UL 971

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Nonmetallic Underground Piping For Flammable Liquids

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UL Standard for Safety for Nonmetallic Underground Piping For Flammable Liquids, UL 971

First Edition, Dated October 30, 1995

Revisions: This Standard contains revisions through and including March 2, 2006.

Summary of Topics

These revisions are being issued to correct the requirements that were published on February 22, 2006. Corrections to paragraphs 15A.12 and 15A.13 are being published to delete the references to reverse extrapolations.

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Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revisions dated March 2, 2006 include a reprinted title page (page1) for this Standard.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: http://ulstandardsinfonet.ul.com/ulforeword.html

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

This Standard consists of pages dated as shown in the following checklist:

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1	March 2, 2006
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5-14	January 2, 2004
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UL 971

Standard for Nonmetallic Underground Piping For Flammable Liquids

First Edition

October 30, 1995

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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INTRODUCTION

1 Scope

1.1 These requirements cover primary carrier, secondary containment, integral primary/secondary containment, normal vent and vapor recovery, nonmetallic pipe, fittings, and systems (products) intended for use underground in the distribution of petroleum-base flammable and combustible liquids, alcohols, and alcohol-blended fuels as identified in this standard.

Revised 1.1 effective July 1, 2005

1.2 The piping covered by these requirements is intended to be installed and used in accordance with the Flammable and Combustible Liquids Code, NFPA 30 and the Standard for Automotive and Marine Service Station Code, NFPA 30A.

1.3 These requirements cover nonmetallic thermoplastic (flexible) and thermoset (rigid) plastic piping with manufacturer-supplied fittings for underground use only. The products covered by this standard have been evaluated for assembly in normal soil applications by qualified persons in accordance with the manufacturer's instructions.

Revised 1.3 effective July 1, 2004

1.3.1 The products covered by this standard have not been evaluated for applications in sumps [more than 12 inches (30.5 cm) from sump wall], as connector pipe (between underground pipe and dispensing device), aboveground or marine use, or other applications exceeding ambient temperatures of 75°F (23°C).

Added 1.3.1 effective July 1, 2005

1.4 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 General

2.1 Units of measurement

2.1.1 If a value for measurement is followed by a value in other units in parentheses, the second value shall be only approximate. The first stated value is the requirement.

2.2 Undated references

2.2.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

2.3 Glossary

2.3.1 OPEN SECONDARY CONTAINMENT PIPING SYSTEM – A secondary piping system with ends normally open at the sump and a minimum rated pressure of 5.0 psig (35 kPa).

Revised 2.3.1 effective July 1, 2004

2.3.2 CLOSED SECONDARY CONTAINMENT PIPING SYSTEM – A secondary piping system with ends normally closed at the tank and sump with a minimum rated pressure of 50 psig (350 kPa).

Revised 2.3.2 effective July 1, 2004

2.3.3 BARRIER LINER – The thin inner or outer layer of a composite pipe that contains internal fuels, provides permeation resistance, and protects the outer structural pipe wall from exposure to fuels or external fluids.

Added 2.3.3 effective July 1, 2004

2.3.4 CHASE PIPE – An underground pipe that is used to route primary carrier, secondary containment, or integral primary/secondary pipe between storage tanks and containment sumps. Typically used to extract pipe without excavation and is not considered secondary containment.

Added 2.3.4 effective July 1, 2004

2.3.5 FITTING – A manufacturer-supplied component designed to connect, branch, or terminate pipe sections and contain liquids. Connections may be threaded, welded, crimped, clamped, compressed, thermo fused, solvent welded, or adhesive joined. Sump boots are not considered fittings.

Added 2.3.5 effective July 1, 2004

2.3.6 FLEXIBLE PIPING – Pipe with a manufacturer's recommended minimum bend radius less than or equal to 6 feet (1.8 m). Typically constructed from thermoplastic materials.

Added 2.3.6 effective July 1, 2004

2.3.7 INTEGRAL – Two or more separate components physically joined together or combined to form a single part at the manufacturer. Primary and secondary pipe joined in the field with a common fitting is not considered integral.

Added 2.3.7 effective July 1, 2004

2.3.8 INTEGRAL PRIMARY/SECONDARY PIPE – A single pipe, constructed at the manufacturer, that combines both primary carrier and secondary containment with an interstitial space that can be monitored for leakage.

Added 2.3.8 effective July 1, 2004

2.3.9 METALLIC – Pipe, fittings, or components primarily consisting of metals (typically corrosion-resistant malleable types such as steel, aluminum, copper, and brass) with or without minor nonmetallic components (such as gaskets, seals, sleeves or bushings).

Added 2.3.9 effective July 1, 2004

2.3.10 NON-INTEGRAL PRIMARY/SECONDARY PIPE – A pipe system with independent primary carrier and secondary containment connected in the field with an interstitial space that can be monitored for leakage.

Added 2.3.10 effective July 1, 2004

2.3.11 NONMETALLIC – Pipe, fittings, or components primarily consisting of nonmetals (typically polymeric thermoplastics, thermosets or composites) with or without minor metallic components (such as foils, braids, tapes, sleeves, or bushings).

Added 2.3.11 effective July 1, 2004

2.3.12 NORMAL VENT PIPE – A pipe system intended to transfer displaced gases (air and fluid vapors) from the top of an underground tank to grade during filling and provide atmospheric pressure equalization.

Added 2.3.12 effective July 1, 2004

2.3.13 PIPE – A long cylindrical thin-walled structure designed for the intended use of underground burial and conveying or containing liquids. The pipe structure may be formed from homogenous (single material), composite (multiple materials mixed together) or integral (individual materials joined as one component) elements.

Added 2.3.13 effective July 1, 2004

2.3.14 PIPE OR FITTING SIZE – Nominal or trade size (inches or mm) based on inside diameters of pipe and fittings.

Note – Nominal or trade sizes may not be equivalent to the actual measurements.

Added 2.3.14 effective July 1, 2004

2.3.15 PIPING SYSTEM – A combination of pipes and fittings joined to contain liquids transferred between a storage tank and sumps or dispensers (primary, secondary, or integral primary/secondary types) and vapor or air transfer between dispenser or tank to atmosphere (normal vent and vapor recovery types). The system may be primary, secondary, or an integral primary/secondary type. Also known as system.

Added 2.3.15 effective July 1, 2004

2.3.16 PRIMARY CARRIER PIPE – Pipe intended to be in continuous contact with the liquid flowing in a piping system under normal use. Also known as carrier pipe, primary pipe, or product pipe.

Added 2.3.16 effective July 1, 2004

2.3.17 QUALIFIED PERSON – A worker specifically trained by the manufacturer to perform proper installations of its piping systems in the field in accordance with the specified instructions. The qualified person is not required to be an employee of the manufacturer.

Added 2.3.17 effective July 1, 2004

2.3.18 RIGID PIPING – Pipe with a manufacturers recommended minimum bend radius greater than 6 feet (1.8 m). Typically constructed from thermoset materials.

Added 2.3.18 effective July 1, 2004

2.3.19 SECONDARY CONTAINMENT PIPE – Pipe intended to contain the liquid of a piping system during abnormal use (for example, primary carrier pipe leaks and sump or dispenser spills).

Added 2.3.19 effective July 1, 2004

2.3.20 SUMP – Accessible atmospheric enclosure located underground, typically below a dispenser or above a tank, and designed to monitor leaks, contain spills and house connector pipe and control valves.

Added 2.3.20 effective July 1, 2004

2.3.21 UNDERGROUND – Physically located below the surface layer of the earth in contact with soil (direct burial) or routed in a secondary or chase pipe (indirect burial). Underground does not include sump use more than 12 inches (30.5 cm) from the sump wall.

Added 2.3.21 effective July 1, 2004

2.3.22 VAPOR RECOVERY PIPE – A pipe system intended to transfer collected gasses (air and fluid vapors) from a vacuum system to an underground tank during dispensing. Also known as vapor pipe.

Added 2.3.22 effective July 1, 2004

CONSTRUCTION

2A General

Added 2A effective July 1, 2005

2A.1 All materials used in the construction of pipe, fittings or systems shall be suitable for their intended use with respect to normal (expected use within marked ratings) and abnormal (reasonable foreseeable misuse) conditions per the required performance tests described in Table 3.1.

2A.2 Metallics used in the construction of pipe, fittings or systems shall be inherently corrosion resistant (stainless steel, aluminum, brass) or be evaluated as equivalent to coating Designation G90 (galvanized with minimum 40 percent zinc on all sides) in ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process. Metallics shall not promote dielectric corrosion of dissimilar metals.

2A.3 All nonmetallics used in the construction of pipe, fittings, and systems shall be evaluated for long term exposure compatibility to air, soil, ultraviolet light and internal and external fluids at maximum 75°F (23°C) expected use.

2A.4 All gaskets and seals used to contain fluids used in piping systems shall comply with the performance tests in Table 3.1 plus the applicable requirements for their intended use in the Standard for Gaskets and Seals, UL 157.

2A.5 All adhesives used to join components in piping systems shall comply with the performance tests for the system in Tables 3.1 and the requirements for ″Adhesives – Specialized Applications″ specified in the Standard for Polymeric Materials, UL 746C.

2A.6 All tapes used to join components in piping systems shall comply with the performance tests for the system in Tables 3.1 and the requirements for the ″Tape Adhesion Test″ specified in the Standard for Polymeric Materials, UL 746C.

PERFORMANCE

3 General

3.1 Representative sample sizes of each type pipe, component, or system shall be subjected to the appropriate Performance Tests as specified in Table 3.1:

a) Pipe type – rigid (R), flexible (F);

b) Component – pipe (P), fitting (F);

c) System – primary carrier (PC), secondary containment (SC), integral primary/secondary (PS), normal vent (NV) or vapor recovery (VR).

Revised 3.1 effective July 1, 2005

3.1.1 Critical dimensions of all pipe (as applicable for each pipe construction and test) shall be measured before testing in accordance with ASTM D 3567, Standard Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings. All test samples shall be within the manufacturer's quality control specifications for minimum and average thickness and diameter.

Added 3.1.1 effective July 1, 2005

3.1.2 Calculated hoop stress of each type pipe in all nominal sizes in a product range shall be determined by the formula:

$$S = \frac{P(D-t)}{2t}$$

in which:

S is hoop stress (psi),

P is the breakdown pressure (psi) per 4A.4,

D is the average outside diameter inches per 3.1.1, and

t is the minimum wall thickness inches per 3.1.1.

This information may be used to determine ″worst case″ sizes for some tests to reduce samples.

Added 3.1.2 effective July 1, 2005

3.1.3 Representative sample sizes for the Performance Tests specified in Table 3.1 are defined as either

a) ″ALL″ for all nominal or trade sizes in a product range,

b) ″WC″ for worst case sizes per maximum average hoop stress per 3.1.2, or other analytical method, or

c) As otherwise indicated in the specific test.

Added 3.1.3 effective July 1, 2005

3.1.4 Representative worst case sample sizes for Long Term Compatibility and Permeation Tests shall be based on the minimum thickness of interior or exterior materials in contact with the test fluids.

Added 3.1.4 effective July 1, 2005

3.2 New samples may be used for each test except for the sequence of the Short Term Pressure Tests (Leakage per 4A.2, Hydrostatic per 4A.3 and Breakdown per 4A.4), which shall use the same sample and test equipment at successively higher pressures.

Revised 3.2 effective July 1, 2005

Table 3.1
Performance Tests for Underground Piping

Added Table 3.1 effective July 1, 2005

Clause	Test	Pipe type	Sample	Component/System
4A	Short Term Pressure			
4A.2	Leakage	R, F	ALL	PC, SC, PS, NV, VR
4A.3	Hydrostatic	R, F	ALL	PC, SC, PS, NV, VR
4A.4	Breakdown	R, F	ALL	PC, SC, PS, NV, VR
5A	Long Term Pressure			
5A.2	Sustained Pressure	F	WC	PC, PS
5A.3	Cyclic Pressure	R	WC	PC, PS
6A	Vacuum			
6A.2	Static Vacuum	R, F	ALL	PC, PS, NV
6A.3	Cyclic Vacuum	R, F	ALL	PC, PS, VR
7	Fitting Torque	R, F	ALL	F
8	Fitting Bending	R, F	ALL	F
9	Pipe Bending	R, F	ALL	P
10	Drop	R, F	ALL	F, P
11	Drop after Conditioning	R, F	ALL	F, P
12	Ball Impact	R, F	ALL	PC, SC, PS, NV, VR
13	Ball Impact after Conditioning	R, F	ALL	PC, SC, PS, NV, VR
14A	Pipe Burial			
14A.2	Pull Strength	R, F	ALL	PC, SC, PS, NV, VR
14A.3	Puncture Resistance	R, F	ALL	PC, SC, PS, NV, VR
14A.4	Crush Resistance	R, F	ALL	PC, SC, PS, NV, VR
15A	Long Term Compatibility	R, F	WC	PC, SC, PS, NV, VR
16A	Interstitial Communication	R, F	WC	PC, SC, PS, NV, VR
16B	UV Compatibility	R, F	WC	PC, SC, PS, NV, VR
16C	Nonmetallic Fitting Stress	R, F	WC	F
16D	Metallic Fitting Stress	R, F	WC	F
17	Permeation	R, F	WC	PC, SC, PS

NOTE – "WC" (worst case) indicates a sample, size, or test condition that is most likely to cause a non-complying result. Material, thickness, construction, components, and connections are to be considered for the selection of worst case samples or test conditions.

3.3 Assembly of all piping system samples shall be conducted by a qualified person using manufacturer-supplied components and tools in accordance with the manufacturer's instructions (minimum thread or screw torques, minimum cure temperature and time, crimp setting, or other critical parameters). If multiple methods of connecting pipe and fittings are used, each shall be evaluated.

Added 3.3 effective July 1, 2004

3.4 Damage shall be determined by visual examination of any critical part of a component or system sample after testing. The following items are examples of complying and non-complying results:

a) Flexible Piping and Fittings – discoloration or minor dimensional change is acceptable, but major dimensional change, cracking, splitting, bulging, collapse, and delamination are non-complying results;

b) Rigid Piping and Fittings – discoloration or minor stress cracking is acceptable, but major cracking, splitting, bulging, collapse, and delamination are non-complying results.

Added 3.4 effective July 1, 2005

3.5 Unless otherwise indicated in a specific test method, all tests shall be conducted with working fluids at 70 ±10°F (20 ±6°C) or at normal ambient temperatures between 65°F and 85°F (17°C and 29°C) and 50 percent (± 20 percent) RH. All pressures shall be measured with respect to gauge (psig).

Added 3.5 effective July 1, 2005

3.6 Unless otherwise indicated in a specific test method, hydrostatic tests shall be conducted with water and pneumatic tests shall be conducted with air (or other inert gasses). In either case, precautions shall be used to prevent personal injury.

Added 3.6 effective July 1, 2005

4 Cyclic Pressure Test – Primary Piping

4 deleted effective July 1, 2005

4A Short Term Pressure Tests

Added 4A effective July 1, 2005

4A.1 General

4A.1.1 Three 3-foot lengths of pipe types and systems indicated in each test method in all sizes shall be:

a) Measured per 3.1.1,

b) Assembled per 3.3, and

c) Tested in a continuous sequence in accordance with the Leakage, Hydrostatic, and Breakdown tests specified in sections 4A.2 – 4A.4

Six 3-foot samples of integral primary/secondary pipe are required to separately test the primary (3 samples) and secondary (3 samples).

4A.1.2 All pipe systems evaluated are to be filled with water before applying the test pressures hydrostatically. The test sequence shall start at 0 psig and gradually increase at:

a) 10 ±5 psig/min for pipe rated less than 50 psig;

b) 100 ±20 psig/min for pipe rated 50 psig or more.

There shall be a minimum 5-minute pause at each test level (except for the Breakdown Test, 4A.4) when the samples are to be visually examined for damage and leakage. Filling and sealing the primary of an integral pipe is permitted when testing the secondary to prevent implosion.

4A.1.3 All samples used for the Short Term Pressure Tests shall be tested hydrostatically. Alternatively, an aerostatic method or combined hydrostatic/aerostatic method may be used if found superior to the hydrostatic method when accurately determining leakage. Leakage is to be detected by visual examination with the aid of dyes, leak solution, blotting paper, bubble submersion or any other accurate and repeatable method.

4A.2 Leakage test

4A.2.1 Rigid and flexible type primary carrier, secondary containment, integral primary/secondary, normal vent and vapor recovery pipe systems shall be subjected to the Leakage Test.

4A.2.2 The Leakage Test pressure shall be twice the rating, and there shall be no leakage or any non-complying damage (see 3.4) while the samples are pressurized.

4A.3 Hydrostatic test

4A.3.1 Rigid and flexible type primary carrier, secondary containment, integral primary/secondary, normal vent and vapor recovery pipe systems shall be subjected to the Hydrostatic Test.

4A.3.2 The Hydrostatic Test pressure shall be five times the rating. There shall be no leakage while the samples are pressurized.

4A.4 Breakdown test

4A.4.1 Following the Hydrostatic Test, rigid & flexible type primary carrier, secondary containment, integral primary/secondary, normal vent and vapor recovery pipe systems shall be subjected to the following test.

4A.4.2 The test pressure is to be gradually increased at the rates specified in 4A.1.2 until severe leakage, rupture or burst occurs. The type and location of the breakdown or other significant observations (damage) shall be recorded along with the breakdown pressure for use in determining the retention values with other tests.

5 Leakage Test – Primary and Secondary Containment Piping

5 deleted effective July 1, 2005

5A Long Term Pressure Tests

Added 5A effective July 1, 2005

5A.1 General

5A.1.1 Three 3-foot lengths of pipe types and systems indicated in each test method in all sizes shall be:

a) Measured per 3.1.1,

b) Assembled per 3.3, and

c) Tested in accordance with the Sustained Pressure Test, Section 5A.2, or the Cyclic Pressure Test, Section 5A.3, as appropriate.

Only the primary of an integral primary/secondary system shall be pressurized for the test.

5A.1.2 Worst case samples used for the Long Term Pressure Tests shall use water as the test fluid. Leakage shall be detected by visual examination with or without dyes, leak solution, blotting paper, bubble submersion or any other accurate and repeatable method.

5A.2 Sustained pressure test

5A.2.1 Only flex type primary carrier and the primary of integral primary/secondary systems shall be subjected to the Sustained Pressure Test.

5A.2.2 Three samples of each system shall be tested in accordance with ASTM D 2837, Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials, with the breakdown time and pressures recorded at targeted times of approximately 1, 10, 100, 1000, and 2000 hours.

5A.2.3 Following the collection of all data points, a log and log plot of time verses pressure shall be developed, and a 30-year breakdown pressure extrapolated. The rated pressure shall be greater than the extrapolated 30-year breakdown pressure.

5A.3 Cyclic pressure test

5A.3.1 Only rigid type primary carrier and the primary of integral primary/secondary systems shall be subjected to the Cyclic Pressure Test.

5A.3.2 Three samples of each system shall be tested in accordance with ASTM D 2143, Test Method for Cyclic Pressure Strength of Reinforced Thermosetting Plastic Pipe. Alternating pressures (between 0 and rated pressure of equal times) shall be applied at 25 ±2 cycles per minute for 1.5 million cycles.

5A.3.3 Following the completion of the cycling, the test samples shall be visually examined for damage and leakage. There shall be no leakage or any non-complying damage during or after testing.

6 Hydrostatic Pressure Strength Test – Primary Piping

6 deleted effective July 1, 2005

6A Vacuum Tests

Added 6A effective July 1, 2005

6A.1 General

6A.1.1 Three 3-foot lengths of pipe types and systems indicated in each test method in all sizes shall be measured per 3.1.1 and assembled per 3.3, then tested in accordance with either 6A.2, Static Vacuum Test or 6A.3, Cyclic Vacuum Test or both. Only primary pipe or the primary of an integral primary/secondary normal vent or vapor recovery piping system shall be tested.

6A.1.2 Vacuum tests shall be conducted on all samples using air. Unless otherwise specified, a leakage test shall be conducted using water as the test fluid. Leakage shall be detected by visual examination with or without dyes, leak solution, blotting paper, bubble submersion or any other accurate and repeatable method.

6A.2 Static vacuum test

6A.2.1 Rigid and flexible type normal vent pipe systems shall be subjected to the Static Vacuum Test.

6A.2.2 All samples shall be subjected to a static vacuum of 28 inches Hg for 60 minutes followed by the Leakage Test specified in 4A.2 and visual examination.

6A.2.3 Following the test sequence, there shall be no leakage or any non-complying damage.

6A.3 Cyclic vacuum test

6A.3.1 Rigid and flexible type vapor recovery pipe systems shall be subjected to the Cyclic Vacuum Test.

6A.3.2 All samples are to be subjected to alternating pressures (approximately 3 seconds at 0 and approximately 7 seconds at rated vacuum) applied at 6 cycles per minute for 250,000 cycles followed by the Leakage Test specified in 4A.2 and visual examination.

6A.3.2 revised August 16, 2005

6A.3.3 Following the test sequence, there shall be no leakage or any non-complying damage.

7 Fitting Torque Test

Revised 7 effective July 1, 2005

7.1 Six 3-foot samples of all metallic or nonmetallic, rigid, and flexible-type fittings with any threaded connections in all sizes intended to accommodate threaded components not included in the manufacturer's piping system (such as connector pipe or valves) are to be assembled to mating nonmetallic pipe per 3.3. The samples shall then be assembled to a threaded Schedule 40 steel pipe at the torque values indicated in 7.2 at normal and low temperatures. The Leakage Test, 4A.2, shall then be repeated. Ninety-degree elbows are to be considered worst case for this test.

7.2 Three samples are to be assembled at 1-1/2 times the manufacturer's torque value under normal temperature conditions and another three samples are to be assembled at minus 20°F (minus 30°C). All of the samples shall then be subjected to the leakage test specified in 7.1 under normal temperature conditions.

7.3 The samples shall not leak or show any signs of non-complying damage when subjected to the test torques or pressures.

8 Fitting Bending Test

Revised 8 effective July 1, 2005

8.1 Six 3-foot samples of all metallic or nonmetallic, rigid, and flexible-type fittings with threaded connections intended to accommodate threaded components not included in the manufacturer's piping system (such as connector pipe or valves) in all sizes are to be assembled to mating nonmetallic pipe per 3.3. The samples are then be assembled to a 4-foot length of Schedule 40 steel pipe and subjected to the bending moment indicated in 8.2 and 8.3. The Leakage Test specified in 4A.2 shall be repeated. Ninety-degree elbows are to be considered worst case for this test.

8.2 Three samples are to be fixed (without adding or reducing the pipe stress) and subjected to a 2000 ft-lb bending moment applied within 1 minute at the top of the pipe under normal temperature conditions. The bending moments are to be applied both parallel and perpendicular to the pipe axis within 1 minute of each other. If the nonmetallic or steel pipe bends more than 45 degrees from the original axis before reaching the maximum value, the bending moment shall be stopped. The remaining three samples are to be subjected to the same test method except the temperature shall be minus 20°F (minus 30°C). After the conditioned samples return to normal temperature, all samples are to be subjected to the leakage test specified in 7.1.

8.3 The samples shall not leak or show any signs of non-complying damage when subjected to the bending load or and test pressures.

9 Pipe Bending Test

Revised 9 effective July 1, 2005

9.1 Six samples of rigid and flexible type pipe in all sizes, minimum 10 feet long, are to be measured per 3.1.1 and assembled per 3.3. The samples are to be divided into two equal sets of three. The samples of each set shall be provided with capped end fittings, and two of those samples shall be provided with centered connection fittings. All samples are to be subjected to a bending radius or deflection load per 9.2 and 9.3 at normal and low temperatures. The radius is to be measured at the pipe center. The Leakage Test specified in 4A.2 is to be repeated while in the bent position.

9.2 One set of samples is to be bent 1-1/2 times below the manufacturer's minimum bending radius (for pipe with marked bending radius) or deflected 1-1/2 times the centered distance at no load of the longest pipe (for pipe with zero bend radius) under normal temperature conditions for 1 minute. The other set of samples is to be subjected to the same test method except the temperature shall be minus 20°F (minus 30°C). The bend is to be applied using a simple support, 2- or 3-point loading system, or a mandrel. Any forces used are to be applied at the ends or center to equalize bending. After the conditioned samples return to normal temperature, all samples are to be subjected to the leakage test specified in 4A.2 while in the bent position.

9.3 The samples shall not leak or show any signs of non-complying damage when subjected to the bending load or and test pressures.

10 Drop Test

Revised 10 effective July 1, 2005

10.1 Three 2-foot samples of all rigid and flexible type pipe and fittings shall be measured per 3.1.1, then subjected to a drop test as indicated in 10.2 and 10.3. Following the drop, pipe and fittings are to be assembled per 3.3 and the Leakage Test specified in 4A.2, is to be repeated. Fittings are to be tested as parts (shell halves, bushings, rings, etc.) and subassemblies, except for metal and rubber components.

10.2 Each fitting component, fitting, and pipe is to be dropped six feet (measured from the bottom of the test sample) onto a flat concrete surface. The samples are to be impacted at the worst case locations. Each sample is to be visually examined before system assembly and evaluation to the Leakage Test specified in 4A.2.

10.3 If non-complying damage is visible to the naked eye from three feet away, the test is to be repeated with new samples at a reduced drop height. The drop height is to be maximum 6 inches below the original height but not less than 3 feet. The drops are to be repeated (each time reduced by 6-inch increments) until no damage is visible. The leakage test shall then be repeated. The samples shall not leak or show any signs of non-complying damage when assembled and subjected to the test pressure.

11 Drop Test After Conditioning

Revised 11 effective July 1, 2005

11.1 Six 2-foot samples of all rigid and flexible type pipe and fittings are to be measured per 3.1.1, with three samples conditioned for a minimum of 2 hours at 120°F (50°C) and three samples conditioned for a minimum of 16 hours at minus 20°F (minus 30°C). The samples are then to be subjected to a drop test as indicated in 11.2 and 11.3. Following the drop, pipe and fittings are to be assembled per 3.3, and the Leakage Test specified in 4A.2 is to be repeated. Fittings are to be tested as parts (shell halves, bushings, rings, etc.) and subassemblies, except for metal and rubber components.

11.2 Each fitting component, fitting, and pipe is to be dropped six feet (measured from the bottom of the test sample) onto a flat concrete surface. The samples are to be impacted at the worst case locations. Each sample is to be visually examined before system assembly and evaluation to the Leakage Test specified in 4A.2.

11.3 If non-complying damage is visible to the naked eye from three feet away, the test is to be repeated with new samples at a reduced drop height. The drop height is to be maximum 6 inches below the original height but not less than 3 feet. The drops are to be repeated (each time reduced by 6-inch increments) until no damage is visible. The leakage test shall then be repeated. The samples shall not leak or show any signs of non-complying damage when assembled and subjected to the test pressure.

12 Ball Impact Test

Revised 12 effective July 1, 2005

12.1 Three 2-foot samples of all rigid and flexible pipe systems are to be measured per 3.1.1 and assembled per 3.3. The samples are then to be subjected to the ball impact test as indicated in 12.2 and 12.3. Following the impact test, the Leakage Test specified in 4A.2 is to be repeated. Only exposed parts of the fitting and pipe after assembly (except for metal or rubber components) are to be subjected to this test.

12.2 Each pipe system shall be impacted with a 1.18-lb, 2.0-inch diameter steel ball dropped from 6 feet (measured from ball bottom to test point) on worst case locations of the fitting and pipe surface. The sample is to be visually examined before being subjected to the Leakage Test specified in 4A.2.

12.3 If non-complying damage is visible to the naked eye from three feet away, the test is to be repeated with new samples impacted at a reduced drop height. The steel ball is to be dropped maximum 6 inches from the original height but not less than 3 feet. The impacts are to be repeated (each time reduced by 6-inch increments) until no damage is visible. The leakage test shall then be repeated. The samples shall not leak or show any signs of non-complying damage when assembled and subjected to the test pressure.

13 Ball Impact Test After Conditioning

Revised 13 effective July 1, 2005

13.1 Six 2-foot samples of all rigid and flexible pipe systems are to be measured per 3.1.1 and assembled per 3.3, with three samples conditioned for a minimum of 2 hours at 120°F (50°C) and three samples conditioned for a minimum of 16 hours at minus 20°F (minus 30°C). The samples are then to be subjected to a ball impact test as indicated in 13.2 and 13.3, followed by the Leakage Test specified in 4A.2. Only exposed parts of the fitting and pipe after assembly (except for metal or rubber components) are to be subjected to this test.

13.2 While still at the conditioning temperature, each pipe system is to be impacted with a 1.18-lb, 2.0-inch diameter steel ball dropped 6 feet (measured from ball bottom to test point) on worst case locations of the fitting and pipe surface. The sample is then to be visually examined before being subjected to the Leakage Test specified in 4A.2.

13.3 If non-complying damage is visible to the naked eye from three feet away, the test is to be repeated with new samples impacted at a reduced drop height. The steel ball is to be dropped maximum 6 inches from the original height but not less than 3 feet. The impacts are to be repeated (each time reduced by 6-inch increments) until no damage is visible. The leakage test shall then be repeated. The samples shall not leak or show any signs of non-complying damage when assembled and subjected to the test pressure.

14 Crush-Strength Test – Primary and Secondary Containment Piping

14 deleted effective July 1, 2005

14A Pipe Burial Tests

Added 14A effective July 1, 2005

14A.1 General

14A.1.1 Three 18-inch lengths of all rigid and flexible pipe systems in all sizes for each test method are to be measured per 3.1.1 and assembled per 3.3, then tested in accordance with the Pull Strength, Puncture Resistance, and Crush Resistance tests specified in 14A.2 – 14A.4 respectively. Both the primary and secondary of an integral primary/secondary system shall be evaluated; however, separate samples may be used if necessary.

14A.1.2 After each Pipe Burial Test, all samples shall be subjected to the Leakage Test specified in 4A.2. Water shall be used as the test fluid to determine compliance. Leakage shall be detected by visual examination with or without dyes, leak solution, blotting paper, bubble submersion or any other accurate and repeatable method.

14A.2 Pull strength test

14A.2.1 Two 18-inch samples of each system shall be subjected to a pull force applied by a loading machine. The force is to be applied at the end fittings parallel to the axis at 1/2 inch per minute until the maximum value per Table 14A.1 is obtained and held for 1 minute. After unloading the force, the sample shall be visually examined before being subjected to the Leakage Test.

Table 14A.1
Pull force

Nominal pipe size,		Tension,	
inches	(mm)	pounds	(N)
3/8 – 1/2	9.5 – 12.7	300	1334
3/4	19.1	350	1557
1	25.4	400	1779
1-1/4	31.8	500	2224
1-1/2	38.1	600	2669
2	50.8	800	3579
2-1/2	63.5	1000	4448
3	76.2	1200	5338
4	101.6	1600	7117

14A.2.2 The samples shall not leak or show any signs of non-complying damage after the applied force or when subjected to the test pressure.

14A.2.3 One additional sample is to be prepared and subjected to the pull test specified in 14A.2.1 until breakdown. The maximum load and breakdown details shall be recorded for percent retention comparison purposes.

14A.3 Puncture resistance test

14A.3 revised August 16, 2005

14A.3.1 Three 18-inch samples of each system shall be subjected to a point force applied by a loading machine holding a steel probe with a 0.180-inch diameter shaft with 0.04-inch diameter tip and 30 degree edge. The probe is to be applied at the pipe center perpendicular to the axis at 1/2 inch per minute until a force of 15 lb is obtained and held for 1 minute. After unloading the force, the sample shall be visually examined before being subjected to the Leakage Test.

14A.3.2 The samples shall not leak or show any signs of non-complying damage after the applied force or when subjected to the test pressure.

14A.4 Crush resistance test

14A.4.1 Three 18-inch samples of each system are to be tested in accordance with ASTM D 2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading. The load is to be applied at the pipe center perpendicular to the axis at 1/2 inch per minute until conditions per 14A.4.2 (for rigid pipe) or 14A.4.3 (for flexible pipe) are met. After unloading the force, the sample shall be visually examined before being subjected to the Leakage Test.

14A.4.2 For rigid pipe, the load to obtain a stiffness factor of 56.25 lbf/in shall be held for 1 minute and the value recorded for comparison purposes.

14A.4.3 For flex pipe, the load to obtain a 40 percent reduction of the O.D. shall be held for 1 minute and the value recorded for comparison purposes.

14A.4.3 revised August 16, 2005

14A.4.4 The samples shall not leak or show any signs of non-complying damage after the applied force or when subjected to the test pressure.

15 Immersion Tests – Primary and Secondary Containment Piping

15 deleted effective July 1, 2005

15A Long Term Compatibility Test

Added 15A effective July 1, 2005

15A.1 Sets of three 18-inch lengths of each type rigid and flexible pipe systems in representative worst case sizes for each exposure fluid and time period shall be measured per 3.1.1 and assembled per 3.3. The samples are then to be subjected to the applicable exposures specified in Table 15A.1 to simulate long term compatibility to intended use fuels and surrounding environmental conditions. Both the primary and secondary of an integral primary/secondary system shall be evaluated, but separate primary and secondary samples may be used if representative of the materials, design and fittings.

15A.1.1 Additional samples shall be permitted to be tested, and the average of all samples tested shall be used as the basis for evaluating performance.

15A.1.1 added February 22, 2006

15A.1.2 Mechanical pre-flexing shall be permitted prior to testing of as-received samples. The mechanical pre-flexing shall consist of rolling and unrolling based on number of times, spool diameter, and speed parameters associated with manufacturing and installation.

15A.1.2 added February 22, 2006

15A.1.3 Thermal stress relaxation shall be permitted prior to testing of as-received samples. The thermal stress relaxation shall consist of exposing samples to 65° C air at 50 percent relative humidity for 12 hours followed by cooling to room temperature.

15A.1.3 added February 22, 2006

Table 15A.1
Compatibility test fluids

External soil and environmental fluids at 100°F (38°C) required for all pipe systems	
Type A	**Type B**
Ph 3.0 sulfuric acid	1 percent hydrochloric acid[a]
Saturated sodium chloride	1 percent nitric acid[a]
Distilled Water[b]	Ph 10 sodium carbonate – sodium bicarbonate[c]
Air (except at 70°C)	Ph 12 sodium hydroxide
Motor Vehicle Fuels at 100°F (38°C) required for pipe systems marked per 20.1(g).	
Type A	
100 percent ASTM Reference Fuel No. 2	
100 percent ASTM Reference Fuel C	
85 percent Reference Fuel C – 15 percent MTBE	
85 percent Reference Fuel C – 15 percent methanol	
70 percent Reference Fuel C – 30 percent ethanol	
Concentrated Fuels at 100°F (38°C) required for pipe systems marked per 20.1(g) All external soil and environmental fluids and motor vehicle fuels are also required plus:	
Type A	**Type B**
100 percent methanol	100 percent Toluene
100 percent ethanol	

Table 15A.1 Continued on Next Page

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Table 15A.1 Continued

External soil and environmental fluids at 100°F (38°C) required for all pipe systems	
Type A	**Type B**
Special use fuels at 100°F (38°C) required for pipe systems marked for ratings All external soil and environmental fluids and motor vehicle fuels are also required plus:	
Type A – Marked per 20.1(g) for high blend fuels	
50 percent Reference Fuel C – 50 percent methanol 50 percent Reference Fuel C – 50 percent ethanol	
Type A – Marked per 20.1(g) for aviation and marine fuels	
100 percent premium leaded gas 100 percent kerosene	
NOTES 1) Test parameters, such as temperature and concentrations of media, are increased in severity over those of normal operating conditions to obtain observable deterioration in a reasonable period of time. This accelerated test does not give a direct correlation with service performance. However, this method of testing yields comparative data on which to evaluate the product. 2) ASTM Reference Fuel C is to be as described in the Test Method for Rubber Property – Effect of Liquids, ASTM D 471-79. [a] Percentage by weight. [b] Distilled water having a maximum total matter of 2.0 ppm and a maximum electrical conductivity of 5.0 microhms/cm at 25°C (77°F), as described for Type IV grade reagent water in the Standard Specification for Reagent Water, ASTM D 1193-77. [c] A pH of 10 is to be obtained by mixing 10.6 grams per liter of sodium carbonate and 8.4 grams per liter of sodium bicarbonate. A pH meter is to be used and the ratio of sodium carbonate to sodium bicarbonate is to be adjusted to obtain a pH of 10. The pH is to be checked several times during the test.	

15A.2 The samples for this test are to be preconditioned to simulate transport, assembly and installation conditions by using cut length of pipe that has been subjected to the Pipe Bending Test, Section 9 (except at one times the minimum bend radius on samples without fittings), Drop Test, section 10, and Impact Test, section 12. All precondition tests do not require a Leakage Test, and the Drop and Impact tests shall be done at heights that do not show visible damage per 10.3 and 12.3 respectively.

15A.3 Before immersion, one sample (for repeat leakage/breakdown test) per set is to be measured to the nearest 0.004 inch (0.1 mm) for:

a) Length between 2 reference points approximately 12 inches (30.5 cm) apart and

b) Diameter between 2 reference points near the center of the pipe.

The reference marks are to be visible after the immersion for dimensional comparison specified in 15A.6 but shall not damage the pipe. The same sample is to be weighed to the nearest 0.0035 ounces (0.1 g) for use in determining the weight comparison specified in 15A.7. Pipe systems using nonmetallic removable fittings (connectors, plugs or caps) are to be measured with the fittings. Pipe systems using metallic removable fittings are to be measured without the fittings. For pipe systems using adhesives, the measurement is to be made after full cure per the manufacturer's instructions. One control sample of each pipe type is to be prepared for post immersion comparison, but shall not be subject to any test fluids.

15A.4 All exposures specified in Table 15A.1 are to be maintained over the entire time period at the indicated temperatures ±4°F (2°C) with equipment such as a water bath used for all liquid exposures and a circulating oven used for all air exposures. The exposed surfaces of the test samples for internal and external fluids for each system are to be as indicated in Table 15A.2 to simulate normal and abnormal use conditions.

Table 15A.2
Exposed surfaces for test samples

Pipe System	Test Fuels	Soil Fluids	Air Oven
Primary carrier	PI, PE	PE	All
Secondary containment	SI	SE	All
Integral primary/secondary	PI, PE, SI	SE	All
Normal vent	PI	PE	All
Vapor recovery	PI	PE	All
NOTES P = Primary pipe and fittings I = Interior surface of pipe and fittings S = Secondary pipe and fittings E = Exterior surface of pipe and fittings All = All interior and exterior surfaces of pipe and fittings			

15A.5 Type A fluids are intended to represent exposures expected in normal use and are to be subjected to 30-, 90-, 180-, and 270-day exposures. Extrapolations (using regression analysis) for the 270-day exposure shall be permitted (to reduce testing and time) but are to be an additional 20 percent above the minimums in 15A.11 and have a correlation coefficient of 1 ±0.15 to qualify for the waiving of 270-day testing.

15A.6 Type B fluids are intended to represent exposures more severe than expected and shall be subject to 30-, 90-, and 180-day exposures.

15A.7 Following each exposure time period, each set of samples is to be drained of any test fluid, dried, and visually examined for damage. One sample (repeat leakage/breakdown) is to be subjected to repeat dimensional and weight measurements per 15A.3. The repeat physical tests specified in 15A.10 are then to be conducted on individual samples. Fittings shall not be removed or reassembled before the repeat physical tests.

15A.8 Repeat dimensional measurements are to be made before the or after the repeat leakage/breakdown test. The dimensional change (length and O.D.) shall not exceed ±2 percent of the original sample. Adjustments shall be allowed for differences in the control sample in the as-received condition and at each time period.

15A.9 Repeat weight measurements may be made before or after the repeat leakage/breakdown test. Any sample material lost from the repeat leakage/breakdown test is to be included in the measurement. The weight change shall not exceed ±5.0 percent of the original sample. Adjustments shall be allowed for differences in the control and test samples at each time period.

15A.10 Following each exposure time, repeat physical tests are to be conducted in accordance with the:

a) Short Term Pressure Tests, Section 4A,

b) Pull Strength Test, Section 14A.2, and

c) Crush Resistance Test, Section 14A.4.

One sample is to be used for each test. The results for these repeat tests shall comply with 15A.11, 15A.12, and 15A.13 respectively. Fittings shall not be removed or reassembled before the repeat physical tests.

Exception No. 1: The Hydrostatic Test, 4A.3, is not required for (a).

Exception No. 2: For item (b), a repeat leakage test is not required and the sample is to be loaded until breakdown.

15A.11 Samples subjected to the repeat Short Term Pressure Tests shall comply with the Leakage Test, 4A.2 and the Breakdown Test, 4A.4, with a breakdown pressure retention value per Table 15A.3.

Table 15A.3
Retention values for long term test samples

Compatibility test fluids	Pipe system type	Minimum property retention values (percentage)	
		Type A	Type B
External soil and environmental fluids	PC, SC, PS	80	50
	NV, VR	70	50
Motor vehicle fuels	PC, SC, PS	80	50
	NV, VR	70	50
Concentrated fuels	PC, SC, PS	80	50
	NV, VR	70	50
Special use fuels	PC, SC, PS	80	50
	NV, VR	70	50
NOTE – See 3.1 for pipe system type legend.			

15A.12 Samples subjected to the repeat Pull Strength Test shall comply with either data points or a data curve meeting one of the following:

a) The minimum retention values specified in Table 15A.3 comparing pull breakdown loads of as-received and conditioned samples, or

b) The minimum pull values and breakdown values complying with both of the following:

1) The samples shall withstand a minimum pull strength per 14A.2 except at two times the pull force values identified in Table 14A.1 for the specific diameter. Following this preconditioning pull load, the samples shall be subjected to the Leakage Test in accordance with 4A.2 followed by the Breakdown Test in accordance with 4A.4. The samples shall not leak, and

2) All minimum breakdown values of these samples shall be at least 70 percent (Type A Fluids) or 50 percent (Type B Fluids), and all values shall be at least 250 psig (PC, PS and closed SC systems) or 25 psig (open SC systems).

Data points shall comply as individual points or as averaged points (per 15A.1.1) for each time period. Data curves shall comply as a generated curve (from least squares or higher order method with at least a 0.85 correlation coefficient) using at least 0, 30, 90, 180 and 270 day data.

15A.12 revised March 2, 2006

15A.13 Samples subjected to the repeat Crush Resistance Test shall comply with either data points or a data curve meeting one of the following:

a) The minimum retention values specified in Table 15A.3 comparing crush loads of as-received and conditioned samples, or

b) The minimum crush values and breakdown values, complying with both of the following:

1) The samples shall be subjected to crush loading per 14A.4 except at 150 lb times the pipe O.D. in inches. Following this preconditioning crush load, the samples shall be subjected to the Leakage Test in accordance with 4A.2 followed by the Breakdown Test in accordance with 4A.4. The samples shall not leak, and

2) All minimum breakdown values of these samples shall be at least 70 percent (Type A Fluids) or 50 percent (Type B Fluids), and all values shall be at least 250 psig (PC, PS and closed SC systems) or 25 psig (open SC systems).

Data points shall comply as individual points or as averaged points (per 15A.1.1) for each time period. Data curves shall comply as a generated curve (from least squares or higher order method with at least a 0.85 correlation coefficient) using at least 0, 30, 90, 180 and 270 day data.

15A.13 revised March 2, 2006

16 Air-Oven-Aging Test – Primary and Secondary Containment Piping

16 deleted effective July 1, 2005

16A Interstitial Communication Test

Added 16A effective July 1, 2005

16A.1 A minimum 10-foot length of the following pipe types in representative worst case sizes with respect to minimum interstitial space shall be subjected to this test:

a) Field-use combinations of rigid and flexible primary and secondary pipe, and

b) Integral primary/secondary pipe systems

The samples are to be measured for the communication rate specified in 16A.2. A 90-degree end fitting on one end of the pipe, assembled as specified in 3.3, is to be used to add the test fluid.

Exception: Interstitial spaces 5 mm or larger are exempt from this test.

16A.2 The sample is to be laid horizontally on a level surface, and water is to be added to the interstitial space at the end fitting with a hydrostatic head not exceeding 6 inches (15 cm). A stop watch is to be started when the fluid is introduced and then stopped when the fluid exits from the opposite end of the pipe. The calculated (distance/time) communication rate shall not exceed 2.08 ft/hr (63.4 cm/hr).

16B UV Compatibility Test

Added 16B effective July 1, 2005

16B.1 Three 18-inch samples of all rigid and flexible-type pipe systems in representative worst case sizes are to be measured and assembled per 15A.1. The samples are to be subjected to 720 hours of ultraviolet light and water exposure in accordance with Test Method 1 in ASTM G 153, Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials. Only exterior parts of the pipe system are to be exposed, and the cycle rate shall be 17 minutes light and 3 minutes water.

16B.2 Alternatively, the samples referenced in 16B.1 are to be exposed for 1000 hours to light and water in accordance with ASTM G 155, Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials, using Test Method A.

16B.3 Following the exposure, the samples are to be subjected to the test sequence specified in 15A.9 and evaluated in accordance with 15A.10 – 15A.12.

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16C Nonmetallic Fitting Stress Crack Test

Added 16C effective July 1, 2005

16C.1 One six-inch sample of all pipe and fittings in all sizes constructed with polyethylene (any type or percentage blend) is to be exposed to a 10-percent solution of nonylphenoxl (ethylenoxy) ethanol for 120 hours at 140°F (60°C). The sample is to be completely immersed in a heated water bath in a suitable container.

16C.2 Following the exposure, the samples are to be visually examined without magnification tools. The sample shall not have any evidence of surface cracking or crazing.

16D Metallic Fitting Stress Crack Test

Added 16D effective July 1, 2005

16D.1 Three samples of all metallic fittings in all sizes constructed with at least 15 percent zinc are to be subjected to a moist ammonia-air mixture of minimum 20 fluid ounces (600 ml) of 0.94 specific gravity aqueous ammonia for 10 days at 95°F (34°C). The samples are to be grease-free and positioned above the ammonia in a glass container.

16D.2 Following the exposure, the samples are to be visually examined without magnification tools. The sample shall not have any evidence of surface cracking or crazing.

17 Permeation Test

Revised 17 effective July 1, 2005

17.1 Eighteen-inch lengths of all rigid and flexible type pipe systems in representative worst case sizes for each rated test fuel are to be measured per 3.1.1. The samples are to be filled to 80 percent capacity with the rated test fuels specified in Table 15A.1 and sealed with the intended fittings per 3.3. The prepared samples are to be weighed (to 0.1 gm) at standard temperature and pressure (STP) and stored vertically at 80 ±5°F (27 ±3°C) for 180 days. One control sample of each pipe type is to be prepared for comparison, kept in the same location as the test samples, but shall not be filled with any test fluids.

17.1 revised August 16, 2005

17.2 The samples for this test are to be preconditioned to simulate transport, assembly and installation conditions by using cut length of pipe that has been subjected to the Pipe Bending Test, Section 9 (except at one times the minimum bend radius on samples without fittings), Drop Test, Section 10, and Ball Impact Test, Section 12. All precondition tests do not require a Leakage Test, and the Drop and Impact Tests shall be done at heights that do not show visible damage per 10.3 and 12.3 respectively.

17.3 If nonmetallic fitting assembly methods requiring adhesives could affect curing by the test fuel, an alternative method to add fluids through the top fitting (threaded plug or tap hole) after assembly and proper curing is to be used if it is leak-tight.

17.4 If metallic fitting assembly methods requiring fusion could cause a fire hazard by igniting the fuel, an alternative method to add the fluid through the top fitting (threaded plug or tap hole) after assembly is to be used provided it is leak tight.

17.5 The weight measurements specified in 17.1 are to be repeated once per week for the first 30 days and once every other week from 30 to 180 days. The time from the test start is to be recorded in days. The repeat measurements are to be taken the same day of the week at approximately the same time as the initial measurement, ± 2 hours, for consistency. The control sample is to be weighed at the same time as the test samples.

17.6 The collected time and weight data are to be used to calculate the permeation rate (weight loss/time) between each time interval (to determine maximum values) and the overall time interval (to determine average values). A data plot of time versus weight may be used to determine these permeation values, and adjustments shall be made based on differences in the control sample and test samples at each time period. The permeation rates shall not exceed the minimum values in Table 17.1.

Table 17.1
Permeation values for permeation test samples

Permeation test fluids	Pipe system type[a]	Permeation value limits			
		Average		Maximum	
		g/m^2 per day	(oz/ft^2 per day)	g/m^2 per day	(oz/ft^2 per day)
Motor vehicle fuels	PC, PS[b]	1.0	0.0033	4.0	0.013
	SC, NV, VR, PS[c]	4.0	0.013	24	0.079
Concentrated fuels	PC, PS[b]	1.0	0.0033	4.0	0.013
	SC, NV, VR, PS[c]	4.0	0.013	24	0.079
Special use fuels	PC, PS[b]	1.0	0.0033	4.0	0.013
	SC, NV, VR, PS[c]	4.0	0.013	24	0.079

NOTES:
[a] See 3.1 for pipe system type legend
[b] Primary of Integral Primary/Secondary
[c] Secondary of Integral Primary/Secondary

MANUFACTURING AND PRODUCTION TESTS

18 General

18.1 All pipe and fittings shall be subjected to material, process, and performance checks by the manufacturer to adequately control the quality of the products. Material checks shall include pre-process acceptance of raw materials and post process evaluations of critical properties. Process checks shall include process parameters (such as time, temperature, pressure or other machine settings). Performance tests shall include the Leakage Test specified in Section 19. Details of the manufacturer's quality control program shall be documented.

Revised 18.1 effective July 1, 2005

18.2 Dimensional checks on finished pipe and fittings as specified in 3.1.1 shall be conducted by the manufacturer to ensure compliance with the minimum thickness for laminates or co-extrusions and minimum/maximum ranges for inside and outside diameters. Random sampling of batches or lots shall be allowed if a minimum sampling plan of 1/100 ft (pipe) or 1/100 units (fittings) is conducted.

Added 18.2 effective July 1, 2005

19 Leakage Test

19.1 All pipe (each length or roll) and fittings after production shall be subjected to the leakage test specified in 4A.2 except that the test pressure shall be at the marked rating for 1 minute. Air or water may be used for the test, and the leak detection method shall be accurate and repeatable.

Revised 19.1 effective July 1, 2005

MARKING

20 General

20.1 Each pipe (at minimum 10-foot intervals) and fitting (primary piece or packaging) shall be marked with the following required information on the outer surface in a permanent and legible manner where visible after assembly. Abbreviations may be used for smaller parts if detailed information is also provided in the instructions.

a) The manufacturer's name, trade name, trademark or other descriptive mark that identifies the company responsible for the product. If the product is manufactured at more than one location, a factory code shall also be provided.

Exception: The manufacturer's identification may be in a traceable code if the product is identified by the brand or trademark owned by a private labeler.

b) Manufacturing date, with a minimum combination of day, month, year, or time period not exceeding three consecutive months (for example, first quarter of the year).

Exception: A date code may be used provided it is traceable by the manufacturer, does not repeat in less than 20 years, and does not require reference to production records.

c) Catalog, model, part or equivalent number to identify the pipe, fitting or component and the nominal size (inches or mm).

d) The statement ″Underground Use Only″ and the maximum pressure rating (psig).

e) The statement ″Use Only OEM Fittings – Follow Installation Instructions.″

f) The type of pipe system(s), marked on the pipe only (abbreviations or codes may be used if identified in the instructions):

1) ″Primary Carrier″,

2) ″Secondary Containment″,

3) ″Integral Primary/Secondary″,

4) ″Normal Vent″,

5) ″Vapor Recovery″.

g) The flammable liquid group rating(s), marked on the pipe only (abbreviations or codes may be used if identified in the instructions):

1) ″Motor Vehicle Fuels″,

2) ″Concentrated Fuels″,

3) ″High Blend Fuels″,

4) ″Aviation and Marine Fuels″.

h) Assembly specifications:

1) For threaded pipe or compression fittings – recommended torque (inch-lbs),

2) For screw clamp fittings – recommended torque (inch-lbs),

3) For crimp fittings – proper tool setting or ″See Joining Instructions″,

4) For adhesives, weld or other connection means – ″See Joining Instructions″.

i) The statement “For Use Only With __Mfg & Model__ Secondary Containment Pipe” for primary carrier pipe intended for use only with a specific secondary containment pipe when used as a system.

Revised 20.1 effective July 1, 2004

20.2 Permanent is defined as the use of die or ink stamping, paint stenciling, etching or molding. Adhesive labels shall be evaluated for the intended surface for outdoor use in accordance with the Standard for Marking and Labeling Systems, UL 969, using minimum temperature ratings of minus 20°F – 140°F (minus 29°C – 60°C), exposure to water, ultraviolet light, and occasional exposure to fuel specifications.

Revised 20.2 effective July 1, 2004

20.3 Legible is defined as raised, indented, or printed text in minimum 4.0 mm high letters in a contrasting color to the product’s surface. Other methods that are equivalent may be alternatively used.

Revised 20.3 effective July 1, 2004

20.4 Deleted effective July 1, 2004

INSTRUCTIONS

21 General

Added 21 effective July 1, 2004

21.1 Instructions shall be attached to all pipe (roll or bundle) and included with fittings (boxes or packages). Instructions shall be preceded by the statement ″IMPORTANT INFORMATION – FOLLOW ALL INSTRUCTIONS″ in bold text minimum 8.0 mm high and shall include the following information:

a) General and Ratings – A statement indicating that the piping system shall only be installed by a qualified person (determined by the manufacturer) and that the use of non-qualified personnel or any deviations from these recommended procedures could result in damage or leakage of the system. The instructions shall provide the company name, phone number and any other information that is essential to contact the qualified person. Additionally, the following information shall be provided:

1) The manufacturer and model of each pipe and fitting component in a system matching items 20.1 (a) and (c);

2) The type of pipe system for underground use only at maximum pressures per 20.1 (f) and (d); and

3) The flammable liquid group rating(s) per 20.1(g).

b) Storage and Transit – Instructions shall specify that pipe and fittings are not intended for storage in direct sunlight or excessive temperatures and that rough handling (drops and impacts) during storage and transit may cause damage and leaking. Any special procedures for protection against environmental conditions and physical abuse during storage and transit shall be identified. Any special procedures for the inspection of parts for non-complying damage before assembly shall be identified with instructions specifying that a damaged part shall not be used.

c) Assembly – Information shall specify the use of OEM fittings, parts, and accessories (adhesives, special tools, etc.) only and the minimum bend radius along with complete procedures for parts, combs, and proper leak-tight assembly per 20.1(h) and (i). Any special procedures for the inspection of parts for non-complying damage during or after assembly shall be identified with instructions to replace that part. Information shall indicate that the piping system is intended for installation in normal soil applications.

d) Use – Instructions shall be specified for intended use details (for example, not for use as connector pipe, aboveground, or marine applications applications) and for the specific fuels and maximum percentages for each fuel group (for example Motor Vehicle Fuel Rating) as specified in Table 15A.1. Instructions shall also specify that sumps are to be kept free of debris and spilled fuel from fuel filters. This information shall be transferred by the qualified person or manufacturer to the owner, operator or other responsible person of the facility where the installation is done.

e) Maintenance – Instructions shall specify the designated leak test method and procedure, after assembly but before burial, and any maintenance required for continued leak-tight use. If monitoring is recommended, information concerning the specific method and minimum