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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4176C

Issued	NOV 1970
Revised	JUL 1992
Noncurrent	MAR 1992
Cancelled	NOV 2001

Superseded by AMS 4349
Superseding AMS 4176B

Honeycomb Core, Aluminum Alloy For Sandwich Construction 5056, 350 (175)

(Composition similar to UNS A95096)

CANCELLATION NOTICE

This specification has been declared “CANCELLED” by the Aerospace Materials Division, SAE, as of November 2001, and has been superseded by AMS 4349. The requirements of the latest issue of AMS 4349 shall be fulfilled whenever reference is made to the cancelled AMS 4176. By this action, this document will remain listed in the Numerical Section of the Index of Aerospace Material Specifications noting that it is superseded by AMS 4349.

Cancelled specifications are available from SAE.

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1. SCOPE:

1.1 Form:

This specification covers one type of honeycomb core made of aluminum alloy and supplied in the form of blocks, slices, or other configurations as ordered.

1.2 Application:

Primarily for use in sandwich construction for short-term exposure, as in missile or space applications, to temperatures up to 350° F (175° C), or for long-term exposure, as in aircraft applications, to temperatures up to 200° F (95° C).

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 SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 Standards and Test Methods
AMS 4005 Aluminum Alloy Foil, 5.0Mg - 0.12Mn - 0.12Cr (5056-H191)

2.2 ASTM Publications:

Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM C273 Shear Test in Flatwise Plane of Flat Sandwich Constructions or Sandwich Cores
ASTM C365 Flatwise Compressive Strength of Sandwich Cores

2.3 Government Publications:

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

2.3.1 Federal Standards:

FED-STD-595 Color

2.3.2 Military Standards:

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

3. TECHNICAL REQUIREMENTS:

3.1 Material:

3.1.1 Metal: Shall be AMS 4005 (5056-H191) aluminum alloy foil of the thickness specified in the designation on the drawing or purchase order.

3.1.2 Adhesive: The adhesive system used for node-to-node attachment shall be selected at the option of the core manufacturer such that the resultant core meets the requirements specified herein.

3.2 Configuration:

The core material shall consist of strips of aluminum alloy foil bonded together such that cells approximately hexagonal in shape are formed when fully expanded (See Fig. 1).

3.2.1 Designation: Core shall be designated according to the following numbering system:

a. Nominal density, lb per cu ft (kg/m^3)

b. Cell size, in. (mm)

c. Foil thickness, ten-thousandths in. (µm)

d. “N” for nonperforated or “P” for perforated

e. Alloy

f. Adhesive, option of supplier, unless otherwise specified

Example: Core with a nominal density of 4.3 lb per cu ft (68.9 kg/m^3) with a 1/4 in. (6.4 mm) cell size, 0.0020 in. (51 µm) foil thickness, nonperforated, made of AMS 4005 alloy, and bonded with required adhesive shall be numbered as follows:

4.3 - 1/4 20N (5056) (XXXX) in U.S. Conventional units
68.9 - 6.4 51N (5056) (XXXX) in SI units

3.2.2 Perforations: When perforated core is specified, the perforations shall be approximately 0.005 in. (0.13 mm) in diameter and spaced to vent each cell into at least three adjacent cells at least once per 1/4 in. (6.4 mm) of core thickness. When thicknesses less than 1/4 in. (6.4 mm) are furnished, there shall be at least one perforation per cell into each of three adjacent cells.

3.2.3 Cell Pitch: Shall be 1.733 times the nominal cell size, +20%, -10%, measured by taking the average distance between 10 nodes along a ribbon for 6 different ribbons.

3.3 Condition:

Core shall be clean and free of contamination; it shall be supplied in the expanded form, unless otherwise specified.

3.4 Properties:

Core having nominal dimensions as specified in Table I shall conform to the following requirements; tests shall be conducted on the core supplied and in accordance with specified test methods. Properties of core having nominal dimensions other than specified in Table I shall be as agreed upon by purchaser and vendor.

3.4.1 Flatwise Compressive Strength: The minimum individual values shall be as specified in Table I, determined in accordance with 4.5.1.

3.4.2 Plate Shear Strength and Plate Shear Modulus: Shall be as specified in Table I, determined in accordance with ASTM C273 at 77° F ± 5 (25° ± 3), using a 0.625-in. (15.88-mm) thick specimen.

3.4.3 Node Bond Strength: Shall be not less than 30 lb (133 N) at 77° F ± 5 (25° ± 3) and not less than 15 lb (66.7 N) at 350° F ± 5 (177° C ± 3), determined in accordance with 4.5.2. In case of partial delamination at the minimum specified load, the delamination shall be less than 10% of the total stress section of the core slice.

3.4.4 Core Density: Shall be within ±10% of the nominal specified density, determined in accordance with 4.5.3.

3.5 Quality:

The core, as received by the purchaser, shall be uniform in quality and free from imperfections detrimental to usage of the core.

3.5.1 Cleanliness: The core shall be free from corrosion, oil, and other contamination detrimental to bonding.

3.5.2 Discoloration: A change in color of core material shall be acceptable provided the color change occurs in a line parallel to “L” (Fig. 1), indicative of a change in foil material where more than one foil coil is used in the manufacture of a core block. All other discolorations of core material, such as spots, will be unacceptable.

3.5.3 Flatness: Expanded core shall make total facing contact with a flat surface under uniform pressure without resulting in any damage that would cause core rejection.

3.5.4 Double Foils: Expanded core splices which have double foils (two ribbons bonded together which cause uneven expansion in the “L” direction (Fig. 1)) shall be acceptable if the double foils are not more frequent than one in any 8 in. (203 mm).

3.5.5 Mismatched Nodes: The c/d ratio (See Fig. 2) of mismatched nodes shall be 0.00 to 0.25.

3.5.6 Visual Imperfections: The following maximum requirements apply for imperfections observed in any randomly selected 12-in. or 305-mm diameter circle:

	Maximum Number for Cell Size, Inch (mm), Shown				
Type of Imperfection	1/8(3.2)	5/32(4.0)	3/16(4.8)	1/4(6.4)	3/8(9.5)
Mismatched Nodes	70	55	40	25	10
Loose Metal or Flakes (3.5.6.1)	35	28	20	12	5
Split Cell Walls	0	0	0	0	0
Buckled Cell Walls	0	0	0	0	0
Unbonded Nodes	2	2	2	2	2

3.5.6.1 Flakes are excess metal attached to foil edges which do not interfere with measurement of core thickness.

3.6 Sizes and Tolerances:

3.6.1 Size: Core shall be supplied in the size ordered, with core dimensions as shown in Fig.1, where,

T = Thickness, depth, or height dimension, measured parallel to the core cell size
L = Longitudinal or ribbon (length) dimension, measured along the direction of a ribbon
W = Width dimension, measured normal to the ribbon direction

3.6.2 Core Thickness Tolerance: Shall be ±0.005 in. (±0.13 mm) for machined slices up to 4.0 in. or 100 mm in nominal thickness, ±0.062 in. (±1.57 mm) for machined slices over 4 in. or 100 mm in nominal thickness; and +0.25 in. (+6.4 mm), -0.00 for raw block.

3.6.3 “L” and “W” Tolerance: Length and width of unexpanded core shall be as ordered, +0.25 in. (+6.4 mm), -0; for expanded core, tolerances shall be +2 in. (+50.8 mm), -0.

3.6.4 Average Cell Size Tolerance: The cell size of any 10 adjacent cells shall not vary more than ±10% from nominal, determined by taking the average distance between node bonds along the “W” dimension (Fig. 1) for at least 60 cells selected at random in groups containing 10 adjacent cells.

3.6.5 Ribbon Direction Tolerance: All ribbons shall be parallel to each other with 10 deg (0.175 rad). The ribbon direction shall be determined by measuring the angle between one line through two nodes on the same ribbon (“L” direction), 12 in. or 300 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 flatwise compressive strength (3.4.1), node bond strength (3.4.3), and density (3.4.4) requirements are classified as acceptance tests.

4.2.2 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests.

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

4.3 Sampling:

Shall be as follows; a lot shall be all slices cut from a single block:

4.3.1 Acceptance Tests: Each block or 2% of the slices from each lot.

4.3.2 Preproduction 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 procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Flatwise Compressive Strength: Shall be determined at 77° F ± 5 (25° C ± 3) in accordance with ASTM C365, Method A for stabilized specimens and Method B for bare specimens. Test specimens shall be nominally 0.625 in. (15.88 mm) thick by 3.00 in. ± 0.25 (76.2 mm ± 6.4) square. The test machine loading faces shall be approximately 4 in. or 100 mm square. Spherical loading blocks, preferably the suspended self-aligning type, shall transfer the load at 0.0020 in. ± 0.0005 (0.051 mm ± 0.013) per minute. At least 6 specimens shall be tested for each product. The flatwise compressive strength shall be computed by dividing the maximum load by the cross-sectional area of the specimen. Report all values.

4.5.2 Node Bond Strength: A 0.625 x 5 x 10 in. (15.88 x 127 x 254 mm) core slice shall be tested in a suitable tension fixture by mounting, without causing cell distortion, at opposite ends of the "W" dimension (See Fig. 3) with round pins. Pins shall be as large as cell size permits and shall engage all cells of a continuous row. Opposite pins shall be in mirror image alignment at a distance as near to 8 in. or 200 mm as this mounting method permits. The fixture shall be slotted to allow horizontal pin movement. A steady loading rate of 1.00 in. ± 0.05 (25.4 mm ± 1.3) per min. shall be maintained. Specimens shall be brought to temperature equilibrium before testing; elevated temperature tests shall be conducted at the specified temperature after holding at that temperature for 15 min. ± 1.

4.5.3 Core Density: Shall be determined on blocks and slices from their weight and dimensions to an accuracy within 1%. Thickness shall be measured with an accuracy of 0.001 in. (0.03 mm) and width and length with an accuracy of 0.010 in. (0.25 mm). Measurements shall be made using a dial gage capable of applying a 10 lb or 45 N force over a 1.5 in. or 38 mm diameter area. Density shall be calculated in lb per cu ft (kg/m^3).

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, product designation, size, quantity, block or lot number, and, when requested, the foil 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 form 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 Identification:

5.1.1 Color Identification: Each block or slice of core shall be identified on the edges by parallel stripes: One 2-in. or 50-mm wide red stripe to designate 350° F (175° C) core, two 0.5-in. or 13-mm wide black stripes to identify 5056 alloy, and a 0.5-in. or 13-mm wide colored stripe between the black stripes to identify the density range. The colors of the stripes shall be as specified in Table II and shall approximately match the color numbers of FED-STD-595. The group of parallel identification stripes shall be repeated at intervals not greater than 2 ft or 600 millimetres. The color shall be produced by adding a dye to an adhesive which is compatible with the core. Stripes shall be painted or sprayed on the edges of core blocks or slices. The dye shall retain its color through the curing cycles, shall be noncorrosive, and shall have no adverse effect on the curing or the strength of the adhesive used for construction of the core or the adhesive used with the core in fabricating sandwich components.

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

CORE, HONEYCOMB, ALUMINUM ALLOY, 5056-H191
AMS 4176C
CORE DESIGNATION _____
PURCHASE ORDER NUMBER _____
MANUFACTURER'S DESIGNATION _____
BLOCK OR CORE LOT NUMBER _____
PART NUMBER OR SIZE (T x L x W) _____
QUANTITY _____

5.2 Packaging:

5.2.1 Core shall be packaged and shipped in outer containers in such a manner as to ensure that the core, during shipment and storage, will not be permanently distorted and will be protected against damage from exposure to weather or any normal hazard.

5.2.2 Containers shall be prepared for shipment in accordance with commercial practice to ensure carrier acceptance and safe transportation to the point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.2.3 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 5.2.2 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 A change bar (**l**) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revisions. Change bars and (R) are not used in original publications, nor in specifications that contain editorial changes only.

8.2 For direct U.S. Military procurement, purchase documents should specify not less than the following:

Title, number, and date of this specification
Cell size and density of core desired
Size of core slices or blocks desired
Quantity of core desired
Applicable level of packaging (See 5.2.3).

8.3 Similar Specification:

8.3.1 This specification of MIL-C-7438F, Class 1, Grade B, dated 13 March 1972.

8.3.2 MIL-C-7438 is listed for information only and shall not be construed as an acceptable alternate unless all requirements of this AMS are met.

PREPARED UNDER THE JURISDICTION OF AMS COMMITTEE “D”

TABLE I

Nominal Core Dimensions			Plate Shear Strength psi, min		Plate Shear Modulus psi, min		Compression Strength psi, min	
Cell Size Inch	Foil Thickness Inch	Density lb per cu ft	Direction of Test W	Direction of Test L	Direction of Test W	Direction of Test L	Bare	Stabilized
1/8	0.0007	3.1	110	200	16000	31000	250	260
	0.0010	4.5	205	350	25000	51000	475	500
	0.0015	6.1	305	525	37000	77000	760	825
	0.0020	8.1	440	740	50000	112000	1200	1300
5/32	0.0007	2.6	80	152	12000	24000	180	185
	0.0010	3.8	155	272	20000	41000	360	375
	0.0015	5.3	250	435	31000	64000	615	650
	0.0020	6.9	360	610	42000	91000	920	1000
	0.0025	8.4	455	775	52000	115000	1110	1375
3/16	0.0007	2.0	50	105	9000	17000	110	120
	0.0010	3.1	110	200	16000	31000	250	260
	0.0015	4.4	198	340	24000	50000	460	490
	0.0020	5.7	280	480	34000	70000	685	735
	0.0025	6.9	360	610	42000	91000	920	1000
	0.0030	8.1	440	740	50000	112000	1200	1300
1/4	0.0007	1.6	38	78	6000	13000	75	80
	0.0010	2.3	62	130	11000	21000	145	155
	0.0015	3.4	130	230	18000	35000	300	315
	0.0020	4.3	190	325	24000	48000	440	465
	0.0025	5.2	245	425	30000	62000	600	645
	0.0030	6.0	300	512	36000	75000	740	805
	0.0040	7.9	430	720	49000	108000	1150	1265
3/8	0.0007	1.0	25	45	4000	7000	25	35
	0.0010	1.6	38	78	6000	13000	75	80
	0.0015	2.3	62	130	11000	21000	145	155
	0.0020	3.0	100	190	15000	30000	240	250
	0.0025	3.7	150	260	20000	40000	335	362
	0.0030	4.2	180	315	23000	47000	410	443
	0.0040	5.4	260	450	32000	66000	630	680
	0.0050	6.5	335	568	39000	84000	825	908

TABLE I (SI)

Nominal Core Dimensions			Plate Shear Strength MPa, min		Plate Shear Modulus MPa, min avg		Compression Strength MPa, min	
Cell Size mm	Foil Thickness mm	Density kg/m^3	Direction of Test W	L	Direction of Test W	L	Bare	Stabilized
3.2	0.018	49.7	0.758	1.379	110	214	1.724	1.793
	0.025	72.1	1.413	2.413	172	352	3.275	3.448
	0.038	97.7	2.103	3.620	255	531	5.240	5.688
	0.051	129.7	3.034	5.102	345	772	8.274	8.964
4.0	0.018	41.6	0.552	1.048	83	165	1.241	1.276
	0.025	60.9	1.069	1.875	138	283	2.482	2.586
	0.038	84.9	1.724	2.999	214	441	4.240	4.482
	0.051	110.5	2.482	4.206	290	627	6.343	6.895
	0.064	134.6	3.137	5.344	359	793	7.633	9.481
4.8	0.018	32.0	0.345	0.724	62	117	0.758	0.827
	0.025	49.7	0.758	1.379	110	214	1.724	1.793
	0.038	70.5	1.365	2.344	165	345	3.172	3.379
	0.051	91.3	1.931	3.310	234	483	4.723	5.068
	0.064	110.5	2.482	4.206	290	627	6.343	6.895
	0.076	129.7	3.034	5.102	345	772	8.274	8.964
6.4	0.018	25.6	0.262	0.538	41	90	0.517	0.552
	0.025	36.8	0.427	0.896	76	145	1.000	1.069
	0.038	54.5	0.896	1.586	124	241	2.068	2.172
	0.051	68.9	1.310	2.241	165	331	3.034	3.206
	0.064	83.3	1.689	2.930	207	427	4.137	4.447
	0.076	96.1	2.068	3.530	248	517	5.102	5.550
	0.102	126.5	2.965	4.964	338	745	7.929	8.722
9.5	0.018	16.0	0.172	0.310	28	48	0.172	0.241
	0.025	25.6	0.262	0.538	41	90	0.517	0.552
	0.038	36.8	0.427	0.896	76	145	1.000	1.069
	0.051	48.1	0.690	1.310	103	207	1.655	1.724
	0.064	59.3	1.034	1.793	138	276	2.310	2.496
	0.076	67.3	1.241	2.172	159	324	2.827	3.054
	0.102	86.5	1.793	3.103	221	455	4.344	4.689
	0.127	104.1	2.310	3.916	269	579	5.688	6.261