

POLYURETHANE FINISHING SYSTEM FOR VEHICLES AND EQUIPMENT

1 SCOPE

A two-pack polyurethane paint system to be used for the finishing and refinishing of vehicles and equipment of the Australian Defence Services.

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

- A two-pack polyurethane paint system to be used for the finishing and refinishing of vehicles and equipment of the Australian Defence Services.
- Available in a flat (sub-class AP-S0154/1 and AP-S0154/8) or low gloss (sub-class AP-S0154/3 and AP-S0154/9) and at two levels of infra-red reflectance:
 - Conventional:** provides low IR reflectance for maximised camouflage effect
 - Near Infrared Reflecting:** designated as NIRR, intended for minimised solar heat absorption
- The paint systems shall be suitable for use over suitably pre-treated ferrous and non-ferrous metal surfaces and over aged polyurethane or alkyd paintwork.
- The finishing paint, when applied by spray in accordance with the manufacturer's directions to a vertical surface, shall produce a film of dry thickness 20 - 30 µm.
- On Ferrous Metals:** Following metal pre-treatment by phosphating or abrasive blast cleaning, application of one coat of epoxy primer to sub-class AP-S0154/2 (conforming to the performance requirements of MIL DTL 53022) or one coat of a suitable commercial multipurpose primer to sub-class AP-S0154/6, followed by one coat of the appropriate polyurethane finish, sub-class AP-S0154/1, AP-S0154/3, AP-S0154/8 or AP-S0154/9.
- On Non Ferrous Metals:** Following metal pre-treatment by conversion coating or application of an etch primer to sub-class AP-S0154/5, application of a coat of epoxy primer to sub-class AP-S0154/7 (conforming to the performance requirements of MIL PRF 23377) or one coat of a suitable commercial multipurpose primer to sub-class AP-S0154/6 followed by polyurethane finish, sub-class AP-S0154/1, AP-S0154/3, AP-S0154/8 or AP-S0154/9.

- On Previously Painted Surfaces:** Following pre-treatment by removing any oil or grease and by lightly abrading the previous film of aged polyurethane or aged alkyd paint, application of polyurethane finish, sub-class AP-S0154/1, AP-S0154/3, AP-S0154/8 or AP-S0154/9.

3.2 Sub-Classes

- This specification incorporates the following sub-classes:
 - AP-S0154/1:** Flat DPP Finish Coat - Camouflage
 - AP-S0154/2:** Epoxy Primer for Steel
 - AP-S0154/3:** Low Gloss DPP Finish Coat - Camouflage
 - AP-S0154/4:** Thinner
 - AP-S0154/5:** Etch Primer
 - AP-S0154/6:** Epoxy Primer (multi-purpose)
 - AP-S0154/7:** Epoxy Primer for Aluminium
 - AP-S0154/8:** Flat Finish Coat (solar heat reflecting)
 - AP-S0154/9:** Low Gloss Finish Coat (solar heat reflecting)

3.3 Basis of this Specification

- This specification is based on the following standards:
 - MIL DTL 53022 for sub-class AP-S0154/2
 - Australian Army Specification 6461 for sub-class AP-S0154/3
 - APAS specification AP-S0035/2 for sub-class AP-S0154/5
 - MIL PRF 23377 for sub-class AP-S0154/7
 - Australian Army Specification 6828 for sub-class AP-S0154/9
- Paints approved under this specification do not comply with any of the paint types referenced in either AS/NZS 2311 or AS/NZS 2312.

4 REFERENCED DOCUMENTS

- The following standards are referenced in this document:
 - AS/NZS 1580** – Paints and related materials: Methods of test
 - AS/NZS 2311** – Guide to the painting of buildings
 - AS/NZS 2312** – Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings – Paint Coatings
 - SAE AMS STD 595** – Colours used in Government Procurement
 - MIL PRF 23377 Revision K** – Primer Coatings: Epoxy, High-Solids – Revision K
 - MIL DTL 53022 Revision E** – Primer, Epoxy Coating, Corrosion Inhibiting and Chromate Free – Revision E
 - MIL C 46168 Revision D** – Coating, Aliphatic Polyurethane, Chemical Agent Resistant – Revision D

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

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



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- viii. **The Poisons Standard October 2021:** Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) No. 34, 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/F2021L01345>

- b) The following APAS documents are referenced in this document:
- AP-D001 Rules Governing How APAS® Operates
 - AP-D123 Restrictions on Ingredients in Product Formulations
 - AP-D152 APAS® Participating Manufacturers and Resellers
 - AP-D177 Rules Governing How Product Manufacturers participate in APAS®
 - AP-D181 Volatile Organic Compounds (VOC) Limits
 - AP-D192 Rules Governing APAS® Product Certification Scheme
 - AP-S0035/2 Etch Primer for Zinc and Zinc/Aluminium Coated Metals – One pack etch primer, chromate-free

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/>

5 COMPOSITIONAL REQUIREMENTS

5.1 Binder

- The polyurethane finish sub-classes (AP-S0154/1, AP-S0154/3, AP-S0154/8 and AP-S0154/9) shall typically be supplied in two components.
- One component shall consist essentially of orthophthalic trimethylol propane polyesters combined with pigments and solvents. The second component shall consist essentially of an aliphatic polyisocyanate dissolved in solvents. The two components shall be mixed in a simple volume ratio.

5.2 Volatiles

- Although not restricted by this specification, the volatile component is typically hydrocarbon-based solvents.
- For VOC content restrictions, refer to APAS document AP-D181.

5.3 Pigmentation

- The pigmentation shall be chosen to impart the properties detailed in clause 10, Table 1 below.
- Some colours (e.g., reds, oranges or yellows) may variously contain lead or chromate-based pigments qualifying specific Schedule status according to the SUSMP. Such colours shall be clearly identified in accordance with local legislation and regulations.

5.4 Colour

- Products approved under this specification are normally available in a wide range of colours, including camouflage colours and colours suitable for producing a disruptive pattern (DPP) finish such as Camouflage Green (Olive Drab), Camouflage Brown, Black, Pilbara Brown as well as Olive Drab, White and Off White.

6 PRODUCT APPROVAL REQUIREMENTS

6.1 General Requirements

- 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

- Tests are to be carried out under the routine conditions of AS/NZS 1580.101.5 unless otherwise specified.
- Panels are to be cured for 24 hours before testing unless otherwise specified.
- Finishing Products:** sub-classes AP-S0154/1, AP-S0154/3, AP-S0154/8 and AP-S0154/9 - all testing shall be performed in accordance with clause 10, Table 1 and clause 11, Table 2 below.
- Priming Products:** sub-classes AP-S0154/2, AP-S0154/5, AP-S0154/6 and AP-S0154/7 - initial testing shall be performed in accordance with the tests detailed in clause 10, Table 1 under the heading **Individual Component Testing**.
- The primer shall subsequently be included in some tests involving the coating system and satisfactory test results as part of the coating system tested will allow granting of approval to the particular primer used.
- Subject to compliance with all the requirements of this specification, the level of Approval appropriate to the application shall be given to the system.
- Due to the extremely hazardous nature of the chemicals used in the tests in Clause 7 and Clause 9, the test procedure detailed in these clauses shall be performed by the Land Division of DSTG. The following contact information is current until 30th June 2022 after which time the details will be updated to reflect impending divisional changes:

Ms Sue Pantelidis
Land Division, DSTG
Email: sue.pantelidis@defence.gov.au

6.3 Health and Safety Requirements

- The manufacturer's Safety Data Sheet (SDS) must be studied closely prior to using the product and complied with during use of the product.
- This paint is based upon polyurethane resins which rely on isocyanate curing agents. Appropriate precautions should be taken during application and cure. Avoid contact with the skin by the use of protective clothing and barrier cream. Isocyanates can cause severe irritation to eyes and respiratory tract necessitating strict attention to safety.

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- c) Since the paint contains hydrocarbon solvents, the paint components are flammable and should be stored away from all sources of heat or ignition. 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 into the lungs.
- d) Care should be taken to avoid contact with the skin by the use of protective clothing and barrier cream. All pumping equipment should be adequately earthed.
- e) 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.
- f) The product shall comply with all requirements of clause 6.3 and 6.4 of APAS document AP-D192.

7 APPENDIX A

Chemical Agent Simulant Resistance

NOTE: Due to the extremely hazardous nature of the chemicals used in this test, the test procedure detailed in this appendix shall be performed by the Land Division of DSTG - refer to contact information in clause 6.2 g).

7.1 Panel Preparation

- 7.1.1 Coat by spraying both sides of four steel panels, 100 x 20 x 1.2 mm, with the coating system to a dry film thickness of between 40 and 70 µm.
- 7.1.2 If necessary, to obtain correct film thickness, thin with the recommended solvent supplied by the manufacturer.
- 7.1.3 Age the films at room temperature for 7 days before test.

7.2 Test Procedure

- 7.2.1 Weigh the coated panels to the nearest 0.1 mg and immerse duplicate panels to a depth of 75 mm in each chemical agent simulant (tri-propyl phosphate, practical grade for GF agent and tetrachloroethylene, reagent grade for HD Agent).
- 7.2.2 After 60 minutes, remove the panels from the simulants, rinse thoroughly with a stream of isopropyl alcohol from a wash bottle, blot dry with absorbent paper and reweigh the panels between 10 and 15 minutes after removal from the simulants.
- 7.2.3 Calculate the mass gain in milligrams.

8 APPENDIX B

Resistance to Fluids

8.1 Water Resistance

- 8.1.1 When a film of the paint, applied over Epoxy Primer sub-class AP-S0154/2, is allowed to dry for 7 days, immersed in distilled water for 7 days, removed and allowed to dry for 18 hours, and then examined, the film shall show no defects and shall appear identical with an un-immersed panel, similarly prepared.

8.2 Mineral Oil Resistance

- 8.2.1 When a film of the paint, applied over Epoxy Primer sub-class AP-S0154/2, is allowed to dry 7 days, immersed in mineral oil at $50 \pm 2^\circ\text{C}$ for 7 days, removed, dried and examined, the film shall show no defects and shall appear identical with an un-immersed panel, similarly prepared.

8.3 Petroleum Spirit Resistance

- 8.3.1 When a film of the paint, applied over Epoxy Primer sub-class AP-S0154/2, is allowed to dry for 7 days, immersed in petroleum spirit for 7 days, removed, dried and examined, the film shall show no defects and shall appear identical with an un-immersed panel, similarly prepared.

8.4 Acid Resistance

- 8.4.1 When a film of the paint, applied over Epoxy Primer sub-class AP-S0154/2, is allowed to dry for 7 days, spotted with a 30 - 50 mm diameter spot of 10 % acetic acid (by volume), which shall then be covered with a watch-glass and allowed to stand for 1 hour, rinsed with water and dried, the spotted area shall show no defects and shall appear identical with the unspotted surroundings.

9 APPENDIX C

Chemical Agent Resistance

NOTE: Due to the extremely hazardous nature of the chemicals used in this test, the test procedure detailed in this appendix shall be performed by the Land Division of DSTG - refer to contact information in clause 6.2 g).

9.1 Panel Preparation

- 9.1.1 Spray two 75 x 75 x 1.2 mm steel panels, with epoxy primer conforming to sub-class AP-S0154/2 to a dry film thickness of 23 - 28 µm.
- 9.1.2 Air dry 2 hours and spray on the finish to be tested to a dry film thickness of 46 - 56 µm.
- 9.1.3 Age the films for 7 days before testing.

9.2 Test Condition

- 9.2.1 Because the desorption rate of agents from paint is temperature dependent, all agent tests will be conducted at 25°C.
- 9.2.2 Toxic materials are used in this testing; therefore, all work will be performed in an approved fume hood.

9.3 Test Apparatus

- 9.3.1 In the fume hood, use a short length of tubing, not exceeding 50 mm, to attach an apparatus similar to that shown in Figure 1 to a sampling bubbler similar to that shown in Figure 2 filled with 5 mL diethyl phthalate. Refer to page 8 of this specification for Figures 1 and 2.
- 9.3.2 The inlet of the apparatus should be supplied with dry air. Connect the outlet of the bubbler to a



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vacuum line in the hood with a 1L per minute critical orifice between the bubbler and the vacuum line.

9.4 Test Procedure

- 9.4.1 Using separate panels for each of the agents detailed in clause 7, Appendix A and using a soft lead pencil so that the coating is not damaged, outline a circle 30 cm² in area near the centre of the panel.
- 9.4.2 Using a micro-syringe, place 30 mL of the chemical agent in 1 µL drops within the 30 cm² area so that the entire area is evenly covered.
- 9.4.3 After 30 minutes remove the agent from the surface by directing a stream of isopropanol (reagent grade) onto the panel.
- 9.4.4 Use a series of such washes and after the final rinse, continuously monitor the panel until the isopropanol has evaporated.
- 9.4.5 Place the panel in the test apparatus and start sampling.
- 9.4.6 Draw dry air into the inlet of the test apparatus, over the contaminated film and through the bubbler and critical orifice. Any agent vapours emitted are picked up by the air stream and absorbed in the diethyl phthalate in the bubbler.
- 9.4.7 After sampling continuously for 24 hours, analyse the diethyl phthalate for the presence of agent using the methods detailed in the Appendix of MIL C 46168.
- 9.4.8 Determine the amount of agent recovered in micrograms.



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10 TABLE 1: PERFORMANCE PROPERTIES

| TEST | AS/NZS 1580 METHOD | REQUIREMENTS |
|--|--------------------|--|
| Individual Component Testing - To be carried out on both Part A and Part B components - Applicable to ALL sub-classes except AP-S0154/4 | | |
| Preliminary Examination | 103.1 | To be readily reincorporated. Shall be free of coarse particles, gel and foreign matter. |
| Density | 202.1 | To be recorded. |
| Non-volatile Content | 301.1 | To be recorded. |
| Fineness of Grind | 204.1 | AP-S0154/1: Maximum 45 µm. AP-S0154/2: Maximum 75 µm. AP-S0154/3: Maximum 25 µm. AP-S0154/4: Not applicable. AP-S0154/5: Maximum 75 µm. AP-S0154/6: Maximum 75 µm. AP-S0154/7: Maximum 75 µm. AP-S0154/8: Maximum 45 µm. AP-S0154/9: Maximum 25 µm. |
| Reincorporation after Storage | 203.1 Method B | After storage for 18 months at ambient temperature, there shall be no curdling, gelling or seeding and the settling rating shall not be less than 6. Manual stirring shall produce a uniform product. |
| 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. |
| Finishing Paint Testing – applicable to sub-class AP-S0154/1, AP-S0154/3, AP-S0154/8 and AP-S0154/9 | | |
| Application Properties - Spraying | 205.2 | Shall show satisfactory application properties and the dry film shall be free of defects. |
| Consistency | 214.X | To be recorded. |
| Thinner Compatibility | 208.1 | No defects when thinned to the maximum amount allowed in the manufacturers written instructions. |
| Dry Hiding Power - Contrast ratio | 213.2 | Minimum 98% @ 16 m2/L. |
| Surface Dry Condition | 401.1 | Maximum 1 hour. |
| Hard Dry Condition (Mechanical Thumb Test) | 401.6 | Maximum 6 hours. |
| Recoating Properties | 404.1 | The paint shall be suitable for recoating in less than 18 hours. |
| Pot life | | The paint shall have satisfactory application properties for a minimum of 4 hours after combining the components. |



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| TEST | AS/NZS 1580 METHOD | REQUIREMENTS | | | | | | | | |
|---|--------------------|--|----------------|---|--------------|---|----------|---|---------------|---|
| Complete Coating System | | | | | | | | | | |
| Infra-red Reflectance | | Shall comply with the requirements of clause 11, Table 2 below. Values shall be recorded. <ul style="list-style-type: none"> Infra-red reflectance measurement may employ any spectrophotometer having an integrating sphere detector with spectral included and capable of measuring reflectance at 800 nm. | | | | | | | | |
| Bend test | 402.1 | After air drying for seven days, the film shall show no sign of cracking or loss of adhesion after bending round a 6 mm mandrel. | | | | | | | | |
| Adhesion | 408.4 | Adhesion rating shall not be greater than 1. | | | | | | | | |
| Scratch Resistance | 403.1 | Minimum 1000g. | | | | | | | | |
| Resistance to Impact - Falling Weight Test | 406.1 | Minimum 4.5 joules. | | | | | | | | |
| Resistance to Natural Weathering | 457.1 | After 12 months exposure at 45°N at a temperate site, no integrity failure and ratings shall not be greater than: <table style="margin-left: 20px; border: none;"> <tr><td>Discolouration</td><td style="text-align: right;">1</td></tr> <tr><td>Gloss Change</td><td style="text-align: right;">1</td></tr> <tr><td>Chalking</td><td style="text-align: right;">1</td></tr> <tr><td>Colour Change</td><td style="text-align: right;">1</td></tr> </table> Infra-Red Reflectance shall not decrease by more than 5% of the initial IR reflectance. | Discolouration | 1 | Gloss Change | 1 | Chalking | 1 | Colour Change | 1 |
| Discolouration | 1 | | | | | | | | | |
| Gloss Change | 1 | | | | | | | | | |
| Chalking | 1 | | | | | | | | | |
| Colour Change | 1 | | | | | | | | | |
| Specular Gloss | 602.2 | AP-S0154/1: < 5 gloss units using the 85° head. AP-S0154/3: Between 7 and 10 units using the 60° head. AP-S0154/8: < 5 gloss units using the 85° head. AP-S0154/9: Between 7 and 10 units using the 60° head. | | | | | | | | |
| Colour - Visual Comparison | 601.1 | Close colour match to the relevant colour reference: Camouflage Green (Olive Drab): SAE AMS STD 595 Colour No. 34088. Camouflage Brown: SAE AMS STD 595 Colour No. 30219. Black: SAE AMS STD 595 Colour No. 37038. Pilbara Brown: SAE AMS STD 595 Colour No. 30109. Off White: SAE AMS STD 595 Colour No. 37875. | | | | | | | | |
| Finish | 603.1 | Shall be smooth, free of coarse particles, wrinkling or orange peel and have a uniform gloss, colour and appearance. | | | | | | | | |
| Resistance to Artificial Weathering - Fluorescent UV - condensation type instrument (QUV) | 483.2 | After 1000 hours (continuous alternating cycles of 4 hours UV @ 60°C and 4 hours condensation @ 50°C), no integrity failure and ratings shall not be greater than: <table style="margin-left: 20px; border: none;"> <tr><td>Discolouration</td><td style="text-align: right;">1</td></tr> <tr><td>Gloss Change</td><td style="text-align: right;">1</td></tr> <tr><td>Chalking</td><td style="text-align: right;">1</td></tr> <tr><td>Colour Change</td><td style="text-align: right;">1</td></tr> </table> | Discolouration | 1 | Gloss Change | 1 | Chalking | 1 | Colour Change | 1 |
| Discolouration | 1 | | | | | | | | | |
| Gloss Change | 1 | | | | | | | | | |
| Chalking | 1 | | | | | | | | | |
| Colour Change | 1 | | | | | | | | | |



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| TEST | AS/NZS 1580 METHOD | REQUIREMENTS |
|---|----------------------|--|
| Complete Coating System (Cont.,) | | |
| Chemical Agent Simulant Resistance | Clause 7, Appendix A | When immersed in both simulants, maximum mass gain shall not be greater than 5.0 mg. |
| Resistance to Fluids - Water - Mineral Oil - Petroleum Spirit - Acetic Acid | Clause 8, Appendix B | No change. No change. No change. No change. |
| Chemical Agent Resistance | Clause 9, Appendix C | A maximum of 40 µg of GF and a maximum of 180 µg of HD to be desorbed. |

11 TABLE 2: INFRA-RED REFLECTANCE REQUIREMENTS

| | Conventional Sub-classes AP-S0154/1 and AP-S0154/3 only | NIRR Sub-classes AP-S0154/8 and AP-S0154/9 only |
|------------------|--|--|
| Camouflage Green | 40-50% | Greater than 60% |
| Camouflage Brown | 20-30% | Greater than 70% |
| Pilbara Brown | 20-30% | Greater than 60% |
| Black | Less than 10% | Greater than 65% |
| White | No requirement | No requirement |

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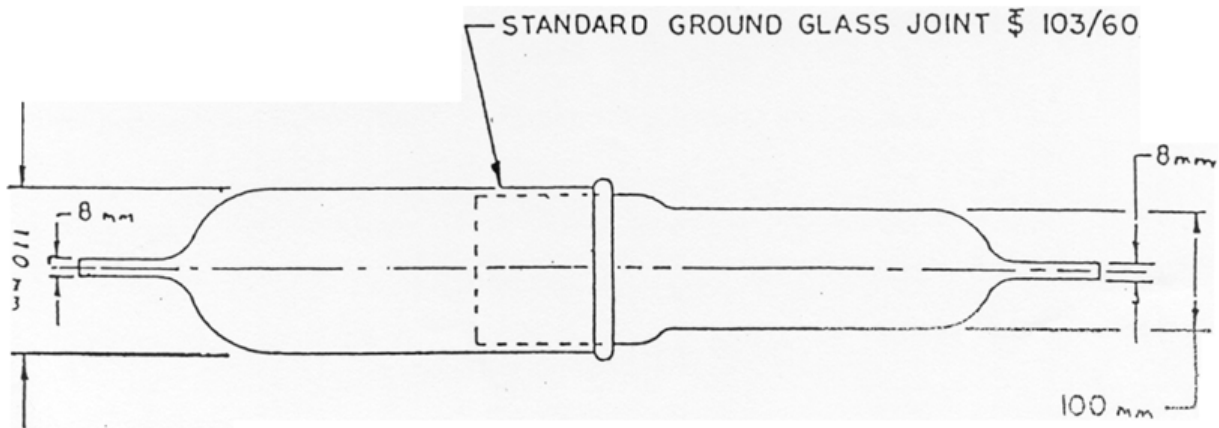


FIGURE 1 - TEST APPARATUS

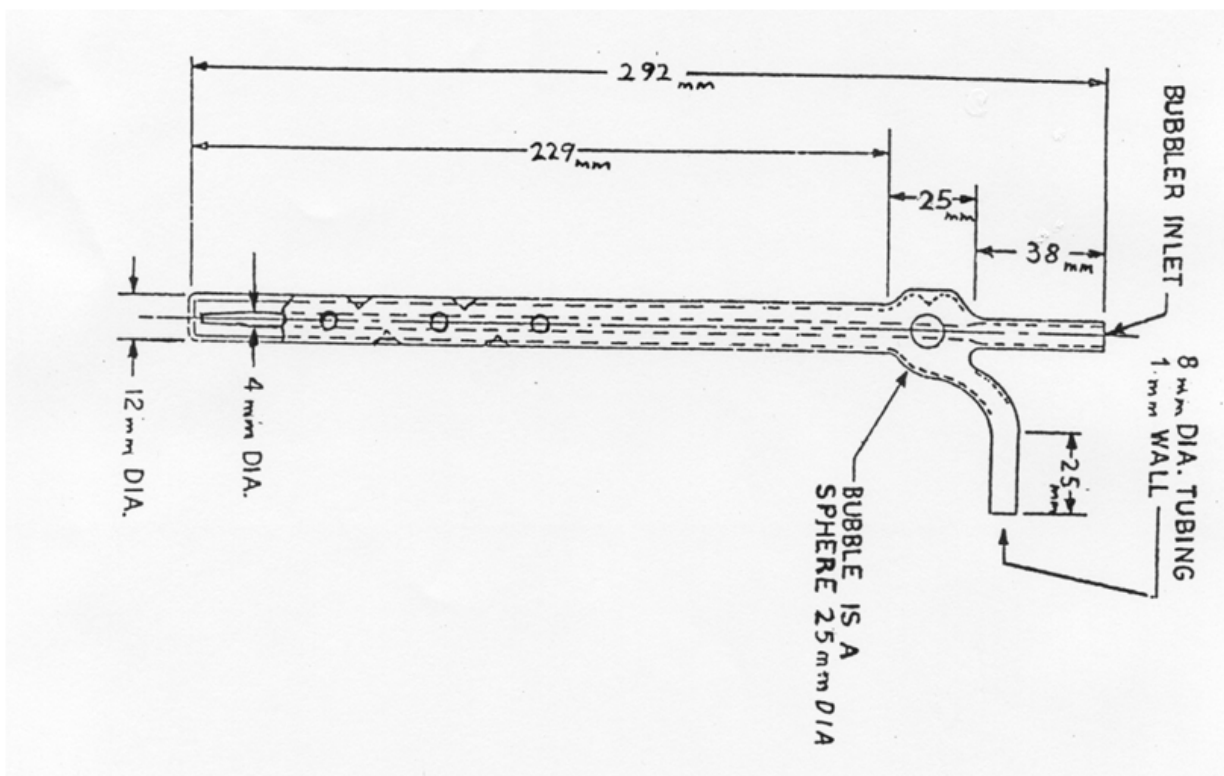


FIGURE 2 - SAMPLING BUBBLER



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12 APPENDIX D

Document History

Status: Current
Version: 15
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| Document Version No.: | Date Published: | Summary of Changes: |
|-----------------------|-----------------|---|
| 15 | 14-01-2022 | <ul style="list-style-type: none">• General formatting changes• Updated SUSMP information• Updated contact information for testing relevant to Appendices 7 and 9 from the Aeronautical and Maritime Research Laboratory to Land Division, DSTG in clauses 6.2 g), 7 and 9 |
| 14 | 30-08-2021 | <ul style="list-style-type: none">• General format changes• Updated background information in clause 2• Updated SUSMP information• Updated APAS website information |
| 13 | 18-11-2020 | <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• Inclusion of VOC Content requirement to Table 1 Performance Properties• Addition of "People + Product = Protection" to Footer |
| 12 | 06-12-2006 | <ul style="list-style-type: none">• Updated contact details in 2.2 and more clearly defined colour standards in Table 1 |
| 11 | 30-03-2005 | <ul style="list-style-type: none">• Updated contact details in clause 2.2 |
| 10 | 23-09-2003 | <ul style="list-style-type: none">• Deleted reference to GPC numbering and incorporated a general format update |
| 9 | 07-03-2002 | <ul style="list-style-type: none">• More clearly delineated the camouflage and solar heat reflecting nature of the topcoats by adding two new sub-groups 0154/8 and 0154/9 |
| 8 | 05-12-2001 | <ul style="list-style-type: none">• Deleted paragraphs 3.1, 3.3 & 3.4 as they were incorporated into AP-D192 |
| 7 | 05-03-2001 | <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-154) |