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AEROSPACE MATERIAL SPECIFICATION



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Submitted for recognition as an American National Standard

HONEYCOMB CORE, ALUMINUM ALLOY
For Sandwich Construction
5056, 350 (175)

UNS A95056

This specification has been declared "NONCURRENT" by the Aerospace Materials Division, SAE, as of March, 1992. It is recommended, therefore, that this specification not be specified for new designs.

This cover sheet should be attached to revision "A" of the subject specification.

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HONEYCOMB CORE, ALUMINUM ALLOY
 For Sandwich Construction
 5056, 350 (175)
1. SCOPE:

- 1.1 Form: This specification covers one type of honeycomb core made of aluminum alloy and supplied in 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 Society of Automotive Engineers, Inc., 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:

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

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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 foil 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 $77^\circ \text{F} \pm 5$ ($25^\circ \text{C} \pm 3$), 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 $77^\circ \text{F} \pm 5$ ($25^\circ \text{C} \pm 3$) and not less than 15 lb (66.7 N) at $350^\circ \text{F} \pm 5$ ($177^\circ \text{C} \pm 3$), 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 cure slice.

3.4.4 Core Density: Shall be within $\pm 10\%$ 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 Cleanness: 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 \emptyset 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:

| Type of Imperfection | Maximum Number for Cell Size, Inch (mm), Shown | | | | |
|------------------------------------|---|-----------|------------|-----------|----------|
| | 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. \emptyset (+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 $\pm 10\%$ 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
0 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.

0 4.3 Sampling: Shall be as follows; a lot shall be all slices cut from a single block:

0 4.3.1 Acceptance Tests: Each block or 2% of the slices from each lot.

0 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
0 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
0 be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Flatwise Compressive Strength: Shall be determined at $77^{\circ}\text{F} \pm 5$ ($25^{\circ}\text{C} \pm 3$) 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
0 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. \pm 0.05 (25.4 mm \pm 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. \pm 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/m³).

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 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 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 Labelling: 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-HI91

AMS 4176A

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 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from the previous issue of this specification.

- 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.

Ø TABLE I

| Nominal Core Dimensions | | | Plate Shear Strength psi, min | | Plate Shear Modulus psi, min | | Compression Strength psi, min | |
|-------------------------|----------------|--------------|----------------------------------|-----|---------------------------------|--------|----------------------------------|------------|
| Cell Size | Foil Thickness | Density | Direction of Test | | Direction of Test | | | |
| Inch | Inch | lb per cu ft | W | L | W | 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 | | Plate Shear Modulus | | Compression strength | |
|-------------------------|----------------|-------------------|----------------------|-------|---------------------|-----|----------------------|------------|
| Cell Size | Foil Thickness | Density | MPa, min | | MPa, min avg | | MPa, min | |
| mm | mm | kg/m ³ | Direction of Test | | Direction of Test | | Bare | Stabilized |
| | | | W | L | W | L | | |
| 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 |