Designation: ~~A524 – 17~~ A524/A524M – 21

Standard Specification for Seamless Carbon Steel Pipe for Atmospheric and Lower Temperatures[1]

This standard is issued under the fixed designation ~~A524;~~A524/A524M; 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 reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification[2] covers seamless carbon steel pipe intended primarily for service at atmospheric and lower temperatures, NPS ⅛ to 26 [DN 6 to 650] inclusive, with nominal (average) wall thickness as given in ANSI B36.10. Pipe having other dimensions may be furnished, provided such pipe complies with all other requirements of this specification. Pipe ordered to this specification shall be suitable both for welding, and for bending, flanging, and similar forming operations.

1.2 The product is available in two grades (Tables 1 and 2).

1.3 Product may be either of hot finished or cold drawn manufacture (see 5.1.4 and 5.1.5).

1.4 *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 ~~as standard. The values~~ 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. The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

~~NOTE 1—The dimensionless designator NPS (nominal pipe size) has been substituted in this standard for such traditional terms as "nominal diameter," "size," and "nominal size."~~

NOTE 1—The dimensionless designator NPS (nominal pipe size) has been substituted in this standard for such traditional terms as "nominal diameter," "size," and "nominal size."

1.5 The following hazard caveat applies to the test methods portion, Section 16, only. *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.*

1.6 *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.*

[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.

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[2] For ASME Boiler and Pressure Vessel Code Applications see related Specification SA-524 in Section II of that Code.

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

TABLE 1 Chemical Requirements

Element	Grades I and II, Composition, %
Carbon, max	0.21
Manganese	0.90–1.35
Phosphorus, max	0.035
Sulfur, max	0.035
Silicon	0.10–0.40

2. Referenced Documents

2.1 *ASTM Standards:*[3]

A530/A530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *American National Standards Institute Standard:*

B36.10 Welded and Seamless Wrought Steel Pipe[4]

3. Ordering Information

3.1 Orders for material under this specification should include the following, as required, to describe the desired material adequately:

3.1.1 Quantity ~~(feet~~ (feet, meters, or number of lengths),

3.1.2 Name of material (seamless carbon steel pipe),

3.1.3 Grade (Table 1 and Table 2),

3.1.4 Manufacture (hot finished or cold drawn (see 5.1.4 and 5.1.5)),

3.1.5 Size (either nominal NPS [DN] wall thickness and weight class or schedule number, or both, or outside diameter and nominal wall thickness, ANSI B36.10),

3.1.6 Length (Section 17),

3.1.7 Optional requirements (Section 8 and Section 11 of Specification A530/A530M),

3.1.8 Test report required ~~(Certification~~ (Material Test Report Section of Specification A530/A530M),

3.1.9 Specification ~~designation,~~ (A524 or A524M) designation,

3.1.10 Hydrostatic test (see 11.2).

3.1.11 End use of material, and

3.1.12 Special requirements.

4. General Requirements

4.1 Material furnished to this specification shall conform to the applicable requirements of the current edition of Specification A530/A530M unless otherwise provided herein.

5. Materials and Manufacture

5.1 *Process:*

[3] 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.

[4] Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

TABLE 2 Tensile Requirements

	Wall Thicknesses			
	~~Grade I, 0.375 in. (9.52 mm) and under~~		~~Grade II, greater than 0.375 in. (9.52 mm)~~	
	Grade I, 0.375 in. [9.52 mm] and under		Grade II, greater than 0.375 in. [9.52 mm]	
~~Tensile strength, psi (MPa)~~	~~60 000–85 000 (414–586)~~		~~55 000–80 000 (380–550)~~	
Tensile strength, psi [MPa]	60 000–85 000 [415–585]		55 000–80 000 [380–550]	
~~Yield strength, min, psi (MPa)~~	~~35 000 (240)~~		~~30 000 (205)~~	
Yield strength, min, psi [MPa]	35 000 [240]		30 000 [205]	
	Longitudinal	Transverse[A]	Longitudinal	Transverse[A]
~~Elongation in 2 in. or 50 mm, min %:~~				
Elongation in 2 in. [50 mm], min %:				
~~Basic minimum elongation for walls 5/16 in. (7.9 mm) and over in thickness, strip tests, and for all small sizes tested in full section~~	~~30~~	~~16.5~~	~~35~~	~~25~~
Basic minimum elongation for walls 5/16 in. [7.9 mm] and over in thickness, strip tests, and for all small sizes tested in full section	30	16.5	35	25
~~When standard round 2 in. or 50 mm gauge length test specimen is used for strip tests, a deduction for each 1/32 in. (0.8 mm) decrease in wall thickness below 5/16 in. (7.9 mm) from the basic minimum elongation of the following percentage~~	~~22~~ ~~1.50[A]~~	~~12~~ ~~1.00[A]~~	~~28~~ ...	~~20~~ ...
When standard round 2 in. [50 mm] gauge length test specimen is used for strip tests, a deduction for each 1/32 in. [0.8 mm] decrease in wall thickness below 5/16 in. [7.9 mm] from the basic minimum elongation of the following percentage	22 1[B]	12 1[B]	28 ...	20 ...

[A] Transverse elongations may not be calculable for sizes smaller than NPS 6 [DN 150] based on test equipment limitations.
[B] The following table gives the computed minimum values:

Wall Thickness		Elongation in 2 in. ~~or 50 mm,~~ min, %	
		Grade I	
in.	mm	Longitudinal	Transverse
~~5/16 (0.312)~~	~~7.94~~	~~30.0~~	~~16.5~~
~~9/32 (0.281)~~	~~7.14~~	~~28.5~~	~~15.5~~
~~1/4 (0.250)~~	~~6.35~~	~~27.0~~	~~14.5~~
~~7/32 (0.219)~~	~~5.56~~	~~25.5~~	~~...~~
~~3/16 (0.188)~~	~~4.76~~	~~24.0~~	~~...~~
~~5/32 (0.156)~~	~~3.97~~	~~22.5~~	~~...~~
~~1/8 (0.125)~~	~~3.18~~	~~21.0~~	~~...~~
~~3/32 (0.094)~~	~~2.38~~	~~19.5~~	~~...~~
~~1/16 (0.062)~~	~~1.59~~	~~18.0~~	~~...~~

Wall Thickness		Elongation in 2 in. [50 mm], min, %	
		Grade I	
in.	mm	Longitudinal	Transverse
5/16 (0.312)	[7.94]	30.0	16.5
9/32 (0.281)	[7.14]	28.5	15.5
1/4 (0.250)	[6.35]	27.0	14.5
7/32 (0.219)	[5.56]	25.5	...
3/16 (0.188)	[4.76]	24.0	...
5/32 (0.156)	[3.97]	22.5	...
1/8 (0.125)	[3.18]	21.0	...
3/32 (0.094)	[2.38]	19.5	...
1/16 (0.062)	[1.59]	18.0	...

Note—The above table gives the computed minimum elongation values for each 1/32-in. ~~(0.79-mm)~~[0.79-mm] decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value is determined by the following equation:

Grade	Direction of Test	Equation
I	transverse	E = 32t + 6.50
I	longitudinal	E = 48t + 15.00

where:

~~*E* = elongation in 2 in. or 50 mm in % and~~
~~*t* = actual thickness of specimen, in. (mm).~~

E = elongation in 2 in. [50 mm] in % and
t = actual thickness of specimen, in. [mm].

5.1.1 The steel shall be killed steel made by one or more of the following processes: ~~open-hearth,~~ electric-furnace, ~~or basic-oxygen.~~ basic-oxygen, or any other commercially viable process.

5.1.2 The steel shall be made to fine grain practice.

5.1.3 Steel may be cast in ingots or may be strand cast. When steel of different grades are sequentially strand cast, identification of the resultant transition material is required. The producer shall remove the transition material by any established procedure that positively separates the grades.

5.1.4 Pipe NPS 1½ ~~and~~ [DN 40] and under may be either hot finished or cold drawn.

5.1.5 Unless otherwise specified, pipe NPS 2 [DN 50] and over shall be furnished hot finished. When agreed upon between the manufacturer and purchaser, cold-drawn pipe may be furnished.

5.2 *Heat Treatment*—All hot-finished and cold-drawn pipe shall be reheated to a temperature above ~~1550 °F (845°C)~~ 1550°F [845°C] and followed by cooling in air or in the cooling chamber of a controlled atmosphere furnace.

6. Chemical Composition

6.1 The steel shall conform to the chemical requirements prescribed in Table 1.

7. Heat Analysis

7.1 An analysis of each heat of steel shall be made by the steel manufacturer to determine the percentages of the elements specified in Section 6. The chemical composition thus determined, or that determined from a product analysis made by the manufacturer, if the latter has not manufactured the steel, shall be reported to the purchaser or the purchaser's representative, and shall conform to the requirements specified in Section 6.

8. Product Analysis

8.1 At the request of the purchaser, analyses of two pipes from each lot (Note 2) shall be made by the manufacturer from the finished pipe. The chemical composition thus determined shall conform to the requirements specified in Section 6.

NOTE 2—A lot shall consist of 400 lengths, or fraction thereof, for each size NPS 2 [DN 50] up to but not including NPS ~~6,~~ 6 [DN 150], and of 200 lengths, or fraction thereof, for each size NPS 6 [DN 150] and over.

8.2 If the analysis of one of the tests specified in 8.1 does not conform to the requirements specified in Section 6, analyses shall be made on additional pipe of double the original number from the same lot, each of which shall conform to requirements specified.

9. Physical Properties

9.1 *Tensile Properties*—The material shall conform to the requirements as to tensile properties prescribed in Table 2.

9.2 *Bending Properties:*

9.2.1 For pipe NPS 2 [DN 50] and under, a sufficient length of pipe shall stand being bent cold through 90° around a cylindrical mandrel, the diameter of which is twelve times the nominal diameter of the pipe, without developing cracks. When ordered for close coiling, the pipe shall stand being bent cold through 180° around a cylindrical mandrel, the diameter of which is eight times the nominal diameter of the pipe, without failure.

9.2.2 For pipe whose diameter exceeds 25 in. ~~(635 mm)~~[635 mm] and whose diameter to wall thickness ratio is 7.0 or less, bend test specimens shall be bent at room temperature through 180° without cracking on the outside of the bent portion. The inside diameter of the bend shall be 1 in. ~~(25.4 mm).~~[25.4 mm]. This test shall be in place of Section 10.

NOTE 3—Diameter to wall thickness ratio = specified outside diameter/nominal wall thickness.
Example: For 28 in. [710 mm] diameter 5.000 in. [125 mm] thick pipe the diameter to wall thickness ratio = 28/5 = 5.6.

10. Flattening Test Requirements

10.1 For pipe over NPS ~~2,~~ 2 [DN 50], a section of pipe not less than 2½ in. ~~(63.5 mm)~~[63.5 mm] in length shall be flattened cold between parallel plates until the opposite walls of the pipe meet. Flattening tests shall be in accordance with Specification A530/A530M, except that in the equation used to calculate the *H* value, the following *e* constants shall be used:

0.07 for Grade I
0.08 for Grade II

10.2 When low *D*-to-*t* ratio tubulars are tested, because the strain imposed due to geometry is unreasonably high on the inside surface at the 6 and 12 o'clock locations, cracks at these locations shall not be cause for rejection if the *D*-to-*t* ratio is less than ten.

11. Hydrostatic Test Requirements

11.1 Each length of pipe shall be subjected to the hydrostatic pressure, except as provided in 11.2.

11.2 When specified in the order, pipe may be furnished without hydrostatic testing and each length so furnished shall include with the mandatory marking the letters "NH."

11.3 When certification is required by the purchaser and the hydrostatic test has been omitted, the certification shall clearly state "Not Hydrostatically Tested," and the specification number and grade designation, as shown on the certification, shall be followed by the letters "NH."

12. Dimensions and Weights

12.1 The dimensions and weights of plain-end pipe are included in ANSI B36.10. Sizes and wall thicknesses most generally available are listed in Appendix X1.

13. Dimensions, Weight, and Permissible Variations

13.1 *Weight*—The weight of any length of pipe shall not vary more than 6.5 % over and 3.5 % under that specified for pipe of Schedule 120 (Table X1.2) and lighter nor more than 10 % over and 3.5 % under that specified for pipe heavier than Schedule 120. Unless otherwise agreed upon between the manufacturer and purchaser, pipe in sizes NPS 4 [DN 100] and smaller may be weighed in convenient lots; pipe in sizes larger than NPS 4 [DN 100] shall be weighed separately.

13.2 *Diameter*—Variations in outside diameter shall not exceed those specified in Table 3.

TABLE 3 Variations in Outside Diameter

~~NPS Designator~~	~~Permissible Variations in Outside Diameter, in. (mm)~~	
	~~Over~~	~~Under~~
~~⅛ to 1½, incl~~	~~1/64 (0.4)~~	~~1/64 (0.8)~~
~~Over 1½ to 4, incl~~	~~1/32 (0.8)~~	~~1/32 (0.8)~~
~~Over 4 to 8, incl~~	~~1/16 (1.6)~~	~~1/16 (0.8)~~
~~Over 8 to 18, incl~~	~~3/32 (2.4)~~	~~3/32 (0.8)~~
~~Over 18~~	~~⅛ (3.2)~~	~~⅛ (0.8)~~

TABLE 3 Variations in Outside Diameter

Designator		Permissible Variations in Outside Diameter, in. [mm]	
NPS	DN	Over	Under
⅛ to 1½, incl.	6 to 40, incl.	1/64 [0.4]	1/32 [0.8]
Over 1½ to 4, incl.	40 to 100, incl.	1/32 [0.8]	1/32 [0.8]
Over 4 to 8, incl.	100 to 200, incl.	1/16 [1.6]	1/32 [0.8]
Over 8 to 18, incl.	200 to 450, incl.	3/32 [2.4]	1/32 [0.8]
Over 18	Over 450	⅛ [3.2]	1/32 [0.8]

13.3 *Thickness*—The minimum wall thickness at any point shall not be more than 12.5 % under the nominal wall thickness specified.

NOTE 4—The minimum wall thickness on inspection is shown in Appendix X1.

14. Workmanship, Finish, and Appearance

14.1 The pipe manufacturer shall explore a sufficient number of visual surface imperfections to provide reasonable assurance that they have been properly evaluated with respect to depth. Exploration of all surface imperfections is not required but may be necessary to assure compliance with 14.2.

14.2 Surface imperfections that penetrate more than 12½ % of the nominal wall thickness or encroach on the minimum wall thickness shall be considered defects. Pipe with such defects shall be given one of the following dispositions:

14.2.1 The defect may be removed by grinding provided that the remaining wall thickness is within specified limits.

14.2.2 Repaired in accordance with the repair welding provisions of 14.6.

14.2.3 The section of pipe containing the defect may be cut off within the limits of requirements on length.

14.2.4 Rejected.

14.3 To provide a workmanlike finish and basis for evaluating conformance with 14.2, the pipe manufacturer shall remove by grinding the following noninjurious imperfections:

14.3.1 Mechanical marks, abrasions (Note 5), and pits, any of which imperfections are deeper than 1⁄16 in. (1.58 mm).

NOTE 5—Marks and abrasions are defined as cable marks, dinges, guide marks, roll marks, ball scratches, scores, die marks, and the like.

14.3.2 Visual imperfections, commonly referred to as scabs, seams, laps, tears, or slivers, found by exploration in accordance with 14.1 to be deeper than 5 % of the nominal wall thickness.

14.4 At the purchaser's discretion, pipe shall be subject to rejection if surface imperfections acceptable under 14.2 are not scattered, but appear over a large area in excess of what is considered a workmanlike finish. Disposition of such pipe shall be a matter of agreement between the manufacturer and the purchaser.

14.5 When imperfections or defects are removed by grinding, a smooth curved surface shall be maintained, and the wall thickness shall not be decreased below that permitted by this specification. The outside diameter at the point of grinding may be reduced by the amount so removed.

14.5.1 Wall thickness measurements shall be made with a mechanical caliper or with a properly calibrated nondestruc-tive testing device of appropriate accuracy. In case of dispute, the measurement determined by use of the mechanical caliper shall govern.

14.6 Weld repair shall be permitted only subject to the approval of the purchaser and in accordance with Specification A530/A530M.

14.7 The finished pipe shall be reasonably straight.

15. Number of Tests and Retests

15.1 One of either of the tests specified in 9.1 shall be made on one length of pipe from each lot (Note 2).

15.2 For pipe NPS 2 [DN 50] and under, the bend test specified in 9.2 shall be made on one pipe from each lot (Note 2). The bend tests specified in 9.2.2 shall be made on one end of each pipe.

15.3 The flattening test specified in Section 10 shall be made on one length of pipe from each lot (Note 2).

15.4 Retests shall be in accordance with Specification A530/A530M and as provided in 15.5 and 15.6.

15.5 If a specimen breaks in an inside or outside surface flaw, a retest shall be allowed.

15.6 Should a crop end of a finished pipe fail in the flattening test, one retest may be made from the broken end.

16. Test Specimens and Methods of Testing

16.1 Specimens cut either longitudinally or transversely shall be acceptable for the tension test.

16.2 Test specimens for the bend test specified in 9.2 and for the flattening tests specified in Section 10 shall consist of sections cut from a pipe. Specimens for flattening tests shall be smooth on the ends and free from burrs, except when made on crop ends.

16.3 Test specimens for the bend test specified in 9.2.2 shall be cut from one end of the pipe and, unless otherwise specified, shall be taken in a transverse direction. One test specimen shall be taken as close to the outer surface as possible and another from as close to the inner surface as possible. The specimens shall be either ½ by ½ in. ~~(12.7 mm)~~[12.7 mm] in section or 1 by ½ in. ~~(25.4~~[25.4 by 12.7 ~~mm)~~mm] in section with the corners rounded to a radius not over 1⁄16 in. ~~(1.6 mm)~~[1.6 mm] and need not exceed 6 in. ~~(152 mm)~~[152 mm] in length. The side of the samples placed in tension during the bend shall be the side closest to the inner and outer surface of the pipe respectively.

17. Lengths

17.1 Pipe lengths shall be in accordance with the following regular practice:

17.1.1 The lengths required shall be specified in the order, and

17.1.2 No jointers are permitted unless otherwise specified.

17.2 If definite lengths are not required, pipe may be ordered in single random lengths of 16 to 22 ft ~~(4.9~~[4.9 to 6.7 ~~m),~~m], with 5 % 12 to 16 ft ~~(3.7~~[3.7 to 4.9 ~~m),~~m], or in double random lengths with a minimum average of 35 ft ~~(10.7 m)~~[10.7 m] and a minimum length of 22 ft [6.7 m] with 5 % 16 to 22 ~~ft.~~ ft [4.9 to 6.7 m].

18. Rejection

18.1 Each length of pipe that develops injurious defects during shop working or application operations will be rejected, and the manufacturer shall be notified. No rejections under this or any other specifications shall be marked as specified in Section 19 for sale under this specification except where such pipe fails to comply with the weight requirements alone, in which case it may be sold under the weight specifications with which it does comply.

19. Product Marking

19.1 In addition to the marking prescribed in Specification A530/A530M, the marking shall include the hydrostatic test pressure when tested or the letters "NH" when not tested, the length and schedule number, and on pipe sizes larger than NPS 4 [DN 100] the weight shall be given. Length shall be marked in feet and tenths of a foot, or metres to two decimal places, depending on the units to which the material was ordered, or other marking subject to agreement.

19.2 *Bar Coding*—In addition to the requirements in 19.1, bar coding is acceptable as a supplemental identification method. The purchaser may specify in the order a specific bar coding system to be used.