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June 27, 1990



National Aeronautics and
Space Administration

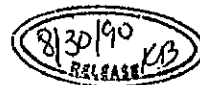
George C. Marshall Space Flight Center
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ADHESIVE BONDING, PROCESS AND INSPECTION, REQUIREMENTS FOR

Prepared by --
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MSFC-SPEC-445A

June 27, 1990



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CHANGE (DATE)	TO INCORPORATE THE CHANGE INTO THE DOCUMENT:		OTHER COMMENTS REGARDING THIS CHANGE (AUTH., INSTRUCT., ETC.)
	1. ADD PAGES;	2. REMOVE PAGES;	
8/30/90 RELEASE X12 06/27/90	ALL	ALL	Revision A Supersedes THE BASELINE Revision

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

**ADHESIVE BONDING, PROCESS AND INSPECTION, REQUIREMENTS
FOR**

1.0 SCOPE

- 1.1 This specification provides guidance for the preparation of, and requirements to be included in, the contractor process specification required for the processing and inspection of adhesive bonded parts, including sandwich construction.

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

MILITARY

MIL-STD-105 Sampling Procedures and Tables for Inspection by
Attributes.

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

3.0 REQUIREMENTS

3.1 PRIME CONTRACTOR'S PROCESS SPECIFICATION

Unless otherwise specified in the contract or purchase order, a description of material, process and inspection requirements in the form of a titled, numbered and dated process specification shall be prepared by the prime contractor and submitted to the procuring activity for approval before beginning production. The process specification shall comply with the requirements of this specification and shall follow its format as closely as possible.

The specific material, process and inspection requirements specified hereinafter shall be included and described in the process specification. The contractor shall certify that compliance with such process specification will produce a material meeting all the contract requirements.

3.1.1 Materials

The specification shall define the materials to be bonded and the service conditions under which the resulting structure must function. All materials used in the process shall conform to applicable Government specifications or other specifications as stipulated or approved by the procuring activity.

3.1.1.1 Adhesives

The adhesive system (including primer, if one is used) shall be specified. Adhesives to be used in production bonding of parts shall be validated preceding their use within a period not exceeding the shelf life specified by the manufacturer. In addition, validation of adhesives are required prior to use when the shelf or storage life specified in the controlling material specification has been exceeded. Validation shall include sampling and testing to determine the conformance of the adhesives to room temperature and short-term extreme temperature shear strength requirements of the specification governing its procurement or such other requirements as the procuring activity may direct or approve. The test specimens shall be of the same materials and processed by the same methods as are used on production parts.

3.1.1.2 Operator Certification

The prime contractor shall certify operators to ensure proper preparation/application techniques in accordance with an approved process specification. The prime contractor shall submit a plan outlining the certification process to be approved by the procuring activity before beginning production.

3.1.1.3 Handling/Storage

The prime contractor shall submit an adhesive control plan which defines a methodology for use of the adhesives including storage requirements.

3.1.1.4 Contamination

Adhesives are to be handled and stored in accordance with an adhesive control plan such that contamination will be prevented.

3.1.2 Environment

All operations connected with bonding, from surface preparation thru final bonding, shall be conducted in an area that is contaminant free to the extent that bonding is not deleteriously affected. Unless otherwise specified in the process specification, the bonding area shall be maintained at a temperature of $24^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and a relative humidity of 55 percent maximum. Bonding under the specified temperature and humidity conditions shall be limited to the use of such adhesives as will assure adhesion as proven by previous performance records of the contractor.

3.1.3 Bonding Procedure

3.1.3.1 Time, Temperature, and Pressure Requirements and Controls

Time, temperature, and pressure requirements, and controls, during the complete bonding procedure shall be specified in the process specification.

3.1.3.2 Prefitting of Parts

Surfaces shall have good contact over the entire area to be bonded and shall be free of burrs, waves, and other surface imperfections, or as defined in the process specification. When practicable, the surface shall be prefitted. Surfaces not prefitted shall conform to the applicable drawings.

3.1.3.3 Preparation of Faying Surfaces

Surfaces to be bonded shall be cleaned and prepared in such a manner as to achieve an acceptable bond between the surfaces and the adhesive. Surface preparation shall be in accordance with an approved process specification.

3.1.3.3.1 Handling of Treated Parts

Cleaned, treated, or cleaned and treated parts shall not be handled with the bare hands nor shall any contamination result from contact with supporting fixtures or mechanical handling equipment.

3.1.3.4 Assembly of Parts

Care shall be taken in assembling parts in the curing fixture or jig to assure that the adhesive is not disturbed and that excessive residual stresses are avoided. Static electricity, as generated through curing fixtures and bonded assemblies, shall be controlled by grounding or by other means within applicable safety codes.

3.1.3.5 Curing of Adhesives

Heat curing cycles shall be chosen so that, as a result of processing through the maximum number of cycles that may occur during fabrication, there will be no deleterious effect upon any of the materials comprising the bonded structures.

3.1.4 Special Requirements

Special techniques or precautions required, such as control of film thickness, control of application, control of humidity during faying surface preparation, adhesive application, and tooling that may be applicable to the particular adhesive or to the conditions of fabrication being employed, shall be included in the process specification.

3.1.5 Rework or Repair

Provisions for rework or repair of defective parts shall be stated in the process specification.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 RESPONSIBILITY FOR INSPECTION

Unless otherwise specified in the contract or the purchase order (see 6.2), the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facility or any commercial laboratory acceptable to the procuring activity. The procuring activity or its designated representative reserves the right to perform any or all of the inspections set forth in the specification where such inspections are deemed necessary to assure materials and services conform to prescribed requirements.

4.1.1 Records

Records covering the control of the entire fabrication process shall be maintained for permanent reference on each lot of material and on each production part.

4.2 CLASSIFICATION OF TESTS

All of the tests of this specification are classified as acceptance tests, for which the necessary sampling techniques, examination procedures, and methods of testing are specified in this section. Tests shall be performed during the fabrication of adhesive bonded parts that are to be submitted for acceptance under a contract or order.

4.3 ACCEPTANCE TESTS

The primary and continuing purpose of the acceptance tests shall be to see that all the requirements and procedures of the process specification specified in 3.1 are continuously complied with during production of parts. This shall be accomplished by periodic inspection of the production processes, controls, and other items covered by the process specification.

4.4 SAMPLING AND INSPECTION

4.4.1 Nondestructive Tests

Nondestructive inspection shall be made of the adhesive bond of each production part. The process specification shall specify the inspection criteria and the methods employed.

4.4.2 Destructive Quantitative Strength Tests

4.4.2.1 Preparation of Extensions, Coupons, or Standard Specimens

Production bonded parts shall incorporate, where possible, extensions or coupons that may be cut from the parts after bonding and will be representative of the bonds obtained in the part proper. Where extensions cannot be incorporated in the parts, standard specimens shall be fabricated. These shall receive the same treatment as the production parts they represent and, unless otherwise approved by the procuring activity, shall be of the same materials. The process specification shall specify the nature and number of extensions, coupons, and standard specimens to be prepared.

4.4.2.2 Sampling

The number of extensions, coupons, or specimens prepared in accordance with 4.4.2.1 that are to be selected shall be specified by the contractor in the process specification.

4.4.2.3 Test Method

Destructive quantitative strength tests shall be made of the adhesive bonds in the extension, coupons, or specimens prepared in accordance with 4.4.2.1. The test procedures to be used, and the requirements to be met shall be specified in the process specification.

4.4.3 Destructive Inspection

4.4.3.1 Sampling

Unless otherwise specified in the contract or order, the first bonded part and a sufficient number of succeeding parts to be specified by the contractor in the process specification shall be selected from the production run and tested in accordance with 4.4.3.2. Sampling should be in accordance with Standard MIL-STD-105.

4.4.3.2 Test Method

Destructive inspection shall be made on parts selected in accordance with 4.4.3.1. When any changes are made in established curing or tooling or when new tooling is introduced, even though it is identical to the established tooling, new tests shall be made. The process specification shall indicate the test procedures to be used and the requirements to be met, including but not limited to bondline thickness tolerances, minimum strength in shear, tension, compression, and peel failure modes under load and environmental conditions corresponding to design requirements. The frequency of the proposed tests shall be predicated on tool life expectancy and on a realistic curve. Checks of tool dimensions and alignment shall be performed after every assembly is completed, or as prescribed in the process specification. Control and test instruments shall be periodically checked and calibrated.

4.4.4 Materials and Processes

The materials and processes covered by the contractor's process specification, the articles fabricated thereby, and the tests made thereon shall be subjected to the inspection and supervision of authorized Government inspectors. Reports of tests performed under Government inspection and supervision shall be furnished to the authorized inspectors.

5.0 PREPARATION FOR DELIVERY

There are no applicable requirements.

6.0 NOTES

6.1 INTENDED USE

This specification is intended for use by prime contractors in preparing process specifications for space vehicle programs.

6.2 ORDERING DATA

Procurement documents should specify:

A. NUMBER, DATE, AND TITLE OF THIS SPECIFICATION

B. WHETHER QUALITY ASSURANCE DOCUMENTATION IS REQUIRED

C. TYPE OF INSPECTION PLAN REQUIRED

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.

CUSTODIAN:

Preparing Activity:

NASA - George C. Marshall Space
Flight Center

George C. Marshall Space
Flight Center

FILE NO. MSFC-SPEC-445

202 -

DR060PRO

PACKAGE NO. 10443R

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GEORGE C. MARSHALL SPACE FLIGHT CENTERMSFC CODE IDENT 14981/339B2
ISSUE DATE FEB 22 2007

PAGE 1

C	DOCUMENT	DRL DRL	TITLE	CCBD NO.	PCN	PC	EFFECTIVITY
H	NUMBER	DSH REV					
*	MSFC-SPEC-445	202 -	ADHESIVE BONDING PROCESS AND INSPECTION REQUIREMENTS	000-00-0000	0000000	ZA	NONE

CHG	CHG	CHG	RESPONSIBLE	RESPONSIBLE	ACTION	DESCRIPTION
NO.	REV	NOTICE	ENGINEER	ORGANIZATION	DATE	
	A	SCN000	D. GRIFFEN	EH02	03/02/94	REVISION 'A' RELEASED 08/20/90.
*	1 A	SCN000	EUGENA GOGGANS	EO03	02/22/07	DOCUMENT RELEASED THRU PDS. NO LONGER TRACKED IN ICMS.

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EO03-0000	0000000	000-00-0000 SB3-00-0000	02/22/07

DWG SIZE	DRAWING NUMBER	DWG REV	EPL/DRL/DDS NUMBER	DWG REV	EPL DSH	EPL REV	EO DASH NUMBER	EO REV	PART NUMBER
			MSFC-HDBK-1453		202	-			
			MSFC-HDBK-1674		202	-			
			MSFC-HDBK-2221		203	-			
			MSFC-HDBK-505		202	-			
			MSFC-HDBK-670		202	-			
			MSFC-MNL-1951		209	-			
			MSFC-PROC-1301		202	-			
			MSFC-PROC-1721		202	-			
			MSFC-PROC-1831		202	-			
			MSFC-PROC-1832		202	-			
			MSFC-PROC-404		202	-			
			MSFC-PROC-547		202	-			
			MSFC-QPL-1918		204	-			
			MSFC-RQMT-1282		202	-			
			MSFC-SPEC-1198		202	-			
			MSFC-SPEC-1238		202	-			
			MSFC-SPEC-1443		202	-			
			MSFC-SPEC-164		202	-			
			MSFC-SPEC-1870		202	-			
			MSFC-SPEC-1918		203	-			
			MSFC-SPEC-1919		206	-			
			MSFC-SPEC-2083		202	-			
			MSFC-SPEC-2223		202	-			
			MSFC-SPEC-2489		206	-			
			MSFC-SPEC-2490		205	-			
			MSFC-SPEC-2491		203	-			
			MSFC-SPEC-2492		203	-			
			MSFC-SPEC-2497		211	-			
			MSFC-SPEC-250		202	-			
			MSFC-SPEC-445		202	-			
			MSFC-SPEC-504		202	-			
			MSFC-SPEC-521		202	-			
			MSFC-SPEC-548		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	-			

DOCUMENTATION PACKAGE/ROUTING REPORT

02/22/07 DR120PR0 PAGE 2

PACKAGE NO: 10443R

DWG SIZE	DRAWING NUMBER	DWG REV	EPL/DRL/DDS NUMBER	DWG REV	EPL DSH	EPL REV	EO DASH NUMBER	EO REV	PART NUMBER
			MSFC-STD-2903		202	-			
			MSFC-STD-2904		202	-			
			MSFC-STD-2905		202	-			
			MSFC-STD-2906		202	-			
			MSFC-STD-2907		202	-			
			MSFC-STD-366		202	-			
			MSFC-STD-383		202	-			
			MSFC-STD-486		202	-			
			MSFC-STD-506		203	-			
			MSFC-STD-531		202	-			
			MSFC-STD-557		202	-			
			MSFC-STD-561		203	-			
			MSFC-STD-781		202	-			

SUBMITTED BY ENGINEERING AREA:	BASIC	CHANGE	PARTIAL	COMPLETE	CLOSES	ACTION
EO03		X		X		EO03

PREPARED BY:
EUGENA GOGGANS
12/19/06

SUBMITTED BY:

CONCURRENCE:

TRANSMITTAL DATES

TO RELEASE DESK 02/22/07 10:00
TO MSFC DOC REP 02/22/07 00:00

REMARKS:

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MSFC DOCUMENTATION REPOSITORY - DOCUMENT INPUT RECORD

I. GENERAL INFORMATION

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6. DOCUMENT/DRAWING TITLE: Adhesive Bonding, Process and Inspection, Requirements for			7. REPORT TYPE:	
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11. DISPOSITION AUTHORITY (Check One): <input checked="" type="checkbox"/> Official Record - NRRS <u>8/12/1A</u> <input checked="" type="checkbox"/> Reference Copy - NRRS 8/5/A/3 (destroy when no longer needed)	12. SUBMITTAL AUTHORITY:	13. RELEASING AUTHORITY: <u>Gail H. Gordon</u> 10/30/02		
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15. CONTRACTOR/SUBMITTING ORGANIZATION, ADDRESS AND PHONE NUMBER: Nonmetallic Materials and Processes Group Materials, Processes, and Manufacturing Department		16. ORIGINATING NASA CENTER: Marshall Space Flight Center		
		17. OFFICE OF PRIMARY RESPONSIBILITY: ED34, Nonmetallic Materials and Processes Group		
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II. ENGINEERING DRAWINGS

20. REVISION:	21. ENGINEERING ORDER:	22. PARTS LIST:	23. CCBD:
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III. REPORTS, SPECIFICATIONS, ETC.

24. REVISION: <u>A</u>	25. CHANGE:	26. VOLUME:	27. BOOK:	28. PART:	29. SECTION:
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IV. EXPORT AND DISTRIBUTION RESTRICTIONS

- Privacy Act (see MWI 1382.1)

 EAR (see MPG 2220.1)
- Proprietary (see MPD 2210.1)

 Other ACI (see NPG 1620.1 and MPG 1600.1)
- Patent (see MPG 2220.1)

 No statutory or institutional restrictions applicable -- material may be electronically distributed to user in the NASA domain
- ITAR (see MPG 2220.1)

V. ORIGINATING ORGANIZATION APPROVAL

40. ORG. CODE: ED34	41. PHONE NUMBER: (256) 544-2726	42. NAME: Gail H. Gordon	43. SIGNATURE/DATE: <u>Gail H. Gordon</u> 10/30/02
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VI. TO BE COMPLETED BY MSFC DOCUMENTATION REPOSITORY

44. RECEIVED BY: <u>Jimmy Wise</u>	45. DATE RECEIVED: 10-15-03	46. WORK ORDER:
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