

PAVEMENT MARKING MATERIAL – THERMOPLASTIC

1 SCOPE

- a) This specification applies to Thermoplastic for use as a pavement marking material.
- b) This document is prepared in a manner compliant with the requirements of AS/NZS ISO/IEC 17065.
- c) This type of pavement marking material is applied to the following types of surfaces and areas, both in on-road and off-road applications, in order to increase their safe use:
 - i. Bituminous – Asphalt or Spray Seal roads
 - ii. Concrete roads
 - iii. Paved surfaces
 - iv. Car parks
 - v. Bus lanes, cycle lanes and pedestrian crossings
- d) Safe use of these pavement surfaces is facilitated through:
 - i. Brighter lines to separate traffic on both minor and major roads
 - ii. Introduced order in carparks and public spaces
 - iii. Delineation of roads
- e) APAS® is a trademark registered with IP Australia, owned by CSIRO, the Scheme Owner, and protected under applicable laws. Use of the trademark or the Certification Scheme is prohibited unless prior approval in writing is obtained from CSIRO via the APAS Secretariat.

2 BACKGROUND

- a) To obtain a broad overview of the Australian Paint Approval Scheme (APAS), refer to APAS document AP-D001.
- b) To obtain an overview of restricted ingredients in APAS certified products, refer to APAS document AP-D123.
- c) To obtain the current list of APAS participating manufacturers (and suppliers) and resellers, refer to APAS document AP-D152.
- d) To obtain an overview of how to participate in the APAS, refer to APAS document AP-D177.
- e) APAS approval to this specification may be gained by compliance with the requirements detailed in this specification and those in APAS document AP-D192.

3 DESCRIPTION AND GUIDE FOR USERS

3.1 General Requirements

- a) Pavement marking materials are used by road authorities to:
 - i. Improve road safety and other surfaces used to carry all types of traffic including cars, trucks, pedestrians, cyclists, busses and aircraft.
 - ii. Provide delineation, acting as a guide to drivers to maintain their respective lane position, deterring accidents and providing direction.
- b) Because of these functions, pavement marking materials must withstand many different types of wear and still perform as required.
- c) When selecting a pavement marking material, several performance factors should be considered including, but not limited to, the roadway surface i.e., smooth or

- rough, heat sensitivity, porosity, traffic volume, and environmental conditions.
- d) Pavement marking material durability is dependent on many factors including, but not limited to, traffic volume, location of the lines, application rates, retroreflectivity, performance of the material under various traffic conditions, location of the lines and individual product durability. Depending on the circumstances, centre and lane lines can be painted yearly, and edge lines two-yearly but in high traffic volume areas, such lines can require repainting up to four times a year. More durable materials, such as Cold Applied Plastics and Thermoplastic, have been shown to reduce the frequency in pavement material marking application.
 - e) Thermoplastics are high performance pavement marking materials containing resins that turn to liquid when heated, typically between 180-200°C. They cure quicker in cold weather, slower in hot weather and completely in ambient weather conditions. As products are typically 100% solids, they tend to give equal wet film build to final cured film so are applied at the final required thickness, generally less than 5 mm, typically less than 3mm.
 - f) Thermoplastic application is temperature and mixing dependant, and the manufacturer's guidelines must be followed closely in regard to these factors. All modes of application require surface applied glass beads and/or aggregate in order to achieve initial retroreflectivity and anti-skid properties.
 - g) Issues can arise if proper application temperature is not achieved at the time of installation. If the product is too hot, it can be low in viscosity, produce runaway markings, glass beads can sink in it and the resin can be burned causing discolouration. If the product is too cold, can be brittle and cause poor line quality, poor bead embedment and lack of adhesion to substrate.
 - h) Thermoplastic products are applied at high film build and achieve long life due to the sacrificial nature of the material – it wears quickly, exposing new material, glass beads and aggregate underneath. Degradation of the product occurs due to wear by traffic, weather and UV exposure. This type of product does tend to become brittle with age.
 - i) Thermoplastic products show excellent colour fastness, are quick to dry (less traffic disruption so particularly suited to longitudinal line work) and can be stored and transported safely due to their typical 100% solids nature (minimal to no VOC's or waste disposal issues). They are generally cheaper to use than Cold Applied Plastics, but more expensive than traditional solvent-borne or water-borne paint. This product type is also normally climate extreme resistant, however consideration to formulation used for the application of ATLMS must be considered in tropical climates due to potential slumping issues.
 - j) Thermoplastic products have been widely and successfully used in Australia, the USA and parts of Europe for the last 60+ years.
 - k) Thermoplastics have a lower tendency to pick up dirt due to the self-cleaning, sacrificial properties shown in normal traffic and weathering. This can, however, be

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an issue in underground applications such as kerbs, edge work of tunnel walls, vertical surfaces, cycle and shared paths. The normal self-cleaning process cannot occur, providing a potential trip hazard due to high build edges to pedestrians and cyclists. Under these circumstances, the use of this type of material is not recommended.

- l) Thermoplastics are generally classified by their modes of application (with the exception of Profile):
- Screed:** The material is heated in bulk and mixed in a temperature-controlled pre-heater. This mode is best used in smaller quantity applications. There are three modes of screed application:
 - Hand Screeding:** Using a hand-box screeder.
 - Small Machine Screeding:** Using a small pedestrian machine; used for application of arrows, legends and intersection markings.
 - Large Self-propelled Machine Screeding:** Used for longitudinal work, such as ATLMs.
 - Spray:** Machine applied from a heated and agitated pressure vessel through an air atomised spray gun; easily and quickly applied taking seconds to dry; used for longitudinal lines such as seen in highway application and generally applied at < 1.5 mm thicknesses.
 - Extruded:** Machine applied onto road surfaces using a method of dropping a curtain of material from a slightly elevated head; most common method for longitudinal line application as seen in highway and ATLM applications; is most economical when involving large quantities and is typically applied at thicknesses of 1.5 - 2.5 mm.
 - Preformed:** Applied to surfaces by applying heat, such as with the use of the flame of a blow torch, over markings melting them to between 150-180°C (according to grade and manufacturers recommendations); markings cool rapidly once the heat source is removed so are ready for use in traffic within minutes; markings are pre-manufactured with accurate thickness and are available in sheets in a range of sizes, for example 600 x 900 mm, or precisely pre-cut symbols; they are assembled from flat pack on road surfaces, allowing them to be adjusted into position prior to application; typically used for transverse lines or other markings like legends and symbols but can also be used for longitudinal in limited capacity; this mode of application is best used in smaller quantities.
 - Profile:** Also referred to ATLMs, can be applied by either screed or extruded methods and are generally used in longitudinal line marking and application of ATLMs.
 - Structured:** A number of application patterns can be produced such as splatter, multi-dots, checker board pattern and a dotted lines can be achieved, producing a solid line effect in line marking and may contain intermixed glass beads.
- m) Thermoplastic products typically consist of aggregate, pigment, binder (plasticised synthetic hydrocarbon resin, modified resin esters or alkyd resin-based

compounds), intermix glass beads and extenders, capable of being softened by heating and hardened by cooling. Hydrocarbon thermoplastics (petroleum derived) are more heat stable and better suited to longitudinal markings but can also be used in other types of application. Alkyd-based thermoplastics are typically wood derived and less heat stable thereby needing more care in their handling and heating but do show a higher resistance to oil diesel drippings and greater durability giving higher retroreflectivity values, therefore better suited to intersection work but can also be used in other types of application.

- n) Surface applied glass beads (Types B, B-HR, C, C-HR, D or D-HR) are used in conjunction with thermoplastics to provide retroreflectivity under all conditions. The HR glass bead types have been adopted by the majority of road authorities for use in main road production and maintenance due to their superior retroreflectivity for only a small cost increase. Standard glass beads are generally used in car parking applications. Glass beads are also used in thermoplastic production itself, typically Type C, C-HR, D or D-HR, depending on the end use and give retroreflectivity for the life of the road marking as the product wears over time. Drop On glass beads used in thermoplastics must have an adhesion coating so as to be retained in the product upon application and to improve glass bead retention, otherwise extensive glass bead loss can occur.

NOTE: Glass beads are certified by APAS under specification AP-S0042.

- o) Surface applied anti-skid media are added at the time of production (and can also be added in application if required) to aid in the slip and skid resistance of these products. Anti-skid media typically consists of crushed quartz, crushed glass, calcined bauxite aggregates or other approved materials, typically, but not limited to, cubic sized 0.4-0.7 mm or 1-2 mm (depending on end use) that are angular, polishing-resistant and coloured to match the markings.
- p) Coloured Thermoplastic products are used in a variety of road, line and pavement marking applications:
- White:** Longitudinal line and road markings.
 - Yellow:** Longitudinal line and road markings such as parking restriction lines and markings above the snow line.
 - Red:** Bus lanes.
 - Green:** Cycle lanes and high conflict zones.
 - Various other colours (i.e. blue):** Chevrons, words, numerals and other miscellaneous road markings.
 - Matt Grey and Matt Black:** Typically used to either:
 - Enhance visibility due to lack of contrast between pavement luminance and the marking itself; used in conjunction with concrete or light coloured spray seal and adjacent white or yellow markings; or
 - Applied to road surface with a compatible dark aggregate to black out existing line marking to reduce sheen; or

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- Used for offset ATLM or Profile markings away from the edge line onto the sealed shoulder or under the dividing / centre line in a continuous application and coloured so as to blend into the pavement colour background. They do not provide visibility or contrast so do not contain glass beads.
- q) Any substrate a Thermoplastic product is applied to must be stable as the thermoplastic material itself is not flexible and will crack with movement. The substrate must also be completely dry. If it is not, moisture can then be trapped underneath, causing seam holes to punch through the surface and cause delamination. Some substrate use is better with Thermoplastics than others:
- i. **Asphalt:** As asphalt has a similar melting point to thermoplastic, this is the most compatible substrate to be applied to.
 - ii. **Concrete:** To avoid high adhesion failure seen in application to concrete, it must first be primed with a suitable material and works best when the concrete has initially been either shot or water blasted (smooth surfaces only) to increase the effect of the primer-thermoplastic interface.
 - iii. **Pavers:** Thermoplastic use is not recommended with pavers due to similar issues seen with concrete use, the numerous joints this substrate has, and the inflexibility of the material being applied.
 - iv. **Spray Seal:** Thermoplastic products adhere well to spray seal, particularly when screed applied, but may not be suited to coarse seals.

3.2 Sub-Classes

- a) This specification incorporates the following sub-classes:
- i. **0041/4.1:** Screed
 - ii. **0041/4.2:** Spray
 - iii. **0041/4.3:** Extruded
 - iv. **0041/4.4:** Preformed
 - v. **0041/4.5:** Profile
 - vi. **0041/4.6:** Structured

3.3 Basis of this Specification

- a) This specification is based primarily on AS 4049.2, AS 4049.4, industry standards and specifications, and road authority standards and specifications.

4 DEFINITIONS AND ACRONYMS

4.1 Definitions

The definition of terms used in this document and in the Certification Scheme can be found in APAS document AP-D001. In addition, the following definitions within this document shall apply:

- a) **Agency for Conformity Assessment:** An organisation or testing authority, recognised by APAS, that is either part of the Clients Recognised Manufacturing Unit (RMU) and perform all of the required tests, or a specialist laboratory contracted

either by the APAS Secretariat or by the Client, to carry out specific tests that are beyond the capability of the Client RMU.

- b) **Audio Tactile Line Marking:** Raised ribs applied to the road surface to provide a tactile, audio and visual response, also referred to as a type of profile pavement marking; can be in any colour, but are typically white, grey or black; generally produced with CAP or thermoplastic materials but are not limited to this technology; white ATLMs contain intermix beads. There are historically two types:
 - i. **Continuous:** Raised ribs applied at regular intervals over a base strip layer of the same material; this type is generally not used anymore.
 - ii. **Discontinuous:** Raised ribs placed directly on road surface.
- c) **Certification Scheme:** The Certification system related to specified products (Paint, Surface Coating Materials and Non-Paint Products) to which the same specified requirements, specific rules and procedures apply. APAS is the applicable Certification Scheme.
- d) **Coloured Surface Markings:** Provide a trafficable coloured surface for enhanced delineation for a specific road use i.e., bus lanes, cycleways, school crossings; consist of a coloured thermoplastic used in conjunction with coloured aggregate.
- e) **Longitudinal Line Markings:** All lines that are generally parallel to the traffic flow, such as dividing, barrier, lane, edge, turn, continuity and transition lines and outline markings.
- f) **Pavement Markings:** All longitudinal line markings, transverse line markings and pavement messages for the purpose of guiding traffic.
- g) **Retroreflectivity:** The value of reflected light measured in millicandela / square metre / incident lux (mcd/m²/lx) using a retroreflectometer.
- h) **Scheme Owner:** The organisation responsible for developing and maintaining the certification scheme. CSIRO is the APAS Scheme Owner.
- i) **Secretariat:** The organisation that provides administrative support and other resources necessary to keep the Certification Scheme functioning. The Secretariat is vested in CSIRO.
- j) **Thermoplastic:** A solvent-free pavement marking material, supplied in block, granular or powder form, heated to molten state and applied in the appropriate manner either by hand or mechanical application, forming a cohesive film when cooled.
- k) **Transverse Line Markings:** All lines and markings that are marked at right angles to the traffic flow such as stop and give way lines, turn lines, markings at stop and give way signs, pedestrian crossway lines, diagonal and chevron markings, arrows, shapes, symbols, numerals, parking areas and kerb markings.

4.2 Acronyms

ACE	Agency for Conformity Assessment
APAS	Australian Paint Approval Scheme
ATLM	Audio Tactile Line Marking
CRCL	CSIRO Recognised Competent Laboratory



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CSIRO	Commonwealth Scientific and Industrial Research Organisation
EO	Executive Officer, APAS
PDS	Product Data Sheet
RMU	Recognised Manufacturing Unit
SDS	Safety Data Sheet
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
TDS	Technical Data Sheet
VOC	Volatile organic compounds
WHS	Workplace Health and Safety

5 REFERENCED DOCUMENTS

a) The following standards are referenced in this document:

- i. **AS/NZS 1580** – Paints and related materials: Methods of test.
- ii. **AS/NZS 2009** – Glass beads for pavement-marking materials
- iii. **AS 2700** – Colour standards for general purpose
- iv. **AS 4049.2** – Paints and related materials – Pavement marking materials – Part 2: Thermoplastic pavement marking materials – For use with surface applied beads
- v. **AS 4049.4** – Paints and related materials – Pavement marking materials – Part 4: High performance pavement marking systems
- vi. **AS 4049.5** – Paints and related materials – Pavement marking materials – Part 5: Performance assessment of pavement markings
- vii. **AS 4663** – Slip resistance measurement of existing pedestrian surfaces
- viii. **AS ISO/IEC 17025** – General requirements for the competence of testing and calibration laboratories
- ix. **AS/NZS ISO/IEC 17065** – Conformity assessment: Requirements for bodies certifying products, processes and services

These documents may be purchased through the Reference Standards Australia website:

<https://www.standards.org.au/>

- x. **The Poisons Standard June 2022:** Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) No. 36, Part 2: Control on Medicines and Poisons, Section Seven / Appendix I Paint or Tinters

This document is available from the Australian Government Federal Register of Legislation web site at:

<https://www.legislation.gov.au/Details/F2022L00730>

- xi. **Test Method TP343 – Determination of Skid Resistance with the Micro Griptester** DPTI (Department of Planning, Transport & Infrastructure), Technical Services Group Procedures

This document is available from the DPTI website:

https://www.dpti.sa.gov.au/materials_technology_documents/test_procedures2

b) The following documents were utilised in the creation of this document:

- i. Austroads Technical Specification ATS 4110: Longitudinal Pavement Marking
- ii. NZTA P30: Specification for High Performance Roadmarking, New Zealand Transport Agency
- iii. QA Specification R145 Pavement Marking (Performance Based), Transport for NSW (TfNSW)
- iv. QA Specification 3357 Thermoplastic Road Marking Material, Transport for NSW (TfNSW)
- v. QA Specification 3359 Profile Thermoplastic Road Marking Material, Transport for NSW (TfNSW)
- vi. RIAA Industry Guide: Series 2 – Materials, 2.2 Thermoplastics
- vii. Section 721 – Pavement Markings, VicRoads
- viii. Section 711 – Thermoplastic Traffic Stripes and Markings, Florida Department of Transport
- ix. Section 971 – Pavement Marking Materials, Florida Department of Transport
- x. Section 971 – Traffic Marking Materials, Florida Department of Transport
- xi. Specification 604: Pavement Marking, Main Roads QA
- xii. Specification M16 Application of Pavement Marking, DPTI
- xiii. Transport and Main Roads Specifications MRTS45 Road Surface Delineation, Department of Transport and Main Roads QLD
- xiv. Traffic and Road Use Management Volume 3 – Signing and Pavement Making, Part 4: Materials and Equipment, Department of Transport and Main Roads QLD
- xv. TNZ M/20 Specification for Long-life Roadmarking Materials, Transit New Zealand
- xvi. TNZ P/22 Specification for Reflectorised Pavement Marking, Transit New Zealand

c) The following APAS documents are referenced in this document:

- i. AP-D001 Rules Governing How APAS® Operates
- ii. AP-D114 Rules Governing APAS® Recognition as a Testing Authority
- iii. AP-D123 Restrictions on Ingredients in Product Formulations
- iv. AP-D152 APAS® Participating Manufacturers and Resellers
- v. AP-D177 Rules Governing How Product Manufacturers participate in APAS®
- vi. AP-D181 Volatile Organic Compounds (VOC) Limits
- vii. AP-D192 Rules Governing APAS® Product Certification Scheme
- viii. AP-S0042 Glass beads for Use in Pavement Marking Paints

All APAS documents and specifications are available for download from the APAS website:

<https://vs.csiro.au/apas/documents/>

<https://vs.csiro.au/apas/specifications/>

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6 COMPOSITIONAL AND GENERAL REQUIREMENTS

6.1 Binder

- There are no restrictions placed on the type of binder used in the production of Thermoplastic materials, however they are typically plasticised synthetic hydrocarbon resin, modified resin esters or alkyd resin-based compounds.
- Primary importance is placed on the ability of the binder to be compliant with the technical requirements clause 8, Table 1 below.

6.2 Volatiles

- For VOC content restrictions, refer to APAS document AP-D181.

6.3 Pigmentation

- Pigments used shall be non-toxic, non-corrosive, lead-free and either organic or inorganic in nature (for coloured products), complying with the requirements of the SUSMP.
- Primary importance is placed on the ability of the pigmentation to be compliant with the technical requirements clause 8, Table 1 below.

6.4 Glass Beads

- All glass beads used in the production of any Thermoplastic product, such as (but not limited to) Type C / C-HR (intermix) beads, **must be APAS approved prior** to application of the Thermoplastic product for certification. For further information, refer to APAS specification AP-S0042.
- Evidence of the approval of glass beads used in the production of the Thermoplastic, such as valid, non-expired APAS Certificate of Product Conformity, must be provided at the time of product submission / re-submission.

6.5 Colour

- Longitudinal and transverse pavement markings are typically white and yellow.
- Transverse (and other pavement markings) can also be a variety of colours, typically but not limited to white, yellow, red (bus lanes), green (cycle lanes), blue, grey and black. Refer to the manufacturer's Technical Data Sheet (TDS) or Product Data Sheet (PDS) for further information.

7 PRODUCT APPROVAL REQUIREMENTS

7.1 General Requirements

- The product and its application for approval shall comply with the relevant requirements of this specification and of APAS document AP-D192 during the life of the approval.
- Upon successful assessment of the laboratory component of this specification, CLASS II (interim) certification may be awarded in order to undertake the

field testing component. Three (3) years from date of certificate issue is the timeframe given in order to undertake this work.

- After successful assessment of the field testing component of this specification, CLASS I (full) certification may be awarded for the balance of the standard seven (7) year certification period i.e., 4 years.

7.2 Technical Requirements

- Current Requirements:** All laboratory testing must be completed as per the requirements of clause 8, Table 1 by an ACE. All performance based field testing must be carried out by a CRCL (refer to Note B) within the CLASS II certification period.
- Future Requirements:** All laboratory testing and field testing requirements stated in clause 8, Table 1 must be undertaken by an AS ISO/IEC 17025 accredited laboratory with all applicable test methods included in their Scope of Accreditation. A grace period will exist in order for all testing facilities to achieve AS ISO/IEC 17025 accreditation. This Grace period will end on **31st July 2023**.
- AS ISO/IEC 17025 accreditation shall be provided by an organisation accredited by an ILAC Mutual Recognition Arrangement signatory and having a Scope of Accreditation covering AS ISO/IEC 17025 requirements. In Australia, NATA provides AS ISO/IEC 17025 accreditation. A list of international ILAC accreditation bodies can be found on the ISO website.
- Performance based testing is typically to be undertaken on the **white** product only due to coloured materials representing lower market volumes, making them exempt from field testing. This exemption only exists **provided that** coloured materials are based on the same formulation (specifically the binder system) as the white product. Yellow products of the same formulation can be substituted in the absence of white.
- If a coloured material is the only product seeking certification, then it must also undertake the performance-based testing requirements of clause 8, Table 1.

7.3 Health and Safety Requirements

- The product shall comply with all requirements of clause 6.3 and 6.4 of APAS document AP-D192.
- The manufacturer's Safety Data Sheet (SDS) must be studied closely prior to using the product and complied with during use of the product.
- Products intended for sale in Australia shall comply with all the requirements of the SUSMP. Products intended for sale in other countries shall comply with all local WHS and environmental requirements.



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8 TABLE 1: PERFORMANCE PROPERTIES

TEST:	APPLICABLE STANDARD / TEST REFERENCE:	REQUIREMENTS:
Compositional Requirements NOTE: For Thermoplastic products seeking certification that do not meet the Compositional Requirements below, submissions will be considered on a case by case basis by the APAS EO.		
Minimum Binder Content	AS 4049.2 (clause 5.2, Appendix D and Appendix E)	≥ 18 % w/w - report results.
Glass Bead Content	AS 4049.2 (clause 5.2, Appendix F)	≥ 20 % w/w - report results. NOTE: Intermix beads used in production are dependent on product end use and can be C/C-HR, D/D-HR or other, as specified by manufacturer. Above figure does not include surface applied beads.
Aggregate / Pigment / Extender / Glass Beads (Intermix) Content	AS 4049.2 (Clause 5.2)	≥ 70 % w/w - report results.
Inorganic Material Grading	AS 4049.2 (clause 5.3 and Appendix F) AS 1152	100% pass through 2.8 mm sieve - report results.
Laboratory Testing Requirements ^A – Applicable to all Sub-classes		
Colour	AS 4049.2 (clause 6.1 and Appendix D) AS/NZS 1580.601.1 AS 2700	<p>White: Approximate match to N14 White. Alternative colour is whiter than Y35 Off white.</p> <p>Yellow: Approximate match to Y14 Golden Yellow. Alternative colours are Y12 Wattle, Y13 Vivid Yellow or Y15 Sunflower.</p> <p>Red: Approximate match to R13 Signal Red. Alternative colours are R53 Redgum, R54 Raspberry or R62 Venetian Red.</p> <p>Blue: Approximate match to B21 Ultramarine. Alternative colours are B12 Royal Blue, B23 Bright Blue, B24 Harbour Blue or B41 Bluebell.</p> <p>Green: Approximate match to G13 Emerald Green. Alternative colours are G16 Traffic Green, G23 Shamrock or G35 Lime Green.</p> <p>Black: Approximate match to B64 Charcoal. Alternative colour is N61 Black.</p> <p>NOTE:</p> <ul style="list-style-type: none"> Alternative colours (i.e., grey) may also be tested as per requirements of road authorities. Colours must be compared to and equivalent to a known AS 2700 colour. State colour designation and results. No glass beads (intermix or surface applied) are typically used with grey and black coloured materials. Report all results.



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TEST:	APPLICABLE STANDARD / TEST REFERENCE:	REQUIREMENTS:
Laboratory Testing Requirements^A – Applicable to all Sub-classes (Cont..)		
Luminance Factor	AS 4049.2 (clause 6.2, Appendix D and Appendix G)	<p>White: ≥ 80 % - report results. Yellow: ≥ 45 – ≤ 50 % - report results. Red: ≥ 5 – ≤ 15 % - report results. Blue: ≥ 5 – ≤ 15 % - report results. Green: ≥ 5 – ≤ 15 % - report results. Black: ≤ 5 % - report results. Grey: ≥ 5 – ≤ 15 % - report results. Other Colours: ≥ 5 – ≤ 15 % - report results.</p> <p>NOTE: Exceptions to the above luminance range values will be assessed on a case by case basis depending on end user requirements within the AS 2700 colour range.</p>
Heat Stability	AS 4049.2 (clause 6.3 and Appendix H)	<p>White: ≥ 75 % - report results. Yellow (and other colours): ≥ 40 % - report results.</p>
Softening Point	AS 4049.2 (clause 6.4) AS 2341.18	<p>0041/4.5: ≥ 95°C - report results. All other subclasses: 85-105°C - report results.</p> <p>NOTE: Alternative temperature ranges will be considered on a case by case basis by the APAS EO as any new product innovations develop.</p>
Abrasion Resistance	AS 4049.2 (clause 6.5) AS/NZS 1580.403.2	<p>Test run using CS17 abrasion wheels, 1000g applied weight. ≤ 0.4g weight loss after 500 cycles - report results.</p>
Flow Resistance	AS 4049.2 (clause 6.6 and Appendix I)	<p>0041/4.5: ≤ 5% - report results. All other subclasses: ≤ 10% - report results.</p>
Density	AS 4049.2 (clause 6.7 and Appendix J)	<p>≤ 0.05 kg/L variance from manufacturers stated values - report results.</p>
Volatile Organic Content (VOC)	APAS AP-D181	<p>Refer to APAS document AP-D181 for method and limits. If the APAS specification is not listed on AP-D181, a declaration of VOC content is still required.</p>



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TEST:	APPLICABLE STANDARD / TEST REFERENCE:	REQUIREMENTS:
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Performance Based Testing Requirements (Field Testing) ^{A, B}

Setting up Performance Based Testing: Applicable Standard / Test Reference and Requirements

- Refer to AS 4049.2 (clause 8.1 and Appendix K)
- Products applied with the following parameters depending on application type:
 1. **Screed:** 3 mm ± 1 mm WFT (or manufacturer's specified wet/dry film thickness) using B-HR or D-HR (specify which used) applied at >300g/m² ± 25 g/m² bead rate retained on surface with 0.4-0.7 mm anti-skid applied at 200 g/m²
 2. **Spray:** 1-2 mm ± 1 mm (or manufacturer's specified wet/dry film thickness) using B-HR or D-HR (specify which used) applied at >400g/ m² ± 25 g/m² bead rate retained on surface with and 1-2 mm anti-skid applied at 200 g/m²
 3. **Extruded/Structured:** 2-3 mm ± 1 mm WFT (or manufacturer's specified wet/dry film thickness) using B-HR or D-HR (specify which used) applied at >400g/m² bead rate retained on surface and 1-2 mm anti-skid applied at 200 g/m²
 4. **Preformed:** 2.5 mm ± 0.5mm WFT (or manufacturer's specified wet/dry film thickness) using B-HR or D-HR (specify which used) applied at >300g/m² bead rate retained on surface and 0.4-0.7 mm anti-skid applied at 200 g/m²
 5. **Profile:** 8-10 mm ± 2 mm WFT (or manufacturer's specified wet/dry film thickness) using B-HR or D-HR (specify which used) applied at >400g/m² bead rate retained on surface and 1-2 mm anti-skid at 200 g/m²

Measurements are to be taken at three intervals as specified below and all values reported:

Substrate Type:	Initial Measurement Point (IMP):	Interim Measurement Point (INMP):	Final Measurement Point (FMP):
Asphalt (or other substrate types)	After application / cure	2,000,000 vehicle passes	4,000,000 vehicle passes [^]
Spray Seal	After application / cure	500,000 vehicle passes	1,000,000 vehicle passes [^]

NOTE: [^] Substrates must be subjected to specified number of vehicle passes in a 3 to 18 month period post application.

Skid Resistance	AS 4049.2 (clause 8.2 and Appendix L) and/or TP343	≥ 45 BPN or ≥ 0.55 Grip Number NOTE: Must be tested at two pre-determined locations within the field testing area and locations reported.																
Dry Retroreflectivity	AS 4049.2 (clause 8.3 and Appendix M Method 1)	0041/4.5 (ATLMs): ≥ 150 mcd/m ² /lx at all times All other subclasses for Longitudinal, Transverse, and other markings: <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 25%;">Colour:</th> <th style="width: 25%;">IMP mcd/m²/lx</th> <th style="width: 25%;">INMP mcd/m²/lx</th> <th style="width: 25%;">FMP mcd/m²/lx</th> </tr> </thead> <tbody> <tr> <td>White</td> <td>≥ 350</td> <td>≥ 300</td> <td>≥ 150</td> </tr> <tr> <td>Yellow</td> <td>≥ 300</td> <td>≥ 250</td> <td>≥ 150</td> </tr> <tr> <td>Other colours*</td> <td>≥ 250</td> <td>≥ 200</td> <td>≥ 150</td> </tr> </tbody> </table> <p style="font-size: small; margin-top: 5px;">*Not Including black or grey</p>	Colour:	IMP mcd/m ² /lx	INMP mcd/m ² /lx	FMP mcd/m ² /lx	White	≥ 350	≥ 300	≥ 150	Yellow	≥ 300	≥ 250	≥ 150	Other colours*	≥ 250	≥ 200	≥ 150
Colour:	IMP mcd/m ² /lx	INMP mcd/m ² /lx	FMP mcd/m ² /lx															
White	≥ 350	≥ 300	≥ 150															
Yellow	≥ 300	≥ 250	≥ 150															
Other colours*	≥ 250	≥ 200	≥ 150															



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PAVEMENT MARKING MATERIAL – THERMOPLASTIC

TEST:	APPLICABLE STANDARD / TEST REFERENCE:	REQUIREMENTS:
Performance Based Testing Requirements (Field Testing) ^{A, B} (Cont.,)		
Wet Retroreflectivity	AS 4049.4 (clause 6.3.3, Table 4, Appendix K Method 2)	Applicable to all substrate types and all colours (except grey and black): ≥ 80 mcd/m ² /lx at all times; measurements to be taken at IMP, INMP, FMP and results reported.
Degree of Wear	AS 4049.2 (clause 8.4 and Appendix N)	≥ 95 % remaining intact at FMP in the wheel path - report results.
Luminance	AS 4049.2 (clause 8.5, Appendix G Method 2)	White: Lighter than Natural Colour System (NCS) swatch S 2500-N - report results. Yellow: Approximate match to Natural Colour System (NCS) swatch S 1070-Y20R - report results. NOTE: This is applicable to white and yellow materials only, refer to Colour Change for all other colours.
Colour Change	AS 4049.4 (clause 6.3.8 and Appendix G)	All colours assessed at IMP, INMP, FMP testing points must have results ≥ 3 on grey scale - report results. NOTE: Only colours are assessed in this method, refer to Luminance for white and yellow material testing.
Slip Resistance	AS 4049.4 (clause 6.3.6) AS 4663 Appendix A and Table A1	≥ 35 BPN - report results.
Visibility	AS 4049.5 (clause 8.3.1 and Appendix C)	Markings must be easily recognisable and clearly visible and must meet the minimum visual performance levels for Transverse (and other) markings (Table C1) or Longitudinal markings (Table C2), whichever is applicable. A minimum of 5 testing locations over the length of a road must be assessed; record and report all measurements, the weather, on-road and lighting conditions. Report all results.

NOTE:

A: Laboratory Testing must be conducted by an ACE and field testing by a CRCL. From **31st July 2023**, all laboratory and field testing must be carried out by an AS ISO/IEC 17025 accredited facility with all applicable testing under its Scope of Accreditation. The NATA website can assist in identifying an appropriate testing facility <https://www.nata.com.au/>

B: Performance Based Testing (Field Testing) can be conducted by the following CRCLs:

Australian Road Research Board (ARRB)
David Milling
Team Leader, Transport Safety
21 McLachlan Street, Fortitude Valley, QLD, 4006
Phone: +61 438 859 779
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Photometrics Laboratory, Road Asset Management Services
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PAVEMENT MARKING MATERIAL – THERMOPLASTIC

APPENDIX A

Document History

Status: Current
 Version: 1
 Date Published: 06-09-2022

Document Version No.:	Date Published:	Summary of Changes:
1 AP-S0041/4	06-09-2022	<ul style="list-style-type: none"> Updated SUSMP information. Review of Luminance Factor requirements (Laboratory Testing) in line with Y values for AS 2700 colours and variation with swatches and equipment used: Yellow amended to $\geq 45 - \leq 50$ % (from ≥ 50 %); Grey amended to $\geq 5 - \leq 15$ % (from > 5 % - < 15 %) and Other Colours amended to $\geq 5 - \leq 15$ % (from ≥ 15 %); addition of Red, Blue and Green values ($\geq 5 - \leq 15$ %). Addition of NOTE to Luminance requirement - Exceptions to the above luminance range values will be assessed on a case by case basis depending on end user requirements within the AS 2700 colour range.
0 AP-S0041/4	29-07-2021	<ul style="list-style-type: none"> Full Technical document review of APAS specification 0041 Separation of original specification (AP-S0041 V11) into pavement marking material types (Solvent-borne, CAP, Thermoplastics, Water-borne and Airport Pavement Markings); this document is now referenced as AP-S0041/4 Pavement Marking Material – Thermoplastic Document brought in line with requirements of AS/NZS ISO/IEC 17065 General formatting update Update to include clause 3.2, six sub-classes - 0041/4.1, 0041/4.2, 0041/4.3, 0041/4.4, 0041/4.5 and 0041/4.6 Inclusion of clause 4 Definitions and Acronyms Inclusion of clause 5 b) Reference material Inclusion of clause 6.4 regarding certification requirements of glass beads use in the production of thermoplastic products Inclusion of clause 7.1 b) & c) regarding CLASS I & II requirements Inclusion of 7.2 a), b) & c) regarding testing requirements Inclusion of compositional requirements, and revision of laboratory based testing parameters for Colour, Luminance, Softening Point, Flow Resistance Expansion and revision of performance based testing parameters (field testing) relating to increased number of minimum vehicle passes, Dry and Wet Retroreflectivity, Luminance, Colour Change, Slip and Skid Resistance and Visibility Inclusion of alternative CRCL for Field Testing - ARRB
11 AP-S0041	10-11-2020	<ul style="list-style-type: none"> Addition of Appendix A Document History and removal of the Editorial Note previously used in specification versions Updated document to the current format Updated internal and external document references Inclusion of VOC Content requirement to Table 1 Performance Properties Updated Note C contact information Addition of "People + Product = Protection" to Footer
10	16-10-2015	<ul style="list-style-type: none"> Clarified requirements for runway, apron and taxiway markings for sub-class 0041/6
9	23-03-2015	<ul style="list-style-type: none"> Underwent a major revision with the inclusion of requirements for sub-class 0041/3 cold applied products and 0041/6 airport marking
8	10-01-2013	<ul style="list-style-type: none"> Added sub-class 6, underwent a general update and the field-testing details in Table 1 were updated
7	03-05-2007	<ul style="list-style-type: none"> Aligned the specification with the revised AS 4049 – 2005
6	13-02-2001	<ul style="list-style-type: none"> Initiated the second stage of the move to new specification numbering with prominence given to the new number (previously GPC-P-41)