

Specification for the Fabrication of Structural Steel Pipe

API SPECIFICATION 2B
SIXTH EDITION, JULY 2001
EFFECTIVE DATE: JANUARY 1, 2002



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Upstream Segment

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FOREWORD

This specification is under the jurisdiction of the API Committee on Standardization of Offshore Structures.

The purpose of this specification is to provide standards for the fabrication of structural steel pipe formed from plate steel and suitable for use in construction of welded offshore structures.

This specification shall become effective on the date printed on the cover but may be used voluntarily from the date of distribution.

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Suggested revisions are invited and should be submitted to the general manager, Upstream Segment, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

CONTENTS

	Page
1 SCOPE	1
2 REFERENCES.....	1
3 DEFINITIONS.....	1
4 MATERIAL.....	1
5 FABRICATION.....	2
5.1 General	2
5.2 Welding Procedure Qualification	2
5.3 Welder and Welding Operator Qualification	2
5.4 Longitudinal Welds.....	2
5.5 Girth Welds.....	2
5.6	3
6 DIMENSIONS AND TOLERANCES	3
6.1 Diameter, Length, and Wall Thickness.....	3
6.2 Roundness	3
6.3 Circumference	3
6.4 Straightness	3
6.5 Pipe Ends.....	3
7 INSPECTION AND REPAIR	3
7.1 Inspection.....	3
7.2 Weld Inspection.....	3
7.3 Nondestructive Examination.....	3
7.4 Repair of Base Metal Imperfections	3
8 MARKING.....	4
APPENDIX A—SUPPLEMENTARY REQUIREMENTS.....	6
APPENDIX B—METRIC CONVERSION TABLE.....	8
Figures	
A-1—Plate Rolling Direction Orientation.....	6
Tables	
B-1—Metric Conversion Table	8

Suggestions for Ordering API 2B Pipe

In placing orders for steel pipe to be fabricated in accordance with API Specification 2B, the purchaser should specify the following on the purchase order:

- Specification API 2B
- Quantity As required
- Size Nominal length, wall thickness, and outside diameter
- ASTM (or other industry standard) designation for steel plate Specification/Grade/
Supplementary requirements
- Delivery date and shipping instructions As required

The purchaser should state whether any of the following optional requirements are to apply:

- Mill test certificate for steel plate
- End finish (specify, if not standard 30 degree bevel)
- SR1, plate direction of rolling
Longitudinal—"S-IL"
Transverse—"S-IT"
- SR2, notch toughness (specify test temperatures and minimum energy requirements)
- SR3, 100% radiographic examination (joint can quality assurance)
- SR4, matching weld toughness for designated plate material

Nothing in this specification should be interpreted as indicating a preference by the committee for any optional requirement. In the selection of requirements, the purchaser must be guided by the purchaser's experience and by the service for which the pipe is intended.

Specification for the Fabrication of Structural Steel Pipe

1 Scope

1.1 This specification covers the fabrication of structural steel pipe formed from plate steel with longitudinal and circumferential butt-welded seams, typically in sizes 14 in. outside diameter (OD) and larger (40 in. and larger for LWDS) with wall thickness $\frac{3}{8}$ in. and greater (up to a nominal 40 ft in length) suitable for use in construction of welded offshore structures. The use of the ERW process or spiral welded pipe is not included in this specification. Pipe fabricated under this specification is intended to be used primarily in piling and main structural members, including tubular truss connections, where internal stiffeners are not usually required.

1.2 Manufacturers desiring to apply the API Monogram to the products covered by this specification shall demonstrate to the satisfaction of the American Petroleum Institute a program of education, training, experience, and/or examination assuring the manufacturer's personnel are competent in welding, inspection, nondestructive examination, and testing required or referenced by this specification.

2 References

The following specifications and standards become a part of and shall be considered concurrently with this specification:

ASTM¹

- A 6-99 *General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use*
- A 20-99 *General Requirements for Delivery of Steel Plates for Pressure Vessels*
- A 370-97 *Mechanical Testing of Steel Products*
- E 23-98 *Notched Bar Impact Testing of Metallic Materials*

AWS²

- D1.1-2000 *Structural Welding Code—Steel*

3 Definitions

For the purpose of this standard, the following definitions apply:

3.1 can: A section of structural steel pipe with no girth seam.

¹ASTM, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428.

²American Welding Society, 550 N.W. Le Jeune Road, Miami, Florida 33126.

3.2 fabricator: The person, firm, company, or corporation executing the contract or agreement with the purchaser to fabricate the structural steel pipe under this specification.

3.3 girth weld: A circumferential butt-welded seam lying in a plane perpendicular to the longitudinal axis of the pipe, used to join tubular sections into lengths of straight pipe.

3.4 longitudinal seam: A butt-welded seam which parallels the axis of the pipe.

3.5 longitudinally welded double seam (LWDS) pipe: A can with two longitudinal seams, one of which may be made in the flat plate condition.

3.6 manufacturer: The firm, company, or corporation-furnishing plate steel used in the fabrication of the structural steel pipe.

3.7 mill pipe: A structural steel pipe consisting of multiple cans joined by girth welds.

3.8 pile: A cylindrical tubular member fabricated from one or more lengths of structural steel pipe, usually driven through a leg or sleeve of an offshore platform, that carries vertical loads and resists lateral forces.

3.9 pipe weld: A longitudinal seam made after the plate has been formed into pipe.

3.10 plate weld: A longitudinal seam made between flat plates which are subsequently formed into pipe.

3.11 purchaser: The person, firm, company, or corporation entering into a contract or agreement for the purchase of structural steel pipe fabricated under this specification.

3.12 single seam welded pipe: A can with one longitudinal seam, produced by a continuous welding process.

3.13 structural steel pipe: A cylindrical tubular member formed from steel plate, having a uniform material and wall thickness, with longitudinal and/or circumferential butt welded seams, comprising of the following types: can, single seam welded pipe, longitudinally welded double seam (LWDS) and mill pipe.

4 Material

4.1 Pipe furnished to this specification shall be fabricated from plate steel as specified by the purchaser.

4.2 The purchaser shall specify the grade and quality of plate steel to be used. When the plate steel is furnished by the fabricator, a mill test certificate must be available and shall be furnished to the purchaser upon request. All plate shall bear

mill identification numbers, including sections cut to size from the original mill-produced plate.

Note: Ultrasonic inspection, as a supplementary requirement to the designated plate specification, may be specified, if desired, when structural steel pipe is to be used in the fabrication of tubular joint cans in T, Y, and/or K connections where freedom from laminations and/or other internal defects is required.

5 Fabrication

5.1 GENERAL

5.1.1 Forming pipe furnished to this specification shall normally be formed below 400°F, that is, cold formed. Warm forming (between 800°F and 1200°F or 50°F below the tempering temperature of quenched and tempered steels) may be employed provided forming procedures for heat treated or TMCP steel are qualified to demonstrate the mechanical strength properties required by the original plate specification are met in the warm formed condition. Hot forming (above the upper critical temperature) may also be employed provided the forming procedure is qualified to demonstrate all mechanical properties required by the original plate specifications are met.

5.1.2 The purchaser may specify Supplementary Requirement 1 if the rolled direction of the plate is desired to be oriented in a specific direction during the forming of the pipe, and the pipe shall be so identified.

5.1.3 All welding shall be in accordance with AWS D1.1-2000, Structural Welding Code—Steel. Unless otherwise approved by the purchaser, the submerged arc welding process shall be employed for all welding—except tack welds, root passes and repair welding where other AWS approved processes may be utilized. All welds shall be complete joint penetration groove welds produced by employing AWS D1.1 prequalified joint details, or other joint configurations qualified by procedure qualification testing.

Welding electrodes and fluxes shall conform to applicable AWS specifications and shall be selected to match the minimum ultimate strength of the base material, and to provide a minimum of 20 ft-lbs Charpy V-notch (CVN) impact energy at 0°F. Matching CVN toughness may be specified by invoking Supplementary Requirement S4.

If the AWS specification requirement for the electrodes and fluxes to be employed is less than the foregoing, or if the welding procedure falls outside the range of essential variables tested in the AWS specification, then Charpy test specimens shall be removed from a simulated production weld and tested in accordance with Annex III of AWS D1.1.

The deposited weld metal shall possess an energy value not less than indicated. The foregoing requirements shall apply separately to the final condition of plate welds, pipe welds, and girth welds.

All welding shall conform to the minimum workmanship standards of Section 5 of AWS D1.1.

5.2 WELDING PROCEDURE QUALIFICATION

The welding procedures shall be established in accordance with AWS D1.1. Written pre qualified welding procedures may be employed by the fabricator provided the procedure complies with all requirements (joint detail, filler metal, and so forth) for pre qualified status detailed in Appendix IV of AWS D1.1. More stringent Charpy V-notch toughness in the weld and/or heat affected zones than required in 5.1.3 above may be obtained, if desired, by specification of Supplementary Requirement (SR2).

The welding procedures shall be established in accordance with AWS D1.1. Written pre qualified welding procedures may be employed by the fabricator provided the procedure complies with all requirements (joint detail, filler metal, etc.) for pre qualified status detailed in Appendix IV of AWS D1.1. More stringent CVN toughness in the weld and/or heat affected zones than required in Par. 3.3. above may be obtained, if desired, by specification of Supplementary Requirement S2.

The foregoing requirements shall apply separately to plate welds, pipe welds and girth welds.

5.3 WELDER AND WELDING OPERATOR QUALIFICATION

Welders and welding operators shall be qualified in accordance with AWS D1.1, Chapter 4, Part B or C, as applicable. Radiography is acceptable for the qualification of submerged arc machine operators.

5.4 LONGITUDINAL WELDS

Radial offset of abutting edges of longitudinal weld seams shall not exceed $1/8$ in. For LWDS pipe, no two longitudinal seams shall be closer together than one pipe diameter or 5 ft, whichever is greater. Longitudinal weld seams of adjoining cans shall be staggered as shown below, unless closer spacing is agreed upon by the purchaser and the fabricator.

seam spacing	stagger
360° (single seam)	90° - 180°
180° (LWDS)	45° - 90°
other (LWDS)	min. 25% of smaller seam spacing

5.5 GIRTH WELDS

Radial offset of abutting edges of the girth seams shall not exceed $0.2T$ (where T is the wall thickness) or $1/4$ in. maximum provided the offset exceeding $1/8$ in. is welded from both sides. One localized area per girth weld up to $0.3T$, or $3/8$ in. maximum, is permitted provided the localized area is under $8T$ in length and weld metal is added to this region to provide a 4:1 tapered transition.

No two girth welds shall be located closer together than one pipe diameter or 3 ft, whichever is less. There shall be no more than two girth welds in any 10-ft interval of pipe.

5.6

For LWDS pipe, no two girth welds shall be located closer together than 10 ft. This requirement does not apply to subsequent fabrication which incorporates the mill pipe into a pile or structure.

6 Dimensions and Tolerances

6.1 DIAMETER, LENGTH, AND WALL THICKNESS

The diameter, length, and wall thickness of pipe furnished to this specification shall be as specified by the purchaser. The length of each pipe shall not vary from the specified nominal length more than $\pm 1\frac{1}{2}$ in. per 10 ft of length.

6.2 ROUNDNESS

The out-of-roundness, that is, the difference between the major and minor outside diameters at any point in a length of pipe, shall not exceed 1% of the nominal diameter or $\frac{1}{4}$ in. maximum for wall thicknesses up to and including 2 in. For wall thickness exceeding 2 in., the maximum permitted deviation shall not exceed an out-of-roundness to wall thickness ratio of 1:8. For pipe exceeding 48 in. in diameter, a maximum deviation of $\frac{1}{2}$ in. shall be permitted provided the circumference tolerance is maintained within $\pm \frac{1}{4}$ in.

6.3 CIRCUMFERENCE

The outside circumference at any point in a length of pipe shall be within $\pm 1\%$ of the nominal circumference or within $\pm \frac{1}{2}$ in., whichever is less.

6.4 STRAIGHTNESS

The maximum allowable straightness deviation in any 10-ft length shall be $\frac{1}{8}$ in. For lengths over 10 ft, the maximum deviation of the entire length may be computed by the following formula, not to exceed $\frac{3}{8}$ in. in any 40-ft length.

$$\frac{1}{8} \text{ in.} \cdot \frac{\text{total length in ft}}{10 \text{ ft}}$$

6.5 PIPE ENDS

Unless otherwise specified, all pipe shall be beveled for welding with an angle of 30 degrees ± 2.5 degrees (measured from a line perpendicular to the surface of the pipe) with a root face of $\frac{1}{16}$ in. $\pm \frac{1}{32}$ in. The root face shall be perpen-

dicular to the longitudinal axis of the pipe within $\frac{1}{16}$ in. per ft of diameter, with a maximum allowable deviation of $\frac{1}{4}$ in., measured with a square and straight edge across the end of the pipe.

7 Inspection and Repair

7.1 INSPECTION

Fabrication and verification inspection shall be conducted in accordance with the requirements of AWS D1.1, Section 6, to assure compliance with the applicable requirements of Sections 1 through 6.

7.2 WELD INSPECTION

All welds shall be visually inspected on both the inside and outside surfaces. The weld profile shall meet the requirements of AWS D1.1, Section 5.24.

7.3 NONDESTRUCTIVE EXAMINATION

100% of each girth weld and spot testing amounting to 10% of each longitudinal weld (including the extreme ends) shall be examined by radiographic or ultrasonic inspection in accordance with the requirements of Section 6 and Part E with Paragraph 6.12.3 and Part F with Paragraph 6.13.3.1 of AWS D1.1. More extensive radiographic coverage may be obtained, if desired, by specification of Supplementary Requirement SR3. The fabricator shall be responsible for conducting all radiographic examinations.

7.4 REPAIR OF BASE METAL IMPERFECTIONS

Imperfections detected in the base metal shall be explored to determine the extent of each. Imperfections in the finished tube no deeper than 5% of the specified nominal wall thickness and mechanical marks no deeper than 5% of the nominal wall thickness or $\frac{1}{16}$ in. in depth need not be removed. Imperfections which exceed the above shall be ground to sound metal. The excavation area shall be faired, and the thickness in the ground area shall not be reduced more than 7% of the nominal thickness but in no case more than $\frac{1}{8}$ in. depth. If the depth of imperfections in as-rolled plate exceeds the above limits, but not more than 20% of the nominal thickness, welding repairs may be performed. Repair of defects deeper than 20% of the nominal wall thickness or repair of defects with a length and/or width more than 20% of the nominal diameter shall not be permitted. Tubulars made from other than as-rolled plate shall not be repaired by welding unless specifically approved by the purchaser.

8 Marking

Pipe fabricated in conformance with this specification shall be marked by the fabricator as specified below. Each section of the pipe shall be paint stenciled on the inside of both ends in letters a minimum of 1 in. high with the following:

- a. Fabricator's name.
- b. The API Monogram shall be applied to products complying with the requirements of the specification and only by licensed fabricators.
- c. API 2B.
- d. ASTM or other industry designation of plate steel employed in fabricating the pipe.
- e. Nominal outside diameter.
- f. Nominal wall thickness.
- g. Specified supplementary requirements, for example, SR1, SR2, SR3 and/or S4.

APPENDIX A—SUPPLEMENTARY REQUIREMENTS

Introduction

When specified on the purchase order, the following supplementary requirements shall apply:

SR1 Plate Rolling Direction Orientation

SR1.1 The orientation of the pipe axis relative to the final rolling direction of the plate from which the pipe is formed shall be longitudinal or transverse (circumferential) as indicated on the purchase order and illustrated below.

SR1.2 Pipe fabricated in accordance with this supplementary requirement shall be identified by marking “S-IL” or “S-IT” adjacent to “API 2B” as required by Section 8, Item e and Item g. See Figure A-1.

SR2 CVN Toughness Tests

Notch toughness tests shall be conducted as a requirement of the welding procedure qualification tests. The welding procedure qualification test coupon shall be welded and tested in accordance with Paragraph 5.10.1 of AWS D1.1. Charpy V-notch test specimens shall be removed from the weld and heat affected zone in accordance with the requirements of Appendix III of AWS D1.1. The test temperature, notch location (if different from AWS), and the minimum average energy value shall be as indicated on the purchase order. The pipe shall be identified by marking as required in Section 8, Item g.

SR3 100 Percent Radiographic Examination

In addition to 100% radiography of the girth welds specified by 7.3, each designated longitudinal weld shall be examined by radiography throughout its entire length. Pipe inspected in accordance with this supplementary requirement shall be identified by marking as required in Section 8, Item g.

SR4 Matching Weld CVN Toughness for Designated Plate Material

SR4.1 Depending on the Strength Group and Toughness Class of the designated API or ASTM plate specification, as given in Table C2.4 of AWS D1.1, the corresponding

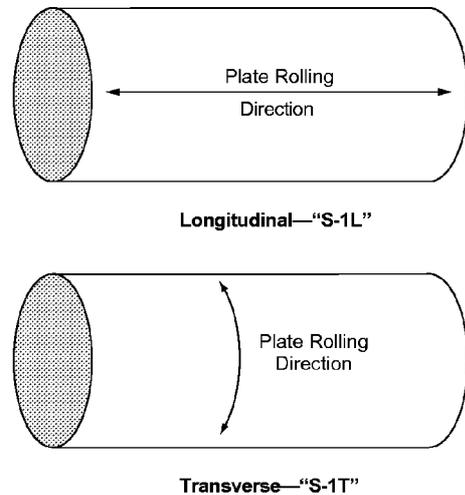


Figure A-1—Plate Rolling Direction Orientation

required weld metal CVN toughness shall be as given in Table C4.1 of AWS D1.1, and the heat affected zone (HAZ) CVN toughness shall be given in Table C4.2 of AWS D1.1.

SR4.2 Charpy test specimens shall be removed from both the weld metal and HAZ of a simulated production weld and tested in accordance with Annex III of AWS D1.1. The deposited weld metal and HAZ shall possess average energy values not less than indicated in Tables C4.1 and C4.2 of AWS D1.1, respectively, and no single test shall be more than 5ft-lbs lower. The foregoing requirements shall apply separately to plate welds, pipe welds and girth welds.

SR4.3 For steels not listed in Table C2.4 of AWS D1.1, or below, the purchaser shall designate the group and class for which matching weld toughness is desired. HAZ requirements for Group III Class B shall be the same as for Group II Class B.

additional steel	group	class
API Spec 2MT1	II	B

SR4.4 Further guidance is given in Sections C2.42.2 and C4.12.4.4 of AWS D1.1.

APPENDIX B—METRIC CONVERSION TABLE

Application of the following equivalent values may be employed when converting the units of measure employed herein to standard metric (SI) practice.

Table B-1—Metric Conversion Table

Stated Value	Metric Equivalent
1/32 in.	0.8 mm
1/16 in.	1.6 mm
1/8 in.	3.2 mm
1/4 in.	6.4 mm
3/8 in.	9.5 mm
1/2 in.	12.7 mm
1 1/2 in.	38.1 mm
2 in.	50.8 mm
48 in.	1.22 m
10 ft	3.05 m
40 ft	12.19 m
0°F	-18°C
50°F	10°C
400°F	204°C
800°F	427°C
1200°F	649°C
20 ft - lbs	28 J

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