



AEROSPACE MATERIAL SPECIFICATION

Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AMS 3711B

Superseding AMS 3711A

Issued 6-1-74

Revised 10-15-79

CORE, HONEYCOMB, FIBROUS ARAMID BASE, PHENOLIC COATED

1. SCOPE:

- 1.1 Form: This specification covers expanded honeycomb core made of fibrous aramid paper sheets and supplied in the form of blocks, slices, and ordered shapes.
- 1.2 Application: Primarily for bonded sandwich structures requiring high strength and corrosion resistance in the temperature range -55° to $+82^{\circ}$ C (-67° to $+180^{\circ}$ F).

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

- 2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods

- 2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM C271 - Density of Core Materials for Structural Sandwich Constructions
ASTM C273 - Shear Test in Flatwise Plane of Flat Sandwich Constructions or Sandwich Cores
ASTM C363 - Delamination Strength of Honeycomb Type Core Material
ASTM C365 - Flatwise Compressive Strength of Sandwich Cores
Ø ASTM F501 - Aerospace Materials Response to Flame, with Vertical Test Specimen (For Aerospace Vehicles Standard Conditions)

- 2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Specifications:

MIL-R-9299 - Resin, Phenolic, Laminating

2.3.2 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Material:

SAE Technical Board rules provide that: "All technical reports, including standards approved or their use by governmental agencies is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

3.1.1 Fibrous Paper: Shall be made from aramid fiber.

3.1.2 Resin: The resin used for impregnating the paper and for any additional dip coatings shall conform to MIL-R-9299, Type II, Class 1. The resin or adhesive used to bond the adjacent cells shall be sufficiently strong to meet the requirements of 3.3.

3.1.3 Designations: Core shall be designated according to the following numbering system:

- a. Material
- b. Cell Size (fraction of an in.) (mm)
- c. Density (lb per cu ft) (kg/m^3)

Example: Core, Fibrous Aramid Phenolic Coated - 1/4 - 2.0
(in Inch/Pound Units)

Core, Fibrous Aramid Phenolic Coated - 6.4 - 32 (in SI Units)

Means: Core, fibrous aramid phenolic coated, 1/4 in. (6.4 mm) cell size,
density of 2.0 lb per cu ft ($32 \text{ kg}/\text{m}^3$).

3.1.4 Cell Configuration: Core shall consist of specified aramid sheets, bonded together so that cells approximately hexagonal in shape are formed when fully expanded (See Fig. 1).

3.1.5 Core Dimensions: Shall be as specified in Fig. 1 where,

T = Thickness, depth, or height dimension measured parallel to the core cell axis

L = Longitudinal or ribbon dimension measured along the direction of a ribbon

W = Transverse dimension perpendicular to the ribbon direction

3.2 Condition: Core shall be supplied completely cured and in the expanded form.

3.3 Properties: Core shall conform to the following requirements:

3.3.1 Core Properties: The compressive strength, core shear strength, and core shear modulus shall be as specified in Table I, determined in accordance with 4.5.1, 4.5.2, and 4.5.3, respectively. Specimens shall be tested after exposure for not less than 30 min. at the test temperature.

3.3.2 Density: The core density shall be within $\pm 10\%$ of the nominal density specified in Table I, determined in accordance with ASTM C271.

3.3.3 Flatness: Expanded core shall make total facing contact with a flat surface under a uniform pressure of not more than 2 psi (14 kPa) without resulting in any damage that would cause core rejection.

3.3.4 Node-Bond Breaks: No more than 3 node-bond breaks or separations per 12-in. (305-mm) diameter circle will be permitted with no two breaks being adjacent in the L (ribbon) direction.

- 3.3.5 Node-Bond Strength: Shall be not less than 16 lb (71 N) at $25^{\circ}\text{C} \pm 3$ ($77^{\circ}\text{F} \pm 5$) and not less than 8 lb (36 N) at $175^{\circ}\text{C} \pm 3$ ($347^{\circ}\text{F} \pm 5$), determined in accordance with ASTM C363.
- 3.3.6 Flame Resistance: Time to extinguish, defined as the total of flame time and glow time, shall not exceed 5.0 sec average, or 6.0 sec individual. Burn length shall not exceed 6.0 in. (153 mm) average, or 7.2 in. (184 mm) individual. Specimens shall be tested in the vertical position with $60 \text{ sec} \pm 1$ flame exposure in accordance with 4.5.4.
- 3.4 Quality: The core shall be uniform in quality, clean, and free from foreign materials and from imperfections detrimental to fabrication, appearance, or performance of parts.
- 3.4.1 Visual Imperfections:
- 3.4.1.1 Cell Walls: There shall be no split or buckled cell walls.
- 3.4.1.2 Double Layer: Expanded core blocks or slices which have double layers (two ribbons bonded together which cause uneven expansion in the "L" direction) shall be acceptable if the double layers are not more frequent than one in 12 in. (305 mm) in the "W" direction, as shown in Fig. 2.
- 3.5 Tolerances: Unless otherwise specified, the following tolerances shall apply:
- 3.5.1 Core Thickness: $\pm 0.008 \text{ in.}$ ($\pm 0.20 \text{ mm}$) for machined slices up to 4 in. (102 mm) thick; $\pm 0.062 \text{ in.}$ ($\pm 1.57 \text{ mm}$) for machined slices over 4 in. (102 mm) thick; and $\pm 0.25 \text{ in.}$ ($\pm 6.4 \text{ mm}$), -0.00 for raw block.
- 3.5.2 Length and Width: $\pm 1.0 \text{ in.}$ ($\pm 25 \text{ mm}$), -0.00 .
- 3.5.3 Cell Pitch: 1.733 times the nominal cell size, $+20\%$, -10% , measured by taking the average distance between 10 nodes along a ribbon. Report the average of determinations of six different ribbons selected at random.
- 3.5.4 Average Cell Size: Shall not vary more than $\pm 10\%$ from nominal dimensions, determined by taking the average distance between node bonds along the "W" dimension for at least 60 cells selected at random in groups containing 10 adjacent cells (See Fig. 1).
- 3.5.5 Ribbon Direction: All ribbons shall be parallel to each other within 10 degrees. The ribbon direction shall be determined by measuring the angle between one line through two nodes on the same ribbon ("L" direction) 12 in. (305 mm) apart, and another line in the principal ribbon direction (See Fig. 1).

4. QUALITY ASSURANCE PROVISIONS:

- 4.1 Responsibility for Inspection: The vendor of core shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.6. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the core conforms to the requirements of this specification.
- 4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for core shear strength (3.3.1), core density (3.3.2), quality (3.4), and tolerances (3.5) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Qualification Tests: Tests to determine conformance to all technical requirements of this specification are classified as qualification tests and shall be performed on the first-article shipment of core to a purchaser, when a change in material or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, qualification test material shall be submitted to the cognizant qualification agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Sampling:

4.3.1 For Acceptance Tests: Each block of 2% of the slices from each lot shall be sampled at random to provide sufficient core to perform all required tests. The number of specimens for each test shall be as specified in the applicable test procedure, or if not specified therein, not less than three.

4.3.1.1 A lot shall be each block or all slices cut from a single block. A lot shall not exceed 250 lb (113 kg).

4.3.1.2 When a statistical sampling plan and acceptance quality level (AQL) for core have been agreed upon by purchaser and vendor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.1 and the report of 4.6.1 shall state that such plan was used.

4.3.2 For Qualification Tests: As agreed upon by purchaser and vendor.

4.4 Approval:

4.4.1 Sample core shall be approved by purchaser before core for production use is supplied, unless such approval be waived. Results of tests on production core shall be essentially equivalent to those on the approved sample.

4.4.2 Vendor shall use ingredients, manufacturing procedures, processes, and methods of inspection on production core which are essentially the same as those used on the approved sample core. If any change is necessary in ingredients, in type of equipment for processing, or in manufacturing procedures, vendor shall submit for reapproval a statement of the proposed changes in material and processing and, when requested, sample core. Production core made by the revised procedures shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Compressive Strength: Shall be determined in accordance with ASTM C365 at $25^{\circ}\text{C} \pm 3$ ($77^{\circ}\text{F} \pm 5$) and $82^{\circ}\text{C} \pm 3$ ($180^{\circ}\text{F} \pm 5$) on core specimens. Specimens for wet testing shall be immersed in water at $25^{\circ}\text{C} \pm 3$ ($77^{\circ}\text{F} \pm 5$) for not less than 24 hr and tested immediately after removal.

4.5.2 Core Shear Strength and Shear Modulus: Shall be determined in two directions, using a plate shear test in accordance with ASTM C273 at $25^{\circ}\text{C} \pm 3$ ($77^{\circ}\text{F} \pm 5$) and $82^{\circ}\text{C} \pm 3$ ($180^{\circ}\text{F} \pm 5$). The test specimen shall be 0.500 in. $\pm$ 0.010 (12.70 mm $\pm$ 0.25) thick with 0.06 lb per sq ft (0.30 kg/m²) adhesive to bond plates to core.

4.5.3 Flame Resistance: Shall be determined in accordance with ASTM F501, using three bare core specimens, 0.500 in. (12.70 mm) thick x 3.0 x 14.0 in. (76 x 356 mm), with the 14 in. (356 mm) dimension in either the "W" or "L" direction, and the flame applied for 60 sec $\pm$ 1.

4.6 Reports:

4.6.1 The vendor of core shall furnish with each shipment three copies of a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the core conforms to the other technical requirements of this specification. This report shall include the purchase order number, material specification number and its revision letter, core designation, quantity, and block or lot number.

4.6.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number and its revision letter, contractor or other direct supplier of core, supplier's material designation, part number, and quantity. When core for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of core to determine conformance to the requirements of this specification, and shall include in the report a statement that the core conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

4.7 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the core may be based on the results of testing three additional specimens, cut from the same block, for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the core represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 The core shall be packaged to prevent physical damage during shipment and handling and shall be shipped flat unless contoured or formed shapes, requiring special support, are ordered.

5.1.2 Each piece of core and each interior and exterior package shall be marked to show not less than the following information applied to a durable tag, using characters of such size as to be clearly legible and which will not be obliterated by normal handling:

CORE, HONEYCOMB, FIBROUS ARAMID BASE, PHENOLIC COATED

AMS 3711B

CORE CLASSIFICATION _____

T x L x W _____

MANUFACTURER'S NAME OR TRADE MARK _____

BLOCK OR LOT NUMBER _____

PURCHASE ORDER NUMBER _____

DATE OF MANUFACTURE _____

- 5.1.3 Packages shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to handling, packaging, and transportation of the core to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.
- 5.1.4 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-794, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.1.1 and 5.1.3 will be acceptable if it meets the requirements of Level C.
6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.
7. REJECTIONS: Core not conforming to this specification or to authorized modifications will be subject to rejection.
8. NOTES:
- 8.1 Marginal Indicia: The phi (ϕ) symbol is used to indicate technical changes from the previous issue of this specification.
- 8.2 The flame resistance requirements of this specification meet the requirements of FAA FAR 25.853 (a) and Appendix F thereto. The flame resistance test is intended only for comparative evaluation of materials and is not to be construed as an indication of characteristics of the product under actual fire conditions.
- 8.3 For direct U.S. Military procurement, purchase documents should specify not less than the following:
- Title, number, and date of this specification
Nominal cell size and density required
Length, width, and thickness of blocks or slices required
Quantity of core desired
Applicable level of packaging (See 5.1.4)
- 8.4 Core meeting the requirements of this specification has been classified under Federal Stock Class FSCN 5680.

TABLE I

Nominal Core Dimensions		Test Temp ° F	Core Shear Strength		Core Shear Modulus		Compressive Strength psi, min		
Cell Size Inch	Density lb per cu ft		psi, min		psi, min avg		Unstabilized		Stabilized Dry
			L	W	L	W	Dry	Wet	
1/8	1.8	77	65	36	2000	1300	70	50	80
		180	58	25	1900	1170	50	--	72
1/8	3.0	77	162	85	5200	2500	180	165	270
		180	145	76	4300	2250	145	--	243
1/8	4.0	77	225	112	7000	3600	330	256	470
		180	200	100	6300	3240	297	--	423
1/8	5.0	77	235	120	8500	4500	600	420	660
		180	210	110	7600	4000	540	--	595
1/8	6.0	77	260	135	10000	4700	800	500	825
		180	235	120	9000	4200	720	--	740
1/8	8.0	77	355	190	13000	6500	1100	750	1250
		180	320	170	11500	5900	1000	--	1125
1/8	9.0	77	370	240	14500	8000	1400	1000	1600
		180	330	215	13000	7200	1250	--	1440
3/16	2.0	77	72	40	2500	1400	90	81	105
		180	64	36	2100	1260	81	--	94
Ø 3/16	3.0	77	135	67	4500	2400	180	167	270
		180	122	60	4050	2160	167	--	243
3/16	4.0	77	225	112	7000	3800	320	256	470
		180	200	100	6300	3420	256	--	423
3/16	4.5	77	225	110	7500	3000	320	225	400
		180	200	100	6700	2700	290	--	360
3/16	6.0	77	330	150	11600	4500	580	405	650
		180	295	135	10500	4000	520	--	585
1/4	1.5	77	45	23	1800	1000	45	40	55
		180	40	20	1600	900	40	--	50
Ø 1/4	2.0	77	72	36	2200	1300	80	72	105
		180	64	32	1980	1170	72	--	94
1/4	3.1	77	135	60	5600	2100	180	125	240
		180	120	55	5000	1900	160	--	215
1/4	4.0	77	200	95	6500	2800	310	215	360
		180	180	85	5800	2500	280	--	325
1/4	4.8	77	255	140	7300	4000	400	320	450
		180	230	125	6500	3600	360	--	405

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TABLE I (Continued)

Nominal Core Dimensions		Test Temp ° F	Core Shear Strength		Core Shear Modulus		Compressive Strength		
Cell Size Inch	Density lb per cu ft		psi, min		psi, min avg		psi, min		Stabilized Dry
			L	W	L	W	Unstabilized	Wet	
							Dry		
3/8	1.5	77	45	23	1800	1000	45	40	55
		180	40	20	1600	900	40		50
Ø 3/8	2.0	77	72	36	2200	1300	80	72	105
		180	64	32	1980	1170	72		94
3/8	3.0	77	110	55	3900	2500	175	130	210
		180	100	50	3500	2200	155		190

TABLE I (SI)

Nominal Core Dimensions		Test Temp ° C	Core Shear Strength		Core Shear Modulus		Compressive Strength		
Cell Size Inch	Density kg/m ³		MPa, min		MPa, min avg		MPa, min		Stabilized Dry
			L	W	L	W	Unstabilized Dry	Wet	
3.2	29	25	0.45	0.25	13.8	8.96	0.48	0.34	0.55
		82	0.40	0.17	13.1	8.07	0.34	--	0.50
3.2	48	25	1.12	0.59	35.9	17.2	1.24	1.14	1.86
		82	1.00	0.52	29.6	15.5	1.00	--	1.68
3.2	64	25	1.55	0.77	48.3	24.8	2.28	1.77	3.24
		82	1.38	0.69	43.4	22.3	2.05	--	2.92
3.2	80	25	1.62	0.83	58.6	31.0	4.14	2.90	4.55
		82	1.45	0.76	52.4	27.6	3.72	--	4.10
3.2	96	25	1.79	0.93	69.0	32.4	5.52	3.45	5.69
		82	1.62	0.83	62.1	29.0	4.96	--	5.10
3.2	128	25	2.45	1.31	89.6	44.8	7.58	5.17	8.62
		82	2.21	1.17	79.3	40.7	6.90	--	7.76
3.2	144	25	2.55	1.66	100.0	55.2	9.65	6.90	11.00
		82	2.28	1.48	89.6	49.6	8.62	--	9.93
4.8	32	25	0.50	0.28	17.2	9.65	0.62	0.56	0.72
		82	0.44	0.25	14.5	8.69	0.56	--	0.65
Ø 4.8	48	25	0.93	0.46	31.0	16.6	1.24	1.15	1.86
		82	0.84	0.41	27.9	14.9	1.15	--	1.68
4.8	64	25	1.55	0.77	48.3	26.2	2.21	1.77	3.24
		82	1.38	0.69	43.4	22.3	1.77	--	2.92
4.8	72	25	1.55	0.76	51.7	20.7	2.21	1.55	2.76
		82	1.38	0.69	46.2	18.6	2.00	--	2.48
4.8	96	25	2.28	1.03	80.0	31.0	4.00	2.79	4.48
		82	2.03	0.93	72.4	27.6	3.59	--	4.03

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