Specification for Coiled Line Pipe

API SPECIFICATION 5LCP
FIRST EDITION, NOVEMBER 1999

American Petroleum Institute

Helping You Get The Job Done Right?

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Upstream Segment

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FOREWORD

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1 Scope

1.1 The purpose of this specification is **to** provide standards for pipe suitable for use in conveying gas, water, **and oil in** both the oil and natural gas industries.

This specification covers welded steel continuously milled pipe in the size range 0.5 in. (12.7 mm) to 6.625 in. (168.3 mm). Pipe that is pipe-to-pipe welded outside the confines of the manufacturing plant is not included within this document.

1.2 Grades **covered by** this specification are X52C, X56C, X60C, X65C, X70C, **and** X80C.

Note: Grade designations used herein are composed of the letter X followed by the first two digits of the specified minimum yield strength in U.S. Customary units, and **the** letter C to indicate coiled **pipe**.

1.3 Pipe manufactured as Grade X60C or higher shall not be substituted for pipe ordered for Grade X52C or lower without purchaser approval.

1.4 Although the plain-end coiled line pipe meeting this specification is intended to be suitable for field welding, the manufacturer will not assume responsibility for field welding.

1.5 The size designations used herein are outside-diameter sizes. Pipe sizes $2^3/_8$ and larger are **expressed** as integers and fractions; pipe sizes smaller than $2^3/_8$ are expressed to three decimal places.

1.6 U.S. Customary units are used in this specification; SI (metric) units are shown in parentheses in the text and in many tables. See Appendix **M** for specific information about conversion factors and rounding procedures.

1.7 The suitability of these products for use in environments containing hydrogen sulfide is outside of the scope of this document.

2 References

2.1 This specification includes by reference-either in total or in part-the latest editions of the following API and industry standards. In the event there are conflicting requirements, this specification shall govern:

API

RP 5C7	*Recommended Practice for Coiled Tubing Operations in Oil and Gas Well Services*
Spec 5L	*Specification for Line Pipe*
Std 1104	*Welding Pipelines and Related Facilities*

ASME[1]

Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"

ASTM[2]

A 370	*Methods and Dejinitions for Mechanical Testing of Steel Products*
A 450	*Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes*
A751	*Test Methods, Practices, and Dejnitions for Chemical Analysis of Steel Products*
E 4	*Practices for Force Verification of Testing Machines*
E 8	*Test methods for Tension Testing of* Metallic *Materials*
E 29	*Practice for Using Significant Digits in Test Data to Determine Conformance With Specifications*
E 83	*Practice for Verification and Classification of Extensometers*
E 165	*Practice for Liquid Penetrant Inspection*
E 709	*Practice* for *Magnetic Particle Inspection*
E 747	*Design, Manufacture, and Material Grouping Classification for Wire Image Quality Indicators (IQIs) used for Radiology*
E 1025	*Design, Manufacture, and Material Grouping Classification for Wire Image Quality Indicators*

2.2 Other nationally or internationally recognized standards shall be submitted to and approved by API for inclusion in this specification prior to their use as equivalent standards.

3 Definitions

For the purposes of this specification, the following definitions apply:

3.1 Bauschinger effect: A phenomenon **that occurs** in polycrystalline metals, including steel, that results in a decrease in the yield strength in one direction due to plastic deformation in another direction, such as caused by service loads, coiling, or straightening.

3.2 coiled line pipe: Pipe manufactured to this specification.

3.3 continuously milled pipe: Carbon steel coiled tubular products manufactured using the electric welding processes in milled lengths greater than **200 ft.**

[1]ASME International, 3 Park Avenue, New York, New York, 10016-5990.

*ASTM, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania. 19428-2959.

3.4 **defect:** An imperfection of sufficient magnitude to warrant rejection of the product based on the stipulations of this specification.

3.5 imperfection: A discontinuity or irregularity in the product detected by methods outlined in this specification.

3.6 lamination: An internal metal separation creating layers generally parallel to the surface.

3.7 manufacturer: A firm, company, or corporation responsible for marking the product to warrant that it conforms to this specification. The manufacturer may be, as applicable, a pipe mill or processor. The manufacturer is responsible for compliance with all of the applicable provisions of this specification.

3.6 master coil: The original wide coil of steel that is supplied by the steel manufacturer and is subsequently slit into several narrower coils of skelp of the appropriate width for the manufacture of coiled line pipe.

3.9 **may:** Used as a verb to indicate that a provision is optional.

3.10 milled length: A single length of coiled line pipe created during continuous operation of a mill. A milled length may include pipe manufactured from a number of coils of skelp. A milled length does not include pipe-to-pipe welds.

3.11 normalize: A heat treatment of steel whereby the steel is heated to a temperature above the upper critical temperature to achieve transformation to austenite then allowed to cool in still air to a temperature substantially below the lower critical temperature.

3.12 pipe mill: A firm, company, or corporation that operates pipe making facilities.

3.13 reel: A wooden or metal capstan-like device for holding coiled pipe.

3.14 shall: Used to indicate that a provision is mandatory.

3.15 should: Used to indicate that a provision is not mandatory but is recommended as good practice.

3.16 skelp: Flat steel rolled to specified tolerances and slit to the appropriate width for the manufacture of coiled line pipe.

3.17 special processes: Certain operations performed during skelp joining and pipe manufacturing that affect attribute compliance required in this document (except chemistry and dimensions). The applicable special processes are as follows:

a. Welded without filler metal (seam weld):

Manufacturing Condition	Special Processes
Heat Treated Pipe	Seam weld and full body heat treatment. NDT.

b. Welded with filler metal (skelp-end weld and pipe-to-pipe weld):

Manufacturing Condition	Special Processes
Heat Treated	Skelpend weld. Heat treatment of skelp-end weld. Pipe-to-pipe weld. Heat treatment of pipe-to-pipe weld. NDT.

4 Information to be Supplied by the Purchaser (See Note 1)

4.1 PURCHASER SPECIFICATION

In placing orders for line pipe to be manufactured in accordance with API Spec 5LCP, the purchaser should specify the following on the purchase order:

Information	Reference
Specification	API Spec 5LCP
Grade	Tables 1 and 2
Size: Outside dieter	7.2, Table 3
Specified wall thickness	7.3
Nominal length	75
Pipe-to-pipe welds	7.6 Appendices A and B
Pipe ends	7.8
Shipping reel dimensions	Appendix H
Delivery date and shipping instructions	

4.2 OPTIONAL PURCHASER REQUIREMENTS

The purchaser should also state on the purchase order his requirements concerning the following stipulations, which are optional with the purchaser:

Information	Reference
Fracture toughness tests	6.25
Nondestructive inspection for laminations	7.7.6
Radiographic penetrameter	8.6.3.4
Nondestructive inspection of standard demonstration	8.6.4.4
Markings in SI (metric) units	9.1.1
Bare pipe — special coatings	10.1
Method of pipe-ta-pipe welding	Appendices A, B
Purchaser inspection	Appendix F
Monogram marking (see Note 2)	Appendix G

4.3 REQUIREMENTS SUBJECTTO AGREEMENT

The following stipulations are subject to agreement between the purchaser and the manufacturer:

Information	Reference
Chemical composition	6.1 .1
Intermediate diameters	7.1
Intermediate wall thickness	7.1
Pipe-to-pipe welds	7.6
Trim of inside flash	7.7.4
Gauge ball	7.9
Hydrostatic test pressure	8.4.3
Additional skelp-end weld inspection	8.6.2.1
Additional inspection of pipe-t&pipe welds	8.6.2.3
Type of X-ray penetrameter	8.6.3.4
Nondestructive test reference standard	8.6.4.2
Marking requirements	9.1 and Appendix G
Drying of coil	10.2.3
Supplementary requirements	Appendix E
Shipping reel size	Appendix H

Notes:

1. Nothing in this specification should be interpreted as indicating a preference by the committee for any material or process or as indicating equality between the various materials or processes. In the selection of materials and processes, the purchaser must be guided by experience and by the service for which the pipe is intended.
2. Users of this specification should note that there is no longer a requirement for marking a product with the API monogram. The American Petroleum Institute continues to License use of the monogram on products covered by this specification, but it is administered by the staff of the Institute separately from the specification. Tbe policy describing use of the monogram is contained in Appendix G. No other use of the monogram is permitted. Licensees may mark products in conformance with Appendix G or Section 9, and nonlicensees may mark products in conformance with Section 9.

5 Process of Manufacture and Material

5.1 PROCESS OF MANUFACTURE

Pipe furnished to this specification shall be welded as defined in 5.2.1.

5.2 TYPE OF PIPE

52.1 Electric Welded Pipe

Electric welded pipe is defined as pipe having one longitudinal seam produced by the electric welding process defined in 5.4.1 .I.

5.3 TYPES OF WELDS

5.3.1 Electric Weld (Seam)

An electric weld is a longitudinal weld produced by the electric-welding process defined in 5.4.1 .1.

5.3.2 Skelp End Weld

A skelp-end weld is a butt-weld that joins skelp-ends together. Skelp-end welds shall be made in accordance with a qualified welding procedure, using gas metal-arc welding, plasma-arc welding or gas tungsten-arc welding. (See Appendix B). Skelp-end welds shall be at right angles or at an acute angle to the edges of the skelp.

5.3.3 Pipe-to-Pipe Weld

A pipe-to-pipe weld is a circumferential butt-weld that joins two pieces of pipe together. Pipe-to-pipe welds shall be made in accordance with a qualified welding procedure, using gas metal-arc welding, plasma-arc welding, gas tungsten-arc welding, or a combination of such welding processes. (See Appendices A and B).

5.4 WELDING PROCESSES

5.4.1 Without Filler Metal

5.4.1.1 Electric Welding

A process of forming a seam by electric resistance or electric induction welding wherein the edges to be welded are mechanically pressed together and the heat for welding is generated by resistance to flow of electric current.

5.4.2 With Filler Metal

Welds made with filler metals are for skelp-end welds and pipe-to-pipe welds only.

5.4.2.1 Gas Metal-Arc Welding

A welding process that produces coalescence of metals by heating them with an arc or arcs between a continuous consumable electrode and the work. Shielding is obtained entirely from an externally supplied gas or gas mixture. pressure is not used, and the filler metal is obtained from the electrode.

5.4.2.2 Plasma Arc Welding

A welding process that produces coalescence of metals by heating them with a constricted arc between an electrode and the workpiece, or the electrode and a nozzle. Shielding is obtained from the hot ionized gas issuing from the torch, which may be supplemented by an auxiliary source of shielding gas. Shielding gas may be an inert gas or a mixture of gases. pressure may or may not be used.

5.4.2.3 Gas Tungsten-Arc Welding

An arc-welding process that produces coalescence of the metals by heating them with an arc between a single tungsten

electrode and the work. Shielding is obtained from a gas. Pressure is not used, and a filler metal may or may not be used.

5.5 HEATTREATMENT

The heat-treating process shall be performed in accordance with a documented procedure. For all grades, the weld seam and the entire heat-affected zone shall be heat treated so as to simulate a normalizing heat treatment (see note) followed by full-body stress relief and/or temper, except that by agreement between the purchaser and the manufacturer, alternative heat treatments or combinations of heat treatment and chemical composition may be substituted. Where such substitutions are made, the manufacturer shall demonstrate the effectiveness of the method selected using a procedure that is mutually agreed upon. This procedure may include, but is not necessarily limited to, hardness testing, microstructural evaluation, and mechanical testing.

Note: During the manufacture of electric-welded pipe, the product is in motion through the surrounding air. Normalizing is usually **defined as "cooling in still air," hence the phrase "to simulate a normalizing heat treatment" is used here.**

See 9.2.6 for applicable marking requirements.

5.6 TRACEABILITY

The manufacturer shall establish and follow procedures for maintaining heat and master coil identity until all required heat and master coil tests are performed and conformance with specification requirements has been shown.

6 Material Requirements

6.1 CHEMICAL PROPERTIES

6.1.1 Chemical Composition

The composition of pipe furnished to this specification shall conform to the chemical requirements specified in Table 1, except that other chemical compositions may be furnished by agreement between the purchaser and the manufacturer.

Columbium, vanadium, titanium, or combinations thereof may be used at the discretion of the manufacturer. For all grades, by agreement between the purchaser and the manufacturer, elements other than niobium (columbium), vanadium, and titanium may be used; however, caution should he exercised in determining the quantity that may be present for any particular size and thickness of pipe, because the addition of such otherwise desirable elements may alter pipe weldability.

Note: For each reduction of **0.01% below the specified maximum** carbon content, an increase of 0.05% above the specified maximum **manganese content is permissible up to a maximum of I .45% for X52C, 1.60% for grades higher than X52C and** lower than X70C, **and 2.00% for grade X70C and higher.**

6.1.2 Elements Analyzed

As a minimum, each required analysis shall include the determination of the following:

a. Carbon, manganese, phosphorus, sulphur, and silicon.

b. Chromium, molybdenum, niobium (columbium), vanadium, nickel, copper, titanium, and boron or combinations thereof, if added during steel making.

c. Any other alloying element added during steel making for other than deoxidation purpose.

6.2 MECHANICAL PROPERTIES

6.2.1 Tensile Properties

All coiled line pipe grades shall conform to the tensile requirements specified in Table 2. Tensile tests to determine conformance shall be conducted on samples taken prior to any spooling.

The yield strength shall be determined by the 0.2% offset method. When elongation is recorded or reported, the record or report shall show the nominal width of the test specimen when strip specimens are used, or state when full section specimens are used.

Note: Spooling and unspooling of coiled line pipe can result in a reduction of the yield strength of approximately 5 to 10% due to the Bauschinger Effect. For this reason, pipe grade will be based on tests conducted prior **to the first spooling step in the manufacturing process.**

Table I-Chemical Requirements by Percentage of Weight

Grade	Carbon Max	Manganese Max	Phosphorus Max	Sulphur Max
X52C	0.22	1.35	0.025	0.015
X56C	0.22	1.35	0.025	0.015
X60C	0.22	1.35	0.025	0.015
X65C	0.22	1.40	0.025	0.015
X70C	0.22	1.60	0.025	0.015
X80C	0.22	1.80	0.025	0.015

Table 2-Tensile Requirements

Grade	Yield Strength psi (MPa) Min.	Ultimate Tensile Strength psi (MPa) Min.	Ultimate Tensile Strength psi (MPa) Max
X52C	52,000 (359)	66,000 (455)	110,000 (758)
X56C	56,000 (386)	71,000 (490)	110,000 (758)
X60C	60,000 (414)	75,000 (517)	110,000 (758)
X65C	65,000 (448)	77,000 (530)	110,000 (758)
X70C	70,000 (483)	80,000 (551)	110,000 (758)
X80C	80,000 (551)	88,000 (607)	120,000 (827)

The minimum elongation in 2.0 in. (50.8 mm) shall be that determined by the following equation:

US. Customary Equation	SI Equation
$e = 625{,}000A^{0.2}/U^{0.9}$	$e = 1944A^{0.2}/U^{0.9}$

where

e = minimum elongation in 2.0 in. (50.8 mm) in percent, to the nearest percent,

A = cross-sectional area of the tensile test specimen in $in.^2$ (mm*) based on specified outside diameter or nominal specimen width and specified wall thickness rounded to the nearest 0.01 $in.^2$ (10 mm^2) or 0.75 in? (485 mm^2), whichever is smaller,

U = specified minimum ultimate tensile strength, psi (MPa).

See Appendix C for minimum elongation values for various size tensile specimens and grades.

6.2.2 Flattening-Test Acceptance Criteria

Acceptable criteria for flattening tests shall be as follows. For all pipe diameter-to-thickness ratios (D/t), flatten to two-thirds of the original OD without weld opening. For pipe with a D/t greater than 10, continue flattening to one-third of the original OD without cracks or breaks other than in the weld. For all pipe D/t, continue flattening until opposite walls of the pipe meet; no evidence of lamination shall develop during the entire test.

6.2.3 Weld Ductility Test

For all pipe, the weld ductility shall be determined by tests on full-section specimens of 4-in. (152.4 mm) minimum length. The specimens shall be flattened at room temperature between parallel plates. The weld shall be placed 90" from the direction of applied force (point of maximum bending). No crack or breaks exceeding 0.125 in. (3.2 mm) in any direction in the weld or the parent metal shall occur on the outside surface until the distance between the plate is less than the value of S calculated by the equation shown below, except that cracks which originate at the edge of the specimen that are less than 0.25 in. (6.4 mm) long shall not be cause for rejection.

U.S. Customary Units	SI (Metric) Units
$S = 3.05t/(0.05 + 3t/D)$	$S = 77.47t/(0.05 + 3t/D)$

where

S = distance between flattening plates, in. (mm),

t = specified wall thickness of the pipe, in. (mm),

D = specified outside diameter of the pipe, in. (mm).

Table 3-Coiled Line Pipe Dimensions, Weights Per Unit Length and Test Pressures

(1)		(2) [a]	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Designation		Outside Diameter D	Wall Thickness t	Weight Per Unit Length w_{pe}	Inside Diameter d	Minimum Test Pressure (psi) Grade					
Size	Wall	(in.)	(in.)[a]	(lb/ft)	(in.)	X52C	X56C	X60C	X65C	X70C	X80C
0.500	0.035	0.500	0.035	0.17	0.430	5,800	6,300	6,700	7,300	7,800	9.000
0.500	0.049	0.500	0.049	0.24	0.402	8,200	8,800	9,400	10,200	11,000	12,500
0500	0.065	0.500	0.065	0.30	0.370	10.800	11,600	12500	13500	14,600	15,000
0.750	0.080	0.750	0.080	0.57	0.590	8,900	9,600	10,200	11,100	11,900	13,700
0.750	0.083	0.750	0.083	0.59	0.584	9,200	9,900	10,600	11,500	12,400	14,200
0.750	0.087	0.750	0.087	0.62	0.576	9,700	10,400	11,100	12,100	13,000	14,800
0.750	0.095	0.750	0.095	0.67	0.560	10,500	11300	12,200	13,200	14,200	15,000
0.750	0.102	0.750	0.102	0.71	0.546	11300	12,200	13,100	14,100	15.000	15,000
1.000	0.080	1.000	0.080	0.79	0.840	6,700	7,200	7,700	8,300	9,000	10,200
1.000	0.083	1.000	0.083	0.81	0.834	6,900	7,400	8,000	8,600	9,300	10,600
1 .000	0.087	1.000	0.087	0.85	0.826	7,200	7,800	8,400	9,000	9,700	11,100
1.000	0.095	1.000	0.095	0.92	0.810	7,900	8,500	9,100	9,900	10,600	12,200

Table 3—Coiled Line Pipe Dimensions, Weights Per Unit Length and Test Pressures (Continued)

(1)		(2)[a]	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Designation		Outside Diameter *D*	Wall Thickness *t*	Weight Per unit Length w_{pe}	Inside Diameter *d*	Minimum Test Pressure (psi) Grade					
Size	Wall	(in.)	(in.)"	(lb/ft)	(in.)	X52C	X56C	X60C	X65C	X70C	X80C
1.000	0.102	1.000	0.102	0.98	0.796	8500	9,100	9,800	10,600	11,400	13,100
1.000	0.109	1.000	0.109	1.04	0.782	9,100	9,800	10,500	11,300	12,200	14,000
1.000	0.125	1.000	0.125	1.17	0.750	10,400	11,200	12,000	13,000	14,000	15,000
1.000	0.134	1.000	0.134	1.24	0.732	11,100	12,000	12,900	13,900	15,000	15,000
1.250	0.075	1.250	0.075	0.94	1.100	5,000	5,400	5,800	6,200	6,700	7,700
1.250	0.080	1.250	0.080	1'00	1.090	5,300	5,700	6,100	6,700	7,200	8,200
1.250	0.087	1.250	0.087	1.08	1.076	5,800	6,200	6,700	7,200	7,800	8,900
1.250	0.095	1.250	0.095	1.17	1.060	6,300	6,800	7,300	7,900	8,500	9,700
1.250	0.102	1.250	0.102	1.25	1.046	6,800	7,300	7,800	8,500	9,100	10,400
1.250	0.109	1.250	0.109	1.33	1.032	7300	7,800	8,400	9,100	9,800	11,200
1.250	0.118	1.250	0.118	1.43	1.014	7,900	8,500	9,100	9,800	10,600	12,100
1.250	0.125	1.250	0.125	1.50	1.000	8,300	9,000	9,600	10,400	11,200	12,800
1.250	0.134	1.250	0.134	1.60	0.982	8,900	9,600	10,300	11,100	12,000	13,700
1.250	0.145	1.250	0.145	1.71	0.960	9,700	10,400	11,100	12,100	13,000	14,800
1.250	0.156	1.250	0.156	1.82	0.938	10,400	11,200	12,000	13,000	14,000	15,000
1.250	0.175	1.250	0.175	2.01	0.900	11,600	12,500	13,400	14,600	15,000	15,000
1.500	0.087	1.500	0.087	1.31	1.326	4,800	5,200	5,600	6,000	6,500	7,400
1.500	0.095	1.500	0.095	1.43	1.310	5,300	5,700	6,100	6,600	7,100	8,100
1500	0.102	1.500	0.102	152	1.296	5,700	6,100	6,500	7,100	7,600	8,700
1500	0.109	1500	0.109	1.62	1282	6,000	6,500	7,000	7,600	8,100	9,300
1.500	0.118	1500	0.118	1.74	1.264	6,500	7,000	7,600	8,200	8,800	10,100
1500	0.125	1500	0.125	1.84	1.250	6,900	7,500	8,000	8,700	9,300	10,700
1500	0.134	1500	0.134	1.96	1.232	7,400	8,000	8,600	97300	10,000	11,400
1500	0.145	1.500	0.145	2.10	1.210	8,000	8,700	9300	10,100	10,800	12,400
1.500	0.156	1500	0.156	2.24	1.188	8,700	9,300	10,000	10,800	11,600	13,300
1.500	0.175	1500	0.175	2.48	1.150	9,700	10,500	11,200	12,100	13,100	14,900
1500	0.188	1500	0.188	2.64	1.124	10,400	11,200	12,000	13,000	14,000	15,000
1500	0.204	1500	0.204	2.83	1.092	11,300	12200	13,100	14,100	15,000	15,000
1.750	0.095	1.750	0.095	1.68	1560	4,500	4,900	5,200	5,600	6,100	6,900
1.750	0.102	1.750	0.102	1.80	1546	4,800	5,200	5,600	6,100	6,500	7,500.
1.750	0.109	1.750	0.109	1.91	1532	5,200	5,600	6,000	6,500	7,000	8,000
1.750	0.118	1.750	0.118	2.06	1514	5,600	6,000	6,500	7,000	7,600	8,600
1.750	0.125	1.750	0.125	2.17	1.500	5,900	6,400	6,900	7,400	8,000	9,100
1.750	0.134	1.750	0.134	231	1.482	6,400	6,900	7,400	8,000	8,600	9,800
1.750	0.145	1.750	0.145	2.49	1.460	6,900	7,400	8,000	8,600	9,300	10,600
1.750	0.156	1.750	0.156	2.66	1.438	7,400	8,000	8,600	9,300	10,000	11,400
1.750	0.175	1.750	0.175	2.95	1.400	8,300	9,000	9,600	10,400	11,200	12,800
1.750	0.188	1.750	0.188	3.14	1.374	8,900	9,600	10,300	11,200	12,000	13,800
1.750	0.204	1.750	0.204	337	1.342	9,700	10,400	11,200	12,100	13,100	14,900
2.000	0.109	2.000	0.109	2.20	1.782	4,500	4,900	5,200	5,700	6,100	7,000
2.000	0.188	2.000	0.118	2.37	1.764	4,900	5,300	5,700	6,100	6,600	7,600
2.000	0.125	2.000	0.125	251	1.750	5,200	5,600	6,000	6,500	7,000	8,000
2.000	0.134	2.000	0.134	2.61	1.732	5,600	6,000	6,400	7,000	7,500	8,600
2.000	0.145	2.000	0.145	2.88	1.710	6,000	6,500	7,000	7,500	8,100	9,300

Table 3-Coiled Line Pipe Dimensions, Weights Per Unit Length and Test Pressures (Continued)

(1)		(2) [a]	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Designation		Outside Diameter D	Wall Thickness t	Weight Per Unit Length w_{pe}	Inside Diameter d	Minimum Test Pressure (psi) Grade					
Size	Wall	(in.)	(in.)"	(lb/ft)	(in.)	X52C	X56C	X60C	X65C	X70C	X80C
2.000	0.156	2.000	0.156	3.08	1.688	6500	7,000	7500	8,100	8,700	10,000
2.000	0.175	2.000	0.175	3.41	1.650	7,300	7,800	8,400	9,100	9,800	11,200
2.000	0.188	2.000	0.188	3.64	1.624	7,800	8,400	9,000	9,800	10,500	12,000
2.000	0.204	2.000	0.204	3.92	1.592	8,500	9,100	9,800	10,600	11,400	13,100
2.000	0.224	2.000	0.224	4.25	1.552	9,300	10,000	10,800	11,600	12,500	14,300
2.000	0.250	2.000	0.250	4.68	1.500	10,400	11,200	12,000	13,000	14,000	15,000
$2^3/_8$	0.109	2.375	0.109	2.64	2.157	3,800	4,100	4,400	4,800	5,100	5,900
$2^3/_8$	0.118	2.375	0.118	2.85	2.139	4,100	4,500	4,800	5,200	5,600	6,400
$2^3/_8$	0.125	2.375	0.125	3.01	2.125	4,400	4,700	5,100	5,500	5,900	6,700
$2/_8$	0.134	2.375	0.134	3.21	2.107	4,700	5,100	5,400	5,900	6,300	7,200
$2^3/_8$	0.145	2.375	0.145	3.46	2.085	5,100	5,500	5,900	6,300	6,800	7,800
$2^3/_8$	0.156	2.375	0.156	3.70	2.063	5,500	5,900	6,300	6,800	7,400	8,400
$2^3/_8$	0.175	2.375	0.175	4.12	2.025	6,100	6,600	7,100	7,700	8,300	9,400
$2^3/_8$	0.188	2.375	0.188	4.40	1.999	6,600	7,100	7,600	8,200	8,900	10,100
$2^3/_8$	0.204	2.375	0.204	4.73	1.967	7,100	7,700	8,200	8,900	9,600	11,000
$2^3/_8$	0.224	2.375	0.224	5.15	1.927	7,800	8,500	9,100	9,800	10,600	12,100
$2^3/_8$	0.250	2.375	0.250	5.68	1.875	8,800	9,400	10,100	10,900	11,800	13,500
$2^3/_8$	0.280	2.375	0.280	6.27	1.815	9,800	10,600	11,300	12,300	13,200	15,000
$2^7/_8$	0.134	2.875	0.134	3.93	2.607	3,900	4,200	4,500	4,800	5,200	6,000
$2^7/_8$	0.145	2.875	0.145	4.23	2585	4200	4,500	4,800	5,200	5,600	6,500
$2^7/_8$	0.156	2.875	0.156	453	2563	4,500	4,900	5,200	5,600	6,100	6,900
$2^7/_8$	0.175	2.875	0.175	5.05	2.525	5,100	5,500	5,800	6,300	6,800	7,800
$2/_8$	0.188	2.875	0.188	5.40	2.499	5,400	5,900	6,300	6,800	7,300	8,400
$2^7/_8$	0.204	2.875	0.204	5.82	2.467	5,900	6,400	6,800	7,400	7,900	9,100
$2^7/_8$	0.224	2.875	0.224	6.35	2.427	6,500	7,000	7,500	8,100	8,700	1,0000
$2^7/_8$	0.250	2.875	0.250	7.02	2.375	7,200	7,800	8,300	9,000	9,700	11,100
$2^7/_8$	0.280	2.875	0.280	7.77	2.315	8,100	8,700	9,300	10,100	10,900	12,500
$3^1/_2$	0.156	3.500	0.156	5.58	3.188	3,700	4,000	4,300	4,600	5,000	5,700
$3^1/_2$	0.175	3.500	0.175	6.22	3.150	4,200	4,500	4,800	5,200	5,600	6,400
$3^1/_2$	0.188	3.500	0.188	6.66	3.124	4,500	4,800	5,200	5,600	6,000	6,900
$3^1/_2$	0.204	3.500	0.204	7.19	3.092	4,800	5,200	5,600	6,100	6,500	7,500
$3^1/_2$	0.224	3500	0.224	7.84	3.052	5,300	5,700	6,100	6,700	7,200	8,200
$3^1/_2$	0.250	3500	0.250	8.69	3.000	5,900	6,400	6,900	7,400	8,000	9,100
$3^1/_2$	0.280	3500	0.280	9.64	2.940	6,700	7,200	7,700	8,300	9,000	10,200
$3^1/_2$	0.300	3.500	0.300	10.26	2.900	7,100	7,700	8,200	8,900	9,600	11,000
4	0.188	4.000	0.188	7.66	3.624	3,900	4,200	4,500	4,900	5,300	6,000
4	0.204	4.000	0.204	8.28	3.592	4,200	4,600	4,900	5,300	5,700	6,500
4	0.224	4.000	0.224	9.04	3.552	4,700	5,000	5,400	5,800	6,300	7,200
4	0.250	4.000	0.250	10.02	3.500	5,200	5,600	6,000	6,500	7,000	8,000
4	0.280	4.000	0.280	11.13	3.440	5,800	6,300	6,700	7,300	7,800	9,000
4	0.300	4.000	0.300	11.87	3.400	6,200	6,700	7,200	7,800	8,400	9,600
4	0.312	4.000	0.312	12.30	3.376	6,500	7,000	7,500	8,100	8,700	10,000
$4^1/_2$	0.204	4.500	0.204	9.37	4.092	3,800	4,100	4,400	4,700	5,100	5,800

Table 3—Coiled Line Pipe Dimensions, Weights Per Unit Length and Test Pressures (Continued)

(1)		(2)[a]	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Designation		Outside Diameter D	Wall Thickness t	Weight Per unit Length w_{pe}	Inside Diameter d	Minimum Test Pressure (psi) Grade					
Size	Wall	(in.)	(in.)"	(lb/ft)	(in.)	X52C	X56C	X60C	X65C	X70C	X80C
4 1/2	0.219	4.500	0.219	10.02	4.062	4,000	4,400	4,700	5,100	5500	6,200
4 1/2	0.224	4.500	0.224	10.24	4.052	4,100	4,500	4,800	5,200	5,600	6,400
4 1/2	0.237	4500	0237	10.80	4.026	4,400	4,700	5,100	5,500	5,900	6,700
4 1/2	0.250	4500	0.250	11.36	4.000	4,600	5,000	5,300	5,800	6,200	7,100
4 1/2	0280	4500	0.280	12.63	3.940	5,200	5,600	6,000	6,500	7,000	8,000
4 1/2	0300	4.500	0.300	13.47	3.900	5,500	6,000	6,400	6,900	7,500	8,500
4 1/2	0.312	4.500	0.312	13.97	3.876	5,800	6,200	6,700	7,200	7,800	8,900
4 1/2	0.344	4.500	0.344	15.28	3.812	6,400	6,800	7,300	8,000	8,600	9,800
5 9/16	0.250	5563	0.250	14.20	5.063	3,700	4,000	4,300	4,700	5,000	5,800
5 9/16	0258	5.563	0.258	14.63	5.047	3,900	4,200	4,500	4,800	5,200	5,900
5 9/16	0280	5.563	0.280	15.81	5.003	4,200	4,500	4,800	5,200	5,600	6,400
5 9/16	0.300	5.563	0.300	16.88	4.963	4,500	4,800	5,200	5,600	6,000	6,900
5 9/16	0.312	5.563	0312	1751	4.939	4,700	5,000	5,400	5,800	6,300	7,200
5 9/16	0344	5.563	0.344	19.19	4.875	5,100	5,500	5,900	6,400	6,900	7,900
5 9/16	0375	5563	0.375	20.80	4.813	5,600	6,000	6,500	7,000	7,600	8,600
6 5/8	0.250	6.625	0.250	17.04	6.125	3,100	3,400	3,600	3,900	4,200	4,800
6 5/8	0.280	6.625	0.280	18.99	6.065	3,500	3,800	4,100	4,400	4,700	5,400
6 5/8	0.300	6.625	0300	20.28	6.025	3,800	4,100	4,300	4,700	5,100	5,800
6 5/8	0312	6.625	0.312	21.06	6.001	3,900	4,200	4,500	4,900	5,300	6,000
6 5/8	0.344	6.625	0.344	23.10	5.937	4,300	4,700	5,000	5,400	5,800	6,600
6 5/8	0.375	6.625	0.375	25.05	5.875	4,700	5,100	5,400	5,900	6,300	7,200
6 5/8	0.432	6.625	0.432	28.60	5.761	5,400	5,800	6,300	6,800	7,300	8,300

[a] Outside diameter and wall thicknesses shown are subject to the tolerances given in Tables 4 and 6. Inside diameters are calculated and are shown here for information.

6.2.4 Flaring Tests-All Grades

All grades of coiled line pipe shall be subjected to a flaring test as specified in 8.3 .3. The acceptable criterion is no cracking in the weld seam region or base metal up to a minimum ID expansion of ID_f (defined in 833).

6.2.5 Fracture Toughness Tests

Fracture toughness testing for Charpy energy is required where possible considering the limitations imposed by diameter and thickness of the pipe ordered. Transverse specimens shah be used when possible to machine full-size, 2/3-size, or 1/2-size specimens using either tapered-end specimens, non-flattened specimens or flattened specimens. Otherwise, longitudinal specimens shah be substituted and shall be limited to 1/2-size specimens. All tests shah be conducted at 32°F or lower. The acceptance shah be 20 ft-lb (27 joules) average, 15 ft-lb (20 joules) minimum for full-size transverse specimens aud 30 ft-lb (41 joules) average, 20 ft-lb (27 joules) minimum for full-size longitudinal specimens. By agreement and when specified on the purchase order, alternative tests may be used when it is not possible to machine specimens in compliance with the above restrictions.

6.2.6 Metallographic Examination

For all pipe, compliance with the requirement in 5.5 that the entire heat-affected zone to be heat treated shah be demonstrated by metallographic examination of a weld cross-section. Such examinations shah be performed on both ends of each milled length.

7 Dimensions, Weights Per Unit Length, Lengths, Defects, and End Finishes

7.1 GENERAL-DIMENSIONS AND WEIGHTS PER UNIT LENGTH

Coiled line pipe shall be furnished in the outside diameters, wall thicknesses, and weights per unit length specified in

Table 3 as specified on the purchase order, except that pipe with outside diameters and wall thickness intermediate to those listed in Table 3 are available by agreement between the purchaser and the manufacturer.

7.2 DIAMETER

The outside diameter shall be within the tolerances specified in Tables 4 and 5.

Pipe sizes $6^5/_8$ and smaller shall permit the passage over the ends, for a distance of 4 in. (101.6 mm), of a ring gauge that has a bore diameter not larger than the pipe's specified outside diameter plus the applicable plus tolerance shown in Table 5.

Diameter measurements of pipe sizes $6^5/_8$ and smaller shall be made with a snap gauge, caliper, or other device that measures actual diameter across a single plane. Diameter measurements shall be made on both ends of each milled length.

7.3 WALL THICKNESS

Both ends of each milled length of pipe shall be measured for conformance to the specified wall thickness requirements. The wall thickness at any location shall be within the tolerances specified in Table 6, except that the weld area shall not be limited by the plus tolerance. Wall thickness measurements shall he made with a mechanical caliper or with a properly calibrated nondestructive inspection device of appropriate accuracy. In case of dispute, the measurement determined by use of the mechanical caliper shall govern.

The mechanical caliper shall be fitted with contact pins having circular cross-sections of $^1/_4$ in. (6.4 mm) diameter. The end of the pin contacting the inside surface of the pipe shall be rounded to a maximum radius of $^d/_4$ with a minimum radius of 0.125 in. (3.2 mm). The end of the pin contacting the outside surface of the pipe shall be either flat or rounded to a radius of not less than $1^1/_2$ in. (38.1 mm).

7.4 CALCULATED WEIGHT PER UNIT LENGTH

The weight per unit length, w_{pe}, shall be calculated using the following equation and rounded to the nearest 0.01 lb/ft (0.01 kg/m):

U.S. Customary equation = $w_{pe} = 10.69\ (D\text{-}t)t$

SI equation = $w_{pe} = 0.02466\ (D\text{-}t)t$

where

w_{pe} = weight per unit length rounded to the nearest 0.01 lb/ft (0.01 kg/m),

D = specified outside diameter, in. (mm),

t = specified wall thickness, in. (mm).

7.5 LENGTH

The measured length of each spooled length of pipe shall be as specified on the purchase order (– 0%, + 2%). The accuracy of length measuring devices shall be ± 1%.

7.6 PIPE-TO-PIPE WELDS

By written agreement, and when specified on the purchase order, two or more lengths of pipe may be welded together by the manufacturer. See Appendix B .

7.7 WORKMANSHIP AND DEFECTS

Imperfections of the types described in 7.7.1 through 7.7.10 that exceed the specified criteria shall be considered defects. The manufacturer shall take all reasonable precautions to minimize recurring imperfections, damage, and defects.

7.7.1 Dents

The pipe shall contain no dents greater than the specified wall thickness, measured as the gap between the lowest point in the dent and a prolongation of the original contour of the pipe. The length of the dent in any direction shall not exceed one-half the diameter of the pipe. All cold-formed dents deeper than $^1/_8$ in. (3.2 mm) with a sharp bottom gouge shall be considered a defect. The gouge may be removed by grinding.

7.7.2 Offset Skelp Edges

The radial offset of the skelp edges of the longitudinal weld shall not exceed 0.020 in. (OS mm) or $0.1t$, whichever is greater.

Table 4—Tolerances for Diameter of Pipe Body

Size Designation	Tolerance
$< 2^3/_8$	+0.016, –0.031 in. (+0.4, –0.8 mm)
$\geq 2^3/_8$ and $\leq 6^5/_8$	± 0.75%

Table 5—Tolerances for Diameter at Pipe Ends
(Within 4 in. (101.6 mm) of the Pipe End)

Size Designation	Minus Tolerance	Plus Tolerance
$\leq 6^5/_8$	0.016 in. (0.4 mm), ($^1/_{64}$ in.)	0.062 in. (1.6 mm), ($^1/_{16}$ in.)

Table 6—Tolerances for Wall Thickness

Size	Tolerance (All Grades)
All	+15.0, –12.5%

7.7.3 Height of Flash

The outside flash shall be trimmed to an essentially flush condition.

For pipe sixes less than $3^1/_2$, the inside flash shah not extend above the prolongation of the original inside surface of the pipe more than 0.090 in. (2.3 mm), or the specified wall thickness, f, whichever is less. For pipe sixes $3^1/_2$ and above, the flash height shall not exceed 0.125 in. (3.2 mm).

7.7.4 Trim of Inside Flash

Unless agreed to otherwise, the inside flash shall be trimmed and shah not extend above the prolongation of the original inside surface of the pipe more than 0.020 in. (05 mm).

The depth of the groove resulting from removal of the inside flash shall not be greater than that listed in Table 7 for the various wall thicknesses. Depth of groove is defined as the difference between the wall thickness measured approximately 0.5 in. (12.7 mm) from the weld line and the remaining wall under the groove.

7.7.5 Cracks and Leaks

All cracks and leaks shall be considered defects.

7.7.6 Laminations and Inclusions

Any lamination or inclusion extending into the face or bevel of the pipe and having a visually determined transverse dimension exceeding $^1/_4$ in. (6.4 mm) is considered a defect. Pipe containing such defects shall be cut back until no lamination or inclusion is greater than $^1/_4$ in. (6.4 mm). Any lamination in the body of the pipe greater than or equal to $^3/_8$ in. (9.5 mm) in the minor dimension is considered a defect.

Disposition of such defects shall be in accordance with 8.66, item a or b. No specific inspection by the manufacturer is required unless the purchaser specifies special nondestructive inspection on the purchase order.

7.7.7 Arc Bums

Arc burns are localized points of surface melting caused by arcing between electrode or ground and pipe surface, and shall be considered defects (see note).

Disposition of pipe containing arc bums shall be in accordance with 8.6.6 except that removal of defects by grinding shall be subject to the following additional conditioning:

a. Arc burns may be removed by grinding, chipping, or machining. The resulting cavity shall be thoroughly cleaned and checked for complete removal of damaged material by etching with a 10% solution of ammonium persulphate or a 5% solution of nital.

b. If removal of damaged material is complete, the cavity may be merged smoothly into the original contour of the pipe by grinding, provided the wall thickness is within specified limits.

Table 7—Maximum Trim Depth

Specified Wall Thickness (t)	Maximum Depth of Trim
0.150 in. (3.8 mm) and less	0.101
0.151 in. (3.9 mm) too.300 in. (7.6 mm)	0.015 in. (0.4 mm)
0.301 in. (7.7 mm) and greater	0.05t

Note: Contact marks, defined as intermittent marks adjacent to the weld, resulting from electrical contact between the electrodes sup plying the welding current and the pipe surface, are not defects.

7.7.8 Undercuts at Pipe-to-Pipe Welds

Undercutting of pipe-to-pipe welds is the reduction of thickness of the pipe wall adjacent to the weld where it is fused to the surface of the pipe. Undercutting on the outside surface can best be identified and measured visually. (Undercutting on the inside surface can be identified using radiographic or ultrasonic means.) Minor undercutting on either the inside or the outside of the pipe is defined as follows and is acceptable without repair or grinding:

a. Maximum depth $^1/_{32}$ in. (0.8 mm) and not exceeding 10% of the wall thickness with a maximum length of one-half the wall thickness and not more than two such undercuts in any 1 ft (0.3 m) of the weld length.

b. Maximum depth of $^1/_{64}$ in. (0.4 mm) in any length.

Undercutting in excess of item a, above, shall be considered a defect. Disposition shah be as follows:

a. Undercut defects not exceeding $^1/_{32}$ in. (0.8 mm) in depth and not exceeding 10% of the specified wall thickness shall be removed by grinding in accordance with 8.6.6, item a.

b. Disposition of undercuts greater in depth than $^1/_{32}$ in. (0.8 mm) or 10% of the specified wall thickness shah be in accordance with 8.6.6, item b.

7.7.9 Pipe-to-Pipe Radial Offset

For all pipe, the radial offset at pipe-to-pipe welds shah not exceed 0.020 in. (0 5 mm) or 0.1 t, whichever is greater.

7.7.10 Other Defects

Any imperfections having a depth greater than 10% of the specified wall thickness shah be considered a defect. See 8.6.3.9 for defects discovered during radiography.

7.8 PIPE ENDS

For pipe sixes smaller than $2^3/_8$, coils of pipe shah be furnished with unfinished or plain ends, unless otherwise specified on the purchase order. For pipe sizes $2^3/_8$ and larger, the pipe ends shall be cut square within $^1/_{16}$ in. (1.6 mm).

7.9 DRIFT TESTING

Each spool of coiled pipe shall be tested through its entire length with a gauge ball of a diameter as agreed upon between the purchaser and the manufacturer. The gauge ball shall pass freely through the pipe.

8 Inspection and Testing

8.1 TEST EQUIPMENT

If test equipment-whose calibration and verification is required under the provisions of this specification-is subjected to unusual or severe conditions sufficient to make its accuracy questionable, recalibration or reverification shall be performed before further use of the equipment.

8.2 TESTING OF CHEMICAL COMPOSITION

8.2.1 Chemical Analysis Sampling Frequency

The pipe manufacturer shall report the heat analysis and one product analysis representing each heat of steel used in the production of pipe under this specification. Product analyses shah be performed by the pipe manufacturer.

8.2.1.1 Sampling Methods

At the option of the manufacturer, samples used for product analyses shall be taken from either the master coil, skelp, unfinished pine, finished pipe, tensile test specimens or flattening test specimens. The location of the samples shall be a minimum of 90" from the electric weld.

8.3 TESTING OF MECHANICAL PROPERTIES

8.3.1 Tensile Tests

At the option of the manufacturer, longitudinal tests shall utilize a full-section specimen (see Figure 1), or a strip specimen (see Figures 2 and 3) taken from finished pipe. The strip specimen shall be tested without flattening.

8.3.1.1 Tensile Testing Specimens

The type and size of the specimens shall be reported. Strip specimens shah be approximately I $^{1}/_{2}$ in. (38.1 mm) wide in the gauge length if suitable curved-face testing grips are used or if the ends of the specimens are machined to reduce the curvature in the grip area; otherwise, they shah be approximately $^{3}/_{4}$-in. (19.0 mm) wide for pipe in sizes $3^{1}/_{2}$ and smaller and approximately l-in. (25.4 mm) wide for pipe sizes larger than $3^{1}/_{2}$. Alternatively, when grips with curved faces are not available, the ends of the specimens may be flattened without heating.

8.3.1.2 Tensile Testing Frequency

A tensile test shah be made from pipe from each heat made to the same size, same specified wall thickness, by the same process, and with the same manufacturing design control parameters. Tensile tests shall be made from each end of each spool. At least one tensile test shall be made from each 16,000 ft (4,876.6 m) or less of $5^{9}/_{16}$ and smaller pipe, or from each 8,000 ft (2,438.3 m) or less of pipe larger than $5^{9}/_{16}$.

The tensile tests from the ends of the milled lengths may be substituted for the tensile tests required for each 16,000 ft (4.876.6 m) or less of $5^{9}/_{16}$ and smaller pipe or from each 8,000 ft (2,438.3 m) or less of pipe larger than $5^{9}/_{16}$ and for the tensile tests required for each heat, size, and wall thickness .

8.3.2 Flattening Tests

Flattening tests shall be performed for each milled length. One set of flattening tests shall be made on specimens from each end of the milled length. When a section of pipe has been removed because of a defective longitudinal weld, a set of flattening tests shall be made on specimen(s) from the usable end(s). One set of flattening tests consists of one test with the weld at the zero degree position and one test with the weld at the 90" position.

For coiled pipe manufactured from multiple heats, a flattening test shall be made from pipe from each heat made to the same size, same specified wall thickness, by the same process, and with the same manufacturing design control parameters.

8.3.3 Flaring Tests

One flaring test shall be performed from each end of the milled length in accordance with ASTM A 450, except for the following details:

Specimens approximately 4 in. (101.6 mm) in length shah be flared over a mandrel having a 60" included angle until the mouth of the pipe inside diameter has expanded to at least 21% without cracking. The inside diameter flash may be ground flush prior to testing. The calculation for the required minimum inside diameter (ID_f) after flaring is as shown below.

$$ID_f = 1.21 \times ID$$

where

ID_f = required minimum inside diameter of the pipe after flaring, in. (mm).

ID = calculated inside diameter, in. (mm).

For coiled pipe manufactured from multiple heats, a flaring test shall be made from pipe from each heat made to the same size, same specified wall thickness, by the same process, and with the same manufacturing design control parameters.

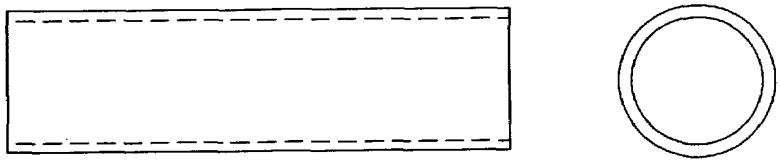

Figure 1 -Tensile Test Full-Section Specimen

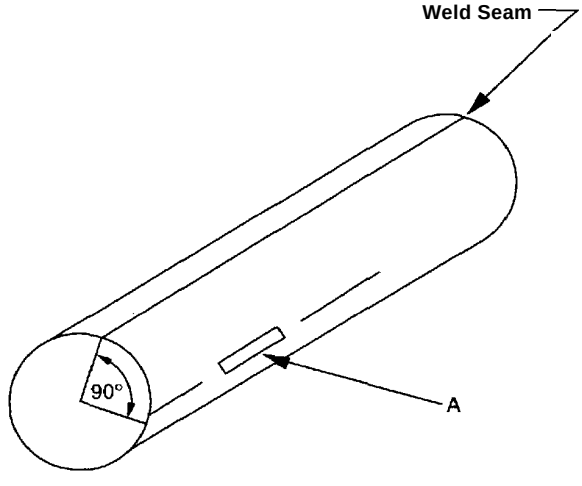

Figure Z-Orientation of Tensile Test Strip Specimen in Pipe

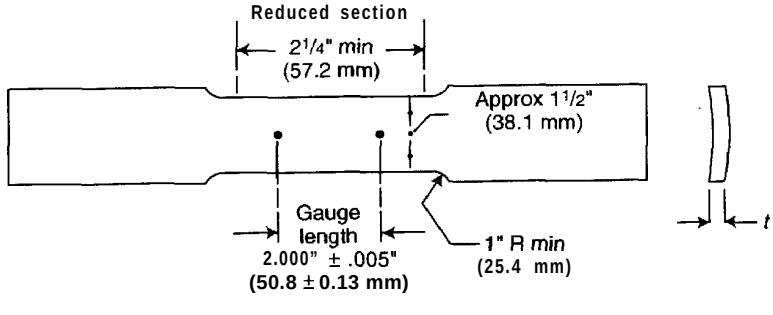

Figure 3-Tensile Test Strip Specimen

8.3.4 Weld Ductility Test Frequency

The minimum test frequencies for milled lengths are as follows: at least one weld ductility test shall be made from each 16,000 ft (4,876.6 m) or less of pipe equal to or smaller than $5^{9}/_{16}$, or 8,000 ft (2,438.3 m) or less of pipe larger than $5^{9}/_{16}$. The flattening tests of 8.3.2 that meet the weld ductility test requirements may be used for weld ductility tests.

8.4 HYDROSTATIC TESTS

Hydrostatic testing shall be performed on finished lengths of coiled line pipe, spooled on the shipping reel, after all weld processes have been completed.

8.4.1 Hydrostatic Test Requirements

Each finished coiled length of pipe shall withstand, without leakage, an inspection hydrostatic test to at least the pressure specified in 8.4.3. Hydrostatic pressure tests shall be conducted after essentially all air has been removed from the coiled pipe. Test pressures shall be held for not less than 15 minutes. Test pressures shall not drop more than 100 psig (0.7 MPa) in the last 15 minutes of the test.

8.4.2 Verification of Hydrostatic Test

To ensure that every milled length is tested to the required test pressure, each tester shall be equipped with a recording gauge that will record the test pressure and duration of time the pressure is applied to each milled length of pipe. Such records or charts shall be available for examination at the manufacturer's facility by the purchaser's inspectors at the manufacturer's facility. The test pressure measuring device shall be calibrated by means of a dead weight tester, or equivalent, within the 4 months prior to each use. Calibration records retention shall be as specified in 11.2.

8.4.3 Test Pressures

The minimum test pressure shall be the standard pressure listed in Table 3; an intermediate or higher pressure at the discretion of the manufacturer unless specifically limited by the purchaser; or a higher pressure as agreed between the purchaser and the manufacturer (see Note 1). The minimum test pressure for grades, outside diameters, and wall thicknesses not listed shall be computed by the equation given in Note 2, below. Test pressures shall be rounded to the nearest 100 psig (0.1 MPa).

Notes:

1. The hydrostatic test pressures shown herein are inspection test pressures, are not intended as a basis for design, and do not necessarily have any direct relationship to working pressures.
2. The test pressures given in Table 3 were computed by the following equation and rounded to the nearest 100 psig (0.1 MPa).
3. The test pressures are limited to 15,000 psi (103.4 MPa) to accommodate hydrostatic tester limitations.

U.S. Customary Equation	SI Equation
$P = 1.60\,S_y t/D$	$P = 1.60\,S_y t/D$

where

P = hydrostatic test pressure, psi (MPa),

S_y = specified minimum yield strength, psi (MPa),

t = specified wall thickness, in. (mm),

D = specified outside diameter, in. (mm).

8.5 DIMENSIONAL TESTING

The accuracy of all measuring instruments used for acceptance or rejection shall be verified on at least every operating shift. Verifying the accuracy of measuring devices, such as snap gauges and gauge balls, shall consist of inspection for wear and conformance to specified dimensions. Verifying the accuracy of rules, length measuring tapes, and other nonadjustable measuring devices shall consist of a visual check for legibility of markings and general wear of fixed reference points. The adjustable and nonadjustable designation of measuring devices used by the manufacturer shall be documented.

If measuring equipment, whose calibration or verification is required under the provisions of this specification, is subject to unusual or severe conditions sufficient to make its accuracy questionable, recalibration or reverification shall be performed prior to using the instrument.

8.6 NONDESTRUCTIVE INSPECTION

8.6.1 Purchaser Inspection

When inspection by the purchaser is stated on the purchase order, the provisions of Appendix F shall apply.

8.6.2 Methods of Inspection

The electric welds shall be inspected full length (100%) in accordance with the methods specified below. In addition, the skelp-end welds and pipe-to-pipe welds shall be inspected. The location of equipment in the manufacturer's facility shall be at the discretion of the manufacturer.

8.6.2.1 Skelp-end welds shall be inspected in skelp form by radiographic inspection. Other methods, such as ultrasound, magnetic particle, and liquid penetrant inspection, shall additionally be performed by agreement between the purchaser and the manufacturer as stated on the purchase order.

8.6.2.2 Electric welds shall be inspected by ultrasonic or electromagnetic methods in accordance with 8.6.4.1 through 8.6.4.4. By agreement between the purchaser and the manufacturer, and when specified on the purchase order, electric welds shall be nondestructively inspected in accordance with SR21 (see Appendix E).

8.6.2.3 pipe-to-pipe welds shall be inspected by radiographic or ultrasonic methods. Other methods, such as magnetic particle inspection and liquid penetrant inspection, shall additionally be performed by agreement between the purchaser and the manufacturer as stated on the purchase order.

8.6.3 Radiographic Inspection of Skelp-End Welds and Pipe-to-Pipe Welds

8.6.3.1 Radiographic Inspection Equipment

The homogeneity of skelp-end welds and pipe-to-pipe welds examined by radiographic methods shall be determined by means of X-rays directed through the weld material onto a suitable radiographic film, or to a detector that will display onto a cathode ray tube screen and be permanently recorded by a digital medium, provided adequate sensitivity can be obtained.

8.6.3.2 Radiographic Operator Qualification

Operators of radiographic equipment shall be trained and tested, and shall be certified by the pipe manufacturer. Details of such training, testing, and certification programs shall be available to the purchaser. This program shall include the following:

a. Classroom instruction in the fundamentals of radiographic inspection techniques.

b. On-the-job training designed to familiarize the operator with specific installations, including the appearance and interpretation of weld imperfections and defects. The duration of such training shall be sufficient to assure adequate assimilation of the knowledge required for conducting the inspection.

c. Knowledge of the appropriate requirements of this specification.

d. A visual acuity examination at least once a year to determine the operator's optical capability to perform the required inspection.

e. Upon completion of items a and d, above, an examination shall be given by the manufacturer to determine if the operator is qualified to properly perform radiographic examinations.

8.6.3.3 Operator Certification

Certified operators whose work has not included radiographic inspection for a period of I year or more shall be recertified by successfully completing the examination (item e, above) and also passing the visual acuity examination (item d, above). Substantial changes in procedure or equipment shall require recertification of the operators.

8.6.3.4 Radiography Reference Standards

One of the following radiographic penetrameters shall be used. The purchaser may specify the radiographic penetrametertobeused.

8.6.3.4.1 API Standard Penetrameter

The API Standard penetrameter shall be as shown in Figure 4 and made of a material with the same radiological characteristics as the pipe. The thickness of the penetrameter shall be a maximum of 4% of the specified wall thickness. Either 4% or 2% penetrameters may be used (see Tables 8 and 9 for sizes).

Notes:
1. The diameter of each hole shall be $^{1}/_{16}$ in. (1.6 mm).
2. Holes shall be round and drilled perpendicular to the surface.
3. Holes shall be free of burrs, but edges shall not be chamfered.
4. Each penetrameter shall carry a lead identification number as given in Tables 8 and 9.

8.6.3.4.2 ISO Wire Penetrameter

The ISO wire penetrameter shall be Fe 6/12 or Fe 10/16 in accordance with Tables 10 and 11 for the appropriate wall thickness. When the wire penetrameter is placed across the weld, the diameter of the wire employed shall be based on the specified wall thickness plus the estimated thickness of the weld reinforcement (not to exceed the maximum allowed) at the penetrameter location. When the penetrameter is placed on the base metal, the diameter of the wire employed shall be based on the specified wall thickness.

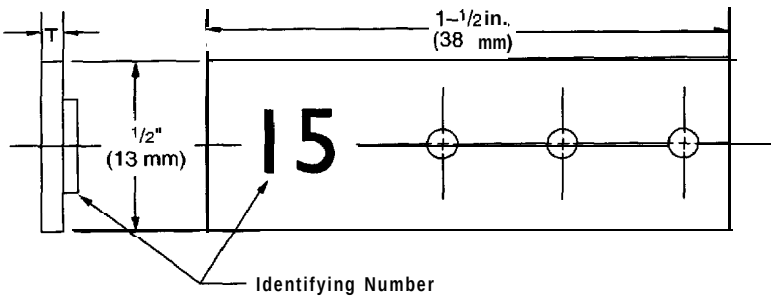

Figure 4-API Standard Penetrameter

Table B-API Standard 4% Penetrameter

(1)		(2)		(3)		(4)
Wall Thickness Over		Through		Maximum Penetrameter Thickness		Identifying number
in.	mm	in.	mm	in.	mm	
3/16 or 0.188	4.8	1/4 or 0.250	6.4	0.0100	0.25	10
1/4 or 0.250	6.4	3/16 or 0.313	7.9	0.0125	0.32	12
5/16 or 0.313	7.9	3/8 or 0.375	9.5	0.0150	0.38	15
3/8 or 0.365	9.5	7/16 or 0.438	11.1	0.0175	0.45	17
7/16 or 0.438	11.1	1/2 or 0.500	12.7	0.0200	0.51	20
1/2 or 0.500	12.7	5/8 or 0.625	15.9	0.0250	0.64	25

Table 9-API Standard 2% Penetrameter

(1)		(2)		(3)		(4)
Wall Thickness Over		Through		Maximum Penetrameter Thickness		Identifying number
in.	mm	in.	mm	in.	mm	
7/32 or 0.219	5.1	1/4 or 0.250	6.4	0.0050	0.13	5
1/4 or 0.250	6.4	5/16 or 0.313	7.9	0.0060	0.15	6
5/16 or 0.313	7.9	3/8 or 0.375	9.5	0.0075	0.19	7
3/8 or 0.365	9.5	1/2 or 0.500	12.7	0.0100	0.25	10
7/16 or 0.438	11.1	1/2 or 0,500	12.7	0.0200	0.51	20
1/2 or 0.500	12.7	5/8 or 0.625	15.9	0.0125	0.32	1

Table 10—ISO Wire 4% Penetrameter

(1)		(2)		(3)		(4)
Wire		Wall Thickness Over		Through		wii diameter
#	in.	mm	in.	mm	in.	mm
9	0.400	10.2	0.500	12.7	0.020	0.50
10	0.325	8.3	0.400	10.2	0.016	0.40
11	0.250	6.4	0.325	8.3	0.113	0.25
12	0.200	5.1	0.250	6.4	0.010	0.25
			Fe 10/16			
10	0.325	8.3	0.400	10.2	0.016	0.40
11	0,250	6.4	0.325	8.3	0.013	0.32
12	0.200	5.1	0.250	6.4	0.010	0.25
13	0.162	4.1	0.200	5.1	0.008	0.20
14	0.125	3.2	0.162	4.1	0.006	0.16
15	0.100	2.5	0.125	3.2	0.005	0.13
16	0.080	2.0	0.100	2.5	0.004	0.10

Table 11—ISO Wire 2% Penetrameter

(1)		(2)		(3)		(4)
Wire		Wall Thickness Over		Through		Wire diameter
#	in.	mm	in.	mm	in.	mm
12	0.400	10.1	0.500	12.7	0.010	0.25
			Fe 6/12			
10	0.625	16.2	0.800	20.3	0.016	0.40
11	0.500	12.7	0.650	16.2	0.013	0.32
12	0.400	10.1	0.500	12.7	0.010	0.25
13	0.325	8.3	0.400	10.1	0.008	0.20
14	0.250	6.4	0.325	8.3	0.006	0.16
15	0.200	5.1	0.250	6.4	0.005	0.13
16	0.160	4.1	0.200	5.1	0.004	0.10

8.6.3.4.3 ASTM Penetrameter

The ASTM penetrameter shall be in accordance with Table 12 for the appropriate wall thickness. Either a wire type or a hole type penetrameter shall be used. The sensitivity may be modified by agreement between the purchaser and manufacturer, as stated on the purchase order.

8.6.3.5 Frequency of Use of Penetrameter

The penetrameter shall be used to check the sensitivity and adequacy of the radiographic technique on each skelp-end weld and each pipe-to-pipe weld.

Table 12—ASTM Penetrameter

Specified Single Wall Thickness	ASTM Designation	Essential Hole	Wire Diameter
t ≤ 0.150 in.	10	2T	0.006 in.
0.150 in. < t ≤ 0.250 in.	12	2T	0.008 in.
0.250 < t ≤ 0.375 in.	15	2T	0.010 in.

The skelp or pipe shall be held in a stationary position during the adjustment of the sensitivity of radiographic technique by use of the penetrameter. Proper definition and sensitivity is attained when any of the following is clearly discernible:

a. All three holes in the API Standard penetrameter.
b. Individual wires of the IS0 penetmmeter.
c. The 2T hole or wire in the ASTM penetrameter.

8.8.3.6 Acceptance Limits for Radiographic Inspection

Radiographic examination shall be capable of detecting weld imperfections and defects as described in 8.6.3.7 and 8.6.3.8.

8.6.3.7 Imperfections Observed During Radiographic Inspection

The maximum acceptable size and distribution of three dimensional imperfections within the welds are as follows:

1. For skelp-end welds, based on which penetrameter is used, the maximum acceptable size shall be no larger than the image of the hole in the API or ASTM penetrameter, or the width of the wire in the IS0 or ASTM penetrameter.
2. For skelp-end welds, no more than two such imperfections shall be permitted in any 6 in. (152.4 mm} length of weld.
3. For pipe-to-pipe welds, the maximum number of radiographic indications determined to be imperfections shall not exceed three indications measuring larger than $^1/_{32}$ in. (0.8 mm) in any dimension or ten indications measuring larger than $^1/_{64}$ in. (0.4 mm) in any dimension in any 6 in. (152.4 mm) length of weld.

8.6.3.8 Defects Observed During Radiographic Inspection

Cracks, lack of complete penetration, lack of complete fusion, and imperfections greater in size and/or distribution than given in 8.6.3.7, as indicated by radiographic examination, shall be considered defects.

8.6.3.9 Disposition of Defects Observed During Radiographic Inspection

Any weld defect detected as a result of radiographic examination shall be rejected. Disposition of the pipe containing the defect shall be in accordance with 8.6.6.

8.6.3.10 Inspection by Other Nondestructive Test Methods

All welds shall be free from two-dimensional defects. Cracks or other two-dimensional defects found by any means shall be rejected.

8.6.4 Ultrasonic and Electromagnetic Inspection

8.6.4.1 Equipment

Any equipment utilizing the ultrasonic or electromagnetic principles and capable of continuous and uninterrupted inspection of the weld seam shall be utilized. The equipment shall be checked with an applicable reference standard, as described in 8.6.4.2, immediately before and after each run of a milled length to demonstrate its effectiveness and the inspection procedures. The equipment shall be adjusted to produce well-defined indications when the reference standard used by the manufacturer is scanned by the inspection unit in a manner simulating the inspection of the product and shall be capable of inspecting $^1/_8$ in. (3.2 mm) on either side of the weld line for the entire wall thickness.

8.6.4.2 NDT Reference Standards

Reference standards shall have the same specified diameter and thickness as the product being inspected and may be of any convenient length as determined by the manufacturer. Reference standards shall contain machined notches, one on the inside surface and one on the outside surface, or a drilled hole as shown in Figure 5, at the option of the manufacturer. The notches shall be parallel to the weld seam and shall be separated by a distance sufficient to produce two separate and distinguishable signals. The $^1/_{32}$ in. (0.8 mm) or $^1/_{16}$ in. (1.6 mm) hole shall be drilled through the wall perpendicular to the surface of the reference standard as shown in Figure 5 (see note).

Note: The reference standards as defined above are convenient standards for calibration of nondestructive testing equipment. The dimensions of these standards should not be construed as the minimum size imperfection detectable by such equipment.

8.6.4.3 Acceptance Limits

Table 13 gives the height of acceptance limit signals produced by reference standards. An imperfection that produces a signal greater than the acceptance limit signal given in Table 13 shall be considered a defect unless it can be demonstrated by the manufacturer that the imperfection does not exceed the provisions of 7.7.

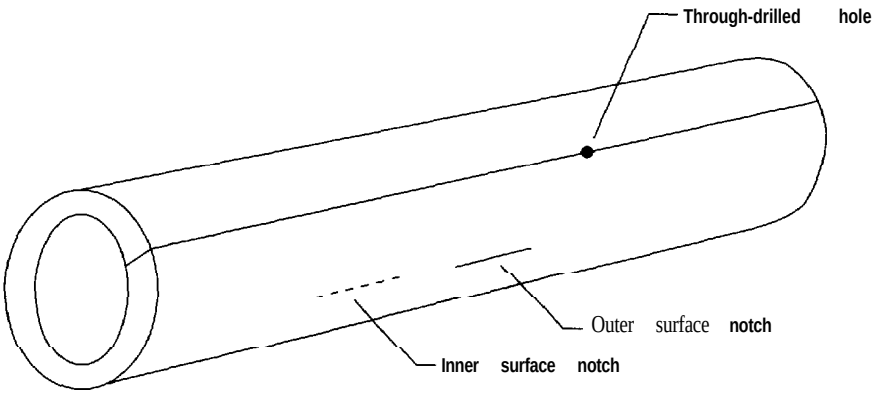

Figure 5—NDT Reference Standard

Table 13—Acceptance Limits

(1)	(2)	(3)	(4)
Weld Type	Notch Type	Size Hole in. (mm)	Acceptance Limits Signal (percent)
Electric Weld	N10	1/16 (1.6)	100
		1/32 (0.8)	100

Note: A 1/16 in. (1.6 mm) through-drilled hole may be used where the entire pipe surface is scanned for pipe body imperfections as well as for weld-line imperfections.

8.6.4.4 Reference Standard Demonstration

When specified on the purchase order, arrangements shall be made by the manufacturer to perform a demonstration for the purchaser or his representative during production of this order. Such demonstration shall be based on pipe in process or sample lengths of similar pipe retained by the manufacturer for that purpose that exhibit natural or artificially produced defects of the character stated in 8.6.4.2 and 8.6.5.1.

8.6.4.5 Weld Repair

Defects in the longitudinal weld, found by any means, shall not be repaired.

8.6.5 Magnetic Particle or Liquid Penetrant Inspection

For pipe ends and for imperfection prove-up on the outer surface of the skelp-end weld and the pipe body, either magnetic particle inspection or liquid penetrant inspection, at the option of the manufacturer, shall be performed.

8.651 Equipment

The equipment used for magnetic particle inspection shall produce a magnetic field, transverse to the imperfection, of sufficient intensity to indicate defects of the following character in the external surface of the pipe: open welds, partial or incomplete welds, intermittent welds, cracks, seams, overlaps and slivers. Magnetic particle inspection shall be performed in accordance with ASTM E 709.

The equipment used for liquid penetrant inspection shall also detect such imperfections. Liquid penetrant inspection shall be performed in accordance with ASTM E 165.

8.652 Acceptance Limits

The manufacturer shall *mark* each magnetic particle or liquid penetrant indication and subsequently explore each indication with respect to the depth of the imperfection. Imperfections that require metal removal to determine their depth shall be completely removed or cut out.

8.6.6 Disposition of Defects

Pipe and welds containing one or more defects shall be given one of the following dispositions.

a. The defect shall be removed provided that the remaining wall thickness is within specified limits. Removal shall be performed in a workmanlike manner.

b. The section of the pipe containing the defect shall be cut out of the pipe and removed as a cylinder.

c. For skelp-end and pipe-to-pipe welds, the weld containing the defect and the complete heat-affected zone associated with the weld shall be cut out and removed.

8.7 TEST METHODS

8.7.1 Methods of Chemical Analysis

Methods and practices relating to chemical analysis shall be performed in accordance with ASTM A 75 1. Calibrations performed shall be traceable to established standards.

8.7.2 Tensile Test Method

The tensile testing procedure shall conform to the requirements of ASTM A 370. All tensile tests shall include yield strength, ultimate tensile strength and elongation determinations and shall be performed with the specimens at room temperature.

8.7.2.1 Equipment

Tensile test machines shall have been calibrated within 15 months preceding any test in accordance with the procedures of ASTM E 4. Where yield strength is determined by the use of extensometers, such extensometers shall be calibrated within the preceding 15 months in accordance with the procedures of ASTM E 83.

8.8 INVALIDATION OF TESTS

8.8.1 Defective Tensile Test Specimens

If any part of the fracture is outside the middle third of the gauge length as indicated by scribe scratches marked on the specimen prior to testing, a retest shall be allowed.

8.8.2 Defective Mechanical Test Specimens

For any of the mechanical tests in Section 6, any test specimen that shows defective preparation or material imperfections unrelated to the intent of the particular mechanical test, whether observed before or after testing, may be discarded and replaced by another specimen from the same length of pipe.

8.9 RETESTS

8.9.1 Recheck Analyses

If either the heat analysis or product analysis representing the heat fails to conform to the specified requirements, at the manufacturer's option, either the heat shall be rejected or two recheck analyses shall be made using two additional samples from the heat. If both recheck analyses conform to the specified requirements, the heat shall be accepted, except for the master coil from which the initial sample that failed was taken. If one or both recheck analyses fail to conform to the specified requirements, at the manufacturer's option, either the heat shall be rejected or the remainder of the heat shall be tested individually for conformance to the specified requirements.

For such individual testing, analyses for only the rejecting element or elements need be determined. Samples for recheck analyses shall be taken in the same location as specified for product analysis samples.

8.9.2 Tensile Retest

If the tensile test specimen fails to conform to the specified requirements, the manufacturer may elect to retest two additional specimens from the same region of the same milled length. If both retested specimens conform to the requirements, the milled length shall be accepted. If one or both of the retested specimens fail to conform to the specified requirements, the manufacturer may elect to further retest two more samples within 50 ft (152 m) of the end of the milled length, in which case determinations are required only for the particular requirements with which the specimens failed to comply in the preceding tests. The segment of the milled length cut out to obtain retest specimens shall be discarded. If one or both of these tests fail, the milled length shall be rejected. Specimens for retest shall be taken in the same manner as the specimen that failed to meet the minimum requirements, except that such retest specimens may have been coiled.

8.9.3 Flattening Retest

If the flattening test fails to conform to the specified requirements, the manufacturer may elect to retest two additional specimens from any failed end or regions adjacent to pipe-to-pipe welds. The retests shall be made with the weld alternately at 0" and 90". If both retested specimens conform to the requirements, the milled length shall be accepted. If one or both of the retested specimens fail to conform to the specified requirements, the manufacturer may elect to further retest within 50 ft (15.2 m) of the end of the milled length or pipe-to-pipe weld region, in which case determinations are required only for the particular requirements with which the specimens failed to comply in the preceding tests. Should this test fail, the milled length shall be rejected. Specimens for retest shall be taken in the same manner as the specimen that failed to meet the minimum requirements.

8.9.4 Flaring Retest

If the flaring test fails to conform to the specified requirements, the manufacturer may elect to retest two additional specimens from the same region of the same milled length. If both retested specimens conform to the requirements, the milled length shall be accepted. If one or both of the retested specimens fails to conform to the specified requirements, the manufacturer may elect to further retest within 50 ft (15.2 m) of the end of the same milled length, in which case determinations are required only for the particular requirements with which the specimens failed to comply in the preceding tests. If this test fails, the milled length shall be rejected. Specimens for retest shall be taken in the same manner as the specimen that failed to meet the minimum requirements.

9 Marking

9.1 GENERAL

Pipe manufactured in conformance with this specification shall be marked by the manufacturer on the shipping reel as specified herein (see note).

Note: Users of this specification should note that there is no longer a requirement for marking a product with the API monogram. API continues to license use of the monogram on products covered by this specification, but it is administered by the staff of the Institute separately from the specification. The policy describing use of the monogram is contained in Appendix G. No other use of the monogram is permitted. Licensees may mark products in conformance with Section 9 or Appendix G and nonlicensees may mark products in conformance with Section 9.

9.1.1 Length and hydrostatic test pressure markings should be in U.S. Customary units. These markings shall be in SI units or both U.S. Customary and SI units if so specified on the purchase order. If not so specified, pipe made and intended for use in countries using the SI system may be marked in metric units only, at the option of the manufacturer.

9.1.2 Additional markings, including those for compatible standards following the specification marking, are allowed and may be applied as desired by the manufacturer or as requested by the purchaser.

9.2 SEQUENCE OF MARKINGS

The sequence of identification markings shall be as specified in 9.2.1 through 9.2.8.

9.2.1 Manufacturer

Manufacturer's name or mark shall be the first identifying mark, followed by manufacturer's spool number.

9.2.2 Specification

Spec 5LCP shall he marked when the product is in complete compliance with this specification.

9.2.3 Compatible Standards

Products in compliance with multiple compatible standards may be marked with the name of each standard.

9.2.4 Designation

The size and specified wall thickness or the applicable intermediate outside diameter and specified wall thickness shall be marked.

9.2.5 Grade

The symbols to be used are as follows:

Grade	Symbol
X52C	X52C
X56C	X56C
X60C	X60C
X65C	X65C
X70C	X70C
X80C	X80C

9.2.6 Heat Treatment

The symbols to be used are as follows:

a. Normalized or normalized and tempered-HN.
b. Stress relieved- HS.
c. Quench and tempered-HQ.
d. Age hardened-HA.

9.2.7 Test Pressure

When the specified hydrostatic test pressure is higher than the tabulated pressure (Table 3), the word TESTED shall be marked, followed by the test pressure in psi.

9.2.8 Supplementary Requirements

See Appendix E for supplementary requirements.

9.3 LENGTH

In addition to the identification markings stipulated in 9.2, the length shall be reported as follows. For all pipe sizes, the length in feet (unless otherwise specified on the purchase order) as measured on the finished coiled line pipe, shall be paint-stencilled on the outside surface of the shipping reel.

10 Coating and Protection

10.1 COATINGS

Unless otherwise ordered, coiled line pipe shall be given an external protective film to protect it from rust during storage or transit. Coatings should he smooth and should not drain or evaporate from the pipe surface. Also, the coating shall be designed so that it does not bind the coiled line pipe together, restricting uncoiling operations.

If bare pipe or specially coated pipe is desired, the purchase order shall so state. For special coatings, the purchase order shall state further whether it is to be applied to the full length or whether a certain specified distance from the end is to be left uncoated.

Note: Unless otherwise specified, such bare ends are commonly given a coating for protection in transit.

10.2 PROTECTION FROM CORROSION

10.2.1 Protection of Outside Diameter of Uncoated Pipe

Coiled line pipe that has not been given a corrosion-resistant external coating shall be protected from exposure to liquid water by wrapping the shipping reel holding the pipe with plastic or by covering the pipe with an appropriate tarpaulin system to protect the outside surface of the pipe from exposure to liquid water, or by placing the shipping reel in a container designed to protect the reels of pipe from water, except that these protective measures are not required while the coiled line pipe is stored in a dry warehouse.

10.2.2 Hydrostatic Test Fluid

The fluid used for hydrostatic testing shall be treated with an agent that limits its pH to a value between 7 and 9. A corrosion inhibitor may be added to the hydrostatic test fluid.

10.2.3 Removal of Test Fluid

After final hydrostatic testing, the manufacturer shall ensure that the hydrostatic test fluid, gauging and fluid removal pigs, and other debris have been removed completely from the ID of the coiled pipe. The manufacturer shall employ a documented drying procedure to displace the test fluid after the hydrostatic test is completed. If the purchaser requires special drying procedures for the ID surface, these procedures shall be stated on the purchase order.

10.2.4 Post-Drying Coiled Pipe Preparation

After all manufacturing steps are complete and the coiled line pipe is ready to be shipped or transferred to storage, the coiled pipe shall be filled with a dry, nonreactive gas and the ends sealed. For coiled line pipe that has been in storage prior to shipment, the end seals shall be inspected prior to shipment. If the end seals are broken, the manufacturer shall repeat the drying procedure, refill the pipe with inert gas, and reseal the pipe ends.

Note: These procedures (drying, filling with *nonreactive* inert gas, and sealing) are required to help minimize ID corrosion before the coiled line pipe product is delivered.

11 Documents

The manufacturer shall establish procedures for maintaining traceability of heat, master coil, and skelp identity of all finished pipe with regard to all applicable chemical and mechanical test results.

11.1 CERTIFICATION

The manufacturer shall furnish to the purchaser a certificate of compliance stating that the material has been manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements.

11.1.1 Spool Documentation

The manufacturer shall provide the following data to the purchaser.

a. The manufacturer's certificate shall state the API specification and date of revision to which the pipe was manufactured.

b. Specified diameter, wall thickness, grade, and type of heat treatment.

c. Chemical analyses (heat, product, and recheck) showing the weight in percent of all elements whose limits or reporting requirements are set in this specification.

d. Test data for all tensile tests required by this specification, including yield strength, ultimate tensile strength and elongation. The type, size, and orientation of specimens shall be shown.

e. The location of any skelp-end welds and any pipe-to-pipe welds, as measured from the reference end of the finished product.

f. Minimum hydrostatic test pressure and duration at specified test pressure.

g. The method of nondestructive inspection employed for the weld seam (e. g., ultrasonic, electromagnetic) and the NDT reference standards used.

h. The type and size of all penetrameters and other reference standards used during the inspection of skelp-end and pipe-to-pipe welds.

i. The minimum temperature for heat treatment of the weld seam.

j. Fracture toughness test results (including test type and criteria and the size, location, and orientation of the specimen} where such testing is specified by the purchaser.

k. Results of any supplemental testing required by the purchaser.

l. The number of times that the pipe has been spooled.

m. Certification of coiled pipe drying procedure.

11.2 RETENTION OF RECORDS

Tests and inspections requiring retention of records in this specification are shown in Table 14. Such records shall be retained by the manufacturer and shall be made available to the purchaser on request for a 3-year period after the date of purchase from the manufacturer.

Table 14—Retention of Records

Requirements	Reference
Chemical Composition	
Heat Analysis	8.2.1
Product Analysis	8.2.1
Mechanical Tests	
Tensile Tests	8.3.1
Flattening Tests	8.3.2
Flaring Tests	8.3.3
Hydrostatic Tests	
Tester recorder charts	8.4.2
Nondestructive Inspection	
Radiographic (Film or digital)	863.1
Radiographic Operator Qualifications	8.6.3.2
Ultrasonic and Electromagnetic	8.6.4
Welding Procedure	Appendices A and B

APPENDIX A-REQUIREMENTS FOR PIPE-TO-PIPE WELDING OF COILED PIPE (NORMATIVE)

A.1 Method

Pipe-to-pipe welds shall be made in accordance with a qualified welding procedure using gas metal-arc welding, plasma-arc welding, gas tungsten-arc welding, or a combination of such welding processes.

A.2 Workmanship

The ends of the pipe to be welded together shall be cut perpendicular to the axis of the pipe and prepared for welding in accordance with the requirements of the procedure to be used. Each weld shall have a substantially uniform cross-section around the entire circumference of the pipe. At no point shall its crowned surface fall below the outside surface of the parent metal nor shall it rise above the parent metal by more than $^{1}/_{16}$ in. (1.6 mm).

A.3 Pipe-to-Pipe Weld Location

The location of each pipe-to-pipe weld relative to the reference end of the coiled pipe shall be recorded. Documentation shall be maintained to identify the welder or operator.

A.4 Nondestructive Testing

The pipe-to-pipe welds between sections of coiled pipe shall be 100% inspected by radiographic or ultrasonic methods.

a. Radiographic inspection shall be performed in accordance with the procedures of 8.6.

b. Ultrasonic shear wave inspection and acceptance criteria shah be in accordance with API Std 1104.

A.5 Disposition

Pipe-to-pipe welds failing to pass these tests shall be subject to disposition as stated in 8.6.6.

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APPENDIX B-SKELP-END AND PIPE-TO-PIPE WELDING PROCEDURE SPECIFICATION (NORMATIVE)

B.I General

All welding materials shall be properly handled and stored in accordance with the manufacturer's recommendations so as to preclude moisture or other contamination. Test welds shall be made on pipe stock.

The manufacturer shall maintain a record of the welding procedure and procedure qualification test results. Welding procedures and welders and welding machine operators (hereafter called operators) shall be qualified in accordance with ASME Section IX or API Std 1104. Copies of the welding procedure specification and procedure qualification record shall be provided to the purchaser on request.

B.2 Skelp-End and Pipe-to-Pipe Welding Procedure Qualification

Welding procedures shall be qualified by preparing and testing welds in accordance with Appendix B. At the option of the manufacturer, the tests specified in the latest issue of the ASME Section IX, or API Std 1104 may be substituted herein. For the purpose of Appendix B, the term automatic welding includes both machine welding and automatic welding as defined in the ASME Section IX.

B.2.1 ESSENTIAL VARIABLES

An existing procedure shall not be applicable and a new procedure must be qualified when any of the following essential variables is changed beyond the stated limits:

B.2.1.1 Welding Process

a. A change in the welding process.

b. A change in method, such as manual to semi-automatic.

B.2.1.2 Pipe Material

a. A change in grade category. When different alloying systems are used within one grade category, each alloying composition must be separately qualified. Grade categories are as follows:

1. Less than Grade X65C.
2. Grades X65C and greater.

b. Within each grade category, a material thicker than 1 .5t for the grade qualified.

c. Within the grade category and thickness range, a carbon equivalent, *CE*, (see note) based on product analysis for the material to be welded that is more than 0.06 percentage points greater than the *CE* of the grade qualified.

Note: $CE = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$

B.2.1.3 Welding Materials

a. A change in filler metal classification.

b. A change in electrode diameter.

c. A change of more than 5% in the composition of the shielding gas.

d. A change of more than 20% in the flow rate of the shielding gas.

B.2.1.4 Welding Parameters

a. A change in the type of current (such as AC vs. DC).

b. A change in polarity.

c. For automatic and semiautomatic welding, schedules of welding current, voltage, and speed may be established to cover ranges of wall thicknesses. Within the schedule, appropriately selected points shah be tested to qualify the entire schedule. Thereafter, a new qualification is required if there is a deviation from the qualified schedule greater than the following:

1. 20% in amperage.
2. 15% in voltage.
3. 20% in travel speed for automatic welding.

B.2.1.5 Weld Bead

For manual and semiautomatic welding, a change of weld bead width greater than 50%.

B-2.1.6 Post-Weld Heat Treatment

The addition or deletion of Post-weld heat treatment.

B.2.2 MECHANICAL TESTING FOR PROCEDURE QUALIFICATION

B.2.2.1 Two specimens of skelp-end welds and/or pipe-to-pipe welds are required for qualification.

B.2.2.2 Tensile Test

The transverse tensile test shah meet the following requirements:

1. *Skelp-end welds:* The manufacturer shah provide a documented procedure which stipulates how the transverse tensile test specimen is prepared and how the transverse tensile test shah be performed.

2. *Pipe-to-pipe welds: The transverse* tensile test specimen may be full section pipe or a strip specimen cut from a full pipe weld. The pipe-to-pipe weld shah be oriented perpendicular to the longitudinal axis of the test specimen.

The weld reinforcement shall be removed from both faces of the strip specimen, or the outside diameter face of the pipe. The test shall be performed to a written procedure. The ultimate tensile strength shall be at least equal to the minimum specified for the pipe grade.

B.2.2.3 Guided-Bend Test for Pipe-to-Pipe Welds

The transverse guided-bend test specimens shall conform to API 5L Figure C-2. Each specimen shall be placed in the die with the weld at midspan and the external surface in tension and shall be bent approximately 180" in a jig in accordance with ASME Section IX, QW-462.3(a). The bend test shall be considered acceptable if no crack or other defect exceeding 1/8 in. (3.2 mm) in any direction is present in the weld metal or the base metal after bending, except that cracks that originate on the outer radius of the bend along the edges of the specimen and are less than 1/4 in. (6.4 mm) shall not be considered. The procedure shall otherwise be qualified in accordance with ASME Section IX.

B.3 Welding Personnel Performance Qualification

B.3.1 QUALIFICATION

B.3.1 .1 General

Each welder and operator is required to qualify. A welder or operator qualified on one grade category is qualified for any lower grade category provided the same welding process is used.

B.3.1.2 Testing

To qualify, a welder or operator must produce welds that are acceptable as determined by film radiographic examination as outlined in Section 8.

B.3.1.3 Test Failures

If the test in B .3.1.2 fails to meet the specified requirements, the welder or operator may make an additional qualification weld. If that weld fails the test in B 3 .1.2, the welder or operator is disqualified. No further retests shall be permitted until the welder has completed additional training.

B.3.2 REQUALIFICATION

Requalification in accordance with B .3.1 is required under the following circumstances:

a. One year has elapsed since the last prior applicable qualification.
b. The individual has not been welding using qualified procedures for a 3-month period.
c. There is reason to question the individual's ability.

APPENDIX C-ELONGATION TABLES (NORMATIVE)

The minimum elongation values calculated by the equation in 6.2.1 are given in Table C- 1.

Table C-t-Elongation Table

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Specified Wall Thickness, in.			Elongation in 2 in., minimum, %					
Area "A" in.^{2}	Tensile Test Specimen			Grade					
	0.750 in. specimen	1.000 in. specimen	1.500 in. specimen	X52C	X56C	X60C	X65C	X70C	X80C
				Specified Minimum Tensile Strength, ksi					
				66.0	71.0	75.0	77.0	80.0	88.0
0.65			0.431 – 0.432	27	25	24	23	22	21
0.64			0.424 – 0.430	27	25	24	23	22	21
0.63			0.417 0.423	26	25	24	23	22	20
0.62			0.410 -0.416	26	25	24	23	22	20
0.61			0.404 – 0.409	26	25	23	23	22	20
0.60			0.397 – 0.403	26	25	23	23	22	20
0.59			0.391– 0.396	26	24	23	23	22	20
0.58			0.384 – 0.390	26	24	23	23	22	20
0.57			0.377 – 0.383	26	24	23	23	22	20
OS6			0.370 0.376	26	24	23	23	22	20
0.55			0364 – 0.369	26	24	23	22	22	20
0.54			0.357 – 0.363	26	24	23	22	22	20
OS3			0.351 – 0.356	26	24	23	22	22	20
0.52			0.344 – 0.350	25	24	23	22	21	20
0.51			0.337 0.343	25	24	23	22	21	20
0.50			0.330 – 0.336	25	24	23	22	21	20
0.49			0.324 – 0329	25	24	22	22	21	19
0.48			0.317 – 0.323	25	23	22	22	21	19
0.47			0.311 -0.316	25	23	22	22	21	19
0.46			0.304 – 0.310	25	23	22	22	21	19
0.45			0.297 – 0.303	25	23	22	22	21	19
0.44			0.290 – 0.296	25	23	22	21	21	19
0.43		0.426 -0.432	0.284 – 0.289	25	23	22	21	21	19
0.42		0.415 -0.425	0.277 – 0.283	24	23	22	21	21	19
0.41		0.406 – 0.414	0.271 – 0.276	24	23	22	21	20	19
0.40		0.395 – 0.405	0.264 0.270	24	23	22	21	20	19
0.39		0.386 0.394	0.257 0.263	24	23	21	21	20	19
0.38		0.375 – 0.385	0.250 – 0.256	24	22	21	21	20	19
0.37		0.366 – 0.374	0.244 – 0.249	24	22	21	21	20	18
0.36		0.355 – 0.365	0.237 – 0.243	24	22	21	21	20	18
0.35		0.346 – 0.354	0.231 -0.236	24	22	21	21	20	18
0.34		0335 -0.345	0.224 0.230	23	22	21	20	20	18
0.33		0.326 – 0.334	0.217 -0.223	23	22	21	20	20	18
0.32	0.420 -0.432	0.315 -0.325	0.210-0.216	23	22	21	20	19	18
0.31	0.407 -0.419	0.306 – 0.314	0.204 – 0.209	23	22	21	20	19	18
030	0.394 – 0.406	0.295 -0.305	0.197 -0.203	23	21	20	20	19	18

Table C-l-Elongation Table (Continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				Elongation in 2 in., minimum, %					
	Specified Wall Thickness, in.			Grade					
Area	Tensile Test Specimen			X52C	X56C	X60C	X65C	X70C	X80C
"A"	0.750 in.	1.000 in.	1.500 in.	Specified Minimum Tensile Strength, ksi					
in.2	specimen	specimen	specimen	66.0	71.0	75.0	77.0	80.0	88.0
0.29	0381-0393	0.286 – 0.294	0.191-0.196	23	21	20	20	19	18
0.28	0367-0380	0.275-0.285	0.184-0.190	23	21	20	20	19	17
0.27	0354-0.366	0.266-0.274	0.177-0.183	22	21	20	19	19	17
0.26	0.340 – 0.353	0.255 -0.265	0.170 – 0.176	22	21	20	19	19	17
0.25	0.327 -0.339	0.246 – 0.254	0.164 – 0.169	22	21	20	19	19	17
0.24	0.314 – 0326	0.235 – 0.245	0.157 – 0.163	22	20	19	19	18	17
0.23	0.301-0.313	0.226-0.234	0.151-0.156	22	20	19	19	18	17
0.22	0.287-0.300	0.215-0.225	0.144-0.150	21	20	19	19	18	17
0.21	0.274 -0.286	0.206 -0.214	0.137 – 0.143	21	20	19	19	18	16
0.20	0.260 -0.273	0.195 -0.205	0.130 – 0.136	21	20	19	18	18	16
0.19	0.247 – 0.259	0.1x6-0.194	0.124-0.129	21	20	19	18	18	16
0.18	0.234 – 0.246	0.175-0.185	0.117-0.123	21	19	18	18	17	16
0.17	0.221-0.233	0.166-0.174	0.111-0.116	20	19	18	18	17	16
0.16	0.207 – 0.220	0.155-0.165	0.104-0.110	20	19	18	18	17	16
0.15	0.194-0.206	0.146-0.154	0.097-0.103	20	19	18	17	17	15
0.14	0.180-0.193	0.135-0.145	0.091-0.096	20	18	18	17	17	15
0.13	0.167 – 0.179	0.126 – 0.134	0.084 – 0.090	19	18	17	17	16	15
0.12	0.154-0.166	0.115 -0.125	0.077-0.083	19	18	17	17	16	15
0.11	0.141 – 0.153	0.106 -0.114	0.071 – 0.076	19	18	17	16	16	15
0.10	0.127 – 0.140	0.095 -0.105	0.064 – 0.070	18	17	16	16	15	14
0.09	0.114 -0.126	0.086 – 0.094	0.057 0.063	18	17	16	16	15	14
0.08	0.100-0.113	0.075 -0.085	0.050-0.056	18	16	16	15	15	14
0.07	0.087-0.099	0.066 – 0.074	0.044-0.049	17	16	15	15	14	13
0.06	0.074 – 0.086	0.055 -0.065	0.037 – 0.043	17	16	15	14	14	13
0.05	0.060 – 0.073	0.045 -0.054	0.030 – 0.036	16	15	14	14	14	12
0.04	0.047 – 0.059	0.035 -0.044	0.024 – 0.029	15	14	14	13	13	12
0.03	0.034 – 0.046	0.025 -0.034	0.017 – 0.023	14	14	13	13	12	11
0.02	0.020-0.033	0.014 – 0.024	0.010-0.016	13	13	12	12	11	10
0.01	0.000 – 0.019	0.000 – 0.013	o.ooo-0.009	12	11	10	10	10	9

APPENDIX D-DIMENSIONS, WEIGHTS PER UNIT LENGTH AND TEST PRESSURES—SI UNITS (INFORMATIVE)

Table D-l-Coiled Line Pipe Dimensions, Weights Per Unit Length and Test Pressure (SI Units)

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Designation		Outside Diameter	Wall Thickness	Weight Per Unit Length	Inside Diameter	Minimum Test Pressure (MPa) Grade					
Size	Wall	D_m (mm)	t_m (mm)	w_{pe} (kg/m)	d_m (mm)	X52C	X56C	X60C	X65C	X70C	X80C
0500	0.9	12.7	0.9	0.26	10.9	40.2	43.2	46.3	50.2	54.1	61.8
0500	1.2	12.7	1.2	0.35	10.2	56.2	605	64.9	70.3	75.7	865
0500	1.7	12.7	1.7	0.45	9.4	74.6	80.3	86.0	93.2	100.4	103.4
0.750	2.0	19.1	2.0	0.85	15.0	61.2	65.9	70.6	765	82.4	94.1
0.750	2.1	19.1	2.1	0.88	14.8	63.5	68.4	73.2	79.4	855	97.7
0.750	2.2	19.1	2.2	0.92	14.6	665	71.7	76.8	83.2	89.6	102.4
0.750	2.4	19.1	2.4	0.99	14.2	72.7	78.3	83.8	90.8	97.8	103.4
0.750	2.6	19.1	2.6	1.05	13.9	78.0	84.0	90.0	975	103.4	103.4
1.000	2.0	25.4	2.0	1.17	21.3	45 9	49.4	53.0	57.4	61.8	70.6
1.000	2.1	25.4	2.1	1.21	21.2	47.6	51.3	54.9	59.5	64.1	73.2
1.000	2.2	25.4	2.2	1.26	21.0	49.9	53.7	57.6	62.4	67.2	76.8
1.000	2.4	25.4	2.4	1.37	20.6	54.5	58.7	62.9	68.1	73.4	83.8
1.000	2.6	25.4	2.6	1 A6	20 2	58.5	63 .0	67.5	73.1	78.8	90.0
1 .000	2.8	25.4	2.8	1.55	19.9	625	67.3	72.1	78.2	84.2	96.2
1.000	3.2	25.4	3.2	1.74	19.1	71.7	77.2	82.7	89.6	965	103.4
1.000	3.4	25.4	3.4	1.85	18.6	76.9	82.8	88.7	96.1	103.4	103.4
1.250	1.9	31.8	1.9	1.40	27.9	34.4	37.1	39.7	43.0	46.3	53.0
1.250	2.0	31.8	2.0	1.49	21.7	36.7	39.5	42.4	45.9	49.4	565
1.250	2.2	31.8	2.2	1.61	27.3	39.9	43 .0	46.1	49.9	53.7	61.4
1.250	2.4	31.8	2.4	I.75	26.9	43.6	47.0	50.3	54.5	58.7	67.1
1.250	2.6	31.8	2.6	1.86	26.6	46.8	50.4	54.0	58.5	63.0	72.0
1.250	2.8	31.8	2.8	1.98	26.2	50.0	53.9	57.7	625	67.3	77.0
1.250	3.0	31.8	3.0	2.13	25.8	54.2	58.3	62.5	67.7	72.9	83.3
1.250	3.2	31.8	3.2	2.24	25.4	57.4	61.8	66.2	71.7	77.2	88.3
1.250	3.4	31.8	3.4	2.38	24.9	61.5	66.2	71.0	76.9	82.8	94.6
1.250	3.7	31.8	3.7	2.55	24.4	66.5	71.7	76.8	83.2	89.6	102.4
1.250	4.0	31.8	4.0	2.72	23.8	71.6	77.1	82.6	89.5	96.4	103.4
1.250	4.4	31.8	4.4	2.99	22.9	80.3	86.5	92.7	100.4	103.4	103.4
1.500	2.2	38.1	2.2	1.96	33.7	33.3	35.8	38.4	41.6	44.8	51.2
1.500	2.4	38.1	2.4	2.12	33.3	36.3	39.1	41.9	45.4	48.9	55.9
1.500	2.6	38.1	2.6	2.27	32.9	39.0	42.0	45 .o	48.8	525	60.0
1.500	2.8	38.1	2.8	2.41	32.6	41.7	44.9	48.1	52.1	56.1	64.1
1.500	3.0	38.1	3.0	2.59	32.1	45.1	48.6	52.1	56.4	60.7	69.4
1.500	3.2	38.1	3.2	2.73	31.8	47.8	51.5	55.2	59.8	64.4	735
1.500	3.4	38.1	3.4	2.91	31.3	51.2	55.2	59.1	64.1	69.0	78.8
1500	3.7	38.1	3.7	3.13	30.7	55.5	59.7	64.0	69.3	74.6	85.3
1.500	4.0	38.1	4.0	3.34	30.2	59.7	64.2	68.8	74.6	80.3	91.8
1500	4.4	38.1	4.4	3.69	29.2	66.9	72.1	77.2	83.7	90.1	103.0

Table D-I-Coiled Line Pipe Dimensions, Weights Per Unit Length and Test Pressure (SI Units) (Continued)

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Designation		Outside Diameter	Wall Thickness	Weight Per Unit Length	Inside Diameter	Minimum Test Pressure (MPa)					
						Grade					
Size	Wall	D_m (mm)	t_m (mm)	w_{pe} (kg/m)	d_m (mm)	X52C	X56C	X60C	X65C	X70C	X80C
1.500	4.8	38.1	4.8	3 92	28.5	71.9	77.4	83.0	89.9	96.8	103.4
1.500	5.2	38.1	5.2	4.21	27.7	78.0	84.0	90.0	975	103.4	103.4
1.750	2.4	44.5	2.4	2.50	39.6	31.1	33.5	35.9	38.9	41.9	47.9
1.750	2.6	445	2.6	2.67	39.3	33.4	36.0	38.6	41.8	45 .o	51.4
1.750	2.8	445	2.8	2.85	38.9	35.7	385	41.2	44.7	48.1	55.0
1.750	3.0	445	3.0	3.06	385	38.7	41.7	44.6	48.3	52.1	595
1.750	3.2	445	3.2	3.23	38.1	41.0	44.1	47.3	51.2	55.2	63.0
1.750	3.4	44.5	3.4	3.45	37.6	43.9	47.3	50.7	54.9	59.1	67.6
1.750	3.7	445	3.7	3.70	37.1	475	51.2	54.8	59.4	64.0	73.1
1.750	4.0	44.5	4.0	3.96	365	51.1	55.1	59.0	63 9	68.8	78.7
1.750	4.4	445	4.4	4.39	35.6	57.4	61.8	66.2	71.7	77.2	883
1.750	4.8	445	4.8	4.67	34.9	61.6	66.4	71.1	77.0	83.0	94.8
1.750	5.2	445	5.2	5.02	34.1	66.9	72.0	77.2	83.6	90.0	102.9
2.000	2.8	50.8	2.8	3.28	45.3	31.3	33.7	36.1	39.1	42.1	48.1
2.000	3.0	50.8	3.0	353	44.8	33.8	36.4	39.1	42.3	45.6	52.1
2.000	3.2	50.8	3.2	3.73	44.5	35.9	38.6	41.4	44.8	483	55.2
2.000	3.4	50.8	3.4	3.98	44.0	38.4	41.4	44.3	48.0	51.7	59.1
2.000	3.7	50.8	3.7	4.28	43.4	41.6	44.8	48 .0	52.0	56.0	64.0
2.000	4.0	50.8	4.0	4.58	42.9	44.7	48.2	51.6	55.9	60.2	68.8
2.000	4.4	50.8	4.4	5.08	41.9	50.2	54.1	57.9	62.7	67.6	77.2
2.000	4.8	50.8	4.8	5.42	41.2	53.9	58.1	62.2	67.4	72.6	83.0
2.000	5.2	50.8	5.2	5.83	40.4	585	63 .0	675	73.1	78.8	90.0
2.000	5.7	50.8	5.7	6.33	39.4	64.2	69.2	74.1	80.3	865	98.8
2.000	6.4	50.8	6.4	6.96	38.1	71.7	77.2	82.7	89.6	96.5	103.4
$2^3/_8$	2.8	60.3	2.8	3.93	54.8	26.3	28.4	30.4	32.9	35.4	405
$2^3/_8$	3.0	603	3.0	424	54.3	28.5	30.7	32.9	35.6	38.4	43.8
$2^3/_8$	3.2	603	3.2	4.47	54.0	30.2	325	34.8	37.7	40.6	46.4
$2^3/_8$	3.4	603	3.4	4.78	535	32.4	34.9	37.3	405	43.6	49.8
$2^3/_8$	3.7	60.3	3.7	5.14	53.0	35.0	37.7	40.4	43.8	47.1	53.9
$2^3/_8$	4.0	60.3	4.0	5.51	52.4	37.7	40.6	43.5	47.1	50.7	58.0
$2^3/_8$	4.4	60.3	4.4	6.13	51.4	42.3	455	48.8	52.8	56.9	65.0
$2^3/_8$	4.8	60.3	4.8	654	50.8	45.4	48.9	52.4	56.8	61.1	69.9
$2^3/_8$	5.2	60.3	5.2	7.05	50.0	49.3	53.1	56.9	61.6	66.3	75.8
$2^3/_8$	5.7	60.3	5.7	7.67	48.9	54.1	58.3	62.4	67.6	72.8	83.2
$2^3/_8$	6.4	60.3	6.4	8.45	47.6	60.4	65.0	69.7	755	81.3	92.9
$2^3/_8$	7.1	60.3	7.1	9.33	46.1	67.6	72.8	78.0	845	91.0	103.4
$2^7/_8$	3.4	73.0	3.4	5.84	66.2	26.7	28.8	30.9	33.4	36.0	41.1
$2^7/_8$	3.7	73.0	3.7	6.30	65.7	28.9	31.2	33.4	36.2	38.9	44.5
$2^7/_8$	4.0	73.0	4.0	6.75	65.1	31.1	335	35 9	38.9	41.9	47.9
$2^7/_8$	4.4	73.0	4.4	752	64.1	34.9	37.6	40.3	43.6	47.0	53.7
$2^7/_8$	4.8	73.0	4.8	8.04	635	375	40.4	43.3	46.9	505	57.7
$2^7/_8$	5.2	73.0	5.2	8.67	62.7	40.7	43.8	47.0	50.9	54.8	62.6

Table D-l -Coiled Line Pipe Dimensions, Weights Per Unit Length and Test Pressure (SI Units) (Continued)

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Designation		Outside Diameter	Wall Thickness	Weight Per Unit Length	Inside Diameter	Minimum Test Pressure (MPa)					
						Grade					
Size	Wall	D_m (mm)	t_m (mm)	w_{pe} (kg/m)	d_m (mm)	X52C	X56C	X60C	X65C	X70C	X80C
$2^7/_8$		73.0		9.45	61.6	44.7	48.1	51.6	55.9	60.2	68.8
$2^7/_8$	6.4	73.0	6.4	10.44	60.3	49.9	53.7	57.6	62.4	67.1	76.7
$2^7/_8$	7.1	73.0	7.1	1156	58.8	55.9	60.2	645	69.8	75.2	86.0
$3^1/_2$	4.0	88.9	4.0	8.30	81.0	25.6	27.5	295	32.0	34.4	39.3
$3^1/_2$	4.4	88.9	4.4	9.26	80.0	28.7	30.9	33.1	35.9	38.6	44.1
$3^1/_2$	4.8	88.9	4.8	9.91	79.3	30.8	33.2	35.6	38.5	415	47.4
$3^1/_2$	5.2	88.9	5.2	10.70	78.5	33.4	36.0	38.6	41.8	45.0	51.4
$3^1/_2$	5.7	88.9	5.7	Il.68	77.5	36.7	395	42.4	45.9	49.4	565
$3^1/_2$	6.4	88.9	6.4	12.93	76.2	41.0	44.1	47.3	51.2	55.2	63 .0
$3^1/_2$	7.1	88.9	7.1	14.35	74.7	45.9	49.4	53.0	57.4	61.8	70.6
$3^1/_2$	7.6	88.9	7.6	1527	73.7	49.2	53.0	56.7	61.5	662	75.6
4	4.8	101.6	4.8	11.40	92.0	27.0	29.0	31.1	33.7	36.3	41.5
4	5.2	101.6	5.2	12.32	91.2	29.3	31.5	33.8	36.6	39.4	45 .o
4	5.7	101.6	5.7	13.46	90.2	32.1	34.6	37.1	40.2	43.2	49.4
4	6.4	101.6	6.4	14.92	88.9	35.9	38.6	41.4	44.8	48.3	55.2
4	7.1	101.6	7.1	16.57	87.4	40.2	43.2	46.3	50.2	54.1	61.8
4	7.6	101.6	7.6	17.66	86.4	43 .0	46.3	49.6	53.8	57.9	66.2
4	7.9	101.6	7.9	18.31	85.8	44.7	48.2	51.6	55.9	60.2	68.8
$4^1/_2$	5.2	114.3	5.2	13.94	103.9	26.0	28.0	30.0	32.5	35.0	40.0
$4^1/_2$	5.6	114.3	5.6	14.92	103.2	27.9	30.1	32.2	34.9	37.6	42.9
$4^1/_2$	5.7	114.3	5.7	15.24	102.9	28.6	30.8	32.9	35.7	38.4	43 9
$4^1/_2$	6.0	114.3	6.0	16.07	102.3	36.2	32.5	34.9	37.8	40.7	46.5
$4^1/_2$	6.4	114.3	6.4	16.91	101.6	31.9	34.3	36.8	39.8	42.9	49.0
$4^1/_2$	7.1	1143	7.1	18.80	100.1	35.7	38.4	41.2	44.6	48 .o	54.9
$4^1/_2$	7.6	114.3	7.6	20.05	99.1	38.2	41.2	44.1	47.8	51.5	58.8
$4^1/_2$	7.9	114.3	7.9	20.79	98.5	39.8	42.8	45.9	49.7	53.5	61.2
$4^1/_2$	8.7	114.3	8.7	22.75	96.8	43.9	47.2	50.6	54.8	59 .0	675
$5^9/_{16}$	6.4	141.3	6.4	21.13	128.6	25.8	27.8	29.7	32.2	34.7	39.7
$5^9/_{16}$	6.6	141.3	6.6	21.77	128.2	26.6	28.7	30.7	33.3	35.8	40.9
$5^9/_{16}$	7.1	141.3	7.1	23.53	127.1	289	31.1	33.3	36.1	38.9	44.4
$5^9/_{16}$	7.6	141.3	7.6	25.12	126.0	30.9	33.3	35.7	38.7	41.6	47.6
$5^9/_{16}$	79	141.3	7.9	26.06	125.4	322	34.7	37.1	40.2	43.3	495
$5^9/_{16}$	8.7	141.3	8.7	28.56	123.8	35.5	38.2	40.9	44.3	47.8	54.6
$5^9/_{16}$	95	141.3	9.5	30.95	122.2	38.7	41.6	44.6	48.3	52.1	59.5
$6^5/_8$	6.4	168.3	6.4	25.36	155.6	21.6	23.3	25 .0	27.1	29.1	33.3
$6^5/_8$	7.1	168.3	7.1	28.27	154.1	24.2	26.1	28 .0	30.3	32.6	37.3
$6^5/_8$	7.6	168.3	7.6	30.19	153.0	26.0	28.0	30.0	32.5	35 .0	40.0
$6^5/_8$	7.9	168.3	7.9	31.34	152.4	27.0	29.1	31.2	33.8	36.4	41.6
$6^5/_8$	8.7	168.3	8.7	34.38	150.8	29.8	32.1	34.4	372	40.1	45.8
$6^5/_8$	9.5	168.3	9.5	37.29	149.2	32.5	35.0	37.5	40.6	43.7	50 .o
$6^5/_8$	11.0	168.3	11.0	42.57	146.3	37.4	40.3	43.2	46.8	50.4	57.5

APPENDIX E-SUPPLEMENTARY REQUIREMENTS

By agreement between the purchaser and the manufacturer and when specified on the purchase order, the following supplementary requirements (SR) shall apply.

SR18 Carbon Equivalent

SR18.1 For pipe grades up to X70C inclusive, the carbon equivalent (*CE*) calculated using product analysis and the following equation shall not exceed 0.43%.

$$CE = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

SR21 Nondestructive Inspection of Electric Welds in CLP

SR21.1 SUPPLEMENTARY NONDESTRUCTIVE INSPECTION

The electric weld shall be inspected full length for surface and subsurface defects by either ultrasonic or electromagnetic methods. The location of the equipment in the mill shall be at the discretion of the manufacturer. However, the nondestructive inspection must take place after all heat treating, hydrostatic testing, expansion/reduction, and rotary straightening operations, if performed, but may take place before cropping, beveling, and sizing of pipe.

SR21.2 EQUIPMENT AND REFERENCE STANDARDS

The ultrasonic or electromagnetic inspection equipment requirements are given in 8.6.4.1 and the reference standards are described in 8.6.4.2. Details of the specific techniques (such as method, reference standards, transducer properties, and sensitivity) shall be agreed upon between the purchaser and the manufacturer for the implementation of this supplementary requirement.

SR21.3 ACCEPTANCE LIMITS

Table 13 gives the height of acceptance limit signal in percent of height of signals produced by reference standards. An imperfection that produce a signal greater than the acceptance limit signal in Table 13 shall be classified as a defect.

SR21.4 DISPOSITION

Defects shall be disposed of in accordance with 8.6.6. Repair by welding is not permitted. If a defect is removed by grinding, the ground area shall be reinspected by magnetic particle inspection or liquid penetrant inspection.

SR21.5 DOCUMENTATION

The Inspection and Test Certificate for pipe nondestructively inspected in accordance with this supplementary requirement shall be marked SR2 1.

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APPENDIX F-PURCHASER INSPECTION (INFORMATIVE)

F.1 Inspection Notice

Where the inspector representing the purchaser desires to inspect this pipe or witness these tests, reasonable notice shall be given of the tune at when the run is to be made.

F.2 Plant Access

The inspector representing the purchaser shall have unrestricted access, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that will concern the manufacture of the pipe ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy the inspector that the pipe is being manufactured in **accordance with** this specification. All inspections should be made at the place of manufacture **prior to** shipment, unless otherwise specified on the purchase order and shall be so conducted as not to interfere unnecessarily with the operation of the works.

F.3 Compliance

The manufacturer is responsible for complying with all **of** the provisions of this specification. The purchaser may make any investigation necessary to satisfy himself of compliance by the manufacturer and may reject any **material that does not** comply with this specification.

F.4 Rejection

Unless otherwise provided, material that shows defects on inspection or subsequent to acceptance at the manufacturer's works, or material that proves defective when properly applied in service, may be rejected **and the manufacturer so notified. If tests that require** the destruction of material are made, any product proven not to have met the requirements of the specification shall be rejected. Disposition of rejected product shall be a matter of agreement between the manufacturer and the purchaser.

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APPENDIX G-MARKING INSTRUCTIONS FOR API LICENSEES (INFORMATIVE)

G.1 General

The marking requirements in Appendix G apply to licensed manufacturers using the API monogram on products covered by this specification.

Pipe manufactured in conformance with this specification may be marked by the licensee as specified in Appendix G or Section 9. Products to which the monogram is applied shall be marked as specified in Appendix G.

G.1.1 The required spool marking shall be as stipulated here inafter.

G.1.2 Length and hydrostatic test pressure markings should be in U.S. Customary units. If so specified on the purchase order, these markings shall be in SI units or both U.S. Customary and SI units. If not so specified, for pipe made and intended for use in countries using the SI system, these markings may be given in SI units only, at the option of the manufacturer.

Additional markings, including those for compatible standards following the specification marking, are allowed and may be applied as desired by the manufacturer or as requested by the purchaser.

G.2 Location of Markings

For all pipe, the location of identification markings shall be on the shipping reel.

G.3 Sequence of Markings

The sequence of identification markings shall be specified in G.3.1 through G.3.9.

G.3.1 MANUFACTURER'S API LICENSE NUMBER

The manufacturer's API license number shall be marked. (The manufacturer's name or mark is optional .)

G.3.2 API MONOGRAM () AND DATE

The API monogram (), immediately followed by the date of manufacture (defined as the month and year when the monogram is applied), shall be applied only to products complying with the requirements of the specification and only by authorized manufacturers.

G.3.3 COMPATIBLE STANDARDS

Products in compliance with multiple compatible standards may be marked with the name of each standard.

G.3.4 DESIGNATION

The size and wall thickness designations are dimensionless quantities based on the former U.S. Customary unit diameter and wall thickness. The size designation (Column 1, Table 3) or the applicable intermediate outside diameter and specified wall thickness shall be marked.

G.3.5 GRADE

The symbols to be used are as follows:

Grade	Symbol
X52C	X52C
X56C	X56C
X60C	X60C
X65C	X65C
X70C	X70C
X80C	X80C

G.3.6 HEAT TREATMENT

The symbols to be used are as follows:

a. Normalized or normalized and tempered-HN.
b. Stress relieved -HS.
c. Quench and Tempered-HQ.
d. Age Hardened-HA.

G.3.7 TEST PRESSURE

When the specified hydrostatic test pressure is higher than the tabulated pressure (Table 3), the test pressure in pounds per square inch, preceded by the word TESTED, shall be marked.

G.3.8 SUPPLEMENTARY REQUIREMENTS

See Appendix E for supplemental requirements.

G.3.9 EXAMPLES

1. Size $4^1/_2$, 0.280 wall thickness, Grade X70C, quench-and-tempered steel pipe should be paint-stenciled as follows:

5LCP () (Mo-Yr) $4^1/_2$ 0.280 X70C HQ

2. Size $6^5/_8$, 0.375 wall thickness, Grade X52C steel pipe should be paint stenciled as follows:

5LCP () (Mo-Yr) $6^5/_8$ 0.375 X52C

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G.4 LENGTH

In addition to the identification markings stipulated in G.2 and G.3, the length shall be marked as follows. For all pipe sizes, the length in feet (unless otherwise specified on the purchase order) as measured on the finished coiled line pipe shall be paint-stenciled on the outside surface of the shipping reel.

APPENDIX H-COILED PIPE REELS (INFORMATIVE)

H.1 General

Coiled line pipe is spooled onto large capstan-like reels, the bed-wrap diameter of which is such as to produce roughly 2% strain in the pipe.

H.2 Reel Dimensions

The size and dimensions of the shipping reels shall be by agreement between the purchaser and the manufacturer.

The purchaser should determine local conditions with regard to the **transportation** of reels of coiled pipe. Size, weight, limitations to daylight travel, and the need for an escort should be considered.

APPENDIX M-SI (METRIC) CONVERSION PROCEDURE

The following procedures were used to make the soft metric conversion of U.S. Customary units to SI units in the metric conversion of API Spec 5LCP.

M.1 Fractions

Fractions and numbers with fractions in U.S. Customary units were converted to the full decimal equivalent in U.S. Customary numbers in inches without rounding, and the full decimal equivalent in U.S. Customary numbers were then converted to SI values using the following formula:

$$N_m = 25.4 \times N$$

where

N_m = the SI equivalent of an inch fraction, mm,

N = the full decimal equivalent of a U.S. Customary fraction which has not been rounded, in.

The SI equivalent of inch fractions were then rounded to the appropriate number of places in millimeters.

M.2 Outside Diameter

The U.S. Customary values for outside diameters of pipe were converted to SI values using the following formula:

$$D_m = 25.4 \times D$$

where

D_m = SI outside diameter, mm,

D = outside diameter, in.

The SI outside diameters of pipe were rounded to the nearest 0.1 mm.

M.3 Wall Thickness

The US. Customary values for wall thickness were converted to SI values using the following formula:

$$t_m = 25.4 \times t$$

where

t_m = SI wall thickness, mm,

t = wall thickness, in.

The SI wall thicknesses were rounded to the nearest 0.1 mm.

M.4 Inside Diameter

The SI inside diameters of pipe were calculated (not converted) using the following formula:

$$d_m = D_m - 2 \times t_m$$

where

d_m = SI inside diameter, mm,

D_m = SI outside diameter, mm,

t_m = SI wall thickness, mm.

The SI inside diameters were rounded to the nearest 0.1 mm.

M.5 Weight Per Unit Length

The SI weights per unit length were calculated (not converted) using the following formula:

$$Wpe = 0.0246615\ (D_m - t_m)\ t_m$$

where

Wpe = SI weight per unit length, kg/m,

D_m = SI outside diameter, mm,

t_m = SI wall thickness, mm.

The SI weights per unit length are rounded to the nearest 0.01 kg/m.

M.6 Yield Strength and Tensile Strength

The U.S. Customary values for yield strength and tensile strength were converted to SI values using the following formula:

$$ys_m = 0.00689476 \times ys$$
$$ts_m = 0.00689476 \times ts$$

where

ts_m = SI tensile strength, MPa,

ts = tensile strength, psi,

ys_m = SI yield strength, MPa,

ys = yield Strength, psi.

The converted SI strengths were rounded to the nearest I MPa.

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M.7 Hydrostatic Test Pressure

The SI hydrostatic test pressures were calculated (not converted) using the following formula:

$$P'_m = 1.6 \times ys_m \times t_m / D_m$$

where

P_m = SI hydrostatic test pressure, MPa,

D_m = SI outside diameter, mm,

ys_m = SI yield strength, MPa,

t_m = SI wall thickness, mm.

The calculated hydrostatic test pressures were rounded to the nearest 0.1 MPa, not to exceed 68 9 MPa.

M.8 Temperature

The U.S. Customary temperatures in degrees Fahrenheit were converted to SI temperatures in degrees Celsius using the following formula:

$$°C = (5/9)\ (°F - 32)$$

where

°C = SI temperature, degrees Celsius,

°F = temperature, degrees Fahrenheit.

The SI temperatures were rounded to the nearest 1°C.

M.9 Charpy Impact Energy

The U.S. Customary values for impact energy were converted to SI values using the following formula:

$$E'_m = 1.35582 \times E$$

where

E_m = SI Charpy impact energy in joules,

E = Charpy impact energy in foot-pounds.

The SI energy values were rounded to the nearest 1 joule.

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