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An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS2355 | REV. J

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Superseding AMS2355H

Quality Assurance, Sampling and Testing Aluminum Alloys and Magnesium Alloy Wrought Products (Except Forging Stock), and Rolled, Forged, or Flash Welded Rings

RATIONALE

AMS2355J revises fatigue testing methodology for 2XXX and 7XXX plate alloys, greater than 4 inches thick, updates referenced standards, and is a Five Year Review and update of this specification.

1. SCOPE

This specification covers quality assurance sampling and testing procedures used to determine conformance to applicable specification requirements of wrought aluminum alloy and wrought magnesium alloy mill products (except forging stock), and includes quality assurance and testing procedures for rolled, forged, and flash welded rings (See 8.3). Requirements are specified in inch/pound units.

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.

2.1 ASTM Publications

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

ASTM B 557	Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
ASTM B 594	Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications
ASTM B 645	Linear-Elastic Plane Strain Fracture Toughness Testing of Aluminum Alloys
ASTM B 646	Fracture Toughness Testing of Aluminum Alloys
ASTM B 953	Sampling Magnesium and Magnesium Alloys for Spectrochemical Analysis
ASTM B 954	Analysis of Magnesium and Magnesium Alloys by Atomic Emission Spectrometry
ASTM E 9	Compression Testing of Metallic Materials at Room Temperature
ASTM E 10	Brinell Hardness of Metallic Materials
ASTM E 18	Rockwell Hardness of Metallic Materials
ASTM E 34	Chemical Analysis of Aluminum and Aluminum-Base Alloys
ASTM E 55	Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition
ASTM E 227	Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique
ASTM E 290	Bend Testing of Material for Ductility
ASTM E 384	Microindentation Hardness of Materials
ASTM E 399	Linear-Elastic Plane-Strain Fracture Toughness of Metallic Materials

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SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS2355J

(Continued)

ASTM E 466 Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials
ASTM E 561 K-R Curve Determination
ASTM E 607 Atomic Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere
ASTM E 716 Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis
ASTM E 1004 Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method
ASTM E 1251 Analysis of Aluminum and Aluminum Alloys by Atomic Emission Spectrometry
ASTM E 1304 Plane-Strain (Chevron Notch) Fracture Toughness of Metallic Materials
ASTM G 34 Exfoliation Corrosion Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO TEST)
ASTM G 47 Determining Susceptibility to Stress-Corrosion Cracking of 2XXX and 7XXX Aluminum Alloy Products

2.2 U.S. Government Publications

Available from Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

MIL-STD-1537 Electrical Conductivity Test for Measurement of Heat Treatment of Aluminum Alloys, Eddy Current Method

2.3 Aluminum Association Publications

The Aluminum Association, Inc., 900 19th Street N.W., Washington, D.C. 20006 or www.aluminum.org.

Aluminum Standards and Data

3. TECHNICAL REQUIREMENTS

3.1 General

3.1.1 Omission from this specification of confirmatory tests of certain material properties or attributes controlled by the applicable specification for a product does not relieve the vendor of responsibility for furnishing products which conform in all respects to the applicable material specification.

3.1.2 In event of conflict between requirements specified herein and requirements of a particular material specification, the following rules shall apply:

3.1.2.1 When requirements of the material specification are more stringent, they shall take precedence.

3.1.2.2 When requirements of this AMS are more stringent, they shall take precedence except as noted in 3.1.2.3.

3.1.2.3 If any tests mentioned in 3.3.2 are not required by the material specification, they shall not be considered a requirement.

3.1.2.4 When instructions are issued by purchaser regarding quality assurance sampling procedures, such instructions shall take precedence over requirements of either this specification or the particular specification in which this specification is invoked.

3.1.3 Properties of the delivered product shall meet those of the specified (ordered) product.

3.2 Responsibility for Tests

The vendor of the product shall supply all samples for vendor's tests and shall be responsible for the performance of all specified tests.

3.3 Detail Requirements

3.3.1 Inspection Lot

3.3.1.1 Wrought Alloy Products Including Forged or Rolled Rings, but Excluding Die and Hand Forgings and Flash Welded Rings

3.3.1.1.1 Heat Treated Tempers

An inspection lot shall be an identifiable quantity of product of the same mill form, alloy, temper, section, and size traceable to a heat treat lot (See 8.3.3), and submitted for vendor's inspection at one time. All sheet and plate of the same thickness is considered to be of the same size.

3.3.1.1.2 Non-Heat-Treated Tempers

An inspection lot shall be an identifiable quantity of material of the same mill form, alloy, temper, section, and size submitted for vendor's inspection at one time.

3.3.1.2 Die, Hand, and Ring Forgings

An inspection lot shall be all forgings of the same alloy and nominal cross-section and configuration heat treated in the same batch furnace or quenched from a continuous furnace consecutively during an 8-hour period. Maximum lot size for forgings heat treated in a continuous furnace and charged consecutively during continuous furnace operation shall be 2000 pounds for forgings weighing 5 pounds and under, and shall be 6000 pounds for forgings weighing over 5 pounds.

3.3.1.3 Flash Welded Rings

An inspection lot shall consist of all rings of the same alloy, cross-sectional configuration, size, and heat treated in the same batch furnace load or in a continuous furnace during a period of 8 consecutive hours, and presented for vendor's inspection at one time.

3.3.2 Sampling and Testing

3.3.2.1 Chemical Analysis

Sampling shall be in accordance with ASTM B 953, ASTM E 55 or ASTM E 716, as applicable.

3.3.2.1.1 Cast Unit

Producer shall take at least one control sample before and at least one additional sample during the casting of each cast unit (units, if cast simultaneously from the same molten metal source). Complete analysis records shall be available for review at producer's plant (See 8.2). Analysis is required for those elements having specified limits.

3.3.2.1.2 Finished Product (Excluding Forgings and Flash Welded Rings)

When compliance with 3.3.2.1.1 cannot be established, sampling shall be as follows: one sample shall be taken for each 2000 pounds, or fraction thereof, of each cast unit in an inspection lot; however, not more than one sample is required from a piece.

3.3.2.1.3 Forgings and Rolled Rings

When compliance with 3.3.2.1.1 cannot be established, sampling shall be as follows: one sample shall be taken for each 2000 pounds, or fraction thereof, in a lot of forgings having a nominal weight of 5 pounds and under; one sample shall be taken for each 6000 pounds, or fraction thereof, in a lot of forgings having a nominal weight greater than 5 pounds.

3.3.2.1.4 Flash Welded Rings

Unless a report showing conformance of chemical composition to the applicable material specification is available on stock used for flash welded rings, one sample shall be taken for each 6000 pounds, or fraction thereof, in a lot; however, not more than one sample is required from a piece.

3.3.2.2 Tensile Properties

The location from which the sample is taken shall be as specified in 3.3.3 for the type of test and type of product being tested. The orientation with respect to direction of predominant grain flow shall be as specified in the applicable material specification or shall be taken from randomly selected pieces of the product. A minimum of one tensile specimen shall be taken in any one direction from any one piece when more than one piece is available. The number of samples shall be as specified herein for the type of product being tested.

3.3.2.2.1 Sheet

One sample shall be taken from each end of each parent coil but not more than one sample for each 2000 pounds, or fraction thereof, in a lot shall be required.

3.3.2.2.2 Plate

One sample shall be taken from each end of each parent plate but not more than one sample for each 4000 pounds, or fraction thereof, in a lot shall be required.

3.3.2.2.3 Wire, Rod, Bar, Shapes, Tube, and Pipe

For products having a nominal weight under 1 pound per linear foot, one sample shall be taken for each 1000 pounds, or fraction thereof, in a lot. For products having a nominal weight of 1 pound or greater per linear foot, one sample shall be taken for each 1000 feet, or fraction thereof, in a lot.

3.3.2.2.4 Die Forgings

For die forgings having a nominal weight of 5 pounds and under, one sample shall be taken in each specimen orientation specified for each 2000 pounds, or fraction thereof, in a lot. For die forgings having a nominal weight over 5 pounds, one sample shall be taken similarly for each 6000 pounds, or fraction thereof, in a lot.

3.3.2.2.5 Hand Forgings

One sample shall be taken for each 6000 pounds, or fraction thereof, in a lot in each grain direction for which properties are specified.

3.3.2.2.6 Flash Welded Rings

One sample shall be taken from parent metal, not including the heat-affected zone of the weld, of a flash welded ring representing the lot.

3.3.2.2.7 Forged or Rolled Rings

One sample shall be taken from one ring or prolongation ring representing the lot. For multi-lot production of large rings, one ring from the run may be cut into segments and one such segment, if heat treated with the production lot, shall be considered to be the sample for that lot.

3.3.2.2.7.1 For multiple lot production of large rings, when mechanical stress relief is not required, one ring from the forged or rolled run may be cut into segments and one such segment, if heat treated with the production lot, shall be considered to be the sample from that lot.

3.3.2.2.7.2 For multiple lot production of large rings, when mechanical stress relief is required after solution treatment, a sample shall be removed from one ring representing the lot after final heat treatment.

3.3.2.2.8 Response to Heat Treatment

When demonstration of response to heat treatment is specified, material produced in the as-fabricated (-F), annealed (-O) or high temperature annealed (-O1) tempers, shall have additional samples, equal in number to those specified for the product herein. The additional samples shall be heat treated and their tensile properties determined. For 2xxx and 7xxx alloy products, samples and specimen orientation and location in samples shall conform to the following:

3.3.2.2.8.1 Bar, Rod Extrusion, Tube, Hand/Ring Forgings, 1/2 Inch and Over in Thickness

At the time of solution heat treatment, the sample material cross-section shall be that of the product and the length shall be at least 3 times the thickness of the product. Sample material may be cut from tube or hand/ring forgings, providing the “width” and length at the time of solution heat treatment are at least 3 times the thickness of the product.

3.3.2.2.8.2 Plate, 1/2 Inch and Over in Thickness

At the time of solution heat treatment, the sample material thickness shall be that of the product and the length and width shall be at least 3 times the thickness of the product.

3.3.2.2.8.3 If 3.3.2.2.8.1 or 3.3.2.2.8.2 requires a sample heavier than 7.2 pounds, it is permissible to excise a smaller sample from the center of the product’s thickness, providing that its thickness and length are at least 2 inches and 6 inches, respectively, and its width is either that of the product or 6 inches, whichever is less.

3.3.2.2.8.4 Product Under 1/2 Inch in Thickness

At the time of solution heat treatment, the sample thickness shall be that of the product and the minimum width shall be, insofar as possible, 3 times the thickness of the product plus 1/2 inch.

3.3.2.2.8.5 Tensile specimen orientation shall be long transverse for sheet and plate and longitudinal for other forms.

3.3.2.2.8.6 Tensile Specimen Location

With respect to width and length, the tensile specimen shall be excised from the center of the sample. Tensile specimen location with respect to sample thickness shall be full thickness under 0.500 inch and at the center for thicker material.

3.3.2.3 Examination

3.3.2.3.1 Dimensional and Workmanship Inspection

Each piece shall be inspected to determine conformance to the applicable material specification with respect to workmanship, dimensional tolerances, and identification marking. Alternatively, the vendor may use a system of statistical quality control to ensure compliance with dimensional, marking, and workmanship requirements.

3.3.2.4 Conductivity Testing

When measurement of electrical conductivity is required as part of the acceptance criteria for resistance to corrosion, the measurements shall be performed at the locations noted in Figure 1, unless otherwise specified by purchaser or material specification.

3.3.2.5 Stress-Corrosion and Exfoliation-Corrosion Testing

Sampling for stress-corrosion and exfoliation-corrosion testing shall initially consist of two samples for each 4000 pounds or fraction thereof from each of the first three production lots for each size range listed in the table of tensile properties in the applicable material specification. Thereafter, testing shall be performed in accordance with frequency requirements of the applicable material specification.

Alloy and Temper	Product	Thickness, Inch (mm)	Location for Electrical Conductivity Measurements (2), (5)
7050-T7451 (4) 7075-T73, T7351 7475-T7351 7140-T7451,7040-T7451,7081-T7451	Sheet and Plate (1)	All	Surface of tensile sample (5)
7050-T7651 7075-T76, T7651 7178-T76, T7651 7475-T761, T7651 7140-T7651,7449-T7651, 7085-T7651,7081-T7651	Sheet and Plate (1)	Up to 0.100 inch (2.54 mm), incl.	Surface of tensile sample (5)
		Over 0.100 inch (2.54 mm)	Sub-surface after removing approximately 10% of thickness of tensile sample
7075-T73, T7351	Rolled or cold finished from rolled, wire, rod, and bar	All	Surface of tensile sample (5)
7050-T73510, T73511, T74510 (4), T74511 (4) 7075-T73, T73510, T73511, T76 T76510, T76511 7178-T76, T76510, T76511	Extruded, or cold finished from extruded, wire, rod, and bar, and extruded shapes and tube	Up to 0.100 inch (2.54 mm), inclusive	Surface of tensile sample (3) (5)
		Over 0.100 inch (2.54 mm) to 0.500 inch (12.70 mm), incl.	Sub-surface after removing approximately 10% of thickness of tensile sample
		Over 0.500 inch (12.70 mm) to 1.500 inch (38.10 mm), incl.	Sub-surface of approximately center of thickness on a plane parallel to the longitudinal center line of the material.
		Over 1.500 inch (38.10 mm)	Sub-surface on test coupon surface that is closest to the center of the thickness and on a plane parallel to the extrusion surface.
7075-T73	Drawn tube	Up to 0.100 inch (2.54 mm)	Surface of tensile sample (3) (5)
		Over 0.100 inch (2.54 mm) to 0.500 inch (12.70 mm), incl.	Sub-surface after removing approximately 10% of thickness of tensile sample
7049-T73, T7352 7050-T74 (4), T7452 (4) 7075-T73, T7352 7175-T74 (4), T7452 (4), and T7454 (4)	Forgings	All	Surface of tensile sample (5)

(1) Also applies to alclad sheet and plate; however, the cladding must be removed and the electrical conductivity determined on the core material.
(2) For curved surfaces, the conductivity is measured on a machined flat spot.
(3) For smaller sizes of tube, a cut-out portion is flattened and the surface measured.
(4) T74 type tempers, although not previously registered, have appeared in the literature and in some specifications as the T736 tempers.
(5) Surface of tensile sample is the mill finished surface of the sample from which the tensile test specimen is taken.

FIGURE 1 – LOCATION FOR ELECTRICAL CONDUCTIVITY MEASUREMENTS

3.3.2.6 Fracture Toughness Testing

Unless specified in the applicable material specification, sampling for fracture toughness testing shall be in the location(s) and at the frequency agreed upon by purchaser and vendor. The direction(s) of test shall be as specified in the material specification and as defined in ASTM E 399 (See 3.3.5.10).

3.3.2.7 Fatigue Testing

For plate 4.00 inches and greater and when specified by the purchase order as an addition to the applicable material specification, two fatigue specimens from each end of the parent plate shall be sampled in the long transverse grain direction. Unless specified and agreed by purchaser and vendor these specimens are to be removed from the T/2, W/2 location. Fatigue testing of the specimen shall be conducted in air at 70 °F + 5 (21 °C + 3). They are to be tested at an R-ratio of 0.1, at a maximum stress of 35.0 ksi (241 MPa) at a frequency of 20 Hz. A specific minimum set of values will be agreed upon between purchaser and vendor.

3.3.3 Tensile Specimen Orientation, Location, and Size

Tensile specimens shall be cut from the product to meet the orientation, location, and size requirements defined below for each product form.

3.3.3.1 Sheet and Plate

3.3.3.1.1 Orientation

3.3.3.1.1.1 Aluminum

For non-heat-treatable aluminum alloys, tensile specimens shall be taken parallel to the direction of rolling. For heat-treatable aluminum alloys, tensile specimens shall be taken perpendicular to the direction of rolling from widths 9 inches and over and parallel to the direction of rolling from widths under 9 inches. When short-transverse tensile properties are specified, specimens shall be taken with the axis of the specimen parallel to the thickness dimension of the product, such that the mid-point of the specimen's axis lies on the plate mid-thickness (T/2).

3.3.3.1.1.2 Magnesium

For magnesium alloys, tensile specimens shall be taken parallel to the direction of rolling. When short-transverse tensile properties are specified, tensile specimens shall be taken with axis of the specimen parallel to thickness dimension of the product, such that the mid-point of the specimen's axis lies on the plate mid-thickness (T/2).

3.3.3.1.2 Location and Size of Tensile Specimen

3.3.3.1.2.1 Longitudinal and Long-Transverse Specimens

The standard 1/2-inch wide rectangular tensile specimen or pin-loaded tensile specimen with 2-inch gage length of ASTM B 557 shall be used for sheet and plate under 0.500 inch in thickness. For plate 0.500 inch and over in thickness, the standard 1/2-inch round tensile specimen with 2-inch gage length of ASTM B 557 or a smaller round specimen proportional to it may be used. Tensile specimens shall be taken midway between the two surfaces (T/2) of the plate for nominal thicknesses 0.500 to 1.500 inches, inclusive. For plate over 1.500 inches in nominal thickness, the tensile specimen shall be taken midway between center and surface (T/4) of the plate.

3.3.3.1.2.2 Short-Transverse Specimens

For plate 1.500 inches and over in thickness, sub-size specimens as specified in 3.3.4.3 shall be used. The specimen shall be centered midway between the two surfaces of the plate such that the midpoint of the specimen axis lies on the plate mid-thickness (T/2).

3.3.3.2 Wire, Rod, and Bar

3.3.3.2.1 Orientation

3.3.3.2.1.1 Aluminum and Magnesium

Tensile specimens shall be taken in the longitudinal direction, except that when long-transverse tensile properties are specified, specimens shall be taken perpendicular to the rolling or extruding direction. When short-transverse tensile properties are specified, specimens shall be taken with the axis of the specimen parallel to the thickness direction of the rod or bar, such that the midpoint of the specimen axis lies on the midpoint of the thickness (T/2) of the rod or bar.

3.3.3.2.2 Location and Size of Tensile Specimens

3.3.3.2.2.1 Longitudinal Specimens

If size or shape of product makes it impractical to use full-section tensile specimens, the standard 1/2-inch round tensile specimen with 2-inch gage length of ASTM B 557 or a smaller round specimen proportional to it shall be used, except that for rectangular bar under 1/2-inch in thickness, the standard 1/2-inch wide rectangular tensile specimen or pin-loaded tensile specimen with 2-inch gage length of ASTM B 557 shall be used. For product not tested in full section, the tensile specimen shall be taken from locations specified in Table 1. Elongation and yield strength requirements of material specifications do not apply to wire 0.125 inch and under in diameter or thickness.

TABLE 1 - LOCATION OF AXIS OF LONGITUDINAL TENSILE SPECIMEN IN ROD AND BAR

Section Thickness or Width, Inches	Thickness (T)	Width (W)
Up to 1.500, inclusive	T/2	W/2
Over 1.500	T/4	W/4

3.3.3.2.2.2 Long-Transverse Specimens

The standard 1/2-inch wide rectangular tensile specimen or pin-loaded tensile specimen with 2-inch gage length of ASTM B 557 shall be used for bar under 0.500 inch in thickness and 8 inches and over in width. For bar 0.500 inch and over in thickness, the standard 1/2-inch round tensile specimen with 2-inch gage length of ASTM B 557 or a smaller round specimen proportional to it shall be used. The axis of the tensile specimen shall fall in the plane midway between the two surfaces (T/2) of bar 0.500 to 1.500 inches, inclusive, in nominal thickness and midway between the center and surface of bar (T/4) over 1.500 inches in nominal thickness.

3.3.3.2.2.3 Short-Transverse Specimens

For rectangular bar 1.500 inches and over in thickness, sub-size specimens as specified in 3.3.4.3 shall be taken at the center of the bar with respect to both thickness (T/2) and width (W/2).

3.3.3.3 Tubing

3.3.3.3.1 Orientation

3.3.3.3.1.1 Drawn Aluminum and Extruded Aluminum and Magnesium

Tensile specimens shall be taken in the longitudinal direction, except that when long-transverse tensile properties are specified for square or rectangular tubing, tensile specimens shall be taken perpendicular to the direction of drawing or extrusion.

3.3.3.3.2 Location and Size of Tensile Specimens

3.3.3.3.2.1 Longitudinal Specimens

Tensile specimens from round tube 2.000 inches and under in nominal OD and from square tubing 1.500 inches and under on a side shall be the full-section of the tube unless limitations of the testing machine preclude the use of such a specimen. For tubing of larger size, or when it is not possible to test the full-section, the standard 1/2-inch wide rectangular tensile specimen or pin-loaded tensile specimen with 2-inch gage length; or standard 1/2-inch round tensile specimens with 2-inch gage length; or standard 1/2-inch longitudinal tensile specimen of ASTM B 557 may be used for large-diameter tubular products. When size of the product makes it impractical to use any of these specimens, round specimens proportional to the standard 1/2-inch round tensile specimen of ASTM B 557 shall be used. For tube having a nominal wall thickness of 1.500 inches and under not tested in full section, the tensile specimen shall be taken from the center of the wall (T/2). For tube having a nominal wall thickness over 1.500 inches, the specimen shall be taken midway between the center of the wall thickness and the inner or outer surface of the tube (T/4).

3.3.3.3.2.2 Long-Transverse Specimens

The standard 1/2-inch round tensile specimen with 2-inch gage length of ASTM B 557 or a smaller round specimen proportional to it shall be used for thicknesses of 3/8-inch and over and having widths of 2-3/8 inches and over, except that for square or rectangular tubing 0.500 inch and under in thickness, the standard 1/2-inch wide rectangular tensile specimen or pin-loaded tensile specimen with 2-inch gage length of ASTM B 557 may be used. For tube from which these machined specimens cannot be obtained, a round or rectangular specimen of the largest possible dimensions shall be used. For tube having a wall thickness of 1.500 inches and under, the tensile specimen shall be taken from the center of the wall (T/2). For tube having a wall thickness over 1.500 inches, the specimen shall be taken midway between the center of the wall thickness and the inner or outer surface of the tubing (T/4).

3.3.3.4 Shapes

3.3.3.4.1 Orientation

3.3.3.4.1.1 Aluminum and Magnesium

Tensile specimens shall be taken in the longitudinal direction except that when long-transverse tensile properties are specified, tensile specimens shall be taken perpendicular to the extruding direction. When short-transverse tensile properties are specified for shapes, short-transverse tensile specimens shall be taken with axis of specimen parallel to the thickness direction of the shape.

3.3.3.4.2 Location and Size of Tensile Specimens

Shall be as specified in 3.3.3.4.2.1 through 3.3.3.4.2.3 except that size, location, and orientation of tensile specimens from complicated shapes shall be as agreed upon by purchaser and vendor.

3.3.3.4.2.1 Longitudinal Specimens

If the size or shape of the product makes it impractical to use full-section tensile specimens, the standard 1/2-inch round tensile specimen with 2-inch gage length of ASTM B 557 or smaller round specimen proportional to it shall be used, except that for shapes 0.500 inch and under in thickness having parallel surfaces, the standard 1/2-inch wide rectangular tensile specimen or pin-loaded tensile specimen with 2-inch gage length of ASTM B 557 may be used. For shapes from which these machined specimens cannot be obtained and which cannot be tested in full-section, a round or rectangular specimen of the largest possible dimensions shall be used. The tensile specimen shall be taken from the predominant section of the shape and from the location which most nearly complies with Table 2. Elongation requirements do not apply to specimens from shapes under 0.062 inch in thickness or to round or rectangular specimens of non-standard proportions.

TABLE 2 - LOCATION OF AXIS OF LONGITUDINAL TENSILE SPECIMEN IN EXTRUDED SHAPES

Section Thickness or Width, Inches	Thickness (T)	Width (W)
Up to 1.500, inclusive	T/2	W/2
Over 1.500	T/4	W/4

3.3.3.4.2.2 Long-Transverse Specimens

The standard 1/2-inch round tensile specimen with 2-inch gage length of ASTM B 557 or a smaller round specimen proportional to it shall be used for thicknesses of 3/8-inch and over and having widths of 2-3/8 inches and over, except that for shapes 0.500 inch and under in thickness having parallel surfaces, the standard 1/2-inch wide rectangular tensile specimen or pin-loaded tensile specimen with 2-inch gage length of ASTM B 557 may be used. For shapes from which these machined specimens cannot be obtained, a round or rectangular specimen of the largest possible dimensions shall be used. The tensile specimens shall be taken from the center of the predominant section of the shape with respect to both thickness (T/2) and width (W/2). Elongation requirements do not apply to specimens from shapes under 0.062 inch in thickness or to round or rectangular specimens of non-standard proportions.

3.3.3.4.2.3 Short-Transverse Specimens

For shapes 1.500 inches and over in thickness, sub-size specimens as specified in 3.3.4.3 shall be used. The tensile specimens shall be taken from the center of the predominant section with respect to both thickness (T/2) and width (W/2).

3.3.3.5 Die Forgings

3.3.3.5.1 Orientation

3.3.3.5.1.1 Aluminum and Magnesium

Tensile specimens shall be taken parallel to the direction of grain flow, except that when tensile properties are required to be determined in other directions, the tensile specimens shall be taken in the specified direction. Unless otherwise specified, tensile specimens may be taken from a prolongation on the forging or from coupons separately forged from the same stock used to produce the forgings. Separately-forged coupons and prolongations shall have reduction not greater than that of the least reduced section of the forging. If prolongations are used, the relationship of mechanical properties of the prolongation to properties of the forging shall be established by statistically valid methods acceptable to purchaser.

3.3.3.5.1.2 Test Direction Orientation Terminology for Aluminum Die Forgings shall be as follows:

Longitudinal – Specimen orientation is parallel, within ±15 degrees, to the predominant grain flow.

Long Transverse – Specimen orientation is perpendicular, within ±15 degrees, to the longitudinal (predominant) grain direction and parallel within ±15 degrees, to the parting plane. (Both conditions shall be met.)

Short Transverse – Specimen orientation is perpendicular, within ±15 degrees, to the longitudinal (predominant) grain direction and perpendicular, within ±15 degrees, to the parting plane. (Both conditions shall be met.) When possible, short transverse specimens shall be taken across the parting plane.

Off Axis – Any specimen orientation or test direction that does not fit any of the above three descriptions.

NOTE: In cases where the grain flow is difficult to define, microstructural analysis shall be performed to verify the grain flow. This can be established on the first cut-up forging.

3.3.3.5.2 Location and Size of Tensile Specimens

3.3.3.5.2.1 Specimens Parallel to Grain Flow

The standard 1/2-inch round tensile specimen with 2-inch gage length of ASTM B 557 or a smaller round specimen proportional to it shall be used for section thicknesses 0.500 inch and over. Smaller round specimens proportional to the standard 1/2-inch tensile specimen or rectangular tensile specimens of ASTM B 557 shall be used for section thicknesses 0.312 to 0.499 inch, inclusive. Rectangular tensile specimens of ASTM B 557 shall be used for section thicknesses under 0.312 inch. The tensile specimen shall be taken at the center of the predominant section with respect to both thickness (T/2) and width (W/2).

3.3.3.5.2.2 Specimens Not Parallel to Grain Flow

Sub-size specimens as specified in 3.3.4.3 may be used if full size specimens cannot be obtained at the specified location. Tensile specimens shall be taken from the location specified on the engineering drawing or otherwise specified by purchaser.

3.3.3.6 Hand Forgings

3.3.3.6.1 Orientation

3.3.3.6.1.1 Aluminum and Magnesium

Tensile specimens shall be taken in the long-transverse direction, except that when longitudinal tensile properties are specified, tensile specimens shall be taken parallel to the forging direction. When short-transverse tensile properties are specified, short-transverse tensile specimens shall be taken with axis of the specimen parallel to the thickness direction of the hand forging.

3.3.3.6.2 Location and Size of Tensile Specimens

3.3.3.6.2.1 Longitudinal Specimens

The standard 1/2-inch round tensile specimen with 2-inch gage length of ASTM B 557 or a smaller round specimen proportional to it shall be used. The tensile specimen shall be taken so that its axis coincides with the longitudinal center line of the hand forging and the distance from midpoint of its axis to end of the hand forging is at least one-half the thickness (T/2) of the hand forging.

3.3.3.6.2.2 Long-Transverse Specimens

The standard 1/2-inch round tensile specimen with 2-inch gage length of ASTM B 557 or a smaller round specimen proportional to it shall be used. The tensile specimen shall be taken so that the midpoint of its axis lies on the longitudinal center line of the hand forging at a distance from the end of the hand forging of at least one-half the thickness (T/2) of the hand forging.

3.3.3.6.2.3 Short-Transverse Specimens

For hand forgings 2.000 inches and over in thickness, sub-size specimens as specified in 3.3.4.3 shall be used. The tensile specimens shall be taken so that the midpoint of its axis lies on the longitudinal center line of the hand forging at a distance from the end of the hand forging of at least one-half the thickness (T/2) of the hand forging.

3.3.3.7 Flash Welded Rings

Tensile specimens shall be taken in the circumferential direction and from a location in respect to cross-section as applicable to the flash welded stock size as specified in 3.3.3.2.2.1.

3.3.3.8 Forged or Rolled Rings

Tensile specimens shall be taken in the circumferential (tangential) direction, but when cross-sectional size is adequate, axial and radial orientations may also be specified. Test specimens shall be located as specified in 3.3.3.2.2 except that tangential shall be equivalent to longitudinal, axial shall be equivalent to short-transverse, and radial shall be equivalent to long-transverse directions for forged rings; and for rolled rings, tangential shall be equivalent to longitudinal, axial shall be equivalent to long-transverse, and radial shall be equivalent to short-transverse directions.

3.3.3.8.1 Location and Size of Tensile Specimens

Standard or subsize round machined specimens (See 3.3.4) shall be taken in the tangential, axial and radial orientations as specified. All specimens shall be taken from the center of the wall. For tangential specimens the distance of the axis to the nearest end of the ring shall be at least one-half of the thickness of the wall. For axial specimens the distance from the midpoint of its axis to the nearest end of the ring shall be at least one-half the thickness of the wall. For radial specimens the specimens shall be taken such that the midpoint of the axis lies at the center of the wall and the distance from the nearest end of the ring is at least one-half the thickness of the wall.

3.3.4 Tensile Specimen Types

Tensile specimens may be substantially the full cross-section of the product being tested or they may be machined.

3.3.4.1 Full-Section Specimens

Tensile specimens of substantially the full cross-section of the product may be used for wire, rod, bar, tube, and shapes. The section may be reduced slightly throughout the test section to ensure fracture within the gage marks. The gage length shall be four times the diameter for solid round specimens and 2 inches for all other specimens.

3.3.4.2 Machined Specimens

Standard machined specimens for tensile specimens are of two types: round and rectangular with a gage length of 2 inches and a width or diameter of 1/2-inch. These standard specimens are shown in ASTM B 557.

3.3.4.3 Sub-Size Specimens

Smaller round specimens proportional to the standard 1/2-inch diameter round specimen shall be used when a standard specimen cannot be prepared. Examples are shown in ASTM B 557. Other sizes of small round specimens may be used if the gage length for measurement of elongation is four times the diameter of the reduced section of the specimen.

3.3.5 Test Methods

Unless otherwise specified, the following test methods shall apply:

3.3.5.1 Chemical Analysis

Shall be performed in accordance with ASTM B 954, ASTM E 34, ASTM E 227, ASTM E 607, ASTM E 1251, or other analytical method acceptable to purchaser.

3.3.5.2 Tensile Testing

Shall be performed in accordance with ASTM B 557.

3.3.5.3 Conductivity

Shall be determined in accordance with ASTM E 1004 using equipment calibrated in accordance with MIL-STD-1537.