

LOW SOLAR ABSORBING, COLOUR STABLE EXTERIOR TOPSIDE PAINT FOR NAVY VESSELS

1 SCOPE

This specification defines and establishes the performance requirements for exterior topside topcoat paints for application to Royal Australian Navy (RAN) vessels.

2 BACKGROUND

- To obtain a broad overview of the Australian Paint Approval Scheme (APAS), refer to APAS document AP-D001.
- To obtain an overview of restricted ingredients in APAS certified products, refer to APAS document AP-D123.
- To obtain the current list of APAS participating manufacturers (and suppliers) and resellers, refer to APAS document AP-D152.
- To obtain an overview of how to participate in the APAS, refer to APAS document AP-D177.
- 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

- This specification defines and establishes the performance requirements for exterior topside topcoat paints for application to Royal Australian Navy (RAN) vessels.
- Refer to clause 3.3 below for descriptions of sub-classes and types available under this specification.
- Type I coatings are durable, colour-stable, low-gloss, low solar-absorbing paint topcoats pigmented to AS 2700 N42 Storm Grey colour to be used for the finishing and refinishing of RAN vessels and associated equipment. Together with the recommended primer, they provide a protective air-drying exterior surface in marine atmospheres. The Type I N42 Storm Grey coatings are formulated using polyurethane as the resin binder. To minimise solar heat absorption the coating shall have a Near Infrared Reflectance (NIRR) of at least 65% at 800 nm and shall have a total solar reflectance (TSR) of at least 42% when measured between 300 – 2500 nm.
- Type II coatings are durable, colour-stable, low solar-absorbing paint topcoats pigmented to either AS 2700 N42 Storm Grey colour or SAE AMS STD 595 26270, Haze Gray colour to be used for the finishing and refinishing of Navy vessels and associated equipment. They can be either low gloss (sub-class AP-S0501/1) or semi-gloss (sub-class AP-S0501/2). Together with the recommended primer, they provide a protective air-drying exterior surface in marine atmospheres.
- Note that although the RAN Haze Grey topcoat is the same colour as USN Haze Gray, it differs from the US coating in NIRR, metamerism requirements, gloss level, TSR and colour and gloss stability. The Type II coatings are formulated using polysiloxane as the resin binder. To minimise solar heat absorption the polysiloxane coatings shall have a NIRR of at least 60% at 800 nm for the RAN Haze Grey colour and a NIRR of at least

65% at 800 nm for the N42 Storm Grey colour and shall have a TSR of at least 42% for N42 Storm Grey and at least 38% for RAN Haze Grey when measured between 300 – 2500 nm.

- Other colours (for use as markings) may also be required for both Types of products.

3.2 Application

- Both Type I and Type II coatings may be applied by airless or conventional spray with thinning as recommended, or by brush or roller unthinned or as recommended, over a high-performance epoxy anticorrosive priming system as recommended by the paint manufacturer.
- The paint system comprising the topcoat and the manufacturer's primer shall be suitable for use over appropriately pre-treated and prepared ferrous and non-ferrous metal surfaces, plastics, composites and over aged APAS specification AP-S0501 topcoats (both polyurethane and polysiloxane).

3.3 Sub-Classes

- This specification incorporates the following sub-classes:
 - 0501/1:** Low gloss (12 – 18 gloss units at 60°)
 - 0501/2:** Semi-gloss (45 – 60 gloss units at 60°)
- In addition, products certified under this specification may be available in the following types:
 - Type I:** Standard durability, low solar absorbing, colour stable polyurethane (not available in RAN Haze Grey colour).
 - Type II:** High durability, low solar absorbing, colour stable polysiloxane.

3.4 Basis of this Specification

- This specification is not based on any known standard or specification.

4 REFERENCED DOCUMENTS

- The following standards are referenced in this document:
 - AS/NZS 1580** – Paints and related materials: Methods of test
 - AS 2106** – Methods for the determination of the flashpoint of flammable liquids
 - AS 2700** – Colour standards for general purposes
 - ASTM D523-14** – Standard Test Method for Specular Gloss
 - ASTM D4541-17** – Standard Test Method for Pull-Off Strength of Coatings using Portable Adhesion Testers
 - ASTM D6905-03** – Standard Test Method for Impact Flexibility of Organic Coatings
 - ASTM D5402-19** – Standard Practice for Assessing the Solvent Resistance of Organic Coatings using Solvent Rubs
 - ASTM E1164-12** – Standard Practice for Obtaining Spectrometric Data for Object-Colour Evaluation

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- ix. **ASTM E1347-06** – Standard Test Method for Colour and Colour-Difference Measurements by Tristimulus Colourimetry
- x. **ASTM G154-16** – Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Non-metallic Materials
- xi. **ASTM G155-13** – Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-metallic Materials
- xii. **ASTM G173-03** – Standard Tables for Reference Solar Spectral Irradiances: Direct Normal and Hemispherical on 37° Tilted Surface
- xiii. **BS 3900-G2** – Methods of Tests for Paints Resistance to Aqueous Liquids
- xiv. **ISO/CIE 11664-4** – Colorimetry – Part 4: CIE 1976 L*a*b* Colour Space
- xv. **MIL PRF 24635 Revision E** – Coating Systems, Weather-Resistant, Exterior Use
- xvi. **MIL PRF 85285 Revision E** – Coating: Polyurethane, aircraft and support equipment
- xvii. **SAE AMS STD 595** – Colours used in Government Procurement

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

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

- xviii. **The Poisons Standard June 2021**: Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) No. 33, 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 website at: <https://www.legislation.gov.au/Details/F2021L00650>

xix. Work Health and Safety Act 2011

This document is available from the Australian Government Federal Register of Legislation website at: <https://www.legislation.gov.au/Details/C2018C00293>

- b) The following APAS documents are referenced in this document:
 - i. AP-D001 Rules Governing How APAS® Operates
 - ii. AP-D123 Restrictions on Ingredients in Product Formulations
 - iii. AP-D152 APAS® Participating Manufacturers and Resellers
 - iv. AP-D177 Rules Governing How Product Manufacturers participate in APAS®
 - v. AP-D181 Volatile Organic Compounds (VOC) Limits
 - vi. AP-D192 Rules Governing APAS® Product Certification Scheme

All APAS documents are available for download from the APAS website: <https://vs.csiro.au/apas/documents/>

5 COMPOSITIONAL REQUIREMENTS

5.1 Binder

- a) Two resin binding systems that can be used to develop colour topcoats that meet the performance specification detailed in clause 10, Table 1 are:
 - a) Polyurethane (Type I)
 - b) Polysiloxane (Type II)
- b) Appropriately formulated one-pack or two-pack products would be considered.
- c) One example of a Type I (polyurethane) binder system conforming to the specification could be a solvent borne two-pack system containing a hydroxy-functional resin polymerised from acrylic monomers in one component, and an aliphatic polyisocyanate resin in a second component. In this example, one component would consist essentially of hydroxyacrylic binder combined with pigments, solvents and a range of additives. The second component would consist essentially of an aliphatic polyisocyanate dissolved in solvents. The two components would be mixed in a simple volume ratio.
- d) Binder systems conforming to the Type II (polysiloxane) specification would be a solvent borne two-pack system containing an organically modified siloxane-based resin in one component and a mixture containing a silane-based crosslinking agent in the second.

5.2 Volatiles

- a) Although not restricted by this specification, the volatile component might be expected to consist of a mixture of hydrocarbon and oxygenated organic solvents representative of those commonly used throughout the paint industry.
- b) Due to the increasing importance to Navy of environmental considerations relating to the use of coatings, a requirement for the volatile organic compound (VOC) content to be reported has been included in this specification as a data gathering exercise. Eventually, VOC limits will be imposed on products. This requirement is partly responsible for the move to the very high solids polysiloxane resin systems.

5.3 Pigmentation

- a) In order to meet the infrared requirements, the paint should be free of carbon black and other high infrared radiation absorbing pigments. Care should be taken during manufacture of paint to avoid contamination by these types of pigments.
- b) Pigments chosen for the topcoat finish must have a high degree of sunlight stability, and when made up into the topcoat colour, must satisfy the colour, accelerated exposure and metamerism requirements of this specification.
- c) The pigments must qualify against the compositional requirements for product approval as covered in clause 6 below.

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- a) Refer to clause 3.1 c) to f).

6 PRODUCT APPROVAL REQUIREMENTS**6.1 General Requirements**

- a) The product and its application for approval shall comply with the relevant requirements of APAS document AP-D192 during the life of the approval.

6.2 Technical Requirements

- a) The product shall comply with **all** the requirements of clause 10, Table 1 below.
- b) Tests are to be carried out under the routine conditions of AS/NZS 1580.101.5 unless otherwise specified.
- c) Test panels shall be as outlined in clause 11, Table 2.
- d) Panels are to be cured for 14-28 days before testing unless otherwise specified.
- e) For all finishing products, testing shall be performed in accordance with all three sections of clause 10, Table 1 below.
- f) For all priming products, initial testing shall be performed in accordance with the tests detailed in clause 10, Table 1 under the heading **For Each Component of the System**.
- g) In some tests as stipulated in clause 10 Tables 1 and clause 11 Table 2 below, the manufacturer's specified primer shall be included as part of the full paint system. Achievement of satisfactory test results as part of the whole coating system tested will also permit granting of approval to the primer used.

6.3 CLASS II (Interim) Approvals

- a) CLASS II (Interim) Approval for a system may be granted by DSTO (Department of Defence) where it can be shown that all parameters except Resistance to Natural Weathering (refer clause 10, Table 1 below) have been complied with **provided that** at least 36 months of durability data for the resin system in a similar product is provided showing no deterioration in film integrity or the presence of corrosion of the substrate. In addition, data for the resin showing that after 12 months natural exposure (see clause 10, Table 1 for conditions) the gloss satisfies the requirement in clause 10, Table 1 (Resistance to Natural Weathering: Gloss) must be submitted.
- b) CLASS II approvals shall only be allowed for a maximum of 3 years during which time natural durability results shall be gathered. Once these results have been recorded, they shall be forwarded to APAS and, if satisfactory, a CLASS I (Full) Approval shall be issued.
- c) If satisfactory durability results are not supplied to APAS within 3 years, the Interim Approval shall be terminated.

6.4 Health and Safety Requirements

- a) The manufacturer's Safety Data Sheet (SDS) must be studied closely prior to using the product and complied with during use of the product.
- b) The product and the practical application of the product shall comply with the requirements stipulated in the appropriate section(s) of the Work Health & Safety (WHS) Act 2011 and regulations.
- c) Products intended for sale in Australia shall comply with all the requirements of the SUSMP and shall not be classified as either Schedule 1, 2, or 3 paints.
- d) Products intended for sale in other countries shall comply with all local WHS and environmental requirements.
- e) For paints which rely on isocyanate (polyurethanes) or silane-based (polysiloxanes) curing agents, appropriate precautions should be taken during mixing, application and cure. Spray painting operations should be conducted in a spray booth away from other personnel, and a positive pressure air-fed full-face respirator should be worn whilst spraying. In all circumstances of use, care should be taken to avoid contact of the mixed paint with the skin.
- f) Paints containing hydrocarbon and/or oxygenated organic solvents are flammable and should be stored away from all sources of heat or ignition. Vapours from these solvents are usually heavier than air and may build up in low-lying areas if ventilation is inadequate. Containers should be resealed immediately after use and good ventilation provided during use to minimise the risk of fire or explosion and the long-term toxic effects of absorption of the vapour by the lungs.
- g) Care should be taken to avoid contact of all paint types with the skin using protective clothing and gloves, and, if necessary, a barrier cream. All pumping equipment should be adequately earthed.
- h) The product shall comply with all requirements of clause 6.3 and 6.4 of APAS document AP-D192.

6.5 Quality Control of Production

- a) On request, the Executive Officer, APAS, or DSTO may request an audit of a master formulation, or of the formulation of any particular batch, or of the batch card applying to a particular batch, to be carried out at any time, particularly in cases where user complaints are unable to be resolved.

LOW SOLAR ABSORBING, COLOUR STABLE EXTERIOR TOPSIDE PAINT FOR NAVY VESSELS**7 APPENDIX A****Dry Hiding Power****7.1 Scope:**

This appendix describes how dry hiding power of applicant products is to be demonstrated.

7.2 Procedure:

- a) The method is based on that described in MIL PRF 85285.
- b) Apply the admixed coating, at a dry film thickness of no greater than 75% of the lower end of the manufacturer's recommended dry film thickness (DFT) range, to a black and white chart (Leneta Form 3B, or equivalent). The contrast ratio of the cured paint shall be determined by measuring the L^* lightness value with a spectrophotometer (Specular Component Included – SCI) of the coating over the black (L^*_B) and white (L^*_W) sides of the chart. The contrast ratio is calculated as $C = L^*_B/L^*_W$ and shall be reported along with the dry film thickness of the coating.

8 APPENDIX B**Aged Recoatability****8.1 Scope:**

- a) This appendix describes how the evaluation of the recoatability of applicant products (either Type I or Type II) over aged substrates is to be demonstrated.
- b) In the field, it is likely that previously painted substrates will need recoating. These aged substrates may be either aged APAS specification AP-S0501 polyurethane or aged APAS specification AP-S0501 polysiloxane.
- c) Aged recoatability testing must be conducted using the application of topcoat directly to the aged coatings in addition to recoat using topcoat applied with a manufacturer recommended tie-coat to the aged coatings.

8.2 Procedure:**a) Preparation of Aged Coatings:**

- i. Prepare four sets of appropriately primed test panels using substrates as indicated in clause 11, Table 2.
- ii. Each set shall comprise of one panel for cross hatch adhesion testing (see clause 11, Table 2 for options) and a 4 mm thick mild steel panel for PATTI adhesion testing.
- iii. Topcoat two sets of panels with:
 - APAS specification AP-S0501 Type I, Sub-class 1 polyurethane finish preferably in N42 Storm Grey colour, and the other two sets with:
 - APAS specification AP-S0501 Type II, Sub-class 1 polysiloxane finish preferably

in RAN Haze Grey or N42 Storm Grey colour

- iv. The coated test panels shall be aged by maintaining them at ambient conditions for one day and then at 50°C for 28 days.

b) Recoating:

- i. Scribe a line 100 ± 10 mm through to metal crosswise on the bottom half of each test panel.
- ii. Using fine grade sandpaper, abrade one half of each test panel lengthwise so that the scribe line crosses from the sanded to the un-sanded section.
- iii. To the bottom 2/3rd of each test panel, apply by spray one coat of the test topcoat (without primer or tie-coat for one set each of the aged polyurethane and aged polysiloxane test panels and with the manufacturer specified tie-coat if applicable for one set each of the aged polyurethane and aged polysiloxane test panels) leaving the top 1/3rd of each panel uncoated.
- iv. Allow the panels to air dry at ambient laboratory conditions.
- v. At this stage there should be eight prepared test panels – four for cross hatch adhesion and four for PATTI adhesion testing. Each set of these four panels should include two panels with aged polyurethane and two panels with aged polysiloxane. On each of these aged coatings there should be one panel with the test topcoat applied directly to aged coating and one panel with the test topcoat applied with tie-coat to the aged topcoat.

8.3 Assessment:

- a) **Visual Assessment:** After 48 hours of ambient cure, inspect the painted film for any defects. Take note of any failure along the top 1/3rd edge of the recoat layer, including inability to wet out the aged paint. Examine the scribe for defects caused by the recoat layer, such as paint lifting and wrinkling.
- b) **Cross Hatch Adhesion Assessment:**
 - i. This test may be performed on coated 1.2 – 2 mm thick or 4 mm thick substrates (see clause 11, Table 2). After 14 days of cure under ambient conditions, perform a crosscut (cross hatch) adhesion test of the recoat layer over both the sanded and un-sanded portions of the aged paint according to AS 1580.408.4. The dry adhesion ratings for the coating applied over the sanded area and the coating applied over un-sanded area shall both be no greater than 1.
 - ii. After dry cross hatch adhesion testing, the panels shall then be immersed in distilled water for not less than 7 days at $50 \pm 3^\circ\text{C}$. After removal, the panels shall be dried with absorbent paper and within 3 minutes after removal from the water, shall be cross hatch

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tested for adhesion in accordance with AS 1580.408.4 in both the areas of the recoat layer applied over the sanded and un-sanded aged coating. The wet adhesion ratings for the coating applied over the sanded area and the coating applied over un-sanded area shall both be no greater than 2. In addition, the coating shall not exhibit any softening, wrinkling, blistering or other defect after the immersion.

c) PATTI Adhesion Assessment

- i. This test is to be performed on the coated 4 mm thick mild steel substrate.
- ii. After 14 days of cure under ambient conditions, perform PATTI adhesion testing according to ASTM D4541 Test Method D (Self-alignment adhesion tester type IV). The pull-off pressure required for the recoat applied to the sanded side of the aged test coating (both with and without tie-coat) should be no less than 10,000 kPa. The pull-off pressure required for the recoat applied to the un-sanded side of the aged test coating (both with and without tie-coat) should be no less than 8,000 kPa.

- b) Place the test panels in the container so that all faces are exposed to the solution and not in proximity to each other. Pour in enough test solution to cover 75% of the panels. Turn on the aeration system.
- c) Leave the panels in the continuously aerating solution for 4 weeks. Maintain the solution level by the periodic addition of distilled water as required.
- d) At the conclusion of the test period remove the panels and rinse under clean running water. Gently dry the panels on absorbent paper and examine the surface appearance.

9.4 Panel Assessment:

- a) **Visual:**
Examine each panel closely, taking note of any appearance changes between the immersed and un-immersed section of each panel. The coating shall not exhibit any softening, wrinkling, blistering or other defect after the immersion.
- b) **Adhesion:**
Within 3 minutes after removal from the water, the coating shall be cross hatch tested for adhesion in accordance with AS 1580.408.4. The paint system shall have a wet adhesion rating of no more than 2.
- c) **Colour Change:**
The colour of the test panels shall be measured instrumentally before and after 4 weeks immersion in the aerated seawater as described in clause 10, Table 1 (Colour – Instrumental) using D65, 10°, SCI data. Panels removed from the aerated seawater shall be immediately rinsed (without scrubbing) with water and allowed to air dry. Colour should be measured within 2 hours of washing. Any colour change (ΔE_{ab}^*) must be no greater than 0.5 units.

9 APPENDIX C

Resistance to Aerated Seawater

9.1 Scope:

- a) This appendix describes how the evaluation of the resistance of a coating system to immersion in sea water is demonstrated.
- b) It focuses on effects on the topcoat rather than effects on the substrate.
- c) This method is based on the superseded method BS 3900-G2.

9.2 Equipment:

- a) One mild steel and one hard aluminium panel approximately 150 x 100 x 1.5 mm each, coated in the manufacturer's recommended system and cured for 14 - 28 days under ambient conditions. The reverse side and all edges shall be sealed with a suitable coating to prevent corrosion or moisture ingress.
- b) Container of sufficient size to accommodate the entire test panel.
- c) 4% w/w solution of NaCl in distilled water of sufficient volume to cover the test panel in the container to the specified level and allow for replacement of evaporation losses.
- d) A means of constantly aerating the seawater via a slow stream of air free of oil and grease for the test duration.

9.3 Procedure:

- a) Ensure laboratory conditions are Routine as defined in AS/NZS1580.101.5.



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10 TABLE 1: PERFORMANCE PROPERTIES

TEST	AS/NZS 1580 METHOD	REQUIREMENTS
For each COMPONENT of the System		
Preliminary Examination	103.1	To be readily reincorporated. Shall be free of coarse particles, gel and foreign matter.
Flash Point	AS 2106	28°C minimum.
Fineness of Grind	204.1	Maximum 40 µm.
Skin Formation	203.1 Method B	No skin.
Settling and Reincorporation after Storage	211.1 211.2 205.1	After storage for 18 months at ambient temperature (23 + 5°C), there shall be no curdling, gelling or seeding and the settle rating shall not be less than 6. Manual stirring shall produce a uniform product. Application by spray shall produce a dry film equivalent in appearance to that obtained with fresh product.
Viscosity	214.x	Viscosity and method shall be recorded.
VOC Content	APAS AP-D181	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 .
For the MIXED (Finishing) Paint		
Application Properties - Brushing - Rolling - Spraying (Conventional) - Spraying (Airless)	205.1 205.3 205.2 205.4	Shall show satisfactory application properties and the dry film shall be free of defects.
Pot Life	--	When mixed according to the manufacturer's directions, the paint shall have satisfactory application properties for up to 2 hours after combining the components.
Surface Dry Condition	401.1	Maximum 5 hours.
Hard Dry Condition (Mechanical Thumb Test)	401.6	Maximum 16 hours.
Tape Resistance	--	This test method is similar to that in MIL PRF 85285. The painted test panels shall be air-dried for no greater than 16 hours and a strip of masking tape (3M Company #250 or equivalent) and no less than 25 mm wide shall be applied to each panel and pressed down with one pass of a roller weighing no less than 2 kg. The tape shall remain in contact with the coating for one hour and then shall be carefully removed. There shall be no evidence of permanent marking or other visible defects caused by the making tape applied to the coating.



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TEST	AS/NZS 1580 METHOD	REQUIREMENTS
For the MIXED (Finishing) Paint (Cont.,)		
Dry Hiding Power	Clause 7, Appendix A	The contrast ratio shall not be less than 0.98 for a dry film of thickness no greater than 75% of the lower end of the manufacturer's recommended DFT range.
Solvent Resistance	ASTM D5402	After 7 days ambient curing, the topcoat applied at the manufacturer's recommended thickness shall withstand 25 double rubs with a swab of cotton wool soaked in methyl ethyl ketone (MEK).
Recoating Properties	404.1 408.4	<p>The paint shall be recoatable with itself in 8 hours or less after initial application at ambient laboratory conditions. After cure the film produced shall be of satisfactory appearance with no wrinkling, lifting or working up of the original film and with no defects in the recoat layer.</p> <p>Cross-cut Adhesion: After 14 days of cure under ambient conditions of the recoated paint, when tested using the cross cut or cross hatch adhesion method, the degree of flaking of the recoat layer around the cross cuts shall have a rating of no greater than 1 for dry adhesion. After immersion of the recoated panel in distilled water at 50°C for 7 days, the wet cross hatch adhesion rating shall be no greater than 2 for the recoat layer.</p>
Aged Recoat	Clause 8, Appendix B 408.4 ASTM D4541, Test Method D	<p>Tested for recoat over aged APAS specification AP-S0501 polyurethane and aged APAS specification AP-S0501 polysiloxane both with and without the manufacturer's recommended tie coat as described in clause 8, Appendix B.</p> <p>A panel coated with the approved APAS specification AP-S0501 system cured at ambient conditions for 24 hours then aged (28 days at 50°C) and recoated by spray shall in all cases (both with and without tie coat) produce a film of satisfactory appearance with no wrinkling, lifting or working up of the original film. There shall be no lifting or wrinkling of the original film along the scribe.</p> <p>Cross-cut Adhesion: For aged recoat paint systems both with and without tie coat, after 14 days of cure at ambient conditions, the degree of flaking of the recoat layer over both the sanded area and the un-sanded shall have a rating of less than or equal to 1. After immersion of the panel in distilled water at 50°C for 7 days the wet cross hatch adhesion rating shall be no greater than 2 for the recoat layer over both the sanded portion and the un-sanded portion of the aged coating.</p> <p>PATTI Adhesion: After 14 days cure under ambient conditions, the pull-off pressure required for removal of the recoat shall be no less than 10,000 kPa (sanded side) and 8,000 kPa (un-sanded side) for systems both with and without tie coat.</p>



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TEST	AS/NZS 1580 METHOD	REQUIREMENTS
For the COMPLETE System		
Finish	603.1	Shall be free of coarse particles, wrinkling or orange peel and have a uniform colour and appearance.
Colour - Visual Comparison	601.1	<p>For low gloss N42 Storm Grey: Close colour match to the colour reference: Storm Grey: AS 2700 N42 Rating 1 or better under the Daylight Simulator.</p> <p>For RAN Haze Grey: Close colour match to the colour reference: SAE AMS STD 595: 26270 Haze Gray Rating 1 or better under the Daylight Simulator.</p>
Colour - Instrumental	601.3 & 4 Note 2	<p>N42 Storm Grey: Overall colour difference ΔE_{ab}^* from the colour reference N42 Storm Grey AS 2700 N42, with colour position $L^* = 62.6$; $a^* = -4.06$; $b^* = 2.70$ to be no greater than 0.5 units using Illuminant D65.</p> <p>RAN Haze Grey: Colour difference from the colour reference US FS-595C 26270 (Haze Gray), with colour position $L^* = 58.8$; $a^* = -1.9$; $b^* = -1.9$; to be ΔE_{ab}^* no greater than 0.5, Δa^* no greater than 0.3 units and Δb^* no greater than 0.3 using Illuminant D65.</p> <p>Note that $\Delta E_{ab}^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$</p>
Specular Gloss (60°)	602.2	<p>For low gloss N42 Storm Grey and low gloss RAN Haze Grey coatings: specular gloss shall be between 12 and 18 units using the 60° head.</p> <p>For semi-gloss coatings: specular gloss shall be between 45 and 60 units using the 60° head.</p>
Metamerism N42 Storm Grey	601.3 & 4 Notes 2 & 3	<p>The colour differences between CIE Illuminants A and D65 shall be within the ranges specified as follows:</p> <p>(a) $\Delta L^* = L^*_{\text{Illuminant A}} - L^*_{\text{Illuminant D65}}$ between -0.3 and 0.0.</p> <p>(b) $\Delta a^* = a^*_{\text{Illuminant A}} - a^*_{\text{Illuminant D65}}$ between +0.8 and +1.8.</p> <p>(c) $\Delta b^* = b^*_{\text{Illuminant A}} - b^*_{\text{Illuminant D65}}$ between -1.1 and -0.1.</p>
Metamerism RAN Haze Grey	601.3 & 4 Notes 2 & 3	<p>The colour differences between CIE Illuminants A and D65 shall be within the ranges specified as follows:</p> <p>(a) $\Delta L^* = L^*_{\text{Illuminant A}} - L^*_{\text{Illuminant D65}}$ between -0.5 and 0.0.</p> <p>(b) $\Delta a^* = a^*_{\text{Illuminant A}} - a^*_{\text{Illuminant D65}}$ between 0.0 and +0.8.</p> <p>(c) $\Delta b^* = b^*_{\text{Illuminant A}} - b^*_{\text{Illuminant D65}}$ between -1.0 and -0.2.</p>
Infrared Reflectance	Note 1	For the manufacturer's full paint scheme (topcoat and primer) applied at the midpoint of the manufacturer's recommended DFTs to an aluminium or mild steel test panel the infrared reflectance (IRR) shall not be less than: 65% at 800 nm for the N42 Storm Grey topcoat and 60% at 800 nm for the RAN Haze Grey topcoat.



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TEST	AS/NZS 1580 METHOD	REQUIREMENTS
For the COMPLETE System (Cont.,)		
Total Solar Reflectance	ASTM G173 Note 1	For the manufacturer's full paint scheme (topcoat and primer) applied at the midpoint of the manufacturer's recommended DFTs to an aluminium or mild steel test panel the total solar reflectance when measured between 300 - 2500 nm, shall be greater than 42% for the N42 Storm Grey topcoat and shall be greater than 38% for the RAN Haze Grey topcoat.
Resistance to Natural Weathering	457.1 481.1	Refer also to clause 6.3 above. After 12 months exposure at 45°N at exposure sites in Australia complying with Category E-M (Very High: Marine) and Category F (Inland Tropical) of AS/NZS 2312, there shall be no film integrity failure and the ratings shall not exceed the criteria below for changes in gloss, discolouration, colour and chalking at either site.
	481.1.5 & 602.2	As described in the Australian Standard methods nominated, the degree of discolouration and the degree of chalking shall be assessed on unwashed panels. The change in gloss, change in colour and the change in infrared reflectance shall be assessed using wiped panels. As described in the Australian Standard methods the panels shall be gently wiped or swabbed with cotton wool under gently running water without scrubbing.
	481.1.2	Gloss (measured instrumentally): After 12 months exposure, the 60° gloss level of the wiped panel shall be at least 80% of the initial 60° gloss.
	481.1.12, 601.3 & 4 Note 2	Discolouration: After 12 months exposure discolouration shall be rated no greater than 1 Colour change (measured instrumentally): After 12 months exposure the colour change, $\Delta E_{ab}^* \left(\sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2} \right)^{1/2}$, shall be no greater than 1.0.
	481.1.11 - Method B IR reflectance Note 1	Chalking: After 12 months exposure any chalking shall not have a rating of greater than 1. For both N42 Storm Grey and RAN Haze Grey after 12 months exposure, the infrared reflectance shall not decrease by more than 2% units of the initial IR reflectance.



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TEST	AS/NZS 1580 METHOD	REQUIREMENTS
For the COMPLETE System (Cont.,)		
Resistance to Artificial Weathering: Colour: Storm Grey	ASTM G155 Note 4 601.4 Note 2 Note 1 ASTM G155 Note 4 601.4 Note 2 Note 1	<p><u>Type I N42 Storm Grey Topcoat:</u> After 1000 hours of continuous light exposure (xenon arc lamp, dry cycle) at an irradiance level of 0.68 W/m² @ 340nm at 63°C, three conditions are required to be met:</p> <p>(a) Overall colour change ΔE_{ab}^* to be no greater than 0.8.</p> <p>(b) The change in a* value, Δa^*, to be no greater than 0.2 units in the negative direction (greener) and no greater than 0.5 units in the positive direction (redder).</p> <p>(c) Infrared reflectance shall not decrease by more than 2% units of the initial IR reflectance.</p> <p><u>Type II N42 Storm Grey Topcoat:</u> After 3000 hours of continuous light exposure (xenon arc lamp, dry cycle) at an irradiance level of 0.68 W/m² @ 340nm at 63°C, three conditions are required to be met:</p> <p>(a) Overall colour change ΔE_{ab}^* to be no greater than 1.0.</p> <p>(b) The change in a* value, Δa^*, to be no greater than 0.2 units in the negative direction (greener) and no greater than 0.5 units in the positive direction (redder).</p> <p>(c) Infrared reflectance shall not decrease by more than 2% units of the initial IR reflectance.</p>
Resistance to Artificial Weathering: Colour: RAN Haze Grey	ASTM G155 Note 4 601.4 Note 2 Note 1	<p><u>Type II RAN Haze Grey Topcoat:</u> After 3000 hours of continuous light exposure at an irradiance level of 0.68 W/m² @ 340 nm at 63°C, four conditions are required to be met:</p> <p>(a) Overall colour change ΔE_{ab}^* to be no greater than 1.0.</p> <p>(b) Change in a* value, Δa^*, to be no greater than 0.3 units in the positive direction (redder) and no greater than 0.5 units in the negative direction (greener).</p> <p>(c) Change in b* value, Δb^* to be no greater than 0.3 in the positive direction (yellow).</p> <p>(d) Infrared reflectance shall not decrease by more than 2% units of the initial IR reflectance.</p>
Resistance to Artificial Weathering: Gloss	ASTM G154 UVB-313 602.2	<p>The panels shall be exposed to accelerated weathering using a Fluorescent-Condensation type apparatus in accordance with ASTM G154, cycle 2 at an irradiance of 0.71 W/m² @ 310 nm. The cycle shall be 4 hours of UV exposure using a UVB-313 bulb at 60°C and 4 hours of condensation exposure at 50°C. After exposure, gloss shall be measured again in accordance with ASTM E1347 and D523.</p> <p>For Type I polyurethane topcoats the 60° gloss level shall not drop by more than 50% of its initial value after 1000 hours of exposure.</p> <p>For Type II polysiloxane topcoats the 60° gloss level shall not drop by more than 50% of its initial value after 1000 hours of exposure and shall not drop by more than 65% of its initial value after 1500 hours of exposure.</p>



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TEST	AS/NZS 1580 METHOD	REQUIREMENTS
For the COMPLETE System (Cont.,)		
Adhesion – Cross Cut or Cross Hatch	408.4	After 14 days cure under standard laboratory conditions, the dry cross hatch adhesion rating shall not be greater than 1. The wet cross hatch adhesion (after immersion in distilled water at 50°C for 7 days) rating shall not be greater than 2.
Adhesion - PATTI	ASTM D4541 Test Method D	After 14 days cure under standard laboratory conditions, when tested in accordance with ASTM D4541 Test Method D (Self-alignment adhesion tester Type IV), the pull-off pressure required should be no less than 10,000 kPa.
Scratch Resistance	403.1	Minimum 1000g.
Bend Test	402.1	After air drying for 14 days (ambient laboratory conditions), both the un-primed polyurethane and un-primed polysiloxane topcoats shall show no sign of cracking or loss of adhesion over tinplate after bending around a 20 mm mandrel.
Resistance to Direct Impact - Falling Weight Test	406.1	The un-primed topcoat shall not crack or wrinkle at a minimum of 1.5 joules when tested on 1.5 mm thick mild steel panels using the hemispherical indenter.
Reverse Impact Flexibility	ASTM D6905	The polyurethane and the polysiloxane topcoats applied to an un-primed 0.5 mm thick aluminium test panel and air dried for 14 days shall be tested in accordance with ASTM D6905. The Type I polyurethane coating shall not exhibit any cracking or flaking at 5% elongation when examined under 2x magnification with the aid of lighting. The Type II polysiloxane coating shall not exhibit any cracking or flaking at 2% elongation when examined under 2x magnification with the aid of lighting.
Resistance to Humidity	452.1	There shall be no sign of softening, breakdown, loss of adhesion or blistering of the coating or rusting (or corrosion) of the substrate after 10 days of exposure of the full system on steel and on hard aluminium panels.
Resistance to Sea Water - Aerated	Clause 9, Appendix C 408.4 601.3 & 4 Note 2	There shall be no sign of breakdown, softening, wrinkling, blistering or other defects in the coating or rusting (or corrosion) of the substrate after 4 weeks of exposure of the full system on steel and hard aluminium panels. The crosshatch adhesion rating shall not be greater than 2. Any colour change (ΔE_{ab}^*) must be no greater than 0.5 units.

NOTE:

- 1 Infra-red reflectance measurement may employ any calibrated spectrophotometer capable of measuring reflectance at 800 nm. The total solar reflectance measurement may employ any calibrated spectrophotometer capable of measuring reflectance between 300 -2500 nm.
- 2 Colour measurement shall be performed in CIE 1976 CIELAB colour space using Illuminants A (incandescent) and/or D65 (daylight) as specified, using the CIE 1964 Standard 10° Observer with the Specular Component included. Instrumentation may employ acceptable geometries conforming to ASTM E1164 or AS/NZS 1580.601.3.
- 3 The metamerism requirement minimises potential colour differences under varying outdoor illumination conditions, particularly after sunrise and before sunset. To obtain the correct properties, the colour coordinates are measured under Illuminants A and D65, and each of the values L^* , a^* and b^* obtained using Illuminant D65 are subtracted from their corresponding values using Illuminant A.
- 4 Continuous light exposure using a xenon-arc apparatus conforming to ASTM G155 shall employ a continuous dry cycle set at 63°C black panel temperature and using a Daylight filter with an irradiance of 0.68 W/m² @ 340 nm.

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11 TABLE 2: TEST PANELS

TEST	TEST PANEL TYPE ¹	COATING DETAILS ²
Application Properties	A or B	
Surface Dry Condition	A or B	
Dry-to-Tape	A or B	
Hard Dry Condition	A or B	
Pot Life	N/A	N/A
Dry Hiding Power	B & W Leneta Form B	Topcoat only - applied at a DFT of ≤ 75% of the lower end of the manufacturer's recommended DFT range
Solvent Resistance	A or B	
Recoating Properties	A or B	As described in clause 10, Table 1
Aged Recoat – Cross Cut Aged Recoat – PATTI Adhesion	A, B or C C	As described in clause 10, Table 1
Finish	A or B	
Colour - Visual Comparison	A or B	
Colour – Instrumental	A or B	
Specular Gloss	A or B	
Metamerism	A or B	
Infrared Reflectance	A or B	As described in clause 10, Table 1
Total Solar Reflectance	A or B	As described in clause 10, Table 1
Resistance to Natural Weathering	A and B	
Resistance to Artificial Weathering: Colour	A or B	
Resistance to Artificial Weathering: Gloss	A or B	
Adhesion – Cross Cut Adhesion – PATTI Adhesion	A or C and B C	
Scratch Resistance	A or B	
Bend Test	D	Topcoat only
Resistance to Direct Impact	E	Topcoat only
Reverse Impact Flexibility	F	Topcoat only
Resistance to Humidity	A and B	
Resistance to Aerated Seawater	A and B	

NOTE:

¹ Test panels substrates types shall be as follows:

TYPE A	1.2 - 2 mm Mild Steel
TYPE B	1.2 - 2 mm Aluminium
TYPE C	4 mm Mild Steel
TYPE D	0.3 mm Tinplate
TYPE E	1.5 mm Mild Steel
TYPE F	0.5 mm Aluminium

² Unless otherwise noted, test panels should be coated with the full paint system (i.e., topcoat and primer) as per the manufacturer's instructions and at the dry film thickness that the manufacturer will recommend for ship application of the coating.



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12 APPENDIX D

Document History

Status: Current
Version: 5
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Document Version No.:	Date Published:	Summary of Changes:
5	10-09-2021	<ul style="list-style-type: none">• General format changes• Updated background information in clause 2• Updated SUSMP information• Updated APAS website information
4	07-12-2020	<ul style="list-style-type: none">• Addition of Appendix D 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• Addition of "People + Product = Protection" to Footer
3	01-09-2014	<ul style="list-style-type: none">• This document version contains two types and two Sub-classes of RAN topcoat. It retained the previous, standard durability, low gloss Storm Grey polyurethane topcoat and introduced the new, high durability polysiloxane topcoats in Storm Grey and RAN Haze Grey colours, both available in low gloss and semi-gloss finishes. During an interim change-over period, both the low gloss N42 Storm Grey polysiloxane and the low gloss RAN Haze Grey polysiloxane co-existed, but after the changeover period the RAN topcoat was exclusively a low gloss RAN Haze Grey topcoat using a polysiloxane resin binder.
2	17-07-2008	<ul style="list-style-type: none">• Clarified the Note references in Table 1 and deleted the sub-classes in 1.2
1	10-12-2007	<ul style="list-style-type: none">• Incorporated a general technical update
0	26-10-2006	<ul style="list-style-type: none">• Original document