



Designation: A 405 - 91

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Standard Specification for Seamless Ferritic Alloy-Steel Pipe Specially Heat Treated for High-Temperature Service¹

This standard is issued under the fixed designation A 405; 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 covers nominal (average) wall seamless, annealed or normalized and tempered alloy steel pipe intended for high-temperature service after special heat treatment. Pipe ordered to this specification shall be suitable for bending, flanging (vanstoning), and similar forming operations, and for fusion welding. The pipe shall be given a special heat treatment after any shop fabrication and prior to installation in service.

1.2 The high-temperature properties of the materials covered in this specification are dependent upon special heat treatment that is required. Although the high-temperature properties are not specified, they are implied by control of chemistry, heat treatment and room-temperature properties.

1.3 The manufacturer shall furnish the pipe in the annealed or normalized and tempered condition, and shall demonstrate that the pipe when specially heat treated, will be capable of meeting the prescribed ambient temperature properties.

1.4 Supplementary requirements of an optional nature are provided. These supplementary requirements call for additional tests to be made, and, when desired, shall be so stated in the order together with the number of such tests required.

1.5 The values stated in inch-pound units are to be regarded as the 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.”

2. Referenced Document

2.1 ASTM Standard:

A530/A 530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe²

3. General Requirements

3.1 Material furnished to this specification shall conform to the applicable requirements of the current edition of Specification A 530/A 530M, unless otherwise provided herein.

¹ This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys, and is the direct responsibility of Subcommittee A01.10 on Tubing.

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² Annual Book of ASTM Standards, Vol 01.01.

4. Ordering Information

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

4.1.1 Quantity (feet, centimetres, or number of lengths),

4.1.2 Name of material (alloy steel pipe),

4.1.3 Grade (Table 1),

4.1.4 Size (NPS designator or outside diameter and schedule number or average wall thickness),

4.1.5 Length (specific or random), (Section 9),

4.1.6 End finish (Ends Section of Specification A 530/A 530M),

4.1.7 Optional requirements (Section 7, Product Analysis, 10.6 Repair by Welding, S1 to S5 Supplementary Requirements, and Hydrostatic Test Requirements Section of A 530/A 530M),

4.1.8 Test report required (Section 13),

4.1.9 Specification designation, and

4.1.10 Special requirements or exceptions to specification.

5. Materials and Manufacture

5.1 Unless otherwise specified, pipe NPS 2 and over shall be hot-finished followed by the heat treatment specified in 5.4.

5.2 Unless otherwise specified, pipe under NPS 2 may be furnished either hot finished or cold drawn followed by the heat treatment as specified in 5.4.

5.3 The steel from which the pipe is made shall be made by coarse-grain melting practice.

5.4 Heat Treatment:

5.4.1 The pipe shall be furnished in the full-annealed or normalized and tempered condition. The procedure for heat treatment shall be at the option of the manufacturer to meet the mechanical test requirements of 11.1 or the flattening tests.

5.4.2 The special heat treatment required as the final fabrication treatment shall consist in normalizing and tempering as defined in 5.4.3 or 5.4.4.

5.4.3 *Normalizing*—The procedure for normalizing shall consist in heating to 1850 to 1950°F (1010 to 1065°C), holding for 1 h/in. (25 mm) of thickness with 2 h minimum period followed by cooling in air. If desired by the manufacturer, cooling may be in the furnace to not less than 1650°F (900°C) and then in air.

5.4.4 *Tempering*—The procedure for tempering shall consist in heating to 1250 to 1350°F (675 to 730°C), holding for a sufficient time for the entire section to attain the required temperature, plus a soaking period of 12 h minimum, followed by cooling in furnace or air.

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6. Chemical Composition

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

7. Product Analysis

7.1 At the request of the purchaser, an analysis of two pipes from each lot as specified shall be made by the manufacturer from the finished pipe. A lot of pipe shall consist of the following:

NPS Designator	Lengths of Pipe in Lot
Under 2	400 or fraction thereof
2 to 5	200 or fraction thereof
6	100 or fraction thereof

7.2 The results of these analyses shall be reported to the purchaser or the purchaser's representative, and shall conform to the requirements specified in Table 1.

7.3 If the analysis of one of the tests specified in 7.1 does not conform to the requirements specified, an analysis of each billet or pipe from the same heat or lot may be made, and all billets or pipe conforming to the requirements shall be accepted.

8. Tensile Requirements

8.1 Material furnished by the manufacturer shall conform to the requirements prescribed in Table 2 as to tensile properties at room temperatures.

8.2 The material, when specially heat treated as in 5.4.2, shall conform to the tensile requirements of Table 3.

9. Lengths

9.1 Pipe NPS 8 and under shall be furnished as follows: Single random lengths shall be 12 to 22 ft (3.7 to 6.7 m); 5 % of the footage on an order may be in lengths of 6 to 12 ft (1.8 to 3.7 m). When ordered in double random lengths, the minimum length shall not be less than 22 ft (6.7 m), with a minimum average for the order of 30 ft (9.1 m).

9.2 Pipe over NPS 8 shall be furnished as follows: 75 % of the footage shall be within the length ranges shown in the Appendix and 25 % of the footage may be in greater lengths or shorter lengths down to 10 ft (3.0 m) min.

10. Finish

10.1 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 10.2.

10.2 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:

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

10.2.2 Repaired in accordance with the repair welding provisions of 10.6,

10.2.3 The section of pipe containing the defect may be cut off within the limits of requirements on length, or

10.2.4 Rejected.

10.3 To provide a workmanlike finish and basis for evaluating conformance with 10.2, the pipe manufacturer shall remove by grinding the following:

10.3.1 Mechanical marks, abrasions (Note 2) and pits, any of which imperfections are deeper than 1/16 in. (1.58 mm).

NOTE 2—Marks and abrasions are defined as cable marks, dinges, guide marks, roll marks, ball scratches, scores, die marks, and the like.

10.3.2 Visual imperfections commonly referred to as

TABLE 2 Tensile Requirements

Grade P24		
Tensile strength, min ksi (MPa)	60 (415)	
Yield strength, min ksi (MPa)	30 (205)	
	Longitudinal	Transverse
Elongation in 2 in. or 50 mm (or 4D) min, %:		
Basic minimum elongation for walls 5/16 in. (7.94 mm) and over in thickness, strip tests, and for all small sizes tested in full section	30	20
When standard round 2-in. or 50-mm gage length or smaller proportionally sized specimen with the gage length equal to 4D (4 times the diameter) is used	22	14
For strip tests, a deduction shall be made for each 1/32-in. (0.79-mm) decrease in wall thickness below 5/16 in. (7.94 mm) from the basic minimum elongation of the following percentage points	1.50 ^A	1.00 ^A

^A The following table gives the calculated minimum values:

Wall Thickness		Elongation in 2 in. or 50 mm, min, % ^B	
in.	mm	Longitudinal	Transverse
5/16 (0.312)	7.94	30	20
9/32 (0.281)	7.14	28	19
1/4 (0.250)	6.35	27	18
7/32 (0.219)	5.56	26	...
3/16 (0.188)	4.76	24	...
5/32 (0.156)	3.97	22	...
1/8 (0.125)	3.17	21	...
3/32 (0.094)	2.38	20	...
1/16 (0.062)	1.59	18	...

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

Direction of Test	Equation
Longitudinal	$E = 48t + 15.00$
Transverse	$E = 32t + 10.00$

where:

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

^B Calculated elongation requirements shall be rounded to the nearest whole number.

TABLE 1 Chemical Requirements

Element	Composition, %
	Grade P24
Carbon, max	0.15
Manganese	0.30–0.60
Phosphorus, max	0.025
Sulfur, max	0.025
Silicon	0.10–0.35
Chromium	0.80–1.25
Molybdenum	0.87–1.13
Vanadium	0.15–0.25