Specification for Coiled Line Pipe

API SPECIFICATION 5LCP
SECOND EDITION, OCTOBER 18, 2006

EFFECTIVE DATE: APRIL 18, 2007

ERRATA, JULY 2007

REAFFIRMED, NOVEMBER 2012

AMERICAN PETROLEUM INSTITUTE

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Upstream Segment

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Suggested revisions are invited and should be submitted to the Standards and Publications Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

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Specification for Coiled Line Pipe

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 coiled line 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, X80C, and X90C. Grades shall not be mixed within a milled length, or a spool.

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 is added to indicate coiled pipe.

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

1.4 Although the 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 US 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 sulphide 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, industry and government 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"

ASNT[2]

SNT-TC-1A	*Personnel Qualification and Certification in Nondestructive Testing*.

ASTM[3]

A 370	*Methods and Definitions for Mechanical Testing of Steel Products.*
A 450	*Specification for General requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes*
A 751	*Test Methods, Practices, and Definitions 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 18	*Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials*
E 29	*Practice for Using Significant Digits in Test Data to Determine Conformance With Specifications*

[1]ASME International, 3 Park Avenue, New York, New York 10016-5900, www.asme.org
[2]ASNT, 1711 Arlingate Lane, Columbus, Ohio 43228, www.asnt.org
[3]ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania, 19428-2959, www.astm.org

E 83 *Practice for Verification and Classification of Extensometers.*
E 94 *Standard Guide for Radiographic Examination*
E 164 *Standard Practice for Ultrasonic Contact Examination of Weldments*
E 165 *Standard Practice for Liquid Penetrant Inspection*
E 213 *Standard Practice for Ultrasonic Examination of Metal Pipe and Tubing*
E 273 *Standard Practice for Ultrasonic Examination of the Weld Zone of Welded Pipe and Tubing*
E 309 *Standard Practice for Eddy-Current Examination of Steel Tubular Products, Using Magnetic Saturation*
E 570 *Standard Practice for Flux leakage Examination of Steel Tubular Products*
E 709 *Standard Guide for Magnetic Particle Examination*
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*

ISO[4]

ISO 1027 *Radiographic image quality indicators for non-destructive testing—Principles and identification*

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 calibration: The adjustment of instruments to a known basic reference, often traceable to the National Institute of Standards and Technology or an equivalent organization.

3.3 coiled line pipe: Pipe manufactured to this specification.

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

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

3.6 imperfection: A discontinuity or irregularity in the product detected by methods outlined in this Specification.

3.7 lamination: A lamination is an internal metal separation creating layers generally parallel to the surface.

3.8 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.

3.9 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.

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

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

3.12 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 air to a temperature substantially below the lower critical temperature.

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

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

3.15 reference end: The end of the spool of pipe from which measurements are recorded.

[4]ISO, Case Postale 56, CH-1211, Geneva 20, Switzerland, www.iso.org

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

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

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

3.19 spool: A finished length of coiled line pipe on a supporting reel. A pipe in the spool of pipe may contain one or more pipe-to-pipe welds.

3.20 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	Skelp-end weld
	Heat treatment of skelp-end weld
	Pipe-to-pipe weld.
	Heat treatment of pipe-to-pipe weld.
	NDT

3.21 standardization: The adjustment of a nondestructive inspection instrument to an arbitrary reference value.

3.22 strip: a single length of skelp, cut from a master coil.

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	Table 1 and 2
Size: Outside diameter:	7.2, Table 3
Specified wall thickness	7.3
Nominal length	7.5
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	6.2.5
Nondestructive inspection for laminations	7.7.6
Radiographic Image Quality Indicator	8.6.5.2
Nondestructive Inspection of Standard-Demonstration	8.6.1
Skelp End weld inspection by Ultrasound	8.6.6
Markings in SI (metric) units	9.1.1
Bare pipe—special coatings	10.1
Method of pipe-to-pipe welding	Appendix A, B
Purchaser Inspection	Appendix F
Monogram marking (see Note 2)	Appendix G

4.3 REQUIREMENTS SUBJECT TO AGREEMENT

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

Information	Reference
Chemical composition	6.1.1
Alternative Fracture Toughness Tests	6.2.5
Intermediate diameters	7.1
Intermediate wall thickness	7.1
Tolerance on length	7.5
Pipe-to-pipe welds	7.6
Height of Inside Flash	7.7.4
Gauge Ball	7.9
Additional Skelp End Weld Inspection	8.6.4.2
Hydrostatic test pressure	8.4.3
Additional Inspection of Pipe-to-pipe welds	8.6.4.4
Type of X-ray Image Quality Indicator	8.6.5.2
Seam Weld Nondestructive Test Reference Standard.	8.6.7.2
Marking requirements	9.1 and Appendix G
Drying of Coil	10.2.3
Supplementary requirements	Appendix E
Supplementary NDE	Appendix E, SR21
Shipping Reel Information	Appendix H

Notes:

1. Nothing in this specification should be interpreted as indicating a preference 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 his 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. 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 Appendix G or Section 9, and non-licensees 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

5.2.1 Electric Welded Pipe

Electric welded pipe is defined as pipe having one longitudinal seam produced by the electric welding process defined in 5.4.1.1.

5.3 TYPES OF WELDS

5.3.1 Electric-Weld (Seam)

An electric-weld is a longitudinal seam 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 at the work. Shielding is obtained from a gas. Pressure is not used, and a filler metal may or may not be used.

5.5 HEAT TREATMENT

The heat treating process shall be performed in accordance with a documented procedure. For all grades, the weld seam and the entire heat effected 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, element other than niobium (columbium) vanadium and titanium may be used; however, caution should be 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 grades X52C through X65C, 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 1.45% for X52C, 1.60% for grades higher than X52C, and lower than X70C, and 2.00% for grade X70C and higher.

Table 1—Chemical Requirements by Percentage of Mass

Grade	Carbon Max	Manganese Max	Phosphorus Max	Sulphur Max
X52C	0.15	1.35	0.020	0.010
X56C	0.15	1.35	0.020	0.010
X60C	0.15	1.45	0.020	0.010
X65C	0.15	1.45	0.020	0.010
X70C	0.15	1.45	0.020	0.010
X80C	0.15	1.45	0.020	0.010
X90C	0.15	1.45	0.020	0.010

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 for deoxidation purpose.

6.2 MECHANICAL PROPERTIES

6.2.1 Tensile Properties

6.2.1.1 All coiled line pipe products 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.

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

The yield strength shall be determined by the 0.2% offset method.

6.2.1.2 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.

Table 2—Tensile Requirements

	Yield Strength (min)		Tensile Strength (min)		Tensile Strength (max)		Hardness (max)
Grade	psi	MPa	Psi	MPa	Psi	MPa	HRC
X52C	52,000	(359)	66,000	(455)	110,000	(758)	22
X56C	56,000	(386)	71,000	(490)	110,000	(758)	22
X60C	60,000	(414)	75,000	(517)	110,000	(758)	22
X65C	65,000	(448)	77,000	(530)	110,000	(758)	22
X70C	70,000	(483)	80,000	(551)	110,000	(758)	22
X80C	80,000	(551)	88,000	(607)	120,000	(827)	22
X90C	90,000	(621)	98,000	(676)	120,000	(827)	23

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

U.S. Customary Equation	SI (Metric) Equation
$e = 625{,}000\, A^{0.2}/U^{0.9}$	$1944\, A^{0.2}/U^{0.9}$

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^2) 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.^{2} (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.

6.2.1.3 Hardness shall be measured on the surfaces of skelp-end and pipe-to-pipe welds.

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 90º 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 that originate at the edge of the specimen and that are less than 0.25 in. (6.4 mm) long shall not be cause for rejection.

US 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).

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 8.3.3).

6.2.5 Fracture Toughness Tests

Fracture toughness testing for Charpy v-notch energy is required where possible, considering the limitations imposed by diameter and thickness of the pipe ordered. Transverse specimens shall be used when possible to machine full size, $^2/_3$ size, or $^1/_2$ size specimens utilizing either tapered-end specimens, non-flattened specimens, or flattened specimens. Otherwise, longitudinal specimens shall be substituted and shall be limited to $^1/_2$ size specimens. The test specimens shall be oriented circumferentially from a location 90º from the weld with the axis of the notch oriented through the pipe wall thickness. All tests shall be conducted at 32ºF (0ºC). The acceptance shall be 20 ft-lb (27 joules) average, 15 ft-lb (20 joules) minimum for full size transverse specimens and 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 meeting the above restrictions.

6.2.6 Metallographic Examination

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

7 Dimensions, Mass Per Unit Length, Defects, and End Finishes

7.1 GENERAL—DIMENSIONS AND MASS PER UNIT LENGTH

Coiled line pipe shall be furnished in the outside diameters, wall thicknesses, and mass per unit length specified in Table 3 as specified on the purchase order, except that pipe with outside diameters and wall thicknesses 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 for product in the as-milled condition.

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, and reported as the maximum and minimum dimension across all planes.

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 be made with a mechanical caliper or with a properly calibrated non-destructive inspection device of appropriate accuracy. In case of dispute, the measurement determined by use of the mechanical caliper shall govern.

Table 3—Coiled Line Pipe Dimensions, Mass per Unit Length and Test Pressures

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Designation		Outside Diameter D	Wall Thickness t	Mass per Unit length wpe	Inside Diameter d	Minimum Test Pressure (psi) Grade						
Size	Wall	(in.)	(in.)a	(lb/ft)	(in.)	X52C	X56C	X60C	X65C	X70C	X80C	X90C
0.500	0.035	0.500	0.035	0.17	0.430	5800	6300	6700	7300	7800	9000	10100
0.500	0.049	0.500	0.049	0.24	0.402	8200	8800	9400	10200	11000	12500	14100
0.500	0.065	0.500	0.065	0.30	0.370	10800	11600	12500	13500	14600	15000	15000
0.625	0.080	0.625	0.080	0.47	0.465	10600	11500	12300	13300	14300	15000	15000
0.625	0.083	0.625	0.083	0.48	0.459	11000	11900	12700	13800	14900	15000	15000
0.625	0.087	0.625	0.087	0.50	0.451	11600	12500	13400	14500	15000	15000	15000
0.750	0.080	0.750	0.080	0.57	0.590	8900	9600	10200	11100	11900	13700	15000
0.750	0.083	0.750	0.083	0.59	0.584	9200	9900	10600	11500	12400	14200	15000
0.750	0.087	0.750	0.087	0.62	0.576	9700	10400	11100	12100	13000	14800	15000
0.750	0.095	0.750	0.095	0.67	0.560	10500	11300	12200	13200	14200	15000	15000
0.750	0.102	0.750	0.102	0.71	0.546	11300	12200	13100	14100	15000	15000	15000
0.875	0.080	0.875	0.080	0.68	0.715	7600	8200	8800	9500	10200	11700	13200
0.875	0.083	0.875	0.083	0.70	0.709	7900	8500	9100	9900	10600	12100	13700
0.875	0.087	0.875	0.087	0.73	0.701	8300	8900	9500	10300	11100	12700	14300
0.875	0.095	0.875	0.095	0.79	0.685	9000	9700	10400	11300	12200	13900	15000
0.875	0.102	0.875	0.102	0.84	0.671	9700	10400	11200	12100	13100	14900	15000
0.875	0.109	0.875	0.109	0.89	0.657	10400	11200	12000	13000	14000	15000	15000
1.000	0.080	1.000	0.080	0.79	0.840	6700	7200	7700	8300	9000	10200	11500
1.000	0.083	1.000	0.083	0.81	0.834	6900	7400	8000	8600	9300	10600	12000
1.000	0.087	1.000	0.087	0.85	0.826	7200	7800	8400	9000	9700	11100	12500
1.000	0.095	1.000	0.095	0.92	0.810	7900	8500	9100	9900	10600	12200	13700
1.000	0.102	1.000	0.102	0.98	0.796	8500	9100	9800	10600	11400	13100	14700
1.000	0.109	1.000	0.109	1.04	0.782	9100	9800	10500	11300	12200	14000	15000
1.000	0.125	1.000	0.125	1.17	0.750	10400	11200	12000	13000	14000	15000	15000
1.000	0.134	1.000	0.134	1.24	0.732	11100	12000	12900	13900	15000	15000	15000
1.250	0.075	1.250	0.075	0.94	1.100	5000	5400	5800	6200	6700	7700	8600
1.250	0.080	1.250	0.080	1.00	1.090	5300	5700	6100	6700	7200	8200	9200
1.250	0.087	1.250	0.087	1.08	1.076	5800	6200	6700	7200	7800	8900	10000
1.250	0.095	1.250	0.095	1.17	1.060	6300	6800	7300	7900	8500	9700	10900
1.250	0.102	1.250	0.102	1.25	1.046	6800	7300	7800	8500	9100	10400	11800
1.250	0.109	1.250	0.109	1.33	1.032	7300	7800	8400	9100	9800	11200	12600
1.250	0.118	1.250	0.118	1.43	1.014	7900	8500	9100	9800	10600	12100	13600
1.250	0.125	1.250	0.125	1.50	1.000	8300	9000	9600	10400	11200	12800	14400
1.250	0.134	1.250	0.134	1.60	0.982	8900	9600	10300	11100	12000	13700	15000
1.250	0.145	1.250	0.145	1.71	0.960	9700	10400	11100	12100	13000	14800	15000
1.250	0.156	1.250	0.156	1.82	0.938	10400	11200	12000	13000	14000	15000	15000
1.250	0.175	1.250	0.175	2.01	0.900	11600	12500	13400	14600	15000	15000	15000
1.250	0.188	1.250	0.188	2.13	0.874	12500	13500	14400	15000	15000	15000	15000
1.500	0.087	1.500	0.087	1.31	1.326	4800	5200	5600	6000	6500	7400	8400
1.500	0.095	1.500	0.095	1.43	1.310	5300	5700	6100	6600	7100	8100	9100
1.500	0.102	1.500	0.102	1.52	1.296	5700	6100	6500	7100	7600	8700	9800
1.500	0.109	1.500	0.109	1.62	1.282	6000	6500	7000	7600	8100	9300	10500

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

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Designation		Outside Diameter D	Wall Thickness t	Mass per Unit length wpe	Inside Diameter d	Minimum Test Pressure (psi) Grade						
Size	Wall	(in.)	(in.)a	(lb/ft)	(in.)	X52C	X56C	X60C	X65C	X70C	X80C	X90C
1.500	0.118	1.500	0.118	1.74	1.264	6500	7000	7600	8200	8800	10100	11300
1.500	0.125	1.500	0.125	1.84	1.250	6900	7500	8000	8700	9300	10700	12000
1.500	0.134	1.500	0.134	1.96	1.232	7400	8000	8600	9300	10000	11400	12900
1.500	0.145	1.500	0.145	2.10	1.210	8000	8700	9300	10100	10800	12400	13900
1.500	0.156	1.500	0.156	2.24	1.188	8700	9300	10000	10800	11600	13300	15000
1.500	0.175	1.500	0.175	2.48	1.150	9700	10500	11200	12100	13100	14900	15000
1.500	0.188	1.500	0.188	2.64	1.124	10400	11200	12000	13000	14000	15000	15000
1.500	0.204	1.500	0.204	2.83	1.092	11300	12200	13100	14100	15000	15000	15000
1.750	0.095	1.750	0.095	1.68	1.560	4500	4900	5200	5600	6100	6900	7800
1.750	0.102	1.750	0.102	1.80	1.546	4800	5200	5600	6100	6500	7500	8400
1.750	0.109	1.750	0.109	1.91	1.532	5200	5600	6000	6500	7000	8000	9000
1.750	0.118	1.750	0.118	2.06	1.514	5600	6000	6500	7000	7600	8600	9700
1.750	0.125	1.750	0.125	2.17	1.500	5900	6400	6900	7400	8000	9100	10300
1.750	0.134	1.750	0.134	2.31	1.482	6400	6900	7400	8000	8600	9800	11000
1.750	0.145	1.750	0.145	2.49	1.460	6900	7400	8000	8600	9300	10600	11900
1.750	0.156	1.750	0.156	2.66	1.438	7400	8000	8600	9300	10000	11400	12800
1.750	0.175	1.750	0.175	2.95	1.400	8300	9000	9600	10400	11200	12800	14400
1.750	0.188	1.750	0.188	3.14	1.374	8900	9600	10300	11200	12000	13800	15000
1.750	0.204	1.750	0.204	3.37	1.342	9700	10400	11200	12100	13100	14900	15000
1.750	0.224	1.750	0.224	3.65	1.302	10600	11500	12300	13300	14300	15000	15000
2.000	0.109	2.000	0.109	2.20	1.782	4500	4900	5200	5700	6100	7000	7800
2.000	0.118	2.000	0.118	2.37	1.764	4900	5300	5700	6100	6600	7600	8500
2.000	0.125	2.000	0.125	2.51	1.750	5200	5600	6000	6500	7000	8000	9000
2.000	0.134	2.000	0.134	2.67	1.732	5600	6000	6400	7000	7500	8600	9600
2.000	0.145	2.000	0.145	2.88	1.710	6000	6500	7000	7500	8100	9300	10400
2.000	0.156	2.000	0.156	3.08	1.688	6500	7000	7500	8100	8700	10000	11200
2.000	0.175	2.000	0.175	3.41	1.650	7300	7800	8400	9100	9800	11200	12600
2.000	0.188	2.000	0.188	3.64	1.624	7800	8400	9000	9800	10500	12000	13500
2.000	0.204	2.000	0.204	3.92	1.592	8500	9100	9800	10600	11400	13100	14700
2.000	0.224	2.000	0.224	4.25	1.552	9300	10000	10800	11600	12500	14300	15000
2.000	0.237	2.000	0.237	4.47	1.526	9900	10600	11400	12300	13300	15000	15000
2.000	0.250	2.000	0.250	4.68	1.500	10400	11200	12000	13000	14000	15000	15000
2 3/8	0.109	2.375	0.109	2.64	2.157	3800	4100	4400	4800	5100	5900	6600
2 3/8	0.118	2.375	0.118	2.85	2.139	4100	4500	4800	5200	5600	6400	7200
2 3/8	0.125	2.375	0.125	3.01	2.125	4400	4700	5100	5500	5900	6700	7600
2 3/8	0.134	2.375	0.134	3.21	2.107	4700	5100	5400	5900	6300	7200	8100
2 3/8	0.145	2.375	0.145	3.46	2.085	5100	5500	5900	6300	6800	7800	8800
2 3/8	0.156	2.375	0.156	3.70	2.063	5500	5900	6300	6800	7400	8400	9500
2 3/8	0.175	2.375	0.175	4.12	2.025	6100	6600	7100	7700	8300	9400	10600
2 3/8	0.188	2.375	0.188	4.40	1.999	6600	7100	7600	8200	8900	10100	11400
2 3/8	0.204	2.375	0.204	4.73	1.967	7100	7700	8200	8900	9600	11000	12400
2 3/8	0.224	2.375	0.224	5.15	1.927	7800	8500	9100	9800	10600	12100	13600
2 3/8	0.237	2.375	0.237	5.42	1.901	8300	8900	9600	10400	11200	12800	14400
2 3/8	0.250	2.375	0.250	5.68	1.875	8800	9400	10100	10900	11800	13500	15000
2 3/8	0.280	2.375	0.280	6.27	1.815	9800	10600	11300	12300	13200	15000	15000

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

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Designation		Outside Diameter D	Wall Thickness t	Mass per Unit length wpe	Inside Diameter d	Minimum Test Pressure (psi) Grade						
Size	Wall	(in.)	(in.)a	(lb/ft)	(in.)	X52C	X56C	X60C	X65C	X70C	X80C	X90C
2 5/8	0.145	2.625	0.145	3.84	2.335	4600	4900	5300	5700	6200	7100	8000
2 5/8	0.156	2.625	0.156	4.12	2.313	4900	5300	5700	6200	6700	7600	8600
2 5/8	0.175	2.625	0.175	4.58	2.275	5500	6000	6400	6900	7500	8500	9600
2 5/8	0.188	2.625	0.188	4.90	2.249	6000	6400	6900	7400	8000	9200	10300
2 5/8	0.204	2.625	0.204	5.28	2.217	6500	7000	7500	8100	8700	9900	11200
2 5/8	0.224	2.625	0.224	5.75	2.177	7100	7600	8200	8900	9600	10900	12300
2 5/8	0.237	2.625	0.237	6.05	2.151	7500	8100	8700	9400	10100	11600	13000
2 5/8	0.250	2.625	0.250	6.35	2.125	7900	8500	9100	9900	10700	12200	13700
2 5/8	0.280	2.625	0.280	7.02	2.065	8900	9600	10200	11100	11900	13700	15000
2 7/8	0.134	2.875	0.134	3.93	2.607	3900	4200	4500	4800	5200	6000	6700
2 7/8	0.145	2.875	0.145	4.23	2.585	4200	4500	4800	5200	5600	6500	7300
2 7/8	0.156	2.875	0.156	4.53	2.563	4500	4900	5200	5600	6100	6900	7800
2 7/8	0.175	2.875	0.175	5.05	2.525	5100	5500	5800	6300	6800	7800	8800
2 7/8	0.188	2.875	0.188	5.40	2.499	5400	5900	6300	6800	7300	8400	9400
2 7/8	0.204	2.875	0.204	5.82	2.467	5900	6400	6800	7400	7900	9100	10200
2 7/8	0.224	2.875	0.224	6.35	2.427	6500	7000	7500	8100	8700	10000	11200
2 7/8	0.237	2.875	0.237	6.68	2.401	6900	7400	7900	8600	9200	10600	11900
2 7/8	0.250	2.875	0.250	7.02	2.375	7200	7800	8300	9000	9700	11100	12500
2 7/8	0.280	2.875	0.280	7.77	2.315	8100	8700	9300	10100	10900	12500	14000
3 1/2	0.156	3.500	0.156	5.58	3.188	3700	4000	4300	4600	5000	5700	6400
3 1/2	0.175	3.500	0.175	6.22	3.150	4200	4500	4800	5200	5600	6400	7200
3 1/2	0.188	3.500	0.188	6.66	3.124	4500	4800	5200	5600	6000	6900	7700
3 1/2	0.204	3.500	0.204	7.19	3.092	4800	5200	5600	6100	6500	7500	8400
3 1/2	0.224	3.500	0.224	7.84	3.052	5300	5700	6100	6700	7200	8200	9200
3 1/2	0.237	3.500	0.237	8.27	3.026	5600	6100	6500	7000	7600	8700	9800
3 1/2	0.250	3.500	0.250	8.69	3.000	5900	6400	6900	7400	8000	9100	10300
3 1/2	0.280	3.500	0.280	9.64	2.940	6700	7200	7700	8300	9000	10200	11500
3 1/2	0.300	3.500	0.300	10.26	2.900	7100	7700	8200	8900	9600	11000	12300
4	0.188	4.000	0.188	7.66	3.624	3900	4200	4500	4900	5300	6000	6800
4	0.204	4.000	0.204	8.28	3.592	4200	4600	4900	5300	5700	6500	7300
4	0.224	4.000	0.224	9.04	3.552	4700	5000	5400	5800	6300	7200	8100
4	0.237	4.000	0.237	9.53	3.526	4900	5300	5700	6200	6600	7600	8500
4	0.250	4.000	0.250	10.02	3.500	5200	5600	6000	6500	7000	8000	9000
4	0.280	4.000	0.280	11.13	3.440	5800	6300	6700	7300	7800	9000	10100
4	0.300	4.000	0.300	11.87	3.400	6200	6700	7200	7800	8400	9600	10800
4	0.312	4.000	0.312	12.30	3.376	6500	7000	7500	8100	8700	10000	11200
4 1/2	0.204	4.500	0.204	9.37	4.092	3800	4100	4400	4700	5100	5800	6500
4 1/2	0.219	4.500	0.219	10.02	4.062	4000	4400	4700	5100	5500	6200	7000
4 1/2	0.224	4.500	0.224	10.24	4.052	4100	4500	4800	5200	5600	6400	7200
4 1/2	0.237	4.500	0.237	10.80	4.026	4400	4700	5100	5500	5900	6700	7600
4 1/2	0.250	4.500	0.250	11.36	4.000	4600	5000	5300	5800	6200	7100	8000
4 1/2	0.280	4.500	0.280	12.63	3.940	5200	5600	6000	6500	7000	8000	9000
4 1/2	0.300	4.500	0.300	13.47	3.900	5500	6000	6400	6900	7500	8500	9600

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

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Designation		Outside Diameter D	Wall Thickness t	Mass per Unit length wpe	Inside Diameter d	Minimum Test Pressure (psi) Grade						
Size	Wall	(in.)	(in.)a	(lb/ft)	(in.)	X52C	X56C	X60C	X65C	X70C	X80C	X90C
4 1/2	0.312	4.500	0.312	13.97	3.876	5800	6200	6700	7200	7800	8900	10000
4 1/2	0.344	4.500	0.344	15.28	3.812	6400	6800	7300	8000	8600	9800	11000
5 9/16	0.250	5.563	0.250	14.20	5.063	3700	4000	4300	4700	5000	5800	6500
5 9/16	0.258	5.563	0.258	14.63	5.047	3900	4200	4500	4800	5200	5900	6700
5 9/16	0.280	5.563	0.280	15.81	5.003	4200	4500	4800	5200	5600	6400	7200
5 9/16	0.300	5.563	0.300	16.88	4.963	4500	4800	5200	5600	6000	6900	7800
5 9/16	0.312	5.563	0.312	17.51	4.939	4700	5000	5400	5800	6300	7200	8100
5 9/16	0.344	5.563	0.344	19.19	4.875	5100	5500	5900	6400	6900	7900	8900
5 9/16	0.375	5.563	0.375	20.80	4.813	5600	6000	6500	7000	7600	8600	9700
6 5/8	0.250	6.625	0.250	17.04	6.125	3100	3400	3600	3900	4200	4800	5400
6 5/8	0.280	6.625	0.280	18.99	6.065	3500	3800	4100	4400	4700	5400	6100
6 5/8	0.300	6.625	0.300	20.28	6.025	3800	4100	4300	4700	5100	5800	6500
6 5/8	0.312	6.625	0.312	21.06	6.001	3900	4200	4500	4900	5300	6000	6800
6 5/8	0.344	6.625	0.344	23.10	5.937	4300	4700	5000	5400	5800	6600	7500
6 5/8	0.375	6.625	0.375	25.05	5.875	4700	5100	5400	5900	6300	7200	8200
6 5/8	0.432	6.625	0.432	28.60	5.761	5400	5800	6300	6800	7300	8300	9400

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

Table 4—Tolerances for Diameter of Pipe Body

Size Designation	Tolerance
< 2 3/8 +0.016	–0.031 in. (+0.4, –0.8 mm)
≥ 2 3/8 and ≥ 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
≤ 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	+10.0%, –10.0%.

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 MASS PER UNIT LENGTH

The mass 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):

$$\text{US Customary Equation (lb./ft)} = w_{pe} = 10.69\,(D\text{-}t)t$$

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

where

w_{pe} = mass 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 length of pipe(s) shall be as specified on the purchase order. Agreement on overage and underage shall be agreed upon between the manufacturer and the purchaser, and specified on the purchase order.

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. Weld surface hardness values shall not exceed those of Table 2.

7.7 WORKMANSHIP AND DEFECTS

Imperfections of the types described in 7.7.1 – 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 at 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 of 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. (0.5 mm) or 0.1t, whichever is greater.

7.7.3 Height of Outside Flash

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

7.7.4 Height of Inside Flash

Where, by agreement between the purchaser and the manufacturer, the inside flash is not to be removed, the following requirements apply:

For pipe sizes less than $3^1/_2$, the inside flash shall 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, t, whichever is less. For pipe sizes $3^1/_2$ and above, the flash height shall not exceed 0.125 in. (3.2 mm)

Otherwise, the inside flash shall be trimmed and shall not extend above the prolongation of the original inside surface of the pipe more than 0.020 in. (0.5 mm), or as agreed upon between the purchaser and the manufacturer.

The inside diameter at which internal flash can not be trimmed should be determined during contract review.

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.

Table 7—Maximum Trim Depth

Specified Wall Thickness (t)	Maximum Depth of Trim
0.150 in. (3.8 mm) and less	0.10t
0.151 in. (3.9 mm) to 0.300 in (7.6 mm)	0.015 in. (0.4 mm)
0.301 in. (7.7 mm) and greater	0.05t

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 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 8.6.9, item a or b. No specific inspection for laminations or inclusions by the manufacturer is required unless the purchaser specifies special nondestructive inspection on the purchase order.

7.7.7 Arc Burns

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

Disposition of pipe containing arc burns shall be in accordance with 8.6.9 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.

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. (0.40 mm) any length.

Undercutting in excess of Item (a) above shall be considered a defect. Disposition shall 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 shall be in accordance with 8.6.9 Item b.

7.7.9 Pipe-to-Pipe Radial Offset

For all pipe, the radial offset at pipe-to-pipe welds shall not exceed 0.020 in. (0.5 mm) or 0.1t, whichever is greater.

7.7.10 Other Defects

Any imperfections having a depth greater than 10% of the specified wall thickness shall be considered a defect. See 8.6.5.6 for defects discovered during radiography.

7.8 PIPE ENDS

Pipe shall be furnished with torch cut, unfinished or plain ends, unless otherwise specified on the purchase order.

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.

8.2.1.1 Sampling Methods

At the option of the manufacturer, samples used for product analyses shall be taken from either finished pipe, skelp, 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 may 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 shall be approximately $1^1/_2$ in. (38.1 mm) wide in gauge length if suitable curved face testing grips are used or if the ends of the specimens are machined to reduce the curvatures in the grip area,

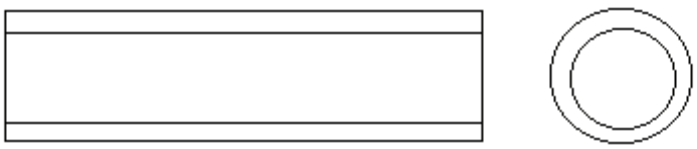

Figure 1—Tensile Test Full Section Specimen

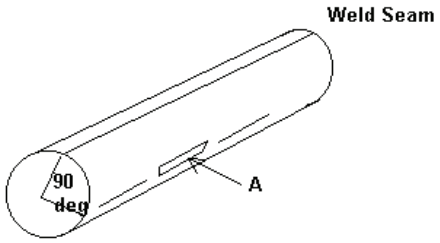

Figure 2—Orientation of Tensile Test Strip Specimen in Pipe

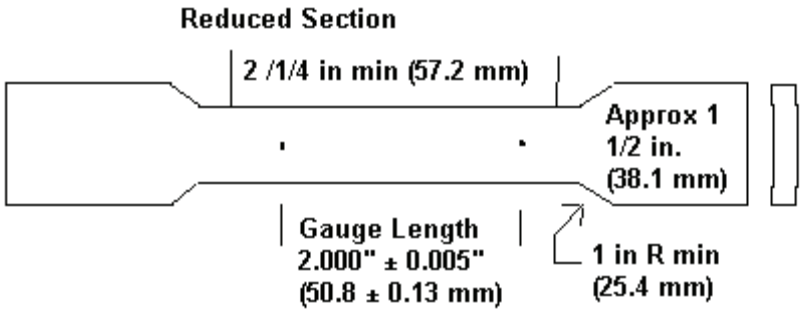

Figure 3—Tensile Test Strip Specimen

otherwise they shall be approximately $^{3}/_{4}$ in. (19.0 mm) wide for pipe in sizes $4^{1}/_{2}$ and smaller, and approximately 1-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 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. Tensile tests shall be made from each end of each spool. At least one tensile test shall be made from each 16,000 ft. (4876.6 m) or less of $5^{9}/_{16}$ and smaller pipe, or from each 8,000 ft. (2438.3 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 (4876.6 m) or less of $5^{9}/_{16}$ and smaller pipe or from each 8,000 ft. (2438.3 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 of welded pipe. 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 90º 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 flare test shall be performed from each end of the continuously milled length of coiled pipe in accordance with ASTM A 450, except for the following details.

Specimens approximately 4 in. (101.6 mm) in length shall be flared over a mandrel having a 60º included angle until the mouth of the pipe inside diameter has expanded to at least 21% without cracking. The ID 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.

8.3.4 Weld Ductility Test Frequency

The minimum test frequencies for milled lengths of coiled line pipe are as follows: at least one weld ductility test shall be made from each 16,000 ft. (4876.6 m) or less of pipe equal to or smaller than $5^9/_{16}$, or 8,000 ft. (2438.3 m) or less of pipe larger than $5^9/_{16}$. The flattening tests of 8.3.2 which 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 (see Table 3) shall be held for not less than 15 minutes. Test pressures (table 3) 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 of pipe 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 or 0.1 MPa.

Note 1: The hydrostatic test pressures given here-in are inspection test pressures, are not intended as a basis for design, and do not necessarily have any direct relationship to working pressures.

Note 2: The test pressures given in Table 3 were computed by the following equation and rounded to the nearest 100 psig or 0.1 MPa.

Note 3: The test pressures are limited to 15,000 psi (103.4 MPa) to accommodate hydrostatic tester limitations.

US Customary Equation	SI (Metric) 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 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 non-adjustable measuring devices shall consist of a visual check for legibility of markings and general wear of fixed reference points. The adjustable and non-adjustable 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 before using the instrument.

8.6 NONDESTRUCTIVE INSPECTION

8.6.1 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. Such demonstration shall be based on material in progress or sample lengths of similar material retained by the manufacturer for that purpose that exhibit natural or artificially produced defects of the character stated in 8.6.5.5, 8.6.5.6, 8.6.6 or 8.6.7.2. When inspection by the purchaser is stated on the purchase order, the provisions of Appendix F shall apply.

8.6.2 Qualification of Personnel

As a minimum, ASNT Recommended Practice No. SNT-TC-1A, or equivalent, shall be the basis of qualification for NDT personnel (excluding the visual method). Personnel shall be requalified for any method previously qualified, if they have not performed NDT in that method for a period exceeding 12 months. NDT shall be conducted by Level I, II, or III personnel.

Evaluation of indications shall be performed by Level I personnel under the supervision of Level II or III personnel, or by Level II or III personnel.

8.6.3 Standard Practices for Inspection

For other than surface inspection (see 9.6) and wall thickness verification, the required inspections shall be performed in accordance with the applicable ASTM standards, or equivalent, as follows:

a. Electromagnetic (flux leakage) E 570
b. Electromagnetic (eddy-current) E 309
c. Ultrasonic Inspection E 164, 213
d. Ultrasonic (weld seam) E 273
e. Magnetic Particle E 709
f. Radiographic Inspection E 94
g. Liquid Penetrant E 165

8.6.4 Methods of Nondestructive Inspection

8.6.4.1 Surface Inspection

The surfaces of the skelp or pipe shall be inspected to detect surface defects by a method that is equivalent to a visual inspection. Optical or electromagnetic methods that have a demonstrated capability of detecting surface defects may be used.

Where visual inspection is performed during the inspection of welds and imperfection prove-up, the visual inspection shall be conducted by personnel who are trained to detect and evaluate surface imperfections and have visual acuity that meets the applicable requirements of ASNT Recommended Practice No. SNT-TC-1A or equivalent.

8.6.4.2 Skelp End Welds

Skelp End Welds shall be inspected in skelp form by radiographic inspection in accordance with 8.6.5. Other methods such as ultrasound, magnetic particle and liquid penetrant inspection shall be performed by agreement between the purchaser and the manufacturer, as stated on the purchase order.

8.6.4.3 Seam Welds

Seam welds shall be inspected full length (100%) by ultrasonic or electromagnetic methods in accordance with 8.6.7.1 through 8.6.7.4. The location of equipment in the manufacturer's facility shall be at the discretion of the manufacturer. 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).

8.6.4.4 Pipe-to-Pipe Welds

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

8.6.5 Radiographic Inspection of Skelp End Welds and Pipe-To-Pipe Welds

8.6.5.1 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 which will display onto a screen and be permanently recorded by a digital medium, provided adequate sensitivity can be obtained.

8.6.5.2 Radiography Reference Standards

Unless otherwise specified on the purchase order, the reference standard shall be the ASTM hole-type image quality indicator (IQI) described in Table 10, the ASTM wire-type image quality indicator described in ASTM E 747 and Table 10, or the ISO wire-type image quality indicator described in ISO 1027 and Tables 8 and 9. By agreement between the purchaser and the manufacturer, other standard image quality indicators may be used, provided that an equivalent or better sensitivity is achieved.

8.6.5.2.1 ISO Wire Image Quality Indicator

The ISO wire-type image quality indicator shall be Fe 6/12 or Fe 10/16 in accordance with ISO Standard 1027, and with Tables 8 and 9 for the appropriate wall thickness. When the wire image quality indicator 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 image quality indicator location. When the image quality indicator is placed on the base metal, the diameter of the wire employed shall be based on the specified wall thickness.

8.6.5.2.2 ASTM Image Quality Indicator

The ASTM image quality indicator shall be in accordance with Table 10 for the appropriate wall thickness. Either a wire type (in accordance with ASTM Standard E 747) or a hole type (in accordance with ASTM Standard E 1025) shall be used. The sensitivity may be modified by agreement between the purchaser and manufacturer, as stated on the purchase order.

Table 8—ISO Wire 4 Percent Image Quality Indicators

(1)	(2)		(3)		(4)	
	Wall Thickness					
Wire	Over		Through		Wire diameter	
#	in.	mm	in.	mm	in.	mm
			Fe 6/12			
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	(0.32)
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 9—ISO Wire 2 Percent Image Quality Indicators

(1)	(2)		(3)		(4)	
	Wall Thickness					
Wire	Over		Through		Wire diameter	
#	in.	mm	in.	mm	in.	mm
			Fe 6/12			
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)

Table 10—ASTM Image Quality Indicator

(1)	(2)	(3)	(4)
Specified Single Wall Thickness	ASTM Designation	Essential Hole	Wire Diameter
$t \leq 0.150$ in.	10	2T	0.006 in.
0.150 in < t ≤ 0.250 in	12	2T	0.008 in.
0.250 in. < t ≤ 0.375 in	15	2T	0.010 in.
0.375 in. < t ≤ 0.432 in	15	2T	0.012 in.

8.6.5.3 Frequency of Use of Image Quality Indicator

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

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

a. individual wires of the ISO image quality indicator, or
b. the 2T hole in the ASTM image quality indicator.

8.6.5.4 Acceptance Limits for Radiographic Inspection

Radiographic examination shall be capable of detecting weld imperfections and defects as described in 8.6.5.6 and 8.6.5.7.

8.6.5.5 Imperfections Observed During Radiographic Inspection

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

1. For skelp end welds, based on which image quality indicator is used, the maximum acceptable size shall be no larger than the image of the hole in the ASTM image quality indicator, or the width of the wire in the ISO or ASTM image quality indicator.
2. 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. (152.44 mm) length of weld.

8.6.5.6 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 8.6.5.5, as indicated by radiographic examination, shall be considered defects.

8.6.5.7 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 8.6.9.

8.6.5.8 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.

8.6.6 Ultrasonic Inspection of Skelp-End Welds

When specified on the purchase order, skelp end welds may be inspected in strip or tube form using ultrasonic shear waves. Inspection shall be conducted in accordance with ASTM E 164. The reference indicator shall be a 0.25-in. long, 10% depth parallel-sided notch. No planar indications shall be permitted.

8.6.7 Ultrasonic and Electromagnetic Inspection of the Seam Weld

8.6.7.1 Equipment

Any equipment utilizing the ultrasonic or electromagnetic principles and capable of continuous and uninterrupted inspection of the entire thickness of the weld seam shall be utilized. The equipment shall be standardized with an applicable reference standard as described in 8.6.7.2 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 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.

Note: Restrictions on residual magnetism in pipe are given in 8.6.10.

8.6.7.2 Reference Standards for Ultrasonic and Electromagnetic Inspection of the Electric Seam Weld

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 4, 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 notches shall have the following dimensions: depth 10%*t* (minimum 0.015 in.), width 0.020 in. maximum, length 0.500 in. maximum. 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 4 (see note).

Reference standards shall be identified. The dimensions and type of reference indicators shall be verified by a documented procedure.

The manufacturer shall use a documented procedure to establish the reject threshold for ultrasonic or electromagnetic inspection. The applicable reference indicators given in Table 11 shall be capable of being detected under normal operating conditions. Such capability shall be demonstrated dynamically, either on-line or off-line at the option of the manufacturer, using a speed of movement between the pipe and the transducer that simulates the inspection to be used for the production pipe.

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

8.6.7.3 Records Verifying System Ability

Inspection system records shall be maintained to document the verification of the system abilities in detecting reference indicators as stated in 8.6.7.2. These records shall include standardization and operating procedures, equipment description, personnel qualifications, and dynamic test data demonstrating the system abilities for detecting the reference indicators.

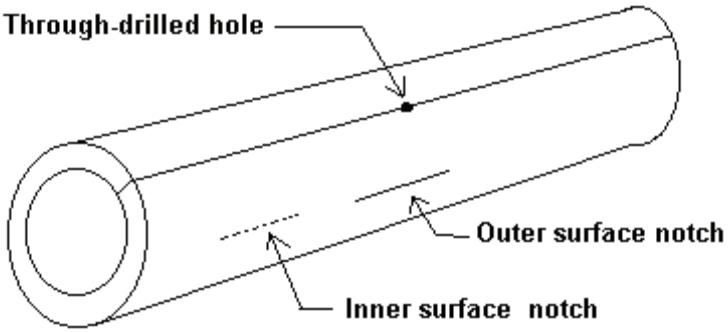

Figure 4—Seam Weld Inspection Reference Standard

8.6.7.4 Acceptance Limits

Table 11—Acceptance Limits

(1)	(2)	(3)	(4)
Weld type	Notch Type	Size hole in (mm)	Acceptance limit signal (per cent)
Electric Weld	N10	1/16 (1.6) 1/32 (0.8)	100 100

Table 11 gives the height of acceptance limit signals produced by reference indicators. An imperfection that produces a signal greater than the acceptance limit signal given in Table 11 shall be considered a defect unless it can be demonstrated by the manufacturer that the imperfection does not exceed the provision of 7.7.

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

8.6.7.5 Weld Repair

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

8.6.8 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.

8.6.8.1 Equipment

The equipment used for magnetic particle inspection shall produce a magnetic field, transverse to the imperfection, of sufficient intensity to indicate imperfections 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.

8.6.8.2 Magnetic Particle or Liquid Penetrant Inspection Reference Standard

If requested by the purchaser, arrangements shall be made by the manufacturer to perform a demonstration for the purchaser's representative during production of the purchaser's order. Such demonstration shall be based on **material** in process or sample lengths of similar material retained by the manufacturer for that purpose that exhibit natural or artificially produced defects of the character stated in 8.6.8.1.

8.6.8.3 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.

8.6.9 Disposition of Defects

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

a. The defect shall be completely removed provided that the remaining wall thickness is within specified limits. Removal shall be performed in such a way that the dressed area blends in smoothly with the contour of the pipe.
b. The section of the pipe or weld containing the defect shall be cut out of the pipe and removed as a cylinder.
c. For skelp-end or 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.

8.6.10 Residual Magnetism Measurement Requirements

The requirements of this paragraph apply only to testing within the pipe manufacturing facility. Measurements of residual magnetism on pipe, subsequent to leaving the pipe manufacturing facility, may be affected by procedures and conditions imposed on the pipe during and after shipment.

a. The longitudinal magnetic field shall be measured on pipe that is inspected full length by magnetic methods, and is to be butt-welded. Such measurements shall be taken on the root face or square cut face of finished pipe.
b. Measurements shall be made using a Hall-effect gaussmeter or other type of calibrated instrument. However, in case of dispute, measurements made with a Hall-effect gaussmeter shall govern. The gaussmeter shall be operated in accordance with written instructions demonstrated to produce accurate results.
c. As a minimum, four readings shall be taken approximately 90° apart around the circumference of each end of the pipe. The average of the four readings shall not exceed 10 gauss (1.0 mT), and no one reading shall exceed 12 gauss (1.2 mT) when measured with a Hall-effect gaussmeter, or equivalent values when measured with other types of instruments. If these values are exceeded, the pipe ends to be butt welded shall be demagnetized.
d. If the full length of the pipe has been inspected by a magnetic method, the purchaser shall be notified that the pipe may contain sufficient magnetism to affect subsequent field welding operations.

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 751. 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 12 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 12 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 before 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 re-test two more samples within 50 ft (15.2 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. Note that these 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 0º and 90º. If one or both of the retested specimens fails to conform to the specified requirements, the manufacturer may elect to further re-test within 50 ft (15.2 m) of the end of the milled length or pipe-to-pipe 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 strip length in question shall be rejected. Further strips within the spooled length shall be inspected as per the requirements for the flattening test. 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 re-test 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 strip length in question shall be rejected. Further strips within the spooled length shall be inspected as per the requirements for the flare testing. 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.

9.1.1 Length and hydrostatic test pressure markings should be in US customary units. These markings shall be in SI units or both US 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 – 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 be 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
Grade X52C	X52C
Grade X56C	X56C
Grade X60C	X60C
Grade X65C	X65C
Grade X70C	X70C
Grade X80C	X80C
Grade X90C	X90C

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 be 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 Outer 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 7.2 and 10. 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 non-reactive 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 non-reactive 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, control, and recheck) showing the mass 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, elongation, and hardness. The type, size, and orientation of specimens shall be shown.
e. The location of any skelp end welds, and any pipe-to-pipe welds, 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 indicators used.
h. The type and size of all image quality indicators 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 and inspection 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 12. Such records shall be retained by the manufacturer and shall be made available to the purchaser upon request for a period of three years after the date of purchase from the manufacturer.

Table 12—Retention of Records

Requirements	Reference
Location of Welds	
Skelp-End Welds	11.1.1
Pipe-to-Pipe Butt Welds	11.1.1
Chemical Composition	
Heat Analysis	8.2.1, 11.1.1
Product Analysis	8.2.1.1, 11.1.1
Seam Weld Heat Treatment	11.1.1
Mechanical Tests	
Tensile Tests	8.3.1, 11.1.1
Flattening Tests	8.3.2, 11.1.1
Flaring Tests	8.3.3, 11.1.1
Fracture Toughness Tests	6.2.5, 11.1.1
Hydrostatic Tests	
Tester recorder charts	8.4.2, 11.1.1
Nondestructive Inspection	
Qualification of Personnel	8.6.2,
Radiographic (Film or digital)	8.6.5.1, 11.1.1
Ultrasonic and Electromagnetic	8.6.7, 11.1.1
Supplemental weld seam inspection	Appendix E, SR21, 11.1.1
Welding Procedure	Appendices A and B
Pipe Spooling	11.1.1.
Pipe Drying Certification	11.1.1

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 be below the outside surface of the parent metal nor shall it rise above the parent metal by more than $^{1}/_{32}$-in. (0.8-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 8.6.5.
b. Ultrasonic shear wave inspection and acceptance criteria shall be in accordance with API Standard 1104.

A.5 Disposition

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

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

B.1 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 upon 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 this Appendix. At the option of the manufacturer, the tests specified in the latest issue of the ASME *Boiler and Pressure Vessel Code*, Section IX, or API Standard 1104 may be substituted herein. For the purpose of this Appendix, the term automatic welding includes both machine welding and automatic welding as defined in the ASME *Boiler and Pressure Vessel Code*, 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

1. A change in the welding process.
2. A change in method, such as manual to semi-automatic.

B.2.1.2 Pipe Material

1. 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:
   - Less than X65C.
   - Grades X65C and greater.
2. Within each grade category, a material thicker than 1.5*t* for the grade qualified.
3. 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

1. A change in filler metal classification.
2. A change in electrode diameter.
3. A change of more than 5% in the composition of the shielding gas.
4. A change of more than 20% in the flow rate of the shielding gas.

B.2.1.4 Welding Parameters

1. A change in the type of current (such as AC vs. DC).
2. A change in polarity.
3. For automatic and semi-automatic welding, schedules of welding current, voltage, and speed may be established to cover ranges of wall thicknesses. Within the schedule, appropriately selected points shall 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:
   - 20% in amperage,
   - 15% in voltage,
   - 20% in travel speed for automatic welding.

B.2.1.5 Weld Bead

For manual and semi-automatic 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 Transverse Tensile Test

The transverse tensile test shall meet the following requirements:

1. *Skelp-end welds:* The manufacturer shall provide a documented procedure which stipulates how the transverse tensile test specimen is prepared and how the transverse tensile test shall 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 shall 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 Figure B-1 (See also API 5L Fig. C-2). Each specimen shall be placed in the die with the weld at mid span 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), Figure B-2, and Table B1. 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 procedures shall otherwise be qualified in accordance with ASME Section IX.

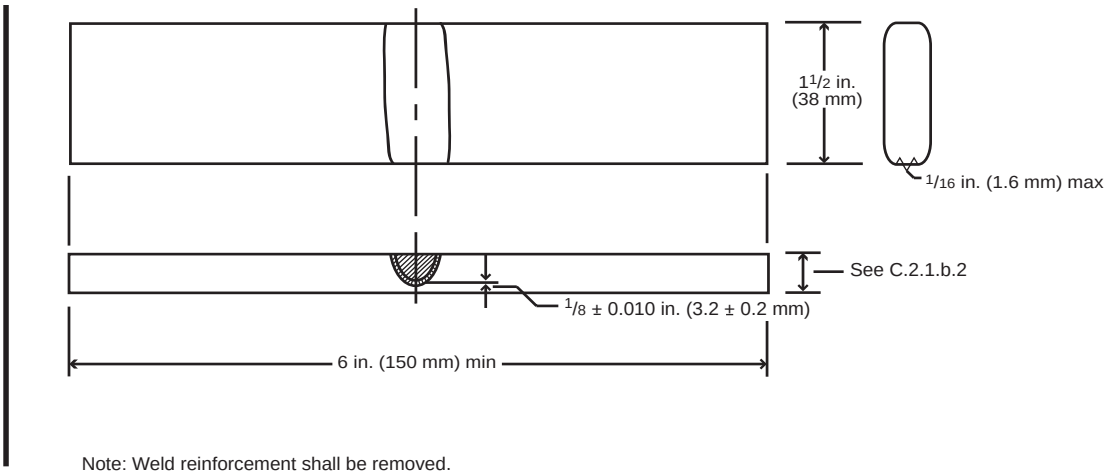

Figure B-1—Guided-bend Test Specimen

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 period of 3 months.
c. There is reason to question the individual’s ability.

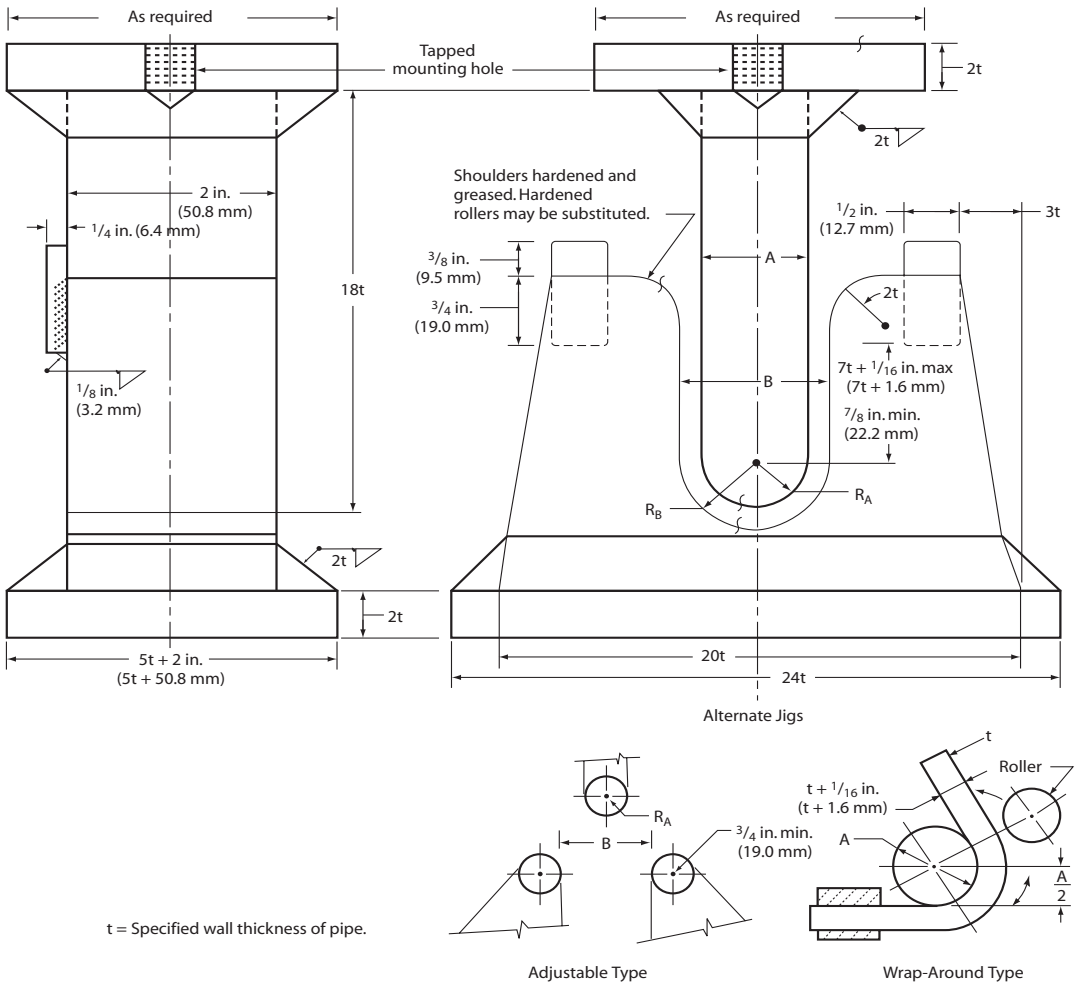

Figure B-2—Jig for Guided Bend Test

Table B-1—Guided-bend Test Jig Dimensions[1]

(1)	(2)	(3)	(4)	(5)
	Pipe Grade			
Member Dimension	X52C, X56C	X60C, X65C	X70C, X80C	X90C
Radius of male member, R_A	4t	4 1/2 t	5t	5 1/2 t
Radius of female member, R_B	5t + 1/16 in (5t + 1.6 mm)	5 1/2 t + 1/16 in. (5.5t + 1.6 mm)	6t + 1/16 in. (6t + 1.6 mm)	6 1/2 t + 1/16 in. (6.5t + 1.6 mm)
Width of male member, A	8t	9t	10t	11t
Width of groove in female member, B	10t + 1/8 in. (10t + 3.2 mm)	11t + 1/8 in. (11t + 3.2 mm)	12t + 1/8 in (12t + 3.2 mm)	13t + 1/8 in (13t+3.2 mm)

Notes:
1. See Figure B-2.
2. t = Specified wall thickness of the pipe

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-1—Elongation Table

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
				Elongation in 2 in., minimum, %						
	Tensile Test Specimen			Grade						
Area	Specified Wall Thickness, inches			X52C	X56C	X60C	X65C	X70C	X80C	X90C
"A"	0.750 in.	1.000 in.	1.500 in.	Specified Tensile Strength, ksi						
sq. in.	specimen	specimen	specimen	66.0	71.0	75.0	77.0	80.0	88.0	98.0
0.65			0.431 – 0.436	27	25	24	23	22	21	18
0.64			0.424 – 0.430	27	25	24	23	22	21	18
0.63			0.417 – 0.423	26	25	24	23	22	20	18
0.62			0.410 – 0.416	26	25	24	23	22	20	18
0.61			0.404 – 0.409	26	25	23	23	22	20	18
0.60			0.397 – 0.403	26	25	23	23	22	20	18
0.59			0.391 – 0.396	26	24	23	23	22	20	18
0.58			0.384 – 0.390	26	24	23	23	22	20	18
0.57			0.377 – 0.383	26	24	23	23	22	20	18
0.56			0.370 – 0.376	26	24	23	23	22	20	18
0.55			0.364 – 0.369	26	24	23	22	22	20	18
0.54			0.357 – 0.363	26	24	23	22	22	20	18
0.53			0.351 – 0.356	26	24	23	22	22	20	18
0.52			0.344 – 0.350	26	24	23	22	21	20	18
0.51			0.337 – 0.343	26	24	23	22	21	20	18
0.50			0.330 – 0.336	26	24	23	22	21	20	18
0.49			0.324 – 0.329	25	24	22	22	21	19	17
0.48			0.317 – 0.323	25	23	22	22	21	19	17
0.47			0.311 – 0.316	25	23	22	22	21	19	17
0.46			0.304 – 0.310	25	23	22	22	21	19	17
0.45			0.297 – 0.303	25	23	22	22	21	19	17
0.44			0.290 – 0.296	25	23	22	21	21	19	17
0.43		0.426 – 0.434	0.284 – 0.289	25	23	22	21	21	19	17
0.42		0.415 – 0.425	0.277 – 0.283	24	23	22	21	21	19	17
0.41		0.406 – 0.414	0.271 – 0.276	24	23	22	21	20	19	17
0.40		0.395 – 0.405	0.264 – 0.270	24	23	22	21	20	19	17
0.39		0.386 – 0.394	0.257 – 0.263	24	23	21	21	20	19	17
0.38		0.375 – 0.385	0.250 – 0.256	24	22	21	21	20	19	17
0.37		0.366 – 0.374	0.244 – 0.249	24	22	21	21	20	18	16
0.36		0.355 – 0.365	0.237 – 0.243	24	22	21	21	20	18	16
0.35		0.346 – 0.354	0.231 – 0.236	24	22	21	21	20	18	16
0.34		0.335 – 0.345	0.224 – 0.230	23	22	21	20	20	18	16
0.33		0.326 – 0.334	0.217 – 0.223	23	22	21	20	20	18	16
0.32	0.420 – 0.433	0.315 – 0.325	0.210 – 0.216	23	22	21	20	19	18	16
0.31	0.407 – 0.419	0.306 – 0.314	0.204 – 0.209	23	22	21	20	19	18	16

Table C-1—Elongation Table (Continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
				Elongation in 2 in., minimum, %						
	Tensile Test Specimen			Grade						
Area	Specified Wall Thickness, inches			X52C	X56C	X60C	X65C	X70C	X80C	X90C
"A"	0.750 in.	1.000 in.	1.500 in.	Specified Tensile Strength, ksi						
sq. in.	specimen	specimen	specimen	66.0	71.0	75.0	77.0	80.0	88.0	98.0
0.30	0.394 – 0.406	0.295 – 0.305	0.197 – 0.203	23	21	20	20	19	18	16
0.29	0.381 – 0.393	0.286 – 0.294	0.191 – 0.196	23	21	20	20	19	18	16
0.28	0.367 – 0.380	0.275 – 0.285	0.184 – 0.190	23	21	20	20	19	17	15
0.27	0.354 – 0.366	0.266 – 0.274	0.177 – 0.183	22	21	20	19	19	17	16
0.26	0.340 – 0.353	0.255 – 0.265	0.170 – 0.176	22	21	20	19	19	17	15
0.25	0.327 – 0.339	0.246 – 0.254	0.164 – 0.169	22	21	20	19	19	17	15
0.24	0.314 – 0.326	0.235 – 0.245	0.157 – 0.163	22	20	19	19	18	17	15
0.23	0.301 – 0.313	0.226 – 0.234	0.151 – 0.156	22	20	19	19	18	17	15
0.22	0.287 – 0.300	0.215 – 0.225	0.144 – 0.150	21	20	19	19	18	17	15
0.21	0.274 – 0.286	0.206 – 0.214	0.137 – 0.143	21	20	19	19	18	16	15
0.20	0.260 – 0.273	0.195 – 0.205	0.130 – 0.136	21	20	19	18	18	16	15
0.19	0.247 – 0.259	0.186 – 0.194	0.124 – 0.129	21	20	19	18	18	16	14
0.18	0.234 – 0.246	0.175 – 0.185	0.117 – 0.123	21	19	18	18	17	16	14
0.17	0.221 – 0.233	0.166 – 0.174	0.111 – 0.116	20	19	18	18	17	16	14
0.16	0.207 – 0.220	0.155 – 0.165	0.104 – 0.110	20	18	18	18	17	16	14
0.15	0.194 – 0.206	0.146 – 0.154	0.097 – 0.103	20	18	18	17	17	15	14
0.14	0.180 – 0.193	0.135 – 0.145	0.091 – 0.096	20	18	18	17	17	15	14
0.13	0.167 – 0.179	0.126 – 0.134	0.084 – 0.090	19	18	17	17	16	15	13
0.12	0.154 – 0.166	0.115 – 0.125	0.077 – 0.083	19	18	17	17	16	15	13
0.11	0.141 – 0.153	0.106 – 0.114	0.071 – 0.076	19	18	17	16	16	15	13
0.10	0.127 – 0.140	0.095 – 0.105	0.064 – 0.070	18	18	16	16	15	14	13
0.09	0.114 – 0.126	0.086 – 0.094	0.057 – 0.063	18	17	16	16	15	14	12
0.08	0.100 – 0.113	0.075 – 0.085	0.050 – 0.056	18	16	16	15	15	14	12
0.07	0.087 – 0.099	0.066 – 0.074	0.044 – 0.049	17	16	15	15	14	13	12
0.06	0.074 – 0.086	0.055 – 0.065	0.037 – 0.043	17	16	15	14	14	13	12

APPENDIX D—DIMENSIONS, MASS PER UNIT LENGTH AND TEST PRESSURES SI UNITS (NORMATIVE)

Table D-1—Dimensions, Mass per unit Length and Test Pressures—SI Units

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Designation		Outside diameter D_m	Wall Thickness t	Mass per Unit Length w_{pe}	Inside Diameter d_m	Minimum Test Pressure (N/mm^2 or MPa) Grade						
Size	Wall	(mm.)	(mm)	(kg/m)	(mm.)	X52C	X56C	X60C	X65C	X70C	X80C	X90C
0.500	0.9	12.7	0.9	0.26	10.9	40.2	43.2	46.3	50.2	54.1	61.8	69.5
0.500	1.2	12.7	1.2	0.35	10.2	56.2	60.5	64.9	70.3	75.7	86.5	97.3
0.500	1.7	12.7	1.7	0.45	9.4	74.6	80.3	86.0	93.2	100.4	103.4	103.4
0.625	2.0	15.9	2.0	0.69	11.8	73.4	79.1	84.7	91.8	98.8	103.4	103.4
0.625	2.1	15.9	2.1	0.72	11.7	76.2	82.0	87.9	95.2	102.5	103.4	103.4
0.625	2.2	15.9	2.2	0.74	11.5	79.9	86.0	92.1	99.8	103.4	103.4	103.4
0.750	2.0	19.1	2.0	0.85	15.0	61.2	65.9	70.6	76.5	82.4	94.1	103.4
0.750	2.1	19.1	2.1	0.88	14.8	63.5	68.4	73.2	79.4	85.5	97.7	103.4
0.750	2.2	19.1	2.2	0.92	14.6	66.5	71.7	76.8	83.2	89.6	102.4	103.4
0.750	2.4	19.1	2.4	0.99	14.2	72.7	78.3	83.8	90.8	97.8	103.4	103.4
0.750	2.6	19.1	2.6	1.05	13.9	78.0	84.0	90.0	97.5	103.4	103.4	103.4
0.875	2.0	22.2	2.0	1.01	18.2	52.4	56.5	60.5	65.6	70.6	80.7	90.8
0.875	2.1	22.2	2.1	1.05	18.0	54.4	58.6	62.8	68.0	73.2	83.7	94.2
0.875	2.2	22.2	2.2	1.09	17.8	57.0	61.4	65.8	71.3	76.8	87.7	98.7
0.875	2.4	22.2	2.4	1.18	17.4	62.3	67.1	71.9	77.9	83.8	95.8	103.4
0.875	2.6	22.2	2.6	1.25	17.0	66.9	72.0	77.2	83.6	90.0	102.9	103.4
0.875	2.8	22.2	2.8	1.33	16.7	71.5	77.0	82.5	89.3	96.2	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	79.4
1.000	2.1	25.4	2.1	1.21	21.2	47.6	51.3	54.9	59.5	64.1	73.2	82.4
1.000	2.2	25.4	2.2	1.26	21.0	49.9	53.7	57.6	62.4	67.2	76.8	86.4
1.000	2.4	25.4	2.4	1.37	20.6	54.5	58.7	62.9	68.1	73.4	83.8	94.3
1.000	2.6	25.4	2.6	1.46	20.2	58.5	63.0	67.5	73.1	78.8	90.0	101.3
1.000	2.8	25.4	2.8	1.55	19.9	62.5	67.3	72.1	78.2	84.2	96.2	103.4
1.000	3.2	25.4	3.2	1.74	19.1	71.7	77.2	82.7	89.6	96.5	103.4	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	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	59.6
1.250	2.0	31.8	2.0	1.49	27.7	36.7	39.5	42.4	45.9	49.4	56.5	63.5
1.250	2.2	31.8	2.2	1.61	27.3	39.9	43.0	46.1	49.9	53.7	61.4	69.1
1.250	2.4	31.8	2.4	1.75	26.9	43.6	47.0	50.3	54.5	58.7	67.1	75.5
1.250	2.6	31.8	2.6	1.86	26.6	46.8	50.4	54.0	58.5	63.0	72.0	81.0
1.250	2.8	31.8	2.8	1.98	26.2	50.0	53.9	57.7	62.5	67.3	77.0	86.6
1.250	3.0	31.8	3.0	2.13	25.8	54.2	58.3	62.5	67.7	72.9	83.3	93.7
1.250	3.2	31.8	3.2	2.24	25.4	57.4	61.8	66.2	71.7	77.2	88.3	99.3
1.250	3.4	31.8	3.4	2.38	24.9	61.5	66.2	71.0	76.9	82.8	94.6	103.4
1.250	3.7	31.8	3.7	2.55	24.4	66.5	71.7	76.8	83.2	89.6	102.4	103.4
1.250	4.0	31.8	4.0	2.72	23.8	71.6	77.1	82.6	89.5	96.4	103.4	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	103.4
1.250	4.8	31.8	4.8	3.18	22.2	86.3	92.9	99.5	103.4	103.4	103.4	103.4

Table D-1—Dimensions, Mass per unit Length and Test Pressures—SI Units (Continued)

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Designation		Outside diameter D_m	Wall Thickness t	Mass per Unit Length w_{pe}	Inside Diameter d_m	Minimum Test Pressure (N/mm^2 or MPa) Grade						
Size	Wall	(mm.)	(mm)	(kg/m)	(mm.)	X52C	X56C	X60C	X65C	X70C	X80C	X90C
1.500	2.2	38.1	2.2	1.96	33.7	33.3	35.8	38.4	41.6	44.8	51.2	57.6
1.500	2.4	38.1	2.4	2.12	33.3	36.3	39.1	41.9	45.4	48.9	55.9	62.9
1.500	2.6	38.1	2.6	2.27	32.9	39.0	42.0	45.0	48.8	52.5	60.0	67.5
1.500	2.8	38.1	2.8	2.41	32.6	41.7	44.9	48.1	52.1	56.1	64.1	72.1
1.500	3.0	38.1	3.0	2.59	32.1	45.1	48.6	52.1	56.4	60.7	69.4	78.1
1.500	3.2	38.1	3.2	2.73	31.8	47.8	51.5	55.2	59.8	64.4	73.5	82.7
1.500	3.4	38.1	3.4	2.91	31.3	51.2	55.2	59.1	64.1	69.0	78.8	88.7
1.500	3.7	38.1	3.7	3.13	30.7	55.5	59.7	64.0	69.3	74.6	85.3	96.0
1.500	4.0	38.1	4.0	3.34	30.2	59.7	64.2	68.8	74.6	80.3	91.8	103.3
1.500	4.4	38.1	4.4	3.69	29.2	66.9	72.1	77.2	83.7	90.1	103.0	103.4
1.500	4.8	38.1	4.8	3.92	28.5	71.9	77.4	83.0	89.9	96.8	103.4	103.4
1.500	5.2	38.1	5.2	4.21	27.7	78.0	84.0	90.0	97.5	103.4	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	53.9
1.750	2.6	44.5	2.6	2.67	39.3	33.4	36.0	38.6	41.8	45.0	51.4	57.9
1.750	2.8	44.5	2.8	2.85	38.9	35.7	38.5	41.2	44.7	48.1	55.0	61.8
1.750	3.0	44.5	3.0	3.06	38.5	38.7	41.7	44.6	48.3	52.1	59.5	66.9
1.750	3.2	44.5	3.2	3.23	38.1	41.0	44.1	47.3	51.2	55.2	63.0	70.9
1.750	3.4	44.5	3.4	3.45	37.6	43.9	47.3	50.7	54.9	59.1	67.6	76.0
1.750	3.7	44.5	3.7	3.70	37.1	47.5	51.2	54.8	59.4	64.0	73.1	82.3
1.750	4.0	44.5	4.0	3.96	36.5	51.1	55.1	59.0	63.9	68.8	78.7	88.5
1.750	4.4	44.5	4.4	4.39	35.6	57.4	61.8	66.2	71.7	77.2	88.3	99.3
1.750	4.8	44.5	4.8	4.67	34.9	61.6	66.4	71.1	77.0	83.0	94.8	103.4
1.750	5.2	44.5	5.2	5.02	34.1	66.9	72.0	77.2	83.6	90.0	102.9	103.4
1.750	5.7	44.5	5.7	5.44	33.1	73.4	79.1	84.7	91.8	98.8	103.4	103.4
2.000	2.8	50.8	2.8	3.28	45.3	31.3	33.7	36.1	39.1	42.1	48.1	54.1
2.000	3.0	50.8	3.0	3.53	44.8	33.8	36.4	39.1	42.3	45.6	52.1	58.6
2.000	3.2	50.8	3.2	3.73	44.5	35.9	38.6	41.4	44.8	48.3	55.2	62.1
2.000	3.4	50.8	3.4	3.98	44.0	38.4	41.4	44.3	48.0	51.7	59.1	66.5
2.000	3.7	50.8	3.7	4.28	43.4	41.6	44.8	48.0	52.0	56.0	64.0	72.0
2.000	4.0	50.8	4.0	4.58	42.9	44.7	48.2	51.6	55.9	60.2	68.8	77.4
2.000	4.4	50.8	4.4	5.08	41.9	50.2	54.1	57.9	62.7	67.6	77.2	86.9
2.000	4.8	50.8	4.8	5.42	41.2	53.9	58.1	62.2	67.4	72.6	83.0	93.3
2.000	5.2	50.8	5.2	5.83	40.4	58.5	63.0	67.5	73.1	78.8	90.0	101.3
2.000	5.7	50.8	5.7	6.33	39.4	64.2	69.2	74.1	80.3	86.5	98.8	103.4
2.000	6.0	50.8	6.0	6.65	38.8	68.0	73.2	78.4	85.0	91.5	103.4	103.4
2.000	6.4	50.8	6.4	6.96	38.1	71.7	77.2	82.7	89.6	96.5	103.4	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	40.5	45.6
2 3/8	3.0	60.3	3.0	4.24	54.3	28.5	30.7	32.9	35.6	38.4	43.8	49.3
2 3/8	3.2	60.3	3.2	4.47	54.0	30.2	32.5	34.8	37.7	40.6	46.4	52.3
2 3/8	3.4	60.3	3.4	4.78	53.5	32.4	34.9	37.3	40.5	43.6	49.8	56.0
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	60.6
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	65.2
2 3/8	4.4	60.3	4.4	6.13	51.4	42.3	45.5	48.8	52.8	56.9	65.0	73.2
2 3/8	4.8	60.3	4.8	6.54	50.8	45.4	48.9	52.4	56.8	61.1	69.9	78.6

Table D-1—Dimensions, Mass per unit Length and Test Pressures—SI Units (Continued)

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Designation		Outside diameter D_m	Wall Thickness t	Mass per Unit Length w_{pe}	Inside Diameter d_m	Minimum Test Pressure (N/mm^2 or MPa) Grade						
Size	Wall	(mm.)	(mm)	(kg/m)	(mm.)	X52C	X56C	X60C	X65C	X70C	X80C	X90C
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	85.3
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	93.6
2 3/8	6.0	60.3	6.0	8.06	48.3	57.2	61.6	66.1	71.6	77.1	88.1	99.1
2 3/8	6.4	60.3	6.4	8.45	47.6	60.4	65.0	69.7	75.5	81.3	92.9	103.4
2 3/8	7.1	60.3	7.1	9.33	46.1	67.6	72.8	78.0	84.5	91.0	103.4	103.4
2 5/8	3.7	66.7	3.7	5.72	59.3	31.7	34.1	36.6	39.6	42.7	48.7	54.8
2 5/8	4.0	66.7	4.0	6.13	58.8	34.1	36.7	39.3	42.6	45.9	52.4	59.0
2 5/8	4.4	66.7	4.4	6.82	57.8	38.2	41.2	44.1	47.8	51.5	58.8	66.2
2 5/8	4.8	66.7	4.8	7.29	57.1	41.1	44.2	47.4	51.4	55.3	63.2	71.1
2 5/8	5.2	66.7	5.2	7.86	56.3	44.6	48.0	51.4	55.7	60.0	68.6	77.2
2 5/8	5.7	66.7	5.7	8.56	55.3	49.0	52.7	56.5	61.2	65.9	75.3	84.7
2 5/8	6.0	66.7	6.0	9.00	54.6	51.8	55.8	59.8	64.7	69.7	79.7	89.6
2 5/8	6.4	66.7	6.4	9.45	54.0	54.6	58.8	63.0	68.3	73.5	84.1	94.6
2 5/8	7.1	66.7	7.1	10.45	52.5	61.2	65.9	70.6	76.5	82.4	94.1	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	46.3
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	50.1
2 7/8	4.0	73.0	4.0	6.75	65.1	31.1	33.5	35.9	38.9	41.9	47.9	53.9
2 7/8	4.4	73.0	4.4	7.52	64.1	34.9	37.6	40.3	43.6	47.0	53.7	60.4
2 7/8	4.8	73.0	4.8	8.04	63.5	37.5	40.4	43.3	46.9	50.5	57.7	64.9
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	70.4
2 7/8	5.7	73.0	5.7	9.45	61.6	44.7	48.1	51.6	55.9	60.2	68.8	77.4
2 7/8	6.0	73.0	6.0	9.95	61.0	47.3	50.9	54.6	59.1	63.7	72.8	81.8
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	86.3
2 7/8	7.1	73.0	7.1	11.56	58.8	55.9	60.2	64.5	69.8	75.2	86.0	96.7
3 1/2	4.0	88.9	4.0	8.30	81.0	25.6	27.5	29.5	32.0	34.4	39.3	44.3
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	49.6
3 1/2	4.8	88.9	4.8	9.91	79.3	30.8	33.2	35.6	38.5	41.5	47.4	53.3
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	57.9
3 1/2	5.7	88.9	5.7	11.68	77.5	36.7	39.5	42.4	45.9	49.4	56.5	63.5
3 1/2	6.0	88.9	6.0	12.30	76.9	38.8	41.8	44.8	48.6	52.3	59.8	67.2
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	70.9
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	79.4
3 1/2	7.6	88.9	7.6	15.27	73.7	49.2	53.0	56.7	61.5	66.2	75.6	85.1
4	4.8	101.6	4.8	11.40	92.0	27.0	29.0	31.1	33.7	36.3	41.5	46.7
4	5.2	101.6	5.2	12.32	91.2	29.3	31.5	33.8	36.6	39.4	45.0	50.6
4	5.7	101.6	5.7	13.46	90.2	32.1	34.6	37.1	40.2	43.2	49.4	55.6
4	6.0	101.6	6.0	14.19	89.6	34.0	36.6	39.2	42.5	45.8	52.3	58.8
4	6.4	101.6	6.4	14.92	88.9	35.9	38.6	41.4	44.8	48.3	55.2	62.1
4	7.1	101.6	7.1	16.57	87.4	40.2	43.2	46.3	50.2	54.1	61.8	69.5
4	7.6	101.6	7.6	17.66	86.4	43.0	46.3	49.6	53.8	57.9	66.2	74.5
4	7.9	101.6	7.9	18.31	85.8	44.7	48.2	51.6	55.9	60.2	68.8	77.4
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	45.0
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	48.3

Table D-1—Dimensions, Mass per unit Length and Test Pressures—SI Units (Continued)

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Designation		Outside diameter D_m	Wall Thickness t	Mass per Unit Length w_{pe}	Inside Diameter d_m	Minimum Test Pressure (N/mm^2 or MPa) Grade						
Size	Wall	(mm.)	(mm)	(kg/m)	(mm.)	X52C	X56C	X60C	X65C	X70C	X80C	X90C
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	49.4
4 1/2	6.0	114.3	6.0	16.07	102.3	30.2	32.5	34.9	37.8	40.7	46.5	52.3
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	55.2
4 1/2	7.1	114.3	7.1	18.80	100.1	35.7	38.4	41.2	44.6	48.0	54.9	61.8
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	66.2
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	68.8
4 1/2	8.7	114.3	8.7	22.75	96.8	43.9	47.2	50.6	54.8	59.0	67.5	75.9
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	44.6
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	46.1
5 9/16	7.1	141.3	7.1	23.53	127.1	28.9	31.1	33.3	36.1	38.9	44.4	50.0
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	53.5
5 9/16	7.9	141.3	7.9	26.06	125.4	32.2	34.7	37.1	40.2	43.3	49.5	55.7
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	61.4
5 9/16	9.5	141.3	9.5	30.95	122.2	38.7	41.6	44.6	48.3	52.1	59.5	66.9
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	37.5
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	42.0
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	45.0
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	46.8
6 5/8	8.7	168.3	8.7	34.38	150.8	29.8	32.1	34.4	37.2	40.1	45.8	51.6
6 5/8	9.5	168.3	9.5	37.29	149.2	32.5	35.0	37.5	40.6	43.7	50.0	56.2
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	64.7

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 equations shall not exceed 0.43%.

a. When the CE is less than or equal to 0.12%:

$$CE\ (Pcm) = C + Si/30 + (Mn + Cu + Cr)/20 + Ni/60 + Mo/15 + V/10 + 5B.$$

b. When the carbon content is greater than 0.12%:

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

SR21 Nondestructive Inspection of Welds in Electric Welded Pipe

SR21.1 SUPPLEMENTARY NONDESTRUCTIVE INSPECTION

The weld seam in electric welded coiled line pipe shall be inspected full length (100%) for the entire thickness by either ultrasonic or electromagnetic methods. The location of the equipment in the mill shall be at the discretion of the manufacturer. The nondestructive inspection shall take place after all heat treating, hydrostatic testing, expansion, 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 8.6.7.1, and the reference indicator requirements are given in 8.6.7.2. Details of the specific techniques (such as method, reference standards, reference indicators, 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 11 gives the height of acceptance limit signals in percent of height of signals produced by reference indicators. An imperfection that produces a signal greater than the acceptance limit signal given in Table 11 shall be classified as a defect.

SR21.4 DISPOSITION

Defects shall be disposed of in accordance with 8.6.9. Repair by welding is not permitted. If a defect is removed by grinding, the ground area shall be reinspected by magnetic particle or liquid particle inspection.

SR21.5 DOCUMENTATION AND MARKING

Pipe nondestructively inspected in accordance with this supplementary requirement shall be marked SR21. The Inspection and Test Certificate for pipe nondestructively inspected in accordance with this supplementary requirement shall be marked SR21.

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 time 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.

APPENDIX G—API MONOGRAM ANNEX (INFORMATIVE)

G.1 General

The API Monogram Program allows an API Licensee to apply the API Monogram to products. The use of the Monogram on products constitutes a representation and warranty by the Licensee to purchasers of the products that, on the date indicated, the products were produced in accordance with a verified quality management system and in accordance with an API product specification. The API Monogram Program delivers significant value to the international oil and gas industry by linking the verification of an organization's quality management system with the demonstrated ability to meet specific product specification requirements.

When used in conjunction with the requirements of the API License Agreement, API Specification Q1, including this standard , defines the requirements for those organizations who wish to voluntarily obtain an API License to provide API monogrammed products in accordance with an API product specification.

API Monogram Program Licenses are issued only after an on-site audit has verified that the Licensee conforms to the requirements described in API Specification Q1 in total..

For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, N. W., Washington, DC 20005 or call 202-682-8000 or by email at quality@api.org.

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 be as stipulated herein-after.

G.1.2 Length and hydrostatic test pressure marking should be in US customary units. If so specified on the purchase order, these markings shall be in SI units or both US 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 US customary unit diameter and wall thickness. The size designation (Column 1, Table 3) or the applicable intermediate outside diameter shall be marked.

G.3.5 GRADE

The symbols to be used are as follows:

Grade	Symbol
Grade X52C	X52C
Grade X56C	X56C
Grade X60C	X60C
Grade X65C	X65C
Grade X70C	X70C
Grade X80C	X80C
Grade X90C	X90C

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-XXXXX [monogram] (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-XXXXX [monogram] (Mo-Yr.) 6-5/8 0.375 X52C

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 – 3% strain in the pipe.

H.2 Reel Dimensions

The size and dimensions (core diameter, core length, flange height) of the shipping reels determines the amount of coiled line pipe that can be stored on a reel, and shall be by agreement between the purchaser and the manufacturer. Attention should be paid to the following when ordering coiled line pipe:

a. Whether the tubing is coated or uncoated.
b. The degree of stabilization of the base of the reel that is needed.
c. Drying and backfilling with inert gas.
d. Crating.

H.3 Reel Transportation

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 US 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 U.S. customary values for wall thickness are 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 is 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 Plain-end Mass Per Unit Length

The SI plain-end mass per unit length were calculated (not converted) using the following formula

$$w_{pem} = 0.024\,661\,5 \times (D_m - t_m)t_m$$

where

w_{pem} = SI plain-end mass per unit length, kg/m.

D_m = SI outside diameter, mm.

t_m = SI wall thickness, mm.

The SI plain-end mass 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:

$$y_{sm} = 0.006\,894\,76 \times y_s$$

$$t_{sm} = 0.006\,894\,76 \times t_s$$

where

t_{sm} = SI tensile strength, MPa,

t_s = tensile strength, psi,

y_{sm} = SI yield strength, MPa,

y_s = yield strength, psi.

The converted SI strengths were rounded to the nearest 1 MPa.

M.7 Hydrostatic Test Pressure

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

$$P_m = 1.6\, y_{sm} \times t_m / D_m$$

where

P_m = SI hydrostatic test pressure, MPa,

y_{sm} = SI Yield Strength, MPa,

t_m = SI wall thickness, mm,

D_m = SI outside diameter, mm.

The calculated hydrostatic test pressure were rounded to the nearest 0,1 MPa, not to exceed 68,9 MPa.

M.8 Temperature

The US customary temperature in degrees Fahrenheit were converted to SI temperature in degrees Celsius using the following formula:

$$^{o}C = (5/9)(^{o}F - 32)$$

where

^{o}C = SI temperature, degrees Celsius,

^{o}F = temperature, degrees Fahrenheit,

The SI temperatures were rounded to the nearest 1^{o}C.

M.9 Charpy Impact Energy

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

$$E_m = 1.355\,82 \times E$$

where

E_m = energy, J,

E = energy, ft-lb.

The SI energy values are rounded to the nearest 1 J.

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