water absorption of the rhyolite aggregates during production. If the weighted average aggregate water absorption changes by $\pm 1\%$, re-design the mix and submit a new nominated mix design. The Hold Point in Clause 2.3.5 will again apply.

E3.3 Storage

As the amount of bitumen absorbed by the rhyolite aggregate is time dependent, asphalt mixes containing rhyolite aggregates can be held in hot storage bins for an extended period of time only if an allowance for the reduction in effective bitumen through bitumen absorption has been made in the mix design.

ANNEXURE R116/F – RAP APPROVAL LEVEL PROGRESSION**F1 GENERAL**

To progress from the existing RAP Approval Level to a higher Approval Level, you must demonstrate:

- (a) compliance with this Specification, including the requirements for RAP Level progression set out in Clause F2;
- (b) compliance with the Performance Period (refer Clause 1.3.1 for definition of “Performance Period”) shown in Table R116.4 corresponding to the higher Approval Level applied for.

For asphalt containing PMB, its RAP Approval Level cannot progress beyond Level 1P or 1PW.

For warm mix asphalt containing RAP material, its RAP Approval Level may not progress beyond Level 2 or 2W; or for asphalt containing PMB, beyond Level 1P or 1PW.

HOLD POINT

Process Held: Progression to a higher RAP Approval Level.

Submission Details: Documentation demonstrating compliance with the Performance Period corresponding to the higher RAP Approval Level applied for.

Release of Hold Point: The Principal will consider the submitted documentation prior to authorising the release of the Hold Point.

F2 PROCESS

To progress to a higher RAP Approval Level, demonstrate that you have met the testing requirements in Tables R116/F.1.

Table R116/F.1 – RAP Level Progression Criteria

Stage	Testing
Section A	
At time of nominated mix design submission, thereafter annually	<ol style="list-style-type: none"> (a) Particle size distribution of RAP aggregate washed in solvent and tested in accordance with AS 1141.11.1 (b) Binder content of RAP in accordance with AS/NZS 2891.3.1 (c) Binder recovery of RAP in accordance with either AG:PT/T191 or ASTM D5404 (d) Recovered binder dynamic viscosity at 60°C of RAP in accordance with either AG:PT/T192 or AS 2341.3 (e) Quality of RAP aggregate washed in solvent to comply with TfNSW 3153

Stage	Testing
During asphalt production for contract (frequency: each Lot of RAP used)	(a) Particle size distribution of RAP aggregate washed in solvent and tested in accordance with AS 1141.11.1 (b) Binder content of RAP in accordance with AS/NZS 2891.3.1
During asphalt production for contract (frequency: daily on RAP used in asphalt)	(a) Moisture content of RAP in accordance with AS/NZS 2891.10 (b) Visual monitoring of incoming RAP by a person experienced in the process
Section B	
During asphalt production for contract, including during trial section (frequency: annually and at change in nominated mix design)	All testing required in Section A, plus: (a) Resilient modulus of asphalt containing RAP in accordance with AS/NZS 2891.13.1 (b) Deformation resistance, measured by wheel tracking depth of asphalt containing RAP in accordance with AGPT/T231 (c) Beam fatigue of asphalt containing RAP in accordance with AGPT/T233 (d) Moisture sensitivity of asphalt containing RAP in accordance with TfNSW T649
Section C	
Optimisation testing to establish the optimum mix design, based on performance testing of at least three separate samples of asphalt containing RAP (frequency: annually and at change in nominated mix)	As per Section B

ANNEXURES R116/G TO R116/J – (NOT USED)

ANNEXURE R116/K – CALCULATIONS OF CHARACTERISTIC VALUES

K1 CALCULATION OF CHARACTERISTIC VALUES OF INSITU AIR VOIDS

Calculate the minimum (lower) and maximum (upper) characteristic values, designated V_L and V_U respectively, for insitu air voids of the Lot as follows:

$$V_L = \bar{a} - ks \quad V_U = \bar{a} + ks$$

where: s = standard deviation of sub-Lot air voids, expressed as a percentage

k = value stated in TfNSW Q Annexure Q/L Clause L3.2

\bar{a} = arithmetic mean of insitu air voids, expressed as a percentage, for all sub-Lots

and
$$a = \left(\frac{MD - BD}{MD} \right) \times 100\%$$

MD = mean maximum density of the Lot, with individual maximum density values determined in accordance with AS/NZS 2891.7.1 or AS/NZS 2891.7.3

BD = bulk density of the sub-Lot determined in accordance with:

- (i) AS/NZS 2891.9.2 for cores
- (ii) AS/NZS 2891.14.2 and AS/NZS 2891.14.3 for nuclear density gauge

Round and report the values of V_L and V_U to the nearest 0.1%.

K2 CALCULATION OF CHARACTERISTIC VALUE OF THICKNESS

Calculate the minimum (lower) and maximum (upper) characteristic values, designated T_L and T_U respectively, for thickness of the Lot as follows:

$$T_L = \bar{x} - ks \quad T_U = \bar{x} + ks$$

where: s = the standard deviation of sub-Lot attribute test results

k = value stated in TfNSW Q Annexure Q/L Clause L3.2 (mm)

x = the average height of a core based on measurements taken at four equidistant points at the circumference of the core (mm)

\bar{x} = the arithmetic mean of attribute test results for all sub-Lots (mm)

Round and report the values of T_L and T_U to the nearest whole millimetre.

ANNEXURE R116/L – MINIMUM FREQUENCY OF TESTING

The minimum frequency of testing of constituent materials, and of asphalt during production, placing and in the finished pavement are listed in Tables R116/L.1 to R116/L.5.

Table R116/L.1 – Constituent Material Properties

Clause	Constituent	Minimum Frequency of Testing
2.1.2	Coarse aggregates	As per TfNSW 3152
2.1.3	Fine aggregates	
2.1.4 (a)	RAP material	As per TfNSW 3153 and Annexure R116/F
2.1.4 (b)	Granulated glass aggregates	As per TfNSW 3154
2.1.5	Added fillers	As per TfNSW 3211
2.1.6	Binder	As per TfNSW 3252 and TfNSW 3253
2.1.8	Bitumen emulsion tackcoat	As per AS 1160

Table R116/L.2 – Production Asphalt Properties

Clause	Characteristic	Test Method	Minimum Frequency of Testing
2.1.5	Total filler in asphalt		One per 10,000 tonnes or part thereof used in asphalt production, and at change in source of mineral matter
	- Dry compacted voids	AS/NZS 1141.17	
	- Methylene blue value	TfNSW T659	
2.2.1 (a)	Combined particle size distribution	AS/NZS 2891.3.1	As per Table R116/L.3
2.2.1 (b)	Binder content		
2.2.2	Filler-binder ratio		
2.2.2	VMA at 120 cycles	AS/NZS 2891.2.2, AS/NZS 2891.7.1 or AS/NZS 2891.7.3, AS/NZS 2891.8, AS/NZS 2891.9.2	As per Table R116/L.3
2.2.2	Air voids in laboratory compacted mix		One per shift per mix type
	- at 120 cycles		
	- at 350 cycles		
2.2.2	Moisture content	AS/NZS 2891.10	One per shift per mix type
2.2.2	Moisture sensitivity, measured by TSR	AG:PT/T232 or TfNSW T640	One test for up to 2,000 tonnes or part thereof and thence one test per 5,000 tonnes or part thereof of the production mix
2.4.5	Production temperature of asphalt	Your documented procedure	As per PROJECT QUALITY PLAN
	Despatch temperature of asphalt		Each delivered load

Table R116/L.3 – Minimum Frequency of Testing of Asphalt

Quantity of Asphalt Supplied in Each Shift ⁽¹⁾	Minimum Frequency of Testing
Less than 100 tonnes	One per 50 tonnes or part thereof
101 to 300 tonnes	One per 100 tonnes or part thereof
301 to 600 tonnes	One per 150 tonnes or part thereof
Over 600 tonnes	One per 200 tonnes or part thereof

Note:⁽¹⁾ Refer Clause 1.3.1 for definition of “shift”.**Table R116/L.4 – Asphalt Placing**

Clause	Property	Test Method	Minimum Frequency of Testing
3.2	Tackcoat application rate	Your documented procedure	Each paving Lot
3.3	Surface temperature		One measurement every 2 hours
	Wind velocity		
3.5	Temperature at initial compaction		Each delivered load

Table R116/L.5 – Placed Asphalt Properties

Clause	Property	Test Method	Minimum Frequency of Testing
5.2	Homogeneity	Visual assessment	Each paving Lot
5.3	Insitu air voids	Clause 4.2	As specified for relative compaction > 100.0% in TfNSW Q Clause L3.1
5.4	Course thickness	Clause 4.3	From cores: as for insitu air voids above By survey: as for course position below
5.5	Course position	Clause 4.4	TfNSW G71 Clause 5.3.3
5.6	Surface shape	TfNSW T183	
	- Within lane		One measurement in longitudinal direction and 1 measurement in transverse direction every 60 m ²
	- Longitudinal joint excluding crowns		One measurement per 20 lineal metres or adjacent to within lane measurements whichever is the lesser
	- Transverse joint		One measurement in each wheel path in each lane except at the boundaries of the Site
5.7	Ride quality	TfNSW T188	Each Lot as defined in TfNSW T188

ANNEXURE R116/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.6.

TfNSW Specifications

TfNSW G10	Traffic Management
TfNSW G71	Construction Surveys
TfNSW Q	Quality Management System
TfNSW R101	Cold Milling of Road Pavement Materials
TfNSW 3152	Aggregates for Asphalt
TfNSW 3153	Reclaimed Asphalt Pavement Material
TfNSW 3154	Granulated Glass Aggregate
TfNSW 3211	Cements, Binders and Fillers
TfNSW 3252	Polymer Modified Binder for Pavements
TfNSW 3253	Bitumen for Pavements

TfNSW Test Methods

TfNSW T183	Surface Deviation Using a Straightedge
TfNSW T188	Project Ride Quality (Vehicular Laser Profilerometer)
TfNSW T640	Propensity for Moisture Damage in Asphalt (Specimens moulded in the laboratory)
TfNSW T649	Propensity for Moisture Damage in Asphalt (Cores)
TfNSW T659	Methylene Blue Adsorption Value of Road Construction Material

Australian Standards

AS 1141	Methods for sampling and testing aggregates
AS 1141.11.1	Particle size distribution - Sieving method
AS/NZS 1141.17	Voids in dry compacted filler
AS 1160	Bituminous emulsions for construction and maintenance of pavements
AS 2150	Hot mix asphalt - A guide to good practice
AS 2341.3	Methods of testing bituminous and related roadmaking products - Determination of kinematic viscosity by flow through a capillary tube
AS 2891	Methods of sampling and testing asphalt
AS/NZS 2891.1.1	Sampling - Loose asphalt
AS 2891.1.2	Sampling - Coring method
AS/NZS 2891.2.2	Sample preparation - Compaction of asphalt test specimens using a gyratory compactor
AS/NZS 2891.3.1	Binder content and aggregate grading - Reflux method
AS/NZS 2891.7.1	Determination of maximum density of asphalt - Water displacement method

AS/NZS 2891.7.3	Determination of maximum density of asphalt - Methylated spirits displacement
AS/NZS 2891.8	Voids and density relationships for compacted asphalt mixes
AS/NZS 2891.9.2	Determination of bulk density of compacted asphalt - Presaturation method
AS/NZS 2891.10	Moisture Content of Asphalt
AS/NZS 2891.13.1	Determination of the resilient modulus of asphalt - Indirect tensile method
AS/NZS 2891.14.2	Field density tests - Determination of field density of compacted asphalt using nuclear thin-layer density gauge
AS/NZS 2891.14.3	Field density tests - Calibration of nuclear thin-layer density gauge using standard blocks

Austrroads Documents

AG:PT/T191	Extractions of Bituminous Binder from Asphalt
AG:PT/T192	Characterisation of the Viscosity of Reclaimed Asphalt Pavement (RAP) Binder Using the Dynamic Shear Rheometer (DSR)
AG:PT/T231	Deformation Resistance of Asphalt Mixtures by the Wheel Tracking Test
AG:PT/T232	Stripping Potential of Asphalt - Tensile Strength Ratio
AG:PT/T233	Fatigue Life of Compacted Bituminous Mixes Subject to Repeated Flexural Bending
AG:PT/T237	Binder Film Index
AGPT04B	Guide to Pavement Technology Part 4B: Asphalt

Other Standards

ASTM D5404	Standard Practice for Recovery of Asphalt from Solution Using the Rotary Evaporator
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AAPA Documents

Advisory Note 7	Guide to the Selection, Heating and Storage of Binders for Sprayed Sealing and Hot Mixed Asphalt
IG-3	Asphalt Plant Process Control Guide Reclaimed Asphalt Pavement (RAP) Management Plan