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19 March 1975
SUPERSEDING
MIL-S-9041A
28 December 1953

MILITARY SPECIFICATION

SANDWICH CONSTRUCTION; PLASTIC RESIN, GLASS FABRIC BASE, LAMINATED FACINGS AND HONEYCOMB CORE FOR AIRCRAFT STRUCTURAL AND ELECTRONIC APPLICATIONS

This specification is approved for use by all Departments and Agencies of the Department of Defense

1. SCOPE

1.1 Scope. This specification covers the requirements for plastic molded sandwich construction using glass fabric base plastic laminate facings and glass fabric base plastic honeycomb core materials for aircraft structural applications, including aircraft exterior parts, such as radio and radar antenna housings, and other parts.

1.2 Classification.

1.2.1 Class. The sandwich construction shall be of the following classes, as specified (see 6.2):

Class I - Radar purpose (Electrical)

Class II - General purpose (Nonelectrical)

1.2.2 Types. The molded sandwich construction, honeycomb core material shall be of the following types, as specified (see 6.2):

Type I-A, 3/16 inch cell size; 4.0 lbs./cu. ft., nominal density

Type I-B, 3/16 inch cell size; 5.5 lbs./cu. ft., nominal density

Type I-C, 3/16 inch cell size; 8.0 lbs./cu. ft., nominal density

Type II-A, 1/4 inch cell size; 3.5 lbs./cu. ft., nominal density

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Type II-B, 1/4 inch cell size; 4.5 lbs./cu. ft., nominal density

Type II-C, 1/4 inch cell size; 6.5 lbs./cu. ft., nominal density

Type II-D, 1/4 inch cell size; 8.5 lbs./cu. ft., nominal density

Type III-A, 3/8 inch cell size; 2.2 lbs./cu. ft., nominal density

Type III-B, 3/8 inch cell size; 3.2 lbs./cu. ft., nominal density

Type III-C, 3/8 inch cell size; 4.5 lbs./cu. ft., nominal density

Type III-D, 3/8 inch cell size; 6.0 lbs./cu. ft., nominal density

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

Military

MIL-C-8073	Core Material, Plastic Honeycomb, Laminated Glass Fabric Base, For Aircraft Structural and Electronic Applications
MIL-P-9400	Plastic Laminate Materials and Sandwich Construction, Glass Fiber Base, Low Pressure Aircraft Structural Process Specification Requirements

STANDARDS

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-401	Sandwich Constructions and Core Materials, General Test Methods

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

2.2 Other publications. The following document forms 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 proposal shall apply.

Aerospace Industries Association of America, Inc.

ATC Report No. ARTC-4; Electrical Test Procedures for Radomes and Radome Materials

(Application for copies should be addressed to the National Standards Association, Inc., 1321 Fourteenth Street NW, Washington, DC 20005).

3. REQUIREMENTS

3.1 Precedence of requirements. The products furnished under this specification shall be as specified herein and in accordance with the drawings, specifications, or contract requirements for the specific sheet or part. In the event of discrepancy between this specification and the requirements of the applicable drawings, specifications, or contract for the specific sheet or part, the requirements of the latter shall govern.

3.2 First article inspection. The sandwich construction furnished under this specification (see 1.2) shall be a product(s) which has been inspected and has passed the first article inspection specified herein (see 4.3). The material supplied under contract shall be identical within manufacturing tolerances with the product receiving first article inspection approval. Any change in the use of materials or processes will necessitate its resubmittal for first article inspection.

3.3 Materials. The materials comprising the sandwich construction shall conform to applicable specifications and shall be as specified herein. Materials which are not covered by applicable specifications, or which are not specifically described herein, shall be subject to the approval of the procuring activity (see 6.2).

3.3.1 Sandwich construction. The sandwich construction shall consist of faces of glass fabric base laminated plastic material bonded to a core of laminated glass fabric base plastic honeycomb material.

3.3.2 Face material. The face material shall consist of a glass fabric base laminated with plastic material capable of meeting the requirements of this specification for use up to 350°F. All materials used in the facings shall be specified in the manufacturing and fabricating process specification of the sandwich construction.

3.3.3 Core material. The core material shall conform to all requirements of MIL-C-8073. Type I, II and III sandwich construction shall be made with Type I, II and III core materials respectively of MIL-C-8073. Bonding of pieces of core material together shall be made with the same resin used in the construction of the core or with an approved compatible resin adhesive. The resins shall not be corrosive to metals.

3.4 Process specification. A detailed description of the manufacturing and fabricating process and methods of control of manufacturing variables in the form of a titled, numbered, and dated process specification shall be prepared by the prime contractor, or obtained from a subcontractor (see 6.3), and approved by the prime contractor. The process specification shall conform to MIL-P-9400, and follow its format as closely as possible. The process specification shall be made available by the prime contractor at the time of first article inspection (see 4.3) and, thereafter, during the course of production for use by authorized Government and industry representatives in the facilities of the prime contractor, his subcontractors, or his vendors. It shall also be made available, on request, for review by engineers of the procuring activity. The prime contractor shall certify that compliance with such process specification will produce material meeting all the contract requirements.

3.5 Mechanical and physical properties. Unless otherwise specified by the procuring activity (see 6.2), the mechanical and physical properties of each type of honeycomb core sandwich construction shall conform to all the applicable requirements of Table I. Reference areas for the "L" and "W" direction of the cells for the plate shear strength and the "T" direction of the cells for the compressive strength shall be in accordance with Figure 1.

3.6 Electrical properties (Class I only). The electrical properties of the sandwich construction, fabricated as specified in 4.3.1, shall conform to the values listed in Table II (see 4.6.6).

3.7 Dimensions and weight. The face thickness, overall sandwich construction thickness, and maximum weight in pounds per square foot, shall be as specified in the specifications, drawings, or contracts for the molded sandwich construction parts (see 6.2).

3.8 Workmanship.

3.8.1 Faces. Except as otherwise specifically approved (3.8.1.1), the plastic material shall be uniform, smooth, and free from uncured or unbonded areas, gaps, cracks, holes, blisters, resin pockets, areas lacking resin, tackiness, excess surface resin, incorrect laps, wrinkles, delamination, air or gas pockets, patches, porosity, and other similar defects as defined in MIL-P-9400.

TABLE I. PROPERTIES OF CLASSES I AND II SANDWICH CONSTRUCTION
FLAT PANELS MADE WITH CORE MATERIALS 1/

Type	Core Material		Core Thickness	2/ Face Thickness	Compression Strength		Sandwich Plate Shear Strength					
							Room Temperature				350°F	
							"L" Direction		"W" Direction		"L"	"W"
	Cell Size Inches ±10%	Density lbs/cu ft ±10%	Inches ±0.006	Inches ±0.003	Room Temperature psi (min)	350°F psi (min)	Strength psi (min)	Minimum Average Modulus KSI	Strength psi (min)	Minimum Average Modulus KSI	Strength psi (min)	Strength psi (min)
I-A	3/16	4.0	0.500	0.030	480	335	212	10.0	110	5.0	130	65
I-B	3/16	5.5	0.500	0.030	750	525	350	12.6	190	6.8	210	115
I-C	3/16	8.0	0.500	0.030	1280	945	625	17.8	370	11.6	375	220
II-A	1/4	3.5	0.500	0.030	400	280	170	7.8	100	4.4	100	60
II-B	1/4	4.5	0.500	0.030	560	390	250	9.5	140	5.2	150	85
II-C	1/4	6.5	0.500	0.030	900	630	450	14.5	245	9.0	270	145
II-D	1/4	8.5	0.500	0.030	1370	960	685	19.0	425	13.0	410	225
III-A	3/8	2.2	0.500	0.030	145	100	85	5.3	45	1.8	50	25
III-B	3/8	3.2	0.500	0.030	350	245	160	7.0	85	3.0	95	50
III-C	3/8	4.5	0.500	0.030	550	385	260	9.0	150	4.5	155	90
III-D	3/8	6.0	0.500	0.030	750	525	380	15.0	210	8.0	230	125

1/ The values in Table I are for procurement only and are not to be used for design values.
2/ Face thickness values of 0.030 ± 0.003 inches shall apply to sandwich construction processed by the vacuum bag cure method. For sandwich construction processed by the autoclave cure method, the face thickness shall be 0.025 ± 0.003 inches.

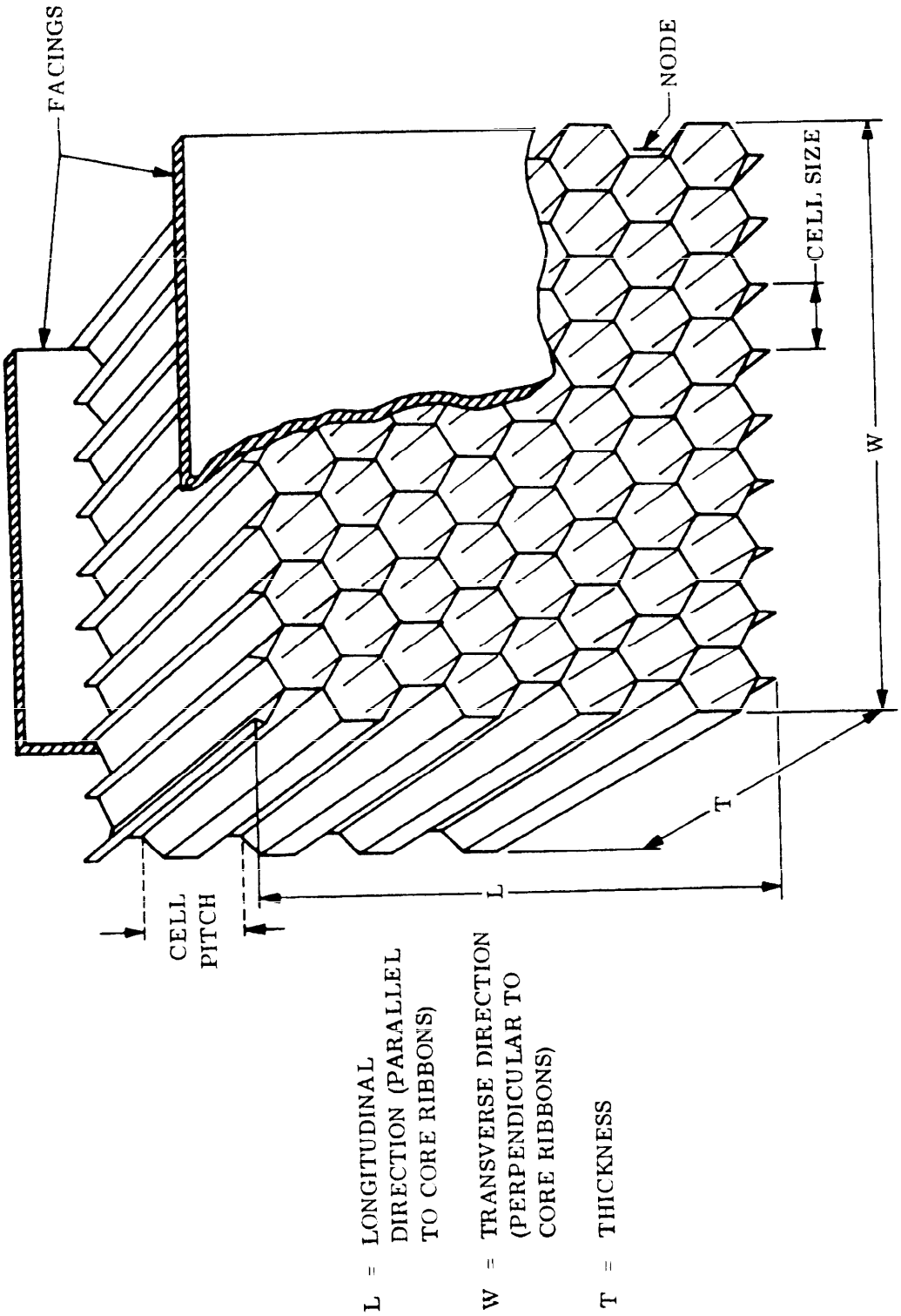

Figure 1. Reference areas for honeycomb cores in the sandwich construction.

TABLE II

ELECTRICAL REQUIREMENTS FOR CLASS I SANDWICH CONSTRUCTION AT 8500 - 10,000 MEGAHERTZ 1/

Test Panel	Electrical Power Transmission Efficiency (Minimum)
Standard Conditions (4.5) 2/	95 Percent
After Environmental Conditioning (4.6.6.2) 2/	90 Percent

(Values reported shall be the average of the determinations made on a minimum of 3 specimens)

1/ "X-band" frequency range. The test frequency for this band is 9,375 megahertz (see 4.6.6).
2/ Panels shall be oriented at 20-degree angle of incidence for both parallel and perpendicular polarization.

3.8.1.1 Allowable defects. Allowable defects in the plastic laminate, including repairable defects corrected by the manufacturer, shall be limited to those described in the applicable drawing, specification, or contract. All allowable defects shall be fully described, in such procurement documents, as to type, size, number, extent, and spacing. Defects other than those so described shall be counted as workmanship defects (see 6.2).

3.8.2 Core. Workmanship requirements of MIL-C-8073 shall apply to the core material before use in sandwich construction.

3.8.3 Sandwich construction. Unless otherwise specifically approved in the manufacturer's process specification (3.4) all sandwich construction parts shall be fabricated as specified in 3.8.3.1 through 3.8.3.3.

3.8.3.1 Lay up of core. The process specification (3.4) shall contain the specific core detail layout as to orientation of the "L" and "W" directions. There shall be no gaps between pieces of core material, and all pieces shall be bonded together.

3.8.3.2 Face to core bond. The faces shall be well bonded to the core over the entire area of the sandwich construction. Whenever the wet lay-up procedure

is used to secure this bond, excessive weight increase caused by excess resin shall be avoided. In the case of radomes, this is necessary to avoid appreciable increase of effective electrical face thickness. However, the face to core bond shall be strong enough to meet the requirements of this specification for service up to 350°F.

3.8.3.3 Fabrication procedure. The fabrication procedures, raw material preparation, and lay-up for the application of premolded laminates or pre-impregnated facings to the core as defined in MIL-P-9400 shall be included in the process specification (3.4). Where prototype radomes or other parts are required by other specifications or contracts to conform to this specification, then in such cases, following determination for conformance to any specified electrical, static test, or other requirements of a finished prototype model radome or other part, the procedure for bonding purposes on all subsequent radomes shall be held uniformly to the same as that used for the approved prototype, with very special care being taken in the case of radomes. No metal staples, paper tape, or other foreign materials shall remain in the finished molded sandwich construction.

3.9 Dimensions and make-up of sandwich construction. The thickness, dimensions, make-up of the laminates and core material, comprising the number of plies of the various fabrics, their position and direction, type of resin and other specific information for the sandwich construction, shall be specified in drawings, specifications or contracts for the parts.

3.10 Overlays. Glass fabric base low pressure laminated plastic material shall not be made with a gel resin overlay, integrally molded or otherwise, or with any other such thick resin surface, or any other surfacing material, unless such overlay or surfacing is specifically approved by the procuring activity.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to the prescribed requirements.

4.2 Classification of inspection. The inspection of the sandwich construction shall be classified as follows:

a. First article inspection (4.3).

b. Quality conformance inspection (4.4).

4.3 First article inspection. First article inspection of the sandwich construction shall consist of examinations and tests for all the requirements of this specification for each applicable class of material, and review for approval of the contractor's process specification (see 3.4).

4.3.1 First article samples and test reports. Prior to production of parts on contract, sample flat sheets and test specimens of sandwich construction shall be made up in accordance with the approved process specification, including separate samples for each producer if two or more producers use the same types of resins, fabric numbers, cores, mats or processes, of each of the types of core material to be employed in production parts. Class I and II sandwich construction test samples shall consist of 5 specimens (machined to size and suitable for testing) for each test required in Table I and one 2 by 2 foot panel. For electrical tests (Class I only), 3 additional sandwich panels 2 by 3 feet, prepared as specified in 4.6.6.1, shall be required. The sandwich and face thickness of the samples shall conform to the requirements specified in Table I. Test samples shall be accompanied by a test report showing the results of all tests specified for each applicable class and type of material.

4.3.2 Submittal of test specimens and reports. Test specimens, test reports and two copies of the contractor's process specification shall be submitted for first article inspection approval as specified by the procuring activity (see 6.2.1.1).

4.4 Quality conformance inspection. Quality conformance inspection shall consist of all the inspections, reports, and examinations specified in 4.4.1 through 4.4.2.2 and the tests and examinations specified in 4.6.1 through 4.6.5.1.

4.4.1 Process inspection. All the requirements and procedures of the approved first article inspection and contractors process specification specified in 3.4 shall be 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, for comparison with requirements of the latter. However, in those cases where the Government representative considers it necessary, in order to obtain material meeting the requirements of this specification, he shall have the right to require the performance of any of the tests at any time. More than one sheet may be made and used for the special tests provided that they are all comparable as to material and process of fabrication. Cuttings of at least 5 specimens (machined to size and suitable for testing) from each sample flat sheet for each test required by Tables I and II (Class I only) and one 2 by 2 foot panel shall be furnished by the prime contractor to the procuring activity within 10 days after receipt of a specific request therefor from the procuring activity any time prior to the completion of the prime contract in which this specification is incorporated. The above is at the option of the procuring activity in the event that Government check tests may be required.

4.4.2 Lot inspection. Unless otherwise specified by the procuring agency, from each lot of honeycomb core material and glass fabric laminate to be used in the fabrication of parts, at least one sample flat panel of sandwich construction plastic material shall be made up in accordance with the approved process specification of each of the types of core materials employed in the production of the lot. This panel shall be tested for properties specified in Table I. A lot of honeycomb core material or glass fabric laminate material shall be defined as all honeycomb core material or glass fabric laminate material representative of the same manufacturer's batch or shipment. Five specimens shall be tested for each test from each sample. In case of failure of the sample of honeycomb core material or glass fabric laminate or the sandwich panel to meet the requirements, an additional sample representative of the same lot shall be tested. If this sample also fails to meet requirements, the material subjected to the production tests shall not be used in the production of parts.

4.4.2.1 Sampling plans. Unless otherwise specified herein, the contract, purchase order, drawing or process specification, sampling plans and procedures in the determination of the acceptability of products submitted by a supplier shall be in accordance with the provisions set forth in MIL-STD-105.

4.4.2.2 Examinations. A random sample of sandwich construction shall be selected from each lot in accordance with procedures of MIL-STD-105, Inspection Level II, Acceptable Quality Level 2.5 percent defective for the examinations specified in 3.7 through 3.10. In addition, representative samples of components and materials used in the construction shall be provided. The sandwich construction sample shall be examined before any coating or finish of any kind is applied to the part after molding.

4.5 Standard test conditions. Test panels shall be conditioned and tested at 23 ± 1.1°C (73.4 ± 2°F) and a relative humidity of 50 ± 4 percent. The conditioning period prior to test shall be 96 hours.

4.6 Test methods.

4.6.1 Dimensions. Dimensions of core material shall be measured with a steel scale to the nearest 0.01 inch.

4.6.2 Thickness. The sandwich panel thickness shall be taken as the average of twenty randomly distributed readings each measured to the nearest 0.001 inch. The face thicknesses shall be determined by averaging several measurements to the nearest 0.001 inch.

4.6.3 Weight. Sandwich weight shall be determined on samples (minimum of one square foot) from the weight and dimensions by calculating the area and dividing the weight of the piece in pounds by the area. Weight shall be determined to an accuracy of at least one percent.

4.6.4 Sandwich flatwise compressive strength. Compressive strength shall be determined in accordance with MIL-STD-401, using stabilized specimens. Five specimens shall be tested at standard conditions. Specimens shall have a 3 by 3 inch cross section; the sandwich thickness dimension shall be in the "T" core thickness direction (see Figure 1).

4.6.4.1 Sandwich flatwise compressive strength at elevated temperature. Five stabilized specimens, prepared in accordance with MIL-STD-401, shall be heated at 350 ± 10°F for 1/2 hour and tested as in 4.6.4 at this temperature.

4.6.5 Sandwich shear strength and shear modulus. Plate shear strength and modulus of rigidity shall be determined in accordance with MIL-STD-401. Five sandwich specimens in both TL and TW directions shall be prepared and tested at standard conditions and the results averaged. Tensile or compressive loading shall be employed. The modulus of rigidity shall be obtained by computing the slope of the initial straight line portion of the stress-strain curve.

4.6.5.1 Sandwich shear at elevated temperature. Five specimens in each direction, prepared in accordance with MIL-STD-401, shall be heated at 350 ± 10°F for 1/2 hour and tested as in 4.6.5 at this temperature.

4.6.6 Electrical properties (Class I only). The electrical power transmission efficiency shall be determined on a minimum of 3 test panels prepared from 4.6.6.1 at standard conditions (4.5) and after environmental conditioning (4.6.6.2) in accordance with ATC Report No. ARTC-4, and checked for conformance to Table II.

4.6.6.1 Electrical test specimens. For each process described in the manufacturer's process specification, three sandwich panels 2 feet by 3 feet using any one type of core shall be furnished. The outside border of these panels shall be a solid laminate having a width of 1 inch ± 1/4 inch. The core shall be 0.330 ± 0.005 inch thick and other dimensions shall be as specified in Table I. The panels shall be fabricated in conformance with this specification and the applicable approved process specification. They shall be accompanied by a description of the resin, fabric, and core used, and identification of the process when more than one process is described in the manufacturer's process specification.

4.6.6.2 Environmental conditioning. Environmental conditioning of the test panels prepared from 4.6.6.1 shall consist of 25 cycles of temperature variation from 71°C to -55°C (160°F to -67°F), with the panels attaining the extreme temperatures during each cycle, after which they shall withstand 50 cycles of simulated altitude changes from 8,000 to 50,000 feet while maintaining an atmosphere saturated with water vapor (sufficient for condensation to form on the faces of the panel) from a steam supply, and having room air temperature metered into the chamber on the descent phase of each cycle to preclude drying.

Upon completion of the environmental conditioning, the panels shall be subjected to the electrical power transmission efficiency test of 4.6.6.

4.7 Destructive testing. All material, specimens, or parts destroyed in making tests required by this specification to determine compliance with the specification shall be in addition to the quantity specified in the contract or purchase order, and shall be furnished without increasing the cost of the contract or purchase order (see 6.2).

4.8 Preservation, packaging, packing and marking. Preservation, packaging, packing and marking of the materials covered by this specification shall be in accordance with the requirements of Section 5.

5. PREPARATION FOR DELIVERY

5.1 Application. The packing, packaging, and marking requirements shall be as specified in the specifications, drawings, or contracts for the parts fabricated from the plastic material.

6. NOTES

6.1 Intended use. Class I sandwich material may be used for aircraft radar antenna housings as well as for applications as indicated for Class II. Class II sandwich material may be used for general aircraft structural parts and other applications. Class I and II materials may be used for application where temperatures will not exceed 350°F.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification.

b. Class required (see 1.2.1).

c. Type required (see 1.2.2).

d. Dimensions and make-up of the sandwich construction (see 3.9).

e. Exceptions, if any, to the optional provisions of this specification including:

(1) Waiving of the compression strength and plate shear strength requirements at 350°F when not required (see 3.5 and Table I). Determination should be based on the temperature limitation of the type laminate facing used in the sandwich construction.

(2) Allowable plastic laminate defects (see 3.8.1.1).

(3) Laminate thickness and make-up of thickness including number of plies and lay-up.

(4) Identification of laminate plies as to type, fabric and number.

(5) Type of resin.

f. Allowance of quantity for destructive testing (see 4.7).

g. Type, class and dimensions of core under MIL-C-8073.

h. Quantity required (see 4.6).

i. Level of packaging, packing and markings when required (see 5.1).

j. Responsibility for the performance of first article inspection (see 6.2.1).

6.2.1 Contracts or orders shall specify the following provisions for first article inspection.

6.2.1.1 Whether first article inspection is required. When a contractor is in continuous production of the sandwich construction from contract to contract, consideration should be given to waiving the first article inspection. If inspection is required, indicate:

a. Where the first article inspection is to be conducted (at the Contractor's plant or Government or commercial laboratory).

b. Where the contractor's process specification is to be forwarded and the number of copies required.

c. That the approval of first article samples or the waiving of the first article inspection shall not relieve the contractor of his obligation to fulfill all other requirements of the specifications and contract.

6.3 Definitions.

6.3.1 Prime contractor. A prime contractor is a contractor fabricating components under direct contract with the Government, or subcontracting the

fabrication of part or all such components; or a fabricator supplying components direct to the Government.

6.3.2 Subcontractor. A subcontractor is a fabricator supplying components to a prime contractor.

Custodians:
Army - AV
Navy - AS
Air Force - 11

Review activities:
Army - AV
Air Force - 84

User activities:
Army - ME, MU

Preparing activity:
Navy - AS
(Project No. 5680-0065)

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 22-R255

INSTRUCTIONS: This sheet is to be filled out by personnel, either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or serve to amend contractual requirements.

SPECIFICATION

MIL-S-9041B, SANDWICH CONSTRUCTION; PLASTIC, RESIN, GLASS FABRIC BASE, LAMINATED FACINGS AND HONEYCOMB CORE FOR AIRCRAFT STRUCTURAL AND ELECTRONIC APPLICATIONS.

ORGANIZATION

CITY AND STATE

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

[ ] DIRECT GOVERNMENT CONTRACT [ ] SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

[ ] YES [ ] NO *(If "yes", in what way?)*

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity - Optional)*

DATE

DD FORM 1 JAN 68 1426

REPLACES EDITION OF 1 OCT 64 WHICH MAY BE USED.

FOLD

DEPARTMENT OF THE NAVY

Naval Air Engineering Center
LAKEHURST, NJ 08733

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