



# AEROSPACE MATERIAL

Society of Automotive Engineers, Inc.

TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

## SPECIFICATION

### AMS 7728C

Superseding AMS 7728B

Issued 7-15-63

Revised 12-1-73

#### ALLOY SHEET, STRIP, AND PLATE, LOW EXPANSION, GLASS SEALING

53Fe - 29Ni - 17Co

#### 1. SCOPE:

- 1.1 Form: This specification covers a low-expansion iron-nickel-cobalt alloy in the form of sheet, strip, and plate.
- 1.2 Application: Primarily for electronic elements to be sealed to hard glasses during assembly of electronic components.
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., Two Pennsylvania Plaza, New York, New York 10001.
    - 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, Pennsylvania 19103.

ASTM B95 - Linear Expansion of Metals

ASTM E18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

ASTM E112 - Estimating Average Grain Size of Metals

ASTM E354 - Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt-Base Alloys
  - 2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.
    - 2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods
3. TECHNICAL REQUIREMENTS:
  - 3.1 Composition: Shall be approximately 53% iron, 29% nickel, and 17% cobalt by weight with impurities not exceeding the following percentages by weight; composition shall be determined by wet chemical methods in accordance with ASTM E354, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

SAE Technical Board rules provide that: "All technical reports, including standards, are advisory only. Their use by anyone engaged in industry or trade 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 infringement of patents."

|                           |      |
|---------------------------|------|
|                           | max  |
| Carbon                    | 0.06 |
| Manganese                 | 0.50 |
| Silicon                   | 0.20 |
| Titanium (3.1.1)          | 0.10 |
| Aluminum (3.1.1)          | 0.10 |
| Magnesium (3.1.1)         | 0.10 |
| Zirconium (3.1.1)         | 0.10 |
| Ti + Al + Mg + Zr (3.1.1) | 0.20 |

3.1.1 Determination not required for routine acceptance.

3.2 Condition: Cold rolled and bright annealed.

3.3 Properties: The product shall conform to the following requirements:

3.3.1 As Received:

3.3.1.1 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, determined by comparison of a polished and etched specimen with the chart in ASTM E112.

3.3.1.2 Hardness: Not higher than 82 HRB or equivalent for product 0.100 in. (2.54 mm) and under in nominal thickness and not higher than 85 HRB for product over 0.100 in. (2.54 mm) in nominal thickness, determined in accordance with ASTM E18.

3.3.2 After Reannealing: Specimens to determine conformance to the following requirements shall be re-annealed by heating in a hydrogen atmosphere to  $900^{\circ}\text{C} \pm 15$  ( $1652^{\circ}\text{F} \pm 27$ ), holding at heat for 60 min.  $\pm 5$ , further heating to  $1100^{\circ}\text{C} \pm 15$  ( $2012^{\circ}\text{F} \pm 27$ ), holding at heat for 15 min.  $\pm 3$ , cooling from  $1100^{\circ}\text{C} \pm 15$  ( $2012^{\circ}\text{F} \pm 27$ ) to  $200^{\circ}\text{C}$  ( $392^{\circ}\text{F}$ ) or below in the hydrogen atmosphere at a rate not greater than  $5^{\circ}\text{C}$  ( $9^{\circ}\text{F}$ ) per min., and air cooling to room temperature; specimens may be cooled to room temperature between the  $900^{\circ}\text{C}$  ( $1652^{\circ}\text{F}$ ) and  $1100^{\circ}\text{C}$  ( $2012^{\circ}\text{F}$ ) heating periods.

3.3.2.1 Thermal Expansion: The average linear coefficient of thermal expansion, determined in accordance with ASTM B95, shall be as follows:

| <u>Temperature Range</u>             |                                        | <u>Average Linear Coefficient<br/>of Thermal Expansion</u> |                  |
|--------------------------------------|----------------------------------------|------------------------------------------------------------|------------------|
| <u><math>^{\circ}\text{C}</math></u> | <u><math>(^{\circ}\text{F})</math></u> | <u>In. per In. (mm/mm) <math>\times 10^{-6}</math></u>     |                  |
|                                      |                                        | <u>Per Deg C</u>                                           | <u>Per Deg F</u> |
| 30 - 400                             | (86 - 752)                             | 4.60 - 5.20                                                | 2.56 - 2.89      |
| 30 - 450                             | (86 - 842)                             | 5.10 - 5.50                                                | 2.83 - 3.06      |

3.3.2.2 Transformation Temperature: The temperature of transformation from gamma to alpha phase, determined by expansion measurements in accordance with ASTM B95 or by metallographic examination, shall be not higher than  $-78.5^{\circ}\text{C}$  ( $-109.3^{\circ}\text{F}$ ).

3.4 Quality: The product shall be uniform in quality and condition, sound, and free from foreign materials and, consistent with the type of material involved, from internal and external imperfections detrimental to fabrication or to performance of parts.

3.5 Tolerances: Unless otherwise specified, tolerances shall conform to the following:

3.5.1 Thickness: Material over 1 in. (25 mm) wide shall be measured at least  $3/8$  in. (9.5 mm) from the edge.

TABLE I

Tolerance, Inch, Plus and Minus,  
Except As Shown  
Width Ranges, Inches

| Nominal Thickness<br>Inches | Up<br>to 3.00<br>excl | 3.00<br>to 6.00<br>incl | Over<br>6.00<br>to 12.00<br>incl | Over<br>12.00<br>to 16.00<br>incl |
|-----------------------------|-----------------------|-------------------------|----------------------------------|-----------------------------------|
| Up to 0.006, excl           | 0.0005                | 0.0005                  | --                               | --                                |
| 0.006 to 0.009, incl        | 0.00075               | 0.00075                 | --                               | --                                |
| Over 0.009 to 0.010, incl   | 0.001                 | 0.001                   | 0.001                            | 0.001                             |
| Over 0.010 to 0.011, incl   | 0.001                 | 0.001                   | 0.001                            | 0.0015                            |
| Over 0.011 to 0.016, incl   | 0.001                 | 0.001                   | 0.0015                           | 0.0015                            |
| Over 0.016 to 0.019, incl   | 0.001                 | 0.001                   | 0.0015                           | 0.002                             |
| Over 0.019 to 0.025, incl   | 0.001                 | 0.0015                  | 0.002                            | 0.002                             |
| Over 0.025 to 0.028, incl   | 0.0015                | 0.0015                  | 0.002                            | 0.002                             |
| Over 0.028 to 0.034, incl   | 0.0015                | 0.002                   | 0.0025                           | 0.0025                            |
| Over 0.034 to 0.049, incl   | 0.002                 | 0.0025                  | 0.003                            | 0.003                             |
| Over 0.049 to 0.068, incl   | 0.0025                | 0.003                   | 0.003                            | 0.003                             |
| Over 0.068 to 0.099, incl   | 0.003                 | 0.003                   | 0.003                            | 0.004                             |
| Over 0.099 to 0.160, incl   | 0.004                 | 0.004                   | 0.004                            | 0.004                             |
| Over 0.160 to 0.189, incl   | 0.005                 | 0.005                   | +0.020                           | +0.020                            |
| Over 0.189 to 0.250, incl   | --                    | --                      | +0.046                           | +0.046                            |
| Over 0.250 to 0.375, incl   | --                    | --                      | +0.046                           | +0.046                            |
| Over 0.375 to 0.500, incl   | --                    | --                      | +0.054                           | +0.054                            |
| Over 0.500 to 0.750, incl   | --                    | --                      | +0.054                           | +0.054                            |
| Over 0.750 to 1.000, incl   | --                    | --                      | +0.060                           | +0.060                            |

TABLE I (SI)

Tolerance, Millimeter, Plus and Minus  
Width Ranges, Millimeter

| Nominal Thickness<br>Millimeters | Up<br>to 76.2<br>excl | 76.2<br>to 152.4<br>incl | Over<br>152.4<br>to 304.8<br>incl | Over<br>304.8<br>to 406.4<br>incl |
|----------------------------------|-----------------------|--------------------------|-----------------------------------|-----------------------------------|
| Up to 0.15, excl                 | 0.013                 | 0.013                    | --                                | --                                |
| 0.15 to 0.23, incl               | 0.0190                | 0.0190                   | --                                | --                                |
| Over 0.23 to 0.25, incl          | 0.03                  | 0.03                     | 0.03                              | 0.03                              |
| Over 0.25 to 0.28, incl          | 0.03                  | 0.025                    | 0.025                             | 0.038                             |
| Over 0.28 to 0.41, incl          | 0.03                  | 0.025                    | 0.038                             | 0.02                              |
| Over 0.41 to 0.48, incl          | 0.03                  | 0.03                     | 0.0254                            | 0.05                              |
| Over 0.48 to 0.64, incl          | 0.03                  | 0.038                    | 0.05                              | 0.05                              |
| Over 0.64 to 0.71, incl          | 0.038                 | 0.038                    | 0.05                              | 0.05                              |
| Over 0.71 to 0.86, incl          | 0.038                 | 0.05                     | 0.064                             | 0.064                             |
| Over 0.86 to 1.24, incl          | 0.05                  | 0.064                    | 0.08                              | 0.08                              |
| Over 1.24 to 1.73, incl          | 0.064                 | 0.208                    | 0.076                             | 0.076                             |
| Over 1.73 to 2.51, incl          | 0.08                  | 0.208                    | 0.08                              | 0.10                              |
| Over 2.51 to 4.06, incl          | 0.10                  | 0.10                     | 0.10                              | 0.10                              |
| Over 4.06 to 4.80, incl          | 0.13                  | 0.13                     | +0.51                             | +0.51                             |
| Over 4.80 to 6.35, incl          | --                    | --                       | +1.17                             | +1.17                             |
| Over 6.35 to 9.52, incl          | --                    | --                       | +1.17                             | +1.17                             |
| Over 9.52 to 12.70, incl         | --                    | --                       | +1.37                             | +1.37                             |
| Over 12.70 to 19.05, incl        | --                    | --                       | +1.37                             | +1.37                             |
| Over 19.05 to 25.40, incl        | --                    | --                       | +1.52                             | +1.52                             |

- 3.5.1.1 For widths over 6.00 in. (152.4 mm) to 16.00 in. (406.4 mm), incl, the minus tolerance for nominal thicknesses over 0.160 in. (4.06 mm) to 0.189 in. (4.80 mm), incl, is 0.000 and for nominal thicknesses over 0.189 in. (4.80 mm) is -0.010 in. (-0.25 mm).

#### 4. QUALITY ASSURANCE PROVISIONS:

- 4.1 Responsibility for Inspection: The vendor of the product 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 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure that the product conforms to the requirements of this specification.
- 4.2 Classification of Tests:
- 4.2.1 Acceptance Tests: Tests of the product to determine conformance to composition (3.1) and hardness (3.3.1.2) are classified as acceptance or routine control tests.
- 4.2.2 Qualification Tests: Tests of the product to determine conformance to grain size (3.3.1.1), thermal expansion (3.3.2.1) and transformation temperature (3.3.2.2), are classified as qualification or periodic control tests.
- 4.3 Sampling: Shall be in accordance with the following; when sampling is on a lot basis, a lot shall be all material of the same nominal size from the same heat processed at the same time.
- 4.3.1 Acceptance Tests:
- 4.3.1.1 Composition: One sample from each heat.
- 4.3.1.2 Hardness: The number, location, and orientation of samples from each lot shall be as agreed upon by purchaser and vendor.
- 4.3.2 Qualification Tests: As agreed upon by purchaser and vendor.
- 4.4 Reports:
- 4.4.1 The vendor of the product shall furnish with each shipment three copies of a report of the results of tests for chemical composition of each heat in the shipment and the results of tests on each thickness from each heat to determine conformance to the hardness requirements of this specification. This report shall include the purchase order number, material specification number and its revision letter, size, and quantity from each heat.
- 4.4.2 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 material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.
- 4.5 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the product represented and no additional testing shall be permitted. Results of all tests shall be reported.