SECTION 407 - DENSE GRADED ASPHALT

~~##This Section cross-references Sections 160, 173, 402, 404, 405, 417, 418, 421, 422, and 801. Sections 160, 173 and 801 should be included in the specification. Sections 402, 404, 405, 417, 418, 421, 422 should be included in the specification as appropriate for the works. If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

407.01 GENERAL

This section covers the requirements for the manufacture and placement of dense graded asphalt, including quality of materials, mix design, supply and placing of the asphalt.

The following Department of Transport and Planning (DTP) Standard Sections shall be read in conjunction with this Section where mixes other than dense graded asphalt are required:

Stone Mastic Asphalt	Section 404
Regulation Gap Graded Asphalt	Section 405
Open Graded Asphalt	Section 417
High Modulus Asphalt (EME2)	Section 418
High Binder Crumb Rubber Asphalt	Section 421
Light Traffic Crumb Rubber Asphalt	Section 422

If any cold milling (planing) is undertaken in association with placing of asphalt, Section 402 shall apply.

407.02 STANDARDS

Documents referred to in Section 407 are listed in Table 407.021.

Any reference made to 'VicRoads' or 'Department of Transport' are taken to mean Department of Transport and Planning.

Table 407.021: Referenced Documents

Australian Standards	
AS 1141.3.1	Methods for sampling and testing aggregates – Sampling - Aggregates
AS 1141.5	Methods for sampling and testing aggregates - Particle density and water absorption of fine aggregate
AS 1141.6.1	Methods for sampling and testing aggregates Particle density and water absorption of coarse aggregate - Weighing-in-water method
AS 1141.6.2	Methods for sampling and testing aggregates Particle density and water absorption of coarse aggregate - Pycnometer method
AS 1141.15	Methods for sampling and testing aggregates – Flakiness Index
AS 1141.17	Methods for sampling and testing aggregates Voids in dry compacted filler
AS 1160	Bituminous emulsions for the construction and maintenance of pavements
AS 1289.3.3.1	Methods of testing soils for engineering purposes Soil classification tests - Calculation of the plasticity index of a soil
AS 2008	Bitumen for pavements
AS 2150	Hot mix asphalt - A guide to good practice
AS 2341.2	Determination of dynamic viscosity by vacuum capillary viscometer
AS/NZS 2891.1.1	Sampling of loose asphalt
AS/NZS 2891.3.1	Methods of Sampling and Testing Asphalt: Binder Content and Aggregate Grading – Reflux Method
AS/NZS 2891.3.3	Methods of Sampling and Testing Asphalt: Binder Content and Aggregate Grading - Pressure Filter Method

Table 407.021 continued next page.

Table 407.021: Referenced Documents (continued)

Australian Standards	
AS/NZS 2891.7.1	Methods of Sampling and Testing Asphalt – Determination of Maximum Density of Asphalt, Water Displacement Method
AS/NZS 2891.10	Methods of sampling and testing asphalt: Moisture Content of Asphalt
AS/NZS 2891.11	Methods of sampling and testing asphalt: Degree of particle coating
AS 3582.2	Supplementary cementitious materials: Slag - Ground granulated blast-furnace
Austroads	
ATS 3050	Supply of Recycled Crushed Glass Sand
ATS 3110	Supply of Polymer Modified Binders
ATS 3125	Fillers for Asphalt
ATS 3135	Supply of Reclaimed Asphalt Pavement
ATS 3471	Supply of Hot Poured Elastomeric Sealants for Pavements
ATS 3472	Sealing of Cracks in Flexible Pavements
ATM 101	Protocol for Sampling of Bituminous Binders and Crumb Rubber
ATM 192	Characterisation of the Viscosity of Reclaimed Asphalt Pavement (RAP) Binder Using the Dynamic Shear Rheometer (DSR)
AGPT/T193	Design of Bituminous Binder Blends to a Specified Viscosity Value
AGPT/T234	Asphalt Binder Content (Ignition Oven Method)
Transport for New South Wales	
T276	Foreign Materials Content of Recycled Crushed Concrete
Department of Transport & Planning	
RC 211.01	Moisture Content of Mixed Asphalt Products
RC 212.01	Recovery of Bituminous Binder from Asphalt for Measurement of Viscosity
RC 370.05	Degradation Factor – Fine Aggregate
RC 372.01	Coarse Aggregate Quality by Visual Assessment
RC 372.04	Foreign Materials in Crushed Concrete
RC 423.02	Measurement of Surface Levels of Pavement Layers
RC 423.02B	Selection of Random Sites for Surface Levels of Pavement Layers
RC 500.01	Registration of Bituminous Mix Designs
RC 500.05	Acceptance of Field Compaction
RC 500.16	Selection of Test Methods for Testing of Materials and Work

Unless stated otherwise, the current version of each referenced document shall apply.

407.03 DEFINITIONS

Added Filler

A fine material, the majority of which passes the 0.075 mm sieve that forms part of the final aggregate grading and is added to the combined asphalt aggregate derived from crushed rock or other similar material. It excludes the natural component of the combined aggregate passing the 0.075 mm sieve.

Asphalt

Asphalt is a designed and controlled mixture of coarse and fine aggregates, filler, binder and other additives which is mixed, spread and compacted to a uniform layer while hot.

Asphalt Base Course

Asphalt base course is that part of an asphalt pavement supporting the intermediate and wearing courses. It rests on the subgrade or pavement subbase.

Asphalt Course

An asphalt course comprises one or more layers of a single asphalt type.

Asphalt Intermediate Course

Asphalt intermediate course is that part of the asphalt pavement immediately under the wearing course. It rests on the asphalt base course.

Asphalt Layer

An asphalt layer comprises a single uniform application of asphalt placed in a single pass of the paver.

Asphalt Pavement

Asphalt pavement comprises the combined thickness of all asphalt courses.

Asphalt Regulating Course

Asphalt regulating course is an asphalt course of variable thickness applied to the road surface to adjust the shape prior to the wearing course or any other bituminous surfacing or re-surfacing.

Asphalt Types (Dense Graded)

Dense graded mixes are designated by a letter indicating their intended use and key materials. Dense graded asphalt types L, N, V and H series mixes are used for wearing courses, and Type S series mixes are used as structural mixes for intermediate and base courses. A brief description of the various types of dense graded asphalt is provided in Code of Practice 500.01.

Asphalt Wearing Course

Asphalt wearing course is the final part of the pavement upon which the traffic travels except for Open Graded Asphalt (OGA) where the wearing course is the layer beneath the OGA.

Assigned Polished Stone Value

The assigned Polished Stone Value (PSV) is a friction rating derived from PSV tests undertaken by the Department of Transport and Planning, which is assigned to each source.

Binder

Binder is bitumen or polymer modified binder (PMB) used to hold a mixture of aggregates together as a cohesive mass.

Binder Film Index

Binder film index is an empirical calculation of theoretical thickness of the binder film around each aggregate particle within the asphalt mix having regard to the aggregate grading, surface area of the aggregates and binder content.

Bulk Density

Bulk density is the mass per unit volume of the compacted mix including the air voids.

Coarse Aggregates

Coarse aggregates are those retained on the 4.75 mm sieve and higher.

Cold Joints

Cold joints are where asphalt is placed against the exposed edge of an existing asphalt mat, where the existing mat has cooled below 95°C for asphalt containing bitumen or below 110°C for asphalt containing PMBs.

Compaction Aid

A chemical additive used to allow compaction of asphalt at low temperatures or improve the workability of mixes.

Density Ratio

The percentage ratio of the field bulk density to the assigned bulk density of the approved laboratory mix design.

Filler

Filler is the portion of aggregates passing the 0.075 mm sieve. It includes the combined mass of crusher dust, any added recycled fines from the asphalt plant dust extraction filters and any added filler.

Fine Aggregates

Fine aggregates are aggregates passing the 4.75 mm sieve and retained on the 0.075 mm sieve.

Hot Joint

A hot joint is a longitudinal joint between two mats that are generally paved in echelon which are compacted simultaneously before the asphalt edge in both mats has cooled below 95°C for asphalt containing bitumen and 110°C for asphalt containing PMBs.

Hot Mix Asphalt (HMA)

Hot Mix Asphalt is asphalt that has been produced at conventional hot mix temperatures, typically above 165°C.

In situ Air Voids

In situ air voids represents the air voids in the field compacted mix. It is based on a ratio of field density to maximum density.

Longitudinal Edge Strip

A longitudinal edge strip is the area of the asphalt layer within 200 mm of a longitudinal edge of the asphalt layer.

Maximum Density (Void free density)

The maximum density is the density that could be achieved in a sample of asphalt if it were possible to compact it to exclude all air voids between coated aggregate particles.

Natural Sand

Natural sand is a fine aggregate material passing the 4.75 mm sieve extracted from natural sand deposits.

Particle Density

Particle density is the mass of a dry particle of aggregate in air divided by volume of the particle of aggregate excluding permeable voids.

Placing

Placing is the spreading and compacting of asphalt, including all necessary ancillary operations.

Reclaimed Asphalt Pavement (RAP) Approval Level

RAP Approval Level describes the range of RAP contents that can be used in a mix and the associated testing required at each level.

Registered Mix

A registered mix is an asphalt mix which has been placed on the DTP Asphalt Mix Design Register under a General or Conditional status.

Rejuvenating Agents

Rejuvenating agents are materials added to RAP mixes to restore the virgin binder and RAP binder blend viscosity to the required level.

Warm Mix Asphalt (WMA)

An asphalt which contains an additive, or uses a manufacturing process, that allows the asphalt mix to be produced and placed at temperatures at least 20°C lower than Hot Mix Asphalt. For a mix to be considered a warm mix asphalt, it should be produced at temperatures less than 155°C for asphalt containing a PMB and less than 145°C for mixes that contain bitumen.

407.04 ASPHALT QUALITY PLAN

In addition to meeting the requirements of Section 160, the Contractor shall provide an asphalt quality plan that addresses the following requirements:

- sourcing, handling and storage of constituent materials
- RAP Management Plan
- asphalt production and process control
- asphalt loading and transportation to minimise segregation and achieve adequate mix temperature on delivery to site
- measuring and recording of pavement temperature, wind speed and weather conditions
- achieving a uniform application of tack coat
- achieving uniform asphalt placement including determination of paving speed and paving plans
- determination of appropriate compaction equipment, number of rollers and rolling patterns required to achieve density
- procedures to maximise density at joints.

407.05 ADDITIVES

(a) Warm Mix Additive

The maximum proportion of warm mix additive shall comply with the limits in Table 407.051

Table 407.051: Maximum Proportion of Warm Mix Additive

Additive Type	Maximum Proportion by Mass of Binder %
Wax	1.5
Chemical surfactants	1.0
Water (applied directly or in the form of crystals containing water)	3.0

(b) Adhesion Agents

The proportion of adhesion agent shall not exceed 1.0% by mass of binder.

(c) Rejuvenating Agents

Rejuvenating agents shall not be added to asphalt mixes.

407.06 AGGREGATES

(a) General

The combined aggregate mixture shall include coarse aggregate, fine aggregate, filler, and any RAP permitted under Clause 407.12.

Aggregate shall be sampled in accordance with AS 1141.3.1.

(b) Source Materials

Source materials including source rock shall comply with the requirements of Section 801.

(c) Coarse Aggregates

(i) Coarse aggregates shall be a mixture of separate sized crushed aggregate fractions.

(ii) The minimum assigned PSV shall comply with the requirements of Section 801.

(iii) The Flakiness Index of each separate sized coarse aggregate fraction, with a nominal size of 10 mm or larger, when tested in accordance with AS 1141.15, shall comply with Table 407.061.

(iv) The unsound and marginal rock of each separate sized aggregate fraction excluding any RAP, shall not exceed the relevant percentages specified in Table 407.061 when tested in accordance with RC 372.01.

(v) The particle density of each separate sized aggregate fraction shall be tested in accordance with AS 1141.6.1 or AS 1141.6.2 and provided by the source quarry.

Table 407.061: Quality of Coarse Aggregates

Type of Asphalt	Flakiness Index (%) (max)	Total of Marginal and Unsound Rock (% by mass) (max)	Unsound Rock (% by mass) (max)
H and V Series	35	8	3
L, N, and S Series	35	10	5

(d) Fine Aggregates

(i) For wearing course mixes fine aggregates shall be a mixture of one or more sands and crushed aggregates which shall be free from lumps and aggregations.

(ii) The particle density of each separate sized aggregate fraction shall be tested in accordance with AS 1141.5 and provided by the source quarry.

(iii) Fine crushed aggregate shall comply with the relevant requirements specified in Table 407.062 and tested in accordance with RC 370.05 and AS 1289.3.3.1.

Table 407.062: Fine Crushed Aggregate Components

Test Value	
Degradation Factor (min)	**Plasticity Index (max)**
60	3

Sand extracted from natural sand deposits shall consist of clean, hard, durable grains free from lumps, clay, mica and organic or harmful matter.

Where a washed natural sand is used in the mix, the Sand Equivalent Value of any such sand supplied for asphalt production shall not be less than 45.

Where unwashed natural sand is used in the mix, the Plasticity Index of any sand supplied for asphalt production shall not be more than 3.

(e) Recycled Crushed Glass Sand (RCGS)

Use of RCGS is permitted as follows:

- up to 5.0% by mass of the total mix in Type L, N, H, V, VP and HP mixes
- as a replacement for the natural sand component in Type SI, SS, SP and SF mixes.

RCGS shall:

(i) comply with the requirements of ATS 3050 excluding Clauses 6.3, 6.4 and 9.3

(ii) meet the Grading Classification Type G of ATS 3050

(iii) contain no more than a total of 2% by mass of contaminants such as paper, corks, metals, ceramics, porcelain and other foreign materials tested in accordance with T276 or RC 372.04.

The Quality Plan and supporting documentation must demonstrate how the requirements of Clause 407.06 (e) have been met.

407.07 FILLER

(a) Dry Compacted Voids

The dry compacted voids for the total combined filler (all filler in the mix including added filler) passing 0.075 mm sieve shall not be less than 38% when tested in accordance with AS 1141.17.

(b) Added Filler

Added Filler shall comply with the requirements of ATS 3125 with the following amendments:

- delete definition of Added Filler in Clause 3.1
- replace references to ATS 3130 with Section 801
- delete reference to ATS 3410
- ground granulated blast furnace slag (GGBFS) must comply with AS 3582.2
- replace Clause 6.3 with:

> The Contractor must ensure that the Added Fillers are tested in accordance with the relevant standards in Table 6.2 and the requirements specified in Table 6.3. For each test (where applicable), the minimum test frequency is as specified in Table 407.151.

407.08 BITUMINOUS MATERIALS

(a) General

The Contractor shall comply with the following requirements for the supply and handling of bituminous binders:

(i) material shall be handled in accordance with the manufacturer's requirements

(ii) a product quality certificate and test report from the manufacturer shall be obtained for each delivery of material

(iii) material shall be transported and stored in such a manner to avoid contamination and in accordance with the manufacturer's recommendations

(iv) on request a binder sample shall be supplied to ~~the Superintendent~~ Council, from the point of binder manufacture/supply, in accordance with the supplier's sampling procedures and the labelling requirements of ATM 101

(v) for asphalt types with no RAP or those containing RAP in accordance with RAP Approval Level 1 as specified in Table 407.121, the class of binder shall comply with Table 407.081.

Table 407.081: Specified Binder Class

Asphalt Type	Specified Binder Class
L	C170[1] / C320
N	C170[1] / C320
H, V, SI and SF	C320
HP, VP and SP	A10E[2]
SS	C600

Notes on Table 407.081

1. For RAP > 15%.
2. A10E shall be used unless otherwise specified in Clause 407.30(e).

(b) Bitumen

All bitumen shall comply with AS 2008.

The viscosity of bitumen recovered from a sample of mixed asphalt prior to placement or from the pavement after compaction shall comply with the requirements specified in Table 407.082 and tested at the frequency specified in Table 407.151. Testing shall be in accordance with RC 212.01.

Table 407.082: Viscosity Range of Bitumen Recovered from Mixed Asphalt

Class of Bitumen	Viscosity Range at 25°C (kPa.s)		
	Wearing Course	Intermediate Course	Base Course
170	200 - 600	-	-
320	500 - 1600	500 - 2300	500 – 3000
600	-	800 - 5500	800 – 5500

(c) Polymer Modified Binder (PMB)

All PMB shall comply with the requirements specified in ATS 3110. Where alternative binders have been permitted through the asphalt mix design approval, the binders shall conform to the requirements set out in that asphalt mix approval.

PMB stored longer than the manufacturer's recommended holding times shall not be used as a modified binder.

(d) Tack Coat

Tack coat shall consist of a bituminous based binder.

Bitumen emulsion used for tack coating shall be a cationic rapid setting type complying with AS 1160. Emulsion diluted with water shall have a bitumen content of not less than 30%.

Proprietary grades of bituminous tack may also be used where it can be demonstrated they will provide an equivalent or better bond between pavement layers compared to a CRS60 emulsion tack and can be applied in a uniform distribution at the residual rates specified in Clause 407.19.

Bituminous tack shall contain no more than two parts of cutter or other hydrocarbon solvent.

407.09 MIX DESIGN

All asphalt mixes proposed for use in the works shall be registered in accordance with RC 500.01.

All mix designs registered with Department of Transport and Planning are issued a status according to compliance as:

General Complies with the requirements of RC 500.01.

Conditional Mixes which do not comply in some respects with the requirements of RC 500.01, but which are considered appropriate for use subject to conditions attached to the registration.

Expired Previously registered mixes which have exceed the registration period. Details are retained in Department of Transport and Planning mix registration system for record purposes.

Withdrawn Mixes which are no longer available for use. Details are retained in the Department of Transport and Planning mix registration system for record purposes.

HP All asphalt mixes proposed for use in the works shall have a mix design registered by Department of Transport and Planning as 'General', unless otherwise approved by the Department of Transport and Planning. The registration for all mixes incorporated into the works shall be current at the time of their use. The Contractor shall submit documentation to ~~the Superintendent~~ Council nominating the asphalt mixes to be supplied no less than 7 days prior to their use.

Approval of a registered mix for use ~~under the Contract~~ does not guarantee the handling properties or performance of the mix nor relieve the Contractor from ~~contractual~~ its obligations regarding rectification of defects.

If a registered mix has unsatisfactory handling or field performance, ~~the Contractor or Superintendent~~ Council may not accept the use of this material. ~~request the mix be de-registered and listed as Withdrawn in accordance with RC 500.01.~~

407.10 TOLERANCES ON MIX PRODUCTION

The tolerance on the binder content in the mix shall be ± 0.3% of the total mix by mass when tested in accordance with AS/NZS 2891.3.1, AS/NZS 2891.3.3 or AGPT/T234.

The production tolerances on the registered mix design grading before compaction shall be as specified in Table 407.101.

Table 407.101: Production Tolerances for Mix Grading

Sieve Size (mm)	Tolerance on Percentage Passing (by mass)			
	Size 7	Size 10	Size 14	Size 20
37.5	Nil	Nil	Nil	Nil
26.5	Nil	Nil	Nil	Nil
19.0	Nil	Nil	Nil	±6
13.2	Nil	Nil	±6	±6
9.5	Nil	±6	±6	±6
6.70 – 4.75	±6	±6	±6	±6
2.36 – 0.600	±5	±5	±5	±5
0.300 – 0.150	±3	±3	±3	±3
0.075	±1.0	±1.0	±1.0	±1.0

Notes on Table 407.101

1. Binder content and aggregate gradings to be undertaken in accordance with AS/NZS 2891.3.1 or AS/NZS 2891.3.3 or AGPT/T234.
2. Tolerances apply to all mix types unless otherwise specified in the relevant standard section or as a condition of mix registration
3. If post compaction grading is checked by binder extraction and sieve analysis after placement, the positive tolerances shall be increased by one percentage point.

407.11 PRODUCTION OF ASPHALT

(a) Temperatures

The temperature of binder and aggregates at the asphalt plant and the temperature of the asphalt as it is discharged from the asphalt plant shall not exceed the limits specified in Table 407.111. Asphalt manufactured at temperatures greater than the limits specified in Table 407.111 shall not be used.

Table 407.111: Maximum Material Storage, Mixing and Asphalt Discharge Temperatures

Material	Temperature °C (max)
Binder plant storage	185[1]
Aggregates before binder is added	200
Asphalt at discharge from asphalt plant	175

Note on Table 407.111

1. This limit may vary in accordance with the binder supplier's recommendations.

(b) Mixing

The mixing period shall be such that at least 99% of the coarse aggregate particles are fully coated with binder. Where requested by ~~the Superintendent~~ Council, testing for particle coating shall be undertaken in accordance with AS/NZS 2891.11.

After completion of mixing, the moisture content of the mix shall not exceed 0.5% when tested in accordance with RC 211.01 or AS/NZS 2891.10.

(c) Hot Storage of Mixed Asphalt

Asphalt types with PMB, C600 and EME binders shall not be stored in hot bins for more than 8 hours prior to use.

All other asphalt types shall not be stored in hot bins for more than 18 hours prior to use, unless otherwise approved by the Department of Transport & Planning.

(d) Warm Mix Asphalt (WMA)

Production, storage, discharge and compaction temperature ranges for warm mix asphalt shall be included in the Contractor's asphalt quality plan.

(e) Asphalt Sampling

Asphalt shall be sampled in accordance with RC 500.16 or AS/NZS 2891.1.1

(f) Assigned Maximum Density

The Assigned Maximum Density of an asphalt mix for a lot shall be the measured maximum density for the days production from the plant that supplied the asphalt mix to that lot. The maximum density shall be measured in accordance with AS/NZS 2891.7.1.

Should a single maximum density result for the production mix vary by more than ± 35 kg/m^3 of its 6-point rolling average, then a check design on the mix volumetrics shall be completed.

Where the check design indicates a significant change to volumetric properties, a re-design shall be undertaken.

407.12 ASPHALT INCORPORATING RAP

(a) General Requirements

RAP shall meet the requirements of ATS 3135 with the following amendments:

- delete references to and all related requirements of ATS 1120, ATS 3130 and ATS 3410
- add reference to AS/NZS 2891.3.3 in Clause 2.1
- delete Clauses 4.3, 6.2 (f) and 7.5
- replace Clause 5.2 with:

  The particle size distribution and materials finer than 75 µm must be determined on the total fraction after removal of the binder using AR grade toluene.

- replace Clause 7.3 with:

  Sampling must be undertaken in accordance with the Contractors ITP and AS 1141.3.1. The sampling and testing must be carried out within a 12-month period prior to the incorporation of RAP into the asphalt manufacturing process.

- add AS/NZS 2891.3.3 for binder content and aggregate grading determination in Table 7.3
- add RC 211.01 for moisture content
- add the following note to Table 7.3.

  (2) Recovered binder viscosity is not required on Type L and N mixes.

(b) RAP Approval Level

No RAP shall be added to mixes containing Polymer Modified or EME2 binders.

In addition to the requirements of 407.12(a), RAP may be added to other asphalt types subject to the following:

(i). the requirements of Clause 407.13 are met
(ii). the RAP content by mass does not exceed the limits shown in Table 407.121 at the designated RAP Approval Level
(iii). for mixes registered at RAP Approval Level 2, RAP binder characterisation and binder blend viscosity adjustments are undertaken in accordance with Clause 407.13(c).

Table 407.121: Permitted RAP Content

Asphalt Type	Permitted RAP Content (% by mass)	
	RAP Approval Level 1	RAP Approval Level 2
L	Up to 15 [1] 16 to 25 [2]	-
N	Up to 15 [1] 16 to 25 [2]	-
H	Up to 15	16 to 20
SI	Up to 15	16 to 30
SS	Up to 15	16 to 30
V	Up to 15	-
SF	Up to 15	16 to 40

Notes on Table 407.121
1. For Type L and N mixes using C320 binder
2. For Type L and N mixes using C170 binder

407.13 RAP MANAGEMENT

(a) RAP Sampling and Testing

In addition to the requirements of ATS 3135 and Clause 407.12(a), for mixes registered at RAP Approval Level 2, characterisation of the viscosity of the RAP lot binder shall be undertaken in accordance with ATM-192, at the frequency specified in Table 407.151.

(b) RAP Process Control

In addition to the requirements of ATS 3135 and Clause 407.12(a), the Contractor shall have documented processes to monitor and manage fluctuations in the aggregate density, moisture content, grading, binder content and binder viscosity of the RAP lot to ensure that the requirements of the specification are met. The following requirements shall also apply:

(i) RAP Grading and binder content: A target grading and binder content shall be established for each RAP component. RAP shall be then produced within the tolerances outlined in Table 407.131.

(ii) RAP Moisture content: The maximum moisture content acceptable for an individual asphalt plant shall be nominated by the Contractor.

(iii) RAP compliance data: The Contractor shall maintain an ongoing system of process control demonstrated by data that shows the RAP processing facility is able to produce RAP to the requirements of the specification and the Contractor's quality plan. This analysis shall be based on:
- 25 continuous data points for asphalt manufacturers seeking registration of mixes at RAP Approval Level 1, and
- 50 continuous data points for asphalt manufacturers seeking registration of mixes at RAP Approval Level 2.

(iv) Allowable deviation from tolerances: the number of test results which constitute a non-conformance for binder content and on each individual sieve for grading that are outside of the permitted tolerances are outlined in Table 407.131.

Table 407.131: RAP Grading and Binder Tolerances

Description	Tolerance	Allowable number of results outside of tolerance
Passing 26.5 mm sieve and larger	± 10	1 out of 5 consecutive results
Passing 4.75 mm to 19.0 mm sieve	± 8	1 out of 5 consecutive results
Passing 1.18 mm and 2.36 mm	± 6	1 out of 5 consecutive results
Passing 0.300 mm and 0.600 mm	± 5	1 out of 5 consecutive results
Passing 0.150 mm	± 3	1 out of 5 consecutive results
Passing 0.075 mm	± 2	1 out of 10 consecutive results
Binder Content (%)	± 0.5	1 out of 10 consecutive results

(c) RAP Binder Blend Viscosity

For RAP Approval Level 2 mixes, the blend of virgin and RAP binder shall be designed to have a viscosity at 60°C that falls within the viscosity range in Table 407.132 for the specified binder class in the nominated asphalt type (as detailed in Table 407.081). The components of the binder blend shall be determined according to AGPT/T193.

To achieve the binder blend viscosity specified in Table 407.132, the Contractor may use a virgin binder class two grades lower (as defined by Australian Standard 2008) than that specified in Table 407.081.

The viscosity of the virgin binder class used in the binder blend calculation shall be determined using either ATM-192 or AS 2341.2.

Table 407.132: Binder Blend Viscosity Range for the Specified Binder Class

Specified Binder Class	Binder Blend Viscosity Range (Pa.s @ 60°C)
C170	170 – 240
C320	320 – 500
C600	600 – 880

(d) Asphalt Plant Capability

Evidence shall be provided that the manufacturing process allows for the controlled addition and mixing of RAP into a plant that has been specifically designed to produce the registered mixes, as governed by the plant manufacturer's specification.

At the asphalt plant the processed RAP shall be stored in stockpiles or cold aggregate storage bins that are covered with a permanent roof and protected from the direction of prevailing weather by permanent walls.

Heating of materials shall be undertaken in such a way to prevent damage to the RAP and virgin binder, but which will ensure binder in the processed RAP is activated. The difference in temperatures between the binder and the aggregate (including RAP) shall be maintained so that it does not exceed 30ºC.

HP **No asphalt containing RAP shall be supplied until the Department of Transport and Planning approved RAP Management Plan has been submitted at least 14 days prior to the asphalt works commencing and approval to proceed is given by ~~the Superintendent~~ Council.**

407.14 RED ASPHALT

Where the works include the provision of red asphalt at the sites as listed in Clause 407.30(i) red asphalt shall conform to the following:

(a) Mix Design and Registration

Mixes shall be designed and registered as per the requirements of Clause 407.09.

(b) Aggregate

Further to Clause 407.06 pink coarse aggregate for the red asphalt shall be obtained from the quarry sources included in Table 407.141.

Table 407.141: Allowable Sources of Pink Aggregate

Source Name	Location
Granite Rock Quarry	Bairnsdale, Victoria
Bald Hills Quarry	Holbrook, NSW

Alternative aggregate sources may be considered by the Department of Transport and Planning depending on the aggregate meeting the requirements of Section 801, and the ability of the aggregate to provide red coloured asphalt to the satisfaction of ~~the Superintendent~~ Council.

(c) Binder

The binder for the red asphalt shall be that specified for the mix type as per Clause 407.08.

(d) Red Oxide Pigment

A minimum of 1% by mass of the binder of red oxide shall be used to colour the binder. Other pigments may be considered by ~~the Superintendent~~ Council.

The Contractor shall provide coloured asphalt samples for approval by ~~the Superintendent~~ Council and these shall be used as the reference to assess the colour of the completed mat. Asphalt samples shall be treated to remove the binder film from the surface aggregate.

407.15 FREQUENCY OF INSPECTION AND TESTING

The frequency of inspection and testing shall not be less than that shown in Table 407.151.

The test frequency for Grading, Degradation Factor, Plasticity Index, Sand Equivalent and Particle Density may be halved where the most recent ten successive test results meet the specified requirements. If any subsequent test result fails, another test shall be immediately undertaken. If the second test fails, the test frequency shall revert to that specified in Table 407.151 and shall not return to half the test frequency until a further ten successive test results comply with the specified requirements.

~~The Superintendent~~ Council shall be informed of a non-conforming result for Binder Content and Grading within 24 hours. For all lots a NATA endorsed certificate shall be provided to the Superintendent within 7 days of completion of the lot.

Table 407.151 Frequency of Inspection and Testing

Checks Required	Minimum Frequency
Aggregates and Fillers	
Particle size distribution of each aggregate and sand component	500 tonnes
Particle size distribution recycled crushed glass sand	500 tonnes
Unsound and marginal rock content	On each day, one per 500 tonnes or part thereof
Degradation Factor of fine aggregate components	2 500 tonnes
Plasticity Index of fine aggregate and natural sand supplied as unwashed sand	2 500 tonnes
Sand Equivalent of natural sand supplied as washed sand	2 500 tonnes
Flakiness Index of coarse aggregate 10 mm and larger	2 500 tonnes
Particle Density of all coarse and fine aggregate components	10 000 tonnes
Added fillers	500 tonnes
Binders	
Compliance against AS 2008 for bitumen	Certification of specification compliance for each delivery of bitumen supplied to the asphalt plant. Testing of viscosity at 60°C, at weekly intervals where bitumen has been stored above 150 ˚C for more than 28 days without the storage tank being topped up by more than 50% of its capacity. In cases where two or more bitumen classes are blended together at the asphalt plant, a viscosity test at 60˚C shall be undertaken prior to use.
Compliance against ATS 3110 for PMBs	Certification of specification compliance for each delivery of PMB supplied to the asphalt plant.
RAP	
RAP Approval Levels 1 and 2: Grading, Binder Content, & Moisture content	One set of tests on a representative sample of RAP for each 500 tonnes of RAP.
RAP Approval Level 2 mixes: RAP binder viscosity characterisation	One test on representative sample of RAP for each 1000 tonnes lot of RAP.
Asphalt	
Scrutiny for segregation, uncoated particles, separated binder, excess binder or overheating before dispatch from the plant	Each loaded truck.
Voids in dry compacted filler	Monthly for a single registered dense graded mix nominated by the supplier for each asphalt plant
Degree of particle coating	As directed by ~~the Superintendent~~ Council
Temperature of asphalt before dispatch from the plant	Each loaded truck or at intervals of 15 minutes if more than one truck is dispatched in 15 minutes.
Binder Content and Full Sieve Analysis of Asphalt (full extraction test)	On each production day: One test per 250 tonnes or part thereof of the asphalt plant production on a representative sample taken from a delivery truck
Maximum Density	On each production day for each asphalt type.
Viscosity of Recovered Bitumen at 25 ˚C	~~As directed by the Superintendent – the~~ The average of three tests where any asphalt mix containing unmodified bitumen is reasonably suspected of being over-heated or over-mixed.

The Contractor shall make available all completed work sheets, checklists and test reports for inspection at the asphalt plant.

407.16 RATE OF DELIVERY

Asphalt shall be placed at a rate that matches the plant and asphalt delivery capacity and ensures continual paving.

407.17 AMBIENT CONDITIONS FOR PLACING

(a) General Requirements

The surface on which asphalt is to be placed shall be essentially dry and free from surface water. Asphalt shall not be placed when the pavement surface is wet, or rain is imminent.

Asphalt shall not be placed when the majority of the area to be paved has a surface temperature less than that detailed in Table 407.171.

Table 407.171: Minimum Pavement Temperatures Prior to Laying Asphalt

Asphalt Type	Intermediate or Base Courses	Wearing Course
All asphalt with a specified binder class of C170 or C320	5°C	10°C
All asphalt with a specified binder class of C600 or containing a PMB	10°C	15°C

(b) Cold Weather Placement

Where approved by ~~the Superintendent~~ Council placement of dense graded asphalt in layers 35 mm or greater may take place at pavement temperatures up to 5ºC below the minimum temperatures specified in Table 407.171 provided that:

(i) The asphalt manufacturer agrees that the requirements of the specification can be met.

(ii) The asphalt is produced using a warm mix technology based on a wax or chemical surfactant as a compaction aid. Evidence shall be supplied of the ability of the process to facilitate compaction at lower temperatures.

(iii) The prevailing wind speeds are less than 30 km/h.

(iv) The asphalt is transported using insulated/heated or double skinned delivery trucks with tight fitting covers.

(v) The minimum temperature of asphalt at the time of discharge into the paver is 145°C for asphalt containing PMBs and 135°C for other mixes.

(vi) The minimum temperature of the asphalt mat at completion of initial breakdown rolling is 110°C for PMBs and 95°C for other binders.

(vii) Additional density testing is undertaken for lots greater than 2,000 m^2. The lot shall be split into two equal sub-lots, representing the first 50% of the lot laid and the last 50% of the lot laid. Compaction testing as per Clause 407.27 shall be undertaken on each sub-lot.

(viii) A job specific inspection and Test Plan ITP is developed which addresses the modified procedures to be used.

(ix) The Contractor personnel are present full time on site to specifically monitor and manage the cold weather paving process.

~~The Superintendent~~ Councill may require a placement trial as detailed in Clause 407.22 to demonstrate that the Contractor's cold weather placement procedures will meet the requirements of this Section.

(c) Cold Weather Placement Management Plan

The cold weather placement management plan shall include as a minimum:

(i) Monitoring frequency of pavement temperature, asphalt temperature at discharge into paver and mat temperature after initial rolling.

(ii) Measures to mitigate risk during the construction process including but not limited to:

a. Asphalt delivery – planning to avoid delays and use of the quickest route to the site, enough trucks to allow continuous paving and avoiding trucks waiting for lengthy periods.

b. Paving – determination of paving width and speed to match roller capacity, measurement of mix temperature prior to discharge, use of material transfer vehicles where practical and a process to cease works where pavement temperatures fall below the minimum requirement.

c. Compaction - modified rolling procedures, additional rollers for surfacing mixes, use of joint compaction devices, monitoring of compaction and mat temperature during laying.

(iii) Quality Records

a. Monitoring of the above measures including method of measurement and frequency of testing.

HP **Prior to commencing cold weather placement of asphalt, the Contractor shall submit a job specific cold weather placement management plan to ~~the Superintendent~~ Council for review.**

~~The Superintendent~~ Council may prohibit cold weather placement at any stage during the works where ~~the Superintendent~~ Council has deemed that the Contractor has not adopted satisfactory measures or demonstrated satisfactory implementation of the cold weather placement plan.

407.18 SURFACE PREPARATION AND RAISING OR LOWERING OF MANHOLE AND VALVE COVERS

(a) Where work ~~under the Contract~~ includes replacement of excavated material with asphalt, any exposed granular pavement material shall be watered, re-compacted and, where specified, primed or heavily tack coated, or given a bitumen emulsion initial seal prior to placing asphalt.

(b) Prior to tack coating and placing of asphalt, the Contractor shall remove all loose and deleterious material and sweep clean the area upon which asphalt is to be placed.

(c) Where specified in Clause 407.30(d), all manhole and valve covers shall be raised or lowered to the new surface level. Where directed by ~~the Superintendent~~ Council temporary ramping around each cover shall be provided and removed in accordance with the requirements of Clause 407.21(f).

407.19 APPLICATION OF TACK COAT

A tack coat shall be applied to all asphalt, concrete or sprayed seals on which asphalt is to be placed.

The tack coat shall achieve an effective bond between the asphalt and the underlying layer.

The application rate for the tack coat shall be 0.15 to 0.30 L/m^2 of residual bitumen (except for joints and chases where rates shall be doubled).

The tack coat shall be:

- applied only to a clean, essentially dry surface, free from surface water
- applied uniformly over the entire road surface
- intact at the time of placing the asphalt.

Before asphalt is placed, sufficient time shall be allowed for the tack coat to break.

Any tack coat not covered by asphalt shall be covered with clean grit or sand before the road is opened to traffic.

Where asphalt is to be spread over a clean, un-trafficked, freshly laid asphalt, or over a clean primed surface, or on a granular material where the overall asphalt depth is 150 mm or greater the Contractor may omit the tack coat.

407.20 DELIVERY OF ASPHALT

(a) General

Delivery of asphalt shall only be made during the hours listed for possession of site.

Asphalt delivered to the site, which is segregated, has been overheated, is too cold, contains separated binder, uncoated particles or which does not comply with the Specification shall be removed from the site.

(b) Delivery Dockets

Delivery dockets shall show:

(i) name of supplier and location of plant
(ii) docket number
(iii) name of user
(iv) project name and location ~~(or contract number)~~
(v) registered number or fleet number of the vehicle
(vi) date and time of loading
(vii) mix or product identifier traceable to the mix registration number
(viii) size and type of asphalt
(ix) empty and loaded mass of the vehicle, or the total of the electronically measured batch weights printed on the docket
(x) class of binder, and proprietary name of modified binder
(xi) temperature of load at the asphalt plant when dispatched.

~~Where asphalt is scheduled for measurement by mass, a copy of the delivery docket for each load shall be provided at the point of delivery or delivered to the Superintendent at the end of each shift.~~

~~Where asphalt is measured by other means and for Lump Sum Contracts, the~~ The Contractor shall make delivery dockets available for inspection on request by ~~the Superintendent~~ Council.

407.21 JOINTS AND JUNCTIONS

(a) General

The location of all joints shall be planned before work commences to achieve the specified offsets between layers and the final position of joints in the wearing course.

The number of joints shall be minimised by adopting good asphalt paving practices. If requested by ~~the Superintendent~~ Council, the Contractor shall produce drawings showing the location of longitudinal joints of asphalt layers in respect to the traffic lane lines.

All joints shall be well bonded and sealed and the surface across the joint shall meet the requirements of Clause 407.29

All cold joints and abutting concrete edges shall be tack coated as per Clause 407.19.

Where cold joints are constructed, any loose or poorly compacted existing asphalt on the exposed edge shall be trimmed back to produce a vertical face of fully compacted asphalt along the exposed edge before fresh asphalt is placed.

(b) Transverse Joints

All transverse joints shall be offset from layer to layer by not less than 2 m.

At the wearing surface where the new and existing pavement join, a hot applied bituminous crack sealant conforming to ATS 3471 shall be applied in accordance with ATS 3472.

(c) Longitudinal Joints

(i) Longitudinal joints in the wearing course shall coincide with the location of intended traffic lane lines.

(ii) Longitudinal joints shall be offset from layer to layer by not less than 150 mm and shall be within 300 mm of the traffic lane line or the centre of traffic lane. Where new pavement abuts an existing full depth asphalt pavement, the existing pavement shall be removed in steps to achieve an offset from layer to layer of not less than 150 mm.

At the wearing surface where the new and existing pavement join, a hot applied bituminous crack sealant conforming to ATS 3471 shall be applied in accordance with ATS 3472.

(iii) Longitudinal joints shall be parallel to the traffic lanes.

Subject to approval by ~~the Superintendent~~ Council, a longitudinal joint in the wearing course may be located up to 150 mm from the traffic lane line, or 150 mm from the centre of a traffic lane.

(d) Joints Against a Granular Pavement

Asphalt joints against a granular pavement shall not be offset between layers but shall form a vertical flush joint.

A tack coat as per Clause 407.19 shall be applied to the vertical surface of the existing pavement.

At the wearing surface where the new and existing pavement join, a hot applied bituminous crack sealant conforming to ATS 3471 shall be applied in accordance with ATS 3472.

(e) Junctions at Limits of Work

At junctions where the new asphalt mat is required to match the level of existing pavement surface at the limits of work, chases shall be cut into the existing pavement by cold milling (planing) as specified in Section 402.

The chase shall be cut by removal of a wedge of asphalt tapering from zero to a depth of 2.5 times the nominal size of the asphalt from the existing pavement to the minimum length as follows:

(i) at side streets and median openings – 600 mm

(ii) on through carriageways with a speed limit of 80 km/h or less – 3 m

(iii) on through carriageways with a speed limit of more than 80 km/h – 6 m.

(f) Treatment of Exposed Edges under Traffic

On completion of each day's work and prior to opening to traffic, the following treatment of exposed edges shall be adopted for asphalt work.

(i) Longitudinal Edges

All longitudinal joints within the trafficked area shall be matched up between paver runs except for a short section required to achieve the minimum offset between transverse joints, unless otherwise approved by ~~the Superintendent~~ Council. Any exposed longitudinal edges within the trafficked area shall be ramped down at a slope of not steeper than 5 horizontal to 1 vertical by constructing a temporary wedge of dense graded or cold mixed asphalt. In unexpected situations such as the sudden onset of inclement weather, a longer length of longitudinal joint may be exposed provided it is ramped down as specified and appropriately signed.

(ii) Transverse Edges

At the end of the paving run in the transverse direction, the new asphalt mat shall be squared up to a straight line and ramped down by constructing a temporary wedge of dense graded or cold mixed asphalt. Temporary ramping shall not be steeper than shown in Table 407.211.

Table 407.211: Maximum Grade of Temporary Ramping

Posted Speed Limit (km/h)	Maximum Ramp Grade (Horizontal to Vertical)
60 or less	30 to 1
> 60	50 to 1

(iii) Removal of Temporary Ramping

Before commencement of each day's work, all temporary ramping shall be removed by cutting back along a straight line to expose a vertical face of fully compacted asphalt at the specified layer depth.

407.22 PLACEMENT TRIAL

Where specified in Clause 407.30(h), the mix, plant, procedures and personnel proposed for the placement of asphalt shall be subjected to a placement trial conforming with the following:

(a) each mix nominated shall be subjected to a separate placement trial

(b) each placement trial may be located within the Works

(c) the size of each placement trial shall be limited to one lot.

The Contractor shall design the trial to implement all the procedures described in the Contractor's quality plan and demonstrate conformance with the Specification.

The Contractor shall submit a copy of the completed inspection and test plan and all relevant test results and records from the placement trial. Prior to further placement ~~the Superintendent~~ Council shall review the outcomes of the placement trial for approval.

In the event of a nonconformance in the placement trial, or when ~~the Superintendent~~ Council determines that a previous trial is not representative of the materials, asphalt mix proportions, asphalt temperature, ambient condition, plant and method of placement, a new trial shall be undertaken prior to placement resuming.

407.23 COMMENCEMENT OF PLACEMENT

HP **The placement of asphalt on the sub-base or granular base for a new pavement or for an overlay of an existing bituminous surfaced pavement shall not commence until approval to proceed is obtained from ~~the Superintendent~~ Council.**

407.24 REGULATING COURSE

A regulating course of asphalt of the type and size specified shall be placed for correction of longitudinal and transverse pavement shape so that the resulting surface is parallel with the finished surface.

407.25 PAVING OF ASPHALT

(a) General

Asphalt shall be spread in layers at the compacted thicknesses shown on the drawings or specified.

(b) Level Control

Asphalt paver screed levels shall be controlled by a suitable combination of manual and automatic controls operating from fixed or moving references.

(c) Spreading by Paver

All asphalt shall be spread with a purpose designed asphalt paving machine to form a uniformly smooth asphalt mat complying with the requirements of Clause 407.29, without segregation, tearing or gouging. In areas inaccessible by a paver, placement of asphalt by other means is permitted.

The width of a single paving run shall not exceed 6 metres unless paving in echelon is proposed or procedures are in place to ensure that a uniform asphalt layer free of segregation can be achieved.

The Contractor shall conduct spreading operations to ensure that the paver speed matches the rate of supply so that stoppages are minimised.

If the paver is required to stop and asphalt in front of the screed cools to below 120°C, a transverse joint shall be constructed.

For asphalt work carried out on a road to be opened for traffic at the completion of work each day, each layer of asphalt shall cover the full width of the trafficked area. The requirements of Clause 407.21(f) shall be followed in respect of the treatment required for exposed edges.

(d) Spreading by Hand

Hand spreading shall only be used for small areas where it is not practical to use a paver.

(e) ~~Echelon Paving~~

~~Where specified in Clause 407.30(g) two or more pavers in echelon shall be used in locations where a full carriageway wider than 6 m is available clear of traffic.~~

~~When paving in echelon the longitudinal joints shall be constructed as hot joints.~~

407.26 COMPACTION

Asphalt shall be uniformly compacted to the standards specified in Clause 407.27. Compaction shall not commence until the asphalt has cooled sufficiently to support the rollers without undue displacement.

Vibratory rolling shall not be used to compact asphalt on bridge decks.

407.27 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF COMPACTION

(a) General

Work shall be tested and accepted for compaction on either a test lot basis as provided in Clause 407.27(b) or on an approved procedural basis as provided in Clause 407.27(c).

Where the total quantity of the size and/or type of asphalt supplied ~~under the Contract~~ exceeds 300 tonnes, compaction shall be tested and accepted on a test lot basis.

Acceptance of compaction for all other asphalt work may be on a procedural basis.

(b) Testing and Acceptance of Compaction on a Lot Basis

(i) Test requirements

The density of extracted cores for the purposes of determining the bulk density for acceptance purposes or to check or assign offsets to a nuclear gauge shall be undertaken in accordance with RC 500.05.

A lot presented for testing shall consist of an asphalt layer which is placed in one shift under uniform conditions and is essentially homogeneous in respect to placement methods, materials and appearance.

Sites for density testing for acceptance of the lot (excluding longitudinal edge strips) shall be selected on a random basis as per RC 500.05.

For lots exceeding 500 m^2, density testing of the longitudinal edge strips for the wearing course shall be undertaken and results reported as a separate lot. Sites for this testing shall be selected as follows:

- The length of all the longitudinal edge strips within a lot shall be added and treated as a continuous length. Six test sites shall be selected so that they are evenly spaced along this length.
- Sites shall not be located within 2 m of a transverse joint.
- Where density is measured using a nuclear gauge, testing shall be undertaken so that the gauge is parallel to the direction of paving and the centre of the nuclear gauge shall be located within ± 50 mm of the centre of the longitudinal edge strip at the selected test location.

For core sample tests, the layer thickness is the mean thickness of the core samples and for nuclear gauge tests, the layer thickness is the nominated layer thickness.

The assigned maximum density of the asphalt shall be determined in accordance with Clause 407.11(f).

(ii) Lot size

For lots with an area less than 50 m^2, acceptance of compaction shall be based on procedures outlined in the Contractor's asphalt quality plan.

Lots between 50 and 500 m^2, the test procedure specified for small areas in Section 173.04 shall apply.

For lots greater than 500 m^2 compaction shall be assessed using the characteristic value of density ratio. Asphalt Density Ratio is defined as the percentage ratio of the characteristic field bulk density to the assigned bulk density of the approved laboratory mix design.

(iii) Characteristic Density Ratio Calculation

The characteristic field bulk density ratio is the calculated value of $\bar{x}$ - 0.92S for six tests per lot where $\bar{x}$ and S are respectively the mean and standard deviation of the individual density ratio test values for the lot.

(iv) Compaction requirements

The work (excluding longitudinal edge strips) represented by a lot of six tests shall be assessed as shown in Table 407.271.

Table 407.271: Limits for Characteristic Density Ratio (Six Tests)

For layers less than 50 mm thick		For layers 50 mm thick or greater	
Characteristic Value of the Density Ratio (Rc)	**Assessment**	**Characteristic Value of the Density Ratio (Rc)**	**Assessment**
95.0% or more	Accept lot subject to no other nonconformances raised for the lot.	96.0% or more	Accept lot subject to no other nonconformances raised for the lot.
~~94.9% to 93.0%~~	~~Lot may be accepted at a reduced rate calculated by P = 15 R_c – 1325~~	~~95.9% to 94.0%~~	~~Lot may be accepted at a reduced rate calculated by P = 15 R_c - 1340~~
~~92.9% or less~~	~~Remove and replace asphalt~~	~~93.9% or less~~	~~Remove and replace asphalt~~

~~**Notes on Table 407.271**~~
~~(Rc) is the Characteristic Value of the density ratio for the lot and (P) is the percentage of the relevant scheduled rate to be paid which shall not be greater than 100%.~~

~~Where the Contract is a lump sum Contract the relevant scheduled rate will be that shown in the 'Rates for Variation Purposes' schedule accompanying the lump sum tender. If no such rate is provided a variation will be considered in accordance with the General Conditions of Contract.~~

The acceptance limits for the Characteristic Value of the Density Ratio applied to the longitudinal edge strips shall be 3 percentage points lower than the values list in Table 404.271.

Unless otherwise approved by ~~the Superintendent~~ Council compaction results shall be supplied to ~~the Superintendent~~ Council within 7 days of asphalt being placed or prior to the placement of any subsequent asphalt layer, whichever is the lesser. Where compaction results are not supplied within this time the asphalt layer shall be considered as non-conforming.

Where one or more individual core thicknesses are less than the relevant values shown in Table 407.272, they shall be discarded, and the acceptance assessment modified in accordance with Table 407.273 provided that there remain at least four test values. The acceptance limits for the Mean Value of the Density Ratio applied to the longitudinal edge strips shall be 3 percentage points lower than the values list in Table 404.273.

Table 407.272: Minimum Thickness of Cores Extracted from the Pavement

Size of Asphalt	Minimum Individual Core Thickness (mm)
7	20
10	25
14	35
20	50

Table 407.273: Mean Density Ratio (less than six cores)

For layers less than 50 mm thickness		For layers 50 mm thickness or greater	
Mean Value of the Density Ratio (Rm)	**Assessment**	**Mean Value of the Density Ratio (Rm)**	**Assessment**
96.5% or more	Accept lot subject to no other nonconformances raised for the lot.	97.0% or more	Accept lot subject to no other nonconformances raised for the lot.
~~94.5% to 96.4%~~	~~Lot may be accepted at a reduced rate calculated by P = 15 Rm – 1348~~	~~95.0% to 96.9%~~	~~Lot may be accepted at a reduced rate calculated by P = 15Rm – 1355~~
~~94.4% or less~~	~~Remove and replace~~	~~94.9% or less~~	~~Remove and replace~~

~~**Notes on Table 407.273**~~
~~(Rm) is the mean of the individual density ratios for the lot and (P) is the percentage of the relevant scheduled rate to be paid which shall not be greater than 100%.~~

(v) In situ Air Voids and Characteristic In situ Air Voids

In situ Air Voids and Characteristic In situ Air Voids shall be reported for each lot.

Percentage In situ Air Voids is defined as the ratio of In-situ Air Voids to the Maximum Density of asphalt. Percentage In situ Air Voids represents the Air Voids of the compacted asphalt as placed onsite, and shall be determined as follows:

$$\text{In situ Air Voids} = \frac{\text{Assigned Maximum density} - \text{Field Bulk Density}}{\text{Assigned Maximum density}} \times 100$$

The Characteristic Value of In situ Air Voids is the calculated value of $\bar{x} + 0.92S$ for six tests per lot where $\bar{x}$ and S are the mean and standard deviation of the individual In situ Air Void test values for the lot, respectively.

(c) Acceptance of Compaction on a Procedural Basis

Where a procedural basis is to be used, the Contractor is required to develop a compaction procedure that has been validated against density testing for the mix placed. Acceptance of work for compaction shall be based on the adoption of these approved placing procedures and a density test check plan that provides for a minimum test frequency of 5% of relevant lots to be tested. The test check plan shall provide for additional testing to demonstrate correction of non-conformance. Placing procedures shall be in accordance with AS 2150.

407.28 TRAFFICKING OF ASPHALT AND PAVING OF MULTIPLE LAYERS

Where trafficking (including construction traffic) results in deformation or any other damage to any asphalt layer, further trafficking shall cease until the asphalt has cooled sufficiently to allow trafficking without further damage. Any damage to the asphalt layers shall be rectified by the Contractor, at the Contractor's expense Additionally, trafficking of Type SF asphalt or placement of asphalt over Type SF asphalt is not permitted unless the majority of the asphalt has a surface temperature below 50°C.

407.29 SURFACE FINISH AND CONFORMITY WITH DRAWINGS

(a) General

For all asphalt works the following requirements shall apply for conformance with shape, location, alignment and width.

(i) Surface Finish

The finished surface of any asphalt course shall be of uniform appearance, free of dragged areas, cracks, open textured patches and roller marks.

(ii) Kerb and Channel

Where asphalt is placed against kerb and channel the surface at the edge of the wearing course shall be either flush with or not more than 5 mm above the lip of the channel.

(iii) Shape

No point on the finished surface of the wearing course shall lie more than 4 mm below a 3 m straight edge laid either parallel to the centreline of the pavement or, except on crowned sections, at right angles to the centreline. For intermediate and base course layers, the distance below the straight edge shall not exceed 6 mm and 10 mm respectively.

(iv) Alignment

Where asphalt pavement is not placed against a concrete edging, the edge of asphalt layers shall not be more than 50 mm inside nor more than 100 mm outside, the designed offset from

centreline or design line. Within these tolerances, the rate of change of offset of the edge of layer shall not be greater than 25 mm in 10 m.

(v) Width

Where asphalt pavement is not placed against a concrete edging, the width of asphalt layers shall not be less than the design or specified width of layer by more than 50 mm or greater than the design or specified width by more than 100 mm. The average width over any 300 m shall not be less than the design or specified width.

(b) Conformity with Drawings for New Pavements and Major Pavement Rehabilitation Projects

For pavement works where design drawings show the finished surface level and thickness of each pavement course, the surface level of each asphalt course shall be measured in accordance with the requirements of Section 173. Every test lot shall meet either a Scale A, B or C requirement as specified in Clause 407.30(b).

Unless otherwise specified in Clause 407.30(f), the maximum lot size for measurement and assessment of surface level shall be 4,000 m².

(i) Scale A and B Surface Level and Thickness Requirements

a. For the surface that the first layer of asphalt is to be placed, surface level measurements shall be taken at random locations over the area of the lot in accordance with RC 423.02 and RC 423.02B. The number of measurements taken within each lot shall not be less that the number specified in Table 407.292.

For each layer of asphalt that is subsequently placed, surface level measurements shall be taken at the same location as used on the previous layer.

b. The mean surface level and the variation in surface level for the base, intermediate and wearing courses within each lot shall meet the requirements of Table 407.293.

Table 407.292: Minimum Number of Level Measurements per Lot

Scale of Surface Level Measurement	Minimum Number of Measurements Per Lot
Scale A	80
Scale B	40

Table 407.293 Mean Surface Level Tolerances for the Sub-base and Pavement Courses

Scale of Surface Level Measurement	Asphalt Layers	
	$\bar{x}$ Range (mm)	Max. S (mm)
Scale A	± 5	8
Scale B	± 8	10

Notes on Table 407.293
$\bar{x}$ is the mean value of all level readings taken in the lot (a negative value designates a measured departure below the design level and positive value designates a surface level above the design level)
S is the standard deviation of all level readings taken in the lot.

~~For Scale A and Scale B level requirements, the Superintendent may agree to accept a lot which does not conform with the limits of Table 407.293 at a reduced payment, in accordance with Table 407.294. The value of the lot of work shall be calculated from the unit rates for pavement construction as specified in Clause 407.30(c).~~

~~Where the surface level tolerances exceed the allowable variation in Table 407.294 rectification of the surface levels shall be undertaken~~

~~HP **Rectification of surface levels shall not commence until approval to proceed is obtained from the Superintendent.**~~

~~**Table 407.294: Payment Deduction for Surface Level**~~

~~**Variation**~~	~~**Payment reduction**~~
~~**Mean ($\bar{x}$)** outside the specified limit up to a maximum of 25% of the limit~~	~~8% plus 4% reduction for each 1 mm the mean value extends outside the tabulated limit~~
~~**Standard Deviation (S)** exceeding the specified limit up to a maximum of 35% of the limit~~	~~8% plus 4% reduction for each 1 mm the Standard Deviation extends outside the tabulated limit~~

~~**Note to Table 407.294**~~
~~If both ($\bar{x}$) and (S) vary by more than the specified limit, the payment reduction shall be the sum of the payment reductions for both ($\bar{x}$) and (S).~~

The total asphalt thickness at each surface level survey point shall be determined by calculating the difference between the final asphalt surface level and the initial surface level on which asphalt was placed, at the same location. At each survey point, the measured total asphalt thickness must be no more than 10 mm less than the specified thickness.

(ii) Scale C Surface Level and Thickness Requirements

Surface level and thickness measurements shall be taken in accordance with the procedure specified in Section 173.06.

The level of the top of each asphalt course shall not differ from the specified level by more than 15 mm for intermediate and base courses and 10 mm for wearing course.

The thickness of each layer shall not deviate from that specified by more than that allowed in 407.029 (b)(iv).

The total asphalt thickness at each survey point must be no more than 10 mm less than the specified thickness.

(iii) Thickness Requirements where no levels specified

Where no levels are specified but a uniform thickness of new asphalt pavement construction is specified the thickness of each layer shall be determined in accordance with Section 173.06.

The thickness of each layer shall not deviate from that specified by more than that allowed in 407.029 (b)(iv).

The total asphalt thickness at each survey point must be no more than 10 mm less than the specified thickness

For the purpose of this Clause, the maximum lot size shall not be more than 4,000 m^2 of pavement area.

(iv) Tolerances for layer thickness

The average compacted layer thickness for each Lot and the thickness of the compacted layer at any point (if the layer being placed is over one or more layers placed by the Contractor) must not vary from the nominated layer thickness by more than the tolerance specified in Table 407.295

Table 407.295: Tolerances for Layer Thickness

Nominal Size of Asphalt	**Layer Thickness Tolerance (mm)**	
	Average Value	**Individual Value at each Survey Point**
7 mm	± 3	± 5
10 mm	± 3	± 5
14 mm	± 4	± 7
20 mm	± 5	± 10

(c) Asphalt Overlays

Where a minimum average or nominal thickness of overlay is specified, and no existing pavement or finished levels are available, the average thickness of the overlay shall be calculated by:

$$T = \frac{M}{D \times A} \times 1000$$

Where:

T is the thickness of overlay in millimetres

A is the area of the job in square metres

D is the mean field density of placed asphalt in tonnes/m^3

M is the mass of asphalt used in tonnes

The average thickness of the overlay shall not be less than the specified thickness

407.30 SCHEDULES OF DETAILS – REFER TO DRAWINGS

*** ~~(a) Asphalt Requirements (Clause 407.09)~~

~~Course~~	~~Layer~~	~~Nominal Size of Asphalt (mm)~~	~~Type of Asphalt~~	~~Specified Layer Thickness (mm)~~
~~Wearing and Regulation~~	~~Open Graded (Section 417)~~	~~##.~~	~~##.~~	~~##.~~
	~~Wearing~~	~~##.~~	~~##.~~	~~##.~~
	~~Regulation~~	~~##.~~	~~##.~~	~~##.~~
~~Intermediate~~	~~Intermediate 1~~	~~##.~~	~~##.~~	~~##.~~
	~~Intermediate 2~~	~~##.~~	~~##.~~	~~##.~~
	~~Intermediate 3~~	~~##.~~	~~##.~~	~~##.~~
~~Base~~		~~##.~~	~~##.~~	~~##.~~
~~Combined Thickness of Asphalt Pavement (less the Open Graded Asphalt Layer)~~				~~##.~~

*** (b) Scale of Level/Thickness Control (Clause 407.29

Road Name	Location	Scale for Level/Thickness Control
All	All	C

~~**Note to Table**: Scale A shall be used unless otherwise approved by the Superintendent.~~

~~*** (c) Basis for Determining the Value of the Lot to be used for Price Deduction for Departure from Specified Density Requirements and Surface Level (Clauses 407.27 and 407.29).~~

~~Location~~	~~Layer~~	~~Unit Price $/m²~~
~~##:~~	~~##:~~	~~##:~~

*** (d) ~~Schedule of~~ Any Manhole and Valve Covers within the works are to be Raised or Lowered to the New Finished Level Prior to Asphalt Overlay

~~Location or Chainage~~	~~Direction or Carriageway~~	~~Lane~~	~~Cover Type (Manhole or Valve)~~
~~##:~~			

(e) Polymer Modified Binder ~~if different to~~ shall be Class A10E (Clauses 407.08) unless otherwise shown on drawings. ~~##[strikethrough if 'default' Class A10E is to be used]:~~

~~*** The class of PMB required in the ##: course shall be Grade ##.~~

(f) ~~Maximum Size of Test Lots if different to 4,000 m² (Clause 407.29b(ii)) ##[strikethrough if the maximum lot size is to be 4,000 m²]:~~

*** The maximum size of test lot for assessment of compaction under Clause 407.27 and if applicable, compliance drawings under Clause 407.29 shall be 4,000 m².

~~(g) Paving in Echelon (Clause 407.25(e))~~

~~*** Two pavers in echelon shall be used on the through carriageways from ##: to ##:~~

~~(h) A placement trial is required for mix type ## (strikethrough if a placement trial is not required)~~

(i) Locations where red asphalt to be placed **– REFER TO DRAWINGS**

~~Location or Chainage~~	~~Direction or Carriageway~~	~~Lanes~~
~~##:~~		

Document Information (Office Use Only)

Criteria	Details
Document number	SS 407:18.0
Document title	Section 407 – Dense Graded Asphalt
Authorised by	Senior Manager, Roads Engineering
Release date	October 2025
Replaces	Section 407 v17.0
Contact	StandardsManagementRD@transport.vic.gov.au
Preface	Under the Transport Integration Act 2010 (Vic) the functions of the Head, Transport for Victoria (Head, TfV) include the development and implementation of standards, guidelines and practices for the public transport system, the road system and related matters. Standards and Guidelines are administered by the Department of Transport and Planning (DTP) on behalf of the Head, TfV. DTP Standards and Guidelines respond to Head, TfV objectives and responsibilities, legislative requirements, Victorian Government policies and guidelines, industry best practice and emerging technologies. Any reference in this document to another document, standard or procedure that is expressed to be a VicRoads, Roads Corporation, Department of Transport (DoT), or DTP document, standard or procedure shall be interpreted and applied as though it was a document, standard or procedure of Head, TfV. Any reference in any such document, standard or procedure to a legal right or obligation of VicRoads, Roads Corporation, DoT or DTP shall be deemed to be a right or obligation of Head, TfV.
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Document History (Office Use Only)

Version	Date	Description
18.0	October 2025	Various updates.
	20 July 2023	Changes to Standard Section 407 include: Allowing up to 5% recycled crushed glass sand in all dense graded asphalt wearing courses Allowing up to 15% RAP (Level 1) in Type V asphalt Removal of Size 14 Type SI Including reference to ATS 3470 Bituminous Pavement Crack Sealing Re-insertion of clauses relating to adhesion & rejuvenating agents inadvertently omitted from published Section 407 Inclusion of new clause requiring density testing to be undertaken within 7 days of asphalt placement.
	July 2022	Updated Table 407.281 Maximum surface temperature of mixes before trafficking or placement. Updated Clause 407.08(d) to note changes to Tack coat - From 1 July 20232 only trackless tack coat or a tack coat application system that prevents pickup of the tack coat must be used
	9 November 2021	Clause 407.06(e) updated to allow recycled crushed glass to be used in Type N and L asphalt mixes. The grading and definition of glass fines has been updated (based on advice from industry feedback) and a requirement for the Contractor to have a quality plan in place to control the supply of glass fines has been included.
	6 July 2021	Update to Type N asphalt Level 1 RAP % (from 20% to 25% for C170 base binder) update to asphalt definitions minor editorial changes removal of Clause 407.30(i), and previous (j) clause updated to (i)
	22 April 2021	Section 407 renamed. Title changed from 'Hot Mix Asphalt' to 'Dense Graded Asphalt'. Key changes include: • incorporation of the findings from an Austroads project that assessed best practice on the use of RAP (reclaimed asphalt pavement) in asphalt • introduction of a "two tier" approach which relates to the amount of RAP that can be incorporated into asphalt mixes with higher levels of RAP in asphalt mixes now permitted • improvement of the sustainability and quality of asphalt being manufactured and placed, through the following - o provision of an asphalt quality plan (407.04) o mandating the use of trackless tack coat by 1 July 2022 (407.08(d)) o allowing the placement of asphalt below the minimum pavement temperatures, subject to a cold weather placement management plan being developed (407.17(b)) o the introduction of joint density testing (initially for information purposes, but with the intention of establishing appropriate specification limits for introduction in future specification updates) – 407.21(b)(i)

		○ increasing the compaction requirements, to achieve higher density (407.27(b)(iv)) ○ introduction of quantity based testing requirements (407.15).
	22 February 2017	Clause 407.22 Requirements for Testing and Acceptance of Compaction To accommodate the use of Section 407 in Minor Works Quotation shells the following change was made. In sub-clause (b) Testing and Acceptance of Compaction on a Lot Basis, the words “Clause 40.2 of the General Conditions of Contract – Valuation of Variations” deleted and replaced with the words “the General Conditions of Contract”.
	4 December 2014	Clause 407.05(a) – title of AS 2008 updated
	8 August 2013	Clause 407.22(b) – two minor editorial changes to 7th paragraph.
	21 May 2013	Editorial changes to types of dense graded asphalts, removal of old terms. Definitions added for Maximum Density and Particle Density. Definition for Void Free Bulk Density removed. Clause 407.03 requirement to provide particle density at regular intervals. Clause 407.06 mix registration status simplified. Registration period changed to three years. Clause 407.111 particle density and maximum density frequency of testing included. Clause 407.22 assigned bulk density based on production. Rolling average of the maximum density. Clause 407.22 percentage in situ voids calculation, removed VFBD, included maximum density.
	24 July 2012	Changes as a result of the publishing of new Section 409 Warm Mix Asphalt. Also includes a minor change to Table 407.052 relating to durability which industry sought earlier in the year.
	8 June 2012	Table 407.223 – change to mean value of density ratio for layers 50 mm thickness or greater.
	18 April 2012	Clause 407.05(a) – in the Notes on Table 407.051, the words ‘PMB Grade A10E’ changed to read ‘PMB Class A10E’. No date change in footer.
	7 July 2011	Insertion of the option to use glass cullet, a crushed recycled glass as a substitute for naturally occurring sands. This was a response to industry and the results from an investigation of the use of glass cullet. Class of Binder M600/170 has been replaced by M500/170 in line with Austroads designations following industry feedback. Insertion of RAP stockpile management requirements for high RAP asphalt mixes. This initiative followed an investigation and report covering RAP management and high RAP asphalt mixes.
	20 April 2011	Clause 407.02 – the words ‘subbase pavement’ changed to read ‘pavement subbase’. No date change in footer.
	27 October 2009	The revised section includes: • a new requirement to report field air voids. The reporting of air voids brings VicRoads in line with other Australian road agencies, and allows us to focus on this important issue for the quality of asphalt. Further information is provided in the Technical Note 98. • includes red asphalt for use in bus lanes. • Clause 407.02 - included definition of 'In situ air voids' • Clause 407.05 - new reference for Polymer Modified Binder • Clause 407.10 - new clause for red asphalt • Clause 407.22 - new requirement to report air voids with density results
	11 December 2008	Clause 407.06 - sentence added to hold point requiring Contractors to only use asphalt mixes registered as ‘General’.
	May 2008	Clause 407.09(c) - cross-reference to 407.09(a)(iv) removed as a result of a change to the Code of Practice. Note: the May 2008 date was not put on this section until 27 August 2008.
	July 2006	Minor editorial changes.
	December 2005	Section amended to accord with VicRoads agreement with AAPA to include Type V asphalt as a suitable alternative to Types HG and SG asphalt, due to the limited availability of multigrade binder.
	October 2005	Editorial correction.
	September 2005	Section rewritten.
	May 2004	Substantial re-write.
	July 2002	Revision of Clause 407.10.
	September 2001	Inclusion of reference to the new Austroads Specification Framework for Polymer Modified Binders. Major revision of Clause 407.10 to allow a substantial increase in the amount of Reclaimed Asphalt Pavement to be used in a number of asphalt mixes.
	July 2000	Table 407.071 – Total Mineral Matter figure of 100 added to Size 20 Mix column.
	July 1998	Table 407.081 - incorrect symbols replaced in Size 28 Mix column. Clause 407.10(b)(i) - Asphalt Type T added
	February 1998	Changes made, but not documented.
	July 1996	Clause 407.05(b) - reference to “Table 407.052” amended to read “Table 407.053”.
	February 1995	Source rock properties now in new Section 801.
	February 1994	Clause 407.03(b) - second last paragraph deleted because it is at odds with QA contracts. The deleted paragraph reads as follows: If at any time the Contractor proposes to obtain source rock from another quarry the

		Superintendent shall be notified in time to undertake additional investigation as may be required. Clause 407.22(b) - third last paragraph reworded.
	July 1993	Clause 407.23(c) - amended to overcome anomaly between 407.23(a) and 407.23(c).
	February 1993	Clause 407.06 - contractor responsibility for mixes highlighted. Clause 407.06 - editorial changes in paragraph order. Also includes timing requirements for submission of mix design details. Clause 407.06 - tender condition (4th paragraph) deleted. Covered by Schedules. Clause 407.10 - editorial. Clause 407.10(d) expanded to cover some detail of the deleted hold point. Clause 407.11 - contractors encouraged to move to statistical control of process at the same time reducing need for quick extraction tests. Tables 407.221 and 407.223 amended to include only acceptance criteria.
	July 1992	Table 407.031 - Editorial changes to table. Clause 407.11 - minimum testing requirements changed to be less restrictive and to recognise that lower frequencies could be satisfactory in cases where a contractor has implemented a system of statistical process control. Includes facility for reduced frequency of testing. Clause 407.16(b) Delivery Dockets - requirement for delivery dockets to show more information. Clause 407.02 Definitions - new definitions for Asphalt Types. Table 407.033 - rationalization of table. Table 407.052 - durability requirement for Class 600 included. Table 407.053 - Class 600 bitumen included. Clause 407.05 - new sub-clause (d) Polymer Modified Binder. Clause 407.10 - redrafted - significant amendment. Clause 407.11 - expanded clause on frequency of testing. Clause 407.16(b) - delivery docket requirements expanded. Clause 407.03(a) - source rock requirements clarified. Clause 407.03(c) - new sub-paragraph (i) - rock quality provisions clarified. Table 407.033 - rationalization of table. Table 407.111 - change to table - reference to "Washington" deleted. Clause 407.03(b) - clarification of source and product quality provisions. Clause 407.03(c) - last paragraph - VIC ROADS Test Method 372.03 deleted Clause 407.13 - Ambient Conditions for Placing - expanded: "for Class 170/320 bitumen or less than 15ºC for Class 600 bitumen and mixes containing polymer modified binders" added to last paragraph.

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