

Standard Specification for

SEAMLESS AND WELDED STEEL PIPE FOR LOW-TEMPERATURE SERVICE¹



ASTM Designation: A 333 – 67

This Standard of the American Society for Testing and Materials is issued under the fixed designation A 333; the final number indicates the year of original adoption as standard or, in the case of revision, the year of last revision.

1. Scope

1.1 This specification² covers nominal (average) wall seamless and welded carbon and alloy steel pipe intended for use at low temperatures. Several grades of ferritic steel are included as listed in Table 2.

NOTE 1—The grades of austenitic stainless steel pipe furnished in accordance with ASTM Specification A 312, Seamless and Welded Austenitic Stainless Steel Pipe³ have been found suitable for low-temperature service down to –325 F (–198 C) where Charpy notched-bar impact values of 15 ft-lb (2.074 m-kJ) min, are required, and need not be impact tested.

NOTE 2—The values stated in U.S. customary units are to be regarded as the standard. The metric equivalents of U.S. customary units given in the body of the standard may be approximate.

¹ Under the standardization procedure of the Society, this specification is under the jurisdiction of the ASTM Committee A-1 on Steel and is the direct responsibility of Subcommittee X on Tubes. A list of committee members may be found in the ASTM Year Book.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-333 in Section II of that Code.

³ Appears in this publication.

2. General Requirements

2.1 Material furnished to this specification shall conform to the applicable requirements of the current edition of ASTM Specification A 530, General Requirements for Specialized Carbon and Alloy Steel Pipe,³ unless otherwise provided herein.

3. Basis of Purchase

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

3.1.1 Quantity (feet, centimeters,⁴ or number of lengths).

3.1.2 Name of material (seamless or welded pipe),

3.1.3 Grade (Table 2),

3.1.4 Size (nominal pipe size or outside diameter and schedule number of average wall thickness),

3.1.5 Length (specific or random), see 17. Lengths (see 13. Variation in Lengths, of Specification A 530),

3.1.6 End finish (16. Ends, of Specification A 530),

- 3.1.7 Optional requirements, (7. Check Analysis; 10.1 lower temperature for impact tests; 4.5 stress-relieving; (see 5.4 special hydrostatic test, of Specification A 530); 15.4 repair by welding),
- 3.1.8 Test report required (18. Certification, of Specification A 530),
- 3.1.9 ASTM designation, and
- 3.1.10 Special requirements or exceptions to this specification.

4. Materials and Manufacture

4.1 *Process*—The steels shall be made by the open-hearth or electric-furnace process except that Grades 1, 3, 4, 6, and 7 may also be made by the basic-oxygen process. The steels shall be made using recognized melting practices necessary to produce steel which will meet the impact requirements of this specification.

4.2 *Discard*—A sufficient discard shall be made from each ingot to secure freedom from injurious piping and undue segregation.

4.3 *Manufacture*—The pipe shall be made by the seamless or welding process with the addition of no filler metal in the welding operation. Grade 4 shall be made by the seamless process.

4.4 Heat Treatment:

4.4.1 All pipe, other than Grade 8 shall be air cooled or in the cooling chamber of a controlled atmosphere furnace from above 1550 F (843 C) and may be reheated to a temperature above 1100 F (593 C). Grade 8 pipe shall be heat treated by the manufacturer by either of the following methods.

4.4.1.1 *Quenched and Tempered*—Heat to a uniform temperature of 1475 F (802 C); hold at this temperature for a minimum time of 1 hr/in. of thickness, but in no case less than 30 min; quench by immersion in circulating water. Reheat until the pipe attains a uniform temperature within the range of 1050 to 1125 F (566 to 607 C); hold at this temperature for a minimum time of 1 hr/in.

of thickness, but in no case less than 30 min; cool in air or water quench at a rate no less than 300 F (166 C)/hr.

4.4.1.2 *Double Normalized and Tempered*—Heat to a uniform temperature of 1650 F (899 C); hold at this temperature for a minimum time of 1 hr/in. of thickness, but in no case less than 30 min; cool in air. Reheat until the pipe attains

TABLE 1—STRESS RELIEVING OF TEST PIECES.

Metal Temperature ^{a, b}				Minimum Holding Time, hr per in. (25.4 mm) of Thickness
Grades 1, 3, 6 and 7		Grade 4 ^c		
deg F	deg C	deg F	deg C	
1100	593	1150	621	1
1050	566	1100	593	2
1000	538	1050	566	3

^a For intermediate temperatures, the holding time shall be determined by straight-line interpolation.

^b Grade 8 shall be stress relieved at 1025 to 1085 F, (552 to 585 C), held for a minimum time of 2 hr for thicknesses up to 1.0 in. (25.4 mm), plus a minimum of 1 hr for each additional inch (25.4 mm) of thickness and cooled in still air to a temperature not exceeding 600 F (316 C).

^c Unless otherwise specified, Grade 4 shall be stress relieved at 1150 F (621 C).

a uniform temperature of 1450 F (788 C); hold at this temperature for a minimum time of 1 hr/in. of thickness, but in no case less than 30 min; cool in air. Reheat to a uniform temperature within the range of 1050 to 1125 F (566 to 607 C); hold at this temperature for a minimum time of 1 hr/in. of thickness, but in no case less than 30 min; cool in air or water quench at a rate not less than 300 F (166 C)/hr.

4.4.2 Material from which test specimens are obtained shall be in the same condition of heat treatment as the pipe furnished. Material from which specimens are to be taken shall be heat treated prior to preparation of the specimens.

4.5 When the vessel or piping system in which the pipe is to be used is to be stress relieved after fabrication by welding, the order shall specify that the test specimens shall be taken from full-thickness test pieces which have been stress relieved after having been removed from the heat-treated pipe. The test pieces shall be gradually and uniformly heated

reported to the purchaser or his representative, and shall conform to the requirements specified.

7. Check Analysis

7.1 At the request of the purchaser, an analysis of one billet or two samples of flat-rolled stock from each heat or of two pipes from each lot shall be made by the

TABLE 2—CHEMICAL REQUIREMENTS.

	Grade 1	Grade 3	Grade 4	Grade 6*	Grade 7	Grade 8	Grade 9
Carbon, max, per cent...	0.30	0.19	0.12	0.30	0.19	0.13	0.20
Manganese, per cent...	0.40 to 1.06	0.31 to 0.64	0.50 to 1.05	0.29 to 1.06	0.90, max	0.90, max	0.40 to 1.06
Phosphorus, max, per cent.....	0.05	0.05	0.04	0.048	0.04	0.045	0.045
Sulfur, max, per cent...	0.06	0.05	0.04	0.058	0.05	0.045	0.050
Silicon, per cent.....	...	0.18 to 0.37	0.08 to 0.37	0.10, min	0.13 to 0.32	0.13 to 0.32	...
Nickel, per cent.....	...	3.18 to 3.82	0.47 to 0.98	...	2.03 to 2.57	8.40 to 9.60	1.60 to 2.24
Chromium, per cent....	...	...	0.44 to 1.01	...	...	...	...
Copper, per cent.....	...	...	0.40 to 0.75	...	...	...	0.75 to 1.25
Aluminum, per cent...	...	...	0.04 to 0.30	...	...	...	...

* For each reduction of 0.01 per cent carbon below 0.30 per cent, an increase of 0.04 per cent manganese above 1.06 per cent would be permitted to a maximum of 1.30 per cent manganese.

to the prescribed temperature, held at that temperature for a period of time in accordance with Table 1, and then furnace cooled to a temperature not exceeding 600 F (316 C). Grade 8 shall be air cooled after the temper to a temperature not exceeding 600 F (316 C).

5. Chemical Composition

5.1 The steel shall conform to the requirements as to chemical composition prescribed in Table 2.

6. Ladle Analysis

6.1 An analysis of each heat of steel shall be made by the steel manufacturer to determine the percentages of the elements specified. The chemical composition thus determined, or that determined from a check analysis made by the pipe manufacturer if the pipe manufacturer has not manufactured the steel, shall be

manufacturer. A lot of pipe shall consist of the following:

Nominal Diameter	Length of Pipe in Lot
Under 2 in. (51 mm).	400 or fraction thereof
2 to 6 in. (51 to 152 mm), incl.....	200 or fraction thereof
Over 6 in. (152 mm).	100 or fraction thereof

7.2 The results of these analyses shall be reported to the purchaser or his representative, and shall conform to the requirements specified.

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.

7.4 For referee purposes, ASTM Methods E 30, Chemical Analysis of