

MSFC-SPEC-1918B
July 22, 1992



National Aeronautics and
Space Administration

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

ABLATIVE COMPOUND, THERMAL

Prepared by
Materials & Processes Laboratory
George C. Marshall Space Flight Center



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Release Date:

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**SPECIFICATION/DOCUMENT
CHANGE INSTRUCTION**

Page 1 of 1

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REPLACE PAGES 1, 3, 6, 9, & 11
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**SPECIFICATION CHANGE NOTICE/
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W. J. Fite
Prepared by

EH33
Organization

7/22/92
Date

Charles W. Mitchell
Approved by

EH31
Organization

7/22/92
Date

Paul W. Scherer
Approved by

FH-01
Organization

7/22/92
Date

STRESS

MATERIALS

Richard H. Bralhar 7/30/92 Donna E. [Signature] 7/24/92

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March 20, 2000

**GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SPECIFICATION**

ABLATIVE COMPOUND, THERMAL

This specification has been approved by the George C. Marshall Space Flight Center (MSFC) and is available for use by MSFC and associated contractors.

1.0 SCOPE

This specification establishes basic requirements for a trowellable, thermal ablative compound, a closeout and patching material for Thermal Protection Systems. Refer to MSFC-QPL-1918 for a list of qualified materials which conform to these specification requirements.

2.0 APPLICABLE DOCUMENTS

2.1 GOVERNMENT DOCUMENTS

The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposals shall apply.

STANDARDS

FEDERAL

FED-STD-313

Symbols for Packaging and Containers for
Hazardous Industrial Chemicals and Materials

ANSI-ASQC Standard
Z1.4-1993

Sampling Procedures and Tables for Inspection by
Attributes

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SPECIFICATIONS

GEORGE C. MARSHALL SPACE FLIGHT CENTER

MSFC-QPL-1918

Qualified Products List, Products Qualified Under
George C. Marshall Space Flight Center
Specification MSFC-SPEC-1918 Ablative
Compound, Thermal

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PUBLICATIONS

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

Occupational Safety and Health Administration Publication Code of Federal Regulations; Title 29 - Labor Chapter XVII (Occupational Health and Safety Administration, Department of Labor, Part 1210.33)

(Application for copies should be addressed to the Occupational Safety and Health Administration, Department of Labor, Washington, D.C. 20212.)

2.2 NON-GOVERNMENT DOCUMENTS

The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposals shall apply.

STANDARDS

American Society for Testing and Materials (ASTM)

| | |
|-------------|--|
| ASTM D 638 | Standard Test Method for Tensile Properties of Plastics |
| ASTM D 1623 | Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics |
| ASTM D 2240 | Rubber Properties - Durometer Hardness, Test for |

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

3.0 REQUIREMENTS

3.1 MATERIAL

The material is a three-part, smooth paste, adhesive system composed of ablative filler, an epoxy resin and an amine-type curing agent. The material constituents shall conform to Table I and shall be capable of meeting the requirements of this specification.

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3.1.1 Formulation for Mixing**TABLE I – ABLATIVE COMPOUND MIX RATIO**

| MATERIAL | PARTS BY WEIGHT | |
|--------------------------------------|-----------------|---------|
| | MINIMUM | MAXIMUM |
| Polyamide resin, hardener, Part A | 99 | 101 |
| Epoxy resin, Part B | 74 | 76 |
| Ablative Filler, Part C | 24 | 26 |

3.2 CHEMICAL AND PHYSICAL PROPERTIES

The material's chemical and physical properties shall conform to the requirements of Table II. The applicable test methods shall be as specified in 4.7.

TABLE II – CHEMICAL AND PHYSICAL PROPERTIES

| <u>PROPERTIES</u> | <u>REQUIRED VALUE</u> |
|--|---|
| Specific Gravity (at 60°F minimum) | 0.55 – 0.68 |
| Solids Content, % | 100 |
| Hardness, Shore D (Minimum) | 15 |
| Tensile Strength: ASTM D638 | |
| Maximum stress, psi | 150 minimum |
| Tensile Strength: ASTM D1623 | |
| Maximum stress, psi | 100 minimum |
| Pot Life | 45 minutes at 77 ± 2°F |
| Cure Time, hours (minimum shore D of 15 Per 4.7.3 required) | a. 18 maximum at 80 ± 5°F b. 72 maximum at 45 ± 5°F |
| Shelf Life | 12 months from date of manufacture in original unopened container stored at 80°F maximum |
| Thermogravimetric Analysis | Per Figure 1 and 4.7.9 |

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NOTE : $\pm 10\%$ OF NOMINAL TGA VALUES REPRESENTED

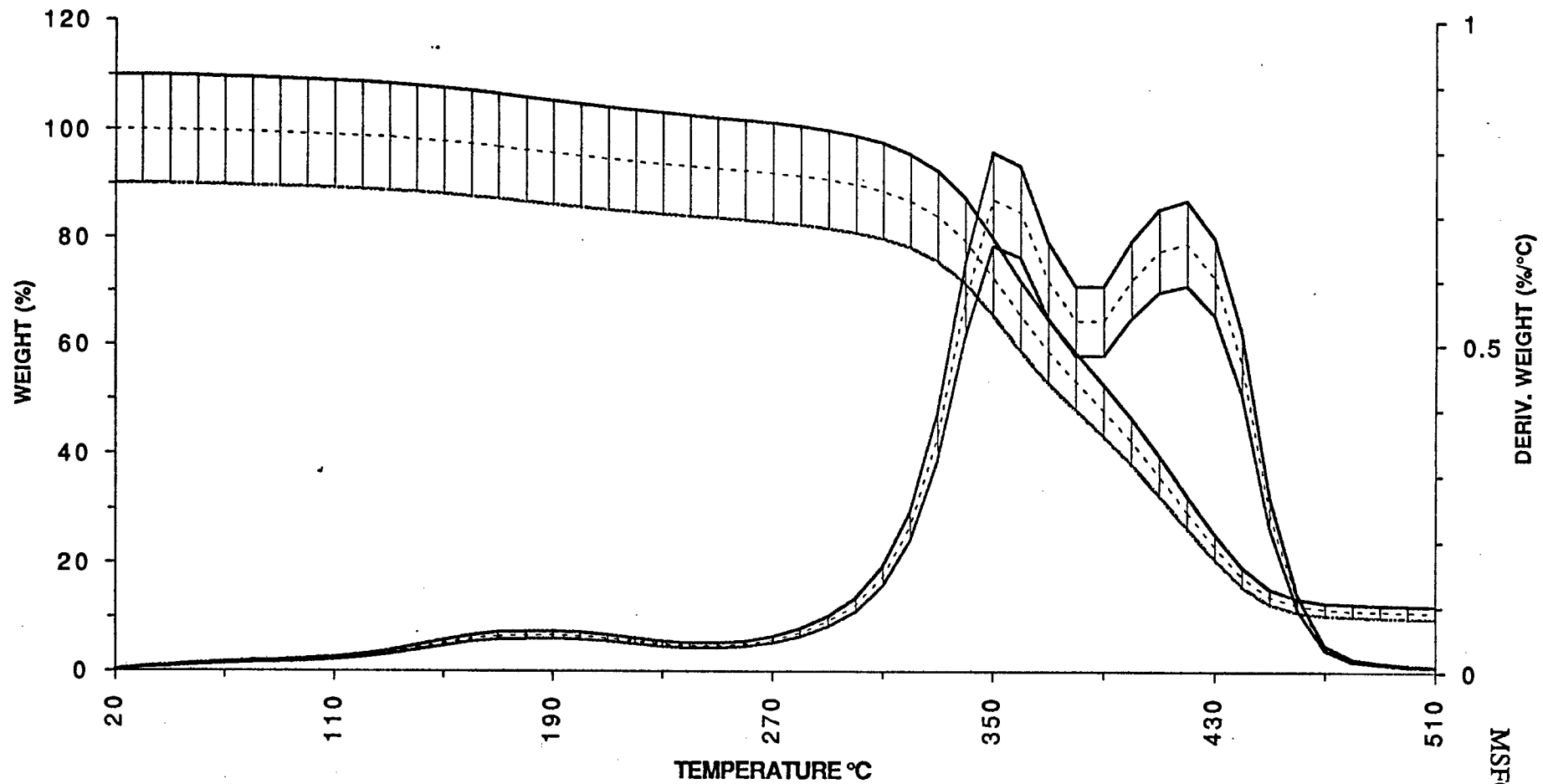


Figure 1. Ablative Compound TGA Graph

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3.3 KITS

The materials shall be furnished in kit form. The polyamide resin hardener (Part A), epoxy resin (Part B), and ablative filler (Part C) shall be packaged separately. One container of hardener shall contain the quantity of hardener required for the one container of resin material and the one container of ablative filler.

3.4 WORKMANSHIP

Workmanship shall be such that the ablative compound ingredients (Part A, Part B, and Part C) are uniform in appearance (with the unaided eye) and free from visible contamination.

3.5 SAFETY REQUIREMENTS

3.5.1 Hazardous Materials Identification and Marking Requirements

- A. At the time of submittal of the product for qualification, the manufacturer shall submit a Material Safety Data Sheet in accordance with Federal Standard 313 if the material fits any of the categories as defined in Table I of Appendix A of the standard or, upon review of the standard, the material is defined as hazardous. The manufacturer shall also describe on the Material Safety Data Sheet itself, or by attached illustration, the Hazard Identification Symbol that would be used if a requirement were established to mark the product in accordance with Federal Standard 313.
- B. If the material does not require a Safety Data Sheet, the manufacturer shall, at the time of submittal of the material for qualification, verify in writing that the product has been evaluated in accordance with Federal Standard 313 and does not require either a Material Safety Data Sheet or a hazardous label.
- C. The Material Safety Data Sheet is required to be on file at the procuring activity.

3.5.2 Occupational Safety and Health Standards Requirements

- A. At the time of submittal of the product for qualification, the manufacturer shall verify in writing that the product does, or does not, contain materials in the concentrations defined as harmful in Title 29, Code of Federal Regulations, Part 1910.93 C through P.
- B. If the product does contain material defined as harmful, complete instructions shall be submitted for personnel safety, storage, handling, and use of the product, as well as disposal or the cleaning of the container and implement used to apply the material.

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- C. If the material as submitted does not contain material defined as harmful, but does utilize in the formulation materials in sufficient quantity as to be defined as harmful, the manufacturer shall indicate by chemical name and trade name, if applicable, the specific ingredient.

**3.6 SHELF LIFE EXTENSION REQUIREMENTS
(APPLICABLE TO THE PROCURING ACTIVITY ONLY)**

Allowable shelf life extension shall be 6 months from the date of test in original sealed container provided storage requirements have been met and the following test requirements performed and determined acceptable. The new expiration date must be within 3 times the original shelf life. The sampling plan shall be per 4.5.4.

| <u>RECERTIFICATION TEST</u> | <u>TEST METHOD</u> | <u>TEST SAMPLES REQUIRED PER KIT</u> |
|-----------------------------|--------------------|--|
| Tensile Adhesion | 4.7.4.2* | 3 |
| Specific Gravity | 4.7.2 | 3 |
| Hardness | 4.7.3 | 1 |

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4.0 QUALITY ASSURANCE PROVISIONS

4.1 IN-PROCESS MATERIAL (APPLICABLE TO USERS DURING RECEIVING INSPECTION)

When the vendor container is opened at the user's site, the material is regarded as In-process material. In-process material can be used up to its certified shelf life provided that normal precautions are taken for handling and storage, including those precautions cited below.

- A. When in-process material is not in use, the material's container shall be closed immediately in a manner as closely as possible to its original state. Opening of containers for inspection of contents shall be limited to less than ten (10) minutes.
- B. Said container shall be stored in a safety approved location within a vented facility, away from direct sun or rain.
- C. This material shall only be used as entire kits. Mixing of partial kits shall not be allowed.
- D. If the integrity of in-process material is at any time suspect (e.g. crust formation, change of color, and cloudiness), then the material in question shall be either recertified or discarded.

4.2 **GENERAL PROVISIONS**

The vendor shall provide and maintain a quality control system in accordance with the requirements of the purchase document. Vendors shall submit only those materials which meet the requirements of this specification.

4.3 **RESPONSIBILITY FOR INSPECTION AND TESTS**

4.3.1 **Vendor**

The vendor is responsible for the performance of all inspection and test requirements as specified herein. Unless otherwise indicated, the vendor may utilize his own or any other inspection facilities and services acceptable to the procuring activity. Records of the examination and tests shall be transported to the procuring activity with the material.

The vendor shall notify the procuring activity of any changes in formulation or procedures used in product manufacture.

4.3.2 **Procuring Activity**

The procuring activity is responsible for the performance of receiving tests or verifying vendor certification data of the selected acceptance test data. Refer to 4.4 B. TABLE IV for required tests to be performed or verified.

Records of the tests shall be retained on file until the material performance has been completed.

4.4 **CLASSIFICATION OF TESTS**

The inspections and testing of the material shall be classified as follows:

- A. **Qualification Tests** - Qualification tests are those tests conducted on samples of material to be considered for qualification as a satisfactory product prior to an invitation for bid. These shall include those test methods specified in 4.7. Other tests may be necessary depending on the specific application.
- B. **Acceptance Tests** - Acceptance tests are those test methods performed on material manufactured and submitted for acceptance under contract. These shall include those test methods specified in 4.7 to meet the requirements of 3.1, TABLE I and 3.2, TABLE II. TABLE III identifies the tests the vendor and procuring activity shall perform (or verify vendor certification data) for receiving inspection.

TABLE III. ACCEPTANCE TESTS

| PROPERTY | TEST METHOD | VENDOR | PROCURING ACTIVITY |
|--------------------|--------------------|---------------|----------------------------------|
| Visual Examination | 4.7.1 | Test | Test or Check Certification Data |
| Specific Gravity | 4.7.2 | Test | Test or Check Certification Data |
| Hardness | 4.7.3 | Test | Test or Check Certification Data |
| Tensile Strength | 4.7.4 | Test | Test or Check Certification Data |
| Pot Life | 4.7.5 | Certify | Check Certification Data |
| Solids Content | 4.7.6 | Certify | Check Certification Data |
| Formulation | 4.7.7 | Certify | Check Certification Data |
| Cure Time | 4.7.8 | Certify | Check Certification Data |
| TGA | 4.7.9 | Test | Test or Check Certification Data |
| Shelf Life | 4.7.10 | Certify | Check Certification Data |

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4.5 SAMPLING PROVISIONS

4.5.1 Lot Definition

A lot of material shall be defined as consisting of all material made in the same production shift, from the same raw materials and by the same manufacturing process and submitted for acceptance at one time.

4.5.2 Sampling for Qualification

A quantity of material sufficient to perform the qualification tests of this specification shall be selected from each lot of material offered for qualification.

4.5.3 Sampling for Acceptance

The number of kits to be selected at random from the lot shall be in accordance with ANSI-ASQC Standard Z1.4-1993, single sampling plans for normal inspections, special level S-4, on each lot of material received except TGA testing in accordance with 4.7.9 shall be limited to one TGA test per lot. Each of the selected kits shall be tested in accordance with 4.4.B.

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4.5.4 Sampling for Recertification

The number of kits to be selected at random from each lot shall be in accordance with ANSI-ASQC Standard Z1.4-1993, single sampling plan for normal inspections, special level S-4.

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4.6 REJECTION

The entire lot of material shall be subject to rejection if a sample of material selected from that lot fails to meet any of the requirements specified herein.

4.7 TEST METHODS

The following test methods and procedures shall be used. Unless otherwise specified in the test or procedure description, all weights, volumes, temperatures, and times shall be measured to the nearest specified unit or decimal.

4.7.1 Visual Examination

The samples of resin, hardener, and ablative filler shall be visually (with the unaided eye) examined for conformance to 3.3 and 3.4. All samples of material shall be carefully examined with respect to requirements not specifically covered by testing. Individual containers shall be examined to determine conformance to the requirements of 3.3 and Section 5.

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4.7.2 Specific Gravity

The specific gravity of the cured ablative compound shall be determined on 2-inch x 2-inch specimens cut from the test panels. The test environment temperature shall be 60°F minimum. A minimum of six specimens shall be used. The specimens shall be weighed on an analytical balance and the average thickness determined from five evenly spaced locations using a micrometer calibrated to 0.001 inch. The ablative compound shall then be removed from the sample substrate and the substrates reweighed, and remeasured for thickness. The ablative compound volume shall be calculated for each specimen and the specific gravity shall be calculated from the ablative compound weight and volume as follows:

$$\text{VOLUME, } V = (TH_I - TH_S) \times L_1 \times L_2$$

$$\text{DENSITY, } D = (W_I - W_S)/V$$

$$\text{SPECIFIC GRAVITY} = D \times (.002205 \text{ LB/GM} \times 1728 \text{ IN}^3/\text{FT}^3) / 62.43 \text{ LB/FT}^3$$

WHERE

TH_I = AVERAGE THICKNESS OF SAMPLE WITH SUBSTRATE - (IN)

TH_S = AVERAGE THICKNESS OF SUBSTRATE AFTER THERMAL ABLATIVE COMPOUND REMOVAL - (IN)

L = LENGTH OF SAMPLE - (IN)

W_I = WEIGHT OF SAMPLE WITH SUBSTRATE - (GMS)

W_S = WEIGHT OF SUBSTRATE AFTER THERMAL ABLATIVE COMPOUND REMOVAL - (GMS)

4.7.3 Hardness

The hardness of the cured material shall be determined with a Shore D instrument, recording the instantaneous reading in accordance with ASTM D 2240.

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4.7.4 Tensile Strength

The tensile strength of the cured thermal ablative compound shall be determined in accordance with ASTM D 638. A minimum of 6 specimens shall be selected at random. Maximum stress shall be determined utilizing a strain rate of 0.05 inches/minute. Average values shall be used to determine conformance to the requirements of this specification.

4.7.4.1 Tensile Strength Per ASTM D638

The tensile strength of the cured thermal ablative compound shall be determined in accordance with ASTM D638. A minimum of 3 specimens shall be selected at random. Maximum stress shall be determined utilizing a strain rate of 0.2 inches/minute. Average values shall be used to determine conformance to the requirements of this specification.

4.7.4.2 Tensile Strength Per ASTM D1623

The tensile strength of the cured thermal ablative compound shall be determined in accordance with ASTM D1623, Type B. Maximum stress shall be determined utilizing a strain rate of 0.05 inches/minute. Individual values shall be used to determine conformance to the requirements of the specification.

4.7.5 Pot Life

The vendor shall certify that the ablative compound has a pot life of 45 minutes Minimum at $77^{\circ}\text{F} \pm 2^{\circ}\text{F}$.

4.7.6 Solids Content

The vendor shall certify that the thermal ablative compound has a percent solids content of 100.

4.7.7 Formulation

The mix ratio of each kit of ablative compound shall be verified to the requirements of 3.1.1 by examination of the vendor component net weight markings as indicated in 5.2.e.

4.7.8 Cure Time

The Vendor shall certify that the ablative compound has a cure time as specified in 3.2, TABLE II.

4.7.9 Thermogravimetric Analysis (TGA)

TGA test performance and resulting data shall conform ($\pm 10\%$) to Figure 1. The test is based on a sample size of 27 milligrams at a decomposition rate of 5°C per minute.

4.7.10 Shelf Life

The Vendor shall certify that the ablative compound has a shelf life as specified in 3.2, TABLE II.

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5.0 PREPARATION FOR DELIVERY

5.1 PACKAGING AND PACKING

Unless otherwise specified in the purchase document, packaging and packing shall be in accordance with standard commercial practice and in conformance to federal and state regulations applicable to the type of material. Containers in the same shipment shall be of such construction and materials that the materials will be adequately protected against loss or contamination.

5.2 MARKING

Unless otherwise specified in the purchase document, each container shall be marked for identification and shipment in accordance with ICC regulations and shall include the following:

- A. Vendor identification, lot number, and material name.
- B. Date of manufacture.
- C. Applicable safety warnings.
- D. This specification number and revision letter.
- E. Component net weight

6.0 NOTES

6.1 ORDERING DATA

Purchase documents shall specify as a minimum the following:

- A. Title, number, and revision letter of this specification.
- B. Number of copies of inspection and test data required.
- C. Special packaging, packing, or shipping requirements (if applicable).
- D. Data retention requirements.
- E. Instructions applicable to certified reports.

6.2 DEFINITIONS

6.2.1 Pot Life

Pot life shall refer to the time between the addition of the hardener (Part A) to the resin (Part B) and the maximum time for ablative compound application. An acceptable method for verifying pot life is as follows: during the pot life the material shall be capable of being formed into a 0.005 inch thick bondline which when cured and tested for tensile adhesion (steel-to-steel) shall obtain 100 psi minimum.

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6.2.2 Cure

The start of cure shall begin with the completion of ablative compound pot life. The completion of cure shall be the time at which a Shore D hardness of 15 minimum is verified per 4.7.3.

6.2.3 Vendor

Vendor shall be defined as the qualified manufacturer of the material.

6.3 MODIFICATION OR CHANGES

Recommendations for modifications or changes to the requirements specified herein shall be submitted in writing to MSFC for consideration.

NOTICE: When 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.

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PREPARING ACTIVITY:

NASA-George C. Marshall
Space Flight Center

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| C H | DOCUMENT NUMBER | DRL DRL DSH REV | TITLE | CCBD NO. | PCN | PC | EFFECTIVITY |
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| * | MSFC-SPEC-1918 | 202 - | ABLATION COMPOUND, THERMAL, CORK FILLED | 000-00-0000 | 0000000 | M | 1 |

| CHG NO. | CHG REV | CHG NOTICE | RESPONSIBLE ENGINEER | RESPONSIBLE ORGANIZATION | ACTION DATE | DESCRIPTION | |
|------------|------------|---------------|-------------------------|-----------------------------|----------------|-------------|---|
| * | 2 | B | SCN002 | DENNIS GRIFFIN | MP41 | 05/26/00 | SCN002 - REVISION B TO SPECIFICATION. REV.B RELEASE DATE 07/31/92. |
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|------------|--------------------|--------------------|---|-----------------------------|----------------|---|--|
| * | MSFC-SPEC-1918 | 203 - | ABLATION COMPOUND, THERMAL, CORK FILLED | 000-00-0000 | 0000000 | M | NONE |
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| * | 5 | B | SCN000 | EUGENA GOGGANS | EO03 | 02/22/07 | DOCUMENT RELEASED THRU PDS. NO LONGER TRACKED IN ICMS. |

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|-------------|-------------------|------------|-----------------------|------------|------------|------------|-------------------|-----------|----------------|
| | | | MSFC-HDBK-1453 | | 202 | - | | | |
| | | | MSFC-HDBK-1674 | | 202 | - | | | |
| | | | MSFC-HDBK-2221 | | 203 | - | | | |
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| | | | MSFC-SPEC-2490 | | 205 | - | | | |
| | | | MSFC-SPEC-2491 | | 203 | - | | | |
| | | | MSFC-SPEC-2492 | | 203 | - | | | |
| | | | MSFC-SPEC-2497 | | 211 | - | | | |
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| | | | MSFC-SPEC-445 | | 202 | - | | | |
| | | | MSFC-SPEC-504 | | 202 | - | | | |
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| | | | MSFC-SPEC-548 | | 202 | - | | | |
| | | | MSFC-SPEC-560 | | 202 | - | | | |
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| | | | MSFC-SPEC-684 | | 202 | - | | | |
| | | | MSFC-SPEC-708 | | 202 | - | | | |
| | | | MSFC-SPEC-766 | | 202 | - | | | |
| | | | MSFC-STD-1249 | | 202 | - | | | |
| | | | MSFC-STD-1800 | | 202 | - | | | |
| | | | MSFC-STD-246 | | 202 | - | | | |
| | | | MSFC-STD-2594 | | 203 | - | | | |

MSFC DOCUMENTATION REPOSITORY - DOCUMENT INPUT RECORD

I. GENERAL INFORMATION

| | | | | |
|---|---|--------------------------|--|---|
| 1. APPROVED PROJECT: | 2. DOCUMENT/DRAWING NUMBER: MSFC-SPEC-1918 B (3) | 3. CONTROL NUMBER: | 4. RELEASE DATE: 08/05/1993 | 5. SUBMITTAL DATE: 10/18/2002 |
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