# CRA Line Pipe

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## Foreword

This edition of API Specification 5LC supersedes the Third Edition and includes items approved by letter ballot through January 2014. Portions of this publication have been changed from the previous edition. Substantive changes are indicated with gray shading and blue font, but API makes no warranty as to the accuracy of such notations. Nonsubstantive changes will not be indicated with shading and colored font.

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— the term “may” is used to express permission or a provision that is optional; and

— the term “can” is used to express possibility or capability.

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

## Suggestions for Ordering API CRA Line Pipe

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

- Specification ..... API Spec 5LC
- Quantity
- Grade ..... Tables 4 and 7
- Type of Pipe ..... Section 4.1 c)
- Size
  - Nominal Diameter:
    - Standard-weight Plain-end Pipe ..... Table 12
    - Extra-strong Plain-end Pipe ..... Table 12
    - Double-extra-strong Plain-end Pipe ..... Table 12
  - Outside Diameter:
    - Regular-weight Plain-end Pipe ..... Table 12
    - Special Plain-end Pipe ..... Table 12
  - Weight per Foot or Wall Thickness ..... Table 12
  - Nominal Length ..... Section 10.5
  - End Finish ..... Section 10
  - Delivery Date and Shipping Instructions

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

- Certificate of Compliance ..... Section 1.5
- Chemical Analysis Test Reports ..... Section 6.5
- Acceptance and Maximum Allowable Percent of Jointers ..... Section 10.7
- Alternative Bevel, Plain-end Pipe in Sizes
  - $2^3/_8$ in. OD and larger ..... Section 10.8
- Defect Repair Procedures ..... Sections 12.7, 12.8, 12.9
- Markings in Metric Units ..... Section 13.1 b)
- Purchaser Inspection ..... Annex G
- Monogram Marking * ..... Annex A, Section A.4

* Users of this specification should note that there is no longer a requirement for marking a product with the API monogram. The American Petroleum Institute continues to license use of the monogram on products covered by this specification but it is administered by the staff of the Institute separately from the specification. The policy describing licensing and use of the monogram is contained in Annex A. No other use of the monogram is permitted. Nonlicensees may mark products in conformance with Section 13 and licensees may mark products in conformance with Annex A or Section 13.

Attention is called to the following stipulations which are subject to agreement between the purchaser and the manufacturer:

- Chemical Composition ..... Section 6.1
- Intermediate Grades ..... Section 7.1, Table D.1
- Flattening Test Orientation ..... Section 7.9
- Intermediate Diameters ..... Section 10.2
- Intermediate Wall Thickness ..... Section 10.3
- Supplementary Requirements ..... Annex B
- Supplementary Hydrostatic Test ..... Section 9.4
- Hydrostatic Test Pressure ..... Section 9.3
- Lengths Applied to Carloads ..... Table 16
- Nonstandard Length and Length Tolerances ..... Section 10.5
- Repair of Welds of Electric-welded Pipe ..... Section 12.7 b)
- Marking Requirements ..... Sections 13.1, 13.4, 13.5

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# CRA Line Pipe

## 1 Scope

### 1.1 Coverage

This specification covers seamless, centrifugal cast, and welded alloy line pipe with improved corrosion resistant properties. The purpose of this specification is to provide standards for pipe with improved corrosion resistance suitable for use in conveying gas, water, and oil in both the oil and natural gas industries.

The size designations are nominal pipe sizes (NPS). In the text paragraphs herein, where pipe size limits (or size ranges) are given, these are outside diameter sizes except where stated to be nominal. These outside diameter size limits and ranges apply also to the corresponding nominal sizes. The primary product is beveled pipe. If plain-end square cut or other special end preparation is desired, this shall be subject to agreement between the purchaser and manufacturer. Included are NPS 1 in. through 42 in. Grades covered by this specification are LC30-1812, LC52-1200, LC65-2205, LC65-2506, LC30-2242, and LC80-2507 [1].

### 1.2 Application of the API Monogram

If product is manufactured at a facility licensed by API and it is intended to be supplied bearing the API Monogram, the requirements of Annex A apply.

## 2 Normative References

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. For a list of other documents and articles associated with this standard, please see the Bibliography. The following referenced documents, either referenced in full or in part, are indispensable for the application of this document.

API Specification 5L, *Specification for Line Pipe*

API Specification Q1, *Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*

ANSI[2]/NACE[3] MR0175, *Petroleum and natural gas industries—Material for use in $H_2S$-containing environments in oil and gas production—Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys*

ASTM A262 [4], *Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels, Practice E*

ASTM A370, *Methods and Definitions for Mechanical Testing of Steel Products, Annex II—Steel Tubular Products*

ASTM A751, *Methods, Practices and Definitions for Chemical Analysis of Steel Products*

ASTM E4, *Practices for Load Verification of Testing Products*

ASTM E10, *Standard Method of Test for Brinell Hardness of Metallic Materials*

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[1] Seamless only.
[2] American National Standards Institute, 1899 L Street, NW, 11th Floor, Washington, DC 20036, www.ansi.org.
[3] NACE International, 1440 South Creek Drive, Houston, Texas 77084, www.nace.org.
[4] ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.

ASTM E18, *Standard Methods of Tests for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials*

ASTM E83, *Method of Verification and Classification of Extensometers*

ASTM E562, *Practice for Determining Volume Fraction by Systematic Manual Point Count*

ISO/TR 9769 [5], *Steel and iron—Review of available methods of analysis*

ISO 15156-3, *Petroleum and natural gas industries-Material for use in $H_2S$-containing environments in oil and gas production—Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys*

# 3 Terms, Definitions, and Abbreviations

## 3.1 Terms and Definitions

For the purposes of this specification the following definitions apply.

**3.1.1**
**heat**
The metal produced by a single cycle of a batch melting process.

**3.1.2**
**heat analysis**
The chemical analysis representative of a heat as reported by the producer.

**3.1.3**
**inspection**
The process of measuring, examining, testing, gaging, or otherwise comparing the unit of product with the applicable requirements.

**3.1.4**
**lot**
A definite quantity of product manufactured under conditions that are considered uniform, for the attribute to be inspected.

**3.1.5**
**lot size**
The number of units of product in a lot.

**3.1.6**
**manufacturer**
Refers to the firm, company, or corporation responsible for marking the product to warrant that the product conforms to the specification.

NOTE The manufacturer may be either a pipe mill or a processor, as applicable. This manufacturer is responsible for compliance with all of the applicable provisions of the specification.

**3.1.7**
**pipe mill**
A firm, company, or corporation that operates pipe-making facilities.

[5] International Organization for Standardization, 1, ch. de la Voie-Creuse, CH-1211 Geneva 20, Switzerland, www.iso.org.

**3.1.8**
**processor**
A firm, company, or corporation that operates facilities capable of heat treating pipe made by a pipe mill.

### 3.2 Abbreviations

For the purposes of this specification the following abbreviations apply.

| | |
|---|---|
| EDI | electronic data interchange |
| ERW | electric resistance welding |
| HAZ | heat-affected zone |
| HRC | Rockwell hardness C scale |
| NPS | nominal pipe size |
| SMYS | specified minimum yield strength |
| UNS | unified numbering system |

## 4 General Information

### 4.1 Metric Units

Metric units in this specification are shown in parentheses in the text and in many tables. Outside diameters air wall thicknesses are converted from inch dimensions. The converted diameters are rounded to the nearest 0.1 mm for diameters less than 18 in. and to the nearest 1.0 mm for diameters 18 in. and larger. Wall thicknesses are rounded to the nearest 0.1 mm.

Metric inside diameters are calculated from the metric outside diameters and wall thicknesses and rounded to the nearest 0.1 mm.

Metric plain-end weights are included from the metric outside diameters and wall thicknesses using the equations in 10.1 and rounded to the nearest 0.01 kg/m (0.01 lb/ft).

Metric hydrostatic pressures are calculated from metric outside diameters and wall thicknesses and metric fiber stresses shown in Section 9.

The factors used where conversions are appropriate are as follows:

| | | |
|---|---|---|
| 1 inch (in.) | = | 25.4 millimeters (mm) exactly |
| 1 square inch ($in.^2$) | = | 645.16 square millimeters ($mm^2$) exactly |
| 1 foot (ft) | = | 0.3048 meters (m) exactly |
| 1 pound (lb) | = | 0.45359 kilograms (kg) |
| 1 pound per foot (lb/ft) | = | 1.4882 kilograms per meter (kg/m) |
| 1 pound per square inch (psi) | = | 6.895 kilopascals (kPa) for pressure |
| | = | 0.006895 megapascals (MPa) for stress |
| 1 foot-pound (ft-lb) | = | 1.3558 Joules (J) for impact energy |

Equation (1) below was used to convert degrees Fahrenheit (°F) to degrees Celsius (°C):

$$°C = \frac{5}{9}(°F - 32) \quad (1)$$

## 4.2 Measuring Devices

If test or measuring equipment, whose calibration or verification is required under the provisions of the specification, is subjected to unusual or questionable conditions, recalibration or reverification shall be performed before further use of the equipment.

## 4.3 Special Processes

Special processes are the final operations that are performed during pipe manufacturing that affect attribute compliance required in this specification (except chemistry and dimensions). The applicable special processes are provided in Table 1.

**Table 1—Special Processes for Manufacturing Conditions**

| Manufacturing Condition | Special Processes |
|---|---|
| Seamless | |
| As-rolled (nonexpanded) | Final reheating and hot sizing or stretch reduction. Cold finishing if applied and repair welding. Nondestructive inspection. |
| As-rolled (expanded) | Expansion, repair welding. Nondestructive inspection. |
| Heat treated | Heat treatment, repair welding. Nondestructive inspection. |
| Centrifugally cast | |
| As-cast (nonexpanded) | Final reheating and hot sizing or stretch reduction. Cold finishing if applied and repair welding. Nondestructive inspection. |
| As-cast (expanded) | Expansion, repair welding. Nondestructive inspection. |
| Heat treated | Heat treatment, repair welding. Nondestructive inspection. |
| Welded without filler metal | |
| As-rolled (nonexpanded) | Seam welding and sizing, if applicable, seam heat treatment, repair welding. Nondestructive inspection. |
| As-rolled (expanded) | Expansion and seam welding. If applicable, seam heat treatment, repair welding. Nondestructive inspection. |
| Heat treated | Seam welding and full-body heat treatment. If applicable, repair welding. Nondestructive inspection. |
| Welded with filler metal | |
| As-rolled (nonexpanded) | Pipe forming, seam welding, and repair welding. Nondestructive inspection. |
| As-rolled (expanded) | Expansion and seam welding and repair welding. Nondestructive inspection. |
| Heat treated | Seam welding, repair welding, and full-body heat treatment. Nondestructive inspection. |
| As-rolled | Seam welding and sizing. Nondestructive inspection. |

## 4.4 Certification

The manufacturer shall, upon request by the purchaser, 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.

Where additional information is required, including the results of mechanical testing, SR15 (Annex B) shall be specified on the purchase order.

A material test report, certificate of compliance or similar document printed from or used in electronic form from an electronic data interchange (EDI) transmission shall be regarded as having the same validity as a counterpart printed in the certifier's facility. The content of the EDI transmitted document shall meet the requirements of this specification and conform to any existing EDI agreement between the purchaser and the supplier.

### 4.5 Retention of Records

Tests and inspections requiring retention of records in this specification are shown in Table 2. Such records shall be retained by the manufacturer and shall be made available to the purchaser upon request for a period of at least three years after the date of purchase from the manufacturer.

**Table 2—Retention of Records**

| Test/Inspection | Section |
|---|---|
| Chemical properties | |
| Heat analysis | 6.2 |
| Product analysis | 6.2 |
| Mechanical tests | |
| Tensile tests | 7.1 to 7.4 |
| Weld tensile tests | 7.5 |
| Mill control tests | 7.6 |
| Guided-bend tests | 7.14 |
| Hydrostatic tests | |
| Tester recorder charts (where used) | 9.2 |
| Supplementary hydrostatic tests | 9.4 |
| Nondestructive testing | |
| Film (where used) fluoroscopic | 11.4 |
| Operator qualifications | 11.5 |
| Repair welding procedure | |
| Transverse tensile test | C.2.3.2 |
| Longitudinal tensile-elongation test | C.2.3.3 |
| Transverse guided-bend test | C.2.3.4 |
| Nick-break test | C.2.3.5 |
| Procedure specification | C.1 |
| Procedure qualification | C.2 |
| Personnel performance qualification | C.3 |
| Calibration tests | Various sections |

## 5 Process of Manufacture and Material

### 5.1 Process of Manufacture

Welded pipe may be furnished in any combination of the listed welding processes, as agreed upon between the purchaser and manufacturer. Pipe furnished to this specification shall be seamless, welded, or centrifugally cast as defined below.

a) *Seamless and Centrifugally Cast*.

1) *Seamless* is defined as wrought tubular product made without a welded seam. It is manufactured by hot working steel or, if necessary, by subsequently cold finishing the hot worked product.

2) *Centrifugally cast* is defined as a casting technique in which the mold is rotated during solidification of the casting.

b) *Welded Processes*.

1) *Without Filler Metal.* Electric weld (applicable to LC30-1512 and full-body heat-treated duplex alloys only). A process of forming a seam by electric-resistance welding, or induction welding wherein the edges to be welded are mechanically pressed together and the heat for welding is generated by the resistance-to-flow of electric current.

2) *With Filler Metal*.

i) *Submerged Arc Welding*. A welding process that produces coalescence of metals by heating them with an arc or arcs between a bare metal electrode or electrodes and the work. The arc and molten metal are shielded by a blanket of granular, fusible material on the work. Pressure is not used, and the filler metal is obtained from the electrode.

ii) *Gas Metal Arc Welding*. A welding process that produces coalescence of metals by heating them with an arc or arcs between a continuous filler metal electrode and the work. Shielding is obtained entirely from an externally supplied gas. Pressure is not used and filler metal is obtained from the electrode.

3) *With or Without Filler Metal*.

i) *Plasma Arc Welding*. An arc welding process that produces coalescence of metals by, heating them with a constricted arc between the electrode and the workpiece (transferred arc) or the electrode and the constricting nozzle (nontransferred arc). Shielding is obtained from the hot, ionizing 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 and filler metal may or may not be supplied.

ii) *Gas Tungsten Arc Welding*. An arc welding process that produces coalescence of metals by heating them with an arc between a tungsten electrode (nonconsumable) and the work pieces. Shielding is obtained from a gas. Pressure may or may not be used and filler metal may or may not be used.

c) *Pipe-making Processes (See Table 3)*.

1) *Seamless*. Seamless pipe is produced by the seamless process defined above in 5.1.

2) *Centrifugally Cast*. Centrifugally cast pipe is produced by the centrifugal casting process defined above in 5.1 a) 2). The entire inner surface of centrifugally cast pipe shall be machined. The outer surface may be machined as well, when agreed upon between the purchaser and the manufacturer.

3) *Electric Weld*. Electric-welded pipe is defined as having one longitudinal seam produced by the electric welding process as defined in 5.1 b) 1).

4) *Submerged Arc*. Submerged arc welded pipe is defined is having one longitudinal seam produced by the automatic submerged arc welding process as defined in 5.1 b) 2) i). At least one pass shall be on the inside and one pass on the outside. All end welding of submerged arc welded pipe, if not done by automatic submerged arc welding, shall be done by a procedure and a welder qualified in accordance with Annex C of this specification.

**Table 3—Pipe Manufacturing Processes**

| Manufacturing Process | No Seam | One Longitudinal Seam | Double Seam |
|---|---|---|---|
| 1) Without welds | | | |
| a) Seamless | X | | |
| b) Centrifugally cast | X | | |
| 2) Welding processes | | | |
| a) Without filler metal electric weld | | X | |
| b) With filler metal | | | |
| i) Submerged arc | | X | X |
| ii) Gas metal arc | | X | X |
| c) With or without filler metal | | | |
| i) Plasma arc | | X | X |
| ii) Gas tungsten arc | | X | X |
| iii) Combination welding | | X | X |

5) *Gas Metal Arc*. Gas metal arc welded pipe is defined as having one longitudinal seam produced by the continuous gas metal arc welding process as defined in 5.1 b) 2) ii). At least one pass shall be on the inside and one pass on the outside.

6) *Combination Welding*. Combination welded pipe is defined as pipe having one longitudinal or double seam produced by a combination of welding processes defined in 5.1 b) 2) and 5.1 b) 3).

7) *Double Seam*. Double seam pipe is defined as pipe having two longitudinal seams formed by welding. The location of the seams shall be approximately 180° apart. All requirements specified for the welding process used shall be applicable to double seam pipe. All weld tests shall be performed after forming and welding.

d) *Tack Welding*. A tack weld is defined as a weld made to hold parts of a weldment in proper alignment until the final welds are made. Tack welds may be by any of the processes described in 5.1 b). They shall be removed by machining or remelted by subsequent arc welding. They are not subject to the subsequent weld requirements of this specification.

e) *Jointer Weld*. A jointer weld is a circumferential seam weld that joins two pieces of pipe together.

## 5.2 Cold Expansion

Cold expansion up to 1.5 % for sizing shall be permitted if agreed upon between the purchaser and the manufacturer.

### 5.3 Heat Treatment

Pipe furnished to this specification may be as-rolled, solution annealed [6], except LC52-1200, which shall be quenched and tempered. Other appropriate heat treatment may be agreed upon between purchaser and manufacturer.

### 5.4 Traceability

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

### 5.5 Hydrogen Sulfide Environments

For any grade, if the intended application is for use in an environment that contains hydrogen sulfide then this should be clearly stated in the purchase agreement.

Where use in an environment containing hydrogen sulfide is stated in the purchase agreement, all requirements of ANSI/NACE MR0175 and ISO 15156-3 shall be satisfied.

In such cases, sour service designation marking according to ANSI/NACE MR0175 and ISO15156-3, Annex C shall be applied.

## 6 Chemical Properties and Tests

### 6.1 Composition

The composition of pipe furnished to this specification, as determined by heat analyses, shall conform to the chemical requirements specified in Table 4.

If necessary, all grades listed in Table 4, column 1 may be modified or other grades may be specified by agreement between purchaser and manufacturer. In this case, the composition of the grade shall be designated with Cr and Ni content after the ksi value of yield strength using Equation (2) as follows:

$$\mathrm{LC}(\mathrm{YS\ ksi}) - (\mathrm{Cr\ \%})(\mathrm{Ni\ \%}) \tag{2}$$

### 6.2 Heat Analyses

When requested by the purchaser, the manufacturer shall furnish a report giving the heat analysis of each heat of material used in the manufacture of pipe furnished on the purchaser order. The analysis so determined shall conform to the requirements specified in 6.1.

If elements other than those specified in Table 4 for a particular grade are added for other than deoxidation purposes, the heat analyses, including the element additions, shall be reported for each heat applied to the purchaser's order.

[6] Solution annealing involves treating at an appropriate temperature and cooling at an appropriate rate to minimize the precipitation of harmful carbides, as well as to secure softness and ductility. The rate of cooling determines the amount of carbides remaining in solution.

## Table 4—Chemical Requirements for Heat Analyses, Percent (%)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | | 8 | | 9 | | 10 | | 11 | | 12 | | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grades [a] | C | Mn | P | S | Si | Ni | | Cr | | Mo | | N | | Cu | | Others | | UNS [b] Numbers | Material Classification |
| | Max | Max | Max | Max | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | | |
| LC30-1812 | 0.030 | 2.00 | 0.040 | 0.030 | 0.75 | 10.0 | 15.0 | 16.0 | 18.0 | 2.0 | 3.0 | — | 0.16 | — | — | — | — | S31603 or S31653 | Austenitic Stainless |
| | | | | | | | | | | | | | | | | | | | |
| LC52-1200 | 0.08 | 1.00 | 0.040 | 0.030 | 0.75 | — | 0.5 | 11.5 | 13.5 | — | — | — | — | — | — | — | — | S41008 | Martensitic Stainless |
| | | | | | | | | | | | | | | | | | | | |
| LC65-2205 | 0.030 | 2.00 | 0.030 | 0.020 | 1.00 | 4.5 | 6.5 | 21.0 | 23.0 | 2.5 | 3.5 | 0.08 | 0.20 | — | — | — | — | S31803 | Duplex Stainless |
| | | | | | | | | | | | | | | | | W | | | |
| LC65-2506 | 0.030 | 1.00 | 0.030 | 0.030 | 0.75 | 5.5 | 7.5 | 24.0 | 26.0 | 2.5 | 3.5 | 0.10 | 0.30 | — | 1.5 | — | 0.50 | S31260 | Duplex Stainless |
| | | | | | | | | | | | | | | | | W | | | |
| LC80-2507 | 0.030 | 1.00 | 0.030 | 0.020 | 0.80 | 6.0 | 8.0 | 24.0 | 26.0 | 2.5 | 3.5 | 0.24 | 0.32 | 0.20 | 0.80 | 1.5 | 2.5 | S39274 | Duplex Stainless |
| | 0.030 | 1.00 | 0.030 | 0.010 | 1.00 | 6.0 | 8.0 | 24.0 | 26.0 | 3.0 | 4.0 | 0.20 | 0.30 | 0.50 | 1.00 | 0.5 | 1.0 | S32760 | |
| | 0.030 | 1.20 | 0.035 | 0.020 | 0.80 | 6.0 | 8.0 | 24.0 | 26.0 | 3.0 | 5.0 | 0.24 | 0.32 | — | — | — | — | S32750 | |
| | | | | | | | | | | | | | | | | Ti | | | |
| LC30-2242 | 0.050 | 1.00 | 0.030 | 0.030 | 0.50 | 38.0 | 46.0 | 19.5 | 23.5 | 2.5 | 3.5 | — | — | 1.5 | 3.0 | 0.6 | 1.20 | N08825 | Ni Base Alloy |

[a] For editorial purposes, the first four (4) alphanumerics of the grade designation are used to describe the grades in this document.

[b] Unified numbering system (UNS) numbers do not show exactly the same chemical compositions depicted in this table.

## 6.3 Product Analyses

One test from each of two lengths of pipe or plate or skelp from each lot size as indicated in Table 5 below shall be analyzed for product analyses by the manufacturer. The results of the analyses shall be available to the purchaser on request.

**Table 5—Purchaser Provided Analysis**

| Grade | Size (in.) | Lot Size (no. of lengths) |
|---|---|---|
| All Grades | 1 through $12^{3}/_{4}$ | 200 or less |
| | 14 and over | 100 or less |

For multiple length seamless pipe, a length shall be considered as all of the sections cut from a particular multiple length. The samples shall be taken as follows.

a) *Seamless Pipe*. At the option of the manufacturer, samples used for product analyses shall be taken either from tensile test specimens or from the finished pipe.

b) *Welded Pipe*. At the option of the manufacturer, samples used for product analyses shall be taken from either finished pipe, plate, skelp, tensile test specimens, or flattening test specimens. The location of the samples shall be a minimum of 90° from the weld, of longitudinally welded pipe.

For pipe manufactured from plate or skelp, the product analyses may be made by the supplier of the plate or skelp, providing the analyses are made in accordance with the frequency requirement stated above.

The composition so determined shall conform to the chemical requirements shown in Table 4 within the permissible variations for product analyses shown in Table 6, where the permissible variations shall be applied to under-minimum or over-maximum of specified limit of element.

## 6.4 Recheck Analyses

If the product analyses of both lengths of pipe representing the lot fail to conform to the specified requirements, at the manufacturer's option, either the lot shall stand rejected or all the remaining lengths in the lot shall be tested individually for conformance to the specified requirements. If only one of the two samples fails, at the manufacturer's option, either the lot shall stand rejected or two recheck analyses shall be made on two additional lengths from the same lot. If both recheck analyses conform to the requirements, the lot shall be accepted except for the length represented by the initial analyses that failed. If one or both of the recheck analyses fail, at the manufacturer's option, the entire lot shall be rejected or each of the remaining lengths shall be tested individually. In the individual testing of the remaining lengths in any lot, 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.

## 6.5 Control Analyses

A product analysis shall be made by the manufacturer, as a control, of each heat of steel used for the production of pipe under this specification. A record of such analyses shall be available to the purchaser.

## 6.6 Chemical Analyses Procedures

Methods of analysis methods and practices relating to chemical analysis shall be performed in accordance with ASTM A751 or ISO/TR 9769. Calibrations performed shall be traceable to established standards.

**Table 6—Permissible Variation for Product Analyses of CRA Line Pipe**

| Element | Specified Limit of Element | Permissible Variation |
|---|---|---|
| Carbon | | 0.01 |
| Manganese | | 0.04 |
| Phosphorus | | 0.005 |
| Sulfur | | 0.005 |
| Silicon | | 0.05 |
| Nickel | over 1.00 to 5.00, incl | 0.07 |
| | over 5.00 to 10.00, incl | 0.10 |
| | over 10.00 to 20.00, incl | 0.15 |
| | over 20.00 to 25.00, incl | 0.20 |
| | over 25.00 to 30.00, incl | 0.25 |
| | over 30.00 to 40.00, incl | 0.30 |
| | over 40.00 to 60.00, incl | 0.35 |
| Chromium | over 10.00 to 15.00, incl | 0.15 |
| | over 15.00 to 20.00, incl | 0.20 |
| | over 20.00 to 25.00, incl | 0.25 |
| | over 25.00 to 30.00, incl | 0.30 |
| Molybdenum | over 1.00 to 3.00, incl | 0.05 |
| | over 3.00 to 5.00, incl | 0.10 |
| | over 5.00 to 20.00, incl | 0.15 |
| Nitrogen | over 0.02 to 0.20, incl | 0.01 |
| | over 0.20 to 0.25, incl | 0.02 |
| | over 0.25 to 0.30, incl | 0.03 |
| Copper | | 0.05 |
| Tungsten | | 0.04 |
| Titanium | | 0.05 |

# 7 Mechanical Properties and Tests

## 7.1 Tensile Tests—General

All grades listed in this specification shall conform to the tensile requirements specified in Table 7. Other grades intermediate to the listed grades shall conform to the tensile requirements agreed upon between the purchaser and manufacturer, which shall be consistent with those specified in Table 7. The yield strength shall be the tensile stress required to produce a total elongation of 0.5 % of the gauge length as determined by an extensometer. 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 specimens are used.

**Table 7—Tensile Requirements**

| 1 | 2 | | 3 | | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| | **Yield Strength** min. [a] | | **Ultimate Tensile Strength** min. | | **Elongation,** min. percent in 2 in. | **UNS Numbers** [b] | **Max Hardness** Rc |
| **Grade** | psi | MPa | psi | MPa | | | |
| LC30-1812 | 30,000 | (207) | 70,000 | (482) | 25 | S31603<br>S31653 | — |
| | | | | | | | |
| LC52-1200 | 52,000 | (358) | 66,000 | (455) | 20 | S41008 | 22 |
| | | | | | | | |
| LC65-2205 | 65,000 | (448) | 90,000 | (621) | 25 | S31803 | — |
| | | | | | | | |
| LC65-2506 | 65,000 | (448) | 95,000 | (656) | 25 | S31260 | — |
| | | | | | | | |
| LC80-2507 | 80,000 | (552) | 110,000 | (758) | 20 | S39274<br>S32760<br>S32750 | — |
| | | | | | | | |
| LC30-2242 | 30,000 | (207) | 80,000 | (551) | 30 | N08825 | — |

[a] When yield strength is changed by the modification of chemical composition or heat treatment, a grade designation shall be changed with ksi value of yield strength.

[b] UNS numbers do not show the exact tensile requirements depicted in this table.

The basic elongation shoe, listed in Table 7, column 4, is for wall thicknesses 0.500 in. and greater for 1.5 in. wide specimens. Equation (3) below is for thinner wall thicknesses:

$$e = C \times A^{0.2} \tag{3}$$

where,

$A$ is the diameter of the guided blend test former;

$e$ is the minimum elongation in 2 in. (to the nearest 0.5 %);

$C$ is the constant, as shown below:

26.5 for LC30-1812, LC65-2205, and LC65-2506;

To be developed for LC52-1200;

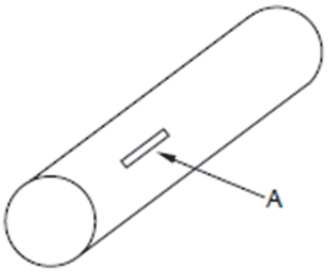
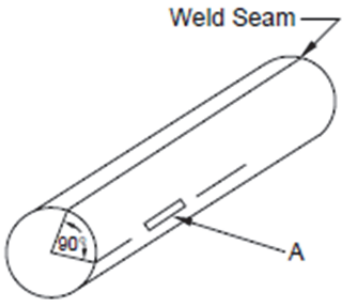
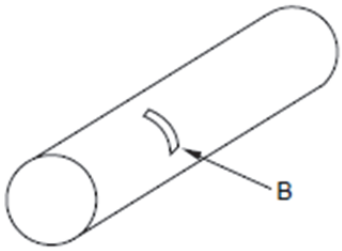
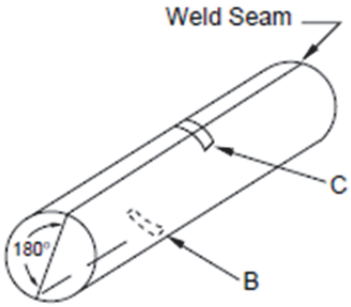
31.8 for LC30-2242;

21.2 for LC80-2507.

NOTE See Annex D for minimum elongation values calculated from this equation.

Tensile test orientation shall be as shown in Figure 1. At the option of the manufacturer, longitudinal specimens may be taken from the skelp parallel to the rolling direction and approximately midway between edge and center. Testing procedure shall conform to the requirements of the latest edition of ASTM 370. All tensile tests, except transverse weld and ring tests, shall include yield strength, ultimate tensile strength, and elongation determinations. Transverse weld tests shall include ultimate tensile strength, and ring tests shall include yield strength. All tensile tests shall be performed with the specimens at room temperature. The strain rate shall be in accordance with the requirements of the latest edition of ASTM A370. At the option of the manufacturer, the specimen may be either full section, strip specimen, or round-bar specimens according to

7.3, 7.4, and Figure 2. The type, size, and orientation of the specimens shall be reported. Strip specimens shall be approximately $1^1/_2$ in. (38.1 mm) wide in the gauge length if suitable curved-face testing grips are used or if the ends of the specimens are machined to reduce the curvatures in the grip area. Otherwise, they shall be approximately $^3/_4$ in. (19.0 mm) wide for pipe $3^1/_2$ in. and smaller, approximately 1 in. (25.4 mm) wide for pipe 4 in. through $6^5/_8$ in., and approximately $1^1/_2$ in. (38.1 mm) wide for pipe $8^5/_8$ in. and larger. Alternately, when grips with curved faces are not available, the ends of the specimens may be flattened without heating. All tensile tests shall be made in the delivery condition.

| O.D. | Seamless Pipe, Hot Rolled[a] and Cold Worked | Welded Pipe<br>Straight Seam |
|---|---|---|
| ≤ $6^5/_8$ |  |  |
| ≥ $8^5/_8$ |  |  |

**Key**

A strip specimen (any circumferential location for seamless)

B transverse specimen (any circumferential location for seamless). For two-seam pipe, the specimen shall be taken from a location midway between the welds.

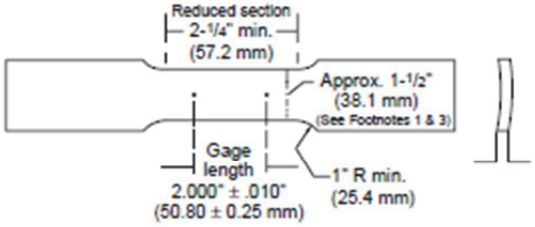
C transverse weld specimen

[a] For hot-rolled seamless pipe, all tensile tests shall be obtained in the longitudinal direction, except when agreed upon between purchaser and manufacturer transverse tests may be specified for $8^5/_8$ in. and larger.

**Figure 1—Orientation of Tensile Test Specimens**

A – Ring Expansion Specimen

B – Full Section Specimen



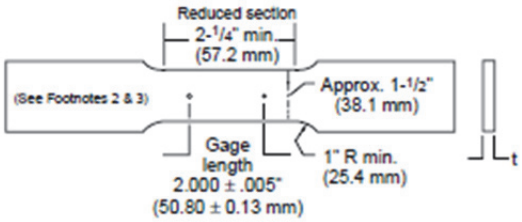

C – Strip Specimen


| | | in. | mm |
|---|---|---|---|
| G | Gage length | 2.000 ± 0.005 | 50.0 ± 0.10 |
| D | Diameter | 0.500 ± 0.010 | 12.5 ± 0.26 |
| R | Radius of fillet, min. | 3/8 | 10 |
| A | Length of reduced section, min. | 2-1/4 | 60 |

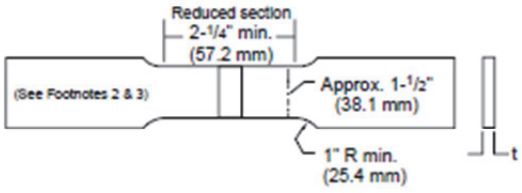
D – Round Bar Specimen

For pipe with wall thickness of 0.750 inch or greater

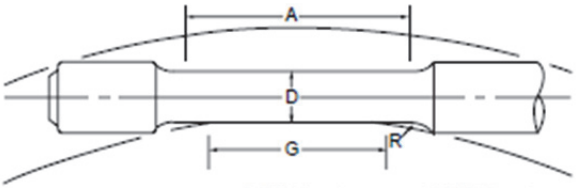
LONGITUDINAL SPECIMENS




E – Strip Specimen, Base Metal




F – Strip Specimen, Weld




| | | 0.500" Specimen | | 0.350" Specimen | |
|---|---|---|---|---|---|
| | | in. | mm | in. | mm |
| G | Gage length | 2.000 ± 0.005 | 50.4 ± 0.10 | 1.400 ± 0.005 | 35.0 ± 0.10 |
| D | Diameter | 0.500 ± 0.010 | 12.7 ± 0.25 | 0.350 ± 0.007 | 8.9 0.18 |
| R | Radius of fillet, min. | 3/8 | 10 | 1/4 | 6 |
| A | Length of reduced Section, min. | 2-1/4 | 60 | 1-3/4 | 45 |

G – Round Bar Specimen

The larger possible of either the 0.500-inch or 0.350-inch diameter specimen shall be used.

TRANSVERSE SPECIMENS

NOTE 1 See 7.1 for gauge width if testing is not done with properly curved grips.

NOTE 2 Flattening of transverse and weld specimens shall be performed at room temperature.

NOTE 3 Hot flattening, artificial aging, or heat treatment of tensile specimens is not permitted.

**Figure 2—Tensile Test Specimens**

## 7.2 Tensile Testing

The following are requirements for all tensile testing.

a) *Frequency*. Tensile tests shall be made at the frequency shown in Table 8.

**Table 8—Frequency of Tensile Testing**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Size** (in.) | **Tensile Tests** | **Weld Tensile Tests** | **Control Tensile Tests** |
| Less than or equal to $5^{9}/_{16}$ OD | 1 per 400 lengths | | |
| $6^{5}/_{8}$ OD thru $12^{3}/_{4}$ OD | 1 per 200 lengths | | One per heat on |
| $>12^{3}/_{4}$ OD | 1 per 100 lengths per cold expansion amount [a] | | All sizes |
| $8^{5}/_{8}$ OD thru $12^{3}/_{4}$ OD | | 1 per 200 lengths | |
| $>12^{3}/_{4}$ OD | | 1 per 100 lengths per cold expansion amount [b] | |

[a] Pipe manufactured with the same amount of cold expansion, ±0.2 %, shall be considered to have the same cold expansion.

[b] Each weld for two-seam pipe.

For heat-treated pipe, the sample frequency shown for each size shall apply to all pipe of the same heat and thickness heat-treated in one furnace charge. For pipe heat treated in a continuous furnace, the sample frequency shown shall apply for all pipe of the same heat and thickness.

The size of the lot shown in Table 8 is maximum. For smaller lots than those shown, the frequency shall be as listed.

b) *Equipment*. Tensile test machines shall have been calibrated within 15 months preceding any test in accordance with the procedures of ASTM E4. Extensometers shall be calibrated within 15 months preceding any test in accordance with the procedures of ASTM E83. Records retention shall be according to Section 4.

## 7.3 Longitudinal Tensile Tests

At the option of the manufacturer, longitudinal tests may utilize a full section specimen (Figure 2B), a strip specimen (Figure 2C), or for pipe with wall thickness greater than 0.750 in., a 0.500 in. diameter round-bar specimen (Figure 2.D). The trip specimen shall be tested without flattening.

## 7.4 Transverse Tensile Tests

The transverse tensile properties shall be determined, at the option of the manufacturer, by one of the following methods.

a) The yield strength, ultimate strength, and elongation values shall be determined on either a flattened rectangular specimen (Figure 2E), or a 0.500 in. or 0.350 in. specimen (Figure 2G).

b) The yield strength shall be determined by the ring expansion method (Figure 2A) with the ultimate strength and elongation values determined from a flattened rectangular specimen or round bar.

The same method for testing shall be employed for all lots on an order item. All transverse specimens shall be as shown in Figure 2. All specimens shall represent the full wall thickness of the pipe from which the specimen was cut, except round-bar tensile specimens. Transverse round-bar specimens shall be secured from nonflattened pipe sections, and the largest possible diameter round bar shall be used; 0.500 in. diameter round-bar specimens shall be used when the pipe size allows, and the 0.350 in. diameter round-bar specimen shall be used for other sizes. For pipe sizes too small to allow a 0.350 in. specimen, round-bar tensile specimens may not be used.

## 7.5 Weld Tensile Tests

Weld tensile test specimens as specified in Table 8 shall be taken 90° to the weld with the weld at the center as shown in Figure 1 and Figure 2 and shall represent the full wall thickness of the pipe from which the specimen was cut. Weld reinforcement may be removed at the manufacturer's option. Weld tensile tests need not include determination of yield and elongation.

## 7.6 Control Tensile Tests

One tensile test shall be made as a control for each heat of material used by the manufacturer for the production of pipe. A record of such tests shall be available to the purchaser. For welded pipe, these tensile tests shall be made on either the skelp or the finished pipe, at the option of the manufacturer.

## 7.7 Retests—Tensile Tests

If the tensile test specimen representing a lot of pipe failed to conform to the specified requirements, the manufacturer may elect to make retests on two additional lengths from the same lot. If both retest specimens conform to the requirements, all the lengths in the lot shall be accepted, except for the length from which the initial specimen was taken. If one or both of the retest specimens fail to conform to the specified requirements, the manufacturer may elect to test individually the remaining lengths in the lot. In this case, determinations are required only for the particular requirements with which the specimens failed to comply in the preceding tests. Specimens for retest shall be taken in the same manner as the specimen which failed to meet the minimum requirements.

## 7.8 Defective Specimens—Tensile Tests

If any tensile test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted. When the elongation is less than that specified, and 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.

## 7.9 Flattening Tests—Electric Weld

Flattening tests shall be performed for electric-weld pipe. Frequency of testing, sample location, and test orientation are shown in Figure 3. When a weld-stop condition occurs during the production of a multiple length, flattening tests with the weld at 90° shall be made from the crop ends resulting from each side of the weld stop and may be substituted for intermediate flattening tests.

NOTE Flattening tests with the weld at the 0° orientation may be conducted at 180° and the 90° orientation at 270° upon agreement between the purchaser and manufacturer.

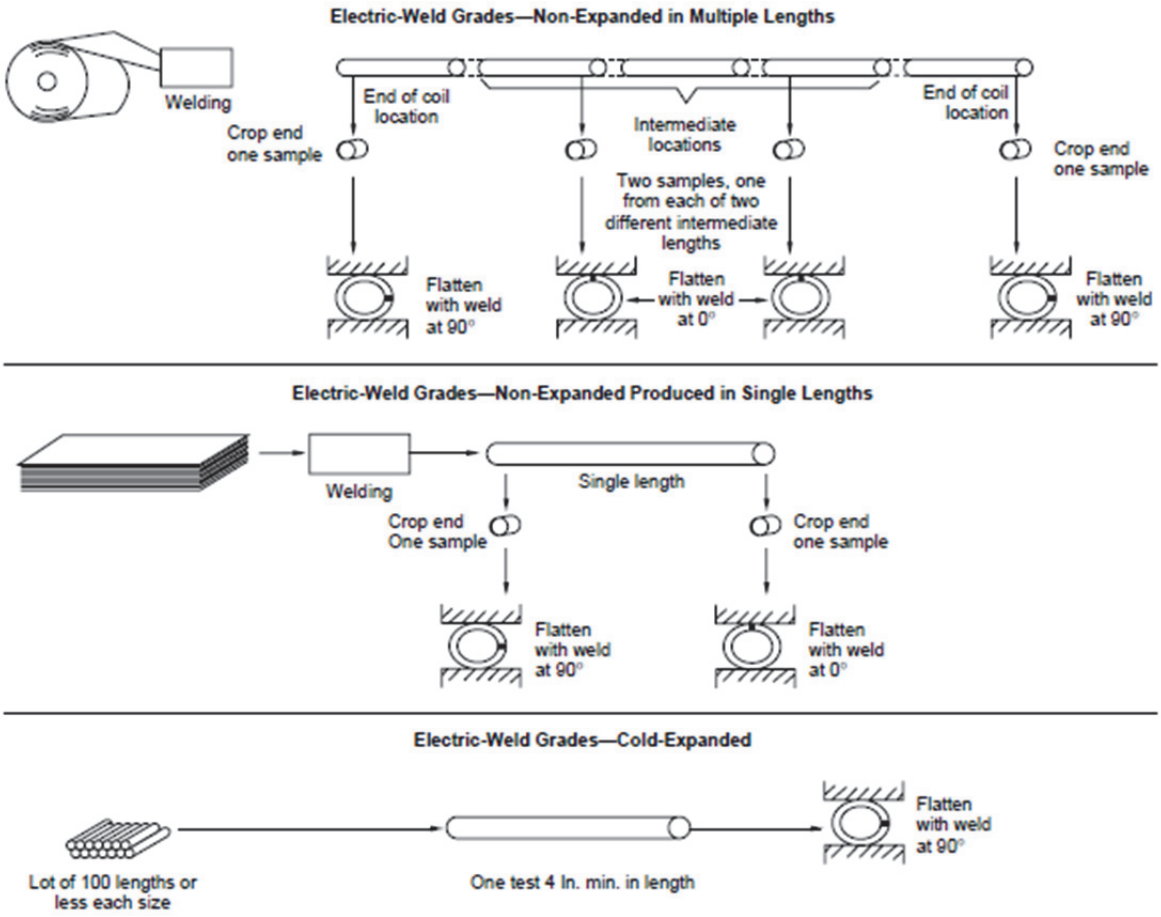



**Figure 3—Flattening Tests**

## 7.10 Acceptance Criteria—Flattening Tests

Acceptance criteria for flattening tests shall be as follows.

a) Flatten to $^{2}/_{3}$ original OD without the weld opening.

b) Continue flattening to $^{1}/_{3}$ original OD without cracks or breaks other than the weld.

c) Continue flattening until opposite walls of the pipe meet.

d) No evidence of lamination or burnt metal may develop during the entire test.

## 7.11 Retests—Flattening Tests

Flattening retest provisions shall be performed as shown in Table 9.

**Table 9—Flattening Retests**

| Pipe | Retests |
|---|---|
| Nonexpanded electric weld produced in single lengths | Manufacturer may elect to retest any failed end until the requirements are met providing the finished pipe is not less than 80 % of its length after initial cropping. |
| Nonexpanded electric weld produced in multiple lengths | Manufacturer may elect to retest each end of each individual length if any test fails. The retests for each end of each individual length shall be made with the weld alternately at 0° and 90°. |
| Cold-expanded electric weld | Manufacturer may elect to retest one end from each of two additional lengths of the same lot. If both retests are acceptable, all lengths in the lot shall be accepted, except the original failed length. If one or both retests fail, the manufacturer may elect to repeat the test on specimens cut from one end of each of the remaining individual lengths in the lot. |
| NOTE For the purpose of mechanical testing the weld of electric-welded pipe of 2 in. nominal and larger, "the weld" extends to a distance of $^1/_2$ in. (12.7 mm) on either side of the fusion line. For pipe smaller than 2 in. nominal, "the weld" extends to a distance of $^1/_4$ in. (6.35 mm) on either side of the fusion line. | |

## 7.12 Flattening Tests—Seamless, Centrifugally Cast, and Welded Without Filler Metal

Seamless, centrifugally cast, and welded without filler metal pipe shall be tested by flattening, except that welded without filler metal pipe, with the exception of electric resistance welding (ERW), may be tested by the guided-bend test—in lieu of flattening—at the option of the manufacturer.

A section of pipe not less than $2^1/_2$ in. (63.5 mm) in length shall be flattened cold between parallel plates in two steps. During the first step, which is a test for ductility, no cracks or breaks on the inside, outside, or end surfaces shall occur until the distance between the plates is less than the value of $H$, calculated using Equation (4) as follows:

$$H = \frac{1.09t}{\left(0.09 + \frac{t}{D}\right)} \tag{4}$$

where

$H$ is the distance between flattening plates, in. (mm);

$t$ specified wall thickness in. (mm);

$D$ specified or calculated (from the specified inside diameter and wall thickness outside diameter, in. (mm).

During the second step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the pipe meet.

a) *Frequency of Test*. One end of each pipe shall be tested for centrifugally cast. For seamless and welded pipe without filler metal, except ERW, two tests per lot of 50 maximum.

b) *Retest*. Manufacturer may elect to retest any failed end until the requirements are met, providing that the finished pipe is not less than 80 % of its length after initial cropping.

## 7.13 Weld With Filler Metal Manipulation Tests

Welds with filler metal and, at the option of the manufacturer, welds without filler metal shall be tested by the guided-bend test.

The specimens shall be taken from each weld in a length of pipe from each lot of 50 lengths or less of each size. The specimens shall not contain any repair welding made by the manual metallic arc procedure.

## 7.14 Guided-Bend Test

One face bend and one root bend specimen, both conforming to Figure 4 shall be bent approximately 180° in a jig, substantially in accordance with Figure 5. For any combination of diameter, wall thickness, and grade, the maximum value for jig Dimension "A" may be calculated by the formula illustrated in Figure 5. The manufacturer shall use a jig based on this dimension, or a smaller dimension at their option. However, to minimize the number of jigs required, standard values for Dimension "A" have been selected for pipe sizes $12^1/_4$ in. and larger. These values are listed for each diameter, wall thickness, and grade in Annex B.

For intermediate grades or wall thicknesses, the next smaller standard value for Dimension "A" is greater than 9 in., the length of the specimen required to contact the male die need not exceed 9 in. For pipe with wall thickness over 0.750 in., a reduced wall specimen as shown in Figure 4 may be used at the option of the manufacturer. Reduced wall specimens shall be tested in a jig with the "A" dimension calculated for 0.750 in. (19.1 mm) wall pipe of the appropriate size and grade.

The specimens shall comply with the following requirements:

a) not fracture completely,

b) not reveal any cracks or ruptures in the weld metal greater than $^1/_8$ in. (3.18 mm) in length regardless of depth, and

c) not reveal any cracks or ruptures in the parent metal, the heat-affected zone (HAZ), or the fusion line longer than $^1/_8$ in. (3.18 mm) and deeper than $12^1/_2$ % of the specified wall thickness.

However, cracks that occur at the edges of the specimen and that are less than $^1/_4$ in. (6.35 mm) long shall not be cause for rejection in Item b) or Item c) regardless of depth. If the fracture or crack in the specimen is caused by a defect or flaw, that specimen may be discarded and a new specimen substituted.

## 7.15 Retests—Guided-bend Test

If one or both of the guided-bend test specimens fail to conform to the specified requirements, the manufacturer may elect to repeat the tests on specimens cut from two additional lengths of pipe from the same lot. If such specimens conform to the specified requirements, all lengths in the lot shall be accepted, except the length initially selected for the test. If any of the retest specimens fail to pass the specified requirements, the manufacturer may elect to test specimens cut from the individual lengths remaining in the lot. The manufacturer may also elect to retest any length that has failed to pass the test by cropping back and cutting two additional specimens from the same end. If the requirements of the original test are set by both of these additional tests, that length shall be acceptable. No further cropping and retesting is permitted. Specimens for retests shall be taken in the same manner as specified in 7.14 and 7.15.

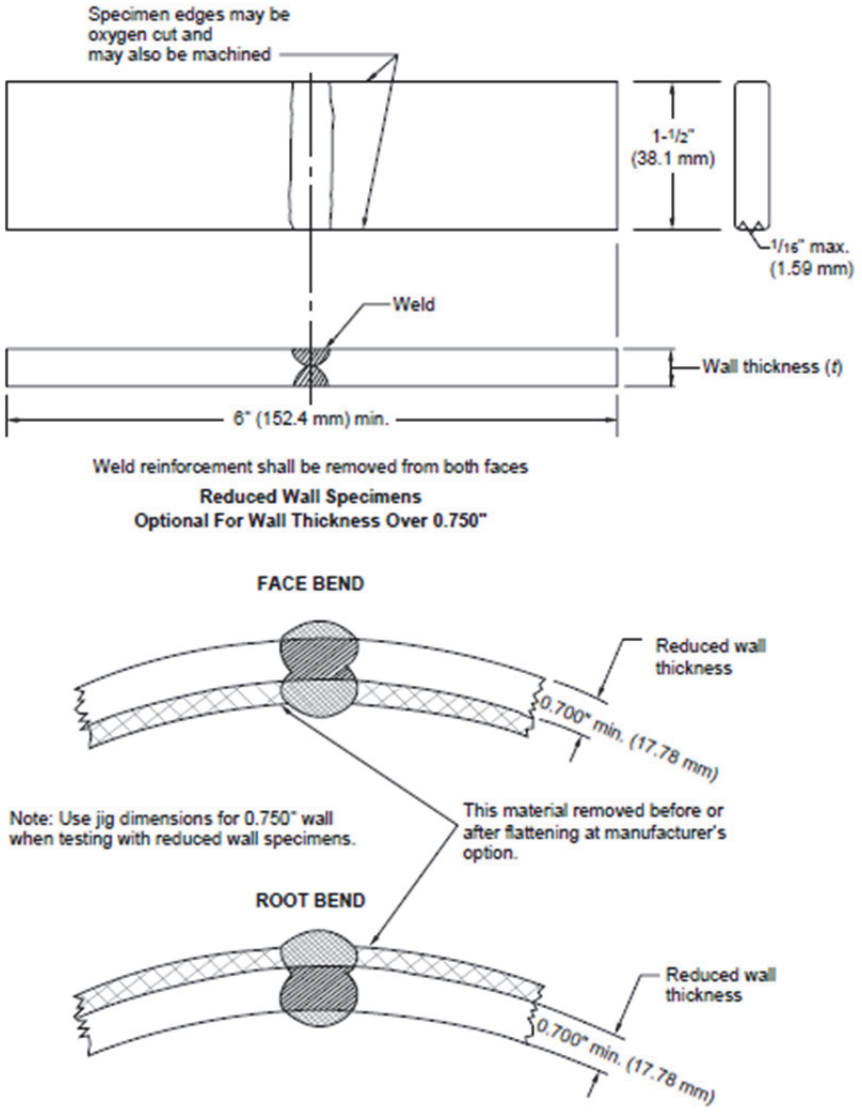



**Figure 4—Guided-bend Test Specimen**

## 7.16 Weld Ductility Test for Electric-welded Pipe

The weld ductility shall be determined by tests on full section specimens of 2 in. (50.8 mm) minimum length. The specimens shall be flattened cold between parallel plates. The weld shall be placed 90° from the direction of applied force (point of maximum bending). No cracks or breaks exceeding $^1/_8$ in. (3.18 mm) in any direction in the weld or parent metal shall occur on the outside surface until the distance between the plates is less than the value of "$S$" calculated by Equations (5) and (6) below.

a) Grades Less than 52 ksi Yield Strength

$$S = \frac{3.07t}{\left(0.07 + \frac{3t}{D}\right)} \tag{5}$$

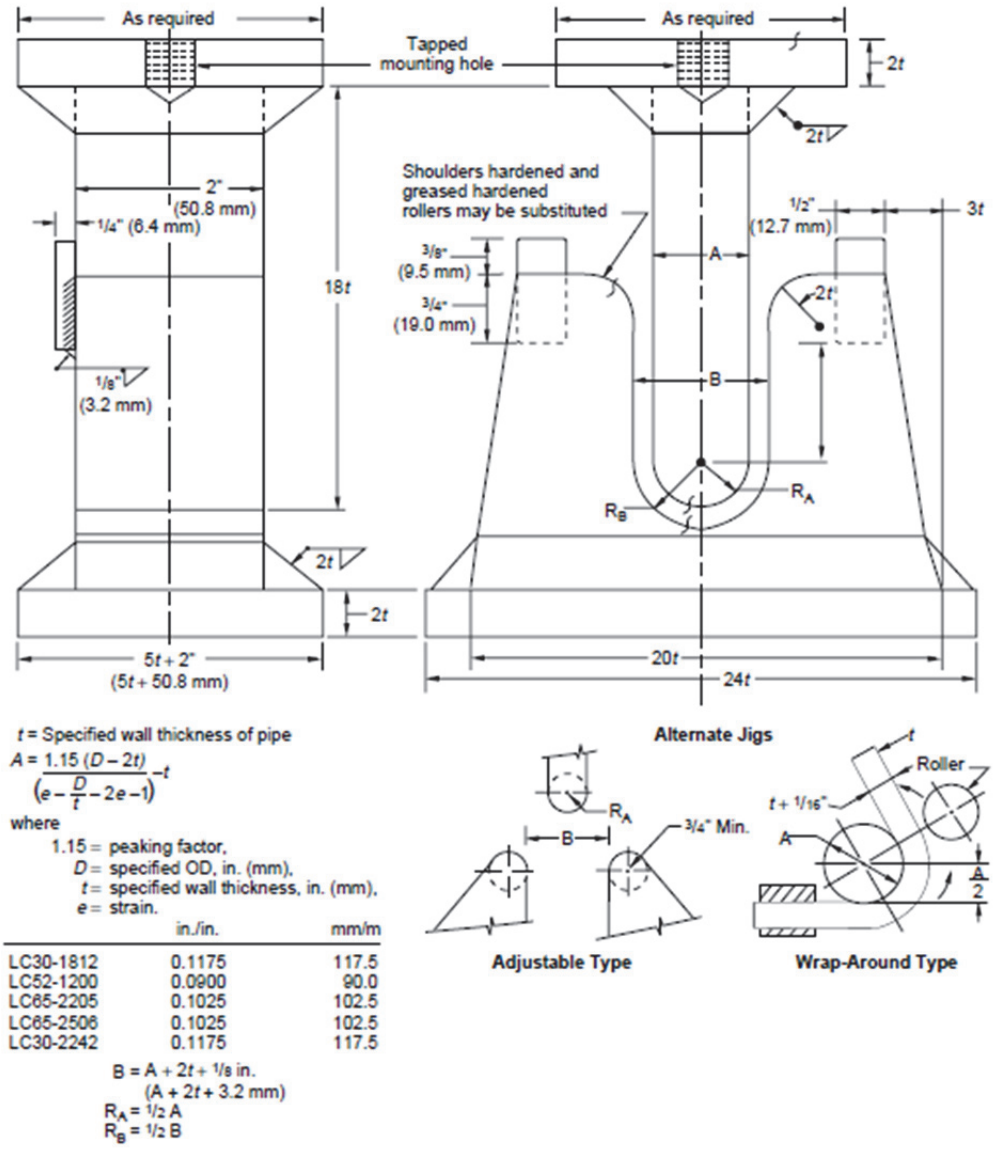



**Figure 5—Jig for Guided-bend Test**

b) Grades 52 ksi Yield Strength and Higher

$$S = \frac{3.05t}{\left(0.05 + \frac{3t}{D}\right)} \tag{6}$$

where

$S$ is the distance between flattening plates. in. (mm);

$t$ is the specified wall thickness of the pipe, in. (mm);

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

Cracks which originate at the edge of the specimen and which are less than $^1/_4$ in. (6.35 mm) long shall not be cause for rejection. One test shall be made on a length of pipe from each lot size as indicated in Table 10.

**Table 10—Specimen Lot Test Lengths**

| **Outside Diameter** (in.) | **Lot Size** (no. of lengths) |
|---|---|
| Through $12^3/_4$ | 200 or less |
| 14 and over | 100 or less |

For multiple length pipe, a length shall be considered as each section cut from a particular multiple length. The weld ductility test may also serve as one of the flattening tests in 7.9 by compliance with the appropriate amounts of flattening.

## 7.17 Retests—Weld Ductility Test

If the weld ductility test specimen representing a lot of pipe fails to conform to any of the requirements of 7.16, the manufacturer may elect to make retests on two additional lengths from the same lot.

If both retest specimens conform to the requirements, all the lengths in the lot shall be accepted, except for the length from which the initial specimen was taken. If one or both of the retest specimens fail to conform to the specified requirements, the manufacturer may elect to test specimens cut from one end of the individual lengths remaining in the lot. Precautions shall be taken so that the specimens can be identified with respect to the length of pipe from which they were cut. The manufacturer may also elect to retest any length which has failed to pass the above test procedure by cropping back and cutting two additional specimens from the same end. If the weld ductility test requirements are met by both of these additional tests, that length shall be acceptable. No further cropping and retesting is permitted.

## 7.18 Centrifugally Cast Homogeneity Test

Centrifugally cast pipe furnished to this specification shall be tested for hardness as follows.

a) *Definitions*.

1) *Impression*. One Rockwell hardness C scale (HRC) indentation (see Figure 6). Although impressions below HRC 20 may not be precise, they may be used for the calculation of readings. Care should be exercised when evaluating those hardness values below HRC 20.

2) *Reading*. The average of three impressions in an arc parallel to the circumference of the pipe (see Figure 6).

b) *Hardness Requirements*. Hardness tests shall be made in accordance with the latest edition of ASTM E18.

Hardness readings are not taken into account. Only the difference between readings is to be measured. The difference in hardness readings in a quadrant on any test ring shall not exceed that specified below in Table 11.

**Table 11—Quadrant Hardness Readings**

| Nominal Wall Thickness (in.) | Allowable Hardness Gradation (HRC) |
|---|---|
| 0.500 or less | 3.0 |
| 0.501 to 0.749 | 4.0 |
| 0.750 to 0.999 | 5.0 |
| 1.000 and greater | 6.0 |

c) *Test Frequency*. A test ring shall be cut from one end of each pipe. Approximately 50 % of these test rings shall be cut from the front ends and approximately 50 % from the back ends of the pipe. HRC impressions shall be made in one quadrant of each ring as shown in Figure 6.

By agreement between the purchaser and the manufacturer, hardness test frequencies other than required above may be specified.

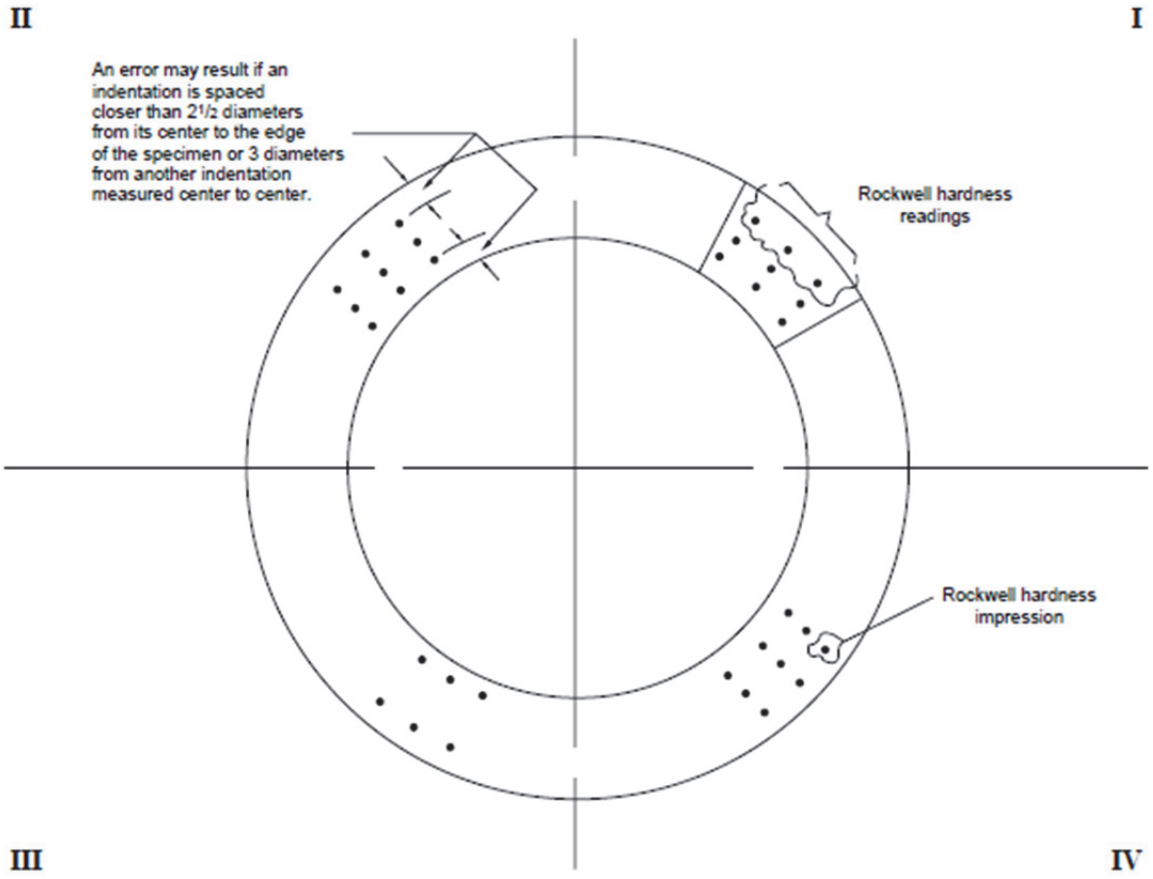



**Figure 6—Through-wall Hardness Test Locations**

### 7.19 Hardness Tests (LC52-1200)

Hardness readings (three impressions) shall be made in accordance with the latest editions of ASTM E18 and ASTM E10, as appropriate.

Conversions shall be made in accordance with the latest edition of ASTM A370. The use of the HRC scale is permissible at hardness levels of less than HRC 20. Although impressions below HRC 20 may not be precise, they may be used for the calculation of readings. Care should be exercised when evaluating those hardness levels below HRC 20.

Each tensile specimen required for Grade LC52-1200 in accordance with 7.2 shall be tested for hardness and shall comply with the requirements given in Table 7. For hardness readings of weld areas, a test specimen shall be taken adjacent to the Weld Tensile Test specimen specified in 7.5. This hardness test shall include both weld metal and HAZ, and comply with the maximum reading shown in Table 7. By agreement between purchaser and manufacturer, additional hardness tests may be specified.

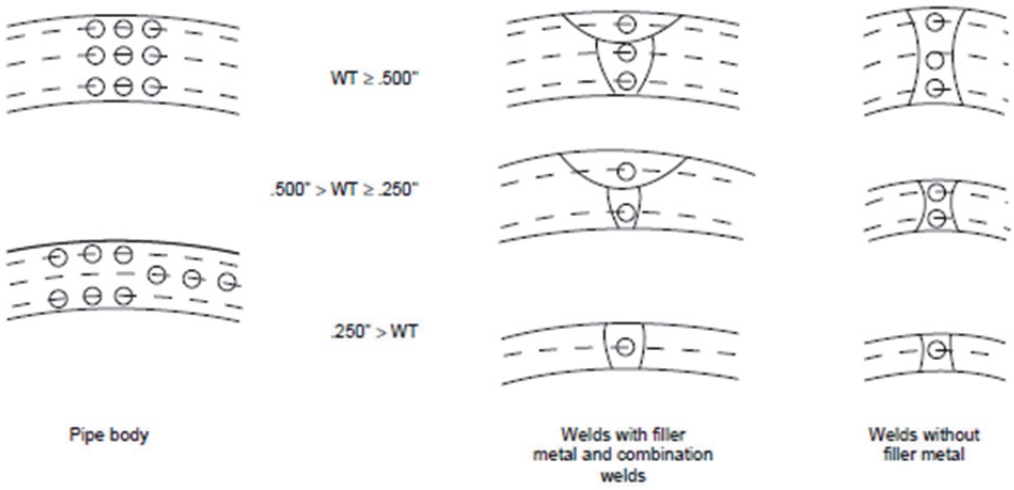
## 8 Special Tests

### 8.1 Ferrite/Austenite Ratio for Duplex Stainless Steel

Ferrite/austenite ratio for duplex stainless steel shall be within 0.35 to 0.65. This ratio shall be determined by using commercially available methods such as ferrite indicator, microscopic point-count method, computerized structure analysis method, etc. In case of dispute, microscopic point-count method shall be used as the standard method (reference ASTM E562).

Each tensile test specimen shall be tested to determine the ferrite/austenite ratio and shall comply with the requirement described above. For the ferrite/austenite ratio determination on the weld, a test specimen shall be taken adjacent to weld tensile test specimen as specified in 7.5. The ratio measured on this test specimen shall comply with the requirements described above.

The determination of ferrite/austenite ratio shall be conducted at nine points for pipe body specimen and at one-to-three points, depending upon thickness, for the weld specimen as shown in Figure 7. The average of three readings of the OD, centerline, and ID of the pipe body shall be within specified values. For the weld, each reading shall be within the specified values.




NOTE OD and ID readings shall be as close as practical to the OD or ID surface.

**Figure 7—Location for Determination of Through-wall Ferrite/Austenite Ratio**

## 8.2 Intergranular Corrosion Test (Strauss Test)

The purpose of this test is to assure proper manufacturing procedures for austenitic steel (LC30-1812) and Ni-base alloy (LC30-2242). It is not a test to determine susceptibility for use with a particular environment. Listed below is information regarding intergranular corrosion testing (Strauss test) that is in accordance with this specification.

a) *Summary of Test Procedure*. A suitable sample embedded in copper shot or grindings is exposed to boiling acidified copper sulfate solution for 24 hours. After exposure in the boiling solution, the specimen is bent. The testing procedure shall conform to the requirement of the latest edition of ASTM A262, Practice E.

b) *Specimen Sampling*. One specimen of the base metal shall be taken from the pipe body. For welded pipe another specimen, containing the weld, shall also be taken from the seam-welded portion. The specimen axis may be either transverse or longitudinal to the pipe axis.

One test for each heat or each heat-treatment lot shall be performed as described in the footnote to Table 8.

c) *Specimen Preparation*. The size of specimen shall be approximately 3 in. (76.2 mm) long and 1 in. (25.4 mm) wide. Detailed sampling condition may be specified in the agreement between the purchaser and the manufacturer. Sawing is preferred to shearing, but if sheared, the sheared edge of specimen shall be machined or ground off. The specimen shall be tested in the as-received condition except that it may be flattened, if desired. Any scale on the specimen shall be removed mechanically with 120 grit iron-free aluminum oxide abrasive. Alternatively, chemical removal of scale is permissible. Each specimen shall be degreased using acetone, alcohol, or a vapor degreaser prior to testing.

d) *Test Condition*. Test solution is made dissolving 100 g of copper sulfate ($CuSO_4 \cdot 5H_2O$) in 700 ml of distilled water, adding 100 ml of sulfuric acid ($H_2SO_4$) and diluting to 1000 ml with distilled water. The volume of test solution shall be sufficient to completely immerse the specimens.

The test specimen shall be immersed in an ambient temperature test solution which is then brought to a boil and maintained at boiling for 24 hours. After 24-hour immersion, the test specimen shall be removed from the test solution. If adherent copper remains, it may be removed by a brief immersion in nitric acid at room temperature prior to bending.

e) *Bend Test*. For acceptance, the tested specimen shall be bent through 180° over a diameter equal to twice the thickness of the specimen. Bending axis shall be perpendicular to the direction of the test specimen. Unless otherwise specified, the bend test system shall be a root bend; i.e. the inside surface of the pipe shall be strained in tension. The wall thickness need not be greater than $^3/_8$ in. (9.52 mm).

In case of material having low ductility, the maximum angle of bend without causing cracks in the material shall be determined by bending an untested specimen of the same configuration as the specimen to be tested.

For welded specimens, the fusion line shall be located approximately at the centerline of the bend.

f) *Minimum Acceptance Criteria*. The bent test specimen shall first be examined at low magnification. If the evaluation is questionable, the specimen shall then be examined at a magnification of 100×. No cracking is permitted. An investigation to determine cause of failure is required; and agreement by the purchaser is required prior to any retest procedure.

# 9 Hydrostatic Tests

## 9.1 Inspection Hydrostatic Test

Each length of pipe shall withstand, without leakage, an inspection hydrostatic test to at least the pressure specified in 9.3. Test pressures for all sizes of seamless pipe and for welded pipe in sizes 15 in. and smaller shall be held for not less than 5 seconds. Test pressures for welded pipe in sizes 20 in. and larger shall be held for not less than 10 seconds. The water used for hydrostatic testing shall contain less than 50 ppm chlorides.

## 9.2 Verification of Test

In order to ensure that every length of pipe is tested to the required test pressure, each tester shall be equipped with a recording device that will record the test pressure and duration of time applied to each length of pipe or equipped with some positive and automatic or interlocking device to prevent pipe from being classified as tested until the test requirements (pressure and time) have been complied with. Such records or charts shall be available for examination at the manufacturer's facility by the purchaser's inspectors when the purchaser is so represented at the manufacturer's facility. The test pressure measuring device shall be calibrated by means of a deadweight tester, or equivalent, within four months prior to each use. Calibration records retention shall be in accordance with Section 4.

## 9.3 Test Pressures

The minimum test pressure shall be the standard test pressure as listed in Table 12, or an intermediate or higher pressure at the discretion of the manufacturer unless specifically limited by the purchaser, or a higher pressure as agreed upon between the purchaser and manufacturer. The minimum test pressures for grades, diameters, and wall thicknesses not listed shall be computed by the formula given below. For all grades in all sizes smaller than $2^3/_8$ in., the test pressure has been arbitrarily assigned. Where the unlisted wall is intermediate to walls whose test pressure has been arbitrarily assigned, the test pressure for the intermediate wall shall be equal to the next heaviest wall. When computed pressures are not an exact multiple of 10 psi (100 kPa), they shall be rounded to the nearest 10 psi (100 kPa).

NOTE 1 The hydrostatic test pressures given herein are manufacturer inspection test pressures, are not intended as a basis for design, and do not necessarily have any direct relationship to working pressures.

The test pressures in Table 12 were computed from Equations (7) and (8) below and rounded to the nearest 10 psi (100 kPa).

In U.S. Customary (USC) units:

$$P = \frac{2St}{D} \tag{7}$$

In metric units:

$$P = \frac{2000St}{D} \tag{8}$$

where

$P$ is the hydrostatic test pressure in psi (kPa);

$S$ is the fiber stress in psi (MPa), equal to a percentage of the specified minimum yield strength (SMYS) for the various sizes as shown in Table 13;

$t$ is the specified wall thickness in inches (mm);

$D$ is the specified outside diameter in inches (mm).

NOTE 2 When hydrostatic testing in excess of 90 % of SMYS using the above formula, the applied forces for end-sealing produce a compressive longitudinal stress which should be considered. Recognizing this phenomenon, the manufacturer should submit appropriate calculations for determining the test pressure.

**Table 12—Plain-end Line Pipe Dimensions [a], Weights [b], and Test Pressures (See Annex F for Metric Tables)**

| 1 | | | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Test Pressures (psi, min.) | | | |
| **Nom.** (in.) | **Size: Designation** | **Outside Diameter** (in.) $D$ | **Plain-end Weight** (lb per ft) $w_{pe}$ | **Wall Thickness** (in.) $t$ | **Inside Diameter** (in.) $d$ | **LC30** | **LC52** | **LC65** | **LC80** |
| 1 | Std | 1.315 | 1.68 | 0.133 | 1.049 | 700 | — | 1520 | — |
| 1 | XS | 1.315 | 2.17 | 0.179 | 0.957 | 850 | — | 1840 | — |
| 1 | XXS | 1.315 | 3.66 | 0.358 | 0.599 | 1000 | — | 2170 | — |
| | | | | | | | | | |
| $1^1/_4$ | Std | 1.660 | 2.27 | 0.140 | 1.380 | 1200 | — | 2600 | — |
| $1^1/_4$ | XS | 1.660 | 3.00 | 0.191 | 1.278 | 1800 | — | 3000 | — |
| $1^1/_4$ | XXS | 1.660 | 5.21 | 0.382 | 0.896 | 2200 | — | 3000 | — |
| | | | | | | | | | |
| $1^1/_2$ | Std | 1.900 | 2.72 | 0.145 | 1.610 | 1200 | — | 2600 | — |
| $1^1/_2$ | XS | 1.900 | 3.63 | 0.200 | 1.500 | 1800 | — | 3000 | — |
| $1^1/_2$ | XXS | 1.900 | 6.41 | 0.400 | 1.100 | 2200 | — | 3000 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal and are given here for information.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered, use the appropriate correction factor from 10.1.

## Table 12—Plain-end Line Pipe Dimensions [a], Weights [b], and Test Pressures (Continued)
## (See Annex F for Metric Tables)

| Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) LC30 | LC52 | LC65 | LC80 | Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) LC30 | LC52 | LC65 | LC80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.375 | 2.03 | 0.083 | 2.209 | 1570 | 2730 | 3000 | 3000 | 3.5 | 3.03 | 0.083 | 3.334 | 1070 | 1850 | 2310 | 2850 |
| 2.375 | 2.64 | 0.109 | 2.157 | 2070 | 3000 | 3000 | 3000 | 3.5 | 3.95 | 0.109 | 3.282 | 1400 | 2430 | 3000 | 3000 |
| 2.375 | 3.00 | 0.125 | 2.125 | 2370 | 3000 | 3000 | 3000 | 3.5 | 4.51 | 0.125 | 3.250 | 1610 | 2790 | 3000 | 3000 |
| 2.375 | 3.36 | 0.141 | 2.093 | 2670 | 3000 | 3000 | 3000 | 3.5 | 5.06 | 0.141 | 3.218 | 1810 | 3000 | 3000 | 3000 |
| 2.375 | 3.65 | 0.154 | 2.067 | 2920 | 3000 | 3000 | 3000 | 3.5 | 5.57 | 0.156 | 3.188 | 2010 | 3000 | 3000 | 3000 |
| 2.375 | 4.05 | 0.172 | 2.031 | 3000 | 3000 | 3000 | 3000 | 3.5 | 6.11 | 0.172 | 3.156 | 2210 | 3000 | 3000 | 3000 |
| 2.375 | 4.39 | 0.188 | 1.999 | 3000 | 3000 | 3000 | 3000 | 3.5 | 6.65 | 0.188 | 3.124 | 2420 | 3000 | 3000 | 3000 |
| 2.375 | 5.02 | 0.218 | 1.939 | 3000 | 3000 | 3000 | 3000 | 3.5 | 7.58 | 0.216 | 3.068 | 2780 | 3000 | 3000 | 3000 |
| 2.375 | 5.67 | 0.250 | 1.875 | 3000 | 3000 | 3000 | 3000 | 3.5 | 8.68 | 0.250 | 3.000 | 3000 | 3000 | 3000 | 3000 |
| 2.375 | 6.28 | 0.281 | 1.813 | 3000 | 3000 | 3000 | 3000 | 3.5 | 9.66 | 0.281 | 2.938 | 3000 | 3000 | 3000 | 3000 |
| 2.375 | 9.03 | 0.436 | 1.503 | 3000 | 3000 | 3000 | 3000 | 3.5 | 10.25 | 0.300 | 2.900 | 3000 | 3000 | 3000 | 3000 |
| | | | | | | | | 3.5 | 18.58 | 0.600 | 2.300 | 3000 | 3000 | 3000 | 3000 |
| 2.875 | 2.47 | 0.083 | 2.709 | 1300 | 2250 | 2810 | 3000 | | | | | | | | |
| 2.875 | 3.22 | 0.109 | 2.657 | 1710 | 2960 | 3000 | 3000 | 4 | 3.47 | 0.083 | 3.834 | 930 | 1620 | 2020 | 2490 |
| 2.875 | 3.67 | 0.125 | 2.625 | 1960 | 3000 | 3000 | 3000 | 4 | 4.53 | 0.109 | 3.782 | 1230 | 2130 | 2660 | 3000 |
| 2.875 | 4.12 | 0.141 | 2.593 | 2210 | 3000 | 3000 | 3000 | 4 | 5.17 | 0.125 | 3.750 | 1410 | 2440 | 3000 | 3000 |
| 2.875 | 4.53 | 0.156 | 2.563 | 2440 | 3000 | 3000 | 3000 | 4 | 5.81 | 0.141 | 3.718 | 1590 | 2750 | 3000 | 3000 |
| 2.875 | 4.97 | 0.172 | 2.531 | 2690 | 3000 | 3000 | 3000 | 4 | 6.40 | 0.156 | 3.688 | 1760 | 3000 | 3000 | 3000 |
| 2.875 | 5.40 | 0.188 | 2.499 | 2940 | 3000 | 3000 | 3000 | 4 | 7.03 | 0.172 | 3.656 | 1940 | 3000 | 3000 | 3000 |
| 2.875 | 5.79 | 0.203 | 2.469 | 3000 | 3000 | 3000 | 3000 | 4 | 7.65 | 0.188 | 3.624 | 2120 | 3000 | 3000 | 3000 |
| 2.875 | 6.13 | 0.216 | 2.443 | 3000 | 3000 | 3000 | 3000 | 4 | 9.11 | 0.226 | 3.548 | 2540 | 3000 | 3000 | 3000 |
| 2.875 | 7.01 | 0.250 | 2.375 | 3000 | 3000 | 3000 | 3000 | 4 | 10.01 | 0.250 | 3.500 | 2810 | 3000 | 3000 | 3000 |
| 2.875 | 7.66 | 0.276 | 2.323 | 3000 | 3000 | 3000 | 3000 | 4 | 11.16 | 0.281 | 3.438 | 3000 | 3000 | 3000 | 3000 |
| 2.875 | 13.69 | 0.552 | 1.771 | 3000 | 3000 | 3000 | 3000 | 4 | 12.50 | 0.318 | 3.364 | 3000 | 3000 | 3000 | 3000 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal and are given here for information.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered, use the appropriate correction factor from 10.1.

## Table 12—Plain-end Line Pipe Dimensions [a], Weights [b], and Test Pressures (Continued)
## (See Annex F for Metric Tables)

| Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) LC30 | LC52 | LC65 | LC80 | Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) LC30 | LC52 | LC65 | LC80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.5 | 3.92 | 0.083 | 4.334 | 830 | 1440 | 1800 | 2210 | 5.563 | 27.04 | 0.500 | 4.563 | 3000 | 3000 | 3000 | 3000 |
| 4.5 | 5.84 | 0.125 | 4.250 | 1250 | 2170 | 2710 | 3000 | 5.563 | 32.96 | 0.625 | 4.313 | 3000 | 3000 | 3000 | 3000 |
| 4.5 | 6.56 | 0.141 | 4.218 | 1410 | 2440 | 3000 | 3000 | 5.563 | 38.55 | 0.750 | 4.063 | 3000 | 3000 | 3000 | 3000 |
| 4.5 | 7.24 | 0.156 | 4.188 | 1560 | 2700 | 3000 | 3000 | | | | | | | | |
| 4.5 | 7.95 | 0.172 | 4.156 | 1720 | 2980 | 3000 | 3000 | 6.625 | 5.80 | 0.083 | 6.459 | 560 | 980 | 1220 | 1500 |
| 4.5 | 8.66 | 0.188 | 4.124 | 1880 | 3000 | 3000 | 3000 | 6.625 | 7.59 | 0.109 | 6.407 | 740 | 1280 | 1600 | 1970 |
| 4.5 | 9.32 | 0.203 | 4.094 | 2030 | 3000 | 3000 | 3000 | 6.625 | 8.68 | 0.125 | 6.375 | 850 | 1470 | 1840 | 2260 |
| 4.5 | 10.01 | 0.219 | 4.062 | 2190 | 3000 | 3000 | 3000 | 6.625 | 9.76 | 0.141 | 6.343 | 960 | 1660 | 2080 | 2550 |
| 4.5 | 10.79 | 0.237 | 4.026 | 2370 | 3000 | 3000 | 3000 | 6.625 | 10.78 | 0.156 | 6.313 | 1060 | 1840 | 2300 | 2830 |
| 4.5 | 11.35 | 0.250 | 4.000 | 2500 | 3000 | 3000 | 3000 | 6.625 | 11.85 | 0.172 | 6.281 | 1170 | 2030 | 2530 | 3000 |
| 4.5 | 12.66 | 0.281 | 3.938 | 2810 | 3000 | 3000 | 3000 | 6.625 | 12.92 | 0.188 | 6.249 | 1280 | 2210 | 2770 | 3000 |
| 4.5 | 13.96 | 0.312 | 3.876 | 3000 | 3000 | 3000 | 3000 | 6.625 | 13.92 | 0.203 | 6.219 | 1380 | 2390 | 2990 | 3000 |
| 4.5 | 14.98 | 0.337 | 3.826 | 3000 | 3000 | 3000 | 3000 | 6.625 | 14.98 | 0.219 | 6.187 | 1490 | 2580 | 3000 | 3000 |
| 4.5 | 19.00 | 0.438 | 3.624 | 3000 | 3000 | 3000 | 3000 | 6.625 | 17.02 | 0.250 | 6.125 | 1700 | 2940 | 3000 | 3000 |
| 4.5 | 22.51 | 0.531 | 3.438 | 3000 | 3000 | 3000 | 3000 | 6.625 | 18.97 | 0.280 | 6.065 | 1900 | 3000 | 3000 | 3000 |
| 4.5 | 27.54 | 0.674 | 3.152 | 3000 | 3000 | 3000 | 3000 | 6.625 | 21.04 | 0.312 | 6.001 | 2120 | 3000 | 3000 | 3000 |
| | | | | | | | | 6.625 | 23.08 | 0.344 | 5.937 | 2340 | 3000 | 3000 | 3000 |
| 5.563 | 4.86 | 0.083 | 5.397 | 670 | 1160 | 1450 | 1790 | 6.625 | 25.03 | 0.375 | 5.875 | 2550 | 3000 | 3000 | 3000 |
| 5.563 | 7.26 | 0.125 | 5.313 | 1010 | 1750 | 2190 | 2700 | 6.625 | 28.57 | 0.432 | 5.761 | 2930 | 3000 | 3000 | 3000 |
| 5.563 | 9.01 | 0.156 | 5.251 | 1260 | 2190 | 2730 | 3000 | 6.625 | 32.71 | 0.500 | 5.625 | 3000 | 3000 | 3000 | 3000 |
| 5.563 | 10.79 | 0.188 | 5.187 | 1520 | 2640 | 3000 | 3000 | 6.625 | 53.73 | 0.875 | 4.875 | 3000 | 3000 | 3000 | 3000 |
| 5.563 | 12.50 | 0.219 | 5.125 | 1770 | 3000 | 3000 | 3000 | | | | | | | | |
| 5.563 | 14.62 | 0.258 | 5.047 | 2090 | 3000 | 3000 | 3000 | 8.625 | 11.35 | 0.125 | 8.375 | 650 | 1130 | 1410 | 1740 |
| 5.563 | 15.85 | 0.281 | 5.001 | 2270 | 3000 | 3000 | 3000 | 8.625 | 14.11 | 0.156 | 8.313 | 810 | 1410 | 1760 | 2170 |
| 5.563 | 17.50 | 0.312 | 4.939 | 2520 | 3000 | 3000 | 3000 | 8.625 | 16.94 | 0.188 | 8.249 | 980 | 1700 | 2130 | 2620 |
| 5.563 | 19.17 | 0.344 | 4.875 | 2780 | 3000 | 3000 | 3000 | 8.625 | 18.26 | 0.203 | 8.219 | 1060 | 1840 | 2290 | 2820 |
| 5.563 | 20.78 | 0.375 | 4.813 | 3000 | 3000 | 3000 | 3000 | 8.625 | 19.66 | 0.219 | 8.187 | 1140 | 1980 | 2480 | 3000 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal and are given here for information.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered, use the appropriate correction factor from 10.1.

**Table 12—Plain-end Line Pipe Dimensions [a], Weights [b], and Test Pressures (Continued)**
**(See Annex F for Metric Tables)**

| Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) LC30 | LC52 | LC65 | LC80 | Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) LC30 | LC52 | LC65 | LC80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.625 | 22.36 | 0.250 | 8.125 | 1300 | 2260 | 2830 | 3000 | 8.625 | 33.04 | 0.375 | 7.875 | 1960 | 3000 | 3000 | 3000 |
| 8.625 | 24.70 | 0.277 | 8.071 | 1450 | 2510 | 3000 | 3000 | 8.625 | 38.30 | 0.438 | 7.749 | 2290 | 3000 | 3000 | 3000 |
| 8.625 | 27.70 | 0.312 | 8.001 | 1630 | 2820 | 3000 | 3000 | 8.625 | 43.39 | 0.500 | 7.625 | 2610 | 3000 | 3000 | 3000 |
| 8.625 | 28.55 | 0.322 | 7.981 | 1680 | 2910 | 3000 | 3000 | 8.625 | 48.40 | 0.562 | 7.501 | 2930 | 3000 | 3000 | 3000 |
| 8.625 | 30.42 | 0.344 | 7.937 | 1790 | 3000 | 3000 | 3000 | 8.625 | 53.40 | 0.625 | 7.375 | 3000 | 3000 | 3000 | 3000 |
| 8.625 | 33.04 | 0.375 | 7.875 | 1960 | 3000 | 3000 | 3000 | 8.625 | 60.71 | 0.719 | 7.187 | 3000 | 3000 | 3000 | 3000 |
| 8.625 | 38.30 | 0.438 | 7.749 | 2290 | 3000 | 3000 | 3000 | 8.625 | 63.08 | 0.750 | 7.125 | 3000 | 3000 | 3000 | 3000 |
| 8.625 | 43.39 | 0.500 | 7.625 | 2610 | 3000 | 3000 | 3000 | 8.625 | 67.76 | 0.812 | 7.001 | 3000 | 3000 | 3000 | 3000 |
| 8.625 | 48.40 | 0.562 | 7.501 | 2930 | 3000 | 3000 | 3000 | 8.625 | 72.42 | 0.875 | 6.875 | 3000 | 3000 | 3000 | 3000 |
| 8.625 | 53.40 | 0.625 | 7.375 | 3000 | 3000 | 3000 | 3000 | 8.625 | 81.44 | 1.000 | 6.625 | 3000 | 3000 | 3000 | 3000 |
| 8.625 | 60.71 | 0.719 | 7.187 | 3000 | 3000 | 3000 | 3000 | | | | | | | | |
| 8.625 | 63.08 | 0.750 | 7.125 | 3000 | 3000 | 3000 | 3000 | 10.75 | 17.65 | 0.156 | 10.438 | 740 | 1280 | 1600 | 1970 |
| 8.625 | 67.76 | 0.812 | 7.001 | 3000 | 3000 | 3000 | 3000 | 10.75 | 21.21 | 0.188 | 10.374 | 890 | 1550 | 1930 | 2380 |
| 8.625 | 72.42 | 0.875 | 6.875 | 3000 | 3000 | 3000 | 3000 | 10.75 | 22.87 | 0.203 | 10.344 | 960 | 1670 | 2090 | 2570 |
| 8.625 | 81.44 | 1.000 | 6.625 | 3000 | 3000 | 3000 | 3000 | 10.75 | 24.63 | 0.219 | 10.312 | 1040 | 1800 | 2250 | 2770 |
| 8.625 | 22.36 | 0.250 | 8.125 | 1300 | 2260 | 2830 | 3000 | 10.75 | 28.04 | 0.250 | 10.250 | 1190 | 2060 | 2570 | 3000 |
| 8.625 | 24.70 | 0.277 | 8.071 | 1450 | 2510 | 3000 | 3000 | 10.75 | 31.20 | 0.279 | 10.192 | 1320 | 2290 | 2870 | 3000 |
| 8.625 | 27.70 | 0.312 | 8.001 | 1630 | 2820 | 3000 | 3000 | 10.75 | 34.24 | 0.307 | 10.136 | 1460 | 2520 | 3000 | 3000 |
| 8.625 | 28.55 | 0.322 | 7.981 | 1680 | 2910 | 3000 | 3000 | 10.75 | 38.23 | 0.344 | 10.062 | 1630 | 2830 | 3000 | 3000 |
| 8.625 | 30.42 | 0.344 | 7.937 | 1790 | 3000 | 3000 | 3000 | 10.75 | 40.48 | 0.365 | 10.020 | 1730 | 3000 | 3000 | 3000 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal and are given here for information.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered, use the appropriate correction factor from 10.1.

## Table 12—Plain-end Line Pipe Dimensions [a], Weights [b], and Test Pressures (Continued)
## (See Annex F for Metric Tables)

| Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) | | | | Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LC30 | LC52 | LC65 | LC80 | | | | | LC30 | LC52 | LC65 | LC80 |
| 10.75 | 48.24 | 0.438 | 9.874 | 2080 | 3000 | 3000 | 3000 | 12.75 | 96.12 | 0.750 | 11.250 | 3000 | 3000 | 3000 | 3000 |
| 10.75 | 54.74 | 0.500 | 9.750 | 2370 | 3000 | 3000 | 3000 | 12.75 | 103.53 | 0.812 | 11.126 | 3000 | 3000 | 3000 | 3000 |
| 10.75 | 61.15 | 0.562 | 9.626 | 2670 | 3000 | 3000 | 3000 | 12.75 | 110.97 | 0.875 | 11.000 | 3000 | 3000 | 3000 | 3000 |
| 10.75 | 67.58 | 0.625 | 9.500 | 2970 | 3000 | 3000 | 3000 | 12.75 | 118.33 | 0.938 | 10.874 | 3000 | 3000 | 3000 | 3000 |
| 10.75 | 77.03 | 0.719 | 9.312 | 3000 | 3000 | 3000 | 3000 | 12.75 | 125.49 | 1.000 | 10.750 | 3000 | 3000 | 3000 | 3000 |
| 10.75 | 86.18 | 0.812 | 9.126 | 3000 | 3000 | 3000 | 3000 | 12.75 | 132.57 | 1.062 | 10.626 | 3000 | 3000 | 3000 | 3000 |
| 10.75 | 92.28 | 0.875 | 9.000 | 3000 | 3000 | 3000 | 3000 | 12.75 | 139.67 | 1.125 | 10.500 | 3000 | 3000 | 3000 | 3000 |
| 10.75 | 98.30 | 0.938 | 8.874 | 3000 | 3000 | 3000 | 3000 | 12.75 | 153.53 | 1.250 | 10.250 | 3000 | 3000 | 3000 | 3000 |
| 10.75 | 104.13 | 1.000 | 8.750 | 3000 | 3000 | 3000 | 3000 | | | | | | | | |
| 10.75 | 126.83 | 1.250 | 8.250 | 3000 | 3000 | 3000 | 3000 | 14 | 27.73 | 0.188 | 13.624 | 680 | 1190 | 1480 | 1830 |
| | | | | | | | | 14 | 29.91 | 0.203 | 13.594 | 740 | 1280 | 1600 | 1970 |
| 12.75 | 23.11 | 0.172 | 12.406 | 690 | 1190 | 1490 | 1830 | 14 | 30.93 | 0.210 | 13.580 | 770 | 1330 | 1660 | 2040 |
| 12.75 | 25.22 | 0.188 | 12.374 | 750 | 1300 | 1630 | 2010 | 14 | 32.23 | 0.219 | 13.562 | 800 | 1380 | 1730 | 2130 |
| 12.75 | 27.20 | 0.203 | 12.344 | 810 | 1410 | 1760 | 2340 | 14 | 36.71 | 0.250 | 13.500 | 910 | 1580 | 1970 | 2430 |
| 12.75 | 29.31 | 0.219 | 12.312 | 880 | 1520 | 1900 | 2670 | 14 | 41.17 | 0.281 | 13.438 | 1020 | 1770 | 2220 | 2730 |
| 12.75 | 33.38 | 0.250 | 12.250 | 1000 | 1730 | 2170 | 3000 | 14 | 45.61 | 0.312 | 13.376 | 1140 | 1970 | 2460 | 3000 |
| 12.75 | 37.42 | 0.281 | 12.188 | 1120 | 1950 | 2440 | 3000 | 14 | 50.17 | 0.344 | 13.312 | 1250 | 2170 | 2720 | 3000 |
| 12.75 | 41.45 | 0.312 | 12.126 | 1250 | 2160 | 2700 | 3000 | 14 | 54.57 | 0.375 | 13.250 | 1370 | 2370 | 2960 | 3000 |
| 12.75 | 43.77 | 0.330 | 12.090 | 1320 | 2290 | 2860 | 3000 | 14 | 58.94 | 0.406 | 13.188 | 1480 | 2560 | 3000 | 3000 |
| 12.75 | 45.58 | 0.344 | 12.062 | 1380 | 2390 | 2980 | 3000 | 14 | 63.44 | 0.438 | 13.124 | 1600 | 2770 | 3000 | 3000 |
| 12.75 | 49.56 | 0.375 | 12.000 | 1500 | 2600 | 3000 | 3000 | 14 | 67.78 | 0.469 | 13.062 | 1710 | 2960 | 3000 | 3000 |
| 12.75 | 53.52 | 0.406 | 11.938 | 1620 | 2810 | 3000 | 3000 | 14 | 72.09 | 0.500 | 13.000 | 1820 | 3000 | 3000 | 3000 |
| 12.75 | 57.59 | 0.438 | 11.874 | 1750 | 3000 | 3000 | 3000 | 14 | 80.66 | 0.562 | 12.876 | 2050 | 3000 | 3000 | 3000 |
| 12.75 | 65.42 | 0.500 | 11.750 | 2000 | 3000 | 3000 | 3000 | 14 | 89.28 | 0.625 | 12.750 | 2280 | 3000 | 3000 | 3000 |
| 12.75 | 73.15 | 0.562 | 11.626 | 2250 | 3000 | 3000 | 3000 | 14 | 97.81 | 0.688 | 12.624 | 2510 | 3000 | 3000 | 3000 |
| 12.75 | 80.93 | 0.625 | 11.500 | 2500 | 3000 | 3000 | 3000 | 14 | 106.13 | 0.750 | 12.500 | 2730 | 3000 | 3000 | 3000 |
| 12.75 | 88.63 | 0.688 | 11.374 | 2750 | 3000 | 3000 | 3000 | 14 | 114.37 | 0.812 | 12.376 | 2960 | 3000 | 3000 | 3000 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal and are given here for information.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered, use the appropriate correction factor from 10.1.

**Table 12—Plain-end Line Pipe Dimensions [a], Weights [b], and Test Pressures (Continued)**
**(See Annex F for Metric Tables)**

| Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) | | | | Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LC30 | LC52 | LC65 | LC80 | | | | | LC30 | LC52 | LC30 | LC52 |
| 14 | 122.65 | 0.875 | 12.250 | 3000 | 3000 | 3000 | 3000 | 16 | 102.63 | 0.625 | 14.750 | 1990 | 3000 | 3000 | 3000 |
| 14 | 130.85 | 0.938 | 12.124 | 3000 | 3000 | 3000 | 3000 | 16 | 112.51 | 0.688 | 14.624 | 2190 | 3000 | 3000 | 3000 |
| 14 | 138.84 | 1.000 | 12.000 | 3000 | 3000 | 3000 | 3000 | 16 | 122.15 | 0.750 | 14.500 | 2390 | 3000 | 3000 | 3000 |
| 14 | 146.74 | 1.062 | 11.876 | 3000 | 3000 | 3000 | 3000 | 16 | 131.71 | 0.812 | 14.376 | 2590 | 3000 | 3000 | 3000 |
| 14 | 154.69 | 1.125 | 11.750 | 3000 | 3000 | 3000 | 3000 | 16 | 141.34 | 0.875 | 14.250 | 2790 | 3000 | 3000 | 3000 |
| 14 | 170.21 | 1.250 | 11.500 | 3000 | 3000 | 3000 | 3000 | 16 | 150.89 | 0.938 | 14.124 | 2990 | 3000 | 3000 | 3000 |
| | | | | | | | | 16 | 160.20 | 1.000 | 14.000 | 3000 | 3000 | 3000 | 3000 |
| 16 | 31.75 | 0.188 | 15.624 | 600 | 1040 | 1300 | 1600 | 16 | 169.43 | 1.062 | 13.876 | 3000 | 3000 | 3000 | 3000 |
| 16 | 34.25 | 0.203 | 15.594 | 650 | 1120 | 1400 | 1730 | 16 | 178.72 | 1.125 | 13.750 | 3000 | 3000 | 3000 | 3000 |
| 16 | 36.91 | 0.219 | 15.562 | 700 | 1210 | 1510 | 1860 | 16 | 187.93 | 1.188 | 13.624 | 3000 | 3000 | 3000 | 3000 |
| 16 | 42.05 | 0.250 | 15.500 | 800 | 1380 | 1730 | 2130 | 16 | 196.91 | 1.250 | 13.500 | 3000 | 3000 | 3000 | 3000 |
| 16 | 47.17 | 0.281 | 15.438 | 900 | 1550 | 1940 | 2390 | | | | | | | | |
| 16 | 52.27 | 0.312 | 15.376 | 990 | 1720 | 2150 | 2650 | 18 | 35.76 | 0.188 | 17.624 | 530 | 920 | 1150 | — |
| 16 | 57.52 | 0.344 | 15.312 | 1100 | 1900 | 2380 | 2920 | 18 | 41.59 | 0.219 | 17.562 | 620 | 1080 | 1340 | — |
| 16 | 62.58 | 0.375 | 15.250 | 1200 | 2070 | 2590 | 3000 | 18 | 47.39 | 0.250 | 17.500 | 710 | 1230 | 1530 | — |
| 16 | 67.62 | 0.406 | 15.188 | 1290 | 2240 | 2800 | 3000 | 18 | 53.18 | 0.281 | 17.438 | 800 | 1380 | 1730 | — |
| 16 | 72.80 | 0.438 | 15.124 | 1400 | 2420 | 3000 | 3000 | 18 | 58.94 | 0.312 | 17.376 | 880 | 1530 | 1920 | — |
| 16 | 77.79 | 0.469 | 15.062 | 1490 | 2590 | 3000 | 3000 | 18 | 64.87 | 0.344 | 17.312 | 970 | 1690 | 2110 | — |
| 16 | 82.77 | 0.500 | 15.000 | 1590 | 2760 | 3000 | 3000 | 18 | 70.59 | 0.375 | 17.250 | 1060 | 1840 | 2300 | — |
| 16 | 92.66 | 0.562 | 14.876 | 1790 | 3000 | 3000 | 3000 | 18 | 76.29 | 0.406 | 17.188 | 1150 | 1990 | 2490 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal and are given here for information.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered, use the appropriate correction factor from 10.1.

## Table 12—Plain-end Line Pipe Dimensions [a], Weights [b], and Test Pressures (Continued)
## (See Annex F for Metric Tables)

| Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) | | | | Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LC30 | LC52 | LC65 | LC80 | | | | | LC30 | LC52 | LC30 | LC52 |
| 18 | 82.15 | 0.438 | 17.124 | 1240 | 2150 | 2690 | — | 20 | 97.83 | 0.469 | 19.062 | 1270 | 2190 | 2740 | — |
| 18 | 87.81 | 0.469 | 17.062 | 1330 | 2300 | 2880 | — | 20 | 104.13 | 0.500 | 19.000 | 1350 | 2340 | 2930 | — |
| 18 | 93.45 | 0.500 | 17.000 | 1420 | 2460 | 3000 | — | 20 | 116.67 | 0.562 | 18.876 | 1520 | 2630 | 3000 | — |
| 18 | 104.67 | 0.562 | 16.876 | 1590 | 2760 | 3000 | — | 20 | 129.33 | 0.625 | 18.750 | 1690 | 2930 | 3000 | — |
| 18 | 115.98 | 0.625 | 16.750 | 1770 | 3000 | 3000 | — | 20 | 141.90 | 0.688 | 18.624 | 1860 | 3000 | 3000 | — |
| 18 | 127.21 | 0.688 | 16.624 | 1950 | 3000 | 3000 | — | 20 | 154.19 | 0.750 | 18.500 | 2030 | 3000 | 3000 | — |
| 18 | 138.17 | 0.750 | 16.500 | 2130 | 3000 | 3000 | — | 20 | 166.40 | 0.812 | 18.376 | 2190 | 3000 | 3000 | — |
| 18 | 149.06 | 0.812 | 16.376 | 2300 | 3000 | 3000 | — | 20 | 178.72 | 0.875 | 18.250 | 2360 | 3000 | 3000 | — |
| 18 | 160.03 | 0.875 | 16.250 | 2480 | 3000 | 3000 | — | 20 | 190.96 | 0.938 | 18.124 | 2530 | 3000 | 3000 | — |
| 18 | 170.92 | 0.938 | 16.124 | 2660 | 3000 | 3000 | — | 20 | 202.92 | 1.000 | 18.000 | 2700 | 3000 | 3000 | — |
| 18 | 181.56 | 1.000 | 16.000 | 2830 | 3000 | 3000 | — | 20 | 214.80 | 1.062 | 17.876 | 2870 | 3000 | 3000 | — |
| 18 | 192.11 | 1.062 | 15.876 | 3000 | 3000 | 3000 | — | 20 | 226.78 | 1.125 | 17.750 | 3000 | 3000 | 3000 | — |
| 18 | 202.75 | 1.125 | 15.750 | 3000 | 3000 | 3000 | — | 20 | 238.68 | 1.188 | 17.624 | 3000 | 3000 | 3000 | — |
| 18 | 213.31 | 1.188 | 15.624 | 3000 | 3000 | 3000 | — | 20 | 250.31 | 1.250 | 17.500 | 3000 | 3000 | 3000 | — |
| 18 | 223.61 | 1.250 | 15.500 | 3000 | 3000 | 3000 | — | 20 | 261.86 | 1.312 | 17.376 | 3000 | 3000 | 3000 | — |
| | | | | | | | | 20 | 273.51 | 1.375 | 17.250 | 3000 | 3000 | 3000 | — |
| 20 | 46.27 | 0.219 | 19.562 | 590 | 1020 | 1280 | — | | | | | | | | |
| 20 | 52.73 | 0.250 | 19.500 | 680 | 1170 | 1460 | — | 22 | 50.94 | 0.219 | 21.562 | 540 | 930 | 1160 | — |
| 20 | 59.18 | 0.281 | 19.438 | 760 | 1320 | 1640 | — | 22 | 58.07 | 0.250 | 21.500 | 610 | 1060 | 1330 | — |
| 20 | 65.60 | 0.312 | 19.376 | 840 | 1460 | 1830 | — | 22 | 65.18 | 0.281 | 21.438 | 690 | 1200 | 1490 | — |
| 20 | 72.21 | 0.344 | 19.312 | 930 | 1610 | 2010 | — | 22 | 72.27 | 0.312 | 21.376 | 770 | 1330 | 1660 | — |
| 20 | 78.60 | 0.375 | 19.250 | 1010 | 1760 | 2190 | — | 22 | 79.56 | 0.344 | 21.312 | 840 | 1460 | 1830 | — |
| 20 | 84.96 | 0.406 | 19.188 | 1100 | 1900 | 2380 | — | 22 | 86.61 | 0.375 | 21.250 | 920 | 1600 | 1990 | — |
| 20 | 91.51 | 0.438 | 19.124 | 1180 | 2050 | 2560 | — | 22 | 93.63 | 0.406 | 21.188 | 1000 | 1730 | 2160 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal and are given here for information.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered, use the appropriate correction factor from 10.1.

## Table 12—Plain-end Line Pipe Dimensions [a], Weights [b], and Test Pressures (Continued)
## (See Annex F for Metric Tables)

| Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) | | | | Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LC30 | LC52 | LC65 | LC80 | | | | | LC30 | LC52 | LC30 | LC52 |
| 22 | 100.86 | 0.438 | 21.124 | 1080 | 1860 | 2330 | — | 24 | 86.91 | 0.344 | 23.312 | 770 | 1340 | 1680 | — |
| 22 | 107.85 | 0.469 | 21.062 | 1150 | 2000 | 2490 | — | 24 | 94.62 | 0.375 | 23.250 | 840 | 1460 | 1830 | — |
| 22 | 114.81 | 0.500 | 21.000 | 1230 | 2130 | 2660 | — | 24 | 102.31 | 0.406 | 23.188 | 910 | 1580 | 1980 | — |
| 22 | 128.67 | 0.562 | 20.876 | 1380 | 2390 | 2990 | — | 24 | 110.22 | 0.438 | 23.124 | 990 | 1710 | 2140 | — |
| 22 | 142.68 | 0.625 | 20.750 | 1530 | 2660 | 3000 | — | 24 | 117.86 | 0.469 | 23.062 | 1060 | 1830 | 2290 | — |
| 22 | 156.60 | 0.688 | 20.624 | 1690 | 2930 | 3000 | — | 24 | 125.49 | 0.500 | 23.000 | 1130 | 1950 | 2440 | — |
| 22 | 170.21 | 0.750 | 20.500 | 1840 | 3000 | 3000 | — | 24 | 140.68 | 0.562 | 22.876 | 1260 | 2190 | 2740 | — |
| 22 | 183.75 | 0.812 | 20.376 | 1990 | 3000 | 3000 | — | 24 | 156.03 | 0.625 | 22.750 | 1410 | 2440 | 3000 | — |
| 22 | 197.41 | 0.875 | 20.250 | 2150 | 3000 | 3000 | — | 24 | 171.29 | 0.688 | 22.624 | 1550 | 2680 | 3000 | — |
| 22 | 211.00 | 0.938 | 20.124 | 2300 | 3000 | 3000 | — | 24 | 186.23 | 0.750 | 22.500 | 1690 | 2930 | 3000 | — |
| 22 | 224.28 | 1.000 | 20.000 | 2450 | 3000 | 3000 | — | 24 | 201.09 | 0.812 | 22.376 | 1830 | 3000 | 3000 | — |
| 22 | 237.48 | 1.062 | 19.876 | 2610 | 3000 | 3000 | — | 24 | 216.10 | 0.875 | 22.250 | 1970 | 3000 | 3000 | — |
| 22 | 250.81 | 1.125 | 19.750 | 2760 | 3000 | 3000 | — | 24 | 231.03 | 0.938 | 22.124 | 2110 | 3000 | 3000 | — |
| 22 | 264.06 | 1.188 | 19.624 | 2920 | 3000 | 3000 | — | 24 | 245.64 | 1.000 | 22.000 | 2250 | 3000 | 3000 | — |
| 22 | 277.01 | 1.250 | 19.500 | 3000 | 3000 | 3000 | — | 24 | 260.17 | 1.062 | 21.876 | 2390 | 3000 | 3000 | — |
| 22 | 289.88 | 1.312 | 19.376 | 3000 | 3000 | 3000 | — | 24 | 274.84 | 1.125 | 21.750 | 2530 | 3000 | 3000 | — |
| 22 | 302.88 | 1.375 | 19.250 | 3000 | 3000 | 3000 | — | 24 | 289.44 | 1.188 | 21.624 | 2670 | 3000 | 3000 | — |
| 22 | 315.79 | 1.438 | 19.124 | 3000 | 3000 | 3000 | — | 24 | 303.71 | 1.250 | 21.500 | 2810 | 3000 | 3000 | — |
| 22 | 328.41 | 1.500 | 19.000 | 3000 | 3000 | 3000 | — | 24 | 317.91 | 1.312 | 21.376 | 2950 | 3000 | 3000 | — |
| | | | | | | | | 24 | 332.25 | 1.375 | 21.250 | 3000 | 3000 | 3000 | — |
| 24 | 63.41 | 0.250 | 23.500 | 560 | 980 | 1220 | — | 24 | 346.50 | 1.438 | 21.124 | 3000 | 3000 | 3000 | — |
| 24 | 71.18 | 0.281 | 23.438 | 630 | 1100 | 1370 | — | 24 | 360.45 | 1.500 | 21.000 | 3000 | 3000 | 3000 | — |
| 24 | 78.93 | 0.312 | 23.376 | 700 | 1220 | 1520 | — | 24 | 374.31 | 1.562 | 20.876 | 3000 | 3000 | 3000 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal and are given here for information.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered, use the appropriate correction factor from 10.1.

## Table 12—Plain-end Line Pipe Dimensions [a], Weights [b], and Test Pressures (Continued)
## (See Annex F for Metric Tables)

| Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) LC30 | LC52 | LC65 | LC80 | Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) LC30 | LC52 | LC30 | LC52 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 68.75 | 0.250 | 25.500 | 520 | 900 | 1130 | — | 28 | 119.65 | 0.406 | 27.188 | 780 | 1360 | 1700 | — |
| 26 | 77.18 | 0.281 | 25.438 | 580 | 1010 | 1260 | — | 28 | 128.93 | 0.438 | 27.124 | 840 | 1460 | 1830 | — |
| 26 | 85.60 | 0.312 | 25.376 | 650 | 1120 | 1400 | — | 28 | 137.90 | 0.469 | 27.062 | 900 | 1570 | 1960 | — |
| 26 | 94.26 | 0.344 | 25.312 | 710 | 1240 | 1550 | — | 28 | 146.85 | 0.500 | 27.000 | 960 | 1670 | 2090 | — |
| 26 | 102.63 | 0.375 | 25.250 | 780 | 1350 | 1690 | — | 28 | 164.69 | 0.562 | 26.876 | 1080 | 1880 | 2350 | — |
| 26 | 110.98 | 0.406 | 25.188 | 840 | 1460 | 1830 | — | 28 | 182.73 | 0.625 | 26.750 | 1210 | 2090 | 2610 | — |
| 26 | 119.57 | 0.438 | 25.124 | 910 | 1580 | 1970 | — | 28 | 200.68 | 0.688 | 26.624 | 1330 | 2300 | 2870 | — |
| 26 | 127.88 | 0.469 | 25.062 | 970 | 1690 | 2110 | — | 28 | 218.27 | 0.750 | 26.500 | 1450 | 2510 | 3000 | — |
| 26 | 136.17 | 0.500 | 25.000 | 1040 | 1800 | 2250 | — | 28 | 235.78 | 0.812 | 26.376 | 1570 | 2710 | 3000 | — |
| 26 | 152.68 | 0.562 | 24.876 | 1170 | 2020 | 2530 | — | 28 | 253.48 | 0.875 | 26.250 | 1690 | 2930 | 3000 | — |
| 26 | 169.38 | 0.625 | 24.750 | 1300 | 2250 | 2810 | — | 28 | 271.10 | 0.938 | 26.124 | 1810 | 3000 | 3000 | — |
| 26 | 185.99 | 0.688 | 24.624 | 1430 | 2480 | 3000 | — | 28 | 288.36 | 1.000 | 26.000 | 1930 | 3000 | 3000 | — |
| 26 | 202.25 | 0.750 | 24.500 | 1560 | 2700 | 3000 | — | | | | | | | | |
| 26 | 218.43 | 0.812 | 24.376 | 1690 | 2920 | 3000 | — | 30 | 79.43 | 0.250 | 29.500 | 450 | 780 | 980 | — |
| 26 | 234.79 | 0.875 | 24.250 | 1820 | 3000 | 3000 | — | 30 | 89.19 | 0.281 | 29.438 | 510 | 880 | 1100 | — |
| 26 | 251.07 | 0.938 | 24.124 | 1950 | 3000 | 3000 | — | 30 | 98.93 | 0.312 | 29.376 | 560 | 970 | 1220 | — |
| 26 | 267.00 | 1.000 | 24.000 | 2080 | 3000 | 3000 | — | 30 | 108.95 | 0.344 | 29.312 | 620 | 1070 | 1340 | — |
| | | | | | | | | 30 | 118.65 | 0.375 | 29.250 | 680 | 1170 | 1460 | — |
| 28 | 74.09 | 0.250 | 27.500 | 480 | 840 | 1040 | — | 30 | 128.32 | 0.406 | 29.188 | 730 | 1270 | 1580 | — |
| 28 | 83.19 | 0.281 | 27.438 | 540 | 940 | 1170 | — | 30 | 138.29 | 0.438 | 29.124 | 790 | 1370 | 1710 | — |
| 28 | 92.26 | 0.312 | 27.376 | 600 | 1040 | 1300 | — | 30 | 147.92 | 0.469 | 29.062 | 840 | 1460 | 1830 | — |
| 28 | 101.61 | 0.344 | 27.312 | 660 | 1150 | 1440 | — | 30 | 157.53 | 0.500 | 29.000 | 900 | 1560 | 1950 | — |
| 28 | 110.64 | 0.375 | 27.250 | 720 | 1250 | 1570 | — | 30 | 176.69 | 0.562 | 28.876 | 1010 | 1750 | 2190 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal and are given here for information.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered, use the appropriate correction factor from 10.1.

## Table 12—Plain-end Line Pipe Dimensions [a], Weights [b], and Test Pressures (Continued)
## (See Annex F for Metric Tables)

| Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) LC30 | LC52 | LC65 | LC80 | Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) LC30 | LC52 | LC30 | LC52 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 196.08 | 0.625 | 28.750 | 1130 | 1950 | 2440 | — | 32 | 250.31 | 0.750 | 30.500 | 1270 | 2190 | 2740 | — |
| 30 | 215.38 | 0.688 | 28.624 | 1240 | 2150 | 2680 | — | 32 | 270.47 | 0.812 | 30.376 | 1370 | 2380 | 2970 | — |
| 30 | 234.29 | 0.750 | 28.500 | 1350 | 2340 | 2930 | — | 32 | 290.86 | 0.875 | 30.250 | 1480 | 2560 | 3000 | — |
| 30 | 253.12 | 0.812 | 28.376 | 1460 | 2530 | 3000 | — | 32 | 311.17 | 0.938 | 30.124 | 1580 | 2740 | 3000 | — |
| 30 | 272.17 | 0.875 | 28.250 | 1580 | 2730 | 3000 | — | 32 | 331.08 | 1.000 | 30.000 | 1690 | 2930 | 3000 | — |
| 30 | 291.14 | 0.938 | 28.124 | 1690 | 2930 | 3000 | — | 32 | 350.90 | 1.062 | 29.876 | 1790 | 3000 | 3000 | — |
| 30 | 309.72 | 1.000 | 28.000 | 1800 | 3000 | 3000 | — | 32 | 370.96 | 1.125 | 29.750 | 1900 | 3000 | 3000 | — |
| 30 | 328.22 | 1.062 | 27.876 | 1910 | 3000 | 3000 | — | 32 | 390.94 | 1.180 | 29.624 | 2000 | 3000 | 3000 | — |
| 30 | 346.93 | 1.125 | 27.750 | 2030 | 3000 | 3000 | — | 32 | 410.51 | 1.250 | 29.500 | 2110 | 3000 | 3000 | — |
| 30 | 365.56 | 1.188 | 27.624 | 2140 | 3000 | 3000 | — | | | | | | | | |
| 30 | 383.81 | 1.250 | 27.500 | 2250 | 3000 | 3000 | — | 34 | 90.11 | 0.250 | 33.500 | 400 | 690 | 860 | — |
| | | | | | | | | 34 | 101.19 | 0.281 | 33.438 | 450 | 770 | 970 | — |
| 32 | 84.77 | 0.250 | 31.500 | 420 | 730 | 910 | — | 34 | 112.25 | 0.312 | 33.376 | 500 | 860 | 1070 | — |
| 32 | 95.19 | 0.281 | 31.438 | 470 | 820 | 1030 | — | 34 | 123.65 | 0.344 | 33.312 | 550 | 950 | 1180 | — |
| 32 | 105.59 | 0.312 | 31.376 | 530 | 910 | 1140 | — | 34 | 134.67 | 0.375 | 33.250 | 600 | 1030 | 1290 | — |
| 32 | 116.30 | 0.344 | 31.312 | 580 | 1010 | 1260 | — | 34 | 145.67 | 0.406 | 33.188 | 640 | 1120 | 1400 | — |
| 32 | 126.66 | 0.375 | 31.250 | 630 | 1100 | 1370 | — | 34 | 157.00 | 0.438 | 33.124 | 700 | 1210 | 1510 | — |
| 32 | 136.99 | 0.406 | 31.188 | 690 | 1190 | 1480 | — | 34 | 167.95 | 0.469 | 33.062 | 740 | 1290 | 1610 | — |
| 32 | 147.64 | 0.438 | 31.124 | 740 | 1280 | 1600 | — | 34 | 178.89 | 0.500 | 33.000 | 790 | 1380 | 1720 | — |
| 32 | 157.94 | 0.469 | 31.062 | 790 | 1370 | 1710 | — | 34 | 200.70 | 0.562 | 32.876 | 890 | 1550 | 1930 | — |
| 32 | 168.21 | 0.500 | 31.000 | 840 | 1460 | 1830 | — | 34 | 222.78 | 0.625 | 32.750 | 990 | 1720 | 2150 | — |
| 32 | 188.70 | 0.562 | 30.876 | 950 | 1640 | 2050 | — | 34 | 244.77 | 0.688 | 32.624 | 1090 | 1890 | 2370 | — |
| 32 | 209.43 | 0.625 | 30.750 | 1050 | 1830 | 2290 | — | 34 | 266.33 | 0.750 | 32.500 | 1190 | 2060 | 2580 | — |
| 32 | 230.08 | 0.688 | 30.624 | 1160 | 2010 | 2520 | — | 34 | 287.81 | 0.812 | 32.376 | 1290 | 2240 | 2790 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal and are given here for information.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered, use the appropriate correction factor from 10.1.

## Table 12—Plain-end Line Pipe Dimensions [a], Weights [b], and Test Pressures (Continued)
## (See Annex F for Metric Tables)

| Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) LC30 | LC52 | LC65 | LC80 | Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) LC30 | LC52 | LC30 | LC52 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | 309.55 | 0.875 | 32.250 | 1390 | 2410 | 3000 | — | 36 | 351.25 | 0.938 | 34.124 | 1410 | 2440 | 3000 | — |
| 34 | 331.21 | 0.938 | 32.124 | 1490 | 2580 | 3000 | — | 36 | 373.80 | 1.000 | 34.000 | 1500 | 2600 | 3000 | — |
| 34 | 352.44 | 1.000 | 32.000 | 1590 | 2750 | 3000 | — | 36 | 396.27 | 1.062 | 33.876 | 1590 | 2760 | 3000 | — |
| 34 | 373.59 | 1.062 | 31.876 | 1690 | 2920 | 3000 | — | 36 | 419.02 | 1.125 | 33.750 | 1690 | 2930 | 3000 | — |
| 34 | 394.99 | 1.125 | 31.750 | 1790 | 3000 | 3000 | — | 36 | 441.69 | 1.188 | 33.624 | 1780 | 3000 | 3000 | — |
| 34 | 416.31 | 1.188 | 31.624 | 1890 | 3000 | 3000 | — | 36 | 463.91 | 1.250 | 33.500 | 1880 | 3000 | 3000 | — |
| 34 | 437.21 | 1.250 | 31.500 | 1990 | 3000 | 3000 | — | | | | | | | | |
| | | | | | | | | 38 | 125.58 | 0.312 | 37.376 | 440 | 770 | 960 | — |
| 36 | 95.45 | 0.250 | 35.500 | 380 | 650 | 810 | — | 38 | 138.35 | 0.344 | 37.312 | 490 | 850 | 1060 | — |
| 36 | 107.20 | 0.281 | 35.438 | 420 | 730 | 910 | — | 38 | 150.69 | 0.375 | 37.250 | 530 | 920 | 1150 | — |
| 36 | 118.92 | 0.312 | 35.376 | 470 | 810 | 1010 | — | 38 | 163.01 | 0.406 | 37.188 | 580 | 1000 | 1250 | — |
| 36 | 131.00 | 0.344 | 35.312 | 520 | 890 | 1120 | — | 38 | 175.71 | 0.438 | 37.124 | 620 | 1080 | 1350 | — |
| 36 | 142.68 | 0.375 | 35.250 | 560 | 980 | 1220 | — | 38 | 187.99 | 0.469 | 37.062 | 670 | 1160 | 1440 | — |
| 36 | 154.34 | 0.406 | 35.188 | 610 | 1060 | 1320 | — | 38 | 200.25 | 0.500 | 37.000 | 710 | 1230 | 1540 | — |
| 36 | 166.35 | 0.438 | 35.124 | 660 | 1140 | 1420 | — | 38 | 224.71 | 0.562 | 36.876 | 800 | 1380 | 1730 | — |
| 36 | 177.97 | 0.469 | 35.062 | 700 | 1220 | 1520 | — | 38 | 249.48 | 0.625 | 36.750 | 890 | 1540 | 1920 | — |
| 36 | 189.57 | 0.500 | 35.000 | 750 | 1300 | 1630 | — | 38 | 274.16 | 0.688 | 36.624 | 980 | 1690 | 2120 | — |
| 36 | 212.70 | 0.562 | 34.876 | 840 | 1460 | 1830 | — | 38 | 298.37 | 0.750 | 36.500 | 1070 | 1850 | 2310 | — |
| 36 | 236.13 | 0.625 | 34.750 | 940 | 1630 | 2030 | — | 38 | 322.50 | 0.812 | 36.376 | 1150 | 2000 | 2500 | — |
| 36 | 259.47 | 0.688 | 34.624 | 1030 | 1790 | 2240 | — | 38 | 346.93 | 0.875 | 36.250 | 1240 | 2160 | 2690 | — |
| 36 | 282.35 | 0.750 | 34.500 | 1130 | 1950 | 2440 | — | 38 | 371.28 | 0.938 | 36.124 | 1330 | 2310 | 2890 | — |
| 36 | 305.16 | 0.812 | 34.376 | 1220 | 2110 | 2640 | — | 38 | 395.16 | 1.000 | 36.000 | 1420 | 2460 | 3000 | — |
| 36 | 328.24 | 0.875 | 34.250 | 1310 | 2280 | 2840 | — | 38 | 418.96 | 1.062 | 35.876 | 1510 | 2620 | 3000 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal and are given here for information.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered, use the appropriate correction factor from 10.1.

## Table 12—Plain-end Line Pipe Dimensions [a], Weights [b], and Test Pressures (Continued)
## (See Annex F for Metric Tables)

| Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) | | | | Size: Outside Dia. (in.) $D$ | Weight (lb/ft) $w_{pe}$ | Wall Thick (in.) $t$ | Inside Dia. (in.) $d$ | Test Pressures (psi, min.) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LC30 | LC52 | LC65 | LC80 | | | | | LC30 | LC52 | LC30 | LC52 |
| 38 | 443.05 | 1.125 | 35.750 | 1600 | 2770 | 3000 | — | 40 | 492.44 | 1.188 | 37.624 | 1600 | 2780 | 3000 | — |
| 38 | 467.06 | 1.188 | 35.624 | 1690 | 2930 | 3000 | — | 40 | 517.31 | 1.250 | 37.500 | 1690 | 2930 | 3000 | — |
| 38 | 490.61 | 1.250 | 35.500 | 1780 | 3000 | 3000 | — | | | | | | | | |
| | | | | | | | | 42 | 153.04 | 0.344 | 41.312 | 440 | 770 | 960 | — |
| 40 | 132.25 | 0.312 | 39.376 | 420 | 730 | 910 | — | 42 | 166.71 | 0.375 | 41.250 | 480 | 840 | 1040 | — |
| 40 | 145.69 | 0.344 | 39.312 | 460 | 800 | 1010 | — | 42 | 180.35 | 0.406 | 41.188 | 520 | 900 | 1130 | — |
| 40 | 158.70 | 0.375 | 39.250 | 510 | 880 | 1100 | — | 42 | 194.42 | 0.438 | 41.124 | 560 | 980 | 1220 | — |
| 40 | 171.68 | 0.406 | 39.188 | 550 | 950 | 1190 | — | 42 | 208.03 | 0.469 | 41.062 | 600 | 1050 | 1310 | — |
| 40 | 185.06 | 0.438 | 39.124 | 590 | 1020 | 1280 | — | 42 | 221.61 | 0.500 | 41.000 | 640 | 1110 | 1390 | — |
| 40 | 198.01 | 0.469 | 39.062 | 630 | 1100 | 1370 | — | 42 | 248.72 | 0.562 | 40.876 | 720 | 1250 | 1570 | — |
| 40 | 210.93 | 0.500 | 39.000 | 680 | 1170 | 1460 | — | 42 | 276.18 | 0.625 | 40.750 | 800 | 1390 | 1740 | — |
| 40 | 236.71 | 0.562 | 38.876 | 760 | 1320 | 1640 | — | 42 | 303.55 | 0.688 | 40.624 | 880 | 1530 | 1920 | — |
| 40 | 262.83 | 0.625 | 38.750 | 840 | 1460 | 1830 | — | 42 | 330.41 | 0.750 | 40.500 | 960 | 1670 | 2090 | — |
| 40 | 288.86 | 0.688 | 38.624 | 930 | 1610 | 2010 | — | 42 | 357.19 | 0.812 | 40.376 | 1040 | 1810 | 2260 | — |
| 40 | 314.39 | 0.750 | 38.500 | 1010 | 1760 | 2190 | — | 42 | 384.31 | 0.875 | 40.250 | 1130 | 1950 | 2440 | — |
| 40 | 339.84 | 0.812 | 38.376 | 1100 | 1900 | 2380 | — | 42 | 411.35 | 0.938 | 40.124 | 1210 | 2090 | 2610 | — |
| 40 | 365.62 | 0.875 | 38.250 | 1180 | 2050 | 2560 | — | 42 | 437.88 | 1.000 | 40.000 | 1290 | 2230 | 2790 | — |
| 40 | 391.32 | 0.938 | 38.124 | 1270 | 2190 | 2740 | — | 42 | 464.33 | 1.062 | 39.876 | 1370 | 2370 | 2960 | — |
| 40 | 416.52 | 1.000 | 38.000 | 1350 | 2340 | 2930 | — | 42 | 491.11 | 1.125 | 39.750 | 1450 | 2510 | 3000 | — |
| 40 | 441.64 | 1.062 | 37.876 | 1430 | 2490 | 3000 | — | 42 | 517.82 | 1.188 | 39.624 | 1530 | 2650 | 3000 | — |
| 40 | 467.08 | 1.125 | 37.750 | 1520 | 2630 | 3000 | — | 42 | 544.01 | 1.250 | 39.500 | 1610 | 2790 | 3000 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal and are given here for information.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered, use the appropriate correction factor from 10.1.

**Table 13—Test Pressure for Size Ranges in All Grades [a b c]**

| Grade | Percent of Specified Minimum Yield Strength | |
|---|---|---|
| | **Size** (in.) | **Standard Test Pressure** (psi) |
| All Grades | $2^{3}/_{8}$ to $8^{5}/_{8}$ inclusive | 75 |
| | | |
| All Grades | $10^{3}/_{4}$ to 18 inclusive | 85 |
| All Grades | 20 and larger | 90 |

[a] Test pressures for other sizes established arbitrarily.

[b] Test pressures were limited to 2500 psi (19,300 kPa) for sizes larger than $3^{1}/_{2}$ in. Test pressures for other sizes established arbitrarily.

[c] Test pressures for grade LC65, LC30, LC52, and LC80 were limited to 3000 psi (20,700 kPa) to accommodate hydrostatic tester limitations.

### 9.4 Supplementary Hydrostatic Tests

In all supplementary hydrostatic tests, the formula shown in 9.3 shall be used for stress calculations. The conditions of the test shall be as agreed upon. By agreement between the purchaser and the manufacturer, for Grades LC30, LC52, LC65, and LC80, the manufacturer shall make additional internal pressure tests, which may involve one or more of the following methods.

a) Hydrostatic destructive tests in which the minimum length of the specimen is ten times the outside diameter of the pipe, but need not exceed 40 ft (12.19 m).

b) Full-length destructive tests made by the “hydrostatic pressure water column” method.

Hydrostatic transverse yield strength tests using accurate strain gauges [7]

## 10 Dimensions, Weights, and Lengths

### 10.1 Dimensions and Weights

Line pipe shall be furnished in the sizes, wall thicknesses, and weights provided in Table 12 and 10.2 and 10.3 as specified on the purchase order. The accuracy of all measuring instruments, except ring and plug thread gauges, used for acceptance/rejection shall be verified at least once every operating shift. Accuracy verification of rules, length measuring tapes, and other nonadjustable measuring devices shall be defined as a visual check of marking’s legibility and the general wear of fixed reference points. The verification procedure of these working gauges shall be documented. The adjustable and nonadjustable designation utilized by the manufacturer shall be documented.

If measuring equipment, whose calibration or verification is required under the provisions of the specification, is subject to unusual or severe conditions such as would make its accuracy questionable, recalibration or reverification shall be performed before further use of the equipment.

The correction factor for grades not listed in Table 4 shall be subject to agreement between the purchaser and manufacturer.

[7] Acceptable gauges are the roller-chain ring-expansion gauge, the SR-4 strain gauge, or other suitable gauges of similar accuracy.

The plain-end weight, $w_{pe}$ shall be calculated using Equations (9) and (10).

In U.S. Customary (USC) units:

$$w_{pe} = 10.68(D - t)(t)(F) \quad (9)$$

In m units:

$$w_{pe} = 0.02466(D - t)(t)(F) \quad (10)$$

where

$w_{pe}$ is the plain-end weight, rounded to the nearest 0.01 lb/ft (0.01 kg/m);

$D$ is the outside diameter, rounded to the nearest 0.001 in (0.1 mm for sizes less than 457 mm, and 1 mm for sizes 457 mm and larger);

$t$ is the specified wall thickness, rounded to the nearest 0.001 in. (0.1 mm);

$F$ is the correction factor (see Table 14).

**Table 14—Correction Factors**

| Grade | *F* |
|---|---|
| LC 30-1812 | 1.017 |
| LC 52-1200 | 0.990 |
| LC 65-2205 | 0.995 |
| LC 65-2506 | 0.995 |
| LC 80-2507 | 1.000 |
| LC 30-2242 | 1.038 |

## 10.2 Diameter

The outside diameter shall be within the tolerances specified in Table 15. (Inside diameters are governed by the outside diameter and weight tolerances.) Pipe with outside diameters intermediate to those listed in Table 12 is available by agreement between the purchaser and the manufacturer. Such pipe shall be consistent with all requirements of this specification and shall be marked in accordance with Section 13 and Annex A, using the specified outside diameter for the size designation.

## 10.3 Wall Thickness

Each length of pipe shall be measured for conformance to wall-thickness requirements. The wall thickness at any place shall be within the tolerances specified in Table 15, 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 nondestructive inspection device of appropriate accuracy. In case of dispute, the measurement determined by use of the mechanical caliper shall govern. The mechanical caliper shall be fitted with contact pins having circular cross-sections of $^1/_4$ in. (6.35 mm) diameter. The end of the pin contacting the inside surface of the pipe shall be rounded to a maximum radius of $1^1/_2$ in. (38.10 mm) for pipe $6^5/_8$ in. and larger, a maximum radius of $d/4$ for pipe less than $6^5/_8$ in., with a minimum radius of $^1/_8$ in. 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. (38.10 mm). Pipe with wall

thicknesses intermediate to those listed in Table 12 is available by agreement between the purchaser and manufacturer. Such pipe shall be consistent with all requirements of this specification and shall be marked in accordance with Section 13.

## 10.4 Weight

Each length of pipe $5^{9}/_{16}$ in. and larger shall be weighed separately, and the carload weights determined. Lengths of pipe $4^{1}/_{2}$ in. and smaller shall be weighed either individually or in convenient lots, at the option of the manufacturer, and the carload weights determined. A carload is considered to be a minimum of 40,000 lb. (18,144 kg).

The weights determined as described above shall conform to the specified weights or calculated weights for plain-end pipe.

Calculated weights shall be determined in accordance with Equation (11) below:

$$W_{\mathrm{L}} = \left(w_{\mathrm{pe}} \times L\right) + e_{\mathrm{w}} \tag{11}$$

where

$e_{\mathrm{w}}$ is the weight of coupling less weight removed in threading two pipe ends;

$W_{\mathrm{L}}$ is the calculated weight of a piece of pipe of length $L$, lb (kg);

$w_{\mathrm{pe}}$ is the plain-end weight, lb/ft (kg/m);

$L$ is the length of pipe, including end finish, as defined in 10.5, ft (m).

## 10.5 Length

Unless otherwise agreed upon between the purchaser and the manufacturer, pipe shall be furnished in the lengths and tolerances shown in Table 16, as specified on the purchase order. The accuracy of length measuring devices for lengths of pipe less than 100 ft (30 m) shall be ±0.1ft (0.03 m).

## 10.6 Straightness

Pipe shall be reasonably straight. All pipe shall be randomly checked for straightness and deviation from a straight line shall not exceed 0.2 % the length. Measurements may be made using a taut string or wire from end-to-end along the side of the pipe measuring the greatest deviation.

## 10.7 Jointers

Unless otherwise specified on the purchase order, jointers (two or more pieces of pipe welded together to make a standard length) may be furnished. No lengths used in making a jointer shall be less than 5 ft (1.5 m). Details of procedures and tests required for furnishing such jointers shall be by agreement between the purchaser and the manufacturer.

**Table 15—Tolerance on Dimensions and Weights**

| Outside Diameter | | Out-of-Roundness |
|---|---|---|
| **Pipe Body** | | For pipe larger than 20 in. and for a distance of 4 in. (101.6 mm) from the ends of the pipe, the maximum outside diameter shall not be more than 1 % larger than specified, and the minimum outside diameter shall not be more than 1 % smaller than specified, measured with a bar gauge, caliper, or other device capable of measuring the actual minimum and maximum diameters. |
| 1.900 in. and smaller | +0.016 in. (0.41 mm)<br>–0.031 in. (0.79 mm) | **Wall Thickness** |
| $2^3/_8$ in. through 18 in. | ±0.75 % | |
| 20 in. through 36 in. | ±1.00 % | |
| Larger than 36 in. | ±1.00 % | |
| NOTE In the case of pipe hydrostatically tested to pressures in excess of standard test pressures, other tolerances may be agreed upon between the manufacturer and purchaser. | | |
| For pipe $4^1/_2$ in. OD and larger, the outside diameter measurements on the body of the pipe shall be made at the mill with a diameter tape on a random basis, but not less than three measurements per 8 hour working shift. | | |
| **Pipe Ends** | | |
| Pipe $10^3/_4$ in. and smaller shall not be more than $^1/_{64}$ in. (0.40 mm) smaller than the specified outside diameter for a distance of 4 in. (101.6 mm) from the end of the pipe and shall permit the passage over the ends, for a distance of 4 in. (101.6 mm), of a ring gauge which has a bore $^1/_{16}$ in. (1.59 mm) larger than the specified outside diameter of the pipe. Pipe $12^3/_4$ in. to 20 in., inclusive, shall not be more than $^1/_{32}$ in. (0.79 mm) smaller than the specified outside diameter for a distance of 4 in. (101.6 mm) from the end of the pipe and shall permit passage over the ends, for a distance of 4 in. (101.6 mm), of a ring gauge which has a bore $^3/_{32}$ in. (2.38 mm) larger than the specified outside diameter of the pipe. For SAW line pipe, it is permissible to notch or slot the ring gauge to permit passage of the gauge over the weld bead. At the option of the manufacturer, the minimum outside diameter of pipe in sizes 20 in. and smaller may be measured with a diameter tape. Pipe larger than 20 in. shall not be more than $^1/_{32}$ in. (0.79 mm) smaller nor more than $^3/_{32}$ in. (2.38 mm) larger than the specified outside diameter for a distance of 4 in. (101.6 mm) from the end of the pipe, as measured with a diameter tape. | | |
| By agreement between the purchaser and the manufacturer, the tolerance on outside diameter at the ends may be applied instead to the inside diameter at the ends. | | |

| Size (OD in.) and Process | Tolerance (%) All Grades |
|---|---|
| 2.875 and smaller (seamless & welded) | +15.0, −12.5 |
| 3.50 (seamless & welded) | +15.0, −12.5 |
| 4.00 through 18 (seamless & welded) | +15.0, −12.5 |
| 20 and larger (welded) | +19.5, −8.0 |
| 20 and larger (seamless) | +17.5, −10.0 |
| **Weight** | |
| Single lengths (all Grades) | +10.0, −3.5 |
| Carload lots (all Grades) | −1.75 |

A carload is considered to be a minimum of 40,000 lb (18,144 kg).

When a wall thickness minus tolerance less than that shown above is agreed upon between the purchaser and the manufacturer, the plus tolerance shall be increased by an amount (percentage) equal to the decrease in minus tolerance, and the plus weight tolerance shall be increased to 22.5 % less the wall thickness minus tolerance.

Weight tolerances apply to the calculated weights.

**Table 16—Tolerances on Lengths [a]**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| | **Shortest Length in Entire Shipment** | **Shortest Length in 95 % of Entire Shipment** | **Shortest Length in 90 % of Entire Shipment** | **Minimum Average Length Entire Shipment** |
| Plain-end pipe | | | | |
| Single random lengths | 9.0 ft (2.74 mm) | — | — | 17.5 ft (5.33 m) |
| Double random lengths | 14.0 ft (4.27 mm) | — | 26.3 ft (8.00 m) | 35.0 ft (10.67 m) |
| As agreed upon lengths in excess of 20 ft (6.10 mm) | 40 % of average agreed upon | — | 75 % of average agreed upon | |

[a] By agreement between the purchaser and the manufacturer, these tolerances shall apply to each carload.

## 10.8 Pipe Ends

Unless otherwise ordered, plain-end pipe (other than double-extra-strong pipe) in sizes $2^3/_8$ in. and larger shall be furnished with ends beveled to an angle of 30°, +5°, −0°, measured from a line drawn perpendicular to the axis of the pipe, and with a root face of $^1/_{16}$ in. $\pm^1/_{32}$ in. (1.59 ± 0.79 mm). Double-extra-strong plain-end pipe $2^3/_8$in. OD and larger shall be furnished with square-cut ends, unless beveled ends (as above) are specified on the purchase order. For seamless pipe where internal machining is required to maintain the root face tolerance, the angle of the internal taper, measured from the longitudinal axis, shall be no larger than that listed below in Table 17.

**Table 17—Taper Angle**

| **Specified Wall Thickness** (in.) | **Maximum Angle of Taper** (deg) |
|---|---|
| Less than 0.418 (10.6 mm) | 7 |
| 0.418 thru 0.555 (10.6 through 14.1 mm) | $9^1/_2$ |
| 0.556 thru 0.666 (14.1 through 16.9 mm) | 11 |
| Over 0.666 (16.9 mm) | 14 |

For the removal of an internal burr on welded pipe larger than $4^1/_2$ in. OD, the internal taper, measured from the longitudinal axis, shall be no larger than 7°.

The end finish of pipe smaller than $2^3/_8$ in. OD shall be specified on the purchase order. For pipe $2^3/_8$ in. OD and larger, the pipe ends shall be cut square within $^1/_{16}$ in. (1.59 mm). Pipe ends from each end-finishing machine shall be checked for compliance at least three times per 8 hour working shift.

Both ends of pipe with filler-metal welds shall have the inside reinforcement removed for a distance of approximately 4 in. (101.6 mm) from the end of the pipe.

NOTE The purchaser is directed to the applicable code for the recommended angle of pipe bevel.

# 11 Nondestructive Inspection

## 11.1 Inspection Methods for Welded Pipe

The location of equipment at the manufacturer's facility shall be at the discretion of the manufacturer; however, the nondestructive inspection shall take place after all heat-treating and expansion operations, if performed, but may take place before cropping and beveling. The weld seam of welded pipe shall be inspected full length (100 %) in accordance with methods specified below.

a) Welded pipe except electric-welded pipe shall be inspected full length by radiological methods in accordance with 11.4 through 11.14 or by ultrasonic or electromagnetic methods in accordance with 11.15. For pipe larger than $6^5/_8$ in. OD, eddy-current method shall not be used.

b) Electric-welded pipe shall be inspected by ultrasonic or electromagnetic methods in accordance with 11.15. For pipe larger than $6^5/_8$ in. OD, eddy-current method shall not be used.

## 11.2 Inspection Methods for Seamless Pipe

Seamless pipe shall be inspected full length for longitudinal defects by ultrasonic or electromagnetic methods in accordance with 11.16. Eddy-current method shall not be used for pipe larger than $6^5/_8$ in. OD. The location of the equipment shall be at the discretion of the manufacturer; however, the nondestructive inspection shall take place after all heat-treating and expansion operations, if performed, but may take place before cropping, beveling, and end sizing.

## 11.3 Inspection Methods for Centrifugally Cast Pipe

Centrifugally cast pipe shall be inspected full length for defects by ultrasonic methods, in accordance with 11.17. The location of the equipment shall be at the discretion of the manufacturer; however, the nondestructive inspection shall take place after all heat-treating and expansion operations, if performed, but may take place before cropping, beveling, and end sizing.

## 11.4 Radiological Inspection Equipment

The homogeneity of weld seams examined by radiological methods shall be determined by means of X-rays directed through the weld onto a suitable radiographic film or fluorescent screen. A television screen may be used, provided that adequate sensitivity can be obtained.

## 11.5 Fluoroscopic Operator Qualification

Operators of fluoroscopic equipment shall be trained, tested, and certified by the manufacturer.

Details of such training, testing, and certification programs shall be available to the purchaser. Included in this program shall be the following:

a) classroom instructions in the fundamentals of radiological inspection techniques,

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

c) knowledge of appropriate requirements of this specification,

d) an eye examination at least once per year to determine the operator's optical capability to perform the required inspection, and

e) upon completion of Items a), b), and c) above, an examination shall be given by the manufacturer to determine if the operator is qualified to properly perform fluoroscopic examinations.

## 11.6 Operator Certification

Certified operators whose work has not included fluoroscopic inspection for a period of one year or more shall be recertified by successfully completing the examination of 11.5 e) and also passing the eye examination of 11.5 d). Substantial changes in procedure or equipment shall require recertification of the operators.

## 11.7 Reference Standard

Unless otherwise specified, the reference standard shall be the ISO Wire Penetrameter described in 11.8. By agreement between purchaser and manufacturer, other standard penetrameters may be used.

## 11.8 ISO Wire Penetrameter

The ISO Wire Penetrameter shall be 2 % of wall thickness and either Fe 6/12 or Fe 10/16, in accordance with Table 18 for the appropriate wall thickness.

When the wire penetrameter is placed across the weld, the diameter of the wire employed shall be based on the specified wall thickness plus the estimated thickness of the weld reinforcement (not to exceed the maximum allowed) at the penetrameter location. When the penetrameter is placed on the base metal, the diameter of the wire employed shall be based on the specified wall thickness.

**Table 18—ISO Wire Penetrameter (Sensitivity 2 %)**

| Wire No. | Wire Diameter | | Wall Thickness | |
|---|---|---|---|---|
| | mm | in. | in. | mm |
| Fe 6/12 | | | | |
| 6 | (1.00) | 0.040 | 2.000 | (50.8) |
| 7 | (0.80) | 0.032 | 1.600 | (40.6) |
| 8 | (0.63) | 0.025 | 1.250 | (31.8) |
| 9 | (0.50) | 0.020 | 1.000 | (25.4) |
| 10 | (0.40) | 0.016 | 0.800 | (20.3) |
| 11 | (0.32) | 0.013 | 0.650 | (15.9) |
| 12 | (0.25) | 0.010 | 0.500 | (12.7) |
| Fe 10/16 | | | | |
| 10 | (0.40) | 0.016 | 0.800 | (20.3) |
| 11 | (0.32) | 0.013 | 0.650 | (15.9) |
| 12 | (0.25) | 0.010 | 0.500 | (12.7) |
| 13 | (0.20) | 0.008 | 0.400 | (10.2) |
| 14 | (0.16) | 0.006 | 0.325 | (8.3) |
| 15 | (0.13) | 0.005 | 0.250 | (6.4) |
| 16 | (0.10) | 0.004 | 0.200 | (5.1) |
| NOTE Should always use penetrameter with wall-equivalent wire near center. | | | | |

## 11.9 Frequency

The penetrameter shall be used to check the sensitivity and adequacy of the radiological technique on each length of pipe, when the fluoroscopic method is used full length, and on each film when film is used. Each length of pipe shall be held in a stationary position during the adjustment of the radiological technique by use of the penetrameter. Proper definition and sensitivity is attained when individual wires of the ISO penetrameter are clearly discernible.

## 11.10 Procedure for Evaluating In-Motion Operation of the Fluoroscope

To evaluate the definition of defects at operational speeds, a pipe section having a minimum wall of 0.375 in. (9.5 mm) shall be used. Series of $^{1}/_{32}$ in. (0.79 mm) holes, as shown in Example 6, Figure 8, shall be drilled into the center of the weld to a depth of 30 % of the total thickness. At least four such series shall be used, spaced 1 ft apart. As an alternate to the use of the pipe section described above, a penetrameter as described in 11.8 may be used at the option of the manufacturer. The speed of operation shall be adjusted so that the holes in the pipe section, or at least the wire in the ISO penetrameter requested for the nominal wall thickness, are clearly visible to the operator.

## 11.11 Acceptance Limits

Radiological examination shall be capable of detecting weld imperfections and defects as described in 11.12 and 11.13.

## 11.12 Imperfections

The maximum acceptable size and distribution of slag inclusion and/or gas pocket discontinuities are shown in Tables 19 and 20, and Figures 8 and 9.

NOTE Unless the discontinuities are elongated, it cannot be determined with assurance whether the radiological indications represent slag inclusions or gas pockets. Therefore, the same limits apply to all circular-type discontinuities.

The important factors to be considered in determining rejection or acceptance limits are size and spacing of discontinuities and the sum of the diameters in an established distance. For simplicity, the distance is established as any 6 in. (152.4 mm) length. Discontinuities of this type usually occur in an aligned pattern; but no distinction is made between aligned or scattered patterns. Also, the distribution pattern may be of assorted sizes.

## 11.13 Defects

Cracks, lack of complete penetration, or lack of complete fusion, and discontinuities greater in size and/or distribution than shown in Tables 19 and 20, and Figures 8 and 9, as indicated by radiological examination shall be considered defects.

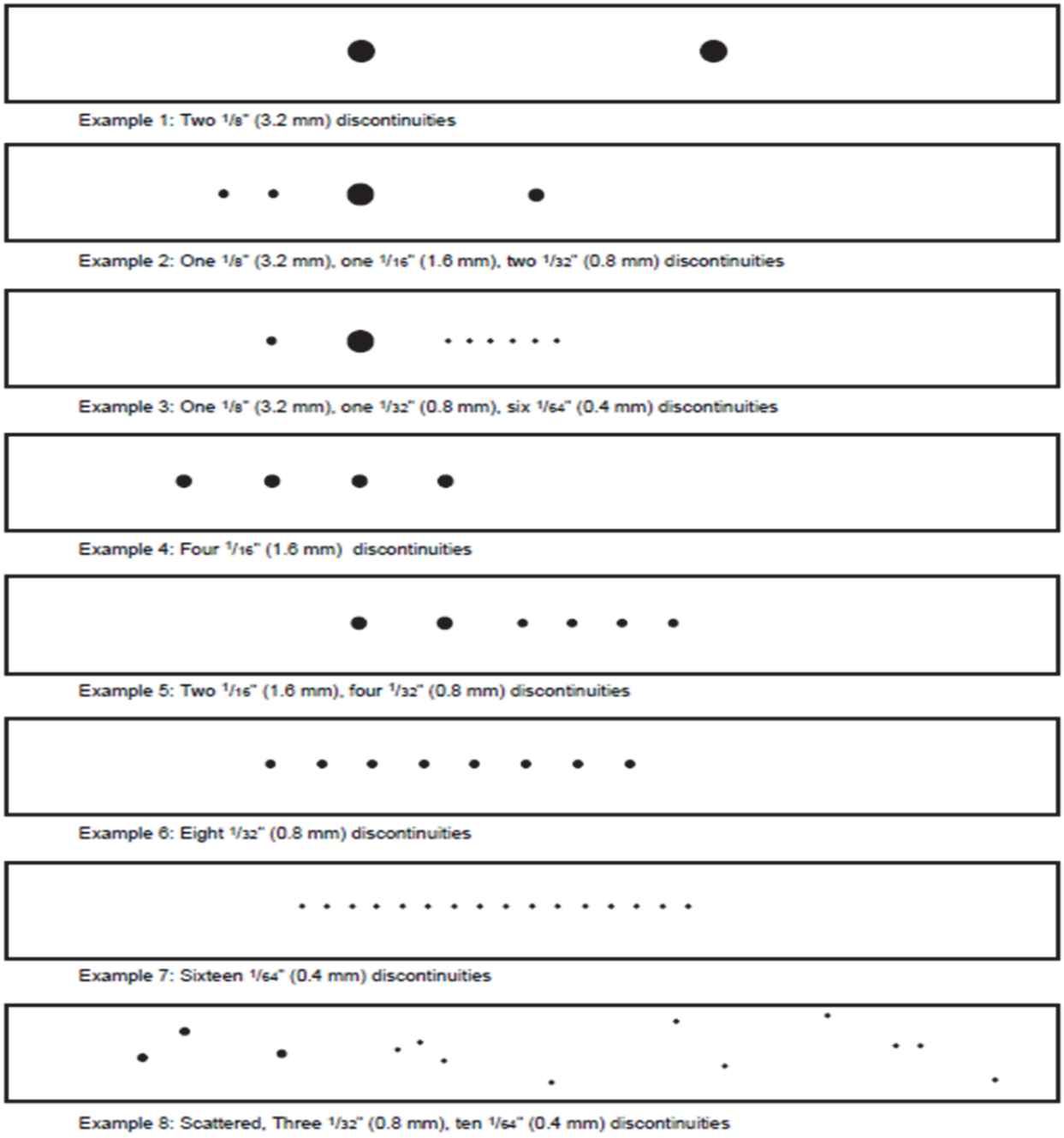



**Figure 8—Examples of Maximum Distribution Patterns of Indicated Circular Slag-inclusion- and Gas-pocket-type Discontinuities**

**Table 19—Elongated Slag-inclusion-type Discontinuities [a] (See Figure 9)**

| 1 | | 2 | | 3 |
|---|---|---|---|---|
| **Maximum Dimensions** | | **Minimum Separation** | | **Maximum Number in Any** |
| in. | mm | in. | mm | 6 in. (152.4 mm) |
| $^1/_{16} \times ^1/_2$ | (1.6 × 12.7) | 6 | (152.4) | 1 |
| $^1/_{16} \times ^1/_4$ | (1.6 × 6.4) | 3 | (76.2) | 2 |
| $^1/_{16} \times ^1/_8$ | (1.6 × 3.2) | 2 | (50.8) | 3 |

[a] Maximum accumulated length of discontinuities in any 6 in. (152.4 mm) shall not exceed $^1/_2$ in. (12.7 mm).

**Table 20—Circular Slag-inclusion- and Gas-pocket-type Discontinuities [a] (See Figure 9)**

| 1 | | 3 | | 4 |
|---|---|---|---|---|
| **Size** | | **Minimum Separation** | | **Maximum Number in Any** |
| in. | mm | in. | mm | 6 in. (152.4 mm) |
| $^1/_8$ [b] | (3.2) | 2 | (50.8) | 2 |
| $^1/_8$ [b] | (3.2) | 1 | (25.4) | Varies |
| $^1/_8$ [b] | (3.2) | $^1/_2$ | (12.7) | Varies |
| $^1/_8$ [b] | (3.2) | $^3/_8$ | (9.5) | Varies |
| $^1/_{16}$ | (1.6) | $^1/_2$ | (12.7) | 4 |
| $^1/_{16}$ | (1.6) | $^3/_8$ | (9.5) | Varies |
| $^1/_{16}$ | (1.6) | $^1/_4$ | (6.4) | Varies |
| $^1/_{32}$ | (0.8) | $^1/_4$ [c] | (6.4) | 8 |
| $^1/_{32}$ | (0.8) | $^3/_{16}$ | (4.8) | Varies |
| $^1/_{64}$ | (0.4) | $^1/_8$ | (3.2) | 16 |

[a] The sum of the diameters of all discontinuities in any 6 in. (152.4 mm) not to exceed $^1/_4$ in. (6.4 mm).

[b] Maximum size discontinuity for 0.250 in. (6.4 mm) wall and lighter shall be $^3/_{32}$ in. (2.4 mm).

[c] Two discontinuities, $^1/_{32}$ in. (0.8 mm) or smaller, may be as close as one diameter apart provided they are separated from any other discontinuity by at least $^1/_2$ in. (12.7 mm).

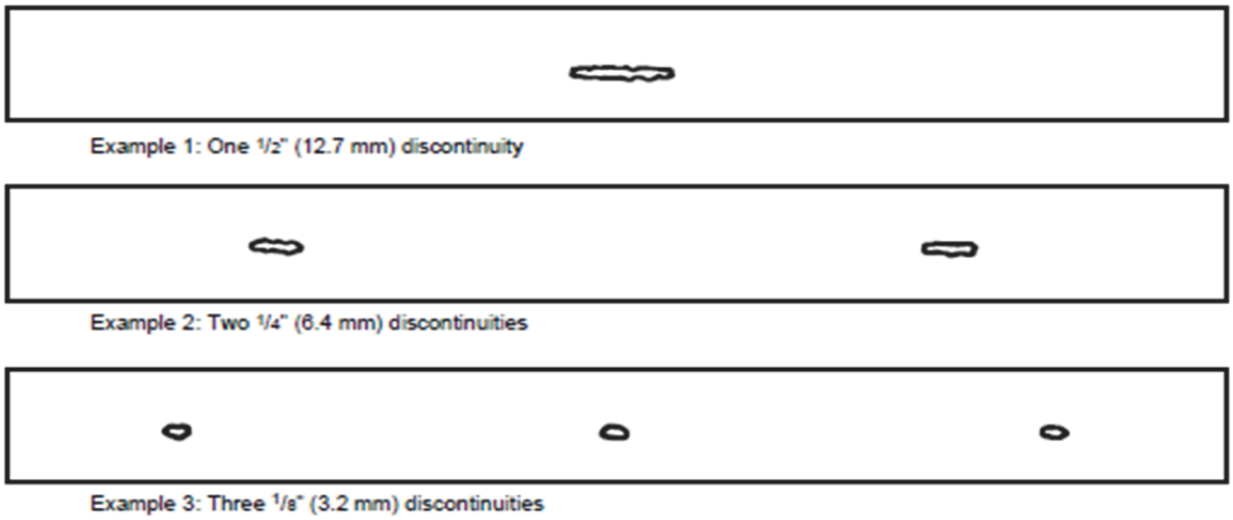



**Figure 9—Examples of Maximum Distribution Patterns of Indicated Elongated Slag-inclusion-type Discontinuities**

## 11.14 Weld Repair

Any weld rejected as a result of radiological examination may be repaired at the option of the manufacturer and, if repaired by welding, shall be done in accordance with 11.10 and shall be reexamined radiologically.

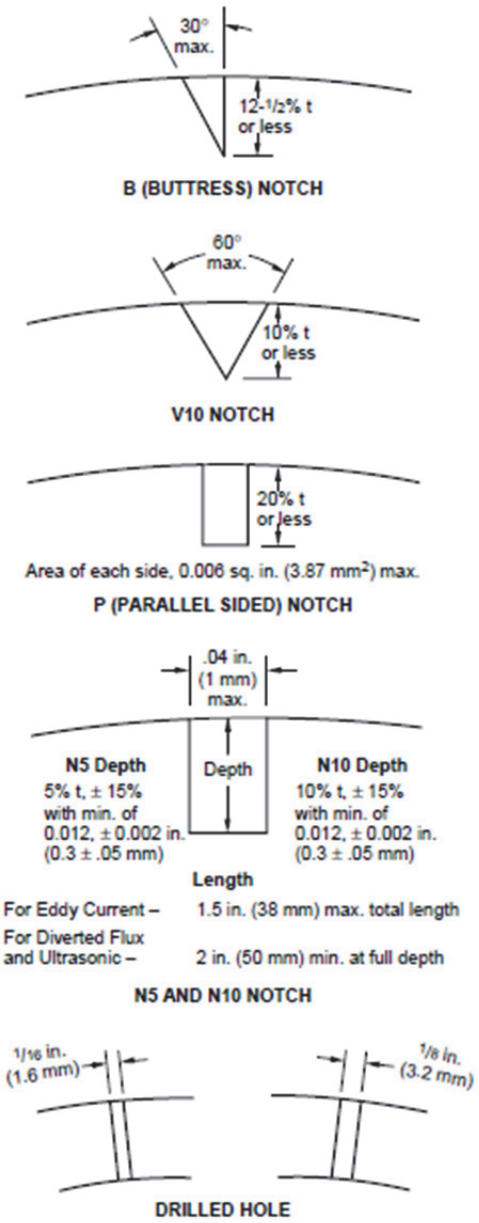
## 11.15 Ultrasonic and Electromagnetic Inspection of Welded Pipe

Listed below is information regarding ultrasonic and electromagnetic inspection of seamless pipe that is in accordance with this specification.

a) *Equipment*. Any equipment utilizing the ultrasonic or electromagnetic principles and capable of continuous and uninterrupted inspection of the weld seam shall be used. For welds except electric-weld, pipe ends within 4 in. (100 mm) may be inspected radiologically in accordance with 11.4 through 11.14. The equipment shall be checked with an applicable reference standard as described in Item b) below at least once every 8 hour working shift to demonstrate its effectiveness and the inspection procedures. The equipment shall be adjusted to produce well-defined indications when the reference standard used by the manufacturer is scanned by the inspection unit in a manner simulating the inspection of the product, and shall be capable of inspecting $^{1}/_{8}$ in. (3.2 mm) on either side of the weld line for the entire wall thickness.

b) *Reference Standards*. Reference standards shall have the same specified diameter and thickness as the product being inspected and may be of any convenient length as determined by the manufacturer. Reference standards shall contain machined notches on the inside surface and on the outside surface, or a drilled hole as shown in Figure 10, 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 separate and distinguishable signals. The $^{1}/_{8}$ in. (3.2 mm) hole shall be drilled through the wall and perpendicular to the surface of the reference standard as shown in Figure 10.

c) *Acceptance Limits*. Table 21 gives the height of acceptance limit signals in percent of the height of signals produced by reference standards. An imperfection that produces a signal greater than the acceptance limit signal given in Table 21 shall be considered a defect unless it can be demonstrated by the manufacturer that the imperfection does not exceed the provisions of 12.5 and 12.7. Alternatively, indicated imperfections in welded pipe, except electric-welded pipe, may be reinspected by radiological methods in accordance with 11.4 through 11.14.




NOTE 1 The reference standards defined above are convenient standards for calibration of nondestructive testing equipment. The dimensions of these standards should not be construed as the minimum size imperfection detectable by such equipment.

NOTE 2 Reference standards other than specified above may be used by agreement between the purchaser and manufacturer.

**Figure 10—Reference Standards**

**Table 21—Acceptance Limits**

| Type Notch | Size Hole | | Acceptance Limit Signal (%) |
|---|---|---|---|
| | in. | mm | |
| N10 | 1/8 | (3.2) | 100 |

d) *Weld Repair*. Defects in the weld, found by ultrasonic or electromagnetic methods of inspection, may be repaired by welding in accordance with 12.8, and the repaired area shall be reexamined nondestructively by the ultrasonic or electromagnetic inspection method, at the option of the manufacturer.

## 11.16 Ultrasonic and Electromagnetic Inspection of Seamless Pipe

Listed below is information regarding ultrasonic and electromagnetic inspection of seamless pipe that is in accordance with this specification.

a) *Equipment*. Any equipment utilizing the ultrasonic or electromagnetic principles and capable of continuous anti uninterrupted inspection of the entire volume of the pipe may be used. Pipe ends within 4 in. (100 mm) may be inspected using hand-held ultrasonic equipment in accordance with 11.16 a) and 11.16 b) below. The equipment shall be of sufficient sensitivity to indicate defects and shall be checked as described in 11.16 b).

b) *Reference Standards*. Reference standards having the same nominal diameter and thickness as the product being inspected shall be used to demonstrate the effectiveness of the inspection equipment and procedures at least once every working shift. The reference standard may be of any convenient length as determined by the manufacturer. It shall be scanned by the inspection unit in a manner simulating the inspection of the product. For ultrasonic inspection, the reference standard shall contain a machined notch as specified in Figure 11. For electromagnetic inspection, the reference standard shall contain either a machined notch or a 1/8 in. (3.2 mm) drilled hole, as specified in Figure 11, at the option of the manufacturer. The notches shall be one on the outer surface and one on the inner surface of the reference standard and parallel to the longitudinal axis of the pipe or, at the option of the manufacturer, may be oriented at such an angle as to optimize the detection of anticipated defects. The 1/8 in. (3.2 mm) hole shall be drilled radially through the wall of the reference standard. The inspection equipment shall be adjusted to produce a well-defined indication when the reference standard is scanned by the inspection unit.

c) *Acceptance Limits*. Any imperfection that produces a signal greater than the signal received from the reference standard shall be considered a defect unless it can be demonstrated by the manufacturer that the imperfection does not exceed the provisions of 12.7. Pipe containing defects shall be given one of the dispositions specified in 12.7.

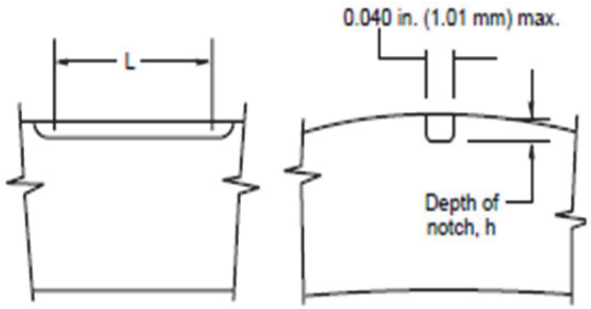



**Figure 11—Reference Standard**

### 11.17 Ultrasonic Inspection of Centrifugally Cast Pipe

Listed below is applicable information regarding ultrasonic inspection of centrifugally cast pipe that is in accordance with this specification.

a) *Equipment*. Any equipment utilizing the ultrasonic principles and capable of continuous and uninterrupted inspection of the entire volume of the pipe may be used. Pipe ends within 4 in. (100 mm) may be inspected using hand-held ultrasonic equipment in accordance with Items b) and c) below. The equipment shall be of sufficient sensitivity to indicate defects and shall be checked as prescribed in 11.17 b).

b) *Reference Standard*. A reference standard having the same nominal diameter and thickness as the product being inspected shall be used to demonstrate the effectiveness of the inspection equipment and procedures at least once every working shift. The reference standard may be of any convenient length as determined by the manufacturer. It shall be scanned by the inspection unit in a manner simulating the inspection of the product. The reference standard shall contain a machined notch as specified in Figure 11.

   The notch shall be in the outer surface of the reference standard and parallel to the longitudinal axis of the pipe.

   By agreement between purchaser and manufacturer, another notch of identical depth, width, and length shall be located on either of the following:

   1) the inner surface of the reference standard and parallel to the axis of the pipe;

   2) in the outer surface of the reference standard and perpendicular to the axis of the pipe;

   3) in the inner surface of the reference standard and perpendicular to the axis of the pipe; or

   4) any combination thereof.

   The inspection equipment shall be adjusted to produce a well-defined indication when the reference standard is scanned by the inspection unit.

   Depth of notch shall be 10 % (±1.5 %) of the nominal wall thickness of the pipe being inspected, but not less than 0.012 in. (0.30 mm).

   By agreement between purchaser and manufacturer, the depth of the notch, $h$, shall be 5 % (+0.5 %, −0.75 %) of the nominal wall thickness of the pipe being inspected, but not less than 0.005 in. (0.13 mm).

   The length of the notch at full depth, $L$, shall be at least twice the width of the scanning head.

   NOTE The reference standard defined above is a convenient standard for calibration of nondestructive testing equipment. The dimensions of this specification should not be construed as the minimum size imperfection detectable by such equipment.

c) *Acceptance Limits*. Any imperfection that produces a signal greater than the signal received from the reference standard shall be considered a defect unless it can be demonstrated by the manufacturer that the imperfection does not exceed the provisions of 12.7. Pipe containing defects shall be given one of the dispositions as specified in 12.7.

## 12 Workmanship, Visual Inspection, and Repair of Defects

### 12.1 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 at which the run is to be made.

## 12.2 Purchaser Inspection

When stated on the purchase order, the provisions of Annex G shall apply.

## 12.3 Workmanship

The manufacturer shall take all reasonable precautions to minimize damage to the pipe. Pipe containing defects listed below shall be rejected.

a) *Dents*. The pipe shall contain no dents greater than $^1/_4$ in. (6.35 mm), measured at the gap between the lowest point of the dent and a prolongation of the original contour of the pipe. The length of the dent in any direction shall not exceed one-half the pipe diameter. All cold-formed dents deeper than $^1/_8$ in. (3.18 mm) with a sharp bottom gouge shall be considered a defect. The gouge may be removed by grinding.

b) *Offset of Plate Edges*. For submerged arc and gas metal arc welded pipe with wall thicknesses 0.500 in. (12.7 mm) and less, the radial offset (misalignment) of plate edges in the weld seams shall not be greater than $^1/_{16}$ in. (1.59 mm). For submerged arc and gas metal arc welded pipe with wall thicknesses over 0.500 in. (12.7 mm), the radial offset shall not be greater than $0.125t$ or $^1/_8$ in. (3.18 mm), whichever is smaller. For electric-welded pipe, the radial offset of plate edges plus flash trim shall be no greater than 0.060 in. (1.52 mm).

c) *Out-of-line Weld Bead in Submerged Arc and Gas Metal Arc Welded Pipe*. Out-of-line weld bead (off-seam weld) shall not be cause for rejection provided complete penetration and complete fusion have been achieved as indicated by nondestructive examination. When the electric-resistance welding process is used for tack welding, the subsequent submerged arc or gas metal arc weld shall eliminate all evidence of the tack weld.

d) *Height of Outside and Inside Weld Beads—Except ERW*. The weld head shall not extend above the prolongation of the original surface of the pipe more than the amount listed below in Table 22.

**Table 22—Outside/Inside Weld Bead Height (Except ERW)**

| Wall Thickness | Maximum Height of Weld Bead |
|---|---|
| $^1/_2$ in. (12.70 mm) and under | $^1/_8$ in. (3.18 mm) |
| Over $^1/_2$ in. (12.70 mm) | $^3/_{16}$ in. (4.76 mm) |

Weld beads higher than permitted by the requirements of this paragraph may be ground to acceptance criteria at the option of the manufacturer.

The height of the weld bead shall in no case come below a prolongation of the surface of the pipe (outside or inside the weld head), except that contouring by grinding, otherwise covered in this specification, shall be permitted.

e) *Height of Flash of Electric-welded Pipe*. The outside flash of electric-welded pipe shall be trimmed to an essentially flush condition.

The inside flash of electric-welded pipe shall not extend above the prolongation of the original inside surface of the pipe more than 0.060 in. (1.52 mm).

f) *Trim of Inside Flash of Electric-welded Pipe*. Depth of groove is defined as the difference between the wall thickness measured approximately 1 in. (25.4 mm) from the weld line and the remaining wall under the

groove. The depth of groove resulting from removal of the internal flash of electric-welded pipe shall not be greater than the amount listed below in Table 23 for the various wall thicknesses.

g) *Grinding*. When surface conditioning by grinding is performed, it shall be done in a workmanlike manner.

**Table 23—Electric-Welded Pipe Inside Flash Trim**

| Wall Thickness | Maximum Depth of Trim |
|---|---|
| 0.150 in. (3.8 mm) and less | $0.10t$ |
| 0.151 in. (3.8 mm) to 0.301 in. (7.6 mm) | 0.015 in. (0.38 mm) |
| 0.301 in. (7.6 mm) and greater | $0.05t$ |

## 12.4 Visual Inspection

All finished pipe shall be visually examined and shall be free of defects as defined in 12.5. See 12.6 for repair of defects.

## 12.5 Defects

Listed below are requirements for defects in order to conform to this standard.

a) *Cracks and Leaks*. All cracks, sweats, and leaks shall be considered defects.

b) *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. (6.35 mm) is considered a defect. Pipe containing such defects shall be cut back until no lamination or inclusion on the face of the bevel is greater than $^1/_4$ in. (6.35 mm). Any lamination in the body of the pipe that is both the following:

1) greater than or equal to $^3/_4$ in. (19.0 mm) in the minor dimension, and

2) greater than or equal to 12 in.$^2$ (7742 mm$^2$) in area is considered a defect.

Disposition of such defects shall be in accordance with API 5L. No specific inspection by the manufacturer is required unless the purchaser specifies special nondestructive inspection on the purchase order.

NOTE A lamination is defined as an internal metal separation creating layers generally parallel to the surface.

c) *Arc Burns*. Arc burns, defined as localized points of surface melting caused by arcing between electrode or ground and the pipe surface, shall be considered defects.

NOTE Contact marks, defined as intermittent marks adjacent to the weld line, resulting from the electrical contact between the electrodes supplying the welding current and the pipe surface, are not defects.

Pipe containing arc burns shall be given one of the following dispositions.

1) 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 an appropriate reagent.

The cavity may be merged smoothly into the original contour of the pipe by grinding, provided the remaining wall thickness is within the specified limits.

2) The section of pipe containing the arc burn may be cut off within the limits of the requirements on length.

3) Rejected.

d) *Undercuts*. Undercutting on submerged arc or gas metal arc welded pipe is the reduction in thickness of the pipe wall adjacent to the weld where it is fused to the surface of the pipe. Undercutting can best be located and measured visually. Minor undercutting on either the inside or the outside of the pipe is permissible without repair or grinding. Minor undercutting is defined as follows.

1) Maximum depth of $^1/_{32}$ in. (0.79 mm) with a maximum length of one-half the wall thickness and not more than two such undercuts in any 1 ft (0.30 m) of the weld length.

2) Maximum depth of $^1/_{64}$ in. (0.40 mm), any length.

Undercuts longer than one-half the wall thickness and $^1/_{64}$ to $^1/_{32}$ in. (0.40 to 0.79 mm) in depth, but not exceeding $12^1/_2$ % of the specified wall thickness, shall be removed by grinding. Undercuts greater in depth than $^1/_{32}$ in. (0.79 mm) shall be considered defects.

e) *Other Defects*. Any imperfection having a depth greater than $12^1/_2$ % of the specified wall thickness, measured from the surface of the pipe, shall be considered a defect.

f) *Disposition*. Pipe containing a defect shall be given one of the following dispositions.

1) The defect may be removed by grinding provided the remaining wall thickness is within specified limits.

2) Repaired in accordance with 12.6 through 12.9.

3) The section of pipe containing the defect may be cut off within the limits of the requirements on length.

4) Rejected.

## 12.6 Repair of Defects

Listed below are requirements for defects in order to conform to this standard.

a) *Seamless Pipe and Parent Metal of Welded Pipe*. Weld repairs are prohibited.

b) *Weld Seam of Welded Pipe*. Defects in the weld seam, except ERW pipe, may be repaired at the discretion of the manufacturer. Such repairs shall be in accordance with Table 24. The weld seam of electric-resistance welded pipe may be repaired only by agreement between the purchaser and manufacturer. Electric-resistance weld seam repairs shall be in accordance with Table 24.

**Table 24—Applicable Repair Procedure**

| Pipe Weld Seam | Section All Grades |
|---|---|
| Weld seam of submerged arc welded pipe | 12.7 |
| Weld seam of electric-resistance and induction-welded pipe | 12.8 |
| Weld seam of gas metal arc welded pipe | 12.9 |

c) *Heat-treated Pipe*. When heat-treated pipe has been repaired by welding, the need for and type of reheat treatment shall be, by agreement between the manufacturer and the purchaser, based on the effect of the repair on the microstructure and properties of the heat-treated pipe.

## 12.7 Procedure for Repair of Weld Seams of Submerged Arc Welded Pipe

Conformance is subject to approval of the purchaser's inspector. The repair of defects in the weld seam of submerged arc welded pipe shall conform to the following requirements.

a) The defect shall be completely removed and the cavity thoroughly cleaned.

b) The minimum length of a repair weld shall be 2 in. (50.8 mm). The repair weld shall be made by either semi-automatic or automatic submerged arc welding; by manual or semi-automatic or automatic gas metal arc (TIG or MIG) welding; or by manual shielded metal arc welding using suitable electrodes. The welding procedures and performance shall be qualified in accordance with Annex C. Shielding gas, containing hydrogen, shall not be used for duplex alloys.

c) Each length of repaired pipe shall be hydrostatically tested in accordance with Section 9.

## 12.8 Procedure for Repair of Weld Seams of Electric-weld and Induction-welded Pipe

Conformance to the repair procedure is subject to approval of the purchaser's inspector. Repair welding of the weld seam of electric-resistance welded pipe and induction welded pipe shall conform to the following requirements and shall include the weld zone which is defined for the purposes of repair as $^1/_2$ in. (12.7 mm) on either side of the fusion line.

a) The weld zone defect shall be removed completely by chipping and/or grinding and the resultant cavity shall be thoroughly cleaned.

b) The minimum length of repair weld shall be 2 in. (50.8 mm), and individual weld repairs shall be separated by at least 10 ft (3 mm).

c) The repair weld shall be made either by manual or semi-automatic submerged arc welding gas metal arc welding, or manual shielded metal arc welding using suitable electrodes. The metal temperature in the area to be repaired shall be a minimum of 50 °F (10 °C). The welding procedure and performance shall be qualified in accordance with Annex C.

d) When a repair weld is made through the full wall thickness, it shall include weld passes made from both the ID and the OD of the pipe. Starts and stops of the ID and OD repair welds shall not coincide.

e) The repair shall be ground to merge smoothly into the original contour of the pipe and shall have a maximum crown of 0.06 in. (1.52 mm).

f) Repair welds shall be inspected by either ultrasonic method in accordance with 11.15, except that the equipment need not be capable of continuous and uninterrupted operation, or by radiological methods in accordance with 11.4 through 11.14. The choice of these nondestructive testing methods shall be at the option of the manufacturer.

g) Repaired pipe shall be hydrostatically tested after repaired in accordance with Section 9.

## 12.9 Procedure for Repair of Weld Seam of Gas Metal Arc Welded Pipe

Conformance is subject to the approval of the purchaser's inspector. The repair of defects in the weld seam of gas metal arc welded pipe shall conform to the following requirements.

a) The defects shall be completely removed and the cavity thoroughly cleaned. The size of the cavity shall be sufficiently large [at least 2 in. (50.8 mm) in length] so as to permit multiple pass repairs wherein starts and stops of individual passes do not coincide.

b) The repair weld shall be made by suitable coated electrodes, semi-automatic or automatic gas metal arc welding. The welding procedure and operator performance shall be qualified in accordance with Annex C.

c) Each length of repaired pipe shall be hydrostatically tested in accordance with Section 9.

# 13 Marking and Surface Treatment

## 13.1 Marking—General

Pipe manufactured in conformance with this specification shall be marked by the manufacturer as specified hereinafter.

a) The required marking on pipe shall be as stipulated in 13.2.

b) Size, weight per foot, length, and hydrostatic test pressure markings shall be in USC units except that for pipe intended for use in countries utilizing the metric system; these markings shall be in metric units or both USC and metric units, if so specified on the purchase order. If not so specified, for pipe made and intended for use in countries utilizing the metric system, these markings may be given in metric units only, at the option of the manufacturer.

## 13.2 Location of Markings

The location and sequence of identification markings shall be as follows.

a) *1.900 in. OD and Smaller*. Die stamped on a metal tag fixed to the bundle, or may be printed on the straps or banding clips used to tie the bundle.

b) *Seamless pipe in All Other Sizes and Welded Pipe up to 16 in. OD*. Paint stencil on the outside surface starting at a point between 18 in. and 30 in. from the end of the pipe, and in the sequence shown below, except when agreed between the purchaser and the manufacturer some or all of the markings may be placed on the inside surface in a sequence convenient to the manufacturer.

c) *Welded Pipe 16 in. OD and Larger*. Paint stencil on the inside surface starting at a point no less than 6 in. from the end of the pipe in a sequence convenient to the manufacturer, unless otherwise specified by the purchaser.

## 13.3 Sequence of Markings

The sequence of markings shall be as follows.

a) Manufacturer's name or mark.

b) *Spec 5LC*. [8] "Spec 5LC" should be paint stenciled when the product is in complete compliance with this specification. Compatible standards products in compliance with multiple compatible standards may be stenciled with the name of each standard.

c) *Sizes*. The outside diameter in inches followed by the nominal wall thickness in inches.

[8] Users of this specification should note that there is no longer a requirement for marking a product with the API monogram. The American Petroleum Institute continues to license use of the monogram on products covered by this specification but it is administered by the staff of the Institute separately from the specification. The policy describing licensing and use of the monogram is contained in Annex A herein. No other use of the monogram is permitted.

d) *Weight per Foot*. For sizes $4^1/_2$ in. and larger, the tabulated weight in pounds per foot for plain-end pipe (Table 12), shall be paint stenciled.

e) *Grade*. The symbols to be used are as follows:

| | |
|---|---|
| Grade LC30-1812 | LC30-1812 |
| Grade LC52-1200 | LC52-1200 |
| Grade LC65-2205 | LC65-2205 |
| Grade LC65-2506 | LC65-2506 |
| Grade LC80-2507 | LC80-2507 |
| Grade LC30-2242 | LC30-2242 |

The symbols to use from grades not listed in Table 4 shall correspond to the designation described in NOTE "a" to Table 4.

f) *Process of Manufacture*. The symbols to be used are as follows:

| | |
|---|---|
| Seamless pipe | S |
| Welded pipe | E |
| Centrifugal cast pipe | C |

g) *Heat Treatment*. The symbols to be used are as follows:

| | |
|---|---|
| As-rolled | AR |
| Quench and tempered | HQ |
| Solution anneal | H |

h) *Test Pressure*. When the specified hydrostatic test pressure is higher than the tabulated pressure (Table 12), the test pressure in pounds per square inch, preceded by the word TESTED, shall be paint stenciled.

i) *Supplementary Requirement(s)*. See Annex B.

Example:

14 in. NPS 0.375 in. wall thickness, Grade LC30-1812, solution annealed, seamless shall be paint stenciled as follows:

ABCO SPEC 5LC 14 × 0.375
55.50 LC30-1812 SH

NOTE The weight per foot (55.50) is determined by applying the F factor, $F$ = 1.017, to 54.57 from Table 12.

For pipe in sizes 1.900 in. OD and smaller, the identification markings specified in 13.2 shall be placed on the tag, strap, or clip used to tie the bundle.

## 13.4 Length

In addition to the identification markings stipulated in 13.1 and 13.2, the length shall be marked as follows.

a) For pipe in sizes larger than 1.900 in. OD, the length in feet and tenths of a foot, unless otherwise specified on the purchase order, as measured on the finished pipe shall be paint stenciled on the outside surface at a place convenient to the manufacturer, except by agreement between the purchaser and the manufacturer, the length marking may be placed inside the pipe at a convenient location.

b) For sizes 1.900 in. OD and smaller, the total length of pipe in the bundle in feet and tenths of a foot (or equivalent metric units), unless otherwise specified on the purchase order, shall be marked on the tag, band, or clip.

## 13.5 Die Stamping

Cold die stamping of all grades plate or pipe not subsequently heat treated, and all pipe with wall thickness of 0.156 in. and less is prohibited, except that by agreement between the purchaser and the manufacturer and when so specified on the purchase order, pipe or plate may be cold die stamped. The manufacturer at their option may hot die stamp [200 °F (93 °C) or higher] plate or pipe, or cold die stamp plate or pipe if it is subsequently heat treated. Cold die stamping shall be done with rounded or blunt dies. All die stamping shall be at least 1 in. (25 mm) from the weld for all grades. Etching or marking with a vibrograph are permitted in lieu of cold die stamping.

## 13.6 Surface Treatment

The corrosion resistant behavior of these alloys is adversely affected by poor surface condition. Therefore, scale spatter and annealing surface residues shall be removed by blasting or pickling, or a combination of both.

## 13.7 Pipe Processor Markings

Pipe heat treated by a processor other than the manufacturer shall be marked as stipulated in 13.1, 13.2, 13.3, 13.4, and 13.5. The processor shall remove any identity which is not indicative of the new condition of the product as a result of heat treating (i.e. prior grade identity, original pipe manufacturer’s name or logo).

# Annex A
(informative)

# API Monogram Program
# Use of the API Monogram by Licensees

## A.1 Scope

### A.1.1 Applicability

This annex is normative (mandatory) for products supplied bearing the API Monogram and manufactured at a facility licensed by API; for all other instances it is not applicable.

### A.1.2 General

The API Monogram® is a registered certification mark owned by the American Petroleum Institute (API) and authorized for licensing by the API Board of Directors. Through the API Monogram Program, API licenses product manufacturers to apply the API Monogram to products which comply with product specifications and have been manufactured under a quality management system that meets the requirements of API Q1. API maintains a complete, searchable list of all Monogram licensees on the API Composite List website (www.api.org/compositelist).

The application of the API Monogram and license number on products constitutes a representation and warranty by the licensee to API and to purchasers of the products that, as of the date indicated, the products were manufactured under a quality management system conforming to the requirements of API Q1 and that the product conforms in every detail with the applicable standard(s) or product specification(s). API Monogram Program licenses are issued only after an on-site audit has verified that an organization has implemented and continually maintained a quality management system that meets the requirements of API Q1 and that the resulting products satisfy the requirements of the applicable API product specification(s) and/or standard(s). Although any manufacturer may claim that its products meet API product requirements without monogramming them, only manufacturers with a license from API can apply the API Monogram to their products.

Together with the requirements of the API Monogram license agreement, this annex establishes the requirements for those organizations who wish to voluntarily obtain an API license to provide API monogrammed products that satisfy the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program requirements.

For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, NW, Washington, DC 20005 or call 202-682-8145 or by email at certification@api.org.

## A.2 Normative References

In addition to the referenced standards listed earlier in this document, this annex references the following standard:

API Specification Q1, *Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*

For Licensees under the Monogram Program, the latest version of this document shall be used. The requirements identified therein are mandatory.

## A.3 API Monogram Program: Licensee Responsibilities

### A.3.1 Monogram Program Requirements

For all organizations desiring to acquire and maintain a license to use the API Monogram, conformance with the following shall be required at all times:

a) quality management system requirements of API Q1;

b) API Monogram Program requirements of API Q1, Annex A;

c) requirements contained in the API product specification(s) to which the organization is licensed; and

d) requirements contained in the API Monogram Program License Agreement.

### A.3.2 Control of the Application and Removal of the API Monogram

Each licensee shall control the application and removal of the API Monogram in accordance with the following:

a) products that do not conform to API specified requirements shall not bear the API Monogram;

b) each licensee shall develop and maintain an API Monogram marking procedure that documents the marking/monogramming requirements specified by this annex and any applicable API product specification(s) and/or standard(s). The marking procedure shall:

   1) define the authority responsible for application and removal of the API Monogram and license number;

   2) define the method(s) used to apply the Monogram and license number;

   3) identify the location on the product where the API Monogram and license number are to be applied;

   4) require the application of the date of manufacture of the product in conjunction with the use of the API Monogram and license number;

   5) require that the date of manufacture, at a minimum, be two digits representing the month and two digits representing the year (e.g. 05-12 for May 2012) unless otherwise stipulated in the applicable API product specification(s) or standard(s); and

   6) define the application of all other required API product specification(s) and/or standard(s) marking requirements.

c) only an API licensee shall apply the API Monogram and its designated license number to API monogrammable products;

d) the API Monogram and license number, when issued, are site-specific and subsequently the API Monogram shall only be applied at that site specific licensed facility location; and

e) the API Monogram may be applied at any time appropriate during the production process but shall be removed in accordance with the licensee's API Monogram marking procedure if the product is subsequently found to be out of conformance with any of the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program.

For certain manufacturing processes or types of products, alternative API Monogram marking procedures may be acceptable. Requirements for alternative API Monogram marking are detailed in the, *API Monogram*

*Program Alternative Marking of Products License Agreement*, available on the API Monogram Program website at http://www.api.org/alternative-marking.

### A.3.3 Design and Design Documentation

Each licensee and/or applicant for licensing shall maintain current design documentation as identified in API Q1 for all of the applicable products that fall under the scope of each Monogram license. The design document information shall provide objective evidence that the product design meets the requirements of the applicable and most current API product specification(s) and/or standard(s). The design documentation shall be made available during API audits of the facility.

In specific instances, the exclusion of design activities is allowed under the Monogram Program, as detailed in Advisory #6, available on API Monogram Program website at http://www.api.org/advisories.

### A.3.4 Manufacturing Capability

The API Monogram Program is designed to identify facilities that have demonstrated the ability to manufacture equipment that conforms to API specifications and/or standards. API may refuse initial licensing or suspend current licensing based on a facility's level of manufacturing capability. If API determines that an additional review is warranted, API may perform additional audits (at the organization's expense) of any subcontractors to ensure their conformance with the requirements of the applicable API product specification(s) and/or standard(s).

### A.3.5 Use of the API Monogram in Advertising

An API Monogram licensee shall not use the API Monogram and/or license number on letterheads, buildings or other structures, websites or in any advertising without an express statement of fact describing the scope of Licensee's authorization (license number and product specification). The Licensee should contact API for guidance on the use of the API Monogram other than on products.

## A.4 Product Marking Requirements

### A.4.1 General

These marking requirements shall apply only to those API Licensees wishing to mark applicable products in conjunction with the requirements of the API Monogram Program.

### A.4.2 Product Specification Identification

Manufacturers shall mark products as specified by the applicable API specifications or standards. Marking shall include reference to the applicable API specification and/or standard. Unless otherwise specified, reference to the API specifications and/or standards shall be, as a minimum, "API [Document Number]" (e.g. API 6A or API 600). Unless otherwise specified, when space allows, the marking may include use of "Spec" or "Std", as applicable (e.g. API Spec 6A or API Std 600).

### A.4.3 Units

Products shall be marked with units as specified in the API specification and/or standard. If not specified, equipment shall be marked with U.S. customary (USC) units. Use of dual units [USC units and metric (SI) units] may be acceptable, if such units are allowed by the applicable product specification and/or standard.

### A.4.4 Nameplates

Nameplates, when applicable, shall be made of a corrosion-resistant material unless otherwise specified by the API specification and/or standard. Nameplate shall be located as specified by the API specification and/or standard. If the location is not specified, then the licensee shall develop and maintain a procedure detailing

the location to which the nameplate shall be applied. Nameplates may be attached at any time during the manufacturing process.

The API Monogram and license number shall be marked on the nameplate, in addition to the other product marking requirements specified by the applicable product specification and/or standard.

### A.4.5 License Number

The API Monogram license number shall not be used unless it is marked in conjunction with the API Monogram. The license number shall be used in close proximity to the API Monogram.

## A.5 API Monogram Program: Nonconformance Reporting

API solicits information on products that are found to be nonconforming with API specified requirements, as well as field failures (or malfunctions), which are judged to be caused by either specification and/or standard deficiencies or nonconformities against API specified requirements. Customers are requested to report to API all problems with API monogrammed products. A nonconformance may be reported using the API Nonconformance Reporting System available at http://compositelist.api.org/ncr.aspx.

# Annex B
(informative)

# Supplementary Requirement(s)

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

## Supplementary Requirement 15 (SR15)—Test Certificates for CRA Line Pipe

### B.1 SR15.1

Manufacturer's certificate shall state the API specification and revision date thereof, to which pipe was manufactured. The manufacturer shall provide the following data, as applicable, for each item for which the Supplementary Requirement is specified on the purchaser order.

a) Specified diameter, wall thickness, grade, process of manufacture, and type of heat treatment.

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

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

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

e) Minimum hydrostatic test pressure and duration.

f) For welded pipe for which nondestructive inspection of the weld seam is required by this specification, the method of nondestructive inspection employed (radiological, ultrasonic, electromagnetic, and/or magnetic particle), and the type and size of all penetrameters and/or reference standards used.

g) For seamless pipe for which nondestructive inspection is specified by the purchaser, the method of inspection employed (ultrasonic, electromagnetic, or magnetic particle), and the type and size of the reference standard used.

h) For electric-welded pipe, the minimum temperature for heat treatment of the weld seam. Where such heat treatment is not performed, "No Seam Heat Treatment" shall be stated on the certificate.

i) Results of any supplemental testing required by the purchaser.

### B.2 SR15.2

The manufacturer shall establish and follow procedures for maintaining heat and lot identity of all pipe covered by this Supplementary Requirement. The procedures shall provide means for tracing any length of pipe or coupling to the proper heat and lot, and to all applicable chemical and mechanical test results.

# Annex C
(normative)

# Repair Welding Procedure

## C.1 General

All repair welds shall be made in the flat position according to a qualified procedure and by a welding machine operator (hereafter operator) or repair welder qualified in a flat position as specified in C.2. Repair welds may be made by one of the following methods.

a) Automatic submerged arc.

b) Automatic or semi-automatic gas metal arc.

c) Manual shielded metal arc using low hydrogen electrodes.

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 may be made on either plate stock or pipe stock, at the option of the manufacturer.

The manufacturer shall maintain a record of the welding procedure and procedure qualification test results; copies of the welding procedure specification and procedure qualification record shall be provided to the purchaser upon request.

## C.2 Repair Welding Procedure Qualification

### C.2.1 General

Welding procedures shall be qualified by preparing and testing welds in accordance with this Annex. At the option of the manufacturer, the tests specified in the latest issue of the ASME *Boiler and Pressure Vessel Code*, Section IX, may be substituted herein. For the purpose of this annex, the term "automatic welding" includes both machine welding and automatic welding as defined in the ASME *Boiler and Pressure Vessel Code*, Section IX.

### C.2.2 Essential Variables

#### C.2.2.1 General

An existing procedure shall not be applicable and new procedure shall be qualified when any of the following essential variables listed under C.2.2.2 to C.2.2.7 are changed beyond the stated limits.

#### C.2.2.2 Welding Process

The following pertain to the welding process.

a) A change in the welding process (i.e. submerged arc to gas metal arc).

b) A change in the method (i.e. manual to semi-automatic).

#### C.2.2.3 Pipe Material

The following pertain to the welding process.

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

   1) SMYS 42,000 psi or less.

   2) SMYS greater than 42,000 psi but less than 65,000 psi.

   3) Each grade with SMYS of 65,000 psi or greater.

b) Within each grade category, a thicker material than the material qualified.

c) Within the grade category and thickness range, a carbon equivalent (CE) based on product analysis for the material to be repaired which is more than 0.04 % greater than the CE of the material qualified [see Equation (C.1)].

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} \quad \text{(C.1)}$$

#### C.2.2.4 Welding Materials

The following pertain to the welding process.

a) A change in filler metal classification.

b) A change in electrode diameter.

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

d) A change of more than 10 % in the flow rate of shielding gas.

e) A change in submerged arc welding flux from one designation to another.

#### C.2.2.5 Welding Parameters

The following pertain to the welding process.

a) A change in the type of current (i.e. AC vs DC).

b) A change in polarity.

c) 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:

   1) 10 % in amperage;

   2) 7 % in voltage; and

   3) 10 % in travel speed for automatic welding.

#### C.2.2.6 Weld Bead

For manual and semi-automatic welding, a change in bead width greater than 50 %.

#### C.2.2.7 Preheat and Postweld Heat Treat

The following pertain to the welding process.

a) Repair welding at a pipe temperature lower than the pipe temperature of the qualification test.

b) The addition or deletion of postweld heat treatment.

### C.2.3 Mechanical Testing

#### C.2.3.1 Number of Tests

Two specimens of each type are required from each test.

#### C.2.3.2 Transverse Tensile Test

The transverse tensile test specimens shall be approximately 1.5 in. (38 mm) wide and shall have the transverse butt weld perpendicular to the longitudinal axis at the center of the test specimen (see Figure C.1 or Figure 7). The weld reinforcement shall be removed from both faces. The ultimate tensile strength shall be at least equal to the minimum specified for the pipe grade.

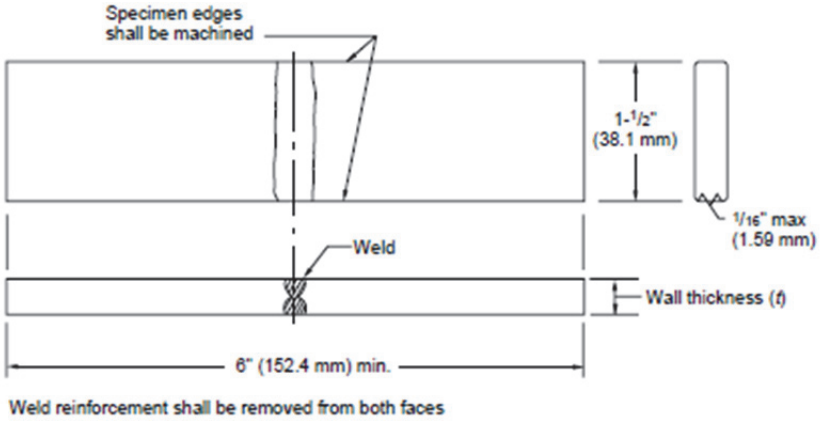



**Figure C.1—Transverse Tensile Test Specimen**

#### C.2.3.3 Longitudinal Tensile-elongation Test

The longitudinal tensile-elongation test specimens shall conform to Figure C.2. The weld shall be made in a groove as shown. The elongation after complete rupture of each test specimen in tension shall be at least equal to the minimum elongation specified for the pipe grade.

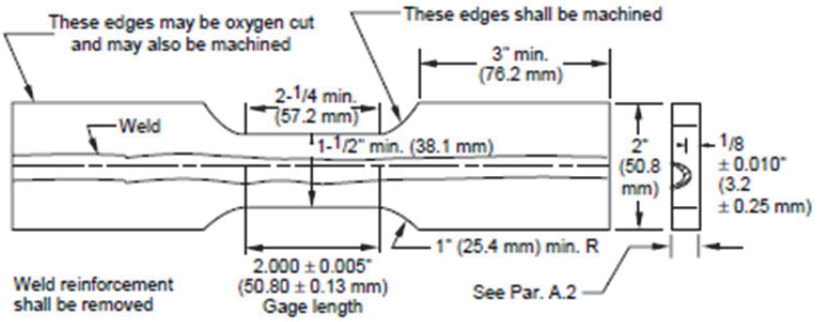



**Figure C.2—Tensile-elongation Test Specimen**

### C.2.3.4 Transverse Guided-bend Test

The transverse guided-bend test specimens shall conform to Figure C.3. The weld shall be made in a groove as shown. Each specimen shall be placed on the die with the weld at mid-span, and shall be bent approximately 180° in a jig, substantially in accordance with Figure C.4 and Table C.1, with the exposed surface of the weld in tension. The bend test shall be considered acceptable if no crack or other defect exceeding $^{1}/_{8}$ in. (3.18 mm) in any direction is present in the weld metal or base metal after bending. Cracks which both originate along the edges of the specimen during testing and measure less than $^{1}/_{4}$ in. (6.35 mm) in all directions shall not be considered.

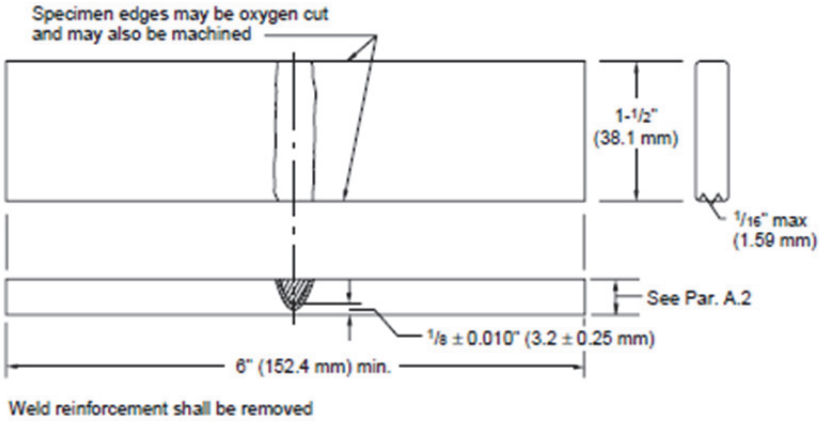



**Figure C.3—Guided-bend Test Specimen**

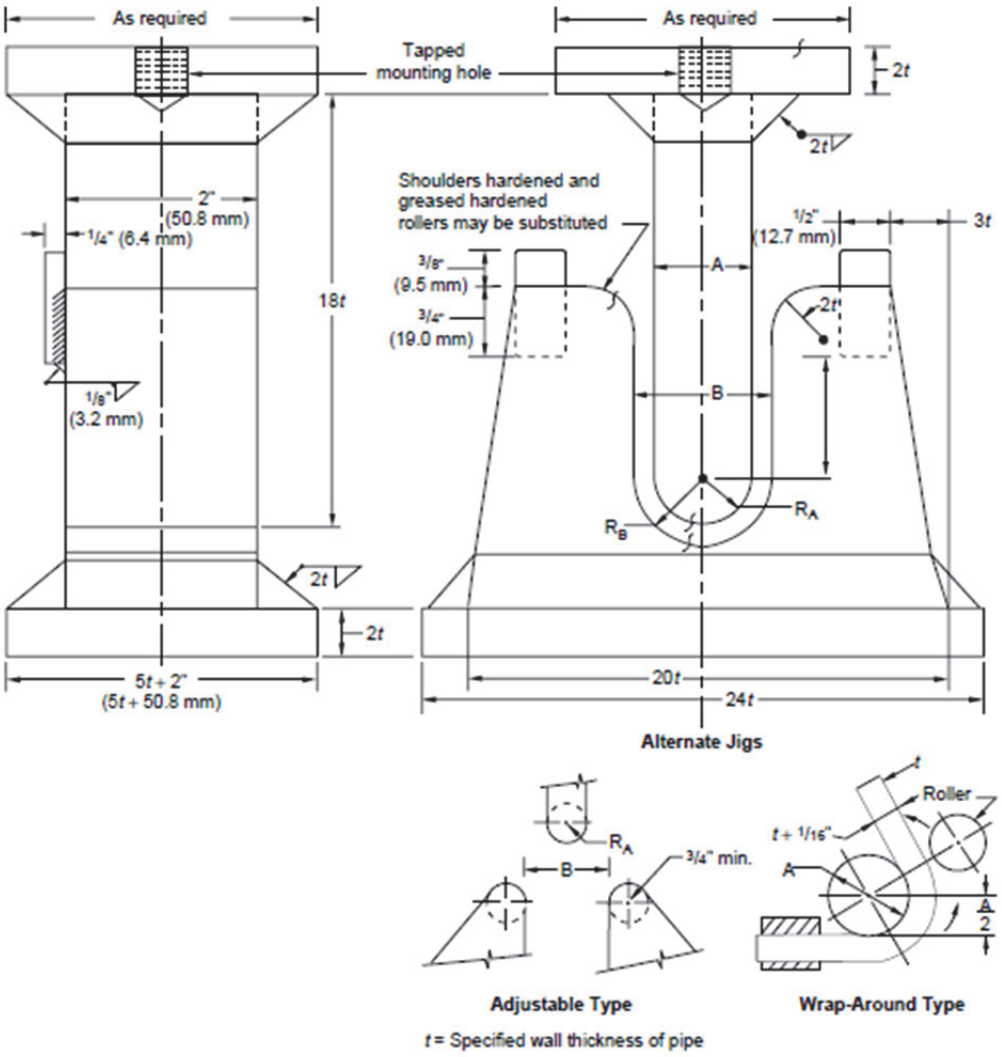



**Figure C.4—Jig for Guided-bend Test**

**Table C.1—Guided-bend Test Jig Dimensions (See Figure C.4)**

| 1 | 2 | 3 | 4 | |
|---|---|---|---|---|
| | **Pipe Grade** | | | |
| | LC30-1812<br>LC30-2242 | LC52-1200 | LC65-2205<br>LC65-2206 | |
| Radius of male member, $R_A$ | 3$t$ | 4$t$ | 4 $^1/_2 t$ | |
| Radius of female member, $R_B$ | 4$t$ + $^1/_{16}$ in. | 5$t$ + $^1/_{16}$ in. | 5 $^1/_2 t$ + $^1/_{16}$ in. | |
| | 4$t$ + 1.6 mm | 5$t$ + 1.6 mm | 5 $^1/_2 t$ + 1.6 mm | |
| Width of male member, A | 6$t$ | 8$t$ | 9$t$ | |
| Width of groove in female member, B | 8 $^1/_8$ in. | 10$t$ + $^1/_8$ in. | 11$t$ + $^1/_8$ in. | |
| | 8$t$ +3.2 mm | 10$t$ + 3.2 mm | 11$t$ + 3.2 mm | |
| NOTE $t$ = specified wall thickness of the pipe. | | | | |

For intermediate grades of pipe, the dimensions in Table C.1 of the bending jig shall conform to those shown for the next lower grade or shall be proportional thereto.

#### C.2.3.5 Nick-break Test

The nick-break specimens shall conform to Figure C.5. The weld shall be made in a groove as shown. Each specimen shall be saw notched from both edges at the center of the weld and shall be broken by pulling or hammer blows at the center of one end. The exposed surface of the specimen shall be visually examined and shall be considered acceptable if it meets the following criteria.

a) No gas pockets exceeding $^{1}/_{16}$ in. (1.59 mm) in any direction.

b) Not more than one gas pocket of any size for specified wall thicknesses of 0.250 in. (6.35 mm) and less.

c) Not more than two gas pockets of any size for specified wall thicknesses of 0.500 in. (12.7 mm) or less, but greater than 0.250 in. (6.35 mm).

d) Not more than three gas pockets of any size for specified wall thicknesses greater than 0.500 in. (12.7 mm).

e) To be acceptable, slag inclusions shall be separated by at least 2 in. (12.7 mm) of sound metal and shall appear no greater than $^{1}/_{16}$ in. (1.59 mm) in width or $^{1}/_{16}$ in. (4.76 mm) in length.

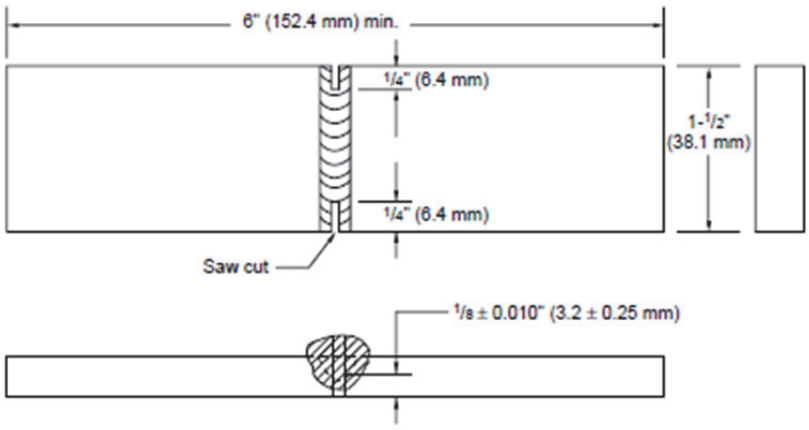



**Figure C.5—Nick-break Test Specimen**

## C.3 Welding Personnel Performance Qualification

### C.3.1 Qualification

Each repair welder and operator is required to qualify according to C.3.2. A repair welder or operator qualified on one grade category is qualified for any lower grade category provided the same welding process is used.

### C.3.2 Testing

For qualification, a repair welder or operator shall produce welds that are acceptable in the following tests.

**C.3.2.1** Film radiographic examination according to Section 12 of this specification.

**C.3.2.2** Two transverse guided-bend tests according to C.2.3.4 of this supplement.

**C.3.2.3** Two nick-break tests according to C.2.3.5 of this supplement.

### C.3.3 Test Failures

If one or more of the tests in C.3.2 fail to meet the specified requirements, the welder or operator may make one additional qualification weld. If that weld fails one or more of the tests in C.3.2, the welder or operator is disqualified. No further retests shall be permitted until the welder has completed additional training.

### C.3.4 Requalification

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

**C.3.4.1** One year has elapsed since the last prior applicable qualification.

**C.3.4.2** The individual has not been welding using qualified procedures for a period of three months.

**C.3.4.3** There is reason to question the individual's ability.

# Annex D
(informative)

# Minimum Elongation Values

The following table list the minimum elongation values used for conforming to this standard.

**Table D.1—Minimum Elongation Values**

| | Grade Constant | LC30-1812 $C$ = 26.5 | LC52-1200 $C$ = 21.2 | LC65-2205 $C$ = 26.5 | LC65-2206 $C$ = 26.5 | LC30-2242 $C$ = 26.5 | LC80-2507 $C$ = 21.2 |
|---|---|---|---|---|---|---|---|
| Sec. Area | $A^{0.2}$ | $e$ | $e$ | $e$ | $e$ | $e$ | $e$ |
| 0.75 over | 0.94 | 25.0 | 27.0 | 25.0 | 25.0 | 30.0 | 20.0 |
| | | | | | | | |
| 0.74 | 0.94 | 25.0 | 27.0 | 25.0 | 25.0 | 30.0 | 20.0 |
| 0.73 | 0.94 | 25.0 | 27.0 | 25.0 | 25.0 | 30.0 | 20.0 |
| 0.72 | 0.94 | 25.0 | 27.0 | 25.0 | 25.0 | 30.0 | 20.0 |
| 0.71 | 0.93 | 24.5 | 27.0 | 24.5 | 24.5 | 29.5 | 20.0 |
| 0.70 | 0.93 | 24.5 | 26.5 | 24.5 | 24.5 | 29.5 | 20.0 |
| | | | | | | | |
| 0.69 | 0.93 | 24.5 | 26.5 | 24.5 | 24.5 | 29.5 | 20.0 |
| 0.68 | 0.93 | 24.5 | 26.5 | 24.5 | 24.5 | 29.5 | 20.0 |
| 0.67 | 0.92 | 24.5 | 26.5 | 24.5 | 24.5 | 29.5 | 19.5 |
| 0.66 | 0.92 | 24.5 | 26.5 | 24.5 | 24.5 | 29.5 | 19.5 |
| 0.65 | 0.92 | 24.5 | 26.5 | 24.5 | 24.5 | 29.0 | 19.5 |
| | | | | | | | |
| 0.64 | 0.91 | 24.0 | 26.5 | 24.0 | 24.0 | 29.0 | 19.5 |
| 0.63 | 0.91 | 24.0 | 26.0 | 24.0 | 24.0 | 29.0 | 19.5 |
| 0.62 | 0.91 | 24.0 | 26.0 | 24.0 | 24.0 | 29.0 | 19.5 |
| 0.61 | 0.91 | 24.0 | 26.0 | 24.0 | 24.0 | 29.0 | 19.5 |
| 0.60 | 0.90 | 24.0 | 26.0 | 24.0 | 24.0 | 28.5 | 19.0 |
| | | | | | | | |
| 0.59 | 0.90 | 24.0 | 26.0 | 24.0 | 24.0 | 28.5 | 19.0 |
| 0.58 | 0.90 | 24.0 | 26.0 | 24.0 | 24.0 | 28.5 | 19.0 |
| 0.57 | 0.89 | 23.5 | 25.5 | 23.5 | 23.5 | 28.5 | 19.0 |
| 0.56 | 0.89 | 23.5 | 25.5 | 23.5 | 23.5 | 28.5 | 19.0 |
| 0.55 | 0.89 | 23.5 | 25.5 | 23.5 | 23.5 | 28.5 | 19.0 |

**Table D.1—Minimum Elongation Values (Continued)**

| | Grade Constant | LC30-1812 $C$ = 26.5 | LC52-1200 $C$ = 21.2 | LC65-2205 $C$ = 26.5 | LC65-2206 $C$ = 26.5 | LC30-2242 $C$ = 26.5 | LC80-2507 $C$ = 21.2 |
|---|---|---|---|---|---|---|---|
| 0.54 | 0.88 | 23.5 | 25.5 | 23.5 | 23.5 | 28.0 | 18.5 |
| 0.53 | 0.88 | 23.5 | 25.5 | 23.5 | 23.5 | 28.0 | 18.5 |
| 0.52 | 0.88 | 23.5 | 25.0 | 23.5 | 23.5 | 28.0 | 18.5 |
| 0.51 | 0.87 | 23.0 | 25.0 | 23.0 | 23.0 | 28.0 | 18.5 |
| 0.50 | 0.87 | 23.0 | 25.0 | 23.0 | 23.0 | 27.5 | 18.5 |
| | | | | | | | |
| 0.49 | 0.87 | 23.0 | 25.0 | 23.0 | 23.0 | 27.5 | 18.5 |
| 0.48 | 0.86 | 23.0 | 25.0 | 23.0 | 23.0 | 27.5 | 18.5 |
| 0.47 | 0.86 | 23.0 | 24.5 | 23.0 | 23.0 | 27.5 | 18.5 |
| 0.46 | 0.86 | 22.5 | 24.5 | 22.5 | 22.5 | 27.0 | 18.5 |
| 0.45 | 0.85 | 22.5 | 24.5 | 22.5 | 22.5 | 27.0 | 18.0 |
| | | | | | | | |
| 0.44 | 0.85 | 22.5 | 24.5 | 22.5 | 22.5 | 27.0 | 18.0 |
| 0.43 | 0.84 | 22.5 | 24.5 | 22.5 | 22.5 | 27.0 | 18.0 |
| 0.42 | 0.84 | 22.5 | 24.0 | 22.5 | 22.5 | 26.5 | 18.0 |
| 0.41 | 0.84 | 22.0 | 24.0 | 22.0 | 22.0 | 26.5 | 18.0 |
| 0.40 | 0.83 | 22.0 | 24.0 | 22.0 | 22.0 | 26.5 | 18.0 |
| | | | | | | | |
| 0.39 | 0.83 | 22.0 | 24.0 | 22.0 | 22.0 | 26.5 | 17.5 |
| 0.38 | 0.82 | 22.0 | 23.5 | 22.0 | 22.0 | 26.0 | 17.5 |
| 0.37 | 0.82 | 21.5 | 23.5 | 21.5 | 21.5 | 26.0 | 17.5 |
| 0.36 | 0.82 | 21.5 | 23.5 | 21.5 | 21.5 | 26.0 | 17.5 |
| 0.35 | 0.81 | 21.5 | 23.5 | 21.5 | 21.5 | 26.0 | 17.0 |
| | | | | | | | |
| 0.34 | 0.81 | 21.5 | 23.0 | 21.5 | 21.5 | 25.5 | 17.0 |
| 0.33 | 0.80 | 21.0 | 23.0 | 21.0 | 21.0 | 25.5 | 17.0 |
| 0.32 | 0.80 | 21.0 | 23.0 | 21.0 | 21.0 | 25.5 | 17.0 |
| 0.31 | 0.79 | 21.0 | 22.5 | 21.0 | 21.0 | 25.0 | 17.0 |
| 0.30 | 0.79 | 21.0 | 22.5 | 21.0 | 21.0 | 25.0 | 17.0 |

**Table D.1—Minimum Elongation Values (Continued)**

| | Grade Constant | LC30-1812 $C$ = 26.5 | LC52-1200 $C$ = 21.2 | LC65-2205 $C$ = 26.5 | LC65-2206 $C$ = 26.5 | LC30-2242 $C$ = 26.5 | LC80-2507 $C$ = 21.2 |
|---|---|---|---|---|---|---|---|
| 0.29 | 0.78 | 20.5 | 22.5 | 20.5 | 20.5 | 25.0 | 16.5 |
| 0.28 | 0.78 | 20.5 | 22.5 | 20.5 | 20.5 | 24.5 | 16.5 |
| 0.27 | 0.77 | 20.5 | 22.0 | 20.5 | 20.5 | 24.5 | 16.5 |
| 0.26 | 0.76 | 20.0 | 22.0 | 20.0 | 20.0 | 24.5 | 16.0 |
| 0.25 | 0.76 | 20.0 | 22.0 | 20.0 | 20.0 | 24.0 | 16.0 |
| | | | | | | | |
| 0.24 | 0.75 | 20.0 | 21.5 | 20.0 | 20.0 | 24.0 | 16.0 |
| 0.23 | 0.75 | 20.0 | 21.5 | 20.0 | 20.0 | 23.5 | 16.0 |
| 0.22 | 0.74 | 19.5 | 21.0 | 19.5 | 19.5 | 23.5 | 15.5 |
| 0.21 | 0.73 | 19.5 | 21.0 | 19.5 | 19.5 | 23.5 | 15.5 |
| 0.20 | 0.72 | 19.0 | 21.0 | 19.0 | 19.0 | 23.0 | 15.0 |
| | | | | | | | |
| 0.19 | 0.72 | 19.0 | 20.5 | 19.0 | 19.0 | 23.0 | 15.0 |
| 0.18 | 0.71 | 19.0 | 20.5 | 19.0 | 19.0 | 22.5 | 15.0 |
| 0.17 | 0.70 | 18.5 | 20.0 | 18.5 | 18.5 | 22.5 | 15.0 |
| 0.16 | 0.69 | 18.5 | 20.0 | 18.5 | 18.5 | 22.0 | 14.5 |
| 0.15 | 0.68 | 18.0 | 19.5 | 18.0 | 18.0 | 22.0 | 14.5 |
| | | | | | | | |
| 0.14 | 0.67 | 18.0 | 19.5 | 18.0 | 18.0 | 21.5 | 14.0 |
| 0.13 | 0.66 | 17.5 | 19.0 | 17.5 | 17.5 | 21.0 | 14.0 |
| 0.12 | 0.65 | 17.5 | 19.0 | 17.5 | 17.5 | 21.0 | 14.0 |
| 0.11 | 0.64 | 17.0 | 18.5 | 17.0 | 17.0 | 20.5 | 13.5 |
| 0.10 | 0.63 | 16.5 | 18.0 | 16.5 | 16.5 | 20.0 | 13.5 |
| | | | | | | | |
| 0.09 | 0.62 | 16.5 | 17.5 | 16.5 | 16.5 | 19.5 | 13.0 |
| 0.08 | 0.60 | 16.0 | 17.5 | 16.0 | 16.0 | 19.0 | 13.0 |
| 0.07 | 0.59 | 15.5 | — | 15.5 | 15.5 | 18.5 | 12.5 |
| 0.06 | 0.57 | 15.0 | — | 15.0 | 15.0 | 18.0 | 12.0 |
| 0.05 | 0.55 | 14.5 | — | 14.5 | 14.5 | 17.5 | 11.5 |
| | | | | | | | |
| 0.04 | 0.53 | 14.0 | — | 14.0 | 14.0 | 16.5 | 11.0 |
| 0.03 | 0.50 | 13.0 | — | 13.0 | 13.0 | 16.0 | 10.5 |
| 0.02 | 0.46 | 12.0 | — | 12.0 | 12.0 | 14.5 | 10.0 |
| 0.01 | 0.40 | 10.5 | — | 10.5 | 10.5 | 12.5 | 8.5 |

# Annex E
(informative)

# Guided-bend Test Jig Dimensions

The following table lists the dimensions used for the guided bend test jig to conform to this standard.

**Table E.1—Guided-bend Test Jig Dimensions**

| 1 | 2 | 3 | | 4 | | 5 | | 1 | 2 | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | | Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | |
| | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | | | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | |
| $D$ | $t$ | in. | mm | in. | mm | in. | mm | $D$ | $t$ | in. | mm | in. | mm | in. | mm |
| $12^3/_4$ | 0.172 | 1.6 | 40.6 | 1.9 | 48.3 | 2.2 | 55.9 | 14 | 0.219 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 |
| $12^3/_4$ | 0.188 | 1.9 | 48.3 | 2.2 | 55.9 | 2.6 | 66.0 | 14 | 0.250 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 |
| $12^3/_4$ | 0.203 | 1.9 | 48.3 | 2.2 | 55.9 | 2.6 | 66.0 | 14 | 0.281 | 2.6 | 66.0 | 3.1 | 78.7 | 4.4 | 111.8 |
| $12^3/_4$ | 0.219 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 | 14 | 0.312 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| $12^3/_4$ | 0.250 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 | 14 | 0.344 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| $12^3/_4$ | 0.281 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 14 | 0.375 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| $12^3/_4$ | 0.312 | 3.1 | 78.7 | 3.7 | 94.0 | 5.2 | 132.1 | 14 | 0.406 | 4.4 | 111.8 | 5.2 | 132.1 | 7.4 | 188.0 |
| $12^3/_4$ | 0.330 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 14 | 0.438 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| $12^3/_4$ | 0.344 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 14 | 0.469 | 5.2 | 132.1 | 7.4 | 188.0 | 8.8 | 223.5 |
| $12^3/_4$ | 0.375 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 14 | 0.500 | 6.2 | 157.5 | 7.4 | 188.0 | 10.5 | 266.7 |
| $12^3/_4$ | 0.406 | 4.4 | 111.8 | 6.2 | 157.5 | 7.4 | 188.0 | 14 | 0.562 | 7.4 | 188.0 | 8.8 | 223.5 | 12.6 | 320.0 |
| $12^3/_4$ | 0.438 | 5.2 | 132.1 | 6.2 | 157.5 | 8.8 | 223.5 | 14 | 0.625 | 8.8 | 223.5 | 12.6 | 320.0 | 15.1 | 383.5 |
| $12^3/_4$ | 0.500 | 6.2 | 157.5 | 8.8 | 223.5 | 10.5 | 266.7 | 14 | 0.688 | 10.5 | 266.7 | 15.1 | 383.5 | 18.1 | 459.7 |
| $12^3/_4$ | 0.562 | 7.4 | 188.0 | 10.5 | 266.7 | 12.0 | 320.0 | 14 | 0.750 | 12.6 | 320.0 | 18.1 | 459.7 | 26.0 | 660.4 |
| $12^3/_4$ | 0.625 | 10.5 | 266.7 | 12.6 | 320.0 | 18.1 | 459.7 | 14 | 0.812 | — | — | — | — | — | — |
| $12^3/_4$ | 0.688 | 12.6 | 320.0 | 18.1 | 459.7 | 26.0 | 660.4 | 14 | 0.812 | 15.1 | 383.5 | 21.7 | 551.2 | 31.2 | 792.5 |
| $12^3/_4$ | 0.750 | 15.1 | 383.5 | 21.7 | 551.2 | 31.2 | 792.5 | 14 | 0.875 | 18.1 | 459.7 | 31.2 | 792.5 | 31.2 | 792.5 |
| $12^3/_4$ | 0.812 | 18.1 | 459.7 | 26.0 | 660.4 | 31.2 | 792.5 | 14 | 0.938 | 21.7 | 551.2 | 31.2 | 792.5 | 31.2 | 792.5 |
| $12^3/_4$ | 0.875 | 21.7 | 551.2 | 31.2 | 792.5 | 31.2 | 792.5 | | | | | | | | |
| | | | | | | | | 16 | 0.188 | 1.6 | 40.6 | 2.2 | 55.9 | 2.6 | 66.0 |
| 14 | 0.188 | 1.6 | 40.6 | 2.2 | 55.9 | 2.6 | 66.0 | 16 | 0.203 | 1.9 | 48.3 | 2.2 | 55.9 | 2.6 | 66.0 |
| 14 | 0.203 | — | — | — | — | 2.6 | 66.0 | 16 | 0.219 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 |
| 14 | 0.210 | 1.9 | 48.3 | 2.2 | 55.9 | 2.6 | 66.0 | 16 | 0.250 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 |

**Table E.1—Guided-bend Test Jig Dimensions (Continued)**

| 1 | 2 | 3 | | 4 | | 5 | | 1 | 2 | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | | Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | |
| | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | | | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | |
| $D$ | $t$ | in. | mm | in. | mm | in. | mm | $D$ | $t$ | in. | mm | in. | mm | in. | mm |
| 16 | 0.281 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 | 18 | 0.438 | 4.4 | 111.8 | 5.2 | 132.1 | 7.4 | 188.0 |
| 16 | 0.312 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 18 | 0.469 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| 16 | 0.344 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 18 | 0.500 | 5.2 | 132.1 | 6.2 | 157.5 | 8.8 | 223.5 |
| 16 | 0.375 | 3.7 | 94.0 | 4.4 | 111.8 | 6.2 | 157.5 | 18 | 0.562 | 6.2 | 157.5 | 7.4 | 188.0 | 10.5 | 266.7 |
| 16 | 0.406 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 18 | 0.625 | 7.4 | 188.0 | 8.8 | 223.5 | 12.6 | 320.0 |
| 16 | 0.438 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 18 | 0.688 | 8.8 | 223.5 | 10.5 | 266.7 | 15.1 | 383.5 |
| 16 | 0.469 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 18 | 0.750 | 10.5 | 266.7 | 12.6 | 320.0 | 18.1 | 459.7 |
| 16 | 0.500 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 18 | 0.812 | 12.6 | 320.0 | 15.1 | 383.5 | 21.7 | 551.2 |
| 16 | 0.562 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 18 | 0.875 | 12.6 | 320.0 | 18.1 | 459.7 | 26.1 | 662.9 |
| 16 | 0.625 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 18 | 0.938 | 15.1 | 383.5 | 21.7 | 551.2 | 31.2 | 792.5 |
| 16 | 0.688 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 18 | 1.000 | 18.1 | 459.7 | 26.0 | 660.4 | 31.2 | 792.5 |
| 16 | 0.750 | 10.5 | 266.7 | 15.1 | 383.5 | 21.7 | 551.2 | 18 | 1.062 | 21.7 | 551.2 | 31.2 | 792.5 | 31.2 | 792.5 |
| 16 | 0.812 | 12.6 | 320.0 | 18.1 | 459.7 | 26.0 | 660.4 | 18 | 1.125 | 26.0 | 660.4 | 31.2 | 792.5 | 31.2 | 792.5 |
| 16 | 0.875 | 15.1 | 383.5 | 21.7 | 551.2 | 31.2 | 792.5 | 18 | 1.188 | 31.2 | 792.5 | 31.2 | 792.5 | 31.2 | 792.5 |
| 16 | 0.938 | 18.1 | 459.7 | 26.0 | 660.4 | 31.2 | 792.5 | 18 | 1.250 | 31.2 | 792.5 | 31.2 | 792.5 | 31.2 | 792.5 |
| 16 | 1.000 | 21.7 | 551.2 | 31.2 | 792.5 | 31.2 | 792.5 | | | | | | | | |
| 16 | 1.062 | 26.0 | 564.2 | 31.2 | 792.5 | 31.2 | 792.5 | 20 | 0.219 | 1.9 | 48.3 | 2.2 | 55.9 | 2.6 | 66.0 |
| 16 | 1.125 | 31.2 | 792.5 | 31.2 | 792.5 | 31.2 | 792.5 | 20 | 0.250 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 |
| | | | | | | | | 20 | 0.281 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 |
| 18 | 0.188 | 1.6 | 40.6 | 1.9 | 48.3 | — | — | 20 | 0.312 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 18 | 0.219 | 1.9 | 48.3 | 2.2 | 55.9 | 2.6 | 66.0 | 20 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 18 | 0.250 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 | 20 | 0.375 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 18 | 0.281 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 | 20 | 0.406 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 18 | 0.312 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 20 | 0.438 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 18 | 0.344 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 20 | 0.469 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| 18 | 0.375 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 20 | 0.500 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| 18 | 0.406 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 20 | 0.562 | 7.4 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |

## Table E.1—Guided-bend Test Jig Dimensions (Continued)

| 1 | 2 | 3 | | 4 | | 5 | | 1 | 2 | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | | Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | |
| | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | | | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | |
| $D$ | $t$ | in. | mm | in. | mm | in. | mm | $D$ | $t$ | in. | mm | in. | mm | in. | mm |
| 20 | 0.625 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 22 | 0.750 | 8.8 | 223.5 | 10.5 | 266.7 | 15.1 | 383.5 |
| 20 | 0.688 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 22 | 0.812 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 20 | 0.750 | 8.8 | 223.5 | 12.6 | 320.0 | 15.1 | 383.5 | 22 | 0.875 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 20 | 0.812 | 10.5 | 266.7 | 15.1 | 383.5 | 18.1 | 459.7 | 22 | 0.938 | 12.6 | 320.0 | 18.1 | 459.7 | 21.7 | 551.2 |
| 20 | 0.875 | 12.6 | 320.0 | 15.1 | 383.5 | 21.7 | 551.2 | 22 | 1.000 | 15.1 | 383.5 | 18.1 | 459.7 | 26.0 | 660.4 |
| 20 | 0.935 | 15.1 | 383.5 | 18.1 | 459.7 | 26.0 | 660.4 | 22 | 1.062 | 15.1 | 383.5 | 21.7 | 551.2 | 31.2 | 792.5 |
| 20 | 1.000 | 15.1 | 383.5 | 21.7 | 551.2 | 31.2 | 792.5 | 22 | 1.125 | 18.1 | 459.7 | 26.0 | 660.4 | 31.2 | 792.5 |
| 20 | 1.062 | 18.1 | 459.7 | 26.0 | 660.4 | 31.2 | 792.5 | 22 | 1.188 | 21.7 | 551.2 | 31.2 | 792.5 | 31.2 | 792.5 |
| 20 | 1.125 | 21.7 | 551.2 | 31.2 | 792.5 | 31.2 | 792.5 | 22 | 1.250 | 21.7 | 551.2 | 31.2 | 792.5 | 31.2 | 792.5 |
| 20 | 1.188 | 26.0 | 660.4 | 31.2 | 792.5 | 31.2 | 792.5 | 22 | 1.312 | 26.0 | 660.4 | 31.2 | 792.5 | 31.2 | 792.5 |
| 20 | 1.250 | 26.0 | 660.4 | 31.2 | 792.5 | 31.2 | 792.5 | 22 | 1.375 | 31.2 | 792.5 | 31.2 | 792.5 | 31.2 | 792.5 |
| 20 | 1.312 | 31.2 | 792.5 | 31.2 | 792.5 | 31.2 | 792.5 | 22 | 1.438 | 31.2 | 792.5 | 31.2 | 792.5 | 31.2 | 792.5 |
| 20 | 1.375 | 31.2 | 792.5 | 31.2 | 792.5 | 31.2 | 792.5 | 22 | 1.500 | 31.2 | 792.5 | 31.2 | 792.5 | 31.2 | 792.5 |
| | | | | | | | | | | | | | | | |
| 22 | 0.219 | 1.9 | 48.3 | 2.2 | 55.9 | 2.6 | 66.0 | 24 | 0.250 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 |
| 22 | 0.250 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 | 24 | 0.281 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 |
| 22 | 0.281 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 | 24 | 0.312 | 3.1 | 66.0 | 3.7 | 94.0 | 4.4 | 111.8 |
| 22 | 0.312 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 24 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 22 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 24 | 0.375 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 22 | 0.375 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 24 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 22 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 6.2 | 157.5 | 24 | 0.438 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 22 | 0.438 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 24 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 22 | 0.469 | 4.4 | 111.8 | 6.2 | 157.5 | 7.4 | 188.0 | 24 | 0.500 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| 22 | 0.500 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 24 | 0.562 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| 22 | 0.562 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 24 | 0.625 | 6.2 | 157.5 | 8.8 | 223.5 | 10.5 | 266.7 |
| 22 | 0.625 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 24 | 0.688 | 7.4 | 188.0 | 8.8 | 223.5 | 12.6 | 320.0 |
| 22 | 0.688 | 7.4 | 188.0 | 10.5 | 266.7 | 12.6 | 320.0 | 24 | 0.750 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |

**Table E.1—Guided-bend Test Jig Dimensions (Continued)**

| 1 | 2 | 3 | | 4 | | 5 | | 1 | 2 | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | | Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | |
| | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | | | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | |
| $D$ | $t$ | in. | mm | in. | mm | in. | mm | $D$ | $t$ | in. | mm | in. | mm | in. | mm |
| 24 | 0.812 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 26 | 0.812 | 8.8 | 223.5 | 12.6 | 320.0 | 15.1 | 383.5 |
| 24 | 0.875 | 10.5 | 266.7 | 12.6 | 320.0 | 18.1 | 459.7 | 26 | 0.875 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 24 | 0.938 | 12.6 | 320.0 | 15.1 | 383.5 | 21.7 | 551.7 | 26 | 0.938 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 24 | 1.000 | 12.6 | 320.0 | 18.1 | 459.7 | 21.7 | 551.2 | 26 | 1.000 | 12.6 | 320.0 | 15.1 | 383.5 | 21.7 | 551.2 |
| 24 | 1.062 | 15.1 | 383.5 | 18.1 | 459.7 | 26.0 | 660.4 | | | | | | | | |
| 24 | 1.125 | 18.1 | 459.7 | 21.7 | 551.2 | 31.2 | 792.5 | 28 | 0.250 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 |
| 24 | 1.188 | 18.1 | 459.7 | 26.0 | 660.4 | 31.2 | 792.5 | 28 | 0.281 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 |
| 24 | 1.250 | 21.7 | 551.2 | 26.0 | 660.4 | 31.2 | 792.5 | 28 | 0.312 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 |
| 24 | 1.312 | 21.7 | 551.2 | 31.2 | 792.5 | 31.2 | 792.5 | 28 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 24 | 1.375 | 26.0 | 660.4 | 31.2 | 792.5 | 31.2 | 792.5 | 28 | 0.375 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 24 | 1.438 | 31.2 | 792.5 | 31.2 | 792.5 | 31.2 | 792.5 | 28 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 24 | 1.500 | 31.2 | 792.5 | 31.2 | 792.5 | 31.2 | 792.5 | 28 | 0.438 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 24 | 1.562 | 31.2 | 792.5 | 31.2 | 792.5 | 31.2 | 792.5 | 28 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| | | | | | | | | 28 | 0.500 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| 26 | 0.250 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 | 28 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 8.8 | 223.5 |
| 26 | 0.281 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 | 28 | 0.625 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| 26 | 0.312 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 | 28 | 0.688 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 26 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 28 | 0.750 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 26 | 0.375 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 28 | 0.812 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 26 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 28 | 0.875 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 26 | 0.438 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 28 | 0.938 | 10.5 | 266.7 | 15.1 | 383.5 | 18.1 | 459.7 |
| 26 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 28 | 1.000 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 26 | 0.500 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | | | | | | | | |
| 26 | 0.562 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 30 | 0.250 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 |
| 26 | 0.625 | 6.2 | 157.5 | 7.4 | 188.0 | 10.5 | 266.7 | 30 | 0.281 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 |
| 26 | 0.688 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 30 | 0.312 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 |
| 26 | 0.750 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 30 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |

## Table E.1—Guided-bend Test Jig Dimensions (Continued)

| 1 | 2 | 3 | | 4 | | 5 | | 1 | 2 | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | | Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | |
| | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | | | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | |
| $D$ | $t$ | in. | mm | in. | mm | in. | mm | $D$ | $t$ | in. | mm | in. | mm | in. | mm |
| 30 | 0.375 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 32 | 0.812 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 30 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 32 | 0.875 | 8.8 | 223.5 | 12.6 | 320.0 | 15.1 | 383.5 |
| 30 | 0.438 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 32 | 0.938 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 30 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 32 | 1.000 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 30 | 0.500 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 32 | 1.062 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 30 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 32 | 1.125 | 15.1 | 383.5 | 18.1 | 459.7 | 21.7 | 551.2 |
| 30 | 0.625 | 6.2 | 157.5 | 7.4 | l88.0 | 8.8 | 223.5 | 32 | 1.188 | 15.1 | 383.5 | 18.1 | 459.7 | 26.0 | 660.4 |
| 30 | 0.688 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 32 | 1.250 | 15.1 | 383.5 | 21.7 | 551.2 | 26.0 | 660.4 |
| 30 | 0.750 | 7.4 | 188.0 | 10.5 | 266.7 | 12.6 | 320.0 | | | | | | | | |
| 30 | 0.812 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 34 | 0.250 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 |
| 30 | 0.875 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 34 | 0.281 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 |
| 30 | 0.938 | 10.5 | 266.7 | 12.6 | 320.0 | 18.1 | 459.7 | 34 | 0.312 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 |
| 30 | 1.000 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 | 34 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| | | | | | | | | 34 | 0.375 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 32 | 0.250 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 | 34 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 32 | 0.281 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 | 34 | 0.438 | 3.7 | 94.0 | 5.2 | 132.1 | 5.2 | 132.1 |
| 32 | 0.312 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 | 34 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 32 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 34 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 32 | 0.375 | 3.7 | 94.0 | 3.7 | 94.0 | 5.2 | 132.1 | 34 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| 32 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.7 | 144.8 | 34 | 0.625 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| 32 | 0.438 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 34 | 0.688 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 32 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 34 | 0.750 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 32 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 34 | 0.812 | 8.8 | 223.5 | 10.5 | 266.7 | 15.0 | 381.0 |
| 32 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 34 | 0.875 | 8.8 | 223.5 | 10.5 | 266.7 | 15.1 | 383.5 |
| 32 | 0.625 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 34 | 0.938 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 32 | 0.688 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 34 | 1.000 | 10.5 | 266.7 | 15.1 | 383.5 | 18.1 | 459.7 |
| 32 | 0.750 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 34 | 1.062 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |

**Table E.1—Guided-bend Test Jig Dimensions (Continued)**

| 1 | 2 | 3 | | 4 | | 5 | | 1 | 2 | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | | Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | |
| | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | | | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | |
| $D$ | $t$ | in. | mm | in. | mm | in. | mm | $D$ | $t$ | $D$ | $t$ | in. | mm | in. | mm |
| 34 | 1.125 | 12.6 | 320.0 | 18.1 | 459.7 | 21.7 | 551.2 | 38 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 34 | 1.188 | 15.1 | 383.5 | 18.1 | 459.7 | 21.7 | 551.2 | 38 | 0.375 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 34 | 1.250 | 15.1 | 383.5 | 18.1 | 459.7 | 26.0 | 660.4 | 38 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| | | | | | | | | 38 | 0.438 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 36 | 0.250 | 2.2 | 55.9 | 2.6 | 66.0 | 3.1 | 78.7 | 38 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 36 | 0.281 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 | 38 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 36 | 0.312 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 | 38 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| 36 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 38 | 0.625 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| 36 | 0.375 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 38 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| 36 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 38 | 0.750 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 36 | 0.438 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 38 | 0.812 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 36 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 38 | 0.875 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 36 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 38 | 0.938 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 36 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 38 | 1.000 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 36 | 0.625 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 38 | 1.062 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 36 | 0.688 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 38 | 1.125 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 36 | 0.750 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 38 | 1.188 | 12.6 | 320.0 | 18.1 | 459.7 | 21.7 | 551.2 |
| 36 | 0.812 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 38 | 1.250 | 15.1 | 383.5 | 18.1 | 459.7 | 21.7 | 551.2 |
| 36 | 0.875 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | | | | | | | | |
| 36 | 0.938 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 40 | 0.312 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 |
| 36 | 1.000 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 40 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 36 | 1.062 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 | 40 | 0.375 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 36 | 1.125 | 12.6 | 320.0 | 15.1 | 383.5 | 21.7 | 551.2 | 40 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 36 | 1.188 | 15.1 | 383.5 | 18.1 | 459.7 | 21.7 | 551.2 | 40 | 0.438 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 36 | 1.250 | 15.1 | 383.5 | 18.1 | 459.7 | 26.0 | 660.4 | 40 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| | | | | | | | | 40 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 38 | 0.312 | 2.6 | 66.0 | 3.1 | 78.7 | 3.7 | 94.0 | 40 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |

## Table E.1—Guided-bend Test Jig Dimensions (Continued)

| 1 | 2 | 3 | | 4 | | 5 | | 1 | 2 | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | | Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | |
| | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | | | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | |
| $D$ | $t$ | in. | mm | in. | mm | in. | mm | $D$ | $t$ | $D$ | $t$ | in. | mm | in. | mm |
| 40 | 0.625 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 42 | 1.188 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 40 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 42 | 1.250 | 15.1 | 383.5 | 18.1 | 459.7 | 21.7 | 551.2 |
| 40 | 0.750 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | | | | | | | | |
| 40 | 0.812 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 44 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 40 | 0.875 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 44 | 0.375 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 40 | 0.938 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 44 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 40 | 1.000 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 44 | 0.438 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 40 | 1.062 | 10.5 | 266.7 | 15.1 | 383.5 | 18.1 | 459.7 | 44 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 40 | 1.125 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 | 44 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 40 | 1.188 | 12.6 | 320.0 | 15.1 | 383.5 | 21.7 | 551.2 | 44 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| 40 | 1.250 | 15.1 | 383.5 | 18.1 | 459.7 | 21.7 | 551.2 | 44 | 0.625 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| | | | | | | | | 44 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| 42 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 44 | 0.750 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 42 | 0.375 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 44 | 0.812 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 42 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 44 | 0.875 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 42 | 0.438 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 44 | 0.938 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 42 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 44 | 1.000 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 408.9 |
| 42 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 44 | 1.062 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 42 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 44 | 1.188 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 42 | 0.625 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 44 | 1.188 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 42 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 44 | 1.250 | 15.1 | 383.5 | 18.1 | 459.7 | 21.7 | 551.2 |
| 42 | 0.750 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | | | | | | | | |
| 42 | 0.812 | 7.4 | 188.0 | 10.5 | 266.7 | 10.5 | 266.7 | 46 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 42 | 0.875 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 46 | 0.375 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 42 | 0.938 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 46 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 42 | 1.000 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 46 | 0.438 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 42 | 1.062 | 10.5 | 266.7 | 12.6 | 320.0 | 18.1 | 459.7 | 46 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 42 | 1.125 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 | 46 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |

**Table E.1—Guided-bend Test Jig Dimensions (Continued)**

| 1 | 2 | 3 | | 4 | | 5 | | 1 | 2 | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | | Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | |
| | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | | | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | |
| $D$ | $t$ | in. | mm | in. | mm | in. | mm | $D$ | $t$ | $D$ | $t$ | in. | mm | in. | mm |
| 46 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 48 | 1.000 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 46 | 0.625 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 48 | 1.062 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 46 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 48 | 1.125 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 46 | 0.750 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 48 | 1.188 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 46 | 0.812 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 48 | 1.250 | 12.6 | 320.0 | 15.1 | 383.5 | 21.7 | 551.2 |
| 46 | 0.875 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | | | | | | | | |
| 46 | 0.938 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 52 | 0.375 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 46 | 1.000 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 52 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 46 | 1.062 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 52 | 0.438 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 46 | 1.125 | 12.6 | 320.0 | 15.1 | 383.0 | 18.1 | 459.7 | 52 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 46 | 1.188 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 | 52 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 46 | 1.250 | 12.6 | 320.0 | 18.1 | 459.7 | 21.7 | 551.2 | 52 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| | | | | | | | | 52 | 0.625 | 6.2 | 157.5 | 6.2 | 157.5 | 7.4 | 188.0 |
| 48 | 0.344 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 52 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| 48 | 0.375 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 52 | 0.750 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 48 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 52 | 0.812 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 48 | 0.438 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 52 | 0.875 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 48 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 52 | 0.938 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 48 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.7 | 170.2 | 52 | 1.000 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 48 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 52 | 1.062 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 48 | 0.625 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 52 | 1.125 | 10.5 | 266.7 | 12.6 | 320.0 | 18.1 | 459.7 |
| 48 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 52 | 1.188 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 48 | 0.750 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 52 | 1.250 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 48 | 0.812 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | | | | | | | | |
| 48 | 0.875 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 56 | 0.375 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 48 | 0.938 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 56 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |

## Table E.1—Guided-bend Test Jig Dimensions (Continued)

| 1 | 2 | 3 | | 4 | | 5 | | 1 | 2 | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | | Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | |
| | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | | | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | |
| $D$ | $t$ | in. | mm | in. | mm | in. | mm | $D$ | $t$ | $D$ | $t$ | in. | mm | in. | mm |
| 56 | 0.438 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 60 | 0.812 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 56 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 60 | 0.875 | 8.8 | 223.5 | 10.5 | 266.7 | 10.5 | 266.7 |
| 56 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 60 | 0.938 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 56 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 60 | 1.000 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 56 | 0.625 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 60 | 1.062 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 56 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 60 | 1.125 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 56 | 0.750 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 60 | 1.188 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 56 | 0.812 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 60 | 1.250 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 56 | 0.875 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | | | | | | | | |
| 56 | 0.938 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 64 | 0.375 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 |
| 56 | 1.000 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 64 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 56 | 1.062 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 64 | 0.438 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 |
| 56 | 1.125 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 64 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 5.2 | 132.1 |
| 56 | 1.188 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 | 64 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 56 | 1.250 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 | 64 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| | | | | | | | | 64 | 0.625 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| 60 | 0.375 | 3.1 | 78.7 | 3.7 | 94.0 | 4.4 | 111.8 | 64 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| 60 | 0.406 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 64 | 0.750 | 7.4 | 188.0 | 7.4 | 188.0 | 8.8 | 223.5 |
| 60 | 0.438 | 3.7 | 94.0 | 4.4 | 111.8 | 5.2 | 132.1 | 64 | 0.812 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 60 | 0.469 | 4.4 | 111.8 | 5.2 | 132.1 | 5.2 | 132.1 | 64 | 0.875 | 8.8 | 223.5 | 10.5 | 266.7 | 10.5 | 266.7 |
| 60 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 64 | 0.938 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 60 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 64 | 1.000 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 60 | 0.625 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 64 | 1.062 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 60 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 64 | 1.125 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 60 | 0.750 | 7.4 | 188.0 | 8.8 | 223.5 | 8.8 | 223.5 | 64 | 1.188 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |

**Table E.1—Guided-bend Test Jig Dimensions (Continued)**

| 1 | 2 | 3 | | 4 | | 5 | | 1 | 2 | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | | Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | |
| | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | | | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | |
| $D$ | $t$ | in. | mm | in. | mm | in. | mm | $D$ | $t$ | $D$ | $t$ | in. | mm | in. | mm |
| 64 | 1.250 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 | 72 | 0.625 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| | | | | | | | | 72 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| 68 | 0.469 | 4.4 | 111.8 | 4.4 | 111.8 | 5.2 | 132.1 | 72 | 0.750 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| 68 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 72 | 0.812 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 68 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 72 | 0.875 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 68 | 0.625 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 72 | 0.938 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 68 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 72 | 1.000 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 68 | 0.750 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | 72 | 1.062 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 68 | 0.812 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 72 | 1.125 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 68 | 0.875 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 | 72 | 1.188 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 68 | 0.938 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 72 | 1.250 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 68 | 1.000 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | | | | | | | | |
| 68 | 1.062 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 76 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 |
| 68 | 1.125 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 76 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 6.2 | 157.5 |
| 68 | 1.188 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 76 | 0.625 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 |
| 68 | 1.250 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 | 76 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| | | | | | | | | 76 | 0.750 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| 72 | 0.500 | 4.4 | 111.8 | 5.2 | 132.1 | 6.2 | 157.5 | 76 | 0.812 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 72 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 6.2 | 157.5 | 76 | 0.875 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |

**Table E.1—Guided-bend Test Jig Dimensions (Continued)**

| 1 | 2 | 3 | | 4 | | 5 | | 1 | 2 | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | | Outside Dia. (in.) | Wall Thick (in.) | Dimension A | | | | | |
| | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | | | | LC30-1812 LC30-2242 | | LC65-2205 LC65-2506 | | LC52-1200 | |
| $D$ | $t$ | in. | mm | in. | mm | in. | mm | $D$ | $t$ | $D$ | $t$ | in. | mm | in. | mm |
| 76 | 0.938 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 80 | 0.750 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 |
| 76 | 1.000 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 | 80 | 0.812 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 76 | 1.062 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 80 | 0.875 | 7.4 | 188.0 | 8.8 | 223.5 | 10.5 | 266.7 |
| 76 | 1.125 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 80 | 0.938 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 76 | 1.188 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 | 80 | 1.000 | 8.8 | 223.5 | 10.5 | 266.7 | 12.6 | 320.0 |
| 76 | 1.250 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 | 80 | 1.062 | 10.5 | 266.7 | 12.6 | 320.0 | 12.6 | 320.0 |
| | | | | | | | | 80 | 1.125 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 80 | 0.562 | 5.2 | 132.1 | 6.2 | 157.5 | 6.6 | 167.6 | 80 | 1.188 | 10.5 | 266.7 | 12.6 | 320.0 | 15.1 | 383.5 |
| 80 | 0.625 | 5.2 | 132.1 | 6.2 | 157.5 | 7.4 | 188.0 | 80 | 1.250 | 12.6 | 320.0 | 15.1 | 383.5 | 18.1 | 459.7 |
| 80 | 0.688 | 6.2 | 157.5 | 7.4 | 188.0 | 8.8 | 223.5 | | | | | | | | |

# Annex F
(informative)

# Metric Tables

The following tables provide the metric equivalents of USC values for dimensions, weights, and test pressures.

**Figure F.1—Metric Dimensions [a], Weights [b], and Test Pressures**

| Size | | | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Diameter $d$ | | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nom. in. | Designation | Outside Diameter $D$ in. | mm | lb/ft | kg/m | in. | mm | in. | mm | LC30 | LC52 | LC65 | LC80 |
| 1 | Std | 1.315 | 33.4 | 1.68 | 2.52 | 0.133 | 3.4 | 1.049 | 26.6 | 48 | — | 104 | — |
| 1 | XS | 1.315 | 33.4 | 2.17 | 3.21 | 0.179 | 4.5 | 0.957 | 24.4 | 59 | — | 128 | — |
| 1 | XXS | 1.315 | 33.4 | 3.66 | 5.45 | 0.358 | 9.1 | 0.599 | 15.2 | 69 | — | 150 | — |
| | | | | | | | | | | | | | |
| $1^1/_4$ | Std | 1.660 | 42.2 | 2.27 | 3.43 | 0.140 | 3.6 | 1.380 | 35.0 | 83 | — | 180 | — |
| $1^1/_4$ | XS | 1.660 | 42.2 | 3.00 | 4.51 | 0.191 | 4.9 | 1.278 | 32.4 | 124 | — | 207 | — |
| $1^1/_4$ | XXS | 1.660 | 42.2 | 5.21 | 7.77 | 0.382 | 9.7 | 0.896 | 22.8 | 152 | — | 207 | — |
| | | | | | | | | | | | | | |
| $1^1/_2$ | Std | 1.900 | 48.3 | 2.72 | 4.07 | 0.145 | 3.7 | 1.610 | 40.9 | 83 | — | 180 | — |
| $1^1/_2$ | XS | 1.900 | 48.3 | 3.63 | 5.43 | 0.200 | 5.1 | 1.500 | 38.1 | 124 | — | 207 | — |
| $1^1/_2$ | XXS | 1.900 | 48.3 | 6.41 | 9.58 | 0.400 | 10.2 | 1.100 | 27.9 | 152 | — | 207 | — |

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 2.375 | 60.3 | 2.03 | 3.01 | 0.083 | 2.1 | 56.1 | 108 | 187 | 207 | 207 |
| 2.375 | 60.3 | 2.64 | 3.97 | 0.109 | 2.8 | 54.7 | 144 | 207 | 207 | 207 |
| 2.375 | 60.3 | 3.00 | 4.51 | 0.125 | 3.2 | 53.9 | 165 | 207 | 207 | 207 |
| 2.375 | 60.3 | 3.36 | 5.03 | 0.141 | 3.6 | 53.1 | 185 | 207 | 207 | 207 |
| 2.375 | 60.3 | 3.65 | 5.42 | 0.154 | 3.9 | 52.5 | 201 | 207 | 207 | 207 |
| 2.375 | 60.3 | 4.05 | 6.07 | 0.172 | 4.4 | 51.5 | 207 | 207 | 207 | 207 |
| 2.375 | 60.3 | 4.39 | 6.57 | 0.188 | 4.8 | 50.7 | 207 | 207 | 207 | 207 |
| 2.375 | 60.3 | 5.02 | 7.43 | 0.218 | 5.5 | 49.3 | 207 | 207 | 207 | 207 |
| 2.375 | 60.3 | 5.67 | 8.51 | 0.250 | 6.4 | 47.5 | 207 | 207 | 207 | 207 |
| 2.375 | 60.3 | 6.28 | 9.31 | 0.281 | 7.1 | 46.1 | 207 | 207 | 207 | 207 |
| 2.375 | 60.3 | 9.03 | 13.47 | 0.436 | 11.1 | 38.1 | 207 | 207 | 207 | 207 |
| | | | | | | | | | | |
| 2.875 | 73.0 | 2.47 | 3.67 | 0.083 | 2.1 | 68.8 | 89 | 155 | 193 | 207 |
| 2.875 | 73.0 | 3.22 | 4.85 | 0.109 | 2.8 | 67.4 | 119 | 206 | 207 | 207 |
| 2.875 | 73.0 | 3.67 | 5.51 | 0.125 | 3.2 | 66.6 | 136 | 207 | 207 | 207 |
| 2.875 | 73.0 | 4.12 | 6.16 | 0.141 | 3.6 | 65.8 | 153 | 207 | 207 | 207 |
| 2.875 | 73.0 | 4.53 | 6.81 | 0.156 | 4.0 | 65.0 | 170 | 207 | 207 | 207 |
| 2.875 | 73.0 | 4.97 | 7.44 | 0.172 | 4.4 | 64.2 | 187 | 207 | 207 | 207 |
| 2.875 | 73.0 | 5.40 | 8.07 | 0.188 | 4.8 | 63.4 | 204 | 207 | 207 | 207 |
| 2.875 | 73.0 | 5.79 | 8.69 | 0.203 | 5.2 | 62.6 | 207 | 207 | 207 | 207 |
| 2.875 | 73.0 | 6.13 | 9.16 | 0.216 | 5.5 | 62.0 | 207 | 207 | 207 | 207 |
| 2.875 | 73.0 | 7.01 | 10.51 | 0.250 | 6.4 | 60.2 | 207 | 207 | 207 | 207 |
| 2.875 | 73.0 | 7.66 | 11.39 | 0.276 | 7.0 | 59.0 | 207 | 207 | 207 | 207 |
| 2.875 | 73.0 | 13.69 | 20.37 | 0.552 | 14.0 | 45.0 | 207 | 207 | 207 | 207 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 3.5 | 88.9 | 3.03 | 4.50 | 0.083 | 2.1 | 84.7 | 73 | 127 | 159 | 196 |
| 3.5 | 88.9 | 3.95 | 5.95 | 0.109 | 2.8 | 83.3 | 98 | 169 | 207 | 207 |
| 3.5 | 88.9 | 4.51 | 6.76 | 0.125 | 3.2 | 82.5 | 112 | 194 | 207 | 207 |
| 3.5 | 88.9 | 5.06 | 7.57 | 0.141 | 3.6 | 81.7 | 126 | 207 | 207 | 207 |
| 3.5 | 88.9 | 5.57 | 8.37 | 0.156 | 4.0 | 80.9 | 140 | 207 | 207 | 207 |
| 3.5 | 88.9 | 6.11 | 9.17 | 0.172 | 4.4 | 80.1 | 154 | 207 | 207 | 207 |
| 3.5 | 88.9 | 6.65 | 9.95 | 0.188 | 4.8 | 79.3 | 168 | 207 | 207 | 207 |
| 3.5 | 88.9 | 7.58 | 11.31 | 0.216 | 5.5 | 77.9 | 192 | 207 | 207 | 207 |
| 3.5 | 88.9 | 8.68 | 13.02 | 0.250 | 6.4 | 76.1 | 207 | 207 | 207 | 207 |
| 3.5 | 88.9 | 9.66 | 14.32 | 0.281 | 7.1 | 74.7 | 207 | 207 | 207 | 207 |
| 3.5 | 88.9 | 10.25 | 15.24 | 0.300 | 7.6 | 73.7 | 207 | 207 | 207 | 207 |
| 3.5 | 88.9 | 18.58 | 27.63 | 0.600 | 15.2 | 58.5 | 207 | 207 | 207 | 207 |
| | | | | | | | | | | |
| 4 | 101.6 | 3.47 | 5.15 | 0.083 | 2.1 | 97.4 | 64 | 111 | 139 | 171 |
| 4 | 101.6 | 4.53 | 6.82 | 0.109 | 2.8 | 96.0 | 86 | 148 | 185 | 207 |
| 4 | 101.6 | 5.17 | 7.76 | 0.125 | 3.2 | 95.2 | 98 | 169 | 207 | 207 |
| 4 | 101.6 | 5.81 | 8.70 | 0.141 | 3.6 | 94.4 | 110 | 191 | 207 | 207 |
| 4 | 101.6 | 6.40 | 9.63 | 0.156 | 4.0 | 93.6 | 122 | 207 | 207 | 207 |
| 4 | 101.6 | 7.03 | 10.55 | 0.172 | 4.4 | 92.8 | 134 | 207 | 207 | 207 |
| 4 | 101.6 | 7.65 | 11.46 | 0.188 | 4.8 | 92.0 | 147 | 207 | 207 | 207 |
| 4 | 101.6 | 9.11 | 13.48 | 0.226 | 5.7 | 90.2 | 174 | 207 | 207 | 207 |
| 4 | 101.6 | 10.01 | 15.02 | 0.250 | 6.4 | 88.8 | 195 | 207 | 207 | 207 |
| 4 | 101.6 | 11.16 | 16.55 | 0.281 | 7.1 | 87.4 | 207 | 207 | 207 | 207 |
| 4 | 101.6 | 12.50 | 18.68 | 0.318 | 8.1 | 85.4 | 207 | 207 | 207 | 207 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| **Size: Outside Dia.** $D$ | | **Plain-end Weight** $w_{pe}$ | | **Wall Thickness** $t$ | | **Inside Dia.** $d$ | **Test Pressure** psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | **LC30** | **LC52** | **LC65** | **LC80** |
| 4.5 | 114.3 | 3.92 | 5.81 | 0.083 | 2.1 | 110.1 | 57 | 99 | 124 | 152 |
| 4.5 | 114.3 | 5.84 | 8.77 | 0.125 | 3.2 | 107.9 | 87 | 151 | 188 | 207 |
| 4.5 | 114.3 | 6.56 | 9.83 | 0.141 | 3.6 | 107.1 | 98 | 169 | 207 | 207 |
| 4.5 | 114.3 | 7.24 | 10.88 | 0.156 | 4.0 | 106.3 | 109 | 188 | 207 | 207 |
| 4.5 | 114.3 | 7.95 | 11.92 | 0.172 | 4.4 | 105.5 | 119 | 207 | 207 | 207 |
| 4.5 | 114.3 | 8.66 | 12.96 | 0.188 | 4.8 | 104.7 | 130 | 207 | 207 | 207 |
| 4.5 | 114.3 | 9.32 | 13.99 | 0.203 | 5.2 | 103.9 | 141 | 207 | 207 | 207 |
| 4.5 | 114.3 | 10.01 | 15.01 | 0.219 | 5.6 | 103.1 | 152 | 207 | 207 | 207 |
| 4.5 | 114.3 | 10.79 | 16.02 | 0.237 | 6.0 | 102.3 | 163 | 207 | 207 | 207 |
| 4.5 | 114.3 | 11.35 | 17.03 | 0.250 | 6.4 | 101.5 | 174 | 207 | 207 | 207 |
| 4.5 | 114.3 | 12.66 | 18.77 | 0.281 | 7.1 | 100.1 | 193 | 207 | 207 | 207 |
| 4.5 | 114.3 | 13.96 | 20.73 | 0.312 | 7.9 | 98.5 | 207 | 207 | 207 | 207 |
| 4.5 | 114.3 | 14.98 | 22.42 | 0.337 | 8.6 | 97.1 | 207 | 207 | 207 | 207 |
| 4.5 | 114.3 | 19.00 | 28.25 | 0.438 | 11.1 | 92.1 | 207 | 207 | 207 | 207 |
| 4.5 | 114.3 | 22.51 | 33.56 | 0.531 | 13.5 | 87.3 | 207 | 207 | 207 | 207 |
| 4.5 | 114.3 | 27.54 | 40.99 | 0.674 | 17.1 | 80.1 | 207 | 207 | 207 | 207 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | **LC30** | **LC52** | **LC65** | **LC80** |
| 5.563 | 141.3 | 4.86 | 7.21 | 0.083 | 2.1 | 137.1 | 46 | 80 | 100 | 123 |
| 5.563 | 141.3 | 7.26 | 10.90 | 0.125 | 3.2 | 134.9 | 70 | 122 | 152 | 188 |
| 5.563 | 141.3 | 9.01 | 13.54 | 0.156 | 4.0 | 133.3 | 88 | 152 | 190 | 207 |
| 5.563 | 141.3 | 10.79 | 16.16 | 0.188 | 4.8 | 131.7 | 105 | 183 | 207 | 207 |
| 5.563 | 141.3 | 12.50 | 18.74 | 0.219 | 5.6 | 130.1 | 123 | 207 | 207 | 207 |
| 5.563 | 141.3 | 14.62 | 21.92 | 0.258 | 6.6 | 128.1 | 145 | 207 | 207 | 207 |
| 5.563 | 141.3 | 15.85 | 23.50 | 0.281 | 7.1 | 127.1 | 156 | 207 | 207 | 207 |
| 5.563 | 141.3 | 17.50 | 25.99 | 0.312 | 7.9 | 125.5 | 173 | 207 | 207 | 207 |
| 5.563 | 141.3 | 19.17 | 28.45 | 0.344 | 8.7 | 123.9 | 191 | 207 | 207 | 207 |
| 5.563 | 141.3 | 20.78 | 30.88 | 0.375 | 9.5 | 122.3 | 207 | 207 | 207 | 207 |
| 5.563 | 141.3 | 27.04 | 40.28 | 0.500 | 12.7 | 115.9 | 207 | 207 | 207 | 207 |
| 5.563 | 141.3 | 32.96 | 49.17 | 0.625 | 15.9 | 109.5 | 207 | 207 | 207 | 207 |
| 5.563 | 141.3 | 38.55 | 57.56 | 0.750 | 19.1 | 103.1 | 207 | 207 | 207 | 207 |
| | | | | | | | | | | |
| 6.625 | 168.3 | 5.80 | 8.61 | 0.083 | 2.1 | 164.1 | 39 | 67 | 84 | 103 |
| 6.625 | 168.3 | 7.59 | 11.43 | 0.109 | 2.8 | 162.7 | 52 | 89 | 112 | 138 |
| 6.625 | 168.3 | 8.68 | 13.03 | 0.125 | 3.2 | 161.9 | 59 | 102 | 128 | 157 |
| 6.625 | 168.3 | 9.76 | 14.62 | 0.141 | 3.6 | 161.1 | 66 | 115 | 144 | 177 |
| 6.625 | 168.3 | 10.78 | 16.21 | 0.156 | 4.0 | 160.3 | 74 | 128 | 160 | 197 |
| 6.625 | 168.3 | 11.85 | 17.78 | 0.172 | 4.4 | 159.5 | 81 | 141 | 176 | 207 |
| 6.625 | 168.3 | 12.92 | 19.35 | 0.188 | 4.8 | 158.7 | 88 | 153 | 192 | 207 |
| 6.625 | 168.3 | 13.92 | 20.91 | 0.203 | 5.2 | 157.9 | 96 | 166 | 207 | 207 |
| 6.625 | 168.3 | 14.98 | 22.47 | 0.219 | 5.6 | 157.1 | 103 | 179 | 207 | 207 |
| 6.625 | 168.3 | 17.02 | 25.55 | 0.250 | 6.4 | 155.5 | 118 | 205 | 207 | 207 |
| 6.625 | 168.3 | 18.97 | 28.22 | 0.280 | 7.1 | 154.1 | 131 | 207 | 207 | 207 |
| 6.625 | 168.3 | 21.04 | 31.25 | 0.312 | 7.9 | 152.5 | 146 | 207 | 207 | 207 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | **LC30** | **LC52** | **LC65** | **LC80** |
| 6.625 | 168.3 | 23.08 | 34.24 | 0.344 | 8.7 | 150.9 | 160 | 207 | 207 | 207 |
| 6.625 | 168.3 | 25.03 | 37.20 | 0.375 | 9.5 | 149.3 | 175 | 207 | 207 | 207 |
| 6.625 | 168.3 | 28.57 | 42.67 | 0.432 | 11.0 | 146.3 | 203 | 207 | 207 | 207 |
| 6.625 | 168.3 | 32.71 | 48.73 | 0.500 | 12.7 | 142.9 | 207 | 207 | 207 | 207 |
| 6.625 | 168.3 | 36.39 | 54.31 | 0.562 | 14.3 | 139.7 | 207 | 207 | 207 | 207 |
| 6.625 | 168.3 | 40.05 | 59.76 | 0.625 | 15.9 | 136.5 | 207 | 207 | 207 | 207 |
| 6.625 | 168.3 | 45.35 | 67.69 | 0.719 | 18.3 | 131.7 | 207 | 207 | 207 | 207 |
| 6.625 | 168.3 | 47.06 | 70.27 | 0.750 | 19.1 | 130.1 | 207 | 207 | 207 | 207 |
| 6.625 | 168.3 | 53.73 | 79.98 | 0.875 | 22.2 | 123.9 | 207 | 207 | 207 | 207 |
| | | | | | | | | | | |
| 8.625 | 219.1 | 11.35 | 17.04 | 0.125 | 3.2 | 212.7 | 45 | 79 | 98 | 121 |
| 8.625 | 219.1 | 14.11 | 21.22 | 0.156 | 4.0 | 211.1 | 57 | 98 | 123 | 151 |
| 8.625 | 219.1 | 16.94 | 25.37 | 0.188 | 4.8 | 209.5 | 68 | 118 | 147 | 181 |
| 8.625 | 219.1 | 18.26 | 27.43 | 0.203 | 5.2 | 208.7 | 74 | 128 | 160 | 197 |
| 8.625 | 219.1 | 19.66 | 29.48 | 0.219 | 5.6 | 207.9 | 79 | 137 | 172 | 207 |
| 8.625 | 219.1 | 22.36 | 33.57 | 0.250 | 6.4 | 206.3 | 91 | 157 | 196 | 207 |
| 8.625 | 219.1 | 24.70 | 36.61 | 0.277 | 7.0 | 205.1 | 99 | 172 | 207 | 207 |
| 8.625 | 219.1 | 27.70 | 41.14 | 0.312 | 7.9 | 203.3 | 112 | 194 | 207 | 207 |
| 8.625 | 219.1 | 28.55 | 42.65 | 0.322 | 8.2 | 202.7 | 116 | 201 | 207 | 207 |
| 8.625 | 219.1 | 30.42 | 45.14 | 0.344 | 8.7 | 201.7 | 123 | 207 | 207 | 207 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 8.625 | 219.1 | 33.04 | 49.10 | 0.375 | 9.5 | 200.1 | 135 | 207 | 207 | 121 |
| 8.625 | 219.1 | 38.30 | 56.94 | 0.438 | 11.1 | 196.9 | 157 | 207 | 207 | 151 |
| 8.625 | 219.1 | 43.39 | 64.64 | 0.500 | 12.7 | 193.7 | 180 | 207 | 207 | 181 |
| 8.625 | 219.1 | 48.40 | 72.22 | 0.562 | 14.3 | 190.5 | 203 | 207 | 207 | 197 |
| 8.625 | 219.1 | 53.40 | 79.67 | 0.625 | 15.9 | 187.3 | 207 | 207 | 207 | 207 |
| 8.625 | 219.1 | 60.71 | 90.62 | 0.719 | 18.3 | 182.5 | 207 | 207 | 207 | 207 |
| 8.625 | 219.1 | 63.08 | 94.20 | 0.750 | 19.1 | 180.9 | 207 | 207 | 207 | 207 |
| 8.625 | 219.1 | 67.76 | 100.84 | 0.812 | 20.6 | 177.9 | 207 | 207 | 207 | 207 |
| 8.625 | 219.1 | 72.42 | 107.79 | 0.875 | 22.2 | 174.7 | 207 | 207 | 207 | 207 |
| 8.625 | 219.1 | 81.44 | 121.33 | 1.000 | 25.4 | 168.3 | 207 | 207 | 207 | 207 |
| | | | | | | | | | | |
| 10.75 | 273.1 | 17.65 | 26.54 | 0.156 | 4.0 | 265.1 | 52 | — | 112 | 137 |
| 10.75 | 273.1 | 21.21 | 31.76 | 0.188 | 4.8 | 263.5 | 62 | — | 134 | 165 |
| 10.75 | 273.1 | 22.87 | 34.35 | 0.203 | 5.2 | 262.7 | 67 | — | 145 | 179 |
| 10.75 | 273.1 | 24.63 | 36.94 | 0.219 | 5.6 | 261.9 | 72 | — | 156 | 192 |
| 10.75 | 273.1 | 28.04 | 42.09 | 0.250 | 6.4 | 260.3 | 82 | — | 179 | 207 |
| 10.75 | 273.1 | 31.20 | 46.57 | 0.279 | 7.1 | 258.9 | 91 | — | 198 | 207 |
| 10.75 | 273.1 | 34.24 | 51.03 | 0.307 | 7.8 | 257.5 | 100 | — | 207 | 207 |
| 10.75 | 273.1 | 38.23 | 56.72 | 0.344 | 8.7 | 255.7 | 112 | — | 207 | 207 |
| 10.75 | 273.1 | 40.48 | 60.50 | 0.365 | 9.3 | 254.5 | 120 | — | 207 | 207 |
| 10.75 | 273.1 | 48.24 | 71.72 | 0.438 | 11.1 | 250.9 | 143 | — | 207 | 207 |
| 10.75 | 273.1 | 54.74 | 81.55 | 0.500 | 12.7 | 247.7 | 164 | — | 207 | 207 |
| 10.75 | 273.1 | 61.15 | 91.26 | 0.562 | 14.3 | 244.5 | 184 | — | 207 | 207 |
| 10.75 | 273.1 | 67.58 | 100.85 | 0.625 | 15.9 | 241.3 | 205 | — | 207 | 207 |
| 10.75 | 273.1 | 77.03 | 114.99 | 0.719 | 18.3 | 236.5 | 207 | — | 207 | 207 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | **LC30** | **LC52** | **LC65** | **LC80** |
| 10.75 | 273.1 | 86.18 | 128.27 | 0.812 | 20.6 | 231.9 | 207 | — | 207 | 207 |
| 10.75 | 273.1 | 92.28 | 137.36 | 0.875 | 22.2 | 228.7 | 207 | — | 207 | 207 |
| 10.75 | 273.1 | 98.30 | 146.32 | 0.938 | 23.8 | 225.5 | 207 | — | 207 | 207 |
| 10.75 | 273.1 | 104.13 | 155.15 | 1.000 | 25.4 | 222.3 | 207 | — | 207 | 207 |
| 10.75 | 273.1 | 126.83 | 189.22 | 1.250 | 31.8 | 209.5 | 207 | — | 207 | 207 |
| | | | | | | | | | | |
| 12.75 | 323.9 | 23.11 | 34.67 | 0.172 | 4.4 | 315.1 | 48 | — | 103 | 128 |
| 12.75 | 323.9 | 25.22 | 37.77 | 0.188 | 4.8 | 314.3 | 52 | — | 113 | 139 |
| 12.75 | 323.9 | 27.20 | 40.87 | 0.203 | 5.2 | 313.5 | 56 | — | 122 | 151 |
| 12.75 | 323.9 | 29.31 | 43.96 | 0.219 | 5.6 | 312.7 | 61 | — | 132 | 162 |
| 12.75 | 323.9 | 33.38 | 50.11 | 0.250 | 6.4 | 311.1 | 69 | — | 151 | 185 |
| 12.75 | 323.9 | 37.42 | 55.47 | 0.281 | 7.1 | 309.7 | 77 | — | 167 | 206 |
| 12.75 | 323.9 | 41.45 | 61.56 | 0.312 | 7.9 | 308.1 | 86 | — | 186 | 207 |
| 12.75 | 323.9 | 43.77 | 65.35 | 0.330 | 8.4 | 307.1 | 91 | — | 198 | 207 |
| 12.75 | 323.9 | 45.58 | 67.62 | 0.344 | 8.7 | 306.5 | 94 | — | 205 | 207 |
| 12.75 | 323.9 | 49.56 | 73.65 | 0.375 | 9.5 | 304.9 | 103 | — | 207 | 207 |
| 12.75 | 323.9 | 53.52 | 79.65 | 0.406 | 10.3 | 303.3 | 112 | — | 207 | 207 |
| 12.75 | 323.9 | 57.59 | 85.62 | 0.438 | 11.1 | 301.7 | 121 | — | 207 | 207 |
| 12.75 | 323.9 | 65.42 | 97.46 | 0.500 | 12.7 | 298.5 | 138 | — | 207 | 207 |
| 12.75 | 323.9 | 73.15 | 109.18 | 0.562 | 14.3 | 295.3 | 155 | — | 207 | 207 |
| 12.75 | 323.9 | 80.93 | 120.76 | 0.625 | 15.9 | 292.1 | 173 | — | 207 | 207 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 12.75 | 323.9 | 88.63 | 132.23 | 0.688 | 17.5 | 288.9 | 190 | — | 207 | 207 |
| 12.75 | 323.9 | 96.12 | 143.56 | 0.750 | 19.1 | 285.7 | 207 | — | 207 | 207 |
| 12.75 | 323.9 | 103.53 | 154.08 | 0.812 | 20.6 | 282.7 | 207 | — | 207 | 207 |
| 12.75 | 323.9 | 110.97 | 165.17 | 0.875 | 22.2 | 279.5 | 207 | — | 207 | 207 |
| 12.75 | 323.9 | 118.33 | 176.13 | 0.938 | 23.8 | 276.3 | 207 | — | 207 | 207 |
| 12.75 | 323.9 | 125.49 | 186.97 | 1.000 | 25.4 | 273.1 | 207 | — | 207 | 207 |
| 12.75 | 323.9 | 132.57 | 197.68 | 1.062 | 27.0 | 269.9 | 207 | — | 207 | 207 |
| 12.75 | 323.9 | 139.67 | 208.27 | 1.125 | 28.6 | 266.7 | 207 | — | 207 | 207 |
| 12.75 | 323.9 | 153.53 | 229.06 | 1.250 | 31.8 | 260.3 | 207 | — | 207 | 207 |
| | | | | | | | | | | |
| 14 | 355.6 | 27.73 | 41.52 | 0.188 | 4.8 | 346.0 | 47 | — | 103 | 127 |
| 14 | 355.6 | 29.91 | 44.93 | 0.203 | 5.2 | 345.2 | 51 | — | 111 | 137 |
| 14 | 355.6 | 30.93 | 45.78 | 0.210 | 5.3 | 345.0 | 52 | — | 114 | 140 |
| 14 | 355.6 | 32.23 | 48.33 | 0.219 | 5.6 | 344.4 | 55 | — | 120 | 148 |
| 14 | 355.6 | 36.71 | 55.11 | 0.250 | 6.4 | 342.8 | 63 | — | 137 | 169 |
| 14 | 355.6 | 41.17 | 61.02 | 0.281 | 7.1 | 341.4 | 70 | — | 152 | 187 |
| 14 | 355.6 | 45.61 | 67.74 | 0.312 | 7.9 | 339.8 | 78 | — | 169 | 207 |
| 14 | 355.6 | 50.17 | 74.42 | 0.344 | 8.7 | 338.2 | 86 | — | 186 | 207 |
| 14 | 355.6 | 54.57 | 81.08 | 0.375 | 9.5 | 336.6 | 94 | — | 204 | 207 |
| 14 | 355.6 | 58.94 | 87.71 | 0.406 | 10.3 | 335.0 | 102 | — | 207 | 207 |
| 14 | 355.6 | 63.44 | 94.30 | 0.438 | 11.1 | 333.4 | 110 | — | 207 | 207 |
| 14 | 355.6 | 67.78 | 100.86 | 0.469 | 11.9 | 331.8 | 118 | — | 207 | 207 |
| 14 | 355.6 | 72.09 | 107.39 | 0.500 | 12.7 | 330.2 | 126 | — | 207 | 207 |
| 14 | 355.6 | 80.66 | 120.36 | 0.562 | 14.3 | 327.0 | 141 | — | 207 | 207 |
| 14 | 355.6 | 89.28 | 133.19 | 0.625 | 15.9 | 323.8 | 157 | — | 207 | 207 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | **LC30** | **LC52** | **LC65** | **LC80** |
| 14 | 355.6 | 97.81 | 145.91 | 0.688 | 17.5 | 320.6 | 173 | — | 207 | 207 |
| 14 | 355.6 | 106.13 | 158.49 | 0.750 | 19.1 | 317.4 | 189 | — | 207 | 207 |
| 14 | 355.6 | 114.37 | 170.18 | 0.812 | 20.6 | 314.4 | 204 | — | 207 | 207 |
| 14 | 355.6 | 122.65 | 182.52 | 0.875 | 22.2 | 311.2 | 207 | — | 207 | 207 |
| 14 | 355.6 | 130.85 | 194.74 | 0.938 | 23.8 | 308.0 | 207 | — | 207 | 207 |
| 14 | 355.6 | 138.84 | 206.83 | 1.000 | 25.4 | 304.8 | 207 | — | 207 | 207 |
| 14 | 355.6 | 146.74 | 218.79 | 1.062 | 27.0 | 301.6 | 207 | — | 207 | 207 |
| 14 | 355.6 | 154.69 | 230.63 | 1.125 | 28.6 | 298.4 | 207 | — | 207 | 207 |
| 14 | 355.6 | 170.21 | 253.92 | 1.250 | 31.8 | 292.0 | 207 | — | 207 | 207 |
| | | | | | | | | | | |
| 16 | 406.4 | 31.75 | 47.54 | 0.188 | 4.8 | 396.8 | 42 | — | 90 | 111 |
| 16 | 406.4 | 34.25 | 51.45 | 0.203 | 5.2 | 396.0 | 45 | — | 97 | 120 |
| 16 | 406.4 | 36.91 | 55.35 | 0.219 | 5.6 | 395.2 | 48 | — | 105 | 129 |
| 16 | 406.4 | 42.05 | 63.13 | 0.250 | 6.4 | 393.6 | 55 | — | 120 | 148 |
| 16 | 406.4 | 47.17 | 69.91 | 0.281 | 7.1 | 392.2 | 61 | — | 133 | 164 |
| 16 | 406.4 | 52.27 | 77.63 | 0.312 | 7.9 | 390.6 | 68 | — | 148 | 182 |
| 16 | 406.4 | 57.52 | 85.32 | 0.344 | 8.7 | 389.0 | 75 | — | 163 | 201 |
| 16 | 406.4 | 62.58 | 92.98 | 0.375 | 9.5 | 387.4 | 82 | — | 178 | 207 |
| 16 | 406.4 | 67.62 | 100.61 | 0.406 | 10.3 | 385.8 | 89 | — | 193 | 207 |
| 16 | 406.4 | 72.80 | 108.20 | 0.438 | 11.1 | 384.2 | 96 | — | 207 | 207 |
| 16 | 406.4 | 77.79 | 115.77 | 0.469 | 11.9 | 382.6 | 103 | — | 207 | 207 |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 16 | 406.4 | 82.77 | 123.30 | 0.500 | 12.7 | 381.0 | 110 | — | 207 | 207 |
| 16 | 406.4 | 92.66 | 138.27 | 0.562 | 14.3 | 377.8 | 124 | — | 207 | 207 |
| 16 | 406.4 | 102.63 | 153.11 | 0.625 | 15.9 | 374.6 | 138 | — | 207 | 207 |
| 16 | 406.4 | 112.51 | 167.83 | 0.688 | 17.5 | 371.4 | 151 | — | 207 | 207 |
| 16 | 406.4 | 122.15 | 182.42 | 0.750 | 19.1 | 368.2 | 165 | — | 207 | 207 |
| 16 | 406.4 | 131.71 | 195.98 | 0.812 | 20.6 | 365.2 | 178 | — | 207 | 207 |
| 16 | 406.4 | 141.34 | 210.33 | 0.875 | 22.2 | 362.0 | 192 | — | 207 | 207 |
| 16 | 406.4 | 150.89 | 224.55 | 0.938 | 22.8 | 358.8 | 206 | — | 207 | 207 |
| 16 | 406.4 | 160.20 | 238.64 | 1.000 | 25.4 | 355.6 | 207 | — | 207 | 207 |
| 16 | 406.4 | 169.43 | 252.61 | 1.062 | 27.0 | 352.4 | 207 | — | 207 | 207 |
| 16 | 406.4 | 178.72 | 266.45 | 1.125 | 28.6 | 349.2 | 207 | — | 207 | 207 |
| 16 | 406.4 | 187.93 | 280.17 | 1.188 | 30.2 | 346.0 | 207 | — | 207 | 207 |
| 16 | 406.4 | 196.91 | 293.76 | 1.250 | 31.8 | 342.8 | 207 | — | 207 | 207 |
| | | | | | | | | | | |
| 18 | 457.0 | 35.76 | 53.53 | 0.188 | 4.8 | 447.4 | 37 | 64 | 80 | — |
| 18 | 457.0 | 41.59 | 62.34 | 0.219 | 5.6 | 445.8 | 43 | 75 | 93 | — |
| 18 | 457.0 | 47.39 | 71.12 | 0.250 | 6.4 | 444.2 | 49 | 85 | 107 | — |
| 18 | 457.0 | 53.18 | 78.77 | 0.281 | 7.1 | 442.8 | 55 | 95 | 118 | — |
| 18 | 457.0 | 58.94 | 87.49 | 0.312 | 7.9 | 441.2 | 61 | 105 | 132 | — |
| 18 | 457.0 | 64.87 | 96.18 | 0.344 | 8.7 | 439.6 | 67 | 116 | 145 | — |
| 18 | 457.0 | 70.59 | 104.84 | 0.375 | 9.5 | 438.0 | 73 | 127 | 158 | — |
| 18 | 457.0 | 76.29 | 113.46 | 0.406 | 10.3 | 436.4 | 79 | 137 | 172 | — |
| 18 | 457.0 | 82.15 | 122.05 | 0.438 | 11.1 | 434.8 | 85 | 148 | 185 | — |
| 18 | 457.0 | 87.81 | 130.62 | 0.469 | 11.9 | 433.2 | 92 | 159 | 198 | — |
| 18 | 457.0 | 93.45 | 139.15 | 0.500 | 12.7 | 431.6 | 98 | 169 | 207 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 18 | 457.0 | 104.67 | 156.11 | 0.562 | 14.3 | 428.4 | 110 | 191 | 207 | — |
| 18 | 457.0 | 115.98 | 172.95 | 0.625 | 15.9 | 425.2 | 122 | 207 | 207 | — |
| 18 | 457.0 | 127.21 | 189.67 | 0.688 | 17.5 | 422.0 | 135 | 207 | 207 | — |
| 18 | 457.0 | 138.17 | 206.25 | 0.750 | 19.1 | 418.8 | 147 | 207 | 207 | — |
| 18 | 457.0 | 149.06 | 221.69 | 0.812 | 20.6 | 415.8 | 159 | 207 | 207 | — |
| 18 | 457.0 | 160.03 | 238.03 | 0.875 | 22.2 | 412.6 | 171 | 207 | 207 | — |
| 18 | 457.0 | 170.92 | 254.25 | 0.938 | 23.8 | 409.4 | 183 | 207 | 207 | — |
| 18 | 457.0 | 181.56 | 270.34 | 1.000 | 25.4 | 406.2 | 195 | 207 | 207 | — |
| 18 | 457.0 | 192.11 | 286.30 | 1.062 | 27.0 | 403.0 | 207 | 207 | 207 | — |
| 18 | 457.0 | 202.75 | 302.14 | 1.125 | 28.6 | 399.8 | 207 | 207 | 207 | — |
| 18 | 457.0 | 213.31 | 317.85 | 1.188 | 30.2 | 396.6 | 207 | 207 | 207 | — |
| 18 | 457.0 | 223.61 | 333.44 | 1.250 | 31.8 | 393.4 | 207 | 207 | 207 | — |
| | | | | | | | | | | |
| 20 | 508.0 | 46.27 | 69.38 | 0.219 | 5.6 | 496.8 | 41 | 71 | 89 | — |
| 20 | 508.0 | 52.73 | 79.16 | 0.250 | 6.4 | 495.2 | 47 | 81 | 102 | — |
| 20 | 508.0 | 59.18 | 87.70 | 0.281 | 7.1 | 493.8 | 52 | 90 | 113 | — |
| 20 | 508.0 | 65.60 | 97.43 | 0.312 | 7.9 | 492.2 | 58 | 100 | 125 | — |
| 20 | 508.0 | 72.21 | 107.12 | 0.344 | 8.7 | 490.6 | 64 | 111 | 138 | — |
| 20 | 508.0 | 78.60 | 116.78 | 0.375 | 9.5 | 489.0 | 70 | 121 | 151 | — |
| 20 | 508.0 | 84.96 | 126.41 | 0.406 | 10.3 | 487.4 | 75 | 131 | 164 | — |
| 20 | 508.0 | 91.51 | 136.01 | 0.438 | 11.1 | 485.8 | 81 | 141 | 176 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 20 | 508.0 | 97.83 | 145.58 | 0.469 | 11.9 | 484.2 | 87 | 151 | 189 | — |
| 20 | 508.0 | 104.13 | 155.12 | 0.500 | 12.7 | 482.6 | 93 | 161 | 202 | — |
| 20 | 508.0 | 116.67 | 174.10 | 0.562 | 14.3 | 479.4 | 105 | 182 | 207 | — |
| 20 | 508.0 | 129.33 | 192.95 | 0.625 | 15.9 | 476.2 | 117 | 202 | 207 | — |
| 20 | 508.0 | 141.90 | 211.68 | 0.688 | 17.5 | 473.0 | 128 | 207 | 207 | — |
| 20 | 508.0 | 154.19 | 230.27 | 0.750 | 19.1 | 469.8 | 140 | 207 | 207 | — |
| 20 | 508.0 | 166.40 | 247.60 | 0.812 | 20.6 | 466.8 | 151 | 207 | 207 | — |
| 20 | 508.0 | 178.72 | 265.95 | 0.875 | 22.2 | 463.6 | 163 | 207 | 207 | — |
| 20 | 508.0 | 190.96 | 284.18 | 0.938 | 23.8 | 460.4 | 174 | 207 | 207 | — |
| 20 | 508.0 | 202.92 | 302.28 | 1.000 | 25.4 | 457.2 | 186 | 207 | 207 | — |
| 20 | 508.0 | 214.80 | 320.26 | 1.062 | 27.0 | 454.0 | 198 | 207 | 207 | — |
| 20 | 508.0 | 226.78 | 338.11 | 1.125 | 28.6 | 450.8 | 207 | 207 | 207 | — |
| 20 | 508.0 | 238.68 | 355.83 | 1.188 | 30.2 | 447.6 | 207 | 207 | 207 | — |
| 20 | 508.0 | 250.31 | 373.43 | 1.250 | 31.8 | 444.4 | 207 | 207 | 207 | — |
| 20 | 508.0 | 261.86 | 389.81 | 1.312 | 33.3 | 441.4 | 207 | 207 | 207 | — |
| 20 | 508.0 | 273.51 | 407.17 | 1.375 | 34.9 | 438.2 | 207 | 207 | 207 | — |
| | | | | | | | | | | |
| 22 | 559.0 | 50.94 | 76.42 | 0.219 | 5.6 | 547.8 | 37 | 65 | 81 | — |
| 22 | 559.0 | 58.07 | 87.21 | 0.250 | 6.4 | 546.2 | 43 | 74 | 92 | — |
| 22 | 559.0 | 65.18 | 96.63 | 0.281 | 7.1 | 544.8 | 47 | 82 | 102 | — |
| 22 | 559.0 | 72.27 | 107.36 | 0.312 | 7.9 | 543.2 | 53 | 91 | 114 | — |
| 22 | 559.0 | 79.56 | 118.06 | 0.344 | 8.7 | 541.6 | 58 | 100 | 126 | — |
| 22 | 559.0 | 86.61 | 128.73 | 0.375 | 9.5 | 540.0 | 63 | 110 | 137 | — |
| 22 | 559.0 | 93.63 | 139.37 | 0.406 | 10.3 | 538.4 | 69 | 119 | 149 | — |
| 22 | 559.0 | 100.86 | 149.97 | 0.438 | 11.1 | 536.8 | 74 | 128 | 160 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 22 | 559.0 | 107.85 | 160.55 | 0.469 | 11.9 | 535.2 | 79 | 137 | 172 | — |
| 22 | 559.0 | 114.81 | 171.09 | 0.500 | 12.7 | 533.6 | 85 | 147 | 183 | — |
| 22 | 559.0 | 128.67 | 192.08 | 0.562 | 14.3 | 530.4 | 95 | 165 | 206 | — |
| 22 | 559.0 | 142.68 | 212.95 | 0.625 | 15.9 | 527.2 | 106 | 184 | 207 | — |
| 22 | 559.0 | 156.60 | 233.68 | 0.688 | 17.5 | 524.0 | 117 | 202 | 207 | — |
| 22 | 559.0 | 170.21 | 254.30 | 0.750 | 19.1 | 520.8 | 127 | 207 | 207 | — |
| 22 | 559.0 | 183.75 | 273.51 | 0.812 | 20.6 | 517.8 | 137 | 207 | 207 | — |
| 22 | 559.0 | 197.41 | 293.87 | 0.875 | 22.2 | 514.6 | 148 | 207 | 207 | — |
| 22 | 559.0 | 211.00 | 314.11 | 0.938 | 23.8 | 511.4 | 159 | 207 | 207 | — |
| 22 | 559.0 | 224.28 | 334.23 | 1.000 | 25.4 | 508.2 | 169 | 207 | 207 | — |
| 22 | 559.0 | 237.48 | 354.22 | 1.062 | 27.0 | 505.0 | 180 | 207 | 207 | — |
| 22 | 559.0 | 250.81 | 374.08 | 1.125 | 28.6 | 501.8 | 190 | 207 | 207 | — |
| 22 | 559.0 | 264.06 | 393.81 | 1.188 | 30.2 | 498.6 | 201 | 207 | 207 | — |
| 22 | 559.0 | 277.01 | 413.42 | 1.250 | 31.8 | 495.4 | 207 | 207 | 207 | — |
| 22 | 559.0 | 289.88 | 431.69 | 1.312 | 33.3 | 492.4 | 207 | 207 | 207 | — |
| 22 | 559.0 | 302.88 | 451.06 | 1.375 | 34.9 | 489.2 | 207 | 207 | 207 | — |
| 22 | 559.0 | 315.79 | 470.30 | 1.438 | 36.5 | 486.0 | 207 | 207 | 207 | — |
| 22 | 559.0 | 328.41 | 489.41 | 1.500 | 38.1 | 482.8 | 207 | 207 | 207 | — |
| | | | | | | | | | | |
| 24 | 610.0 | 63.41 | 95.26 | 0.250 | 6.4 | 597.2 | 39 | 68 | 85 | — |
| 24 | 610.0 | 71.18 | 105.56 | 0.281 | 7.1 | 595.8 | 43 | 75 | 94 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 24 | 610.0 | 78.93 | 117.30 | 0.312 | 7.9 | 594.2 | 48 | 84 | 104 | — |
| 24 | 610.0 | 86.91 | 129.00 | 0.344 | 8.7 | 592.6 | 53 | 92 | 115 | — |
| 24 | 610.0 | 94.62 | 140.68 | 0.375 | 9.5 | 591.0 | 58 | 101 | 126 | — |
| 24 | 610.0 | 102.31 | 152.32 | 0.406 | 10.3 | 589.4 | 63 | 109 | 136 | — |
| 24 | 610.0 | 110.22 | 163.93 | 0.438 | 11.1 | 587.8 | 68 | 117 | 147 | — |
| 24 | 610.0 | 117.86 | 175.51 | 0.469 | 11.9 | 586.2 | 73 | 126 | 157 | — |
| 24 | 610.0 | 125.49 | 187.06 | 0.500 | 12.7 | 584.6 | 78 | 134 | 168 | — |
| 24 | 610.0 | 140.68 | 210.07 | 0.562 | 14.3 | 581.4 | 87 | 151 | 189 | — |
| 24 | 610.0 | 156.03 | 232.94 | 0.625 | 15.9 | 578.2 | 97 | 168 | 207 | — |
| 24 | 610.0 | 171.29 | 255.69 | 0.688 | 17.5 | 575.0 | 107 | 185 | 207 | — |
| 24 | 610.0 | 186.23 | 278.32 | 0.750 | 19.1 | 571.8 | 117 | 202 | 207 | — |
| 24 | 610.0 | 201.09 | 299.41 | 0.812 | 20.6 | 568.8 | 126 | 207 | 207 | — |
| 24 | 610.0 | 216.10 | 321.79 | 0.875 | 22.2 | 565.6 | 136 | 207 | 207 | — |
| 24 | 610.0 | 231.03 | 344.05 | 0.938 | 23.8 | 562.4 | 145 | 207 | 207 | — |
| 24 | 610.0 | 245.64 | 366.17 | 1.000 | 25.4 | 559.2 | 155 | 207 | 207 | — |
| 24 | 610.0 | 260.17 | 388.17 | 1.062 | 27.0 | 556.0 | 165 | 207 | 207 | — |
| 24 | 610.0 | 274.84 | 410.05 | 1.125 | 28.6 | 552.8 | 175 | 207 | 207 | — |
| 24 | 610.0 | 289.44 | 431.80 | 1.188 | 30.2 | 549.6 | 184 | 207 | 207 | — |
| 24 | 610.0 | 303.71 | 453.42 | 1.250 | 31.8 | 546.4 | 194 | 207 | 207 | — |
| 24 | 610.0 | 317.91 | 473.57 | 1.312 | 33.3 | 543.4 | 203 | 207 | 207 | — |
| 24 | 610.0 | 332.25 | 494.95 | 1.375 | 34.9 | 540.2 | 207 | 207 | 207 | — |
| 24 | 610.0 | 346.50 | 516.20 | 1.438 | 36.5 | 537.0 | 207 | 207 | 207 | — |
| 24 | 610.0 | 360.45 | 537.33 | 1.500 | 38.1 | 533.8 | 207 | 207 | 207 | — |
| 24 | 610.0 | 374.31 | 558.32 | 1.562 | 39.7 | 530.6 | 207 | 207 | 207 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 26 | 660.0 | 68.75 | 103.15 | 0.250 | 6.4 | 647.2 | 36 | 63 | 78 | — |
| 26 | 660.0 | 77.18 | 114.31 | 0.281 | 7.1 | 645.8 | 40 | 69 | 87 | — |
| 26 | 660.0 | 85.60 | 127.04 | 0.312 | 7.9 | 644.2 | 45 | 77 | 97 | — |
| 26 | 660.0 | 94.26 | 139.73 | 0.344 | 8.7 | 642.6 | 49 | 85 | 106 | — |
| 26 | 660.0 | 102.63 | 152.39 | 0.375 | 9.5 | 641.0 | 54 | 93 | 116 | — |
| 26 | 660.0 | 110.98 | 165.02 | 0.406 | 10.3 | 639.4 | 58 | 101 | 126 | — |
| 26 | 660.0 | 119.57 | 177.62 | 0.438 | 11.1 | 637.8 | 63 | 109 | 136 | — |
| 26 | 660.0 | 127.88 | 190.19 | 0.469 | 11.9 | 636.2 | 67 | 116 | 145 | — |
| 26 | 660.0 | 136.17 | 202.72 | 0.500 | 12.7 | 634.6 | 72 | 124 | 155 | — |
| 26 | 660.0 | 152.68 | 227.70 | 0.562 | 14.3 | 631.4 | 81 | 140 | 175 | — |
| 26 | 660.0 | 169.38 | 252.55 | 0.625 | 15.9 | 628.2 | 90 | 155 | 194 | — |
| 26 | 660.0 | 185.99 | 277.27 | 0.688 | 17.5 | 625.0 | 99 | 171 | 207 | — |
| 26 | 660.0 | 202.25 | 301.87 | 0.750 | 19.1 | 621.8 | 108 | 187 | 207 | — |
| 26 | 660.0 | 218.43 | 324.81 | 0.812 | 20.6 | 618.8 | 116 | 201 | 207 | — |
| 26 | 660.0 | 234.79 | 349.16 | 0.875 | 22.2 | 615.6 | 125 | 207 | 207 | — |
| 26 | 660.0 | 251.07 | 373.39 | 0.938 | 23.8 | 612.4 | 134 | 207 | 207 | — |
| 26 | 660.0 | 267.00 | 397.49 | 1.000 | 25.4 | 609.2 | 143 | 207 | 207 | — |
| | | | | | | | | | | |
| 28 | 711.0 | 74.09 | 111.20 | 0.250 | 6.4 | 698.2 | 34 | 58 | 73 | — |
| 28 | 711.0 | 83.19 | 123.24 | 0.281 | 7.1 | 696.8 | 37 | 64 | 81 | — |
| 28 | 711.0 | 92.26 | 136.97 | 0.312 | 7.9 | 695.2 | 41 | 72 | 90 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 28 | 711.0 | 101.61 | 150.67 | 0.344 | 8.7 | 693.6 | 46 | 79 | 99 | — |
| 28 | 711.0 | 110.64 | 164.34 | 0.375 | 9.5 | 692.0 | 50 | 86 | 108 | — |
| 28 | 711.0 | 119.65 | 177.98 | 0.406 | 10.3 | 690.4 | 54 | 93 | 117 | — |
| 28 | 711.0 | 128.93 | 191.58 | 0.438 | 11.1 | 688.8 | 58 | 101 | 126 | — |
| 28 | 711.0 | 137.90 | 205.15 | 0.469 | 11.9 | 687.2 | 62 | 108 | 135 | — |
| 28 | 711.0 | 146.85 | 218.69 | 0.500 | 12.7 | 685.6 | 67 | 115 | 144 | — |
| 28 | 711.0 | 164.69 | 245.68 | 0.562 | 14.3 | 682.4 | 75 | 130 | 162 | — |
| 28 | 711.0 | 182.73 | 272.54 | 0.625 | 15.9 | 679.2 | 83 | 144 | 180 | — |
| 28 | 711.0 | 200.68 | 299.28 | 0.688 | 17.5 | 676.0 | 92 | 159 | 199 | — |
| 28 | 711.0 | 218.27 | 325.89 | 0.750 | 19.1 | 672.8 | 100 | 173 | 207 | — |
| 28 | 711.0 | 235.78 | 350.72 | 0.812 | 20.6 | 669.8 | 108 | 187 | 207 | — |
| 28 | 711.0 | 253.48 | 377.08 | 0.875 | 22.2 | 666.6 | 116 | 202 | 207 | — |
| 28 | 711.0 | 271.10 | 403.32 | 0.938 | 23.8 | 663.4 | 125 | 207 | 207 | — |
| 28 | 711.0 | 288.36 | 429.44 | 1.000 | 25.4 | 660.2 | 133 | 207 | 207 | — |
| | | | | | | | | | | — |
| 30 | 762.0 | 79.43 | 119.25 | 0.250 | 6.4 | 749.2 | 31 | 54 | 68 | — |
| 30 | 762.0 | 89.19 | 132.17 | 0.281 | 7.1 | 747.8 | 35 | 60 | 75 | — |
| 30 | 762.0 | 98.93 | 146.91 | 0.312 | 7.9 | 746.2 | 39 | 67 | 84 | — |
| 30 | 762.0 | 108.95 | 161.61 | 0.344 | 8.7 | 744.6 | 43 | 74 | 92 | — |
| 30 | 762.0 | 118.65 | 176.29 | 0.375 | 9.5 | 743.0 | 46 | 80 | 101 | — |
| 30 | 762.0 | 128.32 | 190.93 | 0.406 | 10.3 | 741.4 | 50 | 87 | 109 | — |
| 30 | 762.0 | 138.29 | 205.54 | 0.438 | 11.1 | 739.8 | 54 | 94 | 118 | — |
| 30 | 762.0 | 147.92 | 220.12 | 0.469 | 11.9 | 738.2 | 58 | 101 | 126 | — |
| 30 | 762.0 | 157.53 | 234.67 | 0.500 | 12.7 | 736.6 | 62 | 108 | 134 | — |
| 30 | 762.0 | 176.69 | 263.67 | 0.562 | 14.3 | 733.4 | 70 | 121 | 151 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 30 | 762.0 | 196.08 | 292.54 | 0.625 | 15.9 | 730.2 | 78 | 135 | 168 | — |
| 30 | 762.0 | 215.38 | 321.29 | 0.688 | 17.5 | 727.0 | 86 | 148 | 185 | — |
| 30 | 762.0 | 234.29 | 349.91 | 0.750 | 19.1 | 723.8 | 93 | 162 | 202 | — |
| 30 | 762.0 | 253.12 | 376.63 | 0.812 | 20.6 | 720.8 | 101 | 174 | 207 | — |
| 30 | 762.0 | 272.17 | 405.00 | 0.875 | 22.2 | 717.6 | 108 | 188 | 207 | — |
| 30 | 762.0 | 291.14 | 433.26 | 0.938 | 23.8 | 714.4 | 116 | 202 | 207 | — |
| 36 | 762.0 | 309.72 | 461.38 | 1.000 | 25.4 | 711.2 | 124 | 207 | 207 | — |
| 30 | 762.0 | 328.22 | 489.38 | 1.062 | 27.0 | 708.0 | 132 | 207 | 207 | — |
| 30 | 762.0 | 346.93 | 517.25 | 1.125 | 28.6 | 704.8 | 140 | 207 | 207 | — |
| 30 | 762.0 | 365.56 | 544.99 | 1.188 | 30.2 | 701.6 | 148 | 207 | 207 | — |
| 30 | 762.0 | 383.81 | 572.61 | 1.250 | 31.8 | 698.4 | 155 | 207 | 207 | — |
| | | | | | | | | | | |
| 32 | 813.0 | 84.77 | 127.30 | 0.250 | 6.4 | 800.2 | 29 | 51 | 64 | — |
| 32 | 813.0 | 95.19 | 141.10 | 0.281 | 7.1 | 798.8 | 33 | 56 | 70 | — |
| 32 | 813.0 | 105.59 | 156.84 | 0.312 | 7.9 | 797.2 | 36 | 63 | 78 | — |
| 32 | 813.0 | 116.30 | 172.56 | 0.344 | 8.7 | 795.6 | 40 | 69 | 86 | — |
| 32 | 813.0 | 126.66 | 188.24 | 0.375 | 9.5 | 794.0 | 44 | 75 | 94 | — |
| 32 | 813.0 | 136.99 | 203.88 | 0.406 | 10.3 | 792.4 | 47 | 82 | 102 | — |
| 32 | 813.0 | 147.64 | 219.50 | 0.438 | 11.1 | 790.8 | 51 | 88 | 110 | — |
| 32 | 813.0 | 157.94 | 235.09 | 0.469 | 11.9 | 789.2 | 54 | 94 | 118 | — |
| 32 | 813.0 | 168.21 | 250.64 | 0.500 | 12.7 | 787.6 | 58 | 101 | 126 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 32 | 813.0 | 188.70 | 281.65 | 0.562 | 14.3 | 784.4 | 65 | 114 | 142 | — |
| 32 | 813.0 | 209.43 | 312.54 | 0.625 | 15.9 | 781.2 | 73 | 126 | 158 | — |
| 32 | 813.0 | 230.08 | 343.30 | 0.688 | 17.5 | 778.0 | 80 | 139 | 174 | — |
| 32 | 813.0 | 250.31 | 373.93 | 0.750 | 19.1 | 774.8 | 87 | 152 | 190 | — |
| 32 | 813.0 | 270.47 | 402.54 | 0.812 | 20.6 | 771.8 | 94 | 164 | 204 | — |
| 32 | 813.0 | 290.86 | 432.93 | 0.875 | 22.2 | 768.6 | 102 | 176 | 207 | — |
| 32 | 813.0 | 311.17 | 463.19 | 0.938 | 23.8 | 765.4 | 109 | 189 | 207 | — |
| 32 | 813.0 | 331.08 | 493.32 | 1.000 | 25.4 | 762.2 | 116 | 202 | 207 | — |
| 32 | 813.0 | 350.90 | 523.33 | 1.062 | 27.0 | 759.0 | 124 | 207 | 207 | — |
| 32 | 813.0 | 370.96 | 553.22 | 1.125 | 28.6 | 755.8 | 131 | 207 | 207 | — |
| 32 | 813.0 | 390.94 | 582.98 | 1.188 | 30.2 | 752.6 | 138 | 207 | 207 | — |
| 32 | 813.0 | 410.51 | 612.61 | 1.250 | 31.8 | 749.4 | 146 | 207 | 207 | — |
| | | | | | | | | | | |
| 34 | 864.0 | 90.11 | 135.35 | 0.250 | 6.4 | 851.2 | 28 | 48 | 60 | — |
| 34 | 864.0 | 101.19 | 150.03 | 0.281 | 7.1 | 849.8 | 31 | 53 | 66 | — |
| 34 | 864.0 | 112.25 | 166.78 | 0.312 | 7.9 | 848.2 | 34 | 59 | 74 | — |
| 34 | 864.0 | 123.65 | 183.50 | 0.344 | 8.7 | 846.6 | 37 | 65 | 81 | — |
| 34 | 864.0 | 134.67 | 200.18 | 0.375 | 9.5 | 845.0 | 41 | 71 | 89 | — |
| 34 | 864.0 | 145.67 | 216.84 | 0.406 | 10.3 | 843.4 | 44 | 77 | 96 | — |
| 34 | 864.0 | 157.00 | 233.46 | 0.438 | 11.1 | 841.8 | 48 | 83 | 104 | — |
| 34 | 864.0 | 167.95 | 250.05 | 0.469 | 11.9 | 840.2 | 51 | 89 | 111 | — |
| 34 | 864.0 | 178.89 | 266.61 | 0.500 | 12.7 | 838.6 | 55 | 95 | 119 | — |
| 34 | 864.0 | 200.70 | 299.64 | 0.562 | 14.3 | 835.4 | 62 | 107 | 134 | — |
| 34 | 864.0 | 222.78 | 332.53 | 0.625 | 15.9 | 832.2 | 69 | 119 | 148 | — |
| 34 | 864.0 | 244.77 | 365.31 | 0.688 | 17.5 | 829.0 | 75 | 131 | 163 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 34 | 864.0 | 266.33 | 397.95 | 0.750 | 19.1 | 825.8 | 82 | 143 | 178 | — |
| 34 | 864.0 | 287.81 | 428.44 | 0.812 | 20.6 | 822.8 | 89 | 154 | 192 | — |
| 34 | 864.0 | 309.55 | 460.85 | 0.875 | 22.2 | 819.6 | 96 | 166 | 207 | — |
| 34 | 864.0 | 331.21 | 493.12 | 0.938 | 23.8 | 816.4 | 103 | 178 | 207 | — |
| 34 | 864.0 | 352.44 | 525.27 | 1.000 | 25.4 | 813.2 | 109 | 190 | 207 | — |
| 34 | 864.0 | 373.59 | 557.29 | 1.062 | 27.0 | 810.0 | 116 | 202 | 207 | — |
| 34 | 864.0 | 394.99 | 589.19 | 1.125 | 28.6 | 806.8 | 123 | 207 | 207 | — |
| 34 | 864.0 | 416.31 | 620.96 | 1.188 | 30.2 | 803.6 | 130 | 207 | 207 | — |
| 34 | 864.0 | 437.21 | 652.60 | 1.250 | 31.8 | 800.4 | 137 | 207 | 207 | — |
| | | | | | | | | | | |
| 36 | 914.0 | 95.45 | 143.24 | 0.250 | 6.4 | 901.2 | 26 | 45 | 56 | — |
| 36 | 914.0 | 107.20 | 158.79 | 0.281 | 7.1 | 899.8 | 29 | 50 | 63 | — |
| 36 | 914.0 | 118.92 | 176.52 | 0.312 | 7.9 | 898.2 | 32 | 56 | 70 | — |
| 36 | 914.0 | 131.00 | 194.22 | 0.344 | 8.7 | 896.6 | 35 | 61 | 77 | — |
| 36 | 914.0 | 142.68 | 211.90 | 0.375 | 9.5 | 895.0 | 39 | 67 | 84 | — |
| 36 | 914.0 | 154.34 | 229.54 | 0.406 | 10.3 | 893.4 | 42 | 73 | 91 | — |
| 36 | 914.0 | 166.35 | 247.15 | 0.438 | 11.1 | 891.8 | 45 | 78 | 98 | — |
| 36 | 914.0 | 177.97 | 264.72 | 0.469 | 11.9 | 890.2 | 48 | 84 | 105 | — |
| 36 | 914.0 | 189.57 | 282.27 | 0.500 | 12.7 | 888.6 | 52 | 90 | 112 | — |
| 36 | 914.0 | 212.70 | 317.27 | 0.562 | 14.3 | 885.4 | 58 | 101 | 126 | — |
| 36 | 914.0 | 236.13 | 352.14 | 0.625 | 15.9 | 882.2 | 65 | 112 | 140 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 36 | 914.0 | 259.47 | 386.88 | 0.688 | 17.5 | 879.0 | 71 | 124 | 154 | — |
| 36 | 914.0 | 282.35 | 421.50 | 0.750 | 19.1 | 875.8 | 78 | 135 | 169 | — |
| 36 | 914.0 | 305.16 | 453.84 | 0.812 | 20.6 | 872.8 | 84 | 145 | 182 | — |
| 36 | 914.0 | 328.24 | 488.22 | 0.875 | 22.2 | 869.6 | 90 | 157 | 196 | — |
| 36 | 914.0 | 351.25 | 522.47 | 0.938 | 23.8 | 866.4 | 97 | 168 | 207 | — |
| 36 | 914.0 | 373.80 | 556.59 | 1.000 | 25.4 | 863.2 | 103 | 179 | 207 | — |
| 36 | 914.0 | 396.27 | 590.58 | 1.062 | 27.0 | 860.0 | 110 | 191 | 207 | — |
| 36 | 914.0 | 419.02 | 624.45 | 1.125 | 28.6 | 856.8 | 117 | 202 | 207 | — |
| 36 | 914.0 | 441.69 | 658.19 | 1.188 | 30.2 | 853.6 | 123 | 207 | 207 | — |
| 36 | 914.0 | 463.91 | 691.81 | 1.250 | 31.8 | 850.4 | 130 | 207 | 207 | — |
| | | | | | | | | | | |
| 38 | 965.0 | 125.58 | 186.46 | 0.312 | 7.9 | 949.2 | 30 | 53 | 66 | — |
| 38 | 965.0 | 138.35 | 205.17 | 0.344 | 8.7 | 947.6 | 34 | 58 | 73 | — |
| 38 | 965.0 | 150.69 | 223.84 | 0.375 | 9.5 | 946.0 | 37 | 64 | 79 | — |
| 38 | 965.0 | 163.01 | 242.49 | 0.406 | 10.3 | 944.4 | 40 | 69 | 86 | — |
| 38 | 965.0 | 175.71 | 261.11 | 0.438 | 11.1 | 942.8 | 43 | 74 | 93 | — |
| 38 | 965.0 | 187.99 | 279.69 | 0.469 | 11.9 | 941.2 | 46 | 80 | 99 | — |
| 38 | 965.0 | 200.25 | 298.24 | 0.500 | 12.7 | 939.6 | 49 | 85 | 106 | — |
| 38 | 965.0 | 224.71 | 335.25 | 0.562 | 14.3 | 936.4 | 55 | 96 | 120 | — |
| 38 | 965.0 | 249.48 | 372.14 | 0.625 | 15.9 | 933.2 | 61 | 106 | 133 | — |
| 38 | 965.0 | 274.16 | 408.89 | 0.688 | 17.5 | 930.0 | 68 | 117 | 146 | — |
| 38 | 965.0 | 298.37 | 445.52 | 0.750 | 19.1 | 926.8 | 74 | 128 | 160 | — |
| 38 | 965.0 | 322.50 | 479.75 | 0.812 | 20.6 | 923.8 | 79 | 138 | 172 | — |
| 38 | 965.0 | 346.93 | 516.14 | 0.875 | 22.2 | 920.6 | 86 | 148 | 186 | — |
| 38 | 965.0 | 371.28 | 552.40 | 0.938 | 23.8 | 917.4 | 92 | 159 | 199 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 38 | 965.0 | 395.16 | 588.53 | 1.000 | 25.4 | 914.2 | 98 | 170 | 207 | — |
| 38 | 965.0 | 418.96 | 624.54 | 1.062 | 27.0 | 911.0 | 104 | 181 | 207 | — |
| 38 | 965.0 | 443.05 | 660.42 | 1.125 | 28.6 | 907.8 | 110 | 191 | 207 | — |
| 38 | 965.0 | 467.06 | 696.18 | 1.188 | 30.2 | 904.6 | 117 | 202 | 207 | — |
| 38 | 965.0 | 490.61 | 731.80 | 1.250 | 31.8 | 901.4 | 123 | 207 | 207 | — |
| | | | | | | | | | | |
| 40 | 1016.0 | 132.25 | 196.39 | 0.312 | 7.9 | 1000.2 | 29 | 50 | 63 | — |
| 40 | 1016.0 | 145.69 | 216.11 | 0.344 | 8.7 | 998.6 | 32 | 55 | 69 | — |
| 40 | 1016.0 | 158.70 | 235.79 | 0.375 | 9.5 | 997.0 | 35 | 60 | 75 | — |
| 40 | 1016.0 | 171.68 | 255.45 | 0.406 | 10.3 | 995.4 | 38 | 65 | 82 | — |
| 40 | 1016.0 | 185.06 | 275.07 | 0.438 | 11.1 | 993.8 | 41 | 71 | 88 | — |
| 40 | 1016.0 | 198.01 | 294.66 | 0.469 | 11.9 | 992.2 | 44 | 76 | 94 | — |
| 40 | 1016.0 | 210.93 | 314.22 | 0.500 | 12.7 | 990.6 | 47 | 81 | 101 | — |
| 40 | 1016.0 | 236.71 | 353.24 | 0.562 | 14.3 | 987.4 | 52 | 91 | 114 | — |
| 40 | 1016.0 | 262.83 | 392.13 | 0.625 | 15.9 | 984.2 | 58 | 101 | 126 | — |
| 40 | 1016.0 | 288.86 | 430.90 | 0.688 | 17.5 | 981.0 | 64 | 111 | 139 | — |
| 40 | 1016.0 | 314.39 | 469.55 | 0.750 | 19.1 | 977.8 | 70 | 121 | 152 | — |
| 40 | 1016.0 | 339.84 | 505.66 | 0.812 | 20.6 | 974.8 | 75 | 131 | 164 | — |
| 40 | 1016.0 | 365.62 | 544.06 | 0.875 | 22.2 | 971.6 | 81 | 141 | 176 | — |
| 40 | 1016.0 | 391.32 | 582.33 | 0.938 | 23.8 | 968.4 | 87 | 151 | 189 | — |
| 40 | 1016.0 | 416.52 | 620.48 | 1.000 | 25.4 | 965.2 | 93 | 161 | 202 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

**Table F.1—Metric Dimensions [a], Weights [b], and Test Pressures (Continued)**

| Size: Outside Dia. $D$ | | Plain-end Weight $w_{pe}$ | | Wall Thickness $t$ | | Inside Dia. $d$ | Test Pressure psi min. kPa × 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| in. | mm | lb/ft | kg/m | in. | mm | mm | LC30 | LC52 | LC65 | LC80 |
| 40 | 1016.0 | 441.61 | 658.50 | 1.062 | 27.0 | 962.0 | 99 | 172 | 207 | — |
| 40 | 1016.0 | 467.08 | 696.39 | 1.125 | 28.6 | 958.8 | 105 | 182 | 207 | — |
| 40 | 1016.0 | 492.44 | 734.16 | 1.188 | 30.2 | 955.6 | 111 | 192 | 207 | — |
| 40 | 1016.0 | 517.31 | 771.80 | 1.250 | 31.8 | 952.4 | 117 | 202 | 207 | — |
| | | | | | | | | | | |
| 42 | 1067.0 | 153.04 | 227.05 | 0.344 | 8.7 | 1049.6 | 30 | 53 | 66 | — |
| 42 | 1067.0 | 166.71 | 247.74 | 0.375 | 9.5 | 1048.0 | 33 | 57 | 72 | — |
| 42 | 1067.0 | 180.35 | 268.40 | 0.406 | 10.3 | 1046.4 | 36 | 62 | 78 | — |
| 42 | 1067.0 | 194.42 | 289.03 | 0.438 | 11.1 | 1044.8 | 39 | 67 | 84 | — |
| 42 | 1067.0 | 208.03 | 309.62 | 0.469 | 11.9 | 1043.2 | 42 | 72 | 90 | — |
| 42 | 1067.0 | 221.61 | 330.19 | 0.500 | 12.7 | 1041.6 | 44 | 77 | 96 | — |
| 42 | 1067.0 | 248.72 | 371.22 | 0.562 | 14.3 | 1038.4 | 50 | 86 | 108 | — |
| 42 | 1067.0 | 276.18 | 412.13 | 0.625 | 15.9 | 1035.2 | 55 | 96 | 120 | — |
| 42 | 1067.0 | 303.55 | 452.91 | 0.688 | 17.5 | 1032.0 | 61 | 106 | 132 | — |
| 42 | 1067.0 | 330.41 | 493.57 | 0.750 | 19.1 | 1028.8 | 67 | 116 | 144 | — |
| 42 | 1067.0 | 357.19 | 531.57 | 0.812 | 20.6 | 1025.8 | 72 | 125 | 156 | — |
| 42 | 1067.0 | 384.31 | 571.98 | 0.875 | 22.2 | 1022.6 | 77 | 134 | 168 | — |
| 42 | 1067.0 | 411.35 | 612.26 | 0.938 | 23.8 | 1019.4 | 83 | 144 | 180 | — |
| 42 | 1067.0 | 437.88 | 652.42 | 1.000 | 25.4 | 1016.2 | 89 | 154 | 192 | — |
| 42 | 1067.0 | 464.33 | 692.45 | 1.062 | 27.0 | 1013.0 | 94 | 163 | 204 | — |
| 42 | 1067.0 | 491.11 | 732.36 | 1.125 | 28.6 | 1009.8 | 100 | 173 | 207 | — |
| 42 | 1067.0 | 517.82 | 772.14 | 1.188 | 30.2 | 1006.6 | 105 | 183 | 207 | — |
| 42 | 1067.0 | 544.01 | 811.79 | 1.250 | 31.8 | 1003.4 | 111 | 192 | 207 | — |

[a] Outside diameter and wall thickness dimensions shown are subject to tolerances. Inside diameters are nominal, and are given here for information only.

[b] Weights shown are for carbon steel. To obtain the weight for the alloy ordered use the appropriate correction factor from 10.1.

# Annex G
(informative)

# Purchaser Inspection

## G.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 at which the run is to be made.

## G.2 Inspection Location

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.

## G.3 Compliance

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

## G.4 Rejection

Unless otherwise provided, material that shows defects upon 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 which is 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.

# Bibliography

[1] API Standard 1104, *Welding of Pipelines and Related Facilities*

[2] ASME *Boiler and Pressure Vessel Code* [9], Section IX

[9] ASME International, 2 Park Avenue, New York, New York 10016-5990, www.asme.org.

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