Plus 4003-95

Specifications for Concrete and Concrete Structures Design

Compiled by ASTM for CSA

ASTM Standards referenced in CSA's A23.1/A23.2-94, Concrete Materials and Methods of Concrete Construction
A23.3-94, Design of Concrete Structures
A23.4-94, Precast Concrete — Materials and Construction
S413-94, Parking Structures

PREFACE

This publication was assembled for the Canadian Standards Association, and contains those ASTM standards referenced in the following CSA Concrete and Structural (Design) Standards.

A23.1/A23.2-94, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete

A23.3-94, Design of Concrete Structures

A23.4-94, Precast Concrete—Materials and Construction

S413-94, Parking Structures

This publication is intended to be used as a reference tool in conjunction with these standards.

The purpose of compiling the ASTM standards is to aid users of the CSA standards. The CSA documents remain the primary source-specific standards on concrete and structural design of concrete in Canada. While the issues of the ASTM standards contained in this book are those referenced by CSA, they may not be the latest editions published by ASTM.

ASTM has defined the purpose and use of ASTM standards as representing:

> . . . a common viewpoint of those parties concerned with its provisions, namely, producers, users, consumers, and general interest groups. It is intended to aid industry, government agencies, the general public. The use of an ASTM standard is purely voluntary. It is recognized that, for certain work or in certain regions, ASTM standard specifications may be either more or less restrictive than needed. The existence of an ASTM standard does not preclude anyone from manufacturing, marketing, or purchasing products, or using products, processes, or procedures not conforming to the standard. Because ASTM standards are subject to periodic review and revision, those who use them are cautioned to obtain the latest revision.

CSA is Canada's largest and oldest standards-writing, certification, testing, and inspection organization. A not-for-profit association, it has been bringing representatives of industry, government, and consumers together for over 75 years to develop standards for safety and performance.

All inquiries relating to the purchase of CSA standards should be addressed to: Canadian Standards Association, Standards Sales, 178 Rexdale Boulevard, Rexdale, Ontario M9W 1R3; Tel: (416) 747-4044; FAX: (416) 747-2475; or contact the nearest CSA office.

CONTENTS

Designation: A 53 – 94

Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless[1]

This standard is issued under the fixed designation A 53; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This specification has been approved for use by agencies of the Department of Defense to replace WW-P-404. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This specification[2] covers seamless and welded black and hot-dipped galvanized steel pipe in NPS ⅛ to 26 (Note 1), inclusive, with nominal (average) wall thickness as given in Tables X2.2 and X2.3. Pipe having other dimensions (Note 2) may be furnished provided such pipe complies with all other requirements of this specification.

NOTE 1—The dimensionless designator NPS (nominal pipe size) has been substituted in this standard for such traditional terms as "nominal diameter," "size," and "nominal size."

NOTE 2—A comprehensive listing of standardized pipe dimensions is contained in American National Standard ANSI B36.10.

1.2 Pipe may be furnished in the following types and grades:

1.2.1 *Type F*—Furnace-butt welded, continuous welded,

1.2.2 *Type E*—Electric-resistance welded, Grades A and B, and

1.2.3 *Type S*—Seamless, Grades A and B.

NOTE 3—See Appendix X1 for definitions of types of pipe.

1.3 Pipe ordered under this specification is intended for mechanical and pressure applications and is also acceptable for ordinary uses in steam, water, gas, and air lines. It is suitable for welding, and suitable for forming operations involving coiling, bending, and flanging, subject to the following qualifications:

1.3.1 Type F is not intended for flanging.

1.3.2 When Types S and E are required for close coiling or cold bending, Grade A should be specified. This provision is not intended to prohibit the cold bending of Grade B pipe.

1.3.3 When pipe is required for close coiling, this should be specified on the order.

1.3.4 Type E may be furnished either nonexpanded or cold expanded at the option of the manufacturer. When pipe is cold expanded, the amount of expansion shall not exceed 1½ % of the outside diameter pipe size.

1.4 The values stated in inch-pound units are to be regarded as the standard. The metric equivalents may be approximate.

1.5 The following precautionary caveat pertains only to the test method portion, Sections 9, 10, 11, 12, 13, and 14, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

A 90 Test Method for Weight (Mass) of Coating on Iron or Steel Articles with Zinc or Zinc-Alloy Coatings[3]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[4,5,6]

A 530/A 530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe[4]

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment[6]

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[4,5,6]

A 865 Specification for Threaded Couplings, Steel, Black and Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints[4]

B 6 Specification for Zinc[7]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[8]

E 59 Method for Sampling Steel and Iron for Determination of Chemical Composition[9]

E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing[10]

E 309 Practice for Eddy-Current Examination of Steel Tubular Products Using Magnetic Saturation[10]

E 570 Practice for Flux Leakage Examination of Ferromagnetic Steel Tubular Products[10]

2.2 *ANSI Standards:*

B1.20.1 Pipe Threads, General Purpose[11]

B36.10 Welded and Seamless Wrought Steel Pipe[11]

2.3 *Military Standards:*

---

[1] This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.09 on Steel Pipe.

Current edition approved Dec. 15, 1994. Published February 1995. Originally published as A 53 – 15. Last previous edition A 53 – 93a.

[2] For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-53 in Section II of that code.

[3] *Annual Book of ASTM Standards*, Vol 01.06.

[4] *Annual Book of ASTM Standards*, Vol 01.01.

[5] *Annual Book of ASTM Standards*, Vol 01.03.

[6] *Annual Book of ASTM Standards*, Vol 01.05.

[7] *Annual Book of ASTM Standards*, Vol 02.04.

[8] *Annual Book of ASTM Standards*, Vol 14.02.

[9] *Annual Book of ASTM Standards*, Vol 03.05.

[10] *Annual Book of ASTM Standards*, Vol 03.03.

[11] Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036; and American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017.

TABLE 1 Chemical Requirements

	Composition, max, %			
	Carbon	Manganese	Phosphorus	Sulfur
Type S (seamless pipe)				
Open-hearth, electric-furnace or basic-oxygen:				
Grade A	0.25	0.95	0.05	0.045
Grade B	0.30	1.20	0.05	0.045
Type E (electric-resistance-welded)				
Open-hearth, electric-furnace or basic-oxygen:				
Grade A	0.25	0.95	0.05	0.045
Grade B	0.30	1.20	0.05	0.045
Type F (furnace-welded pipe)				
Open-hearth, electric-furnace, or basic oxygen	0.30	1.20	0.05	0.045

TABLE 2 Limits on Unspecified Elements[A]

	Composition, max, %				
	Copper	Nickel	Chromium	Molybdenum	Vanadium
Type S (seamless pipe) and Type E (electric-resistance-welded)					
Open-hearth, electric-furnace or basic-oxygen:					
Grade A	0.40	0.40	0.40	0.15	0.08
Grade B	0.40	0.40	0.40	0.15	0.08
Type F (furnace-welded pipe)					
Open-hearth, electric-furnace or basic-oxygen:	0.40	0.40	0.40	0.15	0.08

[A] The combination of these five elements shall not exceed 1.00 %.

MIL-STD-129 Marking for Shipment and Storage[12]
MIL-STD-163 Steel Mill Products Preparation for Shipment and Storage[12]

2.4 *Federal Standards:*
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[13]
Fed. Std. No 183 Continuous Identification Marking of Iron and Steel Products[13]

2.5 *API Standard:*
5L Specification for Line Pipe[14]

3. Ordering Information

3.1 Orders for material under this specification should include the following, as required, to describe the desired material adequately:
3.1.1 Specification designation,
3.1.2 Quantity (feet, metres, or number of lengths),
3.1.3 Grade (see Tables 1 and 2),
3.1.4 Type (see 1.2 and Table 3),
3.1.5 Finish (black or galvanized),
3.1.6 Size (either nominal (NPS) and weight class or schedule number, or both; or outside diameter, and nominal wall thickness, Tables X2.2 and X2.3),
3.1.7 Length (specific or random, Section 17),
3.1.8 End finish (plain end or threaded, Section 18),
3.1.8.1 Threaded and coupled,
3.1.8.2 Threads only (no couplings), if desired,
3.1.8.3 Plain end, if desired,
3.1.8.4 Couplings power tight, if desired,
3.1.8.5 Taper tapped couplings for NPS 2 and smaller, if desired,
3.1.9 Close coiling, if required (see 1.3.3),
3.1.10 Skelp for tension tests, if permitted (see 12.2),
3.1.11 Certification (see Section 23),
3.1.12 End use of material,
3.1.13 Special requirements, and
3.1.14 Selection of applicable level of preservation and packaging and level of packing required, if other than as specified or if MIL-STD-163 applies (see 22.2).

[12] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.
[13] Available from General Services Administration, Washington, DC 20405.
[14] Available from American Petroleum Institute, Division of Production, 300 Corrigan Tower Building, Dallas, TX 75201.

4. Materials and Manufacture

4.1 The steel for both seamless and welded pipe shall be made by one or more of the following processes: open-hearth, electric-furnace, or basic-oxygen.

4.2 Steel may be cast in ingots or may be strand cast. When steels of different grades are sequentially strand cast, identification of the resultant transition material is required. The producer shall remove the transition material by any established procedure that positively separates the grades.

4.3 The weld seam of electric-resistance welded pipe in Grade B shall be heat treated after welding to a minimum of 1000°F (540°C) so that no untempered martensite remains, or otherwise processed in such a manner that no untempered martensite remains.

5. Chemical Composition

5.1 The steel shall conform to the requirements as to chemical composition in Tables 1 and 2 and the chemical analysis shall be in accordance with Test Methods, Practices, and Terminology A 751.

6. Product Analysis

6.1 An analysis of two pipes from each lot of 500 lengths, or fraction thereof, may be made by the purchaser. Samples for chemical analysis, except for spectrographic analysis, shall be taken in accordance with Method E 59. The chemical composition thus determined shall conform to the requirements specified in Tables 1 and 2.

6.2 If the analysis of either pipe does not conform to the requirements specified in Table 1, analyses shall be made on additional pipes of double the original number from the same lot, each of which shall conform to the requirements specified.

7. Tensile Requirements

7.1 The material shall conform to the requirements as to tensile properties prescribed in Table 3.

7.2 The yield strength corresponding to a permanent offset of 0.2 % of the gage length of the specimen or to a total extension of 0.5 % of the gage length under load shall be determined.

7.3 The test specimen taken across the weld shall show a tensile strength not less than the minimum tensile strength specified for the grade of pipe ordered. This test will not be required for pipe under NPS 8.

7.4 Transverse tension test specimens for electric-welded

TABLE 3 Tensile Requirements

	Type F	Types E and S	
	Open-Hearth, Basic Oxygen, or Electric-Furnace	Grade A	Grade B
Tensile strength, min, psi (MPa)	48 000 (330)	48 000 (330)	60 000 (415)
Yield strength, min, psi, (MPa)	30 000 (205)	30 000 (205)	35 000 (240)
Elongation in 2 in.	[A,B]	[A,B]	[A,B]

[A] The minimum elongation in 2 in. (50.8 mm) shall be that determined by the following equation:

$$e = 625\ 000\ A^{0.2}/U^{0.9}$$

where:

e = minimum elongation in 2 in. (50.8 mm) in percent rounded to the nearest 0.5 %,

A = cross-sectional area of the tension test specimen in square inches, based on specified outside diameter or nominal specimen width and specified wall thickness rounded to the nearest 0.01 in.^{2} If the area thus calculated is greater than 0.75 in.^{2}, then the value 0.75 shall be used, and

U = specified tensile strength, psi.

[B] See Table X4.1 for minimum elongation values for various size tension specimens and grades.

pipe NPS 8 and larger shall be taken opposite the weld. All transverse test specimens shall be approximately 1½ in. (38.1 mm) wide in the gage length, and shall represent the full wall thickness of the pipe from which the specimen was cut. This test is required for NPS 8 and larger.

8. Bending Requirements

8.1 For pipe NPS 2 and under, a sufficient length of pipe shall be capable of being bent cold through 90° around a cylindrical mandrel, the diameter of which is twelve times the outside diameter of the pipe, without developing cracks at any portion and without opening the weld.

8.2 When ordered for close coiling, the pipe shall stand being bent cold through 180° around a cylindrical mandrel, the diameter of which is eight times the outside diameter of the pipe, without failure.

8.3 Double-extra-strong pipe over NPS 1¼ need not be subjected to the bend test.

9. Flattening Test

9.1 The flattening test shall be made on pipe over NPS 2 with all thicknesses extra strong and lighter.

9.2 *Seamless Pipe:*

9.2.1 For seamless pipe, a section not less than 2½ 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, except as provided for in 9.7, shall occur until the distance between the plates (Table 4) is less than the value of H calculated as follows:

$$H = (1 + e)t/(e + t/D)$$

where:

TABLE 4 Flattening Requirements

Kind of Pipe	Distance between Plates, "H"
Butt-welded	60 % of outside diameter
Electric-resistance-welded, Grades A and B	one-third of outside diameter
Seamless, Grades A and B	to the distance H

H = distance between flattening plates, in. (Note 4),

e = deformation per unit length (constant for a given grade of steel, 0.09 for Grade A, and 0.07 for Grade B),

t = specified wall thickness, in., and

D = specified outside diameter, in.

9.2.2 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. Evidence of laminated or unsound material that is revealed during the entire flattening test shall be cause for rejection.

NOTE 4—The H values have been calculated for standard and extra-heavy weight sizes from NPS 2½ to 24, inclusive, and are shown in Table X2.1.

9.3 *Electric-Resistance-Welded Pipe*—A specimen at least 4 in. (101.6 mm) in length shall be flattened cold between parallel plates in three steps with the weld located either 0° or 90° from the line of direction of force as required in 9.3.1. During the first step, which is a test for ductility of the weld, no cracks or breaks on the inside or outside surfaces shall occur until the distance between the plates is less than two thirds of the original outside diameter of the pipe. As a second step, the flattening shall be continued. During the second step, which is a test for ductility exclusive of the weld, no cracks or breaks on the inside or outside surfaces, except as provided for in 9.7, shall occur until the distance between the plates is less than one third of the original outside diameter of the pipe but is not less than five times the wall thickness of the pipe. During the third step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the pipe meet. Evidence of laminated or unsound material or of incomplete weld that is revealed during the entire flattening test shall be cause for rejection.

9.3.1 For pipe produced in single lengths, the flattening test specified in 9.3 shall be made on both crop ends cut from each length of pipe. The tests from each end shall be made alternately with the weld at 0° and at 90° from the line of direction of force. For pipe produced in multiple lengths, the flattening test shall be made on crop ends representing the front and back of each coil with the weld at 90° from the line of direction of force, and on two intermediate rings representing each coil with the weld 0° from the line of direction of force.

9.4 *Continuous-Welded Pipe*—For continuous-welded pipe, a specimen not less than 4 in. in length shall be flattened cold between parallel plates in three steps. The weld shall be located 90° from the line of direction of force. During the first step, which is a test for quality of the weld, no cracks or breaks on the inside, outside, or end surfaces shall occur until the distance between the plates is less than three fourths of the original outside diameter for butt-welded pipe. As a second step, the flattening shall be continued. During the second step, which is a test for ductility exclusive of the weld, no cracks or breaks on the inside, outside, or end surfaces, except as provided for in 9.7, shall occur until the distance between the plates is less than 60 % of the original outside diameter for continuous-welded pipe. During the third step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the pipe meet. Evidence of laminated or unsound material or of incomplete weld that is revealed during the entire

flattening test shall be cause for rejection.

9.5 Surface imperfections in the test specimen before *flattening*, but revealed during the first step of the flattening test, shall be judged in accordance with the finish requirements in Section 20.

9.6 Superficial ruptures as a result of surface imperfections shall not be cause for rejection.

9.7 When low *D*-to-*t* ratio tubulars are tested, because the strain imposed due to geometry is unreasonably high on the inside surface at the 6 and 12 o'clock locations, cracks at these locations shall not be cause for rejection if the *D*-to-*t* ratio is less than 10.

10. Hydrostatic Test

10.1 The hydrostatic test shall be applied, without leakage through the pipe wall, to each length of pipe except as provided in 11.2 for seamless pipe.

10.2 Each length of plain-end pipe shall be tested by the manufacturer to the hydrostatic pressures prescribed in Table X2.2, and each threaded-and-coupled length shall be hydrostatically tested to pressures prescribed in Table X2.3. The hydrostatic test may be applied, at the discretion of the manufacturer, on pipe with plain ends, with threads only, or with threads and couplings and may be applied to pipe in single lengths or multiple lengths.

NOTE 5—The hydrostatic test pressures given herein are inspection test pressures, are not intended as a basis for design, and do not have any direct relationship to working pressures.

10.3 The minimum hydrostatic test pressure required to satisfy these requirements need not exceed 2500 psi (17.2 MPa) for NPS 3 and under, nor 2800 psi (19.3 MPa) for all sized over NPS 3. This does not prohibit testing at a higher pressure at the manufacturer's option. The hydrostatic pressure shall be maintained for not less than 5 s for all sizes of seamless and electric-welded pipe.

11. Nondestructive Electric Test

11.1 *Type E Pipe:*

11.1.1 The weld seam of each length of ERW pipe NPS 2 and larger shall be tested with a nondestructive electric test as follows:

11.1.2 *Ultrasonic and Electromagnetic Inspection*—Any equipment utilizing the ultrasonic or electromagnetic principles and capable of continuous and uninterrupted inspection of the weld seam shall be used. The equipment shall be checked with an applicable reference standard as described in 11.1.3 at least once every working turn or not more than 8 h to demonstrate its effectiveness and the inspection procedures. The equipment shall be adjusted to produce well-defined indications when the reference standard is scanned by the inspection unit in a manner simulating the inspection of the product.

11.1.3 *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 pipe manufacturer. Reference standards shall contain machined notches, one on the inside surface and one on the outside surface, or a drilled hole, as shown in Fig. 1, at the option of the pipe manufacturer. The notches shall be parallel to the weld seam, and shall be separated by a distance sufficient to produce two separate and distinguishable signals. The ⅛-in. (3.2-mm) hole shall be drilled through the wall and perpendicular to the surface of the reference standard as shown in Fig. 1. Care shall be taken in the preparation of the reference standard to ensure freedom from fins or other edge roughness, or distortion of the pipe.

NOTE 6—The reference standards defined in 11.1.3 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.

11.1.4 *Acceptance Limits*—Table 5 gives the height of acceptance limit signals in percent of the height of signals produced by reference standards. Imperfections in the weld seam that produce a signal greater than the acceptance limit signal given in Table 5 shall be considered an injurious defect unless the pipe manufacturer can demonstrate that the

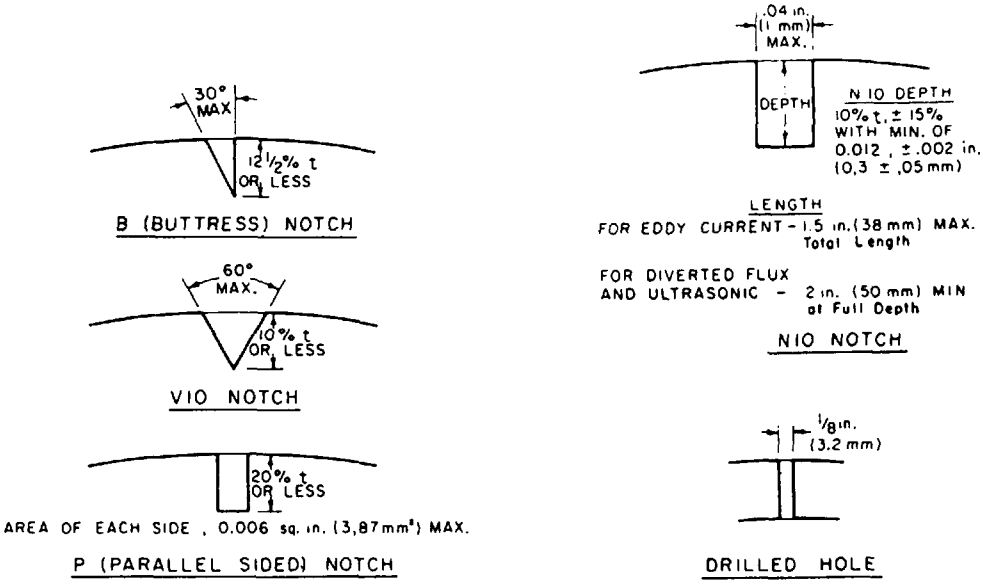

FIG. 1 Reference Standards

TABLE 5 Acceptance Limits

Type Notch	Size of Hole		Acceptance Limit Signal, %
	in.	mm	
N10, V10	⅛	3.2	100
B.P.	...	...	80

imperfection does not reduce the effective wall thickness beyond 12½ % of the specified wall thickness.

11.2 *Seamless Pipe*—As an alternative to the hydrostatic test, and when specified by the purchaser, the full body of each seamless pipe shall be tested with a nondestructive electric test in accordance with Practices E 213, E 309, or E 570. In this case each length so furnished shall include the mandatory marking of the letters "NDE." Except as provided in 11.2.6.2 it is the intent of this test to reject pipe with imperfections which produce test signals equal to or greater than that of the calibration standard.

11.2.1 When the nondestructive electric test is performed, the lengths shall be marked with the letters "NDE." The certification, when required, shall state Nondestructive Electric Tested and shall indicate which of the tests was applied. Also, the letters NDE shall be appended to the product specification number and material grade shown on the certification.

11.2.2 The following information is intended to facilitate the use of this specification.

11.2.2.1 The reference standards defined in 11.2.3 through 11.2.5 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.

11.2.2.2 The ultrasonic testing can be performed to detect both longitudinal and circumferentially oriented defects. It should be recognized that different techniques should be employed to detect differently oriented imperfections. The examination may not detect short, deep defects.

11.2.2.3 The eddy current examination referenced in this specification has the capability of detecting significant discontinuities, especially of the short abrupt type.

11.2.2.4 The flux leakage examination referred to in this specification is capable of detecting the presence and location of significant longitudinally or transversely oriented discontinuities. The provisions of this specification only require longitudinal calibration for flux leakage. It should be recognized that different techniques should be employed to detect differently oriented imperfections.

11.2.2.5 The hydrostatic test referred to in 10.2 has the capability of finding defects of a size permitting the test fluid to leak through the tube wall and may be either visually seen or detected by a loss of pressure. This test may not detect very tight, through-the-wall defects or defects that extend an appreciable distance into the wall without complete penetration.

11.2.2.6 A purchaser interested in ascertaining the nature (type, size, location, and orientation) of discontinuities that can be detected in the specific application of these examinations should discuss this with the manufacturer of the tubular product.

11.2.3 For ultrasonic testing, the calibration reference notches shall be at the option of the producer, and shall be any one of the three common notch shapes shown in Practice E 213. The depth of notch shall not exceed 12.5 % of the specified wall thickness of the pipe or 0.004 in., whichever is greater.

11.2.4 For eddy current testing, the calibration pipe shall contain, at the option of the producer, any one of the following discontinuities to establish a minimum sensitivity level for rejection.

11.2.4.1 *Drilled Hole*—Depending upon the pipe diameter the calibration pipe shall contain three holes spaced 120° apart or four holes spaced 90° apart and sufficiently separated longitudinally to ensure separately distinguishable responses. The holes shall be drilled radially and completely through the pipe wall, care being taken to avoid distortion of the pipe while drilling. Depending upon the pipe diameter the calibration pipe shall contain the following hole:

NPS	Diameter of Drilled Hole
≤ ½ in.	0.039 in (1 mm)
> ½≤ 1¼ in.	0.055 in. (1.4 mm)
> 1¼ ≤ 2 in.	0.071 in. (1.8 mm)
> 2 ≤ 5 in.	0.087 in. (2.2 mm)
> 5 in.	0.106 in. (2.7 mm)

11.2.4.2 *Transverse Tangential Notch*—Using a round tool or file with a ¼ in. (6.4 mm) diameter, a notch shall be filed or milled tangential to the surface and transverse to the longitudinal axis of the pipe. The notch shall have a depth not exceeding 12.5 % of the specified wall thickness of the pipe or 0.012 in. (0.3 mm), whichever is greater.

11.2.4.3 *Longitudinal Notch*—A notch 0.031 in. or less in width shall be machined in a radial plane parallel to the tube axis on the outside surface of the pipe, to have a depth not exceeding 12.5 % of the specified wall thickness of the tube or 0.012 in., whichever is greater. The length of the notch shall be compatible with the testing method.

11.2.4.4 *Compatibility*—The discontinuity in the calibration pipe shall be compatible with the testing equipment and the method being used.

11.2.5 For flux leakage testing, the longitudinal calibration reference notches shall be straight sided notches machined in a radial plane parallel to the pipe axis. For wall thickness under 0.5 in., outside and inside notches shall be used. For wall thickness equal and above 0.5 in. only an outside notch shall be used. Notch depth shall not exceed 12.5 % of the specified wall thickness, or 0.012 in., whichever is greater. Notch length shall not exceed 1 in., and the width shall not exceed the depth. Outside diameter and inside diameter notches shall be located sufficiently apart to allow separation and identification of the signals.

11.2.6 Pipe producing a signal equal to or greater than the signal produced by the calibration standard shall be subject to rejection. The area producing the signal may be re-examined.

11.2.6.1 Test signals produced by imperfections that cannot be identified, or produced by cracks or crack-like imperfections, shall result in rejection of the pipe, unless it is repaired and retested. To be accepted, the pipe must pass the same specification test to which it was originally subjected, provided that the remaining wall thickness is not decreased below that permitted by the specification. The O.D. at the point of grinding may be reduced by the amount as removed.

11.2.6.2 Test signals produced by visual imperfections