



Designation: A1069/A1069M – 23

# Standard Specification for Stainless Steel Laser and Laser Hybrid Welded Bars, Plates, Sharp-Cornered Profile (SCP), and Built-up Shapes<sup>1</sup>

This standard is issued under the fixed designation A1069/A1069M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 1. Scope\*

1.1 This specification covers laser and laser hybrid welded stainless steel bars, plates, sharp-cornered profile (SCP), and built-up shapes of structural quality for use in bolted or welded structural applications. SCP and built-up shapes are used in, but not limited to, the following applications: industrial and general structural applications like buildings, including architecturally exposed steel structures (AESS); architectural steel profiles, such as curtain wall and staircases.

NOTE 1—The term laser fusion is also used to describe laser welding.

1.1.1 Supplementary requirements of an optional nature are provided. They shall apply only when specified by the purchaser.

NOTE 2—Since the product covered by this specification is manufactured in small lots on dedicated production lines, minimum product quality requirements are ensured by requiring welding process specification and operator qualification at each manufacturing facility in accordance with AWS, ASME, or ISO requirements. If required, the purchaser can specify higher levels of weld inspection; supplementary requirements for mechanical and corrosion testing; and other requirements.

NOTE 3—Because of the varying requirements of the end-use applications, different length tolerance and weld inspection levels may be specified.

1.2 Shapes covered in this specification include those defined in Article 3.1.2 of Specification A6/A6M, square and rectangular hollow sections, and additional shapes, including customized, that are made from two or more shapes, plates, bar, sheet, or strip.

1.3 This specification establishes the minimum requirements for manufacturing of laser and laser hybrid welded stainless steel shapes and requires the welds to, at a minimum, match the tensile and yield strength of the base metal. If base metals of different strengths are used, the lower strength base metal shall be matched.

1.4 This specification refers to Specifications A240/A240M, A276/A276M, or A479/A479M for chemical requirements, but

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.17 on Flat-Rolled and Wrought Stainless Steel.

Current edition approved Dec. 1, 2023. Published December 2023. Originally approved in 2011. Last previous edition approved in 2019 as A1069/A1069M – 19. DOI: 10.1520/A1069\_A1069M-23.

the mechanical test requirements are determined by the mechanical properties section of this standard. This standard includes four strength grades. The default strength grade 1 is determined by the base metal standard. Grades 2 through 4 are for specification of higher strength levels.

1.5 The text of this specification contains notes and footnotes that provide explanatory material. Such notes and footnotes, excluding those in tables and figures, do not contain any mandatory requirements.

1.6 *Units*—This specification is expressed in both inch-pound units and in SI units; however, unless the purchase order or contract specifies the applicable M specification designation (SI units), the inch-pound units shall apply. The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards*:<sup>2</sup>

A6/A6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling  
A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

\*A Summary of Changes section appears at the end of this standard

Vessels and for General Applications

**A262** Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

**A276/A276M** Specification for Stainless Steel Bars and Shapes

**A370** Test Methods and Definitions for Mechanical Testing of Steel Products

**A380/A380M** Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

**A479/A479M** Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels

**A480/A480M** Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

**A484/A484M** Specification for General Requirements for Stainless Steel Bars, Billets, Shapes, and Forgings

**A673/A673M** Specification for Sampling Procedure for Impact Testing of Structural Steel

**A700** Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment

**A751** Test Methods and Practices for Chemical Analysis of Steel Products

**A923** Test Methods for Detecting Detrimental Intermetallic Phase in Duplex Austenitic/Ferritic Stainless Steels

**A941** Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

**A1084** Test Method for Detecting Detrimental Phases in Lean Duplex Austenitic/Ferritic Stainless Steels

**E164** Practice for Contact Ultrasonic Testing of Weldments

**E190** Test Method for Guided Bend Test for Ductility of Welds

**E290** Test Methods for Bend Testing of Material for Ductility

**E527** Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 *ANSI/AISC Standard*.<sup>3</sup>

**ANSI/AISC 370** Specification for Structural Stainless Steel Buildings

2.3 *ISO Standards*.<sup>4</sup>

**ISO 4063** Welding and allied processes - Nomenclature of processes and reference numbers

**ISO 11666** Non-destructive testing of welds – Ultrasonic testing – Acceptance levels

**ISO 12932** Welding – Laser-arc hybrid welding of steels, nickel and nickel alloys – Quality levels for imperfections

**ISO 13919-1** Welding and Laser-beam Welded Joints—guidance on Quality Levels for Imperfections—Part 1: Steel

**ISO 15609-4** Specification and Qualification of Welding Procedures for Metallic Materials—Welding Procedure Specification

**ISO 15609-6** Specification and Qualification of Welding Procedures for Metallic Materials—Welding procedure

specification—Part 6: Laser-arc hybrid welding

**ISO 15614-11** Specification and Qualification of Welding Procedures for Metallic Materials—Welding Procedure Test—Part 11: Electron and Laser Beam Welding

**ISO 15614-14** Specification and Qualification of Welding Procedures for Metallic Materials—Welding Procedure Test— Part 14: Laser-Arc Hybrid Welding of Steels, Nickel and Nickel Alloys

**ISO 17640** Non-destructive testing of welds—Ultrasonic testing—Techniques, testing levels, and assessment

2.4 *EN Standards*.<sup>5</sup>

**EN 10204** Metallic Products: Types of Inspection Documents

2.5 *Federal Standards*.<sup>6</sup>

**Federal Standard No. 123** Marking for Shipment (Civil Agencies)

2.6 *AWS Standards*.<sup>7</sup>

**AWS A3.0M/A3.0** Standard Welding Terms and Definition, Including Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying

**AWS D1.6/D1.6M** Structural Welding Code – Stainless Steel

**AWS C7.2M** Recommended Practices for Laser Beam Welding, Cutting, and Allied Processes

**AWS C7.4/C7.4M** Process Specification and Operator Qualification for Laser Beam Welding

**AWS C7.6/C7.6M** Process Specification and Operator Qualification for Laser Hybrid Welding

2.7 *ASME Standards*.<sup>8</sup>

**ASME SA-370**

**ASME BPVC.IX-2019** ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications

2.8 *SAE Standard*.<sup>9</sup>

**J1086** Practice for Numbering Metals and Alloys (UNS)

### 3. Terminology

#### 3.1 Definitions:

3.1.1 Definitions of general terms pertaining to this specification shall be those of Specification **A6/A6M**, “Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling” and Terminology **A941**, “Standard Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys.”

3.1.2 Definitions of terms pertaining to welding terminology shall be those of AWS A3.0M /A3.0, “Standard Welding Terms and Definition, Including Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying.”

<sup>5</sup> Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, <http://www.cen.eu>.

<sup>6</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Phila., PA 19111-5094, Attn: NPODS.

<sup>7</sup> Available from American Welding Society (AWS), 8669 NW 36 St., #130, Miami, FL 33166-6672, <http://www.aws.org>.

<sup>8</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

<sup>9</sup> Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, <http://www.sae.org>.

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

<sup>4</sup> Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <https://www.iso.org>.

#### 4. Ordering Information

4.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for material ordered to this specification. Such requirements shall include but are not limited to the following:

4.1.1 Name of structural product (laser or laser-hybrid welded stainless steel, sharp cornered profile [SCP], or built-up shape).

4.1.2 Shape designation and applicable dimensions including size, thickness, width, sharp or rounded corners, and diameter, if applicable.

4.1.3 UNS designation.

NOTE 4—Stainless steel alloys are identified in the ASTM standards by Unified Numbering System (UNS) number in accordance with Practice E527 and SAE J1086.

4.1.4 Quantity (weight or number of pieces).

4.1.5 ASTM specification designation and edition year if other than the latest edition.

4.1.6 Condition of welded product, whether as welded, or subsequently stress-relieved, or heat treated; default is as welded.

4.1.7 Finish in accordance with Section 9; default is descaled and passivated.

4.1.8 Length(s) (meters [feet]) and length tolerance level (L1, L2, L3 or L4; default is L1).

4.1.9 Welding procedure and operator qualification requirements (specify ASME, AWS, or ISO [see Section 12]; default, if not specified, is at manufacturer's discretion).

4.1.10 Strength grade level [1, 2, 3, or 4]; default is strength grade 1.

4.2 The purchaser has the option to specify additional requirements: including but not limited to the following:

4.2.1 Supplementary requirements, if invoked.

4.2.2 Weld inspection Level (W1, W2, W3, or W4; default is W1).

4.2.3 Provide copy of process welding procedure and operator qualification certification.

4.2.4 Burr removal.

4.2.5 End condition.

4.2.6 Preparation for special delivery.

4.2.7 Special marking requirements.

4.2.8 Other special requirements.

NOTE 5—A typical ordering description is as follows: 5000 lb, sharp cornered, Angle, L4 × 4 × ½ in., laser or laser hybrid welded, 20 ft in length, UNS S30403 Type 304L, ASTM Specification AXXXX dated \_\_\_\_\_.

#### 5. Materials and Manufacture

5.1 The stainless steel plate, bar, sheet, or strip used to produce A1069/A1069M shapes shall conform with the requirements of the following specifications:

5.1.1 Plate, sheet, and strip shall conform to the requirements of Specification A480/A480M and the chemical composition requirements of Specification A240/A240M.

5.1.2 Bars and shapes shall conform to the requirements of Specification A484/A484M and the chemical composition requirements of Specification A276/A276M.

5.1.3 Bars and shapes for use in boilers and other pressure vessels shall conform to the requirements of Specification A484/A484M and the chemical composition requirements of Specification A479/A479M.

5.2 The supplier of the steel plate, bar, sheet, or strip shall be required to provide test reports documenting compliance with the raw material requirements. The stainless steel plate, sheet, or strip manufacturer's test report shall be considered sufficient evidence of the composition and strength of the base metal.

5.3 Products complying with this standard shall be manufactured by welding steel plate, bar, sheet, or strip using the laser beam or laser hybrid welding process. The welds shall be designed to develop the shear and tensile strength of the thinner of the plates joined or, if the steels are of different strengths, the lower strength steel.

#### 5.4 Welding:

5.4.1 Shape products shall be in the as-welded condition unless otherwise specified or necessary to meet the requirements of this specification.

5.4.2 Laser or laser-hybrid weld process for each alloy or alloy family within a strength grade group shall be qualified in accordance with the welding procedure and operator qualification requirements of one of the following:

5.4.2.1 ISO 15614-11 or ISO 15614-14 and ISO 15609-4 or ISO 15609-6.

5.4.2.2 ASME BPVC.IX ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.

5.4.2.3 AWS D1.6/D1.6M Clause 6 Qualification and either AWS C7.4/C7.4M, or AWS C7.6/C7.6M. The practices of AWS C7.2M shall be used.

NOTE 6—The ISO, ASME, and AWS standards establish requirements for welding procedure and operator qualifications for each manufacturing location. The ISO, ASME, and AWS requirements are very similar, but there are differences, such as the frequency of certification and whether third-party verification is required.

5.4.3 The quality levels of welded joints shall be in accordance with 5.4.3.1, 5.4.3.2, or 5.4.3.3.

5.4.3.1 ISO 13919-1 or ISO 12932 standard. If not otherwise specified, quality level B of ISO 13919-1 or ISO 12932 standard shall be met.

5.4.3.2 AWS C7.4/C7.4M (class A, unless otherwise specified) or AWS C7.6/C7.6M.

5.4.3.3 ASME BPVC.IX ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.

#### 6. Chemical Composition

6.1 The stainless steel purchased for products made to this specification shall conform to the chemical composition requirements of Specifications A240/A240M, A276/A276M, or A479/A479M, and shall conform to the applicable requirements of Specifications A480/A480M or A484/A484M.

NOTE 7—The following austenitic stainless steels (UNS number (common name)) are most commonly used for structural applications: UNS S30403 (304L), S31603 (316L), S31703 (317L), S32100 (321), S34700 (347), N08904 (904L), S31254, N08904 (904L), N08367, and N08926. Other alloys can be produced to this specification.

NOTE 8—The following duplex stainless steels (UNS number (common name)) are most commonly used for structural applications: S32101,

S32003, S32202, S32205 (2205), S32304, S32750, S32760, S82011, and S82441. Other alloys can be produced to this specification.

6.2 The chemical analysis of each heat used for products made to this specification shall be determined in accordance with the applicable materials specification and Test Methods and Practices **A751**.

6.3 The steel manufacturer's test report shall be considered sufficient evidence of the composition of the base metal.

## 7. Mechanical Properties

7.1 *Tensile testing*—If required, during weld procedure and operator qualification in accordance with AWS, ASME, or ISO requirements, testing of the tensile strength of the weldment shall be conducted on test specimens excised from the laser or laser hybrid welded stainless steel plates, bar, sheet, or strip, and shall meet or exceed the requirements of the specified strength grade requirements in subsection **7.3** and **Table 1** of this specification. Tensile testing and specimen dimensions shall be in accordance with Test Methods **A370** or ASME SA370.

7.2 Additional tensile testing can be specified by purchase order or contract in accordance with supplementary requirement S4.

7.3 *Strength Grades*—SCP and built-up shapes manufactured to this standard is available in different strength grades, which are limited by plate thickness. Strength grades 1 through 4 are addressed in **7.3.1 – 7.3.4**. The tensile properties required when strength grade 2, 3, or 4 is specified are given in **Table 1**. If strength grade is not specified, the default is Grade 1.

7.3.1 *Strength Grades 1*—The minimum mechanical property requirements for each alloy shall be those in Specifications **A240/A240M**, **A276/A276M**, or **A479/A479M**.

7.3.2 *Strength Grades 2*—This strength grade can be specified for austenitic alloys UNS S30403 (304L), S30409 (304H), S31603 (316L), S31653 (316LN), and S31703 (317L) in thicknesses up to 64 mm (2.5 in.) in accordance with the requirements of **Table 1**.

7.3.3 *Strength Grades 3*—This strength grade can be specified for duplex S32205 in thicknesses up to 64 mm [2.5 in.] in accordance with the requirements of **Table 1**.

7.3.4 *Strength Grades 4*—This strength grade can be specified for super duplexes like S32750 and S32760 in thicknesses of up to 50 mm [2 in.] in accordance with the requirements of **Table 1**.

7.4 The steel manufacturer's test report shall be considered sufficient evidence of the strength of the base metal.

7.5 *Transverse root bend test*—If required, during either weld procedure and operator qualification by ASME, AWS, or ISO or by purchase order or contract, transverse root bend tests shall be conducted in accordance with supplementary requirement S4 to evaluate the ductility of the weldment.

7.6 *Charpy V-notch testing*—If required, during either weld procedure and operator qualification in accordance with AWS, ASME, or ISO requirements or by purchase order or contract, Charpy V-notch impact testing shall be done in accordance with supplementary requirement S1.

## 8. Dimensions, Mass, and Permissible Variations

8.1 The permitted variations in shape dimensions of laser or laser-hybrid welded SCP or built-up shapes shall conform to the requirements of Section **8**.

8.2 *Permissible Variation in Dimensions*—The permissible variation in dimensions, measured at positions at least 50 mm [2 in.] from the ends of the SCP, built-up shape, or tube shall not vary from the specified outside dimensions by more than the applicable amount given in **Table 2**, which provides flatness requirements, and **Table 3**, which provides requirements for maximum concavity or convexity. Flatness is measured on a line parallel to the axis of the SCP or built-up shape. Convexity and concavity are measured on a line transverse to the axis of the SCP or built-up shape.

8.3 *Wall Thickness*—The minimum wall thickness shall be at least 95 % of the specified wall thickness. The maximum wall thickness, excluding the weld seam, shall be not more than 5 % greater than the specified wall thickness.

NOTE 9—Manufacturers should consider the tolerance requirements of the plate, bar, sheet, or strip standard, since specification of tighter tolerances may be necessary.

8.4 *Weight*—The actual weight of an individual length of SCP or built-up shape shall not deviate from the weight specified by more than  $-3.5\%$  or  $+10\%$ .

8.5 *Radius of Corners*—The radius of each outside corner shall be  $1\text{ mm} \pm 0.5\text{ mm}$  [ $0.04\text{ in.} \pm 0.02\text{ in.}$ ] unless a rounded shape is specified.

8.6 *Squareness of Sides*—Adjacent sides shall be square ( $90^\circ$ ) with a permissible variation of  $\pm 1^\circ$  max.

8.7 *Twist*—The maximum permissible variation in twist shall be  $1\text{ mm/m}$  [ $0.012\text{ in./ft.}$ ]. Twist shall be determined by holding one end of the product down on a flat surface plate,

**TABLE 1 Mechanical Test Requirements<sup>A,B,C,D</sup>**

Strength Grade	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. or 50 mm, min, %
	MPa	ksi	MPa	ksi	
	Austenitic (Chromium-Nickel) (Chromium-Manganese-Nickel)				
2	550	80	240	35	35
	Duplex (Austenitic-Ferritic)				
3	655	95	450	65	25
4	795	116	550	80	15

<sup>A</sup> Unless otherwise specified, yield strength shall be determined by the offset method at 0.2 % in accordance with Test Methods and Definitions **A370**.

<sup>B</sup> Bend tests are not required for any austenitic or duplex (austenitic-ferritic) stainless steels regardless of thickness.

<sup>C</sup> Brinell or Rockwell Hardness hardness requirements are determined by Specifications **A240/A240M**, **A276/A276M**, or **A479/A479M**.

<sup>D</sup> All ferritic and duplex (austenitic-ferritic) stainless steels not listed in this table shall be ordered to strength grade 1 in accordance with **7.3.1**.

**TABLE 2 Permissible Variations in Outside Flat Dimensions for Laser or Laser-Hybrid Welded Shape**

Outside Dimensions, mm [in.]	Permissible Variation, mm [in.]
$\leq 50$ [2]	1 [0.04]
$> 50$ [2]	1.5 [0.06]