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George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

EM40
MSFC TECHNICAL STANDARD
ABLATIVE COMPOUND, THERMAL, APPLICATION AND CURE OF

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Revision	E	6/05/15	Revision E Release was authorized by the MSFC Technical Standards Document Control Board (DCB) through the Multiprogram Document Management System (MPDMS). Remove Space Shuttle references and add SLS hardware. Removal of SBU and ITAR content reference Approval of Public Release Banner 06/10/2015: Post Multi Program/Project Document Management System (MPDMS) approval, prior to upload into MSFC Repository Documentum, the following Administrative changes were made: 1. Table of Contents (ToC) and the Numbering for each Section was automated; thereby, increasing the font text in some of the sections; 2. Deleted 'TBD', which had inadvertently not been deleted out by the Effective Date within the header section; 3. Deleted 'TBD', which had inadvertently not been deleted in the Document History Log, page 2 under the Effective Date; 4. Revised the Effective Date in the Document History Log, page 2 to match the correct approval date that was in the header section. Changed FROM '06/06/15' TO '06/05/2015'.

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1.0 SCOPE

This process specification covers the minimum requirements for mixing, application, and cure of MSFC-SPEC-1918 thermal ablative compound. This specification has been approved by the George C. Marshall Space Flight Center (MSFC) and is available for use by MSFC and associated contractors.

Contractors and subcontractors (hereinafter, "contractors") may use other specifications if they have prior approval of National Aeronautics and Space Administration (NASA) Marshall Space Flight Center (MSFC) Materials and Processes (M&P) and meet the product requirements along with the intent of this specification.

1.1 Implementing Documentation

Implementing documentation, such as manufacturing process instructions and process plans and procedures, will contain sufficient detailed instructions and guidelines on operating parameters to ensure reliable and consistent quality processing of hardware. Any subcontractor proposed variations to materials or processes specified in this document will be submitted to NASA MSFC M&P for approval. Approval by NASA MSFC M&P is required before implementation. The contractor will supply necessary technical and supporting test data and Safety Data Sheets.

1.2 Requirements With Limited Applicability to Programs/Projects, Hardware items, or contractors

This specification includes requirements that have applicability to specific program/projects, hardware items, or contractors. When a requirement has limited applicability, the program/project or hardware item applicability is identified preceding the requirement (i.e. paragraph heading or preceding sentence) or is identified in parentheses immediately following the requirement. When requirements include references to contractor documents, those requirements are only applicable to the contractor that originated the applicable document. Access to contractor documentation is only available from the issuing contractor.

1.2.1 Space Launch System (SLS)

MSFC-SPEC-1919 is a critical process for Space Launch System (SLS) hardware per the SLS Project Offices. The qualification tests conducted during the Space Shuttle program are still applicable for use on the SLS Booster Project. These requirements are included for the Booster including the Five Segment Reusable Solid Rocket Motor (RSRMV). The requirements for Core Stage are included in a separate section based upon their qualification tests.

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2.0 APPLICABLE DOCUMENTS

2.1 Government Documents

The following documents, of the issue in effect on the date of invitation for bids, or request for proposal, form a part of this standard to the extent specified herein.

(Copies of specification, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the contracting agency or as directed by the contracting officer.)

2.1.1 Marshall Space Flight Center (MSFC)

MSFC-SPEC-1918	Ablative Compound, Thermal
MSFC-SPEC-2497	Handwipe Cleaning, Requirements For

2.2 Non-Government Documents

The following documents, of the issue in effect on the date of invitation for bids, or request for proposal, form a part of this standard to the extent specified herein.

2.2.1 Standards

ASTM D-2240	Standard Test Method for Rubber Properties – Durometer Hardness
ASTM D-1623	Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics

2.2.2 ORBITAL-ATK Documents

NOTE: Copies of ORBITAL-ATK documents may not be obtained through NASA.

10PRC-0630	Hand Wipe Cleaning Procedure for Critical Process Applications

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2.2.3 Boeing Documents

NOTE: Copies of Boeing documents may not be obtained through NASA.

STP0151	Bonding and Sealing, Surface Preparation for
STM907-01	Primer, Epoxy, Cryogenic, No-Degloss

3.0 REQUIREMENTS

3.1 Safety

The user of this specification shall be responsible for implementing the necessary safety procedure/precautions. Refer to the appropriate Safety Data Sheet (SDS).

3.2 Temperature Restrictions

Temperature of the ablative compound components prior to mixing shall be within the range of 50 degrees Fahrenheit (°F) minimum to 110°F maximum. The application substrate temperature shall be within the range of 40 degrees Fahrenheit (°F) minimum to 110°F maximum.

3.3 Personnel Certification

Personnel performing operations associated with critical processes governed by this procedure shall be skill certified per the Project's training requirements. Additional training is required as follows:

a) Initial training shall include demonstrations of proficiency.

b) Re-training shall be required when the type of work is interrupted for more than six (6) months. This re-training shall include a demonstration of proficiency.

3.4 Preparation of Surfaces

3.4.1 Non-RSRMV Surfaces

Surfaces to which the ablative compound is to be applied shall be free of water, oil, grease, wax, rust, dirt and any other contamination that may inhibit cure or adhesion. Unless otherwise specified on the applicable engineering drawing, surface preparation shall be as follows:

a) Clean all surfaces except Marshall Convergent Coating (MCC-1) per one of the following methods:

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1. Clean per 10PRC-0630.

2. Clean per MSFC-SPEC-2497.

b) Cured Marshall Convergent Coating (MCC-1) shall be abraded using 120 to 180 grit abrasive paper vacuumed to remove dust.

c) Using 120 to 180 grit abrasive paper or 3M 7447 abrasive pad, lightly abrade bonding surfaces to remove gloss/sheen from topcoated surfaces and remove any rough edges on adjacent cork pieces. Remove gloss as accessible. Primed surfaces shall be lightly abraded using 3M 7447 abrasive pad. Bare metal surfaces shall be lightly abraded using 120-180 grit abrasive paper. For topcoated bonding surfaces where topcoat has been sanded off/removed, exposed primer is acceptable if 2 percent or less of a square foot or 0.5 square inch (maximum) area is exposed.

d) Clean all surfaces except Marshall Convergent Coating (MCC-1) per one of the following methods:

1. Clean per 10PRC-0630

2. Clean per MSFC-SPEC-2497.

e) Visually inspect and verify surfaces are free of contamination.

NOTE: Repeat step 3.4.1d and 3.4.1e if the ablative compound is not applied within eight (8) hours of final cleaning.

3.4.2 RSRMV Surfaces

Surfaces to which the ablative compound is to be applied shall be free of water, oil, grease, wax, rust, dirt and any other contamination that may inhibit cure or adhesion. Unless otherwise specified on the applicable engineering drawing, surface preparation shall be as follows:

a) Clean per MSFC-SPEC-2497.

b) Using 120 to 180 grit abrasive paper or 3M 7447 abrasive pad, lightly abrade bonding surfaces to remove gloss/sheen from topcoated surfaces and remove any rough edges on adjacent cork pieces. Primed surfaces shall be lightly abraded using 3M 7447 abrasive pad. Bare metal surfaces shall be lightly abraded using 120-180 grit abrasive paper. For topcoated bonding surfaces where topcoat has been sanded off/removed, exposed primer is acceptable, except in locations where drawing requirements disallow missing topcoat.

c) Clean per MSFC-SPEC-2497.

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d) Visually inspect and verify surfaces are free of contamination.

NOTE: Repeat step 3.4.2c and 3.4.2d if the ablative compound is not applied within eight (8) hours of final cleaning.

3.4.3 SLS Core Stage Surfaces

Surfaces to which the ablative compound is to be applied shall be free of water, oil, grease, wax, rust, dirt and any other contamination that may inhibit cure or adhesion. Unless otherwise specified on the applicable engineering drawing, surface preparation shall be as follows:

a) STM0907-01 Primed surfaces – Surfaces that have been primed with STM0907-01 primer shall be prepared per STP0151-05.

b) Composite Surfaces with Peel Ply – Composite surfaces with peel ply shall be prepared per STP0151-18.

NOTE: Repeat step 3.4.3 if the ablative compound is not applied within eight (8) hours of final cleaning.

3.5 Ablative Compound Mixing

Mixing equipment, bowls and tools shall be clean and dry. The ablative compound kit shall be mixed to obtain a homogeneous consistent mixture. Hand mixing the ablative compound kit is acceptable for kit sizes up to and including one gallon. Mechanical mixing shall be utilized with kit sizes greater than one gallon.

NOTE: When quantities smaller than the regular kit size are required, mix the three ingredient portions by weight specified in Table I.

TABLE I. Ablative Compound Composition

MATERIAL	Parts by Weight Minimum	Parts by Weight Maximum
Polyamide Resin (Hardener), Part A	99	101
Epoxy Resin, Part B	74	76
Ablative Filler, Part C	24	26

Note: DO NOT allow the ablative compound to be dipped in or mixed with water or solvents before application.

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3.6 Application of Ablative Compound

3.6.1 Pot-Life

Ensure that the ablative compound pot life (the time between the addition of the hardener (Part A) to the resin (Part B) and the maximum time for ablative compound application) has not expired (see Table II).

TABLE II. Ablative Compound Pot Life

Premix Ablative Compound Temperature, °F	Pot Life, Minutes
50 to 64	58
65 to 69	53
70 to 74	49
75 to 79	45
80 to 84	41
85 to 89	38
90 to 94	35
95 to 100	32
101 to 106	30
107 to 120	28

3.6.2 Equipment

Apply ablative compound onto the areas defined by the applicable drawings using clean hand tools and/or clean gloves to build and form contours.

3.6.3 Techniques

A tack coat may be used to aid in material application. A tack coat is defined as the initial wetting of the substrate with a thin smear coat of material. The smear coat may be made using dry and visibly clean hand tools or gloved hands. The thickness of the tack coat is undefined but should be thin enough to provide visual indication of complete substrate wetting.

After the tack coat application and prior to the expiration of the material pot life, apply additional material over the tack coat to establish the initial coat. Work material into the surfaces and/or tamp to provide complete contact with surface and remove air pockets. Shape to achieve drawing configuration.

3.6.4 Irregular Area Application

For areas where complicated insulation configurations (ramps, raised areas, shaped contours) are required, use plastic, Teflon, plastic covered plywood or equivalent materials as forming guides.

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Use hand tools (as necessary) to work the ablative compound into/onto areas defined by forming guides to provide complete contact with surface and work out air pockets. Apply the ablative compound to depth/border defined by guides. Forming guides that are not removed prior to the end of ablative pot life shall remain in place until the Type D Durometer hardness requirement is satisfied

3.6.5 Single Layer Application

The ablative compound shall be applied in a single layer application for thicknesses up to 1 ½ inches. Ablative compound application thicknesses greater than 1 ½ inches must have MSFC approval. Application thickness requirements less than or equal to 1 ½ inches shall be considered a single layer application.

3.6.6 Multiple Layer Application

The minimum time between layer applications is 1 ½ hours. Maximum allowed time between layer applications shall be 8 hours. If the time between layer applications exceeds 8 hours the ablative compound layer must be allowed to cure and be prepared per 3.4 prior to the next layer of application.

3.6.7 Water Use During Application and Finishing

Use of controlled water applied directly to the ablative compound using dampened gloves, non-absorbent tools and lightly dampened low-lint cloth is allowed. Water shall not be used in any form such that the water can contact the substrate-to-ablative interface or the tack coat to ablative bond interface. Water shall not be used until the substrate is covered with the initial coat. The water must be a thin film. No free-running or standing water is allowed in the controlled work area where the ablative compound is to be applied. Water finishing shall be completed no later than 30 minutes after pot life expiration if the processing temperature is 85°F or less. If the processing temperature is greater than 85°F then water finishing shall be completed prior to pot life expiration.

CAUTION: Do not dip the ablative compound in water or solvent.

3.7 Cure

The ablative compound will cure in accordance with Figure 1. The lowest ambient temperature that is measured during cure shall be the same as the cure temperature referenced on the chart.

NOTE: Further processing which would disturb the ablative compound shall be avoided until process verification in accordance with 4.1.2 is complete.

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3.8 Finishing Operations (Post Cure)

When final finishing of the ablative compound surfaces is required use surform hand tools, phenolic chisels, cutting tools and 80 to 120 grit abrasive paper. Electric or pneumatic tools may be used at the discretion of engineering/team leader. Remove surface gloss from the ablative compound by sanding with 80 – 120 grit abrasive paper. Clean abraded area with air vacuum and/or dust with a clean cloth. Deglossing is not required on the ablative compound surface which will not be topcoated.

3.9 Inspection/Repair Criteria

Visually inspect the ablative compound application for absence of surface voids, cracks, and edge un-bonds. Pinholes, regardless of depth, are acceptable so long as the diameter does not exceed 1/16 inch at its largest cross section. If the cured ablative compound has any surface voids, cracks, or edge un-bonds, the ablative compound shall be reworked as follows:

a) Trim away the affected ablative compound. Phenolic chisels and cutting tools may be used for the trimming process.

b) Lightly abrade the area using 120 to 180 grit abrasive paper. Verify that the gloss is removed from the affected ablative compound.

c) Remove the grit and ablative compound residue by vacuuming.

d) Clean trimmed away area using MSFC-SPEC-2497 (Booster Surfaces), 10PRC-0630 (non-RSRMV Surfaces only) or STP0151-05 (SLS Core Stage Surfaces).

e) Apply new ablative compound in accordance with section 3.6.

f) After initial cure and inspection, any subsurface voids uncovered during subsequent processing are not allowed.

Chips, cracks, voids and undersized non-conformances located adjacent to areas that will be covered with the ablative compound during subsequent operations and which extend to a maximum of approximately 0.75 inch (or less) from the design “closeout area” are acceptable at the piece-part level. The ablative compound thickness shall be in compliance with applicable drawing requirements.

If sub-surface voids are detected through nominal processing (i.e. abrading RT-455 prior to paint application), then rework per steps a-e above.

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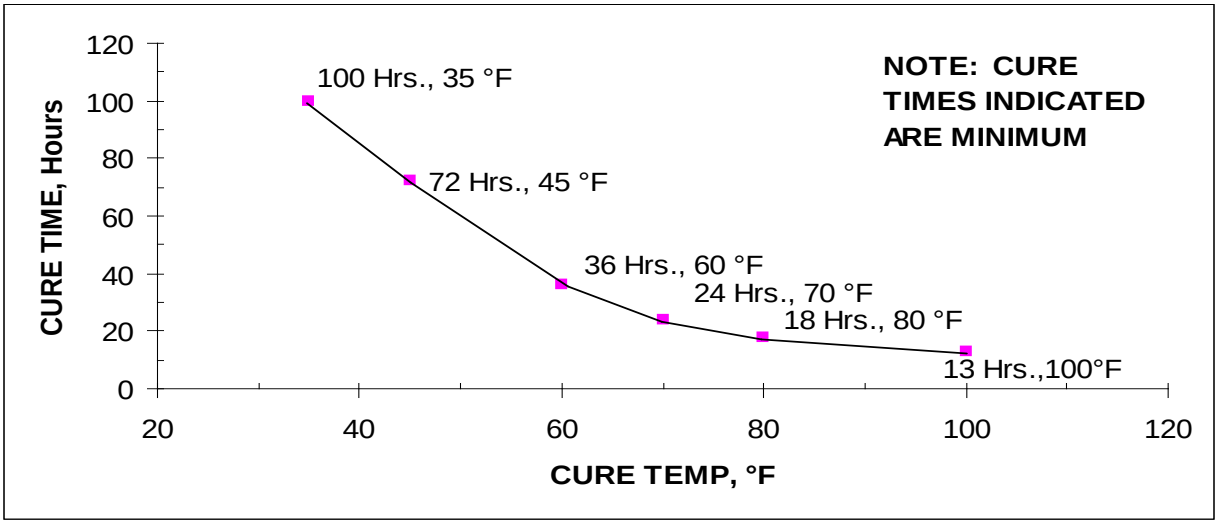

Figure 1. Ablative Compound Cure Time Versus Cure Temperature

4.0 VERIFICATION

4.1 Process Verification

4.1.1 Specimens

All verification specimens shall accomplish their objective (i.e. material tests shall be used to verify material properties and bond tests shall be used to verify bond properties). Bond specimens shall be representative of the production hardware. Material properties specimens including Type D Durometer hardness specimens shall be produced from production materials. The specimens shall be cured with the production hardware and under the same environmental conditions.

4.1.2 Hardness

Hardness testing shall be based on ASTM D-2240. Each batch of the ablative compound processed shall achieve a minimum Type D Durometer hardness of 20. Hardness specimen tests shall be run at standard lab conditions. Random checks of the flight hardware shall be performed to verify accessible ablative compound surfaces conform to the hardness requirement herein.

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4.1.3 Tensile Strength

The tensile properties of the cured ablative compound must be 100 psi minimum. Tensile property verification shall be achieved through testing approved tensile specimens. Tensile specimens shall be processed at the same time the flight hardware is being processed using the same mix of ablative compound. Specimens shall be cured in the same environment for the same time as flight hardware. Tensile specimens testing shall be based on ASTM D-1623. The number of tests required shall be documented.

5.0 PACKAGING

Not Applicable

6.0 NOTES

6.1 Definitions

6.1.1 Cure

The start of cure begins with the completion of ablative compound pot life. The completion of cure is the time at which a Type D Durometer hardness of 20 is verified per 4.1.2

6.2 Modifications or Changes

Recommendations for modifications or changes to the requirements specified herein will be submitted in writing to Materials and Processes Laboratory at MSFC for consideration.

NOTICE: When the Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.