

HEAT AND BLAST PROTECTION COATING MATERIALS AND APPLICATION METHODS, SPECIFICATION FOR

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A		Revision	June 15, 1982
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C		Added seven newly qualified products to the qualified products list. Removed products no longer commercially available. Newly developed qualification test methods and test criteria were added, along with updates to the current methods.	October 6, 2022

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FIGURES

Figure 1. Diagram illustrating the failure mechanisms that can occur. Adhesive failure occurs when the bond between the steel substrate and the coating fails. A cohesive failure occurs when the material itself fails, indicating that the bond of the material to the steel substrate is stronger than the material itself. 3

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

AMPP	Association for Materials Protection and Performance
Btu	British thermal unit
°C	degree Celsius
cm	centimeter
cm ²	square centimeter
CS	Chem Seal
DC	Dow Corning Corporation
°F	degree Fahrenheit
GE	General Electric Company
GSE	Ground Support Equipment
ICC	Interstate Commerce Commission
in	inch
kg	kilogram
km/h	kilometer per hour
KSC	John F. Kennedy Space Center
lb	pound
lb/in	pound per liner inch
MIL	military
mm	millimeter
mph	mile per hour
MMH	Monomethylhydrazine
NASA	National Aeronautics and Space Administration
N ₂ O ₄	Nitrogen Tetroxide
PPE	Personal Protective Equipment
RH	Relative Humidity
s	second
SDS	Safety Data Sheet
SPEC	Specification
ft ²	square foot
STD	Standard

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1. SCOPE

This specification is mandatory for use at the Kennedy Space Center (KSC) and other areas where KSC has jurisdiction. This specification is applicable to NASA Civil Servants and NASA contractors (including subcontractors, service providers, and construction contractors). This specification establishes requirements for ablative coating materials for launch structures and ground support equipment (GSE). Ablative coatings are most commonly, but not limited to, the use as a sacrificial coating to protect underlying GSE from direct or indirect impingement of the heat flux and/or particulates from launch vehicle exhaust.

1.1 Classification

Materials furnished under this specification are silicone rubber-based products of the following types as specified.

- a. Type A – For trowel application to bare or inorganic zinc coated steel and for refurbishment of surfaces coated with products qualified herein. Requires use of product specific primer on bare steel or steel coated with inorganic zinc.
- b. Type B – For spray application to bare or inorganic zinc coated steel and for refurbishment of surfaces coated with products qualified herein. Type B coatings are not required or intended to be used with a product specific primer.

2. APPLICABLE DOCUMENTS

The following documents form a part of this document to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

Copies of the documents are available from the NASA Technical Standards website (<http://standards.nasa.gov>), any NASA installation library or documentation repository, or from the procuring activity.

ASTM D1876	Standard Test Method for Peel Resistance of Adhesives (T-Peel Test)
ASTM D6862	Standard Test Method for 90 Degree Peel Resistance of Adhesives
MIL-PRF-5606	Hydraulic Fluid, Petroleum Base; Aircraft, Missile, and Ordnance
MIL-PRF-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Metric, NATO Code Number H-537

NASA-STD-5008	Protective Coating of Carbon Steel, Stainless Steel and Aluminum on Launch Structures, Facilities, and Ground Support Equipment
NASA-STD-6001	Flammability, Off-gassing, and Compatibility Requirements and Test Procedures
NPR 6000.1	Requirements for Packaging, Handling and Transportation for Aeronautical and Space Systems Equipment and Associated Components
SSPC-SP 1	The Society for Protective Coatings; Surface Preparation Specification NO. 1 Solvent Cleaning
SSPC-SP 2	The Society for Protective Coatings; Surface Preparation Standard NO. 1 Hand Tool Cleaning
SSPC-SP 3	The Society for Protective Coatings; Surface Preparation Specification NO. 3 Power Tool Cleaning
SSPC-SP 10	The Society for Protective Coatings; Joint Surface Preparation Standard SSPC-SP 10/NACE NO. 2 Near-White Metal Blast Cleaning

3. REQUIREMENTS

3.1 Product and Performance Characteristics

3.1.1 Shelf Life

Material will be capable of meeting the requirements of this specification when stored in accordance with the conditions stated in Sections [5.1.4.5](#) and [5.1.4.6](#).

3.1.2 Ease of Application

Material will be capable of being applied by skilled labor following detailed application procedures furnished by the material manufacturer. Type A materials will be capable of being applied to a vertical surface without sagging. Pot life will be a minimum of 1 hour. Sprayable materials will be capable of application with commercially available equipment to the film thicknesses specified.

3.1.3 Cure

The required cure for the material should be complete within 7 days at 10 °C to 37.8 °C (50 °F to 100 °F) and 50 to 100 percent relative humidity (RH).

3.1.4 Resistance to Penetration by Hydraulic Fluids

The surface of the cured material will be impermeable to hydraulic fluid. The material will retain its thermal protection characteristics after exposure to hydraulic fluids conforming to MIL-PRF-5606 and MIL-PRF-83282.

3.1.5 Weathering

The thermal protection characteristics of the material will not degrade due to seacoast atmospheric exposure or ultra-violet light. The material will not mold over time.

3.2 Qualification Tests

Material supplied in accordance with this specification shall have been tested in accordance with tests described in Section [5.2](#) and have met the requirements of each test as specified.

3.2.1 Adhesion

- a. Material shall adhere to uncoated steel and to steel coated with inorganic zinc.
- b. Adhesion shall be a minimum of 0.89 kg/cm (5 lb/in) if an adhesive failure (shown in Figure 1) occurs or a minimum of 0.54 kg/cm (3 lb/in) if a cohesive failure (shown in Figure 1) occurs when tested as described in 5.2.2.1.
- c. Adhesion shall be a minimum of 0.89 kg/cm (5 lb/in) if a combination of adhesive and cohesive failure occurs.

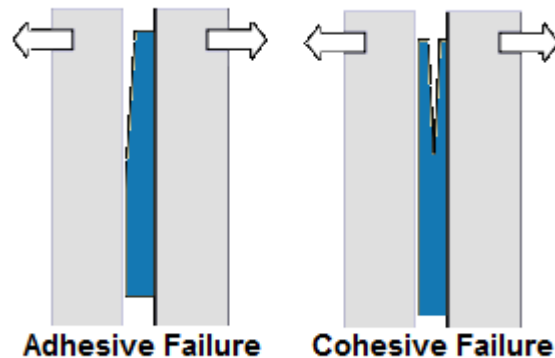


Figure 1. Diagram illustrating the failure mechanisms that can occur. Adhesive failure occurs when the bond between the steel substrate and the coating fails. A cohesive failure occurs when the material itself fails, indicating that the bond of the material to the steel substrate is stronger than the material itself.

3.2.2 Flammability

Materials shall comply with NASA-STD-6001, Test 1.

3.2.3 Flexibility

Material shall be sufficiently flexible to permit wrapping a 3.175-mm (0.125-inch)-thick sample around a 76.2-mm (3-inch) -diameter mandrel without cracking when tested in accordance with 5.2.2.3. Evidence of cracking indicates that the material is too brittle for the application and is cause for rejection.

3.2.4 Resistance to Hypergolic Propellants

Material shall not show indications of gross incompatibility with exposure to hydrazine, monomethyl hydrazine (MMH), and nitrogen tetroxide (N₂O₄) when tested in accordance with NASA-STD-6001, Supplemental Test Procedure A.2.7 Incidental Exposure.

3.2.5 Rocket Engine Exhaust Resistance

- a. Material shall be applied to a thickness that will not burn through to the substrate when exposed to rocket engine exhaust conditions.
- b. The remaining material will adhere to the underlying surface.
- c. Material shall be tested in accordance with Section [5.2.2.5](#) using laboratory scale plasma torch to assess product performance and determine required thickness.

3.2.5.1 Refurbishment

Any char resulting from surface thermal decomposition will be easily removed; for example, by wiping with a cloth, low-pressure washing, using a scrub brush, etc. Resurfacing material will bond to the residual coating after the char has been removed. The bond will be homogeneous and show no tendency to delaminate. If the ablated surface has been eroded to the bare substrate, refurbishment will be identical to the procedure for coating new surfaces (see Section [4.1.1](#)).

4. APPLICATION

4.1 Ablative Application Over New Surface

4.1.1 Surface Preparation

Surfaces to receive an ablative coating will be cleaned of all contaminants using methods similar to SSPC-SP1 and the manufacturer's application instructions. Smooth surfaces that are not already coated with an inorganic zinc primer will be roughened with abrasive paper, by abrasive blasting, or other appropriate methods using guidelines from SSPC-SP2, SSPC-SP3, SSPC-SP10 and the manufacturer's instructions.

Freshly cleaned surfaces that will be exposed to salt-laden winds will be primed (for Type A products) within 2 hours. All other surfaces will be primed (for Type A products) within 8 hours. Suitable precautions will be taken to ensure that the surfaces remain clean until they are primed or coated.

Surfaces will be free of moisture before the primer and ablative coating is applied. Forecast for temperature and humidity will show adequate coating conditions for a minimum of 2 hours from the time of coating application.

4.1.2 Type A, Application of Primer

Following cleaning, coat surfaces with a thin coat of the appropriate primer in accordance with the manufacturer's instructions by application with clean cheesecloth, spraying, or brushing. Application using cheesecloth is the preferred method. For brush application, only good-quality natural-bristle brushes will be used. A thin coating adheres better than a heavy film. A primer coat is considered too heavy when the surface is flooded, causing the primer to run or appear chalky.

The primer will be permitted to dry in accordance with the manufacturer's recommendations before application of the coating material. If the dry primer is chalk-white in appearance, the surface will be wiped down with a clean dry cloth until the chalky material has been removed.

No more than 8 hours will elapse before the coating material is applied to the primed surfaces. If more than 8 hours elapse, the surfaces will be cleaned and primed again. Primed surfaces will be protected from dust, other foreign matter, and handprints. The primed surfaces will be kept dry by any means necessary until the coating material is applied. In cases where the surfaces are exposed to salt-laden winds, the time between primer application and coating material application will be no more than 2 hours.

4.1.3 Type A, Application of Ablative Coating by Troweling or Hand Layup

Refer to the manufacturer's technical data sheet for application instructions. If the ablative has two parts, the base and the catalyst will be mixed in strict accordance with the manufacturer's instructions. After mixing, the ablative coating material will be applied with a trowel or spatula. Coating will be applied within the manufacturer's recommended working time and before set begins.

4.1.4 Type B, Application of Ablative Coating by Spray

Refer to the manufacturer's technical data sheet for application instructions. The coating material will be applied by spraying, rolling, or brushing onto clean, dry, structurally sound surfaces. Coating will be applied within the manufacturer's recommended working time and before set begins.

4.2 Ablative Application Over Existing Ablative Coating

4.2.1 Overcoating Silicone-Rubber-Coated Surfaces

The coating material can be applied directly over most other silicone coatings. When older silicone coats are recoated, the surface will be clean, dry, and structurally sound. The existing coating will be power-washed with an appropriate surfactant solution and then power-rinsed to

remove dirt. Primer will not be applied to silicone rubber surfaces. It is recommended that a test patch be cleaned and coated with material to verify the effectiveness of the cleaning process and the adhesion of the material to the surface prior to application.

4.2.2 Overcoating Ablative Materials Other Than Silicone Rubber

Where it has been determined that the adhesion between the intended overcoat material and the existing ablative is adequate and that the residual coating is firmly bonded to the subsurface, the overcoating ablative will be applied over the residual coating.

4.2.3 Refurbishment

After exposure to rocket engine exhaust, ablated surfaces will be prepared to receive additional ablative coating material by the following procedure:

- a. Ablated surfaces will be roughened with a wire brush or abrasive paper using methods similar to SSPC-SP 2 to remove residual char. Residual coating surfaces will be cleaned with a clean cloth dampened with acetone. Primer will not be applied to residual coating. Ablative coating will be applied over residual coating by following the steps in Section [4.1.3](#) for Type A or Section [4.1.4](#) for Type B. Recoated material will bond to the residual coating and show no tendency to delaminate.
- b. If the ablated surface has been eroded to the bare substrate, refurbishment will be identical to the procedure for coating new surfaces (see Section [4.1.1](#)).

5. QUALITY ASSURANCE PROVISIONS

5.1 Inspections

5.1.1 Governmental Inspection and Verification

- a. The Government and/or the Government's representative shall inspect the surface preparation and coating application processes defined herein as required by the project specifications.
- b. The inspector shall perform all of the in-process inspections required by the project specifications.
- c. The assigned inspector shall be an AMPP-Certified or Senior Certified Coatings Inspector (formerly NACE Level 2 or 3), under the AMPP Coatings Inspector program.
- d. The inspector shall witness, inspect, and test all protective coating work to verify complete compliance with the specified requirements.
- e. For more information regarding AMPP coating inspection requirements, refer to NASA-STD-5008.

5.1.2 Coating Application Contractor Inspection

- a. The contractor and AMPP inspector shall be responsible for performing inspection and tests of materials, equipment, and procedures to ensure conformance to the requirements of this specification.
- b. The contractor and AMPP inspector shall provide and maintain an inspection and test system acceptable to the Government.
- c. Inspection shall include but not be limited to Sections [5.1.2.1](#), [5.1.2.2](#), and [5.1.2.3](#).

5.1.2.1 Cleanliness for Type A Products

Immediately prior to application of the primer, the surface shall be examined to ensure no visible corrosion products, loose paint, dirt, or other foreign matter are present and the surface has been prepared in accordance with Section [4.1.1](#). Adhered paint will not be removed.

5.1.2.2 Primed-Surface Inspection for Type A Products

- a. Final inspection of the primed surface shall be performed no sooner than 30 minutes after the primer application.
- b. If chalking is noted during this inspection, the primed surface shall be inspected again following the wipe-down procedure specified in Section [4.1.2](#).

5.1.2.3 Coating Thickness Test

- a. Coating thickness shall be as specified on the engineering drawing.
- b. Unless otherwise specified, excessive coating thickness shall not be cause for rejection.
- c. Thickness shall be measured by a dry-film-thickness gage suitable for the substrate in accordance with SSPC-PA-2.
- d. Evidence of inadequate coating thickness shall be cause for rejection.

5.1.3 Personnel Hazards

The coating material may consist of two components, the catalyst and the base, or a single component. Prior to handling, personnel will be familiar with Personal Protective Equipment (PPE) recommendations as well as physical and health hazard information contained in the Safety Data Sheet (SDS) of each component.

5.1.4 Material Handling

5.1.4.1 Primer Shelf Life

- a. The primer will be used within the manufacturer's determined shelf life unless it is revalidated in accordance with this specification.

- b. Containers of outdated primer will be properly disposed of or may be submitted to the NASA Laboratories, Development, and Testing Division or the Operations support contract for revalidation at the time of intended use.

5.1.4.2 Primer Maintenance

Opened primer cans will be resealed as quickly as possible following use. The primer tends to pick up moisture from the atmosphere and its effectiveness deteriorates under these circumstances. To prevent deterioration, only the amount of primer to be used should be removed from the container and the original container should be resealed. Unused portions will not be returned to the original container.

5.1.4.3 Primer Inspection

- a. The primer will be inspected for clarity prior to use.
- b. If the clarity is questionable, refer to the manufacturer's instructions to determine its usability.

5.1.4.4 Primer Storage

All primer will be stored per the manufacturer recommendations.

5.1.4.5 Ablative Coating Material Shelf Life

- a. The coating material will be used before the manufacturer's expiration date printed on the packaging unless it is revalidated in accordance with this specification.
- b. Containers of outdated coating material should be properly disposed of or may be submitted to the NASA Laboratories, Development, and Testing Division or Operations support contract for revalidation at the time of intended use.

5.1.4.6 Ablative Coating Material Storage

- a. The coating material will be stored per the manufacturer's recommendations.
- b. The material will be stored in an area where the integrity of the contents of the can be ensured.
- c. The cans will be stored in a manner to ensure against overheating, water intrusion, and physical damage that might open the can and expose the contents.

5.2 Testing

5.2.1 Test Conditions

Standard conditions during testing will be $21.1^{\circ}\text{C} \pm 2.8^{\circ}\text{C}$ ($70^{\circ}\text{C} \pm 5^{\circ}\text{F}$) and 55 ± 5 percent relative humidity.

5.2.2 Preparation of Test Specimens and Test Methods

5.2.2.1 Adhesion Test

The ablative coating material will be tested in accordance with ASTM D6862 *Standard Test Method for 90 Degree Peel Resistance of Adhesives*. The carbon steel test panels will be the rigid adherend. For type A products, the applicable primer will be applied to the test panels per Section 4.1.2. A 1.0-inch-wide strip of the ablative coating material will be applied to the test panels by troweling in accordance with Section 4.1.3 (Type A, trowel) or spraying in accordance with Section 4.1.4 (Type B, spray). Both types of ablative coating material will be applied on bare carbon steel test panels and carbon steel test panels with standardly used inorganic zinc primer. A woven fiberglass fabric will be used as reinforcement for the ablative coating to prevent the coating from pulling out of the test machine clamp. The fabric will be heat cleaned at 900°F to remove organics before being used. 1-inch-wide strips of the heat cleaned fabric will be inserted in between two layers of ablative coating when test specimens are prepared.

NOTE

This test can be conducted at KSC Mechanical & Environmental Testing Labs (METL).

5.2.2.2 Flammability Test

The ablative coating material shall be tested in accordance with NASA-STD-6001, Test 1.

NOTE

This test can be conducted at White Sands Testing Facility (WSTF).

5.2.2.3 Flexibility Test

A sample 3.175 mm by 25.4 mm by 127 mm (0.125 in by 1.0 in by 5.0 in) will be wrapped around a mandrel 76.2 mm (3.0 in) in diameter.

5.2.2.4 Hypergolic Propellant Compatibility Test

The ablative coating material will be tested in accordance with NASA-STD-6001, Supplemental Test Procedure A.2.7 Incidental Exposure. Exposure time will be 10 minutes. Evidence of gross reactivity is cause for rejection. Compatibility with each hypergolic propellant will be determined with separate specimens.

NOTE

This test can be conducted at Component Refurbishment and Chemical Analysis (CRCA).

5.2.2.5 Plasma Torch Test

The ablative coating material shall be tested as follows:

- a. Apply ablative coating material to be tested on carbon steel test panels coated with inorganic zinc primer in accordance with NASA-STD-5008.
- b. The test specimens will be cured in the conditions recommended by the manufacturer for at least the minimum time recommended by the manufacturer's instructions.
- c. Expose the test specimens to the plasma torch stream at a duration and intensity that is expected for in-service launch conditions.

NOTE

The conditions used for the products qualified herein were based on the Mobile Launcher Base Zero Deck requirements in K0000345836-SPC. The conditions used for the testing are in Table 1.

Table 1. Testing conditions used for products qualified herein.

Product Type	Btus	Seconds
Trowelable (Type A)	1250	6
	2000	4
Sprayable (Type B)	35	16
	1250	3

- d. Calculate ablation rate for each specimen and each condition. Ablation rate shall be in thickness ablated (in mils) per second.

NOTE

This test can be conducted at Marshall Space Flight Center (MSFC) by the Non-metallics Materials & Space Environmental Effects Group.

5.2.3 Qualification and Acceptance Testing

To become a qualified product, the ablative coating material shall meet the requirements of Section [3](#).

5.3 Lots, Samples, and Prototypes

- a. A production lot (batch) shall consist of that quantity of material or number of items produced at the same time, under the same manufacturing conditions, of the same materials, and by the same manufacturer.

- b. Prototype samples shall be submitted when required and specified by the procuring activity.
- c. The prototype sample shall be capable of meeting the requirements specified herein and shall be identical to the proposed end product. (Prototype samples are a limited number of contracted articles that are not part of production runs. When received by the end user, prototype samples are further tested and evaluated to determine whether they are fit for the intended application. Evaluation may result in a configuration change and a subsequent contract modification to purchase modified items that best meet the design intent and the performance applications.)

6. NOTES

6.1 Definitions

For the purpose of this document, the following definitions shall apply.

AMPP inspector: AMPP-Certified or Senior Certified Coatings Inspector (formerly NACE Level 2 or 3), under the AMPP Coatings Inspector program that is responsible for performing all of the in-process inspections required by the project specifications including witnessing, inspecting, and testing all protective coating work to verify complete compliance with the specified requirements.

Contractor: Personnel performing the application of the ablative material.

Government: NASA civil servants or NASA representative.

Skilled labor: Personnel with previous experience in applying ablatives or have been properly trained by someone with previous experience.

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APPENDIX A. PRODUCTS QUALIFIED UNDER KSC-SPEC-F-0006

This list has been derived from a continuing test program. All listed materials have passed specific test requirements of KSC-SPEC-F-0006, *Heat and Blast Protection Coating Materials and Application Methods, Specification for*, and have been found to be satisfactory.

Type A (Trowelable)

Product	Manufacturer	Product Form	Color Options
3-6077	Dow Corning	2-part	White
Chem Seal (CS) 3808	Flamemaster Corporation	2-part	Red
93-104	Dow Corning	2-part	Dark Gray
Enduris Seam Sealant	GE/Momentive Performance Materials	1-part	White
993*	Volatile Free Incorporation	1-part	White
LPA-4000	Dow Corning	1-part	White

* 993 shall be used without primer

Type B (Sprayable)

Product	Manufacturer	Product Form	Color Options
SCM-3404-NASA	GE/Momentive	1-part	Gray
991	Volatile Free Incorporation	1-part	White
999	Volatile Free Incorporation	1-part	White
Enduris 3500	GE/Momentive Performance Materials	1-part	White/Gray
LPA-4000	Dow Corning	1-part	White

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