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MEASUREMENT SYSTEM IDENTIFICATION INCH-POUND

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

EM40

MSFC TECHNICAL STANDARD

MATERIAL SPECIFICATION FOR POLYURETHANE FOAM - SPRAYABLE

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DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline	-	4/4/2013	Baseline Release; document authorized through Multiprogram Document Management System (MPDMS).
Revision	A	5/26/2015	Revision A Release; document authorized through Multiprogram Document Management System (MPDMS). General/Overall: A. EM40 Division Chief designee, with concurrence from EM Center Export Representative, changed the determination for Revision A from "Sensitive But Unclassified (SBU) - International Traffic in Arms Regulations (ITAR)" to "Approved for Public Release; Distribution Unlimited." Coversheet and headers-footers updated accordingly. B. Where possible the terms Isocyanate and Polyol where replaced with A-Component and B-Component, respectively, for clarity C. Where necessary, the term "Procuring Authority M&P" was changed to "Procuring Authority" for ease of use D. Where necessary, the phrase "but not limited to" was replaced with "as a minimum" for clarity E. Added Appendix title letter (*e.g.* "A" or "B") to appendix paragraph numbers for increased clarity The following is a summary list of major updates/modifications. Minor changes (e.g. formatting and typographical corrections) are not listed here. Sec. 1: Deleted "…for repair, closeout, and geometrically complex sprays for cryogenic…" Sec. 1: Added paragraph #2. Sec. 1.2.2: Deleted "Consult the Procuring Authority M&P for availability of non-standard sizes. The user and/or Procuring Authority M&P shall set acceptable limits for non-standard sizes based on best-accepted commercial practice." Sec. 2: Updated "…content of this specification takes precedence…" Sec. 2.1: Removed reference to EM50-OWI-028 Sec. 2.1: Added EM40-OWI-058 Sec. 3.1.4: "Polyol material produced under this specification shall be manufactured upon receipt of order. Isocyanate material produced under this specification may be manufactured upon receipt of order or as required." Sec. 3.1.4: Reworded for clarity Sec. 3.1.4: Updated pressurization requirements and temperature range to 40° to 60°F Sec. 3.1.7: Reformatted for clarity Sec. 3.1.8: Added section Tab. I: Updated Isocyanate Specific Gravity range; Changed Polyol Specific Gravity to Information Only and updated range; Added requirement for NCO Content Tab. II: Updated Cream Time range; Changed Rise Time to Information Only; Updated Tack Free Time range; Updated notes (1) and (2) Tab. III: Updated note (2); Added note (3); Updated range for Closed Cell Content; Updated range for Hydrolytic Stability; Updated range for RT Bond Tension; Updated test temperature range for Gradient Cryoflex; Changed RT Bond Tension and Compression Strength data ranges to minimums Sec. 3.3.1: Deleted section on Reagent Strength

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
			Sec. 3.4.1: Changed to "No shelf life extension permitted." Sec. 3.4.2: Changed to "No shelf life extension permitted." Sec. 3.5.1.2: Updated paragraph #1, added paragraphs #2 and removed requirement from vendor Sec. 3.5.1.3: Removed requirement from vendor Sec. 3.5.1.4: Removed requirement from vendor Sec. 3.5.1.5: Removed requirement from vendor Sec. 3.5.1.6: Removed requirement from vendor Sec. 3.5.1.7: Removed requirement from vendor Sec. 3.5.1.9: New Section Sec. 3.5.2: "…The testing shall be performed in a controlled area at ambient environmental conditions as defined per paragraph 6.5.7." Sec. 3.5.2.1 a: Updated "…shall consist of 100 ± 2 grams" and "…A/B ratio (by weight) of (1.02 – 1.11) to 1." Sec. 3.2.5.1 b: Added details for paper cup Sec. 3.2.5.1 c: Added alternative material temperatures for testing Sec. 3.2.5.1 e: Updated mixer RPM range Sec. 3.2.5.1 e: Added "Mixer rpm shall be taken from mixing instrument display." Sec. 3.5.2.2: Added paragraphs #2 and removed requirement from vendor Sec. 3.5.2.4: Added note Sec. 3.5.4.8: Updated to include EM40-OWI-058, removed reference to MSFOC 06-0187WI and updated test temperature ranges Sec. 3.6: Added "Mixing of B-Component with other B-component containers with different lot numbers is not allowed." and "Mixing of A-Component with other A-Component containers with different lot numbers is not allowed." Sec. 3.6.2: Added "Inspection may be performed on individual component liquid specimens pulled for chemistry or reactivity testing." Sec. 3.6.3: Removed callout for Hydroxl Number Sec. 3.7.2: "…tests listed in Table III and other testing not listed in this specification. Values for material test results shall meet the data ranges that are listed in Tables I-III where applicable." Sec. 4.1: Deleted "…as a guideline…" Sec. 4.1.1 c: "…blended kit, or lot as applicable, of material…;" Deleted "…Photos shall be taken of the material containers upon receipt for documentation when a container is received in a damaged condition…" Sec. 4.1.1 e: Changed "Material Safety Data Sheet" to "Safety Data Sheet" Sec. 4.2: Deleted "…and/or of the individual base ingredients…" Sec. 5.4: Updated shipping temperature range and added "The shipping truck must be outfitted with a temperature-recording device used for monitoring the temperature of the material during transit." Sec. 6.1: Updated section Sec. 6.2: Updated "…test reports will be directed…" Sec. 6.3: Updated "…orders will specify title…" Sec. 6.4: Updated "…specified herein will be submitted…" Sec. 6.5.3: Added "…actual or average results (as applicable), applicable lot/kit number, …" Sec. 6.5.6: Updated "…responsible engineering will retain…" Sec. 6.5.7: Deleted "Ambient conditions shall be" Sec. 6.5.10: Updated definition of RT Sec. 6.5.11: New definition Sec. 6.6: New section

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
			Sec. 6.7: New/Updated section App. A, Sec. 2.1: Added note App. A, Sec. 2.3: "…a.k.a. Polyol, Polyol-blend, Component B…" App. A, Sec. 2.4: "Stepan Company" App. A, Sec. 2.4.1.1: Added "…S-180-T, also shown as AM9507" App. B: Assigned paragraphs step numbers for clarity App. B, Tab. IV and V: Added English units to measurements, as applicable App. B, Tab. V: Removed "Freon" from the note
Revision	B	4/10/2017	An extensive revision was performed of the entire document. Test methods and techniques were updated throughout the document, including data range limits for Sections 3.2.2-3.2.4, and Tables I-III. Table II from Revision A was separated into Table II and Table IIa, with Table II pertaining to in-house or MSFC directed mixed component properties testing and Table IIa pertaining to vendor testing of J6 materials. Extensively Updated: Section 3.1.4, Material Manufacture; Section 3.2, Material Properties; Section 3.3, Tolerances and Exceptions; Section 3.4, Shelf Life; 3.5.2 Mixed Component Properties; 3.5.2.4, Density of Reactivity Samples; 3.5.3.2, Thermal Conductivity; 3.5.3.5, Flammability; 3.5.3.7, Compressive Strength; 3.5.3.9 Gradient Cryoflex; Section 3.6, Inspection Testing for Material Acceptance; Section 3.6.1, Vendor Performance of Inspection Tests; 3.6.4, Test Documentation Evaluation; Section 3.7, Qualification Testing; Section 4.1.1 Packaging/Container and Receiving Documentation Inspection; Section 5.4, Transportation. Added: Boeing Specifications & Vendor Documents to sub-section 2.2; Section 3.2.3, Mixed Component Properties As Tested by J6 Polymers, L.L.C.; Section 3.5.3.8, Tensile Strength of Foam Applied to Components; Section 3.5.3.10, Density Testing of Sprayed Foam; Section 5.5, Storage; Section 6.5 renamed to "Definitions and Acronyms"; Sub-section 6.5.12, Certificate of Compliance; Sub-section 6.5.13, Certificate of Analysis; Sub-section 6.5.14, Acronyms.
Revision	C	08/31/2018	Updated document format. Added tolerances on temperature and humidity to requirements where appropriate and not already present. Updated chemical fingerprinting requirement wording in Table 1 for readability. Updated Tolerances and Exceptions. Updated chemical fingerprinting and TGA-IR fingerprinting to reflect ASTM standards used that were called out in EM10-OWI-CHM-101 (previous reference). Updated ASTM reference for Polyol Water Content. Updated requirements for Thermal Conductivity, Closed Cell Content, Hydrolytic Stability, Flammability, Bond Tension, Compressive Strength, and Gradient Cryoflex. These requirements match what was done during material qualification. Stated Flammability criteria match the former MAPTIS criteria for a "B" rating as required by MSFC-SPEC-3686 Rev B. A "B" rating is no longer an option in MAPTIS. Updated sections on Cream Time and Rise Time to clarify operations. Removed "polyethylene" from section on Tack Free Time. Clarified requirements to be verified upon material receipt. Updated J6 Vendor address.

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Revision	D	07/20/2020	Removed STM0878 & STP0598 from Section 2.2. Added Portable Tensile Testing to Table III and added section 3.5.3.8. Renumbered/reorganized requirements in 3.5.3. Updated Section 3.5.3.4.1 to indicate one inch from the edge of the foam panel. Removed Section 3.5.3.11. Removed compression testing from 3.6.3. Added portable tensile testing as a possible test in lieu of bond tension testing under Section 3.6.3. Removed plug pulls on production hardware from this document and added it to MSFC-PROC-3687 Rev C. Added NASA-STD-6016 to Section 2.1.
Revision	E	04/12/2022	Updated Table III and Section 3.5.3.8 to clarify that the portable tensile testing described in this specification is commonly referred to as plug pull testing. Updated shelf-life testing Section 3.4.

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1. SCOPE

This specification establishes the requirements for a rigid, closed-cell polyurethane foam containing 1,1,1,3,3-Pentafluoropropane (HFC-245fa) suitable for spray applications. This document is applicable to all MSFC programs and projects,

Contractors and subcontractors 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) (6.5.1) and meet the product requirements and the intent of this specification.

Language usage throughout this document is defined in Section 6.5.

This standard applies the following: All mandatory actions (i.e., requirements) are denoted by statements containing the term, “shall.” The terms: “may” or “can” denote discretionary privilege or permission; “should” denotes a good practice and is recommended, but not required; “will” denotes an expected outcome; and “are/is” denotes descriptive material.

1.1 Forms Available

The material consists of a two component liquid system (reference Section 3.0).

1.1.1 Drum Kits

One 55-gallon drum of A-component (Isocyanate, Component T) and one 60-gallon pressurized cylinder of B-component (Polyol, Component R) per kit.

1.1.2 Other Sizes

No alternative kit sizes are permitted.

2. APPLICABLE DOCUMENTS

The latest issues of the following documents form a part of this specification to the extent specified herein. In the event of a conflict between the documents referenced herein and the contents of this specification, the content of this specification takes precedence. The user may pursue substituting specifications and documents equivalent to those identified herein if the substitution does not compromise the intent of the specifications and documents identified herein and is approved by the NASA MSFC M&P (6.5.1) or Procuring Authority M&P (6.5.8) organization before implementation.

2.1 Government Documents

Federal Specifications and Standards

29 CFR 1910 Occupational Safety and Health Standards

MIL-PRF-27401	Performance Specification – Propellant Pressurizing Agent, Nitrogen

NASA

NASA-STD-6001	Flammability, Offgassing, and Compatibility Requirements and Test Procedures
NASA-STD-6016	Standard Materials and Processes for Requirements for Spacecraft
MSFC-PROC-3687	Polyurethane Foam, Hand Spray Application Procedure For
EM40-OWI-042	Cryoinsulation In-Process Testing
EM40-OWI-043	EM40 Nonmetallic Material Specimen Bonding
EM40-OWI-058	Gradient Cryoflex Testing

NOTE: Copies may be obtained by contacting MSFC M&P.

Environmental Protection Agency (EPA) Publications

SW-846 Test Method 8000	Determinative Chromatographic Separations *Evaluating Solid Waste, Physical/Chemical Methods*
SW-846 Test Method 8260	Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) *Evaluating Solid Waste, Physical/Chemical Methods*
SW-846 Test Method 8270	Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) *Evaluating Solid Waste, Physical/Chemical Methods*

2.2 Non-government Documents

ASTM-C177	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
ASTM-D756 (Withdrawn 1998, No Replacement)	Standard Practice for Determination of Weight and Shape Changes of Plastics under Accelerated Service Conditions

ASTM-D1621	Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM-D1622	Standard Test Method for Apparent Density of Rigid Cellular Plastics
ASTM-D1623	Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
ASTM-D4662	Standard Test Methods for Polyurethane Raw Materials: Determination of Acid and Alkalinity Numbers of Polyols
ASTM-D4672	Standard Test Method for Polyurethane Raw Materials: Determination of Water Content of Polyols
ASTM-D4889	Standard Test Methods for Polyurethane Raw Materials: Determination of Viscosity of Crude or Modified Isocyanates
ASTM-D5155	Standard Test Methods for Polyurethane Raw Materials: Determination of the Isocyanate Content of Aromatic Isocyanates
ASTM-D6226	Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM-E204 (Withdrawn 2014, No Replacement)	Standard Practices for Identification of Material by Infrared Absorption Spectroscopy, Using the ASTM Coded Band and Chemical Classification Index
ASTM-E1252	Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis
ASTM-E2105	Standard Practice for General Techniques of Thermogravimetric Analysis (TGA) Coupled with Infrared Analysis (TGA/IR)

NOTE: Copies may be obtained via the NASA Technical Standards System.

Vendor Documents

WI 502.3.2	"QC JFoam KB8791 (PR040)" PR040 Manufacturing Standard
J6 Test Method 162-0	(SM 162-0) "Hand Mix Reactivity for Rigid Urethane Foam"
J6 Test Method 163-0	(SM 163-0) "Urethane Foam Core Density"

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

3. REQUIREMENTS

The material furnished under this specification shall be a two part polyurethane system which, when components are combined, will produce an HFC-245fa blown rigid polyurethane foam. The material shall consist of two matched components: a diphenylmethane-4,4'-diisocyanate mixture (a.k.a. Isocyanate, A-component, or Component T) and a formulated polyoxyalkylene polyol resin blend (a.k.a. Polyol, Polyol-blend, B-component, or Component R). Material properties and test regimes (Inspection for Material Acceptance, Qualification, and other testing regimes) shall meet the requirements listed in this section. Language usage throughout this document is defined in Section 6.5.

3.1 Material Requirements

3.1.1 Safety Regulation

This material shall not contain any carcinogens or suspected human carcinogens, including those listed in Occupational Safety and Health Administration (OSHA) Standard, CFR Title 29, Part 1910, subpart Z-Toxic and Hazardous Substances.

3.1.2 Raw Materials

The base ingredients used in the manufacture of the finished product shall be controlled in accordance with specifications and/or recommendations from the respective suppliers.

3.1.3 Traceability of Raw Materials

Traceability of all raw materials shall be maintained and any change in materials or in supplier of materials shall be disclosed to the Procuring Authority M&P (6.5.8) and shall subject the finished material to re-qualification per 3.7.

3.1.4 Material Manufacture

a. A-component material produced under this specification may be manufactured upon receipt of order or as required.
b. B-component (or R) material produced under this specification shall be manufactured upon receipt of order and within 15 days prior to shipment.
c. The B-component resin blend shall be transferred from the blending equipment into visually clean customer-provided stainless-steel (Type 304) cylinders (uncontaminated residual polyol is acceptable).
d. The B-component shall be pressurized per 3.1.8.
e. Within 48 hours of blending, the resin blend shall be packaged and placed in a 50°F +/- 10°F temperature controlled environment.
f. All materials produced or furnished under this specification shall not be stored in direct sunlight or adjacent to a heat source.

3.1.5 Material Handling / Processing

Material handling and processing shall include the proper safeguards to preclude contamination and to assure homogeneous material.

3.1.6 Retention Samples

The vendor shall retain a representative sample kit of sufficient quantity to perform the acceptance tests for the finished material from each lot for a minimum of six months from the date of manufacture.

3.1.7 Labeling

The vendor shall label each individual shipping container in a permanent manner with the following information and shall meet all applicable OSHA and DOT (Department of Transportation) standards for labeling. For further information, see Section 5, Packaging and Transportation, and Section 6.3, Ordering Data.

a. Specification Number and revision
b. Manufacturer's Name and Address
c. Material Name and Chemical Designation
d. Lot Identification (Specify A (or T) and B (or R) Lot Numbers of matched pairs of components)
e. Date of Manufacture and Expiration Date
f. Quantity, reported as both Net Weight of Material and Gross Weight of container plus material (lbs or kg)
g. Shipping and Storage Temperature Range
h. Procuring Authority (6.5.11) Purchase Order Number
i. Drum Number, if applicable

3.1.8 Pressurant Material Classification

Pressurant material shall be nitrogen and shall meet MIL-PRF-27401 (Type 1, Grade A at a minimum).

3.1.9 Material Pressurization

B-component pressure shall be 30 to 90 psig. A-component pressure shall be 3.5 psig maximum.

3.2 Material Properties Requirements

Materials provided under this specification shall be tested to determine their material properties prior to material acceptance. Inspection testing for material acceptance is covered in Section 3.6. Testing in Tables I-III shall be required for Minimum Qualification with the exception of the Cryoflex Testing being performed only to the temperatures that the hardware exposure encompasses. Further details on Qualification testing are listed in Section 3.7. Material property test results for all required tests shall conform to Tables I-III in this section.

3.2.1 Individual Component Properties

Material properties test results for individual component materials tested according to the test procedure paragraphs cited in Table I shall conform to the data ranges specified in Table I.

TABLE I. Properties of isocyanate (A-Component) and polyol (B-Component)

Property	Requirement	Test Procedure Paragraph	Minimum Number of Tests
Isocyanate Viscosity (cP)	150 – 415	3.5.1.1.	2
Isocyanate Specific Gravity	1.19 – 1.26	3.5.1.2.	2
Polyol Specific Gravity (Information Only)	1.11 – 1.26	3.5.1.2.	2
Chemical Fingerprint – Isocyanate (Qualitative Pass/Fail)	A "Pass" or "Normal" indicates that the A-component exhibits strong isocyanate absorbency at 2250 cm^{-1} wavelength	3.5.1.3.	2
Chemical Fingerprint – Polyol (Qualitative Pass/Fail)	A "Pass" or "Normal" indicates that the B-component exhibits the presence of the hydroxyl absorbency at approximately 3400 cm^{-1} wavelength	3.5.1.3.	2
(1)TGA-IR Fingerprinting: Weight Loss at Room Temperature – Polyol (indicates blowing agent content, %)	19 – 25	3.5.1.4.	2
Gas Chromatograph/Mass Spectrometry Fingerprinting Scan for Isocyanate (Information Only)	Pass of this fingerprint scan is successful when the five major peaks of the A-component show on the data chromatograph at accurate peak times	3.5.1.5.	2
Gas Chromatograph/Mass Spectrometry Method for Blowing Agent in Polyol (Information Only, %)	16.5-31.9	3.5.1.6.	2
(2)Polyol Acid Number (mg KOH/g)	1.20 – 1.72	3.5.1.7.	2
Polyol Water Content (%)	0.64 – 0.90	3.5.1.8.	2
Isocyanate NCO Content (%)	30.9 minimum	3.5.1.9.	2

(1) Thermogravimetric Analysis – Infrared Spectrometry (TGA-IR)
(2) Potassium hydroxide (KOH)

3.2.2 Mixed Component Properties

Material properties after mixing shall conform to the data ranges specified in Table II when mixed according to the test procedure paragraphs cited in Table II.

TABLE II. Properties of mixed components (A and B)

Property	Requirement	Test Procedure Paragraph	Minimum Number of Tests
Cream Time(1) (s)	4 – 9	3.5.2.1.	3
Rise Time (s)	21 – 36	3.5.2.2.	3
Tack Free Time (s)	16-28	3.5.2.3.	3
Density of Reactivity Samples(2) (lbs. /ft^3)	1.56 – 1.76	3.5.2.4.	3
(1) Foam components shall be conditioned per 3.5.2.1 at time of mixing. (2) Material shall be cured in accordance with 3.5.2.4 prior to measuring density			

3.2.3 Mixed Component Properties As Tested by J6 Polymers, L.L.C.

J6 material properties after mixing shall conform to the data ranges specified in Table IIa when mixed according to the test procedures cited in Table IIa. The temperature of the Polyol component shall be 59-61°F and the Isocyanate shall be 76-78°F prior to mixing for the Cream Time and Tack Free Time tests in Table IIa.

TABLE IIa. Properties of mixed components (A and B) as tested by J6 polymers, L.L.C.

Property	Requirement	Test Procedure	Minimum Number of Tests
Cream Time (s)	3– 6	J6 Test Method 162-0	3
Tack Free Time (s)	13 – 18	J6 Test Method 162-0	3
Density of Reactivity Samples (lbs. /ft^3)	1.65 – 1.85	J6 Test Method 163-0	3

3.2.4 Physical, Thermal, and Mechanical Properties of Cured Foam

Physical, thermal, and mechanical properties of the cured foam material shall conform to the data ranges specified in Table III when prepared according to MSFC-PROC-3687 and tested according to the test procedure paragraphs cited in Table III.

TABLE III. Physical, thermal, and mechanical properties of cured foam

Property	Requirement	Test Procedure Paragraph	Minimum Number of Tests
Thermal Conductivity (BTU/hr-ft-F)	≤ 0.026 when tested at 75°±3°F	3.5.3.2.	1
Closed Cell Content (% closed cells)	92.5-99.6	3.5.3.3.	3
Density of Sprayed Foam (lbs. /ft^3)	1.9-3.4	3.5.3.4.	5
Hydrolytic Stability (% weight loss)	0.13 – 1.12	3.5.3.5.	3
Flammability	Pass when burn length is less than or equal to 12.0" with no ignition of the paper beneath the sample holder (no drip burning).	3.5.3.6.	1(1)
Bond Tension (psi)	66-105	3.5.3.7.	5
Portable Tensile Testing (aka Plug Pull) (psi) (2)	45-92	3.5.3.8	5
Compressive Strength (parallel to rise) (psi)	32-46	3.5.3.9.	5
Gradient Cryoflex (ksi)(3) Test at -310 ± 10°F or Test at -400 to -423 °F	 Failure at >59 Failure at >61	3.5.3.10.	2 Tests per Temperature(4)

(1) One Flammability Test shall consist of five samples of the same material being tested and evaluated.
(2) The portable tensile testing requirement listed in this Table is for cured sprayed foam material acceptance testing. For the portable tensile testing hardware / product acceptance requirement (pertaining to production hardware and/or witness panels) see MSFC-PROC-3687.
(3) Each substrate shall be 1/8-inch thick Aluminum 2219-T87.
(4) Test Anvil Radius is Infinite. Each test uses two specimens, one on each side of the anvil.

3.3 Tolerances and Exceptions

Per the applicable paragraphs the temperature tolerances specified in ASTM test methods shall be used unless otherwise stated in this specification. Tolerances and exceptions given in this specification shall supersede tolerances and directions given in ASTM test methods.

3.3.1 Accuracy or Repeatability Tolerance

Accuracy or repeatability tolerance specified in ASTM test methods shall be superseded with accuracy or repeatability tolerance specified in this specification.

3.3.2 Vendor Test Procedure Substitution

The Procuring Authority M&P (6.5.8) shall approve vendor test procedures that differ from ASTM test methods or from those specified in this specification.

3.4 Shelf Life

The material shall meet the requirements of this specification for a minimum of twelve (12) months from date of manufacture when stored in a controlled environment at 50°F +/-10°F in the original sealed containers.

3.4.1 Retest to Extend Shelf Life

No shelf life extension is permissible for this product.

3.4.2 Shelf Life Extension Period and Number of Extensions

No shelf life extension is permissible for this product.

3.5 Test Methods

3.5.1 Individual Component Properties

3.5.1.1 Isocyanate Viscosity
Viscosity of A-component (Isocyanate) shall be determined using a Brookfield viscometer with spindle #34 at 77 ± 1 °F in general accordance with ASTM-D4889. Refer to Appendix B (section B.1.3) for additional instructional steps for the determination of viscosity.

3.5.1.2 Specific Gravity
The specific gravity shall be determined at 73 ± 1.8 °F for the A-component (Isocyanate), and at 59 ± 1.8 °F for the B-component (Polyol), according to the following method using a Specific Gravity/Density Meter (Mettler Toledo DA-100M or equivalent):

a. Calibrate meter with deionized (DI) water.
b. Inject sample by syringe into sample cell and select “measure”.
c. Value will flash on screen after instrument stabilizes at 68 ± 0.9 °F standard temperature.

For the B-component (Polyol), this property is taken for information only. Care must be taken during sample collection, transportation, and measurement to minimize blowing agent loss. A specific gravity cup method is an acceptable alternate method for determining these measurements.

3.5.1.3 Chemical Fingerprinting – Isocyanate (A-component) and Polyol (B-component)
The chemical fingerprint shall be qualitatively determined in accordance with ASTM E 1252 and ASTM E 204, and shall include both an isocyanate functional group (N=C=O) scan and a polyol functional group (-OH) scan, respectively.

3.5.1.4 TGA-IR Fingerprinting – Weight Loss at Room Temperature, Polyol (B-Component)
Weight loss at room temperature, which indicates blowing agent content, shall be determined according to ASTM E 2105 and ASTM E 204. This test is not required for the vendor. Care must be taken during sample collection, transportation, and measurement to minimize blowing agent loss.

3.5.1.5 Gas Chromatograph/Mass Spectrometry Fingerprinting Scan for Isocyanate
Determination shall be in accordance with instructions stated in Appendix B (section B.1.1) of this document. This property is taken for information only.

3.5.1.6 Gas Chromatograph/Mass Spectrometry Method for Blowing Agent in Polyol
The fingerprint of the polyol shall be determined in accordance with instructions stated in Appendix B (section B.1.2) of this document. This property is taken for information only. Care must be taken during sample collection, transportation, and measurement to minimize blowing agent loss.

3.5.1.7 Polyol Acid Number
Acid number shall be determined according to ASTM-D4662. This test is not required for the vendor.

3.5.1.8 Polyol Water Content
The water content of the polyol (B-component) shall be determined in accordance with ASTM-D4672.

3.5.1.9 Isocyanate NCO Content (%)
NCO content of the isocyanate (A-component) shall be determined in accordance with ASTM-D5155 Method A or equivalent.

3.5.2 Mixed Component Properties

a. All foaming properties tests shall be performed a minimum of three times.
b. The testing shall be performed in a controlled area at ambient environmental conditions (6.5.7).
c. The sample shall be obtained from representative bulk material and shall consist of 100 ± 2 grams (total A-component plus B-component) combined in A/B ratio (by weight) of (1.02 – 1.11) to 1.
d. 32-ounce, wax-free paper cups (*e.g.* Solo Cup Co., model H4325U or equivalent) shall be used for mix containers.
e. The temperature of the components (A-component and B-component) shall be 50-55°F prior to mixing.

f. Pre-weigh 51.5 ± 1 grams of A-component in the paper cup. Zero the scale and then weigh 48.5 ± 1 grams of B-component on top of the A-component in the same paper cup.
g. Immediately submerge a disc type mixer into the liquid and mix until cream start or for five seconds maximum (whichever comes first) at 1900 +/- 50 rpm; include the bottom and sides of the cup.

For J6 mixed component properties, the vendor shall be required to follow the procedures stated in 3.2.3 and Table IIa. Vendor procedures are subject to MSFC M&P (6.5.1) TPS Lead Engineer (6.5.9) or Procuring Authority M&P (6.5.8) team review for suitability.

3.5.2.1 Cream Time
The cream time shall be that measure of time between when material mixing is started [see 3.5.2(g)] and when material rise (at least 1/8 inch) is observed.

3.5.2.2 Rise Time
The rise time shall be measured from the start of mixing in 3.5.2(g) until visually perceived foam rise is complete. The cup should be held at eye-level to observe the foam cells as they rise just above the cup edge in order to determine when the cells are no longer elongating. Due to the subjectivity of this test it should be used for information only. This test is not required from the vendor.

3.5.2.3 Tack-Free Time
Tack-free time shall be measured from the start of mixing in 3.5.2(g) until the foam is tack-free. Tack-free time shall be determined by lightly touching the top surface of the foam with a gloved hand. The foam is tack-free when the foam does not adhere to the glove. Powder free latex or powder-free nitrile gloves are permitted for use.

3.5.2.4 Density of Reactivity Samples
Density testing shall be performed on foam samples per ASTM-D1622. Custom standardized procedures approved by Quality Engineering (6.5.17) and the user's M&P (6.5.8) may also be used for determination of density. The following requirements are applicable to the determination of free foam density per Table II and shall take precedence over ASTM-D1622.

a. A minimum cure time of 24 hours at ambient conditions (6.5.7) shall elapse from the time of mixing [see 3.5.2(g)] until the machining of density samples according to this method.
b. A minimum of one specimen with nominal dimensions of 2 x 2 x 0.75 inches shall be taken from each cup prepared per 3.5.2.
c. All specimens shall be taken from the crown that rises above the rim of each cup and taken from areas not to include outer "skin" or rind material.
d. The test specimens shall be conditioned at ambient (6.5.7) laboratory conditions for a minimum of 45 minutes prior to testing at ambient laboratory conditions.
e. Foam dimensions shall be measured to the nearest 0.001 inch, at a minimum, using calibrated calipers.

f. Foam weight shall be measured using a calibrated scale and recorded in grams (to the nearest 0.001 grams).
g. Free foam density (lbs. /ft^3) shall be calculated using the formula

$$D = \left(\frac{W}{L \times H \times T} \right) \times 3.8096$$

Where D = Density, W = Weight, L = Length, H = Height, and T = Thickness. Units are as follows: D is in lbs/ft^3, W is measured in grams, and L, H, and T are measured in inches.

3.5.3 Physical, Thermal, and Mechanical Testing of Cured Foam

3.5.3.1 Fabrication of Cured Foam Specimens for Physical, Thermal, and Mechanical Property Determination

3.5.3.1.1 Foam Spray onto a Substrate
Foam to be used for physical, thermal, or mechanical testing shall be sprayed onto a substrate in accordance with MSFC-PROC-3687. Prior to spray foam application, substrate surfaces shall be cleaned or cleaned and primed with a cryogenic compatible primer as needed to ensure adequate foam to substrate adhesion. Data ranges reported in Table III are for foam sprayed in accordance with MSFC-PROC-3687.

3.5.3.1.2 Cure
The foam material to be used for physical, thermal, or mechanical testing shall be cured in accordance with MSFC-PROC-3687 prior to trimming, machining, and testing specimens.

3.5.3.1.3 Trimming/Machining
Trimming and machining shall be performed according to guidance given for specific tests in Section 3.5.3.

3.5.3.2 Thermal Conductivity
Thermal conductivity shall be determined in a direction parallel to the rise in general accordance with ASTM-C177 at 75°F +/-3°F. Testing at 75°F +/-3°F and at other temperatures (e.g. over a temperature range) may be performed as part of the same test, with the data at 75°F +/-3°F used to satisfy the requirement, while data collected at other temperatures may be used for engineering information.

Two ring-shaped samples of the same material (same material is material having the same lot, age, processing, etc.), cut from one blank having nominal dimensions of 8.25” x 8.25” x 1.1”, shall be tested during each thermal conductivity test. Data collected at 75°F +/-3°F shall be used to satisfy requirements for Minimum Qualification, while data collected over a temperature range representative of actual use temperatures shall be used to satisfy requirements for Qualification. The maximum temperature range is -423°F to 308°F. When testing over a range

of temperatures, data should be reported at discrete temperatures throughout the temperature range.

3.5.3.3 Closed Cell Content

Closed cell content testing shall be performed on 1.0 x 1.0 x 1.0 inch samples. Samples shall be conditioned for a minimum of 24 hrs at 73.4°F +/-3.6°F and a relative humidity of 50% +/-10% prior to testing. Samples shall be tested according to ASTM-D6226.

3.5.3.4 Density Testing of Sprayed Foam

3.5.3.4.1 Preparation of Sprayed Foam Density Samples

a. Sprayed foam shall be deposited onto substrates and cured per 3.5.3.1 prior to performing density testing on the sprayed foam.
b. A minimum of 5 specimens per panel with nominal specimen dimensions of 2 x 2 x 0.75 inches shall be taken at least one inch away from the edges of the sprayed foam panel.
c. Rind and substrate shall be removed during sample preparation

3.5.3.4.2 Density Testing Method

Density testing shall be performed on foam samples per ASTM-D1622. Custom standardized procedures approved by Quality Engineering (6.5.17) and the user's M&P (6.5.8) may also be used for determination of density. The following requirements are applicable to the determination of sprayed foam density and shall take precedence over ASTM-D1622.

a. The test specimens shall be conditioned at ambient (6.5.7) laboratory conditions for a minimum of 45 minutes prior to testing at ambient laboratory conditions.
b. Foam dimensions shall be measured to the nearest 0.001-inch, at a minimum, using calibrated calipers.
c. Foam weight shall be measured using a calibrated scale and recorded in grams (to the nearest 0.001 grams).
d. Sprayed foam density (lbs. /ft^3) shall be calculated using the formula

$$D = \left(\frac{W}{L \times H \times T} \right) \times 3.8096$$

Where D = Density, W = Weight, L = Length, H = Height, and T = Thickness. Units are as follows: D is in lbs/ft^3, W is measured in grams, and L, H, and T are measured in inches.

3.5.3.5 Hydrolytic Stability

The hydrolytic stability of the cured foam shall be determined on 1.0 x 1.0 x 1.0 inch samples in general accordance with ASTM-D756, Procedure G. Initial conditioning of specimen shall be a minimum of 40+ hours to ambient (6.5.7) conditions.

3.5.3.6 Flammability

The flammability of the cured foam shall be determined in general accordance with NASA-STD-6001, Test 1. The following requirements shall take precedence over NASA-STD-6001:

a. Nominal sample dimensions shall be 12” (length) x 2.5” (width). Typical foam thickness is one inch, and should be adjusted as needed based on the targeted end-use for the S-180 foam.
b. Testing shall be conducted in an atmosphere of 20.9% oxygen with a balance of GN2.
c. Testing shall be conducted at a pressure of 14.7 psia.
d. When obtaining/creating the correct test atmosphere, the sample shall at no time be exposed to sub-ambient pressure or vacuum.
e. Each sample shall be mounted at a 15 degree angle from the vertical using a wing nut fixture to facilitate a surface ignition of the material as opposed to the standard edge ignition. Typically, a machined foam surface is tested, but an as-sprayed surface may be tested if desired (testing of a machined foam surface produces more conservative results than testing of an as-sprayed foam surface).
f. Igniter shall be positioned 2.0 inches from the bottom and 0.25 inches below the surface of the material so that the flame interacts with the 12” x 2.5” surface.
g. One Flammability Test shall consist of five samples of the same material (same material is material having the same lot number, material age, aging condition, processing, etc.) being tested and evaluated.
h. A sample shall have passed flammability testing if the burn length is less than or equal to 12.0”, with no ignition of the sheet of paper beneath the sample holder (no drip burning).

NOTE: Per NASA-STD-6016 a Material Usage Agreement (MUA) may be required for S-180 foam material.

3.5.3.7 Bond Tension

Bond tension samples having foam dimensions of 2” x 2” x 0.75” which are still adhered to 1/8” thick Aluminum 2219-T87 substrates or to 0.05" thick Inconel 718 (SAE-AMS-5596) substrates shall be prepared according to EM40-OWI-043 or equivalent. Samples shall be conditioned for a minimum of 24 hours at ambient (6.5.7) conditions prior to testing in general accordance with ASTM D1623 at ambient (6.5.7) conditions. ASTM D1623 Type B specimens and grip assembly shall be used.

3.5.3.8 Portable Tensile Testing (aka Plug Pull)

a. Portable tensile testing equipment defined in EM40-OWI-042 shall be used to perform portable tensile testing per EM40-OWI-042 on foam sprayed per MSFC-PROC-3687 onto Aluminum 2219-T87 substrates primed with a cryogenic compatible primer as needed to ensure adequate foam to substrate adhesion. Portable tensile testing shall be performed using a one inch foam core. Minimum number of tests and test results shall conform to Table III. The panels / areas to be tested shall be conditioned at laboratory conditions (6.5.7) for 45 minutes minimum prior to testing at laboratory conditions (6.5.7). Each test panel or test location shall be identified with the appropriate

information to maintain necessary traceability. Due to variability inherent in the test method, portable tensile testing shall be subject to the following: When the minimum tensile requirement is not met, the nonconformance shall be documented per standard nonconformance procedures and, when approved by NASA MSFC M&P (6.5.1) or the user's M&P (6.5.8), one (1) additional tensile test shall be performed adjacent to the original failure.

b. The user's M&P (6.5.8) shall determine the retest location.
c. If the result of the additional test meets the minimum tensile requirement, the material shall be considered conforming. Additional tests may be performed as required by the disposition of the nonconformance.

3.5.3.9 Compressive Strength

Compressive Strength testing shall be performed on foam samples in general accordance with ASTM-D1621. The following requirements are applicable to the determination of compressive strength and shall take precedence over ASTM-D1621.

a. A minimum of five test specimens with nominal dimensions of 3 x 3 x 1 inches shall be prepared per MSFC-PROC-3687 and removed from the substrate.
b. The test specimens shall be conditioned at ambient (6.5.7) laboratory conditions for a minimum of 45 minutes prior to testing at ambient (6.5.7) laboratory conditions.
c. Foam dimensions shall be measured to the nearest 0.001 inch using calibrated calipers.
d. The compressive strength of the foam shall be determined by the load value measured at 10% compression divided by the initial cross-sectional area of the tested sample when using a nominal machine head travel speed of 0.1 inch per minute.

3.5.3.10 Gradient Cryoflex

Gradient Cryoflex testing shall be in accordance with EM40-OWI-058 or equivalent (for testing at MSFC) at -423 to -400 °F and/or -310 ± 10 °F. The test should not be performed at -423 to -400 °F if the intended use (based on hardware exposures) of the material does not encompass this temperature.

a. Testing shall be performed on an 1/8-inch thick Aluminum 2219-T87 substrate on an infinite radius anvil.
b. Each cryoflex test uses two specimens, one on each side of the anvil. Each of the two specimens tested during one cryoflex test shall have the same substrate material and substrate dimensions.
c. Use of a substrate without foam on one side of the anvil is permissible if it is desired to test one cryoflex specimen at a time, as long as the substrates on both sides of the anvil are the same material and have the same configuration.
d. The configuration, number and foam thickness of cryoflex specimens shall be per released engineering documentation.
e. Each specimen shall withstand the minimum substrate stress level as defined in Table III.

f. Test temperatures shall be chosen based on the in-service substrate temperature of the part being foamed.

3.6 Inspection Testing for Material Acceptance

a. Inspection tests shall be required for each lot to ensure the quality of the product.
b. Each lot intended for use with production hardware shall pass both a visual inspection and material property testing (material properties to be tested and acceptable data ranges are listed in Tables I and II) upon receipt prior to acceptance by the Procuring Authority (6.5.11).
c. The Procuring Authority (6.5.11) and/or user reserves the right to perform any other tests listed in this specification and to reject the shipment or lot of manufacture if test values fall outside the acceptable ranges specified in Tables I-III when tested according to methods listed in this specification. When tests from Table I-III are performed, the minimum number of samples that shall be tested for each material property inspection test are listed in Tables I-III.

3.6.1 Vendor Performance of Inspection Tests

The vendor shall perform the following inspection tests and submit actual results on a Certificate of Analysis (6.5.13) to the Procuring Authority (6.5.11) prior to or in conjunction with delivery of foam component materials.

a. Tests shown in Table IIa.
b. B (or R) component (Polyol) water content data range shall be 0.65-0.90% tested per 3.5.1.8.
c. A (or T) component (Isocyanate) viscosity shall be 150-250 cP tested at 77ºF per 3.5.1.1.
d. Isocyanate NCO Content shall be 31.0 minimum tested per 3.5.1.9.
e. Isocyanate Total Acidity (for information only)

Upon successful completion of inspection tests, the vendor shall submit a Certificate of Compliance (COC, 6.5.12) to the Procuring Authority (6.5.11) stating that the material produced by the vendor complies with all requirements listed in MSFC-SPEC-3686. The COC shall include a statement of the amount of blowing agent added to each blended kit, or lot as applicable, of material. The COC shall also list the expiration date for each kit of material. The COC shall be provided prior to or in conjunction with delivery of foam component materials.

3.6.2 Visual Inspection of Foam Materials

The Procuring Authority M&P (6.5.8) shall visually inspect foam component materials prior to material acceptance. Inspection may be performed on individual component liquid specimens taken for chemistry or reactivity testing. Inspection shall include the following as a minimum:

a. Material shall be uniform in condition.
b. Material shall be free from any apparent foreign materials/particles.
c. Material shall be free from sediment.
d. Material shall be free from visual imperfections.

e. Material shall be free from lumps and crystallinity.

3.6.3 Procuring Authority Performance of Inspection Tests

A qualified laboratory identified by either the Procuring Authority M&P (6.5.8) and/or the TPS Lead Engineer (6.5.9), as applicable, shall perform the following inspection tests using the test methods outlined in Section 3.0 of this specification and submit actual results to the Procuring Authority (6.5.11) on a certified test report (6.5.3).

a. All tests listed in Table I and II.
b. Density of Sprayed Foam (3.5.3.4).
c. Tensile Strength (Bond Tension) of Sprayed Foam (3.5.3.7). Portable Tensile Testing (3.5.3.8) may be performed in lieu of Bond Tension testing (3.5.3.7) if desired by the Procuring Authority M&P (6.5.8).

3.6.4 Test Documentation Evaluation

The Procuring Authority M&P (6.5.8) shall analyze the vendor-provided Certificate of Compliance (6.5.12) and Certificate of Analysis (6.5.13) for compliance with the requirements of MSFC-SPEC-3686. The Procuring Authority M&P (6.5.8) shall analyze certified test reports (6.5.3) for compliance with the requirements of MSFC-SPEC-3686.

3.7 Qualification Testing

The material furnished under this specification for use with production products shall have passed, at a minimum, the material property tests listed in Tables I-III, shall have received qualification approval from the Procuring Authority M&P (6.5.8), and shall be listed in Appendix A. Qualification of a material is not necessary prior to performing development work.

NOTE: Testing that is required to be performed by the vendor are only those tests specified in section 3.6.1.

In addition to test documentation listed in 3.6.4, the material formulation, manufacturing process, and acceptance test procedures shall be submitted for qualification approval and include, at a minimum, the following:

a. Raw material constituents and sources.
b. Location of the manufacturing sites.
c. Requirements upon and control of raw material suppliers.
d. Equipment used for control of the manufacturing process, blending, and final acceptance testing.
e. The revision levels and/or revision dates of all specifications and manufacturer's instructions/procedures.

The submitted procedures shall not be changed, once approved, without prior written notification to and written approval by the Procuring Authority M&P (6.5.8).

3.7.1 Minimum Qualification

The tests to be performed for Minimum Qualification shall include all tests listed in Tables I-III. All test values shall fall within the data ranges listed in Tables I-III when material is prepared and testing is performed in accordance with the methods specified in Tables I-III.

3.7.2 Qualification Testing

Qualification Testing may require a separate set of tests to be determined by the TPS Lead Engineer (6.5.9). The TPS Lead Engineer (6.5.9) will consult with the applicable functional organizations on the design team as appropriate.

a. Qualification Testing shall include all tests performed for Inspection Testing for Material Acceptance listed in Table II.
b. Qualification Testing shall also include all of the tests listed in Table III and may include other testing not listed in this specification.
c. Values for material test results shall meet the data ranges that are listed in Tables I-III where applicable.

When testing not listed in this specification is performed, the TPS Lead Engineer (6.5.9) shall determine when material performance is acceptable.

3.8 Notification of Changes in Product

The supplier shall notify Procuring Authority (6.5.11) of any change in the supplier of raw materials, manufacturing location of raw materials, specifications of raw materials, the material formulation, material processing or specifications, material manufacturing location, and manufacturer instructions/procedures revision level/date that has occurred since the receipt of qualification approval. Procuring Authority M&P (6.5.8) may require full performance of qualification tests or performance of selected tests to ensure conformance to this specification.

4. VERIFICATION

4.1 Workmanship Verification

Workmanship verification shall include inspection/verification of the packaging of the material upon receipt from the vendor and inspection/verification of the material appearance. The following outlines the workmanship requirements that shall be used for inspection of the material packaging upon receiving and of the material as it is being used during processing.

4.1.1 Packaging/Container and Receiving Documentation Inspection

Foam material packaging/containers and receiving documentation shall be inspected upon receipt from the vendor for verification that the documentation includes required information and product packaging/containers meet workmanship requirements.

Inspection of the material packaging shall include as a minimum:

a. Material containers shall be as specified on the purchase order or contract.
b. Manufacturer Designation/Part Number and Lot Numbers shall be noted in the received documentation and identified on the material container.
c. Certificate of Analysis (COA) for A-component (Isocyanate) and B-component (R or Polyol) shall be included in the documentation received from the material vendor. The COA shall include all information required by 3.6.3.
d. Date of manufacture of the material shall be noted in the received documentation and identified on the material container.
e. Safety Data Sheets (SDS) covering material components shall be included in the documentation received.
f. Isocyanate component container shall be identified as Component T (A is acceptable) on the material container.
g. Polyol component container shall be identified as Component R (B is acceptable) on the material container.
h. Material container shall be marked with expiration date of 6 months from kit (6.5.5) manufacture date.
i. Drum number shall be identified on the material container, if applicable.
j. Weight information including gross weight and net weight shall be identified on the material container.
k. Material containers shall be inspected for potential damage including but not limited to dents in containers, bulging of containers, leakage of components, etc.
l. Certificate of Compliance (COC) shall be provided stating that all materials comply with this specification. COC shall include a statement of the amount of blowing agent added to each blended kit, or lot as applicable, of material. COC shall list expiration date for each kit of material.

4.2 Fingerprint Baseline

The Procuring Authority M&P (6.5.8) and/or user reserve the right to perform a fingerprint baseline test, such as a Fourier Transform Infrared (FTIR) spectrum or Gas Chromatograph-Mass Spectrometer (GC-MS), on a representative sample of this material.

4.3 Rejection

Failure to meet any requirement of this specification shall be cause for rejection. Excessive rejection shall be considered cause for vendor/material removal from the approved vendors/approved materials listing (ref. Appendix A).

5. PACKAGING, TRANSPORATION, RECEIVING, AND STORAGE

5.1 Packaging

Material shall be suitably packaged to prevent contamination or damage during handling, transporting, and storing.

5.2 Receiving

Procuring Authority (6.5.11) shall verify compliance to the requirements (3.1.7, 3.1.9, 3.6, 3.6.1-3.6.4, 4.1, 4.1.1) for this material upon receipt.

5.3 Marking of Shipments

Each individual shipping container (drum, etc.) shall be marked in a permanent manner with the information specified in 3.1.7.

5.4 Transportation

a. Material shall be shipped in a temperature controlled vehicle maintained at 50°F ± 10°F.
b. Material shall not be stored in direct sunlight.
c. Within two hours of unloading from the temperature controlled vehicle, the material shall be placed in controlled temperature storage, specified in 5.5.
d. The shipping vehicle shall be outfitted with a temperature-recording device which shall be used for monitoring the temperature of the material during transit.

5.5 Storage of Foam Components

5.5.1 B-Component Storage

B-component in pressurized cylinders shall be pressurized per 3.1.9 with nitrogen gas per 3.1.8 and stored at 50°F +/-10°F.

5.5.2 A-Component Storage, As-Received (Manufacturer Sealed Drum)

As-received (manufacturer-sealed) drums of A-component shall be stored at 50°F +/-10°F. As-received drums are drums which still have the manufacturer's seal present on the bung.

5.5.3 A-Component Storage, Opened Drum

Opened drums of A-component shall be buffered per 3.1.9 with nitrogen gas per 3.1.8 and stored at 50°F +/-10°F. Opened drums of A-component are drums that do not have a manufacturer's seal present on the bung.

6. NOTES

6.1 Intended Use

This material will be used primarily as a manually sprayed foam suitable for spray applications.

6.2 Supplier Submittals

All correspondence regarding this specification including requests for qualification, submission of samples, and qualification test reports should be directed to the Procuring Authority (6.5.11).

6.3 Ordering Data

Requests, requisitions, schedules, contracts, or orders will specify title, specification number, revision letter/number of specification, amendment letter if applicable, and types and quantity of the material required. This specification requires procurement from vendors who have qualification approval from the Procuring Authority (6.5.11) when material is to be used with production products. See Appendix A.

6.4 Modifications or Changes

Recommendations for modifications or changes to the requirements specified herein should be submitted in writing to the Office of Primary Responsibility Designee (6.5.16) of this document at 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.

6.5 Definitions and Acronyms

6.5.1 MSFC Materials and Processes Laboratory, M&P, or MSFC: These terms refer to the Materials and Processes Laboratory of the MSFC Engineering Directorate.

6.5.2 Acceptance Tests: Tests required for each lot (6.5.4) of material to ensure the quality of the product.

6.5.3 Certified Test Report: A written report documenting, at a minimum, actual or average results (as applicable), applicable lot (6.5.4) / kit (6.5.5) number, and test methods.

6.5.4 Lot: A grouping of material formulated, produced, and submitted for inspection at one time.

6.5.5 Kit: A kit consists of one 55-gallon drum of A-component (or T) (Isocyanate) and one 60-gallon pressurized cylinder of B-component (or R) (Polyol).

6.5.6 Additional Tests: Tests performed by NASA, the Procuring Authority M&P (6.5.8), or NASA Contractors during qualification or acceptance, as applicable. The responsible engineering shall retain this information for future reference.

6.5.7 Ambient (Laboratory Conditions): 65-85°F with a relative humidity of 70% or less.

6.5.8 Procuring Authority M&P: The responsible Materials and Processes (M&P) organization procuring the material and completing the associated acceptance testing on the qualified product.

6.5.9 TPS Lead Engineer: The subject matter expert directing the TPS Task.

6.5.10 RT: Refers to ambient (6.5.7) room temperature.

6.5.11 Procuring Authority: Refers to any group, not otherwise defined in this document, which purchases the product defined in this material specification. Procuring Authority M&P (6.5.8) is part of the Procuring Authority, and shall be consulted on materials and processing related submissions, requests, issues, or concerns.

6.5.12 Certificate of Compliance (or Certificate of Conformance, COC): A certificate that states the manufactured material complies with all requirements given in this specification. The COC shall include a statement of the amount of blowing agent added to each blended kit (6.5.5), or lot (6.5.4) as applicable, of material. The COC shall also list the expiration date for each kit (6.5.5) of material.

6.5.13 Certificate of Analysis (COA): A written report that is submitted with each manufactured kit (6.5.5), or lot (6.5.4) as applicable, of material. The COA shall document actual test results, applicable lot/kit number, and identify test methods used to obtain tested values.

6.5.14 Acronyms

ASTM	ASTM International
BTU	British Thermal Units
COA	Certificate of Analysis
COC	Certificate of Compliance OR Certificate of Conformance
DI	Deionized
DOT	Department of Transportation
EM	MSFC Materials & Processes Laboratory
EM40	MSFC Nonmetallic Materials & Advanced Manufacturing Division
FTIR	Fourier Transform Infrared spectroscopy
GC-MS	Gas-Chromatograph-Mass Spectrometer
HFC-245fa	1,1,1,3,3-Pentafluoropropane
ITAR	International Traffic in Arms Regulations
KOH	Potassium hydroxide

M&P	Materials and Processes
MAPTIS	Materials and Processes Technical Information System
MPDMS	Multiprogram Document Management System
MSFC	Marshall Space Flight Center
MUA	Material Usage Agreement
NASA	National Aeronautics and Space Administration
NCO	Isocyanate functional group
OPR	Office of Primary Responsibility
OPRD	Office of Primary Responsibility Designee
OSHA	Occupational Safety and Health Administration
OWI	Organizational Work Instruction
RPM	Revolutions per minute
RT	Room Temperature
SBU	Sensitive But Unclassified
SDS	Safety Data Sheet
TGA-IR	Thermogravimetric Analysis – Infrared Spectrometry
TPS	Thermal Protection System

6.5.15 Office of Primary Responsibility: The NASA organization with primary responsibility for the content of specific data items or the organization responsible for the process represented by the document. OPR responsibilities may include preparing a document, controlling a document, and reviewing the technical content of a document submitted by a contractor or external organization. The OPR appoints the OPRD (6.5.16).

6.5.16 Office of Primary Responsibility Designee: Individual(s) appointed by the Office of Primary Responsibility (6.5.15) who is/are responsible for a specific document within their area. OPRD information for this specification is listed in the MPDMS.

6.5.17 Quality Engineering: The Quality Engineering discipline analyzes and plans the techniques and activities (including most notably Government Mandatory Inspection Points) to provide confidence that the hardware will meet program and technical requirements as documented in, for example, procedures, specifications and drawings.

6.6 Rounding Off Values

Reported values shall be rounded off to the same number of significant places as are shown in the requirement.

6.7 Changes from the Previous Issue

A summary of changes from the previous issuance of this standard are noted in the Document History Log located at the beginning of this document. This was done as a convenience only and NASA MSFC M&P (6.5.1) assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this specification based on the entire content irrespective of the relationship to the previous issue.

APPENDIX A. MATERIAL ORDERING INFORMATION

A.1 General

This list has been prepared for use by or for the government to be used in the procurement of products covered by the subject specification; and such listing of a product is not and does not connote endorsement of the product by the government. All products listed herein have been qualified according to the requirements for the products specified in the latest effective issue of the applicable specification. This list is subject to change without notice; a revision or amendment will be issued as necessary. The listing of a product does not release the supplier from compliance with the specification requirements. Use of the information shown herein for advertising or publicity purposes is forbidden.

A.2 Vendor and Procuring Information

A.2.1 Procuring Authority, NASA MSFC M&P Address
NASA/George C. Marshall Space Flight Center
Central Receiving Bldg. 4631
Marshall Space Flight Center, AL 35812

Note: Other procuring authorities may use an alternate address, as applicable, for paragraphs A.2.1 and A.2.2.

A.2.2 Receiving Address for Foam Component Material Deliveries
NASA Marshall Space Flight Center
Building 4765
Huntsville, AL 35812

A.2.3 Material Description

The material furnished under this specification shall be a two part polyurethane system which, when components are combined, will produce an HFC-245fa blown rigid polyurethane foam. The material shall consist of two matched components: a diphenylmethane-4,4'-diisocyanate mixture (a.k.a. Isocyanate, A-component or Component T) and a formulated polyoxyalkylene polyol resin blend (a.k.a. Polyol, Polyol-blend, B-component or Component R).

A.2.4 Vendor

A.2.4.1 J6 Polymers LLC
601 Derby Line Rd.
Genoa, IL 60135
Phone: (815)-517-1179

A.2.4.2 Vendor Designation/Part Numbers

A.2.4.2.1 Isocyanate (S-180-T, also shown as AM9507 or KA8600)

A.2.4.2.2 Polyol (S-180-R, also shown as KB8791)

APPENDIX B. TEST METHODS

B.1 General

The following procedural instructions shall be used as they are referenced in this document:

B.1.1 Mass Spectrometry of A-Component

B.1.1.1 Procedure

B.1.1.1.1 Weigh 0.5 (weight to two decimal places) grams of A-component and place into a calibrated, clean, 40 mL vial (40ml vial calibrated with a Class A volumetric pipet).

B.1.1.1.2 Dilute to 40 mL with Methylene Chloride (CH_2Cl_2).

B.1.1.1.3 Place approximately 1 mL of diluted sample into two auto sampler vials. Analyze sample with the conditions listed in Table IV.

TABLE IV. Spectrometry analysis parameters

Instrument	6890 Gas Chromatograph/5973 Mass Selective Detector with a 7683 liquid auto sampler
Column	30 meter 0.25 mm ID J&W DB5ms
Injection	Split 50:1
Column Flow	1.0 mL/min (0.034 oz./min)
Injector Temperature	250°C (482 °F)
MS Source Temperature	230°C (446 °F)
MS Quad Temperature	150°C (302 °F)
Oven	Set temperature to 35°C and hold for 5 min. Increase temperature by 8°C/min to 300°C. Hold at 300°C for 10 min.
Total Run Time	48.13 min
Tune	DFTPP per SW-846 Method 8270
Solvent Delay	5.0 min
Mass Range	35 to 550 amu at 2.86 scans/second
Library	NIST98

B.1.1.1.4 Run a blank of clean solvent (methylene chloride) between samples to ensure no carry over between samples.

B.1.1.1.5 Acquire spectrum of sample and blank.

B.1.1.1.6 Process each data file by integrating the chromatographs; ensure all peaks are properly integrated.

B.1.1.1.7 Obtain a library search for each detected peak.

B.1.2 Blowing Agent Analysis of B-Component

B.1.2.1 Procedure

B.1.2.1.1 Prepare primary working standards using pure (99%) HFC-245fa obtained from Honeywell following SW-846 method 8000.

B.1.2.1.2 Prepare secondary standard at 200 µg/mL; prepare a calibration curve from this standard.

B.1.2.1.3 Prepare three to five standards with each batch of samples.

B.1.2.1.4 Sample preparation:

B.1.2.1.4.1 Weigh 0.5 (weight to 2 decimal places) grams of B-component and place into a 10 mL Class A volumetric flask containing 5 mL of Purge and Trap grade methanol. Dilute to volume with methanol. Note: Sample will off gas as it comes to room temperature; keep cool.

B.1.2.1.4.2 Use a 100 µL syringe to place 67 µL of this solution into a second 10 mL Class A volumetric flask. Dilute to volume with methanol.

B.1.2.1.4.3 Place 100 µL (using syringe or volumetric pipet) of the solution from the second 10 mL Class A flask into a 100 mL Class A volumetric flask partially filled with DI water. Dilute to volume with DI water.

B.1.2.1.4.4 Fill two VOC 40 mL vials for analysis. Leave zero headspace.

B.1.2.1.4.5 Run standards, blanks, and samples using the conditions listed in Table V.

TABLE V. Blowing agent analysis parameters

Instrument	5890 Gas Chromatograph/5971 Mass Selective Detector
Column	60 meter 0.25 mm ID J&W DB-VRX
Program	Initial 35°C for 5.0 min Ramp 1: 4°C/min to 50°C; hold 0 min Ramp 2: 8°C/min to 220°C; hold 5.0 min Total Run Time: 35 min
Injector Temperature	110°C (230 °F)
Transfer Line	280°C (536 °F)
Flow Set	15.7 psi at 35°C (95 °F)
Column Flow	1.00 mL/min (0.034 oz./min)
Mass Spec. Tune	BFB
Mass Range	35 to 265 amu at 1.97 scans/second
Purge and Trap	Typical for SW-846 Method 8260
Note: HFC 245fa under these conditions is found to elute at 4.94 minutes. The mass spectrum of HFC 245fa consists of a Primary Ion 51 with Secondary Ions at 64, 69, 115, 133 and 95.	

B.1.2.1.5 An initial blowing agent concentration of 30% should yield 100 µg/L in the final solution with the above dilutions.

B.1.2.1.6 Calculate % blowing agent as:

% Blowing Agent=Results × 0.3 × 0.5/ (Actual Weight of Sample)

Note: "Results" in µg/L and "Actual Weight of Sample" in grams

B.1.3 Viscosity Determinations

B.1.3.1 Procedure

a. Turn on viscometer. Auto-zero viscometer.
b. Place spindle on spindle head.
c. Select speed (rpm).
d. Transfer approximately 10 mL of sample into sample cell.
e. Turn on water circulation bath to jacket sample compartment to maintain 25°C standard temperature.
f. Turn on motor and allow viscosity reading to stabilize.