



Designation: A1123/A1123M – 22

Standard Specification for Carbon Steel Laser and Laser-Hybrid Welded, Sharp-Cornered Profile (SCP), Built-Up, Square, Rectangular, and Special Shape Tube¹

This standard is issued under the fixed designation A1123/A1123M; 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 (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This specification covers laser beam or laser hybrid welded, built-up, carbon steel, sharp-cornered profiles (SCP) square, rectangular, or custom shape structural tubing for welded, riveted, or bolted construction. This specification does not include weathering steels, since most cannot be welded by these methods. SCP tubing is used in, but not limited to, the following applications: buildings and structures, including architecturally exposed steel structures (AESS); architectural steel profiles such as curtain wall, staircases, and others; industrial; and general structural applications.

NOTE 1—There is no standard for other sharp-cornered laser or laser hybrid welded carbon steel structural shapes, but Appendix X1 provides guidance on their specification.

1.2 The SCP structural tubing sections produced to this specification have a perimeter of 2845 mm [112 in.] or less and wall thickness of between 4.76 and 38.1 mm [3/16 and 1.50 in.]. The thicknesses of walls within a specified SCP tube shape can be different.

1.3 This specification establishes the minimum requirements for manufacturing of built-up, SCP laser, and laser hybrid welded carbon steel tube sections and requires the welds to, at a minimum, match the tensile and yield strength of the base metal.

NOTE 2—Product covered by this specification is manufactured in small lots on dedicated production lines. Product quality requirements are ensured through welding procedure qualification of the manufacturing facility in accordance with AWS, ISO, or CSA requirements. In addition to the standard weld inspection and weld quality requirements, the purchaser can specify higher levels of weld inspection; Supplementary S1 tensile, S2 bend, and S3 Charpy V-notch lot testing; and other requirements.

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

¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.09 on Carbon Steel Tubular Products.

Current edition approved Nov. 1, 2022. Published December 2022. DOI: 10.1520/A1123_A1123M-22.

1.4 This specification uses Specifications A36/A36M, A572/A572M, EN 10025-2, or EN 10025-3 for the chemical and mechanical requirements of the designated strength grade.

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:²

- A36/A36M Specification for Carbon Structural Steel
- A370 Test Methods and Definitions for Mechanical Testing of Steel Products
- A572/A572M Specification for High-Strength Low-Alloy

² 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.

Columbium-Vanadium Structural Steel
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
A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
E164 Practice for Contact Ultrasonic Testing of Weldments
E165/E165M Practice for Liquid Penetrant Testing for General Industry
E190 Test Method for Guided Bend Test for Ductility of Welds
E290 Test Methods for Bend Testing of Material for Ductility
E1417/E1417M Practice for Liquid Penetrant Testing

2.2 *ANSI/AISC Standard:*³

ANSI/AISC 303 Code of Standard Practice for Steel Buildings and Bridges
ANSI/AISC 360 Specification for Structural Steel Buildings

2.3 *AWS Standards:*⁴

AWS A3.0M/A3.0 Standard Welding Terms and Definition, Including Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying
AWS B2.1/2.1M Specification for Welding Procedure and Performance Qualification
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
AWS D1.1/D1.1M Structural Welding Code—Steel

2.4 *CSA Group Standard:*⁵

CSA W47.1 Certification of Companies for Fusion Welding of Steel

NOTE 4—Fusion welding is another term used to describe laser beam or laser-hybrid welding.

2.5 *EN Standards:*⁶

EN 10025-2 Hot rolled products of structural steels—Part 2: Technical delivery conditions for non-alloy structural steels
EN 10025-3 Hot rolled products of structural steels—Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels
EN 10204 Metallic Products: Types of Inspection Documents

2.6 *Federal Standard:*⁷

Federal Standard No. 123 Marking for Shipment

2.7 *ISO Standards:*⁸

ISO 3452-1 Non-destructive testing—Penetrant testing—Part 1: General Principles
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 17638 Non-destructive testing of welds – Magnetic particle testing
ISO 17640 Non-destructive testing of welds—Ultrasonic testing—Techniques, testing levels, and assessment
ISO 23277 Non-destructive testing of welds – Penetrant testing
ISO 23278 Non-destructive testing of welds – Magnetic particle testing of welds – Acceptance levels

2.8 *U.S. Military Standard:*⁹

MIL-STD-129 Military Marking for Shipment and Storage

3. Terminology

3.1 Definitions of general terms pertaining to this specification shall be those of Terminology **A941**.

3.2 Definitions of terms pertaining to welding terminology shall be those of AWS A3.0M/A3.0.

4. Ordering Information

4.1 Orders for material under this specification shall contain information concerning as many of the following items as are required to describe the desired material adequately. Such requirements shall include, but are not limited to:

- 4.1.1 Quantity (metres [feet] or number of lengths);
- 4.1.2 Name of material [laser-welded carbon steel sharp-cornered profiles (SCP) tube];
- 4.1.3 Size (outside dimensions and wall thickness for square and rectangular tube (mm [inch]), and drawings for custom shapes, if applicable);

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

⁹ Available from <https://www.acq.osd.mil/log/SCI/AIT.html/MIL-STD-129PCH4.pdf>.

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

⁴ Available from American Welding Society (AWS), 8669 NW 36 St., #130, Miami, FL 33166-6672, <http://www.aws.org>.

⁵ Available from Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON M9W 1R3, Canada, <http://www.csagroup.org>.

⁶ Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, <http://www.cen.eu>.

⁷ Available from U.S. Government Publishing Office (GPO), 732 N. Capitol St., NW, Washington, DC 20401, <http://www.gpo.gov>.

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

4.1.5 Steel type (Specification **A36/A36M**; designated Specification **A572/A572M** strength grade; EN 10025-2 grade, designation, and quality; or EN 10025-3 grade and quality level);

4.1.6 ASTM specification designation and edition year if other than the latest edition; and

4.1.7 Welding procedure qualification (AWS, ISO, or CSA, default, if not specified, is at manufacturer's discretion).

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

4.2.1 Supplementary requirements, if invoked;

4.2.1.1 S1. Tensile test;

4.2.1.2 S2. Bend test; and

4.2.1.3 S3. Charpy V-notch impact test;

4.2.2 Weld Inspection Level (W1, W2, W3, W4, and default is W1);

4.2.3 Process welding procedure certification

4.2.4 Burr removal;

4.2.5 End condition;

4.2.6 Finish;

4.2.7 Special packaging, marking or shipment requirements;

4.2.8 Special inspection requirements; and

4.2.9 Other special requirements.

NOTE 5—A typical ordering description is: square tube, L100 × 100 × 13 mm [4 × 4 × ½ in.], 6 m [20 ft], carbon steel, ASTM Specification AXXXX dated ____ with the following special requirements for weld inspection level X and length tolerance X.

5. Materials and Manufacture

5.1 The steel plate, bar, sheet, or strip shall conform with the requirements of the current version of Specification **A36/A36M**; designated Specification **A572/A572M** strength grade; EN 10025-2 grade, designation, and quality; or EN 10025-3 grade and quality level.

5.2 The supplier from which the steel plate, bar, sheet, or strip is purchased shall be required to provide certificates documenting compliance with the raw material requirements.

5.3 Products complying with this standard shall be built-up tube 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.

5.4 Laser or laser hybrid welding process shall be qualified in accordance with the welding qualification requirements of one of the following:

5.4.1 ISO 15614-11 or ISO 15614-14 and ISO 15609-4 or ISO 15609-6;

5.4.2 CSA W47.1; or

5.4.3 Either AWS C7.4/C7.4M or AWS C7.6/C7.6M. When complying with AWS requirements, the practices of AWS C7.2M shall be used.

5.5 Unless otherwise specified, the requirements of **5.5.1** shall apply. The quality levels of welded joints shall be in accordance with:

5.5.1 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;

5.5.2 CSA W47.1; or

5.5.3 AWS C7.4/C7.4M class A, unless otherwise specified, or AWS C7.6/C7.6M and AWS D1.1/D1.1M Clause 8 Inspection.

NOTE 6—The ISO, CSA, or AWS standards establish requirements for manufacturing location welding procedure qualifications involved in welding steel. These requirements are summarized in **Appendix X2**. The ISO, CSA, and AWS requirements within each requirement category are very similar, but there are differences, such as the frequency of certification and whether third-party verification is required.

6. Chemical Composition

6.1 The steel plate, bar, sheet, or strip shall conform to the chemical composition requirements of Specification **A36/A36M**; designated Specification **A572/A572M** strength grade; EN 10025-2 grade, designation, and quality; or EN 10025-3 grade and quality level. The steel manufacturer's certificate of compliance is sufficient evidence of the composition of the base metal.

7. Mechanical Properties

7.1 The base metal and welded product or test specimens excised from the welded product shall conform to the mechanical test requirements of Specification **A36/A36M**; designated Specification **A572/A572M** strength grade; EN 10025-2 grade, designation, and quality; or EN 10025-3 grade and quality level. The steel manufacturer's certificate of compliance is sufficient evidence of the mechanical properties of the base metal.

8. Dimensions, Mass, and Permissible Variations

8.1 *Permissible Variation in Dimensions*—The permissible variation in dimensions, measured across the flats at positions at least 50 mm [2 in.] from the ends of the SCP tube shall not vary from the specified outside dimensions by more than the applicable amount given in **Table 1**, which provides flatness requirements, and **Table 2**, which provides requirements for maximum concavity or convexity. Flatness is measured on a line parallel to the axis of the tube. Convexity and concavity are measured on a line transverse to the axis of the tube.

8.2 *Wall Thickness*—The minimum wall thickness shall be 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 7—Manufacturers should consider the tolerance requirements of the plate, bar, sheet, or strip standard, since specification of tighter tolerances may be necessary.

TABLE 1 Permissible Variations in Outside Flat Dimensions for Square, Rectangular, and Special Shape SCP Tube

Outside Dimensions, mm [in.]	Permissible Variation, mm [in.]
≤50 [2]	1 [0.040]
>50 [2]	1.5 [0.060]

TABLE 2 Permissible Variations in Concavity or Convexity for Built-Up, Square, Rectangular and Special Shape SCP Tube

Outside Dimensions, mm [in.]	Permissible Variations, mm [in.]
≤50 [2]	0.5 [0.020]
>50 [2]	0.01 times outer flat dimension

8.3 *Mass*—On the basis that the density of rolled steel is 7850 kg/m³ [0.2836 lb/in.³], the actual mass of an individual length of SCP shall not deviate from the mass specified by more than –3.5 or +10 %.

8.4 *Radius of Corners*—The radius of each outside corner shall be 1 ± 0.5 mm [0.04 ± 0.02 in.].

8.5 *Squareness of Sides*—Adjacent sides shall be square (90°) with a permissible variation of ±1° max.

8.6 *Twist*—The maximum permissible variation in twist shall be 1 mm/m [0.012 in./ft]. Twist shall be determined by holding one end of the product down on a flat surface plate, measuring the height that each corner on the bottom side of the SCP tube extends above the surface plate near the opposite ends, and calculating the twist (the difference in heights of such corners), except that for heavier sections it shall be permissible to use a suitable measuring device to determine twist. Twist measurements shall not be taken within 50 mm [2 in.] of the ends of the product.

8.7 *Camber*—The maximum permissible camber shall be 1 mm/m [0.012 in./ft].

8.8 *Length*—SCP tube is normally produced to length tolerance L1 in accordance with [Table 3](#).

9. Workmanship, Finish, and Appearance

9.1 *Workmanship*—All products covered by this specification shall be free from unacceptable surface defects and weld defects.

9.2 *Surface Defects*—Surface imperfections shall be classified as defects when their depth reduces the remaining wall thickness to less than 95 % of the specified wall thickness. It shall be permissible for defects having a depth not more than 33⅓ % of the specified wall thickness to be repaired by welding, subject to the following conditions:

9.2.1 The defect shall be completely removed by chipping or grinding to sound metal;

9.2.2 The repair weld shall be made using a low hydrogen welding process and shall only be for aesthetic purposes. Weld repair shall not be used to achieve full penetration structural welds;

9.2.3 The projecting weld metal shall be removed to produce a flat and smooth finish; and

9.2.4 Surface imperfections such as handling marks, light die or roll marks, or shallow pits are not considered defects provided that the imperfections are removable within the specified limits on wall thickness. The removal of such surface imperfections is not required. SCP shall be free of protruding metal on the outside surface of the weld seam.

9.3 *Finish*—The default finish shall be ground and blasted. Specification of a different finish in ANSI/AISC 303, Table 10.1 AESS Category Matrix or a custom finish shall be contractually agreed.

9.4 *Burr and End Condition*—Unless otherwise specified in the purchase order, structural products produced to this specification shall be furnished with square cut ends with the burr removed. When so specified in the purchase order, the burr shall be removed on the outside perimeter or inside perimeter or both.

10. Welding Procedure Qualification

10.1 The welding procedure qualification shall be performed one time at each manufacturing location for Specification [A36/A36M](#); designated Specification [A572/A572M](#) strength grade; EN 10025-2 grade, designation, and quality; or EN 10025-3 grade and quality level processed by laser and laser hybrid welding into a shape by each manufacturer. Welding qualification shall be redemonstrated if the processing method is significantly altered.

10.2 Welding procedure qualification shall be conducted in accordance with one or more of:

- 10.2.1 Either AWS C7.4/C7.4M or AWS C7.6/C7.6M;
- 10.2.2 CSA W47.1, if required; or
- 10.2.3 ISO 15614-11 or ISO 15614-14.

10.3 The manufacturer shall provide a report of the test results documenting compliance with AWS, ISO, and CSA certification requirements for the facility to the purchaser upon request.

NOTE 8—The requirements of these AWS, ISO, and CSA standards are summarized in [Appendix X2](#).

11. Number of Tests and Retests

11.1 The term “lot” shall apply to all product with the same steel grade and quality, dimensional requirements, and belonging to the same purchase order. Mixed heats are permissible. Heat numbers shall be identified by wall thickness on the product certificate of compliance.

11.2 When supplementary mechanical tests are required, one set of tests shall be made from each lot unless otherwise contractually agreed.

11.3 If the results of the supplementary mechanical tests representing any lot fail to conform to the applicable requirements, the lot shall be rejected or retested using double the original number of samples from the lot. The retest results shall be reported. The lot shall be acceptable if the results of all such retests conform to the specified requirements.

11.4 If one or both retests specified in [11.3](#) fail to conform to the applicable supplementary requirements, the lot shall be rejected. If subsequent manufacturer reworking occurs to

TABLE 3 Length Tolerance Requirements

Length	Level L1 mm [in.] ^A	A Level L2 mm [in.]	Level L3 mm [in.]	Level L4
All sizes	–0/+100 [–0/+4]	–0/+25 [–0/+1]	–0/+6 [0/+0.25]	Per contractual agreement

^A If not otherwise specified, L1 is the standard tolerance level.

eliminate the condition responsible for the failure, the product shall be treated as a new lot and tested accordingly.

12. Test Methods

12.1 The testing requirements for qualification of the process line and operator are stipulated in 5.4 and shall be in accordance with the relevant AWS, ISO, or CSA standard.

12.2 Supplementary testing methods S1. Tensile; S2. Bend; and S3. Charpy V-notch impact can be required, if necessary.

NOTE 9—This specification does not cover round tubes so a flattening test is not required.

13. Inspection

13.1 All products produced to this specification shall be inspected at the place of manufacture to ensure conformance to the requirements of this specification.

13.2 The default weld inspection level is W1 unless otherwise specified. Additional inspection requirements shall be specified in accordance with Table 4.

13.2.1 Visual acceptance criteria shall be in accordance with AWS D1.1/D1.1M Clause 8 and ANSI/AISC 360 Chapter N or ISO 13919-1.

13.2.2 Ultrasonic testing shall be performed to the requirements of Practice E164 in accordance with the acceptance criteria determined by AWS D1.1/D1.1M, in accordance with ISO 17640 with the acceptance criteria determined by ISO 11666, or as agreed by the supplier and purchaser.

13.2.3 Penetrant testing or PT testing shall be performed in accordance with Practices E165/E165M or E1417/E1417M or in accordance with ISO 3452-1 with acceptance criteria determined by ISO 23277.

13.2.4 Magnetic particle testing or MT shall be performed in accordance with ISO 17638 with acceptance criteria determined by ISO 23278.

NOTE 10—Boroscopic testing methods are not used on this product due to the standard length of the product and the particularly small dimensions of laser welded seams.

14. Rejection and Rehearing

14.1 It shall be permissible for the purchaser to inspect the product received from the manufacturer and reject any SCP that does not meet the requirements of this specification based on the inspection and test methods outlined herein. The purchaser shall notify the manufacturer of any SCP tube that has been rejected, and the disposition of such SCP tube shall be

subject to agreement between the manufacturer and the purchaser before further processing.

14.2 It shall be permissible for the purchaser to set aside any product that is found in fabrication or installation within the scope of this specification to be unsuitable for the intended end use based on the requirements of this specification. The purchaser shall notify the manufacturer of any SCP that has been set aside. Such SCP shall be subject to mutual investigation as to the nature and severity of the deficiency and the forming or installation or both of the conditions involved. The disposition of such SCP shall be subject to agreement between the manufacturer and the purchaser.

15. Certification

15.1 Mill test reports shall be issued in accordance with EN 10204:2004 2.2 or 3.1.

15.2 When specified in the purchase order or contract, the manufacturer shall furnish to the purchaser a certificate of compliance stating that the product was manufactured, sampled, tested, and inspected in accordance with this specification and any other requirements designated in the purchase order or contract and was found to meet all such requirements. Certificates of compliance shall include the specification number, year of issue, and manufacturer. If testing is not performed by the manufacturer, then the name of the testing agency shall be on the test report in addition to the items previously stated.

15.3 The country of origin and base metal heat numbers shall be identified by wall thickness on the product certificate of compliance. When specified in the purchase order or contract, the manufacturer shall furnish the base metal certificates of compliance to the purchaser with the reports for the tests required by this specification and the purchase order or contract.

15.4 A signature or notarization is not required on certificates of compliance or test reports; however, the documents shall clearly identify the organization submitting them. Notwithstanding the absence of a signature, the organization submitting the document is responsible for its content.

15.5 A certificate of compliance or test report printed from, or used in electronic form, from an electronic data interchange (EDI) shall be regarded as having the same validity as a counterpart printed in the certifying organization's facility. The

TABLE 4 Weld Inspection Level Requirements

Weld Inspection Requirement	Level W1, %	Level W2, %	Level W3, %	Level W4
Visual	100	100	100	100 %
Macro etching ^A	10	20	20	Per contractual agreement (>20 %)
Ultrasonic testing ^B	10	15	20	Per contractual agreement (>20 %)
MT or PT	10	15	20	Per contractual agreement (>20 %)

^A The tubes tested shall be at least 12.7 mm [0.5 in.] longer than the specified length, so that the over length can be removed for testing. All welds shall be macro etched.

^B Ultrasonic testing is only a recognized testing method for wall thicknesses of 8 mm [⁵/₁₆ in.] or greater.