AEROSPACE MATERIAL SPECIFICATION

AMS4177™	REV. F

Issued 1976-01
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Revised 2025-01

Superseding AMS4177E

Core, Flexible Honeycomb, Aluminum Alloy,
For Sandwich Construction,
5056, 350 Fahrenheit (177 Celsius)

RATIONALE

AMS4177F results from a Five-Year Review and update of this specification with changes to update wording to prohibit unauthorized exceptions (see 8.4), clarify temperature values in specification title and titles for Tables 2 and 4 (see title and Tables 2 and 4), relocate Definitions (see 2.3) and room temperature testing temperature for node bond strength from Table 5 to test method for clarity (see 4.5.3), align information in column headings in tables, clarify “T” designation meaning (see 3.2.1), Condition (see 3.3), and Cell Count (see 3.6.2.2), and update Applicable Documents (see Section 2).

1. SCOPE

1.1 Form

This specification covers an aluminum alloy in the form of honeycomb core in a non-hexagonal, flexible cell configuration, the core being treated for increased corrosion resistance and furnished only in the expanded form (see 8.5).

1.2 Application

This honeycomb core has been used typically in contoured sandwich construction for short-term service up to 350 °F (177 °C) or for long-term service up to 200 °F (93 °C), but usage is not limited to such applications.

1.3 Safety - Hazardous Materials

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards that may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS4177F/

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS-A-81596 Aluminum Foil for Sandwich Construction

AMS-STD-595 Colors Used in Government Procurement

AS7766 Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B117 Operating Salt Spray (Fog) Apparatus

ASTM C273/C273M Shear Properties of Sandwich Core Materials

ASTM C365/C365M Flatwise Compressive Properties of Sandwich Cores

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Material

3.1.1 Metal

Shall be AMS-A-81596, alloy 5056 aluminum alloy foil of the thickness specified on the part drawing or purchase order (see 8.5).

3.1.2 Adhesive

The adhesive used to bond the foil shall be of such quality that the resultant core shall meet the requirements of 3.4 and 3.5.

3.2 Configuration

The core material shall consist of strips of aluminum alloy foil bonded together to form cells of approximately uniform shape, as shown in Figure 1.

3.2.1 Designation

Core shall be designated according to the following numbering system:

- Nominal density, pounds per cubic foot (kg/m^3) (see 4.5.1)
- Cell count per linear foot (m) of transverse direction (see 4.5.2)
- Foil thickness in inches (µm)
- “N” for nonperforated or “P” for perforated or “HP” for highly perforated (see 3.2.2)

- “F” for flexible
- “T” for treated for corrosion protection
- Alloy
- Adhesive, option of the supplier

Example in inch/pound units: Core with a nominal density of 2.1 pounds per cubic foot with a cell count of 40, 0.0014-inch foil thickness, non-perforated, flexible, treated, produced from 5056 aluminum alloy, and bonded with required adhesive shall be numbered as follows:

- 2.1-40-14 NFT5056 (XXXX)

Example in SI units: Core with a nominal density of 34 kg/m^3 with a cell count of 131, 36-µm foil thickness, non-perforated, flexible, treated, produced from 5056 aluminum alloy, and bonded with required adhesive shall be numbered as follows:

- 34-131-36 NFT5056 (XXXX)

3.2.2 Perforation

Foil shall be non-perforated, except that, when perforation is specified, the perforations shall be of such size and location that all cells are vented at least once for each 0.250 inch (6.35 mm) of core thickness. When Type HP is specified, there shall be no fewer than 6000 perforations per square foot of foil, uniformly spaced and staggered.

3.3 Condition

The core shall be supplied in the expanded form; it shall be clean, free of contamination, and treated for corrosion resistance.

3.4 Properties

The core shall conform to the following requirements; tests shall be performed, on the core supplied, in accordance with specified test methods:

3.4.1 Stabilized Flatwise Compressive Strength

Shall be as specified in Tables 1 and 2, determined in accordance with ASTM C365/C365M on six specimens 0.625 inch (15.88 mm) in thickness.

Table 1A - Minimum compressive strength at 65 to 85 °F, inch/pound units (see 8.2)

Core Designation	Minimum Individual Compressive Strength psi
2.1-40-14 NFT5056	182
3.1-40-20 NFT5056	329
4.1-40-26 NFT5056	483
4.3-80-14 NFT5056	518
6.5-80-20 NFT5056	910
8.0-80-26 NFT5056	1260

Table 1B - Minimum compressive strength at 18 to 29 °C, SI units

Core Designation	Minimum Individual Compressive Strength MPa
34-131-36 NFT5056	1.26
50-131-51 NFT5056	2.27
66-131-66 NFT5056	3.33
69-262-36 NFT5056	3.57
104-262-51 NFT5056	6.27
128-262-66 NFT5056	8.69

Table 2A - Minimum compressive strength at 350 °F, inch/pound units

Core Designation	Minimum Individual Compressive Strength psi
2.1-40-14 NFT5056	119
3.1-40-20 NFT5056	215
4.1-40-26 NFT5056	315
4.3-80-14 NFT5056	340
6.5-80-20 NFT5056	595
8.0-80-26 NFT5056	820

Table 2B - Minimum compressive strength at 177 °C, SI units (see 8.2)

Core Designation	Minimum Individual Compressive Strength MPa
34-131-36 NFT5056	0.82
50-131-51 NFT5056	1.48
66-131-66 NFT5056	2.17
69-262-36 NFT5056	2.34
104-262-51 NFT5056	4.10
128-262-66 NFT5056	5.65

3.4.2 Shear Strength

Shall be as specified in Tables 3 and 4, determined in accordance with ASTM C273/C273M using five specimens 0.625 inch (15.88 mm) in thickness.

Table 3A - Minimum individual shear strength at 65 to 85 °F, inch/pound units (see 8.2)

Core Designation	Minimum Individual Shear Strength, psi Ribbon Direction	Minimum Individual Shear Strength, psi Transverse Direction
2.1-40-14 NFT5056	74	42
3.1-40-20 NFT5056	151	90
4.1-40-26 NFT5056	217	132
4.3-80-14 NFT5056	235	138
6.5-80-20 NFT5056	364	213
8.0-80-26 NFT5056	506	307

Table 3B - Minimum individual shear strength at 18 to 29 °C, SI units (see 8.2)

Core Designation	Minimum Individual Shear Strength, MPa Ribbon Direction	Minimum Individual Shear Strength, MPa Transverse Direction
34-131-36 NFT5056	0.51	0.29
50-131-51 NFT5056	1.04	0.62
66-131-66 NFT5056	1.50	0.91
69-262-36 NFT5056	1.62	0.95
104-262-51 NFT5056	2.51	1.47
128-262-66 NFT5056	3.49	2.12

Table 4A - Minimum individual shear strength at 350 °F, inch/pound units (see 8.2)

Core Designation	Minimum Individual Shear Strength, psi Ribbon Direction	Minimum Individual Shear Strength, psi Transverse Direction
2.1-40-14 NFT5056	48	30
3.1-40-20 NFT5056	97	59
4.1-40-26 NFT5056	141	86
4.3-80-14 NFT5056	156	91
6.5-80-20 NFT5056	236	139
8.0-80-26 NFT5056	330	200

Table 4B - Minimum individual shear strength at 177 °C, SI units (see 8.2)

Core Designation	Minimum Individual Shear Strength, MPa Ribbon Direction	Minimum Individual Shear Strength, MPa Transverse Direction
34-131-36 NFT5056	0.33	0.21
50-131-51 NFT5056	0.67	0.41
66-131-66 NFT5056	0.97	0.59
69-262-36 NFT5056	1.08	0.63
104-262-51 NFT5056	1.63	0.96
128-262-66 NFT5056	2.28	1.38

3.4.3 Node Bond Strength

Shall be as shown in Table 5, determined in accordance with 4.5.3.

Table 5A - Minimum individual node bond strength, inch/pound units (see 8.2)

Core Designation	Minimum Individual Node Bond Strength, lbf
2.1-40-14 NFT5056	30
3.1-40-20 NFT5056	30
4.1-40-26 NFT5056	30
4.3-80-14 NFT5056	35
6.5-80-20 NFT5056	35
8.0-80-26 NFT5056	35

Table 5B - Minimum individual node bond strength, SI units (see 8.2)

Core Designation	Minimum Individual Node Bond Strength, Newtons
34-131-36 NFT5056	133
50-131-51 NFT5056	133
66-131-66 NFT5056	133
69-262-36 NFT5056	156
104-262-51 NFT5056	156
128-262-66 NFT5056	156

3.4.4 Flexibility

A core slice shall lie flat without crimping, permanent distortion, or delamination when flexed as specified in 4.5.4.

3.4.5 Corrosion Resistance

The core shall show a weight loss not greater than 125 mg/ft^2 (1345 mg/m^2) of exposed foil area, determined in accordance with 4.5.5.

3.5 Quality

Core, as received by the purchaser, shall be free from imperfections detrimental to usage of the core. Core shall be clean and free from grease, oil, trim scraps, and impurities. The foil edges of the core shall be free from notches, crush lines, and rolled metal. The core shall have no more than three node bond breaks per square foot (32 per m^2) with no more than two connected node breaks per square foot (21 per m^2). The core shall have no more than four unexpanded cells per square foot of core (43 per m^2). The core shall not have more than ten multiple laps for each 36 x 96 inch (914 x 2438 mm) sheet of core.

3.6 Sizes and Tolerances

3.6.1 Sizes

Length (L), width (W), and thickness (T) of each panel shall be as ordered.

3.6.2 Tolerances

Shall be as shown in Table 6.

3.6.2.1 Thickness

Table 6A - Thickness tolerances, inch/pound units (see 8.2)

Nominal Thickness Inches	Tolerance Inches Plus and Minus
0.250 to 4.000, incl	0.005
Over 4.000 to 10.500, incl	0.062

Table 6B - Thickness tolerances, SI units (see 8.2)

Nominal Thickness Millimeters	Tolerance Millimeters Plus and Minus
6.35 to 101.60, incl	0.13
Over 101.60 to 266.70, incl	1.57

3.6.2.2 Cell Count

The “W” cell count shall be within ±10% of the specified cell count, determined in accordance with 4.5.1.

3.6.2.3 Density

The core density shall be within ±10% of the nominal specified density, determined in accordance with 4.5.2.

3.7 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.6.1.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The manufacturer of the core shall supply all samples and shall be responsible for all required tests. The purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the core conforms to the specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (see 3.1.1), density (see 3.2.1), cell count (see 3.2.1), foil thickness (see 3.2.1), compressive strength (see 3.4.1), shear strength (see 3.4.2), node bond strength (see 3.4.3), and flexibility (see 3.4.4) are acceptance tests and shall be performed on each lot of foil or core as applicable.

4.2.2 Preproduction Tests

All technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of core by the manufacturer, when a change in ingredients and/or processing requires reapproval as in 4.4.2, and when the purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing

Shall be in accordance with the following schedule:

- Composition (see 3.1.1): each lot of foil
- Density (see 3.2.1): each lot of core
- Cell count (see 3.2.1): each lot of core
- Foil thickness (see 3.2.1): each lot of core
- Compressive strength (see 3.4.1): each lot of core
- Shear strength (see 3.4.2): each lot of core
- Node bond strength (see 3.4.3): each lot of core
- Flexibility (see 3.4.4): each lot of core
- Corrosion resistance (see 3.4.5): acceptable to the purchaser

4.3.1 A lot of foil shall be all foil of one alloy in a single shipment from the foil producer.

4.3.2 A lot of core shall be all product fabricated at one time to form a block of expanded core.

4.4 Approval

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

4.4.2 The manufacturer shall use ingredients, manufacturing procedures, processes, and methods of inspection on production core that are essentially the same as those used on the approved sample. If necessary to make any change in ingredients, in type of equipment for processing, or in manufacturing procedures, the manufacturer shall submit for reapproval a statement of the proposed changes in ingredients and/or 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 Cell Count

Shall be determined by actual count of cells per linear foot (meter) of transverse direction (see Figure 1). Make six determinations and report each value and the arithmetic mean.

4.5.2 Core Density

Shall be determined by weight of a known volume. The test specimens shall be at least 12 x 12 inches (305 x 305 mm) x core thickness. The specimen dimensions shall be measured to the nearest 0.010 inch (0.25 mm) and weighed to an accuracy of ±1.0%. Calculate density using Equation 1 for each of three determinations, reporting each value and the arithmetic mean:

$$\text{Actual Density: pounds per cubic foot} = \frac{3.81\,(\text{weight of specimen, grams})}{(\text{Volume of specimen, cubic inches})}\ \text{in inch / pound units}$$

$$\text{kg / m}^3 = \frac{(\text{weight of specimen, g})}{(\text{Volume of specimen, mm}^3)} \times 10^6\ \text{in SI units} \qquad \text{(Eq. 1)}$$

4.5.3 Node Bond Strength

A 0.625T x 5L x 10W inch (15.88T x 127L x 254W mm) core slice shall be tested at room temperature in a suitable core tension fixture by mounting, without causing cell distortion, at opposite ends of the “W” dimension (see Figure 1) with round pins. Pins shall be as large as cell size permits and engage all cells of a continuous row. Opposite pins shall be in mirror image alignment at a distance as near to 8 inches (203 mm) as this mounting method permits. The fixture shall be slotted to allow horizontal pin movement. A steady loading rate of 1.00 inch ± 0.05 inch (25.4 mm ± 1.3 mm) per minute shall be maintained.

4.5.4 Flexibility Test

A 10-inch (254-mm) square specimen of the as-received thickness or a slice 0.625 inch ± 0.005 inch (15.88 mm ± 0.13 mm) thick, whichever is thinner, shall be wrapped around a 4-inch (102-mm) diameter cylindrical mandrel at room temperature, first perpendicular and then parallel to the L direction of the core. Core under 0.625 inch (15.88 mm) in thickness shall use a mandrel in the same diametric ratio as for 0.625-inch (15.88-mm) thick core material.

4.5.5 Corrosion Resistance

Representative specimens shall be 5 inches ± 1/16 inch (127 mm ± 1.6 mm) long (longitudinal direction "L," see Figure 1), 6 inches ± 1/16 inch (152 mm ± 1.6 mm) wide (transverse direction "W"), and 0.625 inch ± 0.010 inch (15.88 mm ± 0.25 mm) thick "T." The core specimens shall be weighed to the nearest milligram using an analytical balance. Specimens shall be dried for 16 hours ± 0.25 hour at 350 °F ± 10 °F (177 °C ± 6 °C) in an electric drying oven and allowed to cool to room temperature before weighing. The test specimens shall be subjected to a 5% salt spray test in accordance with ASTM B117 except that the cell axis shall be supported or suspended horizontally. At the end of 30 days of exposure, the specimens shall be removed and rinsed thoroughly in clear, running water for not less than 5 minutes. Immediately following rinsing, the specimens shall be stripped by immersion in a phosphoric-chromic acid solution for 5 minutes ± 0.25 minute at 212 °F ± 2 °F (100 °C ± 1 °C). The stripping solution shall consist of the following:

- Phosphoric acid, 85% H_3PO_4: 103 mL
- Chromic acid: 76 g
- Water, to make: 1 gallon (3.8 L)

The specimens shall be removed from the solution, rinsed in distilled or deionized water for at least 5 minutes, dried at 225 °F ± 5 °F (107 °C ± 3 °C) for 30 to 40 minutes, cooled to room temperature, and reweighed. The stripping solution shall be discarded after 1 gallon (3.8 L) of the solution has dissolved 20 g of oxides or coating. Compute the weight loss using Equation 2 (inch/pound units) or Equation 3 (SI units).

4.5.5.1 Weight Loss Inch/Pound Units (see 8.2)

$$\text{40 CELL: } M = \frac{7.5\,(O - A)}{TLW} \qquad \text{80 CELL: } M = \frac{4.2\,(O - A)}{TLW} \tag{Eq. 2}$$

where:

M = weight loss in milligrams per square foot of exposed foil area

L = ribbon length direction, inches

T = thickness measurement in direction of cell axis, inches

W = transverse direction, inches

O = original weight of specimen in milligrams before exposure

A = final weight of specimen in milligrams after stripping

4.5.5.2 Weight Loss SI Units (see 8.2)

$$\text{131 CELL: } M = \frac{1323420\,(O - A)}{TLW} \qquad \text{262 CELL: } M = \frac{741160\,(O - A)}{TLW} \tag{Eq. 3}$$

where:

M = weight loss in milligrams per square meter of exposed foil area

L = ribbon length direction, millimeters

T = thickness measurement in direction of cell axis, millimeters

W = transverse direction, millimeters

O = original weight of specimen in milligrams before exposure

A = final weight of specimen in milligrams after stripping

4.6 Reports

The supplier of core shall furnish with each shipment a report from the manufacturer showing the results of tests to determine conformance to the acceptance test requirements and stating that the core conforms to the other technical requirements. This report shall include the purchase order number, block or lot number, AMS4177F, the manufacturer's identification, size, quantity, and, when requested, the foil lot number.

4.6.1 When material produced to this specification has exceptions authorized by the purchaser taken to the technical requirements listed in Section 3 (see 5.1.3), the report shall contain a statement "This material is certified as AMS4177F(EXC) because of the following exceptions:" and the specific exceptions shall be listed.

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. 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-inch (51-mm) wide red stripe to designate 350 °F (177 °C) core; two 1/2-inch (12.7-mm) wide black stripes matching AMS-STD-595, Color No. 17308 or 27308, to identify the 5056 alloy; and a 1/2-inch (12.7-mm) wide colored stripe between the two black stripes to identify the density range. The color of the density stripe shall be as specified in Table 7 and shall approximately match the listed color numbers of AMS-STD-595. This group of parallel identification stripes shall be repeated at intervals of not more than 2 feet (610 mm). The color shall be produced by adding a dye to an adhesive that 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 and shall be noncorrosive. The dye shall have no adverse effect on the curing or the strength of the adhesive used for construction of the core material or the adhesive used with the core material in the fabrication of sandwich components.