Selecting Optimal Pressure Pipe Material(s) for Commercial Plumbing Systems

A presentation by The Plastics Pipe Institute

ASPE American Society of Plumbing Engineers™ CEU PROVIDER

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PPI Plastics Pipe Institute BUILDING & CONSTRUCTION

Selecting Optimal Pressure Pipe Material(s)

Speaker Introduction: Lance MacNevin, P.Eng.

- Working in the plastic pipe industry since 1993
- Director of Engineering for the Plastics Pipe Institute’s Building & Construction Division since 2015 coordinating research, education, and advocacy activities
- Active member of ASHRAE, ASPE, ASTM, AWWA, CSA, IAPMO, ICC, IGSHPA, NSF, and RPA
- Expertise on pressure pipes CPVC, HDPE, PEX, PE-RT, PP

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The Plastics Pipe Institute (PPI)

Introduction

- PPI is the not-for-profit trade association representing the Plastic Pipe Industry
- PPI was formed in 1950 to research and develop test methods for plastic pressure pipes
- **Today:** 501(c)(6) trade association serving North America, based in Irving, TX
- **PPI Mission:** Improving quality of life today, and for generations to come, by championing the advancement, acceptance, and use of sustainable and resilient plastic pipe systems
- **PPI Members: ~**200 member firms involved with the North American plastic pipe industry
- www.plasticpipe.org

The Plastics Pipe Institute (PPI)

PPI Building & Construction Division (BCD)

- **Focus**: Plastic pressure pipe and tubing systems used within buildings and on building premises
- **Applications**: Plumbing, water service, fire protection, hydronic heating & cooling, snow & ice melting, district energy heating & cooling, and ground source geothermal piping systems
- **Materials:** CPVC, HDPE, PEX, PEX/AL/PEX, PE-RT, PE-RT/AL/PE-RT, PP-R, PP-RCT
- BCD homepage: plasticpipe.org/BuildingConstruction

Selecting Optimal Pressure Pipe Material(s)

Background

- Specifiers of commercial plumbing systems have options when selecting the optimal pipe and fitting material
- **Copper, brass, bronze, ductile iron, galvanized steel, plastic, and stainless steel**
- Considerations include safety for drinking water, long-term reliability, convenience of handling and joining, sustainability, resilience, availability, and affordability
- Other selection factors include sound, vibration, flammability, and heat transfer

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Selecting Optimal Pressure Pipe Material(s)

Course Introduction

- This course will introduce and explain **four major types** of plastic pressure pipe materials that deliver adaptable and reliable solutions for a wide range of plumbing applications: **CPVC, PEX, PE-RT,** and **PP**
- **ASTM** standards will be utilized to explain capabilities
- Piping **limitations** will be addressed for each material
- We will share advice about which types of materials **may not be suitable** for certain types of commercial plumbing applications
- Specific industry **resources** will be shared

Selecting Optimal Pressure Pipe Material(s)

Learning Objectives

1. Describe the piping materials **CPVC, PEX, PE-RT,** and **PP** in terms of material properties, standards, capabilities, joining systems, and code compliance
2. Address the **limitations** of each type of pipe and fitting material to be able to select appropriate materials for specific applications
3. Discuss the **design** of piping materials in terms of sizing for flow, pressure drop, and thermal expansion/contraction using an industry-developed software program
4. Explain how to access **industry resources** related to selecting and specifying the right piping material(s) for various applications

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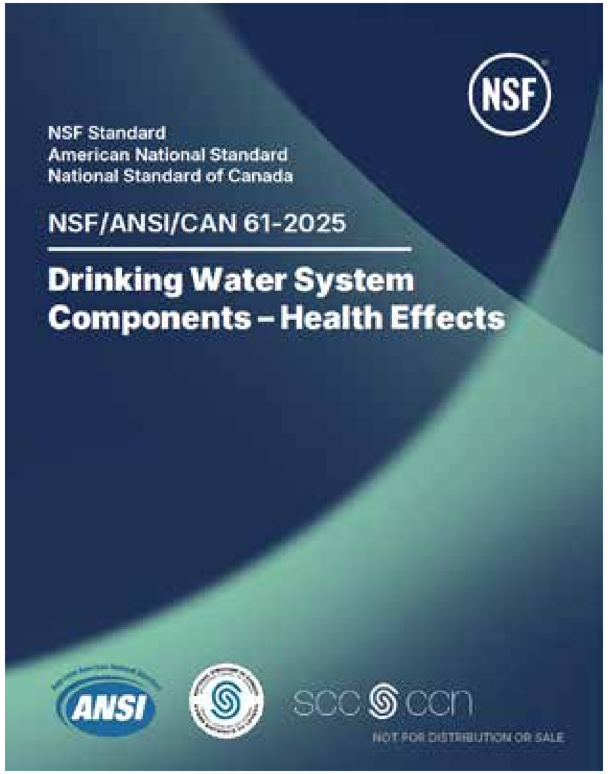
Prologue

Universal Requirements: Drinking Water Safety

- All plastic pipes, tubing, and fittings intended for potable (drinking) water shall meet the requirements of **NSF/ANSI/CAN 61 *Drinking Water System Components - Health Effects***

- “This Standard establishes minimum health effects requirements for the chemical contaminants and impurities that are indirectly imparted to drinking water from products, components, and materials used in drinking water systems.”



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Prologue

Universal Requirements: Drinking Water Safety

- All plastic pipes, tubing, and fittings intended for potable (drinking) water shall meet the requirements of **NSF/ANSI 372 *Drinking Water System Components, Lead Content***

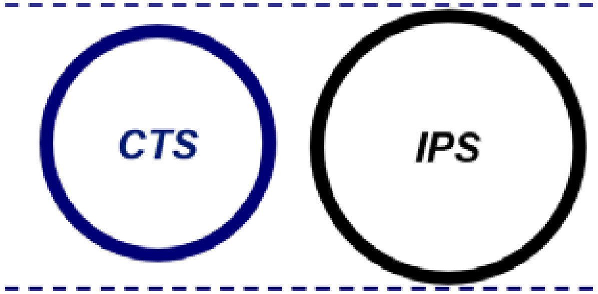
- “This Standard establishes procedures for the determination of lead content based on the wetted surface area of products.”

Prologue

“Pipe” vs. “Tubing”

- **Tubing** means the actual Outside Diameter is **1/8 inch larger** than the nominal size
- **Pipe** means the actual OD **matches** that of **iron/steel** pipe of the same nominal size
- **Metric pipe** has an OD matching the nominal size (e.g., DN 63 pipe = 63 mm OD)
- Tubing uses nominal sizes such as **NTS 3/4**; also known as Copper Tube Size (CTS)
- Pipe uses nominal sizes such as **NPS 3/4**; also known as Iron Pipe Size (IPS)

- NPS pipes are typically larger than NTS tubing
    - NTS 1 Tubing OD = 1.125 in. (28.6 mm)
    - NPS 1 Pipe OD = 1.315 in. (33.4 mm) **15% larger**



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Prologue

Pipe Wall Type/Thickness

- Most* plastic pipe and tubing uses a **Standard Dimension Ratio** (SDR), the ratio of outside diameter to wall thickness (average OD/minimum wall thickness)
- **CPVC pipes follow **Schedule 40/80** dimensions*

Examples:

- PEX and PE-RT tubing have a wall type of **SDR 9** (wall thickness is 1/9 of the OD)
- CPVC tubing has a wall type of **SDR 11** (wall thickness is 1/11 of the OD)
- Within a Standard Dimension Ratio, each diameter of the pipe type has the same pressure capability & pressure rating

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1. CPVC, PEX, PE-RT, and PP Piping

Introduce four pressure piping materials

1. CPVC: chlorinated polyvinyl chloride
2. PEX: crosslinked polyethylene
3. PE-RT: polyethylene of raised temperature resistance
4. PP: polypropylene

Objective: Describe material properties, standards, capabilities, joining systems, and code compliance for each material

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CPVC Pipe & Tubing

CPVC: Chlorinated polyvinyl chloride

- CPVC is produced by adding a chlorine molecule (**C**) to polyvinyl chloride (**PVC**)
- The extra chlorine atom gives CPVC higher temperature performance and improved fire and corrosion resistance
- CPVC is rated for operation up to **200°F** (93°C)
- CPVC was introduced for plumbing in **1959** and fire protection in **1985**
- CPVC is also used for chilled water and hydronic heating and cooling systems, as well as many chemical transport applications

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CPVC Pipe & Tubing

CPVC Configurations

- CPVC is provided in straight lengths
- Available in Nominal Tube Size (NTS) and Nominal Pipe Size (NPS) diameters
- Fittings are molded in both NTS and NPS sizes
- Specific compounds used for plumbing, hydronics, and fire protection applications

Courtesy Lubrizol x 3

CPVC Pipe & Tubing

Pipe & Fitting Standards

- **ASTM D2846** CTS tubing & fittings for potable water; nominal sizes ¼ to 2
- **ASTM F437** Schedule 80 Threaded CPVC fittings
- **ASTM F438** Schedule 40 Socket-type CPVC fittings
- **ASTM F439** Schedule 80 Socket-type CPVC fittings
- **ASTM F441** Schedule 40 and 80 pipe sizes; nominal sizes ¼ to 16
- **ASTM F442** IPS pipe sizes; nominal sizes ¼ to 12
- **ASTM F493** Solvent Cements for CPVC pipe and fittings
- **CSA B137.6** All sizing types; nominal sizes ¼ to 12

CPVC Pipe & Tubing

Material Properties

- Product standards establish capabilities and test requirements, such as:
  - Materials
  - Workmanship
  - Dimensions and tolerances
  - Quick burst pressures
  - Long-term pressure ratings
  - Flattening
  - Marking requirements
  - More…

Nominal Pipe Size	Schedule 40	
	Min	Tolerance
¼ [8]	0.088 [2.24]	+0.020 [0.51]
⅜ [10]	0.091 [2.31]	+0.020 [0.51]
½ [15]	0.109 [2.77]	+0.020 [0.51]
¾ [20]	0.113 [2.87]	+0.020 [0.51]
1 [25]	0.133 [3.38]	+0.020 [0.51]
1¼ [32]	0.140 [3.56]	+0.020 [0.51]
1½ [40]	0.145 [3.68]	+0.020 [0.51]
2 [50]	0.154 [3.91]	+0.020 [0.51]
2½ [65]	0.203 [5.16]	+0.024 [0.61]
3 [80]	0.216 [5.49]	+0.026 [0.66]
3½ [90]	0.226 [5.74]	+0.027 [0.68]

Extract from ASTM F441 Table 2

CPVC Pipe & Tubing

Capabilities: Short-term Burst Pressures

- CPVC Pipe Minimum Burst Requirements per **ASTM F442** at 73°F (23°C)
  - 1,250 psi for SDR 11
  - 1,000 psi for SDR 13.5
  - 800 psi for SDR 17

TABLE 4 Burst Pressure Requirements for Water at 73°F (23°C) for CPVC 4120 Plastic Pipe

SDR	Minimum Burst Pressure[A]	
	psi	kPa
11	1250	[8 620]
13.5	1000	[6 890]
17	800	[5 520]
21	630	[4 340]
26	500	[3 450]
32.5	400	[2 760]

[A] The fiber stress used to derive these test pressures is 6400 psi [44.1 MPa].


Courtesy Lubrizol

CPVC Pipe & Tubing

Capabilities: Long-term Sustained Pressures

- CPVC Tubing & Fitting Assembly, Minimum Requirements per **ASTM D2846**
  - 364 psig at 180°F for **SDR 11**

TABLE 5 Minimum Hydrostatic Sustained Pressure Requirements for CPVC 4120, SDR 11, Pipe, Tubing, and Fitting Assemblies Tested in Either Water or Air Bath External Environment at 180°F [82°C][A]

Test Condition	Test Duration	Hydrostatic Test Pressure	
		Water Bath	Air Bath
A	6 min	521 psi [3 590 kPa]	551 psi [3 800 kPa]
B	4 h	364 psi (2 510 kPa)	403 psi [2 780 kPa]


Courtesy Lubrizol

CPVC Pipe & Tubing

Chemical Compatibility

- CPVC has **incompatibilities** with certain construction materials
- CPVC manufacturers test and publish chemical compatibility data
- See also **PPI TR-19**

CHEMICAL RESISTANCE OF
PLASTIC PIPING MATERIALS

TR-19
2023

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Table 3: List of Chemical Resistances (°F)

Chemical Formula	Concentration	ABS	CPVC	PP (PP-R, PP-RCT)	PVC	PE (MDPE, HDPE, PE-RT)	PB	PVDF	PEX
Acetaldehyde **CAS# 75-07-0** CH_3CHO	40%	---	N	---	L to 73	R to 73	---	N	R to 73
	Pure	---	N	R to 140	N	L to 73	L to 73	---	L to 140
Acetamide **CAS# 60-35-5** CH_3CONH_2	5%	R to 120	---	R to 140	---	R to 140	---	R to 75	R to 140
Acetic Acid **CAS# 64-19-7** CH_3COOH	vapor	R to 120	R to 180	R to 180	R to 140	R to 140	R to 140	---	R to 140
	10%	---	R to 180	---	---	---	---	R to 248	R to 180
	25%	N	N	R to 180	R to 140	R to 140	R to 140	---	R to 140
	40%	---	---	---	---	---	---	R to 140	---
	50%	---	---	---	---	---	---	R to 140	---
	60%	N	N	R to 180	R to 73	R to 73	R to 73	R to 104	---
	85%	N	N	R to 120	R to 73	R to 73	R to 73	---	---
	glacial	N	N	R to 120	R to 73	R to 73	R to 73	R to 104	R to 68
Acetic Anhydride **CAS# 108-24-7** $(CH_3CO)_2O$	---	N	N	R to 73	N	R to 73	R to 140	N	R to 73
Acetone **CAS# 67-64-1** CH_3COCH_3	5%	N	R to 180	R to 73	N	L to 73	R to 140	R to 212	L to 73
	10%	---	L to 180	---	---	---	---	R to 122	---
	100%	---	N	---	---	---	---	---	---
Acetophenone **CAS# 98-86-2** $C_6H_5COCH_3$	---	N	N	R to 120	--	R to 73	---	R to 68	R to 73
Acetyl Chloride **CAS# 75-36-5** CH_3COCl	---	N	N	---	N	---	---	R to 125	---

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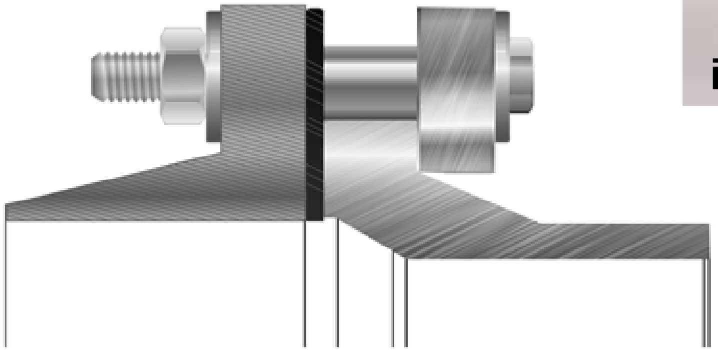
Joining Systems

- CPVC pipe & fittings are joined via:
  i. Solvent Cement joints
  ii. Push-fit Fittings
  iii. Flanged connections
  iiii. Grooved mechanical fittings



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Solvent Cement Welding

- Solvent Cement joints use liquid cement that "welds" pipes to fittings for secure joints
- Specific processes are described in material standards and installation manuals
- Available in nominal sizes from 1/2 to 24

Solvent welding is a form of welding that uses chemistry and geometry rather than heat to produce a permanent molecular bond. When the right mixture of solvents and radial pressure are applied the pipe and fitting become permanently bonded, functioning as a single component.

Courtesy Lubrizol

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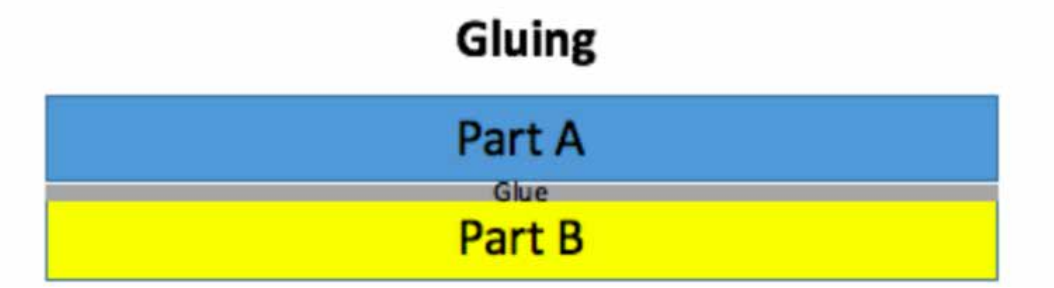
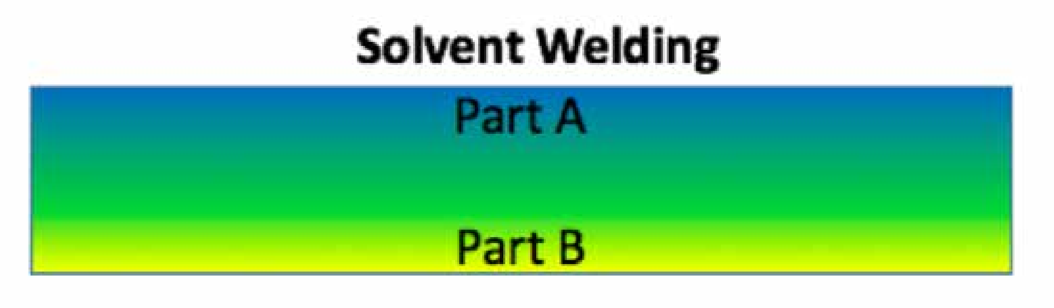
Solvent Cement Welding is Not Gluing

- Glues work by providing a **sticky layer** between two components to create a bond

- **Solvent welding** requires the two components to come into contact
- Solvent cement allows the parts to molecularly bond with each other
- Result is a chemical weld





CPVC Pipe & Tubing

Solvent Cement Fittings

- Solvent Cement fittings are available in tees, elbows, couplings, caps, transition fittings, and multi-port tees

Courtesy Lubrizol x 3

CPVC Pipe & Tubing

ASSE 1061 Push-fit Fittings

- Push-fit fittings are intended for copper, CPVC, PEX, or PE-RT tubing
  - Available in nominal sizes from 1/2 to 2
  - Follow manufacturer’s instructions for installation

Courtesy Reliance Worldwide Corp.

CPVC Pipe & Tubing

Flanged Fittings

- Flanges connect CPVC pipes to fittings, valves, or other materials (e.g., plastic, steel)
- Use full face gaskets which are chemically compatible with fluids
- Use washers on all bolts and nuts
- Follow manufacturer’s torque specifications

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CPVC Pipe & Tubing

Grooved Fittings

- Grooved mechanical fittings connect pipes to fittings quickly
- Specific processes are described in material standards and manufacturer installation manuals

PEX Tubing

PEX: Crosslinked Polyethylene

- PEX is "a polyethylene material that has undergone a change in molecular structure through processing whereby a majority of the polymer chains are chemically linked." – *ASTM F412*
- A high-temperature flexible pressure pipe material, produced as **SDR 9** tubing
- PEX is rated for **160** psig at **73°F** (23°C) and **100** psig at **180°F** (82°C)
- Some PEX tubing is also rated for 80 psig at **200°F** (93°C)
- Crosslinking creates a "3-dimensional molecular network"

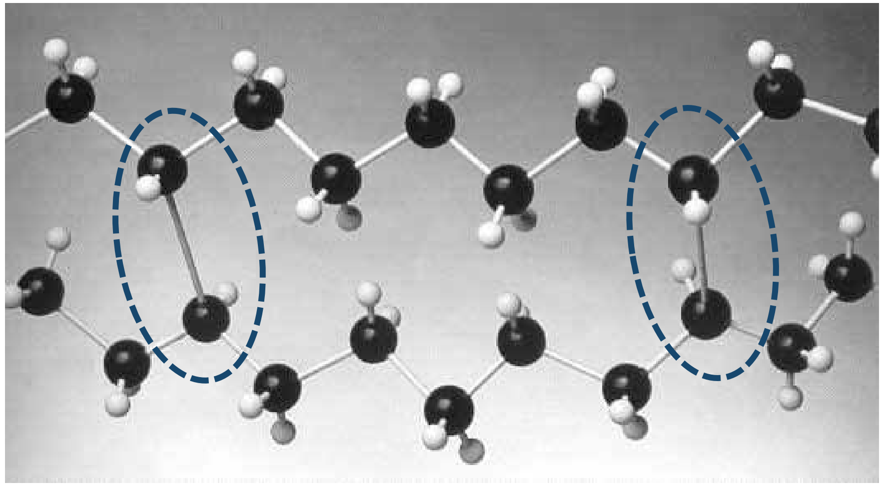

Illustration of a PEX "molecule"

PEX Tubing

PEX History

- PEX was introduced for radiant heating in **1972** in Europe and introduced to USA and Canada in the **1980s** for heating and plumbing applications
- ASTM Standard Specification **F876** published in **1984**
- CSA Standard **B137.5** was published in **1989**
- Adopted into *BOCA National Plumbing Code* in **1993**

Courtesy Viega

*See **PPI TR-56** for details about PEX development*

HISTORY OF CROSSLINKED POLYETHYLENE (PEX) TUBING IN NORTH AMERICA AND THE EVOLUTION OF ASTM STANDARD SPECIFICATION F876 FROM 1984 - 2024

PPI TR-56

2025

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PEX Tubing

PEX Configurations

- PEX plumbing tubing is produced in **SDR 9** nominal tubing sizes from 1/4 to 4 (CTS)
- PEX is available in natural (white) or colors such as red, white, blue, black, orange
- Available in coils or straight lengths, depending on the customer preference



Courtesy Bow Plastics x 3

Courtesy REHAU

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PEX Tubing

Standards

- **ASTM F876** *Standard Specification for Crosslinked Polyethylene (PEX) Tubing*
- **ASTM F877** *Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems*
- **ASTM F2023** *Standard Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Tubing and Systems to Chlorinated Hot Water*
- **ASTM F2657** *Standard Test Method for Outdoor Weathering Exposure of Crosslinked Polyethylene Tubing*
- **CSA B137.5** *Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications*
- **AWWA C904** *Crosslinked Polyethylene (PEX) Pressure Tubing, ½ through 3 in., for Water Service*

PEX Tubing

Material Properties

Product standards establish capabilities and test requirements, such as:

- Materials, Workmanship
- Dimensions and tolerances
- Degree of crosslinking
- Quick burst pressures
- Long-term (sustained) pressure ratings
- Thermocycling resistance
- Hot-bend and cold-bend testing
- Chlorine resistance
- UV resistance
- Marking requirements…

TABLE 2 Outside Diameters and Tolerances for SDR9 PEX

Nominal Tubing Size	Average Outside Diameter		Tolerances for Average Diameter	
	in.	(mm)	in.	(mm)
⅛	0.250	(6.35)	±0.003	(±0.08)
¼	0.375	(9.52)	±0.003	(±0.08)
5⁄16	0.430	(10.92)	±0.003	(±0.08)
⅜	0.500	(12.70)	±0.003	(±0.08)
½	0.625	(15.88)	±0.004	(±0.10)
⅝	0.750	(19.05)	±0.004	(±0.10)
¾	0.875	(22.22)	±0.004	(±0.10)
1	1.125	(28.58)	±0.005	(±0.12)
1¼	1.375	(34.92)	±0.005	(±0.12)
1½	1.625	(41.28)	±0.006	(±0.16)
2	2.125	(53.98)	±0.006	(±0.16)
2½	2.625	(66.68)	±0.007	(±0.18)
3	3.125	(79.38)	±0.008	(±0.20)
3½	3.625	(92.08)	±0.008	(±0.20)
4	4.125	(104.78)	±0.009	(±0.23)
4½	4.625	(117.48)	±0.009	(±0.23)
5	5.125	(130.18)	±0.010	(±0.25)
6	6.125	(155.58)	±0.011	(±0.28)

Extract from ASTM F876-25 Table 2

PEX Tubing

Capabilities: Short-term and Long-term Pressure Ratings

- **Minimum burst requirements** per ASTM F876
  - 475 psig @ 73°F (3.27 MPa @ 23°C)
  - 210 psig @ 180°F (1.45 kPa @ 82°C)
- **Sustained pressure** requirements per ASTM F876
  - 325 psig @ 73°F (2.24 MPa @ 23°C)
  - 180 psig @ 180°F (1.31 MPa @ 82°C)
  - 165 psig @ 200°F (1.14 MPa @ 93°C)
- **Pressure ratings** for PEX tubing and systems
  - 160 psig @ 73°F (1,103 kPa @ 23°C)
  - 100 psig @ 180°F (690 kPa @ 82°C)

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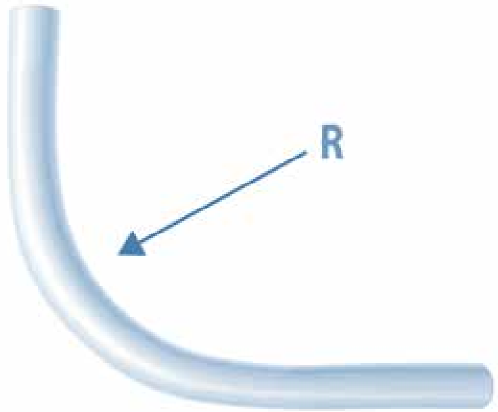
PEX Tubing



Bending and Flexibility

- Minimum bending radius is **6 times** the Outside Diameter* of the tube
- **Consult with tubing manufacturer*

Nominal Tubing Size	Tubing OD (Actual) in.	6 times Bend Radius in.
3/8	0.500	3.0
1/2	0.625	3.8
3/4	0.875	5.3
1	1.125	6.8
1 1/4	1.375	8.3
1 1/2	1.625	9.8
2	2.125	12.8
2 1/2	2.625	15.8
3	3.125	18.8
4	4.125	24.8

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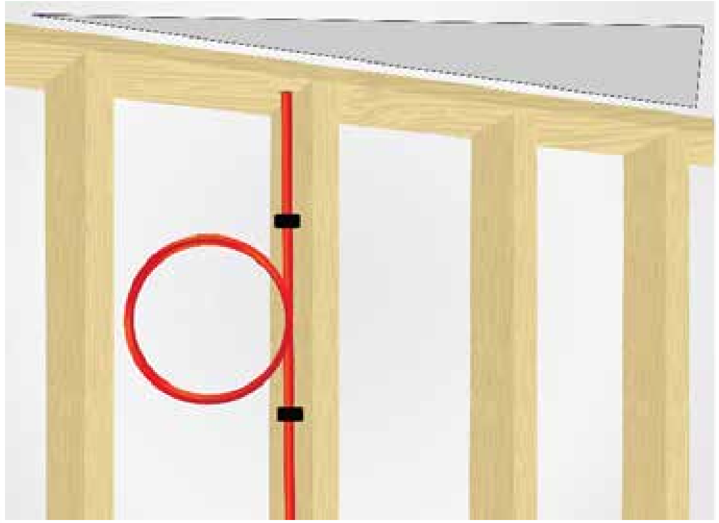
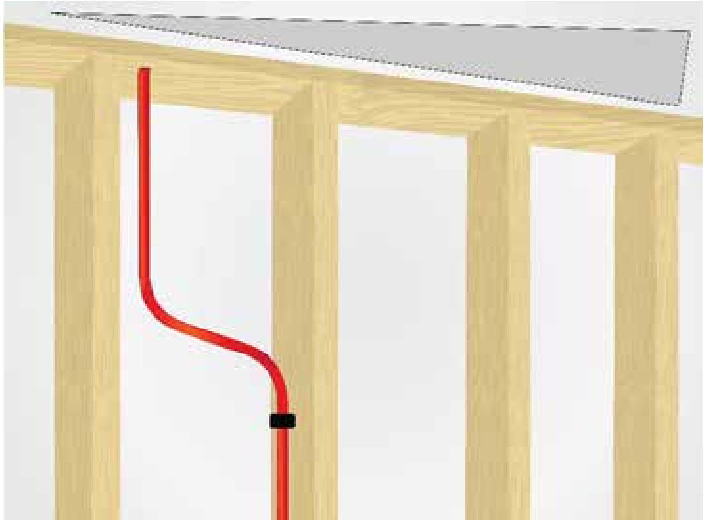
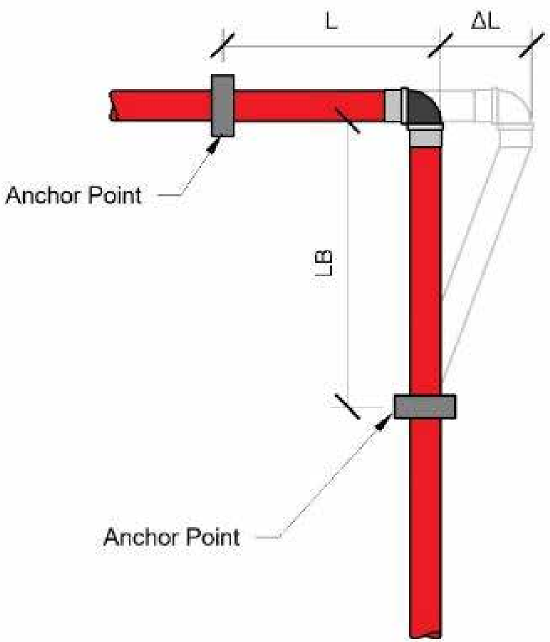
PEX Tubing

Longitudinal Expansion and Contraction

- Linear expansion rate of PEX: **1.1 inch** per **10°F** per **100 ft.** length
- For sizes ≤ NTS 1, expansion is usually accommodated by the tubing's flexibility
  - Offsets and loops can accommodate most thermal expansion and contraction
- For sizes > NTS 1, **expansion arms** and **loops** may be needed







PEX Tubing

Joining Systems

- There are several types of fittings designed for use with PEX tubing
- PEX fittings produced from **lead-free brass/bronze alloys** and **engineered polymers**

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PEX Tubing

Joining Systems

- Lead-free brass alloys must be certified to NSF/ANSI/CAN 61 and NSF/ANSI 372
- Lead-free brass alloy fittings must also comply with the **dezincification resistance** and **stress corrosion cracking resistance** requirements of NSF/ANSI 14

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PEX Tubing

Joining Systems

- Polymer fittings must be certified to NSF/ANSI/CAN 61 and NSF/ANSI 372
- **Polysulfone** (PLS) and **Polyphenylsulfone** (PPSU) are thermoplastic polymers known for their toughness, stability at high temperatures, and chlorine resistance

PEX Tubing

Manifold Systems

- Several styles of manifolds are available in **polymer** and **metallic** materials
- PEX plumbing manifolds must be certified to the same standards as PEX fittings

Courtesy Viega

PE-RT Tubing

PE-RT: Polyethylene of Raised Temperature (Resistance)

- PE-RT was developed in the **1990s** in Europe for radiant heating applications
- Introduced to North America in the **mid-2000s** for heating and plumbing
- A high-temperature flexible pressure pipe material, produced as **SDR 9** tubing
- Same dimensions, primary pressure ratings, and chlorine resistance ratings as PEX
- Rated for 160 psig at **73°F** (23°C) and 100 psig at **180°F** (82°C)

Courtesy CB Supplies

Courtesy Legend Valve

PE-RT Tubing

Standards

- **ASTM F2623** *Standard Specification for Polyethylene of Raised Temperature (PE-RT) SDR 9 Tubing* [non-potable applications only]
- **ASTM F2769** *Standard Specification for Polyethylene of Raised Temperature (PE-RT) Plastic Hot- and Cold-Water Distribution Systems [*for potable water]
- **CSA B137.18** *Polyethylene of Raised Temperature (PE-RT) Tubing Systems for Pressure Applications*

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PE-RT Tubing

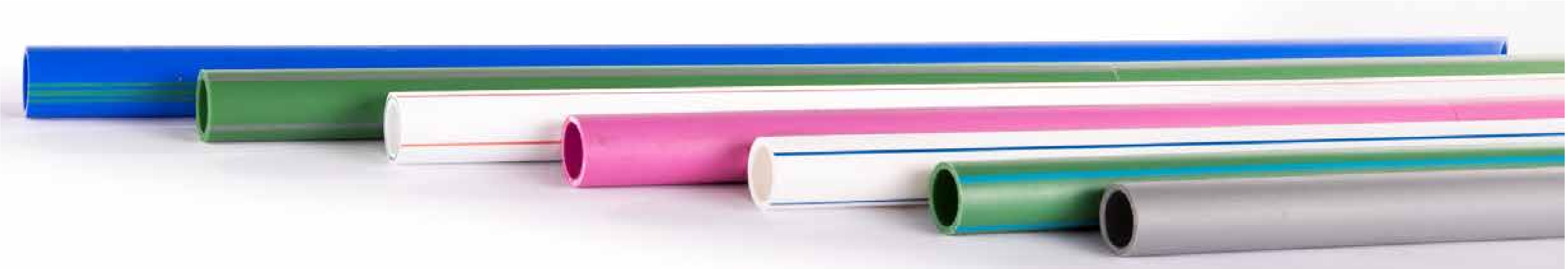
Material Properties

- Similar properties to PEX, similar flexibility, non crosslinked
- Works with most of the same fitting systems as PEX tubing

PP-R and PP-RCT Piping

PP-R/PP-RCT: Polypropylene random copolymer

- **PP-R** was developed in the **1970s** in Europe for heating applications
- Introduced to North America in the **early-2000s** for heating and plumbing
- High-temperature rigid pressure pipe material produced in DN (e.g., metric) diameters
    - DN 16 to 710 (actual OD in mm); a.k.a. 3/8 to 28 nominal
    - Wide range of wall types from DR 5 to DR 17.6 (**SDR 9** and **SDR 11** are common)



PP-R and PP-RCT Piping

PP-R/PP-RCT: Polypropylene random copolymer

- **PP-RCT** (polypropylene random copolymer with modified crystallinity and temperature resistance) is a newer generation material
- **PP-RCT** has approximately **25%** higher pressure rating than PP-R pipes
- **PP-R** and **PP-RCT** pipes and fittings are compatible with each other

PP-R and PP-RCT Piping

Configurations

- PP is provided in straight lengths
- Available in Diameter Nominal (DN) sizes, multiple SDRs to match pressure requirements
- Fittings are molded to match pipe sizes
- Solid wall pipe is used when thermal expansion/contraction is **not** a concern
- Fiber-core layer pipe is used when thermal expansion/contraction **is** a concern

- Solid wall pipe on far left and far right
- Fiber-core layer pipe inside left and inside right

PP-R and PP-RCT Piping

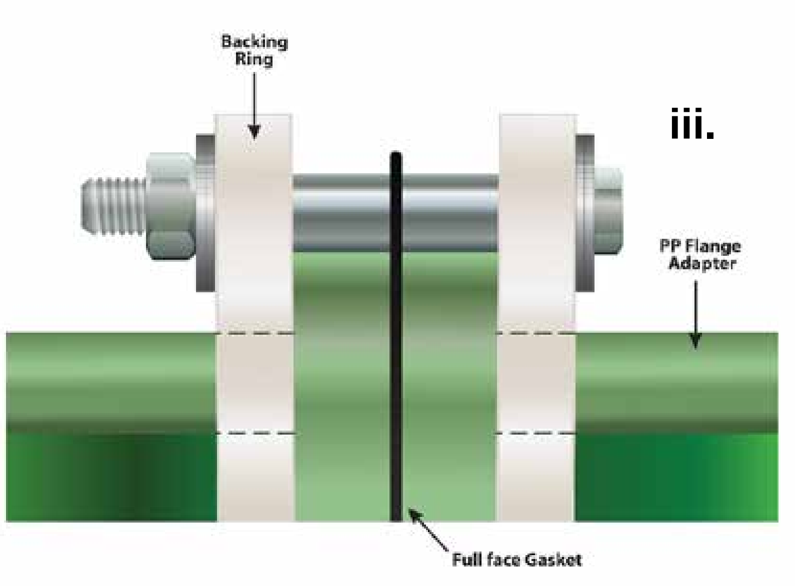
Standards

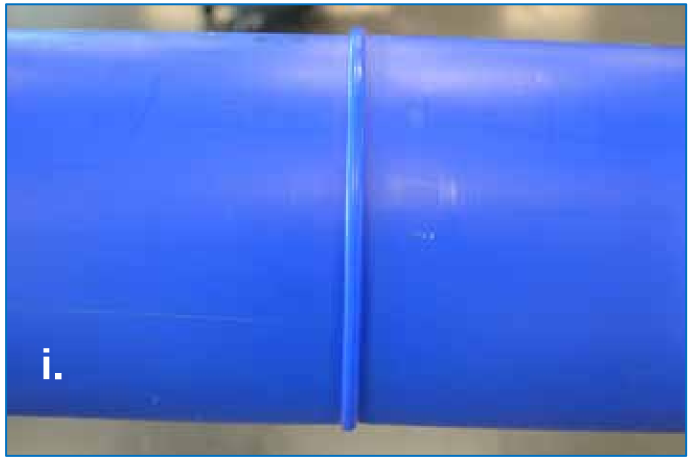
- **ASTM F2389** *Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems*
- **ASTM F3722** *Standard Practice for Heat Fusion Joining of Polypropylene (PP) Pipe and Fittings*
- **CSA B137.11** *Polypropylene (PP) pipe and fittings for pressure applications*

PP-R and PP-RCT Piping

Joining

- PP pipe & fittings are joined via:
  i. Heat fusion (butt, socket, sidewall)
  ii. Electrofusion
  iii. Flanged fittings
  iv. Grooved mechanical fittings

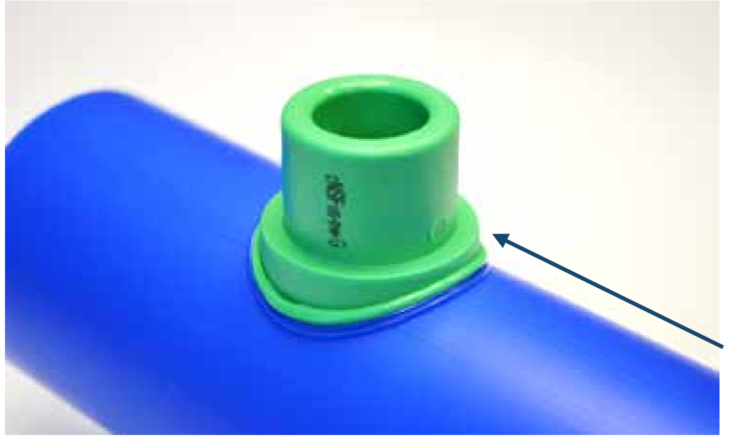




PP-R and PP-RCT Piping

Joining

- Heat fusion (butt, socket, sidewall) joints are "welded" under pressure
- New **ASTM F3722** *Standard Practice for Heat Fusion Joining of Polypropylene (PP) Pipe and Fittings* provides guidance for fusion



Flanged connection

Socket fusion

Sidewall fusion

Butt fusion

Courtesy Aquatherm

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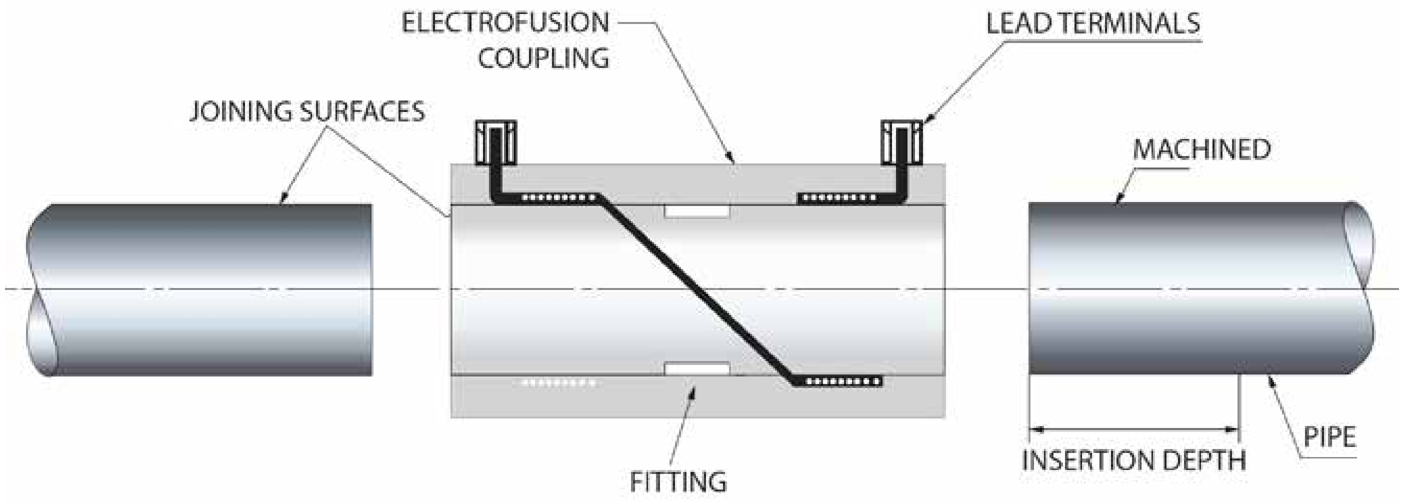
PP-R and PP-RCT Piping

Joining

- Electrofusion fittings have embedded copper wires and weld themselves to pipes
- New **ASTM F3722** *Standard Practice for Heat Fusion Joining of Polypropylene (PP) Pipe and Fittings* provides guidance for fusion

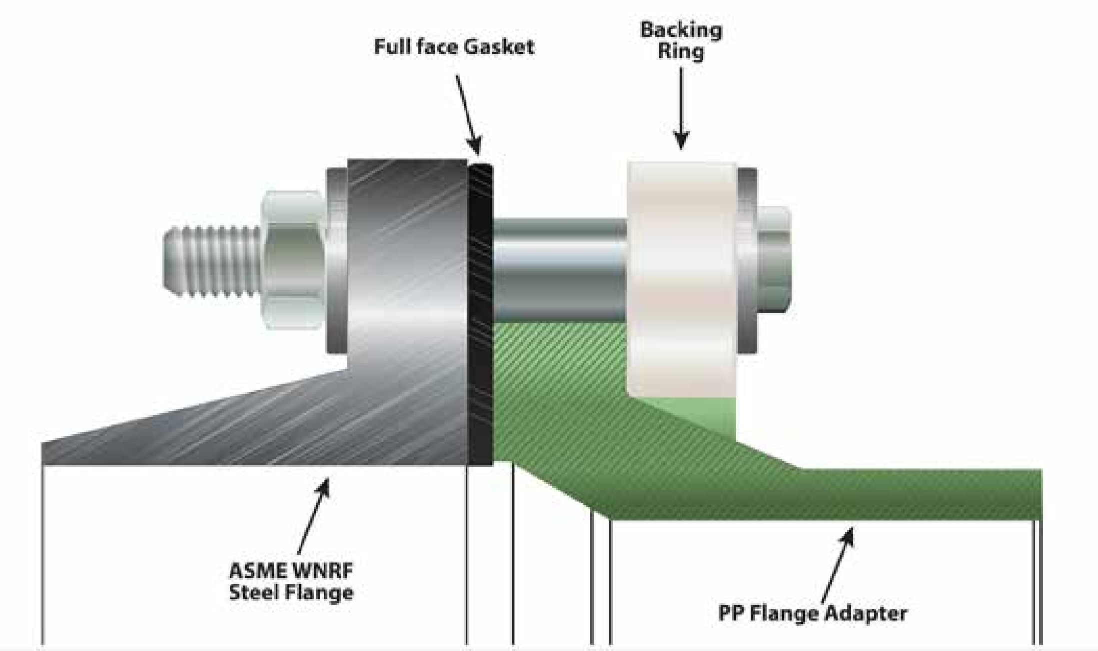
Courtesy Aquatherm

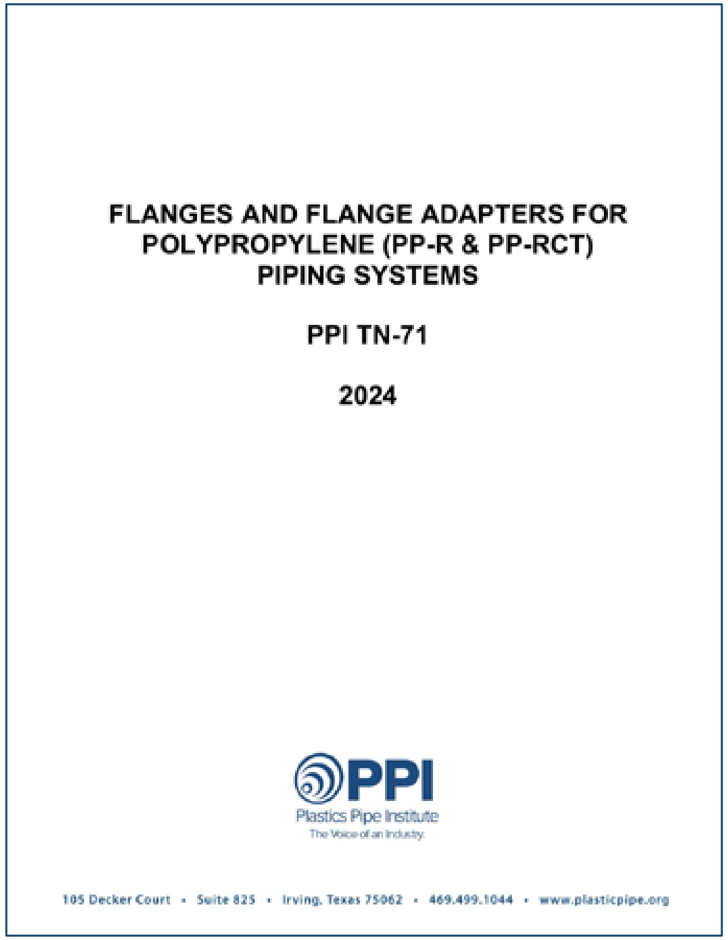


PP-R and PP-RCT Piping

Joining

- Flanged fittings allow fast and reliable joining from PP to valves, fittings, and other materials
- New **PPI TN-71** provides guidance





FLANGES AND FLANGE ADAPTERS FOR POLYPROPYLENE (PP-R & PP-RCT) PIPING SYSTEMS

PPI TN-71

2024

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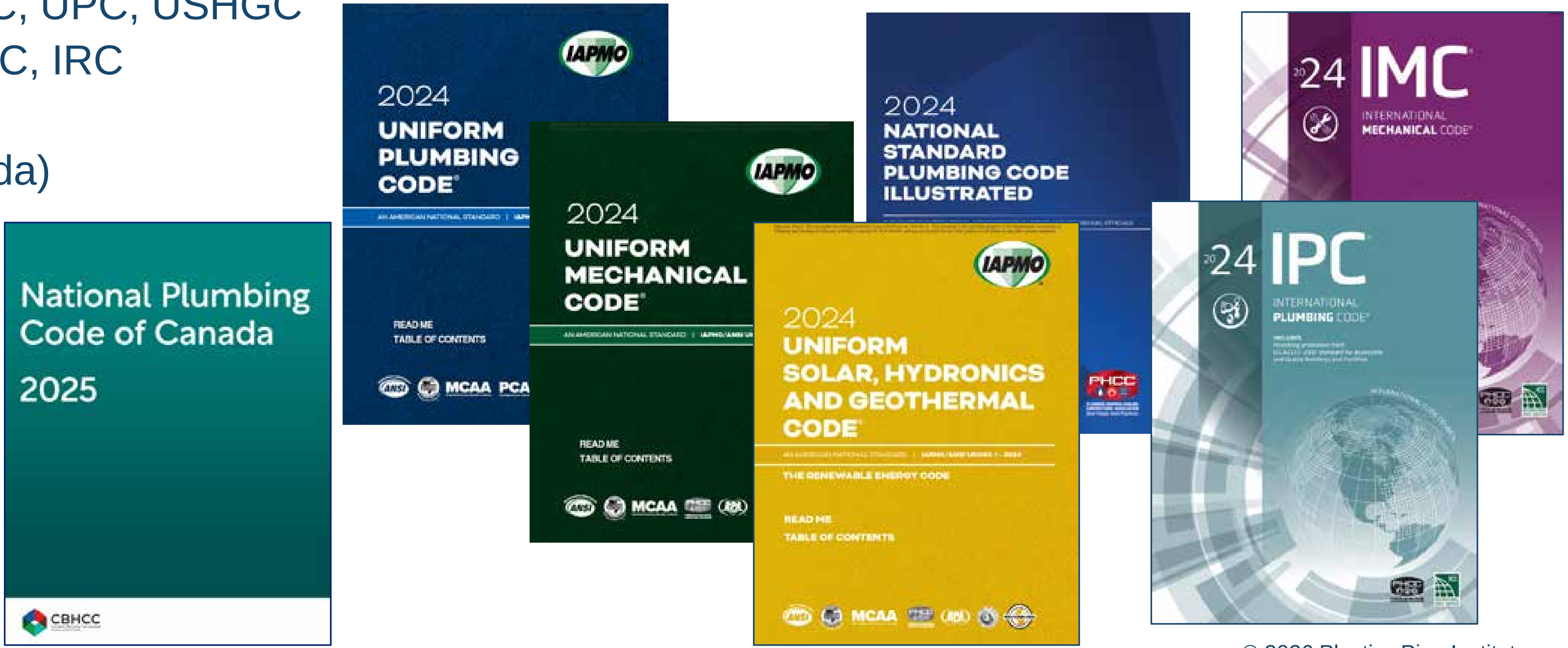
Code Compliance

Plumbing & Mechanical Code Compliance

- Each of these plastic pipes is **Approved** in model codes for plumbing & mechanical piping
- IAPMO UMC, UPC, USHGC
- ICC IMC, IPC, IRC
- NSPC
- NPC (Canada)



2. Piping Limitations

Address the limitations of each type of pipe and fitting material

- Every pipe and fitting material has limitations
    - Excessive velocity
    - Pressure / Temperatures limits
    - Chemical compatibility, including disinfectants
    - Outdoor weathering, UV exposure
    - Thermal expansion/contraction stress
    - Physical forces, mis-installation
    - Flexibility
    - What else?

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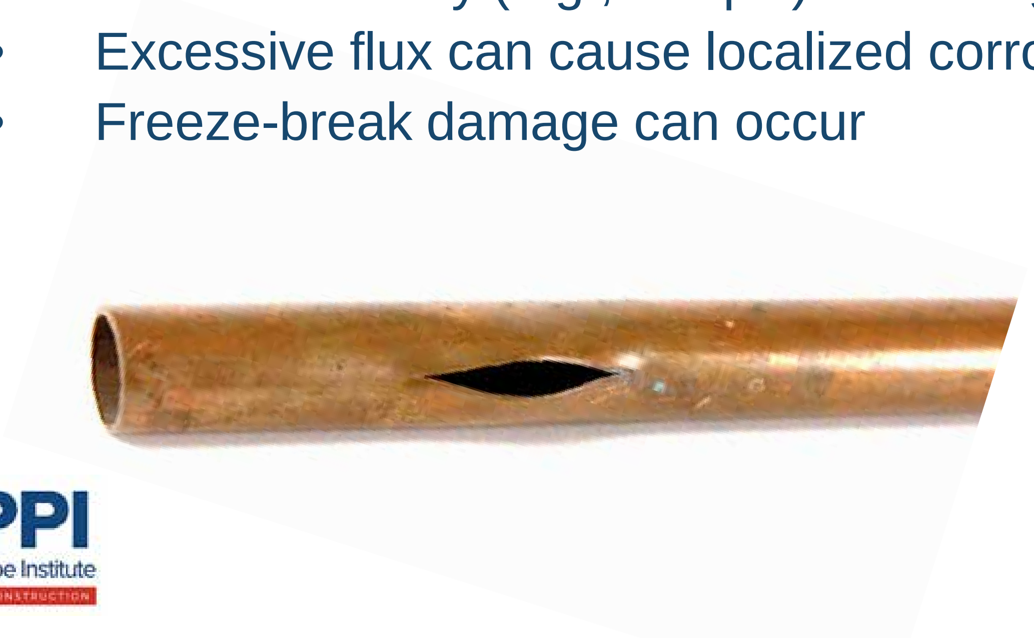
Piping Limitations: Copper

Things that can put copper pipe and fittings at risk

- Excessive temperature and pressure – follow the pressure ratings
- Approved maximum velocity is **8 feet per second** for cold water
- Approved maximum velocity is **5 feet per second** for hot water
- Approved maximum velocity is **2-3 feet per second** for water >140°F (60°C)
- Water chemistry (e.g., low pH) can be aggressive
- Excessive flux can cause localized corrosion
- Freeze-break damage can occur



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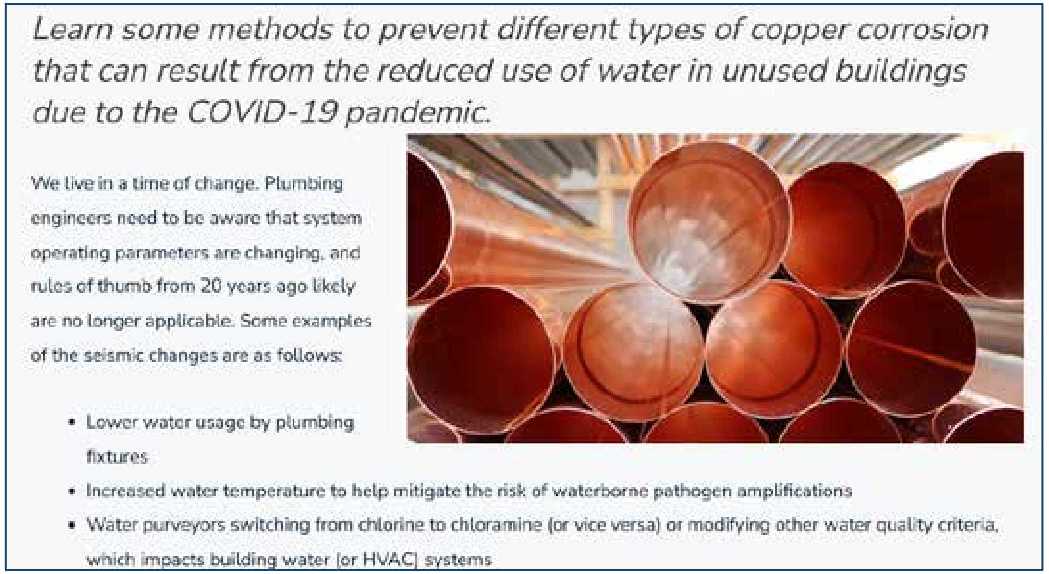
Piping Limitations: Copper

Things that can put copper pipe and fittings at risk

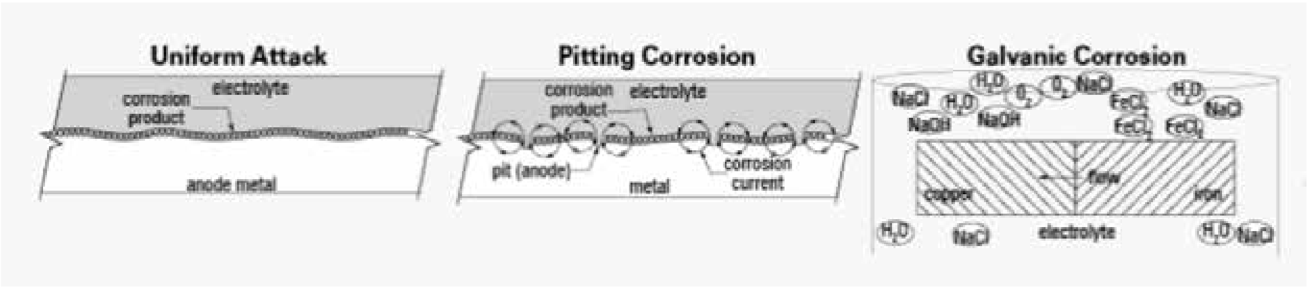
- Types of corrosion: uniform, pitting, galvanic, impingent, stress corrosion, concentration cell, erosion corrosion
- See **ASPE Pipeline** article May 2021
  by AWWA Premise Plumbing Committee

ASPEPipeline
News for the Plumbing System Design Industry


Learn some methods to prevent different types of copper corrosion that can result from the reduced use of water in unused buildings due to the COVID-19 pandemic.

We live in a time of change. Plumbing engineers need to be aware that system operating parameters are changing, and rules of thumb from 20 years ago likely are no longer applicable. Some examples of the seismic changes are as follows:

- Lower water usage by plumbing fixtures
- Increased water temperature to help mitigate the risk of waterborne pathogen amplifications
- Water purveyors switching from chlorine to chloramine (or vice versa) or modifying other water quality criteria, which impacts building water (or HVAC) systems



Piping Limitations: CPVC

Things that can put CPVC pipe and fittings at risk

- Excessive temperature and pressure – follow the pressure ratings
- Approved maximum velocity is **8 feet per second** for CPVC Tubing
- Approved maximum velocity is **5 feet per second** for CPVC Pipe > NPS 4
- Resistant to high levels of chlorine, chloramines, and chlorine dioxide (ClO_2)
- Chemicals: Certain caulks, cleaners, sealants, fire stop materials, pipe clamps, pipe tape, thread sealants, waterproofing products, spray foam, oils and lubricants can all cause damage
- Check with manufacturer

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Piping Limitations: CPVC

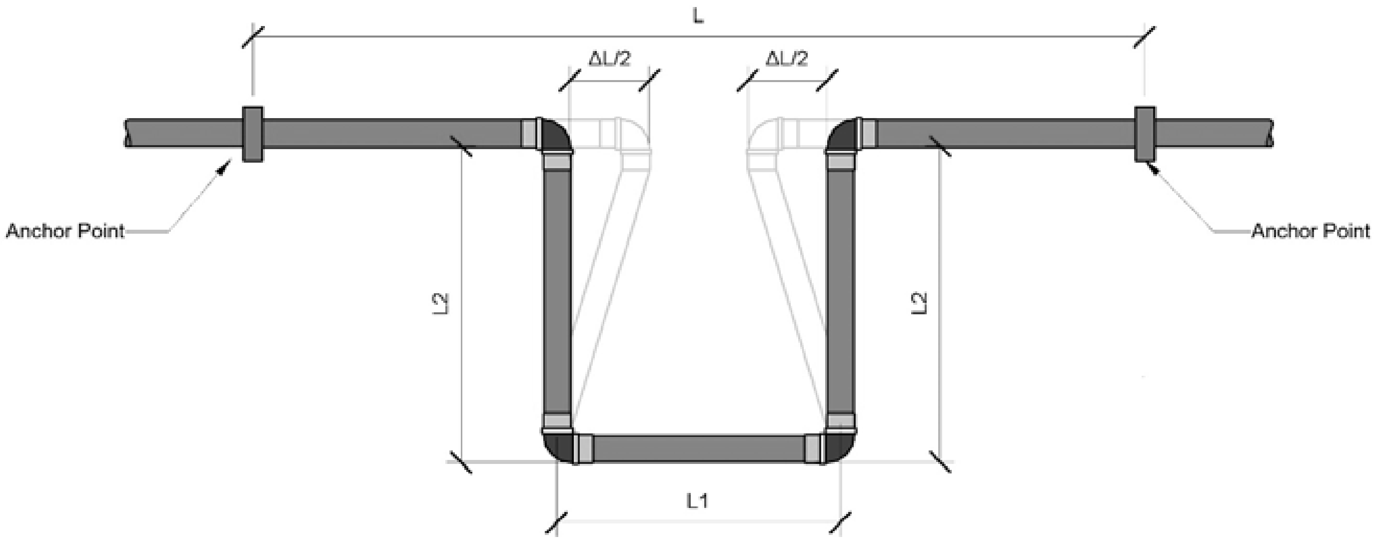
Things that can put CPVC pipe and fittings at risk

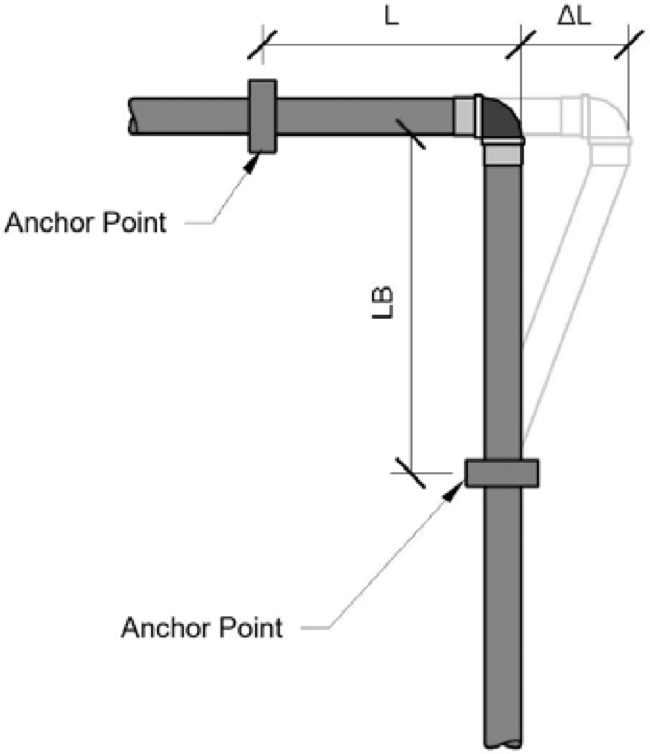
- Fittings must be installed correctly using the right primer & solvent cement
- Pipe hangers must be selected and installed with care to protect pipes (avoid incompatible elastomers)

Piping Limitations: CPVC

Things that can put CPVC pipe and fittings at risk

- **Expansion arms** and **loops** are sometimes needed to accommodate thermal expansion and contraction; industry calculators can help to design these
- Lack of expansion accommodation can lead to **excessive stress** on materials and potential failure at fittings

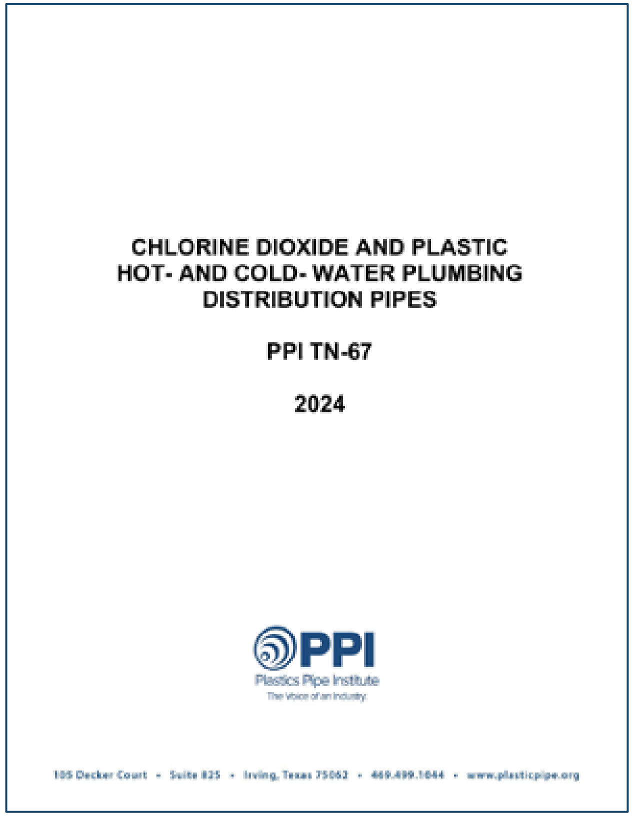




Piping Limitations: PEX and PE-RT

Things that can put PEX and PE-RT pipe and fittings at risk

- Excessive temperature and pressure – follow the pressure ratings
- Approved maximum velocity is **10 feet per second** for cold water
- Approved maximum velocity is **8 feet per second** for hot water
- PEX and PE-RT are sensitive to chlorine dioxide (ClO_2) in treated water (see **PPI TN-67** for details)



CHLORINE DIOXIDE AND PLASTIC HOT- AND COLD- WATER PLUMBING DISTRIBUTION PIPES

PPI TN-67

2024

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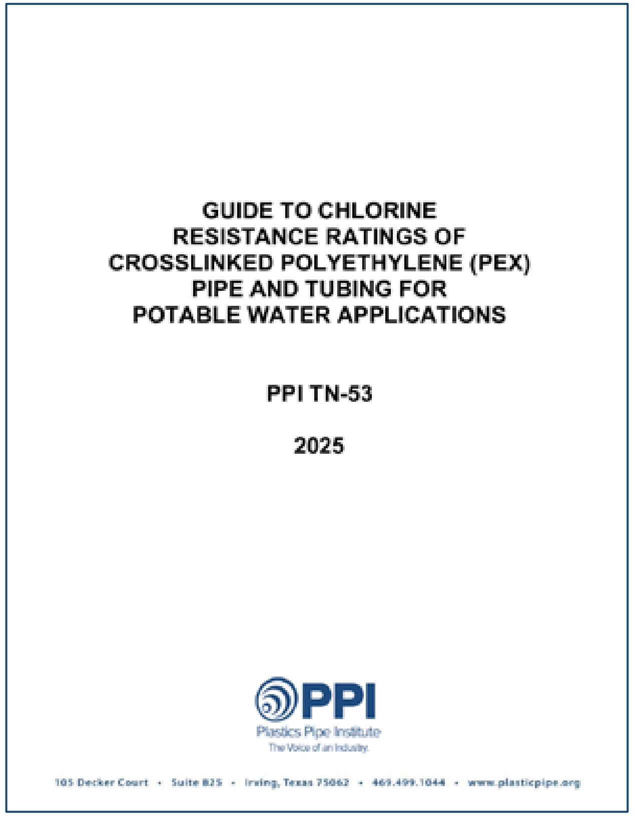
Piping Limitations: PEX and PE-RT

Things that can put PEX and PE-RT pipe and fittings at risk

- PEX/PE-RT are resistant to high levels of chlorine/chloramines (up to 4.0 ppm)
- Chlorine resistance is based on maximum exposure to potable water at **80 psig** and **140°F** (60°C) (see **PPI TN-53** for details)
- Chloramines are less aggressive than chlorine (not a significant concern – see **PPI Statement A** for details)
- Long-term performance of PEX will be compromised by excessive UV radiation from sunlight PEX

- Avoid thread sealing compounds, solder flux, petroleum-based materials, certain firestop compounds (check with pipe manufacturer)



GUIDE TO CHLORINE RESISTANCE RATINGS OF CROSSLINKED POLYETHYLENE (PEX) PIPE AND TUBING FOR POTABLE WATER APPLICATIONS

PPI TN-53

2025

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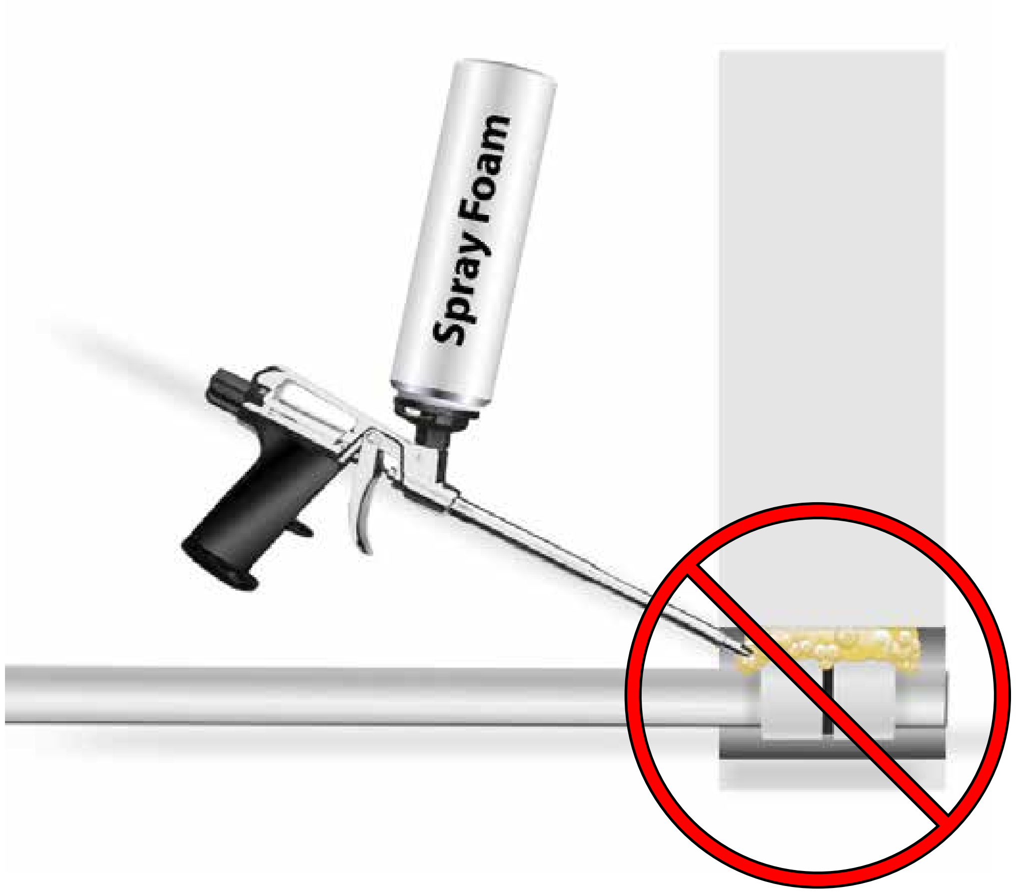
Piping Limitations: PEX and PE-RT

Things that can put PEX and PE-RT pipe and fittings at risk

- Certain polymer fitting materials (e.g., polysulfone/PSU, polyphenlysulfone/PPSU) may be incompatible with **spray foam insulation** and might have chemical-compatibility issues if the fittings are encased directly in SPF

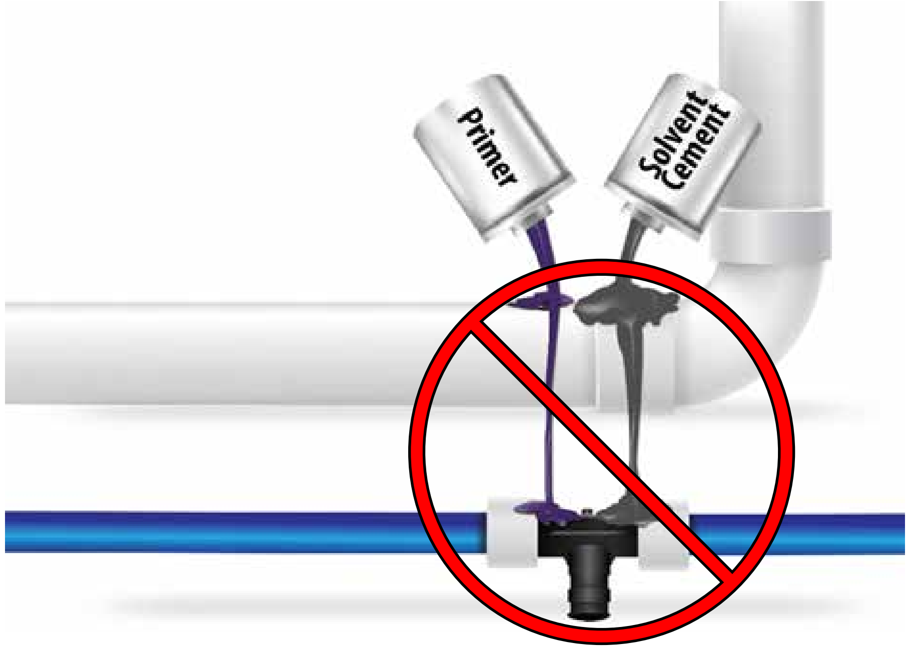
- Direct encasement of polymer fittings in spray foam is **Not recommended**



Piping Limitations: PEX and PE-RT

Things that can put PEX and PE-RT pipe and fittings at risk

- Certain polymer fitting materials (e.g., polysulfone/PSU, polyphenlysulfone/ PPSU) may be incompatible with solder flux or ABS, PVC, or CPVC primer and solvent cement
- Direct contact of polymer fittings with primer or cement is **Not recommended**

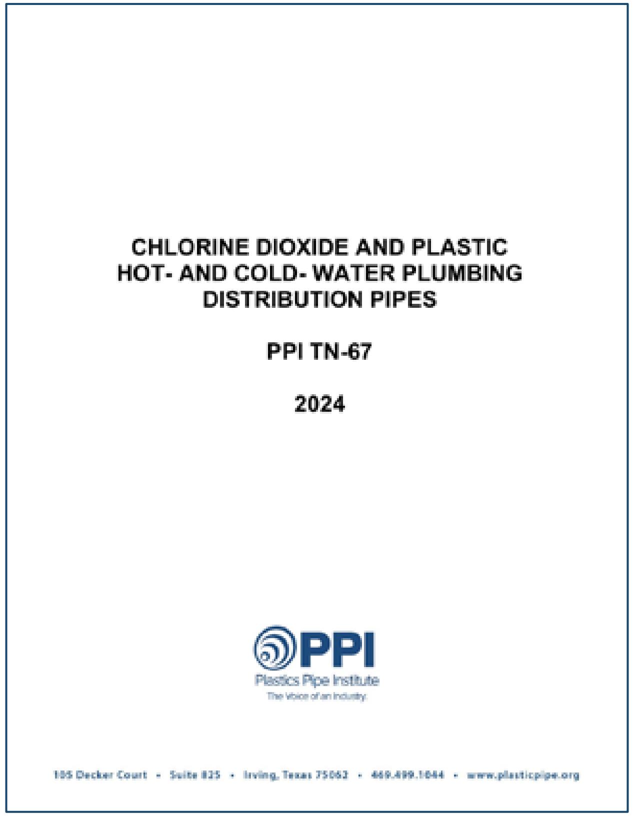


Piping Limitations: PP-R and PP-RCT

Things that can put PP-R and PP-RCT pipe and fittings at risk

- Excessive temperature and pressure – follow the pressure ratings
- Approved maximum velocity is **10 feet per second*** for cold water
- Approved maximum velocity is **8 feet per second*** for hot water
- Chlorine resistance is based on maximum exposure to potable water at **80 psig** and **140°F** (60°C)
- PP-R and PP-RCT are sensitive to chlorine dioxide (ClO_2) in treated water (see **PPI TN-67**)

**check with manufacturer*


CHLORINE DIOXIDE AND PLASTIC HOT- AND COLD- WATER PLUMBING DISTRIBUTION PIPES

PPI TN-67

2024

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Piping Limitations: PP-R and PP-RCT

Things that can put PP-R and PP-RCT pipe and fittings at risk

- Pipe hangers must be selected and installed with care to protect pipes
- **PP-R** is sensitive to dissolved copper, usually caused by erosion corrosion and/or aggressive water (see **PPI TN-57**)
- Does not apply to **PP-RCT**


Courtesy Aquatherm


PROPER INTEGRATION OF
PP-R PIPING MATERIALS WITH
COPPER TUBING AND COMPONENTS
FOR PLUMBING APPLICATIONS

PPI TN-57

2025

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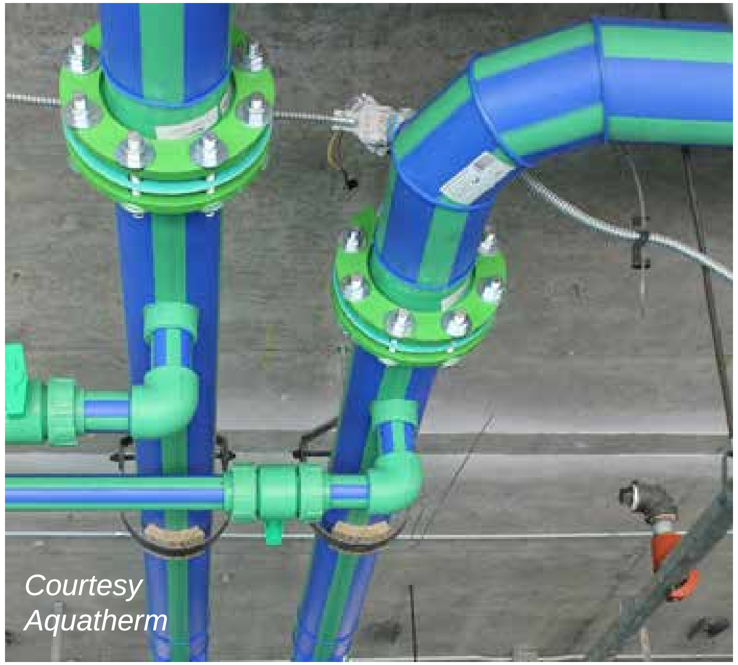
Piping Limitations: PP-R and PP-RCT

Things that can put PP-R and PP-RCT pipe and fittings at risk

- Fittings must be installed correctly following ASTM F3722 *Standard Practice for Heat Fusion Joining of PP Pipes and Fittings*
- Thermal expansion/contraction must be accommodated in design



Selecting Appropriate Materials

Recommendations for choosing type/s of pipe

- For risers and straight mains, select a **rigid** pipe (e.g., copper, CPVC, PP)
- Flexible pipes can use **pipe support channels** to increase hanger spacing
- For long runs with curves and bends, select **flexible** tubing (e.g., PEX, PE-RT)
- When water is potentially corrosive, select **plastic** pipe (e.g., CPVC, PEX, PE-RT, PP)
- If potable water temperature exceeds **140°F**, select copper or CPVC pipe
- If potable water pressure exceeds **80 psig**, select copper or CPVC pipe
- Other plastics may be suitable – check with manufacturer!

Courtesy Aquatherm

Courtesy REHAU

Selecting Appropriate Materials

Recommendations for choosing type/s of pipe

- Where pipes will be embedded within slab or under slabs, select a **flexible** tubing
- When velocity may exceed **8 fps cold/5 fps hot**, select a **plastic** pipe
- When chlorine dioxide is used as the secondary disinfectant, select **CPVC** pipe
- When material costs and installation convenience matter, consider **plastic** pipes

Courtesy Reliance Worldwide Corp.

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Selecting Appropriate Materials

Hybrid piping systems

- Combining various types of plastic piping with each other or with copper in **hybrid piping** systems may deliver the best combination of safety, performance, and reliability
- E.g., **Copper/CPVC/PP** risers and mains with **PEX** or **PE-RT** branch lines
- Large mains are rigid to reduce number of hangers
- Small branches and drops are flexible to minimize fittings and speed installation

Courtesy GF
Uponor x 2

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3. Design of Piping Materials

Goals of Commercial Cold- and Hot-water Plumbing Design

1. Protect the health and safety of users
2. Ensure that water is safe and free from contaminants
3. Deliver hot water quickly for customer satisfaction and efficiency
4. Minimize energy usage when transporting water (don't overpump)
5. Don't waste costs on unnecessary materials (simplify and optimize)
6. Design for the life of piping materials (respect their capabilities)
7. Protect against seismic events and extreme weather, ensure resilience
8. Comply with codes and standards and owner preferences

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Design of Piping Materials

Sizing pipes for flow: Risks of Undersized piping

- Undersized piping causes excessive pressure drop and insufficient pressure
- Undersized piping causes excessive water velocities, leading to:
  - Erosion corrosion in certain components
  - Unwanted noise and vibration
  - Higher probability of surge pressures and water hammer

Design of Piping Materials

Sizing pipes for flow: PEX vs. copper

- "PEX and copper piping systems will deliver sufficient volumetric flow rates to the plumbing fixtures when using the **same nominal size tubing**."
- "The flow rate of each plumbing fixture was virtually identical for both piping systems, except for minor differences in the water closet flow rate."
- *See **NAHB-RC** report (extracts above)*

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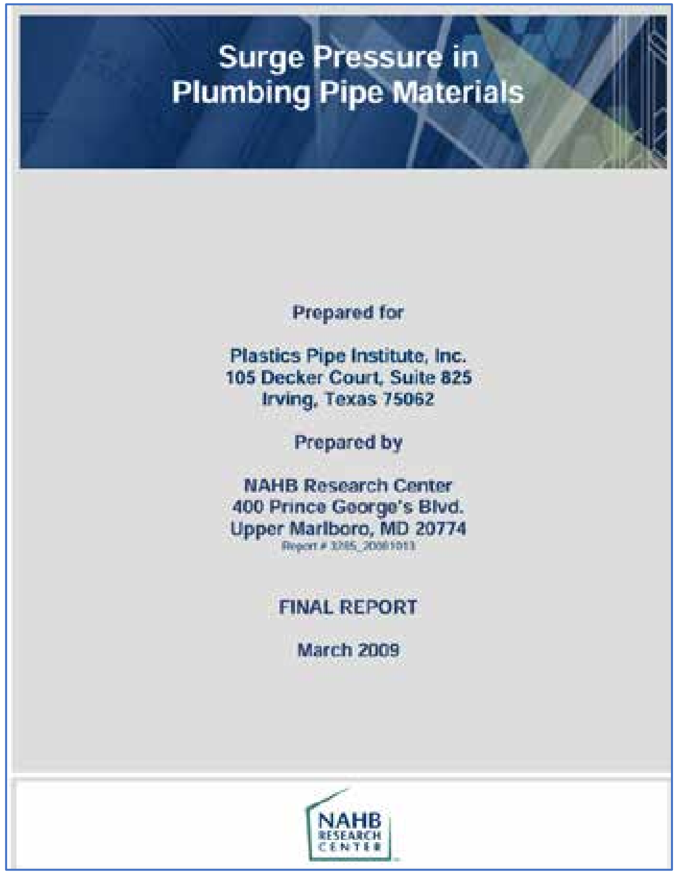
Design of Piping Materials

Sizing pipes for flow: Surge Pressure

- Plastic pipe materials are inherently more flexible and can absorb instantaneous surge pressures, helping to reduce water hammer
- **2.5 GPM cold water test:**
  - CPVC reduces surge pressure **28%** vs. copper
  - PEX reduces surge pressure **30-37%** vs. copper
- *See **NAHB-RC** report (extract below)*

Table 3: Peak Pressure Comparison – 2.5 GPM Cold Water Flow, 54ºF Water (See Figure 4b)

	Pipe Peak 1 (psig)	% Difference
½" Type L Copper	239	0
½" CPVC	173	28
½" PEX-1	168	30
½" PEX-2	150	37


Surge Pressure in Plumbing Pipe Materials

Prepared for

Plastics Pipe Institute, Inc.
105 Decker Court, Suite 825
Irving, Texas 75062

Prepared by

NAHB Research Center
400 Prince George's Blvd.
Upper Marlboro, MD 20774

FINAL REPORT

March 2009

NAHB RESEARCH CENTER

Design of Piping Materials

Sizing pipes for flow: Risks of Oversized piping

- Oversized piping can result in stagnant water, decay of disinfectants
    - May foster growth of pathogens such as *Legionella*
- Oversized piping reduces the velocity of water within the pipes
    - Potential to allow greater biofilm growth
- See *Impact of Premise Plumbing Design, Velocity, and Operational Factors on Microbial Activity During Stagnation in Pipes (Gurian, 2025)*

AWWA Water Science

AWWA WATER SCIENCE

ORIGINAL RESEARCH

Impact of Premise Plumbing Design, Velocity, and Operational Factors on Microbial Activity During Stagnation in Pipes

Patrick L. Gurian[1] | Shahzaib Samuel[1] | Neha Yadav[1] | Michael Krieger[1] | Rajveer Singh[1] | Tim Bartrand[2]

[1]Department of Civil, Architectural, and Environmental Engineering, Drexel University, Philadelphia, Pennsylvania, USA | [2]ESPRI, Philadelphia, Pennsylvania, USA

Correspondence: Patrick L. Gurian (pgurian@drexel.edu)

Received: 17 February 2025 | **Revised:** 13 July 2025 | **Accepted:** 16 July 2025

Design of Piping Materials

Sizing pipes for flow: Risks of Oversized piping

- Oversized piping results in wasted energy and water
    - Takes more time to flush large hot-water lines to get hot water to outlets
- Oversized piping wastes material and increases installation costs

<u>The goal is to pick the optimal pipe size!</u>

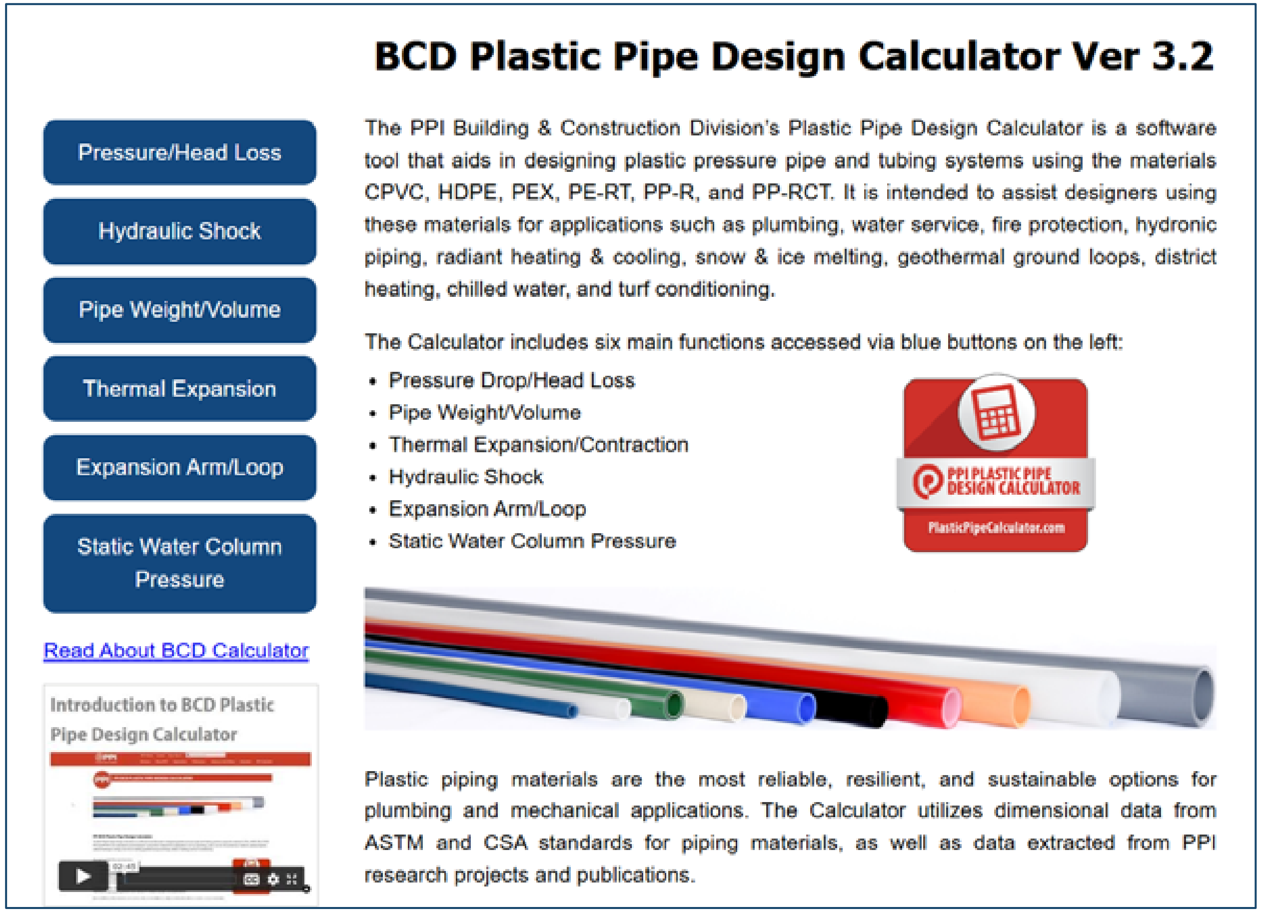
Design of Piping Materials

PPI BCD Plastic Pipe Design Calculator

Free design tool has **six functions**:

1. Pressure Drop/Head Loss
2. Hydraulic Shock
3. Pipe Weight/Volume
4. Thermal Expansion
5. Expansion Arm/Loop Design
6. Static Water Column Pressure

- Go to PlasticPipeCalculator.com



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Design of Piping Materials

Pressure Drop/Head Loss example: CPVC Pipe

PRESSURE DROP / HEAD LOSS

Input

Is this a Geothermal Application?	☐

Pipe/Tubing Selection[1]

Pipe/Tubing Material:	CPVC
Sizing Type (CTS/IPS/Metric):	IPS (ASTM F441/CSA B137.6)
Wall Type (SDR/Schedule):	Schedule 80
Nominal Pipe/Tubing Size[2]:	3

More information on CPVC

Flow Rate:	100 USGPM
Length of Pipe:	75 ft
Fluid Type (Water or % Antifreeze[3]):	100% Water

Calculate

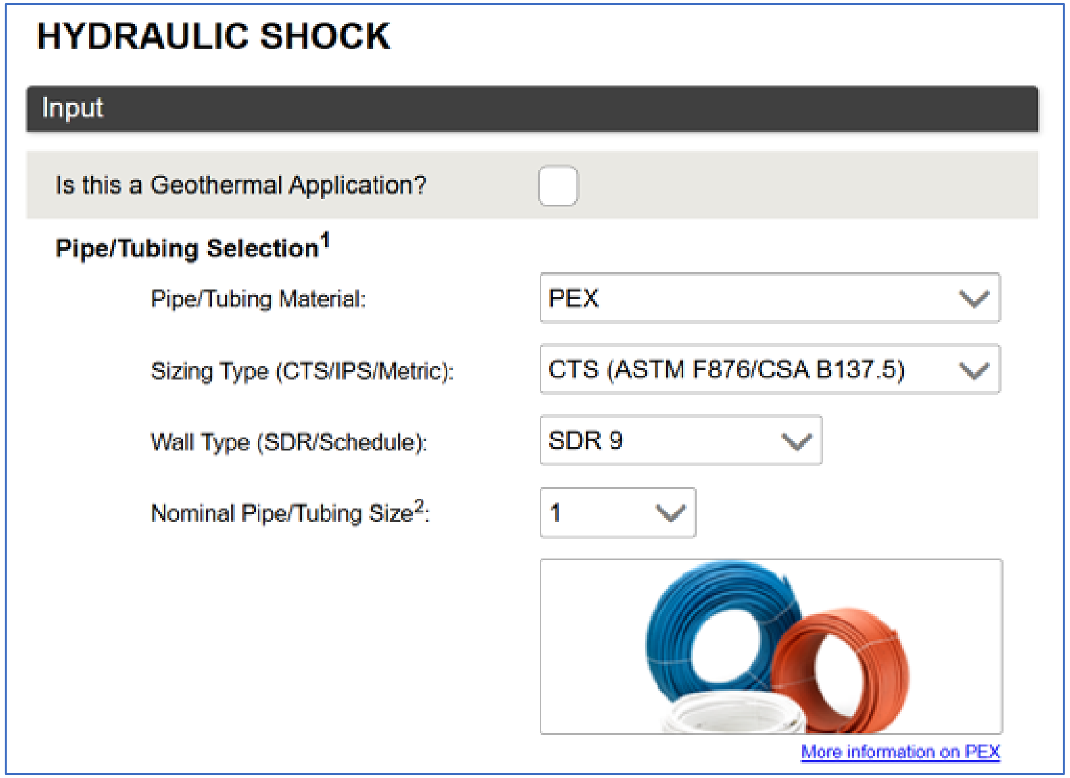
Results

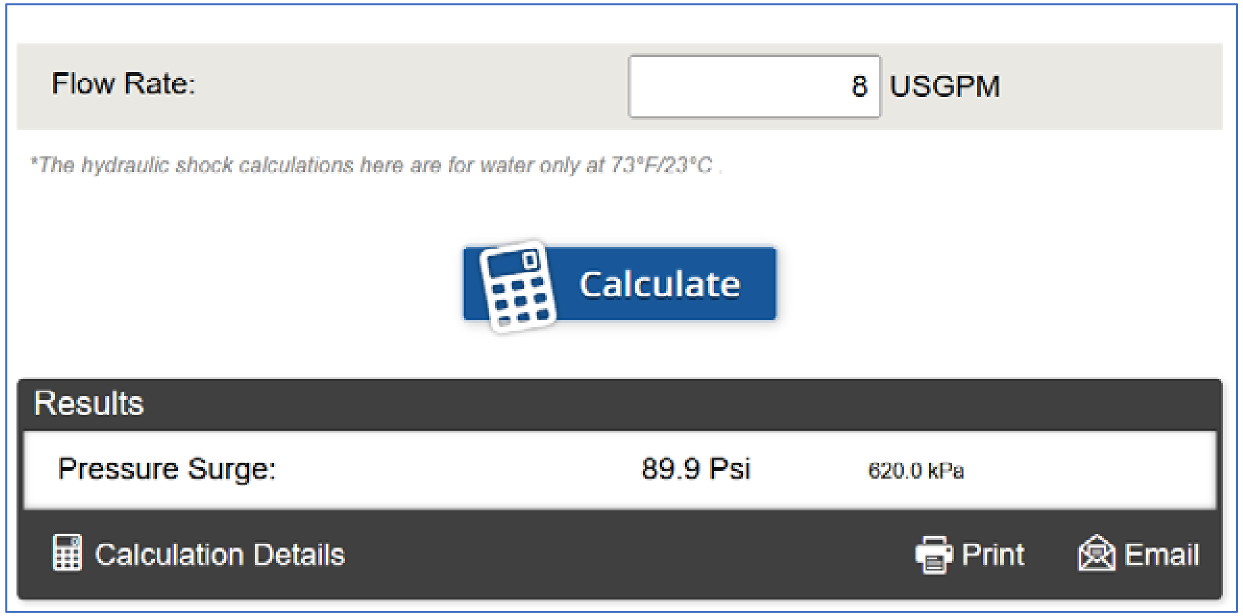
Flow Regime:	Turbulent	
Pressure Drop:	0.80 Psi	5.50 kPa
Head Loss:	1.84 ft water	
Velocity*:	4.98 ft/s	1.52 m/s

Calculation Details Print Email

Design of Piping Materials

Hydraulic Shock example: PEX Tubing





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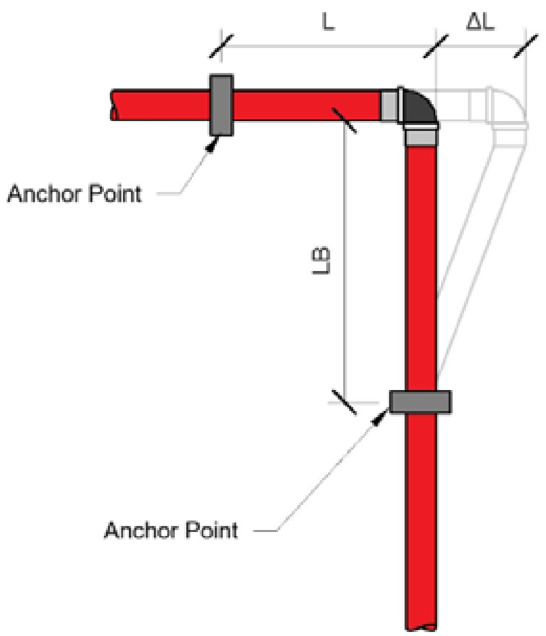
Design of Piping Materials

Expansion Arm example: PP-RCT Pipe with fibre-core

EXPANSION ARM/LOOP

Input

Expansion Type: (●) Arm ( ) Loop

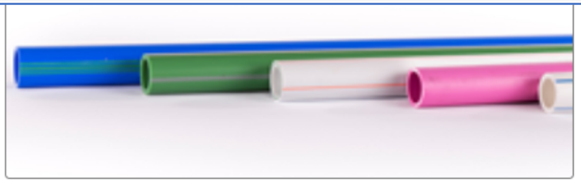


Calculate

Results

Length LB:	29.6 in	751 mm
Expansion Length ΔL:	0.8 in	21 mm

Calculation Details Print Email



More information on PP-RCT

Length L:	50	ft
Temperature Change:	70	°F

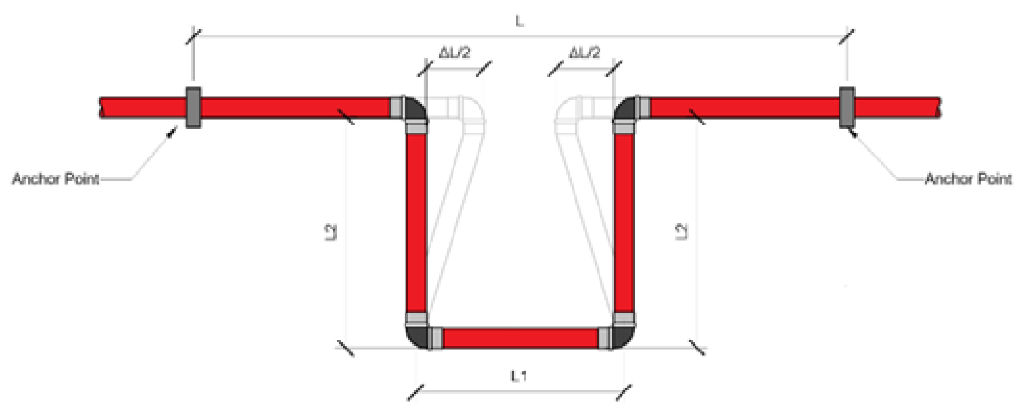
Design of Piping Materials

Expansion Loop example: PP-RCT Pipe with fibre-core

EXPANSION ARM/LOOP

Input

Expansion Type: ○ Arm ◉ Loop



Calculate

Results

Length L_1:	5.9 in	150 mm
Length L_2:	11.8 in	300 mm
Expansion Length ΔL:	0.8 in	21 mm

Calculation Details · Print · Email

More information on PP-RCT

Length L:	50	ft
Temperature Change:	70	°F

Design of Piping Materials

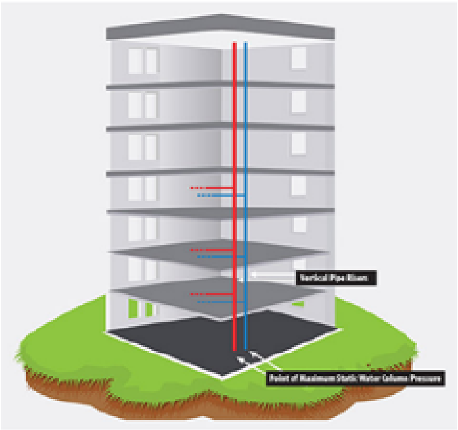
Results can be emailed or printed

- “Print to pdf” example shown
- *Calculation Details* can be seen for all functions
- Try it at PlasticPipeCalculator.com

STATIC WATER COLUMN PRESSURE

Input

Column Type: Geothermal / Plumbing, Fire Protection, Hydronic



Pipe/Tubing Selection[1]

Pipe/Tubing Material:	PE-RT (Potable)
Sizing Type (CTS/IPS/Metric):	CTS (ASTM F2769/CSA B137.18)
Wall Type (SDR/Schedule):	SDR 9
Nominal Pipe/Tubing Size[2]:	1

[1] For more information about plastic piping products included in this calculator, please visit the BCD website.

[2] "Tubing" refers to products with an actual Outside Diameter (OD) 1/8 inch larger than the nominal size. "Pipe" refers to products with an actual OD matching that of steel pipe of the same nominal size (e.g. IPS), or products where the actual OD matches the nominal size (e.g. DN-Metric).

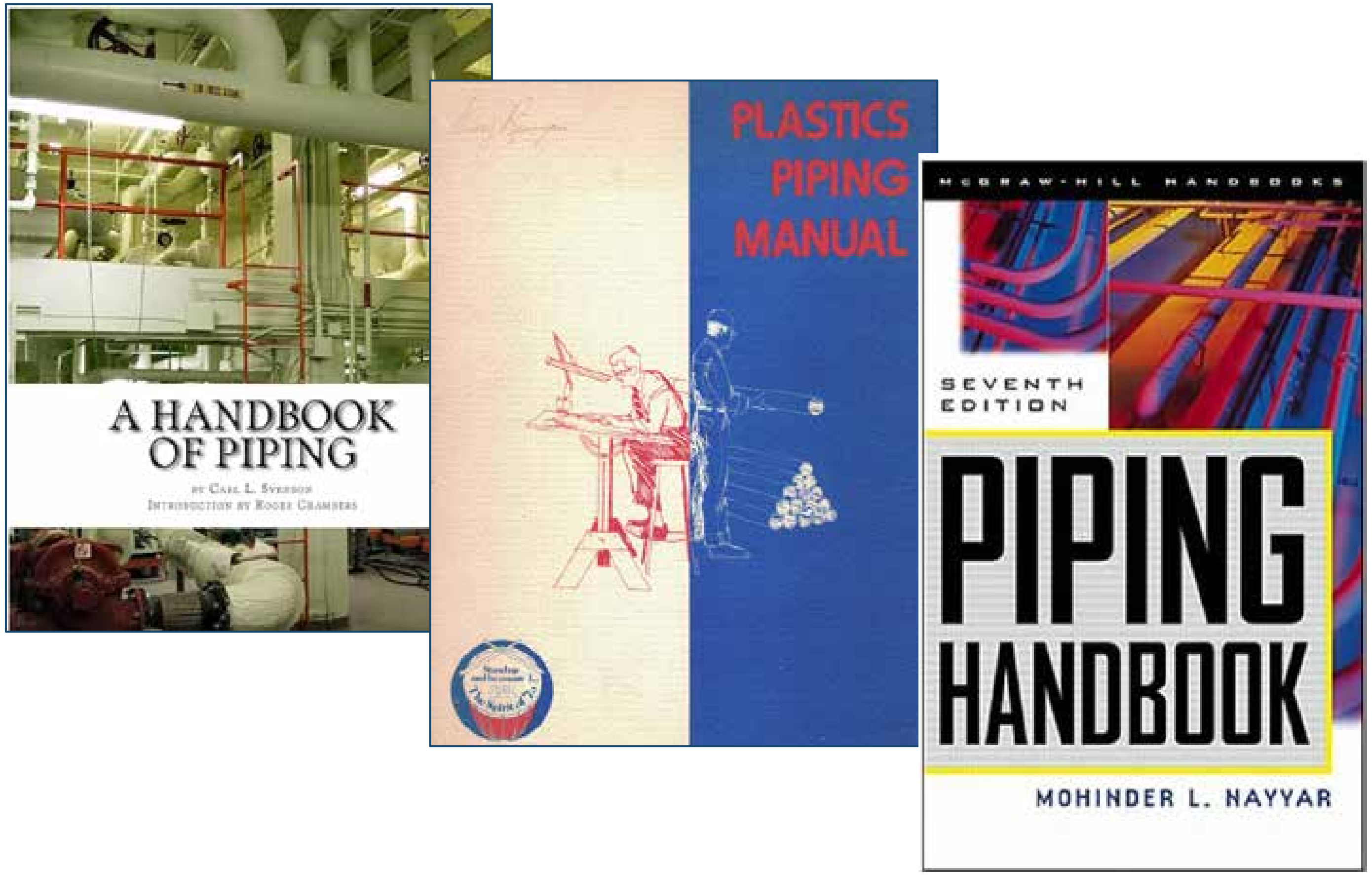
$P_{Surface}$ (Surface Pressure)[3]: 25 psi

Height of Water/Fluid Column: 180 ft

4. Industry Resources

Industry resources for selecting and specifying piping material(s)

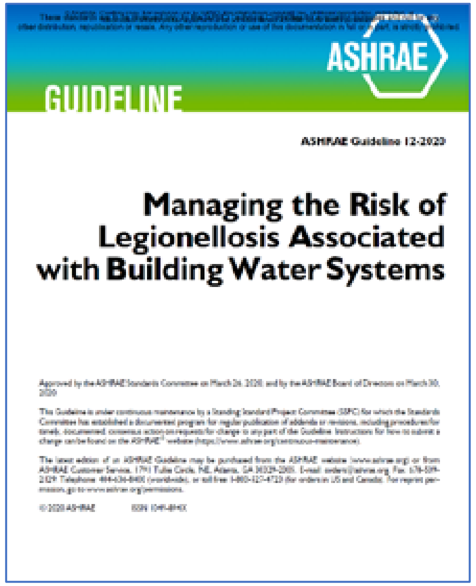
- ASHRAE
- ASPE
- CDA
- IAPMO
- ICC
- PPI
- PPFA
- Others (some obsolete)

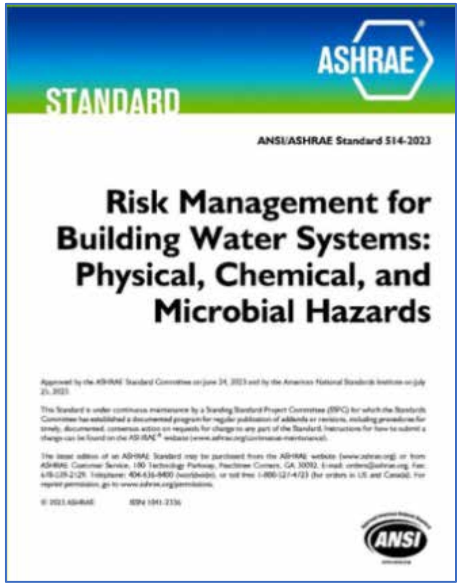


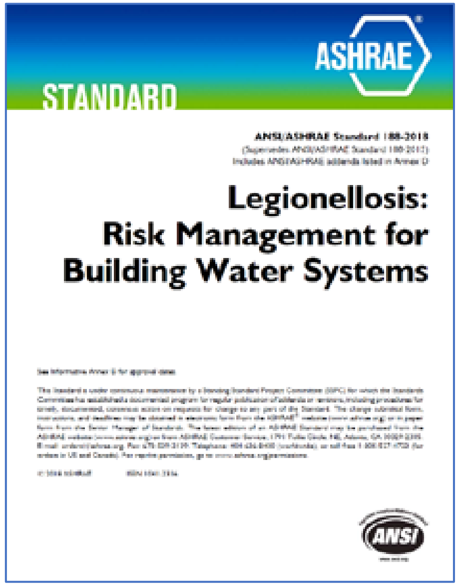
ASHRAE Resources

ASHRAE resources for plumbing design

- **ASHRAE Guideline 12** Managing the Risk of Legionellosis Associated with Building Water Systems
- **ASHRAE 188** Legionellosis: Risk Management for Building Water Systems
- **ASHRAE 514** Risk Management for Building Water Systems: Physical, Chemical and Microbial Hazards







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ASHRAE Resources

ASHRAE Fundamentals Handbook, Ch. 22 Pipe Design

CHAPTER 22

PIPE DESIGN

THIS CHAPTER discusses pipe systems, materials, design, installation, supports, stress calculations, pipe expansion and flexibility, bends and loops, and application of pipe systems commonly used for heating, air conditioning, refrigeration, and service water. When selecting and applying components; applicable local codes, state or provincial codes, and voluntary industry standards (some of which have been adopted by code jurisdictions) must be followed. Further details on specific piping systems can be found in application-specific chapters of the ASHRAE Handbook.

1. FUNDAMENTALS

1.1 CODES AND STANDARDS

The following organizations in the United States issue codes and standards for piping systems and components:

ASME American Society of Mechanical Engineers
ASTM American Society for Testing and Materials
NFPA National Fire Protection Association
ICC International Code Council
MSS Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
AWWA American Water Works Association

- Pressure and temperature of the fluid.
- External environment of the pipe: outdoor installations deal with temperature extremes, environmental contaminants, and ultraviolet radiation. Other environments could contain caustic chemicals. Soil can contain elements that can be corrosive to underground pipe systems.
- Installation cost.
- Pipe's resistance to chemical attack from the fluid.

When designing a fluid flow system, two related but distinct concerns emerge: sizing the pipe and determining the flow/pressure relationship. The two are often confused because they can use the same equations and design tools. Nevertheless, they should be determined separately.

This chapter focuses on sizing the pipe during the design phase, and to this end presents design charts and tables for specific fluids in addition to the equations that describe fluid flow in pipes. Once a system has been sized, it should be analyzed with more detailed methods of calculation to determine the pump head, if applicable, required to achieve the desired flow. Computerized methods are well suited to handling the details of calculating losses around an extensive system.

Not discussed in detail in this chapter, but of potentially great importance, are physical and chemical considerations such as pipe

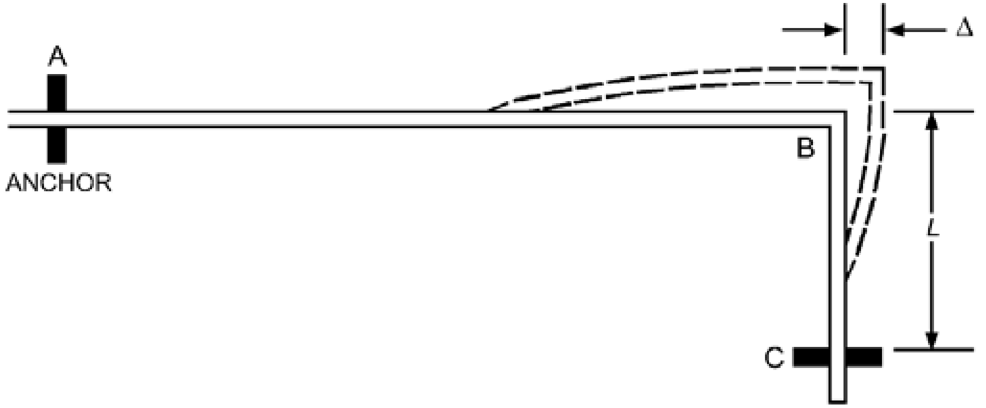


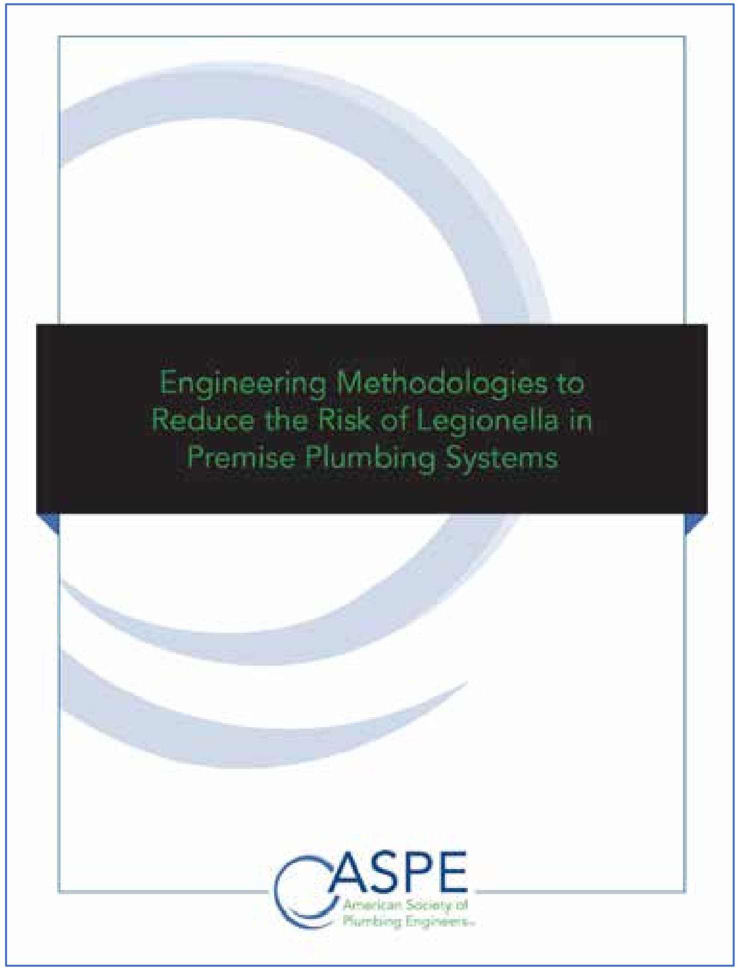
Fig. 4 Guided Cantilever Beam

$$L = \sqrt{\frac{3\Delta DE}{(144\ \text{in}^2/\text{ft}^2)S_A}} \qquad (15)$$

ASPE Resources

ASPE resources for plumbing design

- ASPE Engineered Plumbing Design II
- ASPE Plumbing Engineering Design Handbook, Volume One: Fundamentals of Plumbing Engineering
- ASPE Plumbing Engineering Design Handbook, Volume Two: Plumbing Systems
- ASPE Engineering Methodologies to Reduce the Risk of Legionella in Premise Plumbing Systems



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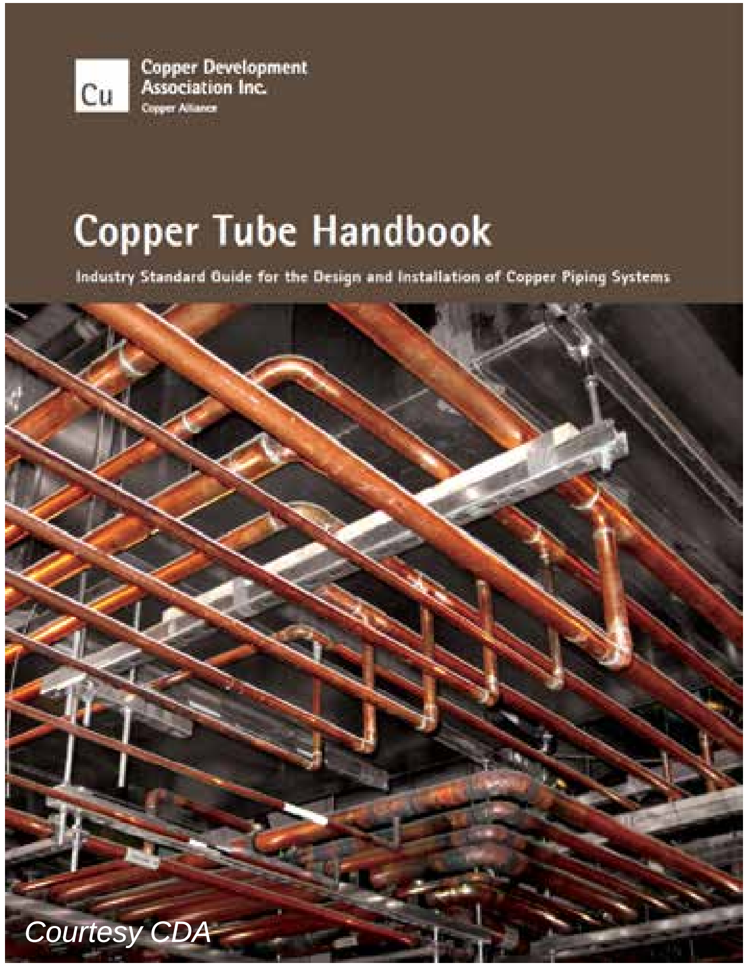
CDA Resources

CDA resources for plumbing design

- CDA Copper Tubing Handbook © 2024
- *Example on Water Velocity Limitations*

Water Velocity Limitations

To avoid excessive system noise and the possibility of erosion-corrosion, the designer should not exceed flow velocities of 8 feet per second for cold water and 5 feet per second in hot water up to approximately 140°F. In systems where water temperatures routinely exceed 140°F, lower flow velocities such as 2 to 3 feet per second should not be exceeded. In addition, where 1/2-inch and smaller tube sizes



Courtesy CDA

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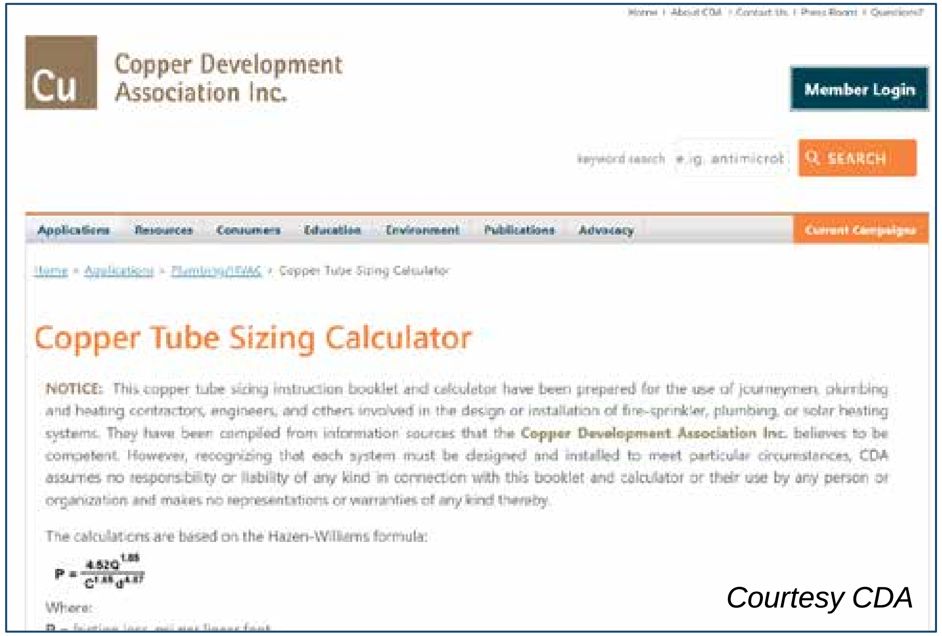
CDA Resources

CDA resources for plumbing design

- Research reports
- Copper Tube Sizing Calculator



Courtesy CDA

PPI Resources

PPI resources for plumbing design

- Model Specifications
- Statements, Recommendations
- Technical Notes, Technical Reports
- Design & Installation Guides
- Case Studies
- Training videos
- Plastic Pipe Design Calculator

- Go to plasticpipe.org/buildingconstruction

PPI BCD TECHNICAL LITERATURE

Model Specifications

- MS-7 Model Specification for Plastic Piping Materials for Ground Source Geothermal Applications
- MS-8 Model Specification for Polypropylene (PP-R & PP-RCT) Pressure Pipe Systems for Plumbing & Mechanical Applications - *revised 2025*

Statements

- PPI Statement A - Relative Oxidative Aggressiveness of Chloramines and Free Chlorine Disinfectants on Crosslinked Polyethylene (PEX) Pipes Used in Treated Potable Water - *revised 2024*
- PPI Statement Y - Taste and Odor of Drinking Water from Plastic Piping Systems
- PPI Statement AA - PFAS Chemicals and Plastic Piping for Portable Water Transport - *revised 2025*
- PPI Statement AB - Microplastics and Plastic Piping for Potable Water
- PFAS and Plastic Piping Frequently Asked Questions (FAQs)

Recommendations

- PPI Recommendation E - Recommendation Against Mixing Hydronic Heating Water with Potable Water In Combined Systems
- PPI Recommendation F - Testing PEX and PE-RT Tubing Systems with Compressed Air or Inert Gas
- PPI Recommendation G - Recommendation Against Using Epoxy Pipe Coatings Within Plumbing Distribution Systems Utilizing Plastic Components
- PPI Recommendation H - Direct Connection of Plastic Piping Materials to Tankless Water Heaters for Domestic Applications - *revised 2024*
- PPI Recommendation I - Guidance on Restoring Potable Water Piping Systems Post-Urban-Wildland Wildfires

Position Papers

- Installation of CPVC Fittings Within and Under Concrete Slabs
- Installation of PEX Fittings Within and Under Concrete Slabs
- Installation of PE-RT Fittings Within and Under Concrete Slabs

Technical Notes

- TN-14 - Utilizing Plastic Piping in Solar Thermal Heating Systems - *revised 2025*
- TN-17 - Crosslinked Polyethylene (PEX) Pipe & Tubing Systems
- TN-26 - Erosion Study on Brass Insert Fittings Used In PEX Piping Systems
- TN-28 - Guide to Differences in Pressure Rating PE Water Pipe Using the ASTM/PPI and ISO Methods
- TN-31 - Differences Between PEX and PB Piping Systems for Potable Water Plumbing Applications
- TN-32 - UV Labeling Guidelines for Crosslinked Polyethylene (PEX) Tubing and Pipe - *revised 2025*
- TN-39 - Recommended Practices Regarding Application of Pesticides and Termiticides near PEX Pipes
- TN-46 - Guidance for Field Hydrostatic Testing of High Density Polyethylene Pressure Pipelines
- TN-52 - Guide to High-Temperature Applications of Non-Potable PEX Pipe and Tubing Systems - *revised 2024*
- TN-53 - Guide to Chlorine Resistance Ratings of PEX Pipes and Tubing for Potable Water Applications - *revised 2025*
- TN-55 - Plastic Piping Materials for Ground Source Geothermal Heating and Cooling Applications - *revised 2024*
- TN-56 - Installation of Plastic Pressure Piping Materials Near IC-Rated and Non-IC-Rated Recessed Lighting Fixtures - *revised 2025*
- TN-57 - Proper Integration of PP-R Piping Materials with Copper Tubing and Components for Plumbing Applications - *revised 2025*
- TN-62 - Suitability and Fitness of CPVC Piping Systems for Commercial Building Applications
- TN-65 - Insulation Recommendations for Plastic Pressure Piping Materials in Residential Applications
- TN-67 - Chlorine Dioxide and Plastic Hot- and Cold-Water Plumbing Distribution Pipes - *revised 2024*

PPI Plastics Pipe Institute BUILDING & CONSTRUCTION

PPI Resources

PPI Statements and Recommendations

- **PPI Statement A** *Relative Oxidative Aggressiveness of Chloramines and Free Chlorine Disinfectants on Crosslinked Polyethylene (PEX) Pipe and Tubing Used in Treated Potable Water*
- **PPI Recommendation F** *Testing PEX and PE-RT Tubing Systems with Compressed Air or Inert Gas*
- **PPI Recommendation H** *Recommendation on Direct Connection of Plastic Piping Materials to Tankless Water Heaters for Domestic (i.e., residential) Applications*

PPI Resources

PPI Technical Notes (TNs)

- **PPI TN-31** *Differences Between Crosslinked Polyethylene (PEX) and Polybutylene (PB) Piping Systems for Potable Water Plumbing Applications*
- **PPI TN-53** *Guide to Chlorine Resistance Ratings of PEX Pipes and Tubing for Potable Water Applications*
- **PPI TN-62** *Suitability and Fitness of CPVC Piping Systems for Commercial Building Applications*
- **PPI TN-71** *Flanges and Flange Adapters for Polypropylene (PP-R & PP-RCT) Piping Systems*

PPI Resources

PPI Technical Reports (TRs)

- **PPI TR-19** *Chemical Resistance of Plastic Piping Materials*
- **PPI TR-48** *R-Value and Thermal Conductivity of PEX and PE-RT Tubing*
- **PPI TR-52** *Resistance of PEX Pipe to Breakage When Frozen (Freeze-break Resistance)*
- **PPI TR-56** *History of PEX Tubing in North America and the Evolution of ASTM Standard Specification F876 from 1984 - 2024*

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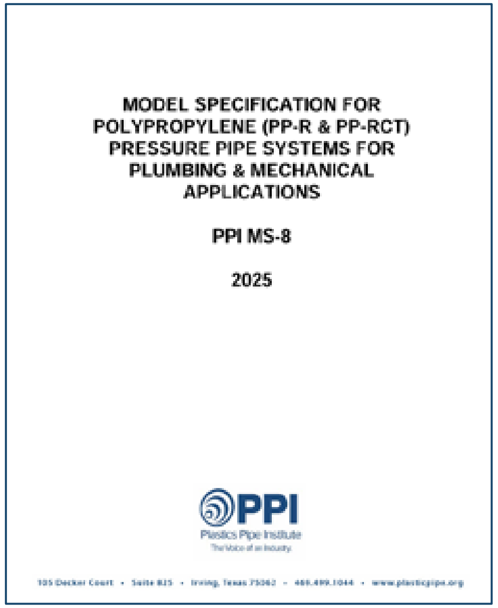
PPI Resources

PPI Model Specifications, Design Guides

- **PPI MS-8** *Model Specification for Polypropylene (PP-R & PP-RCT) Pressure Pipe Systems for Plumbing & Mechanical Applications*
- **Design Guide** *PEX Water Supply Plumbing Systems*
- **3rd Edition** coming soon


MODEL SPECIFICATION FOR POLYPROPYLENE (PP-R & PP-RCT) PRESSURE PIPE SYSTEMS FOR PLUMBING & MECHANICAL APPLICATIONS

PPI MS-8

2025

PPI
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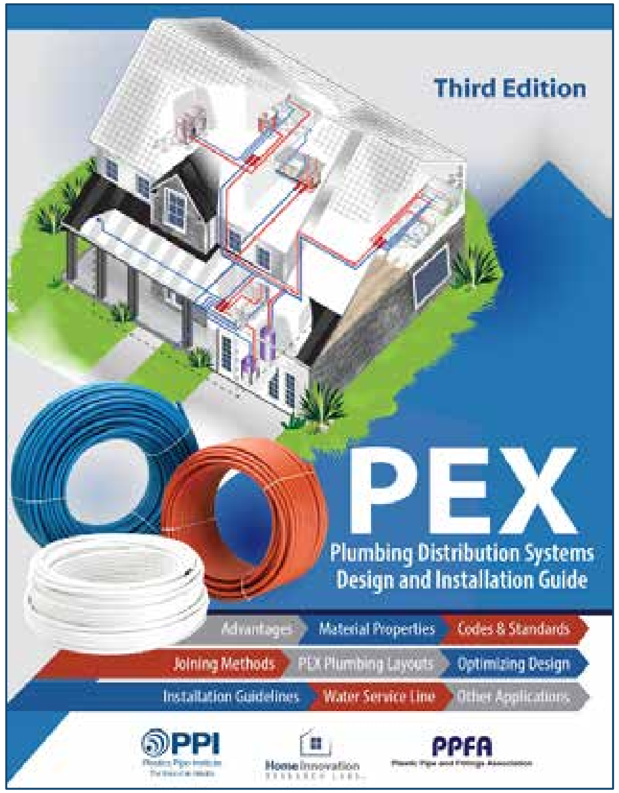

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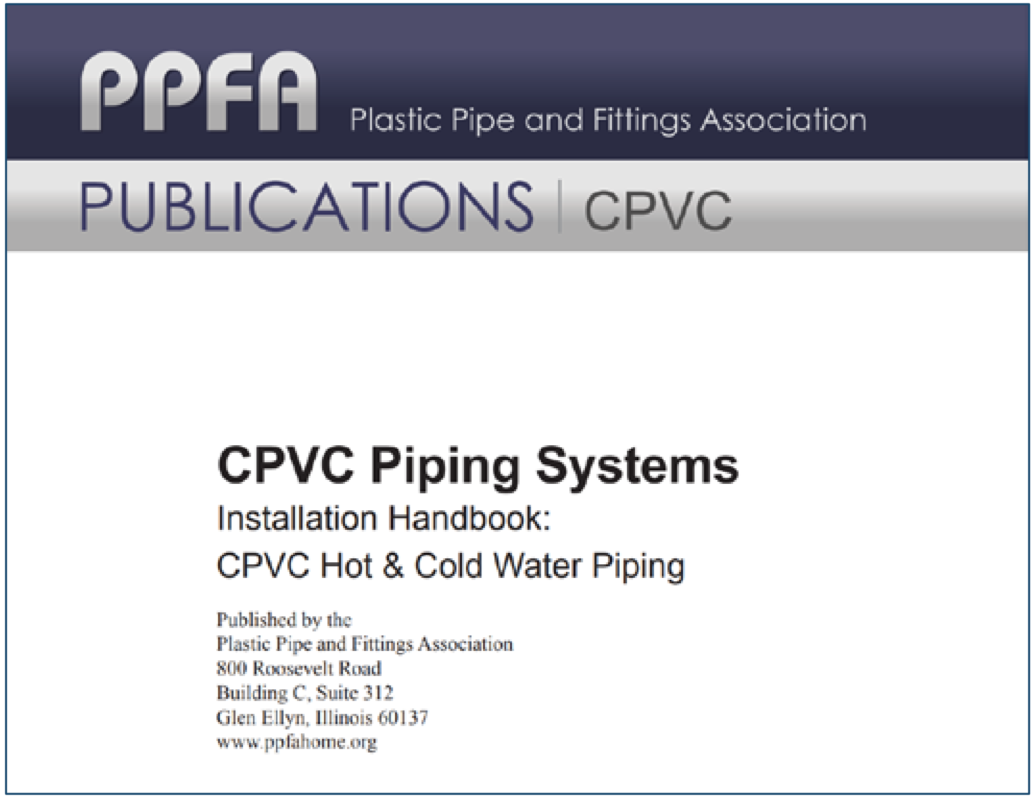
PPFA Resources

CPVC Piping Systems Installation Handbook and Inspector's Checklist


PPFA Plastic Pipe and Fittings Association

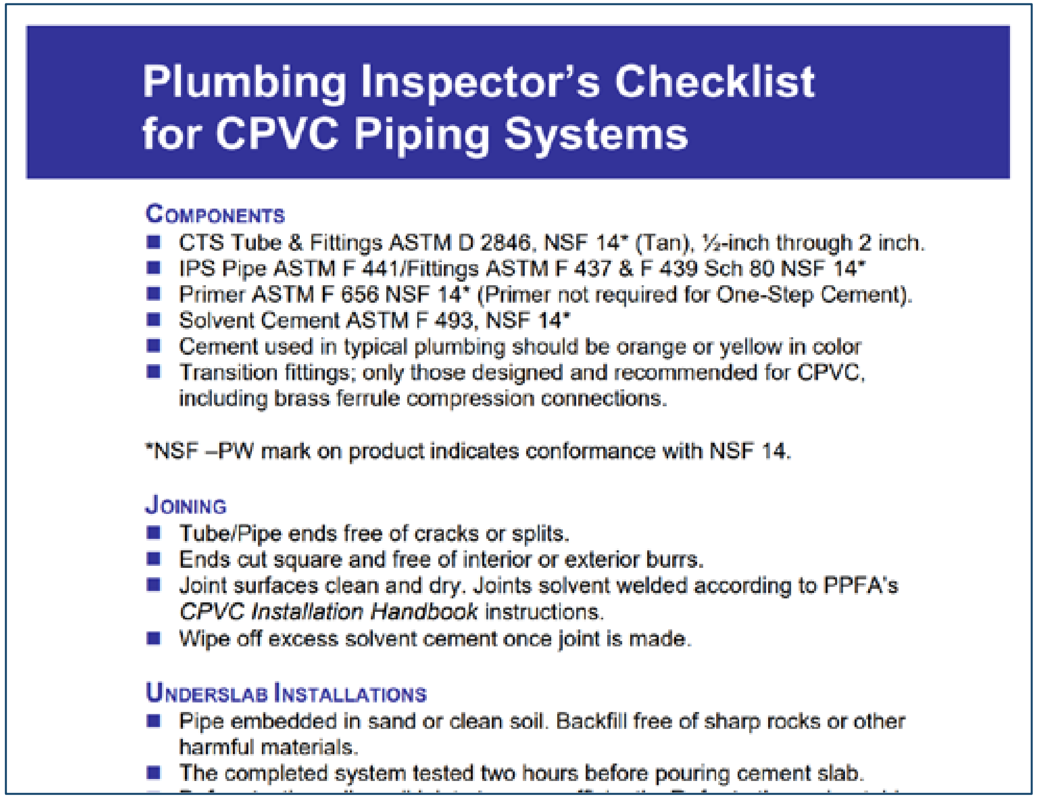
PUBLICATIONS | CPVC

CPVC Piping Systems

Installation Handbook:

CPVC Hot & Cold Water Piping

Published by the
Plastic Pipe and Fittings Association
800 Roosevelt Road
Building C, Suite 312
Glen Ellyn, Illinois 60137
www.ppfahome.org


Plumbing Inspector's Checklist for CPVC Piping Systems

COMPONENTS

- CTS Tube & Fittings ASTM D 2846, NSF 14* (Tan), ½-inch through 2 inch.
- IPS Pipe ASTM F 441/Fittings ASTM F 437 & F 439 Sch 80 NSF 14*
- Primer ASTM F 656 NSF 14* (Primer not required for One-Step Cement).
- Solvent Cement ASTM F 493, NSF 14*
- Cement used in typical plumbing should be orange or yellow in color
- Transition fittings; only those designed and recommended for CPVC, including brass ferrule compression connections.

*NSF –PW mark on product indicates conformance with NSF 14.

JOINING

- Tube/Pipe ends free of cracks or splits.
- Ends cut square and free of interior or exterior burrs.
- Joint surfaces clean and dry. Joints solvent welded according to PPFA's *CPVC Installation Handbook* instructions.
- Wipe off excess solvent cement once joint is made.

UNDERSLAB INSTALLATIONS

- Pipe embedded in sand or clean soil. Backfill free of sharp rocks or other harmful materials.
- The completed system tested two hours before pouring cement slab.

Selecting Optimal Pressure Pipe Material(s)

Conclusion

- Introduced and explained **four major types** of plastic pressure pipe materials that deliver adaptable and reliable solutions for a wide range of plumbing applications: **CPVC, PEX, PE-RT,** and **PP**
- **ASTM** standards were utilized to explain capabilities, **code** compliance was shown
- Piping **limitations** were addressed for each material
- Shared advice about which types of materials **may not be suitable** for certain types of commercial plumbing applications
- Specific industry **resources** were shared

Selecting Optimal Pressure Pipe Material(s)

Summary: In this presentation, we:

1. Described the piping materials **CPVC, PEX, PE-RT,** and **PP**
2. Addressed the **limitations** of each type of pipe and fitting material
3. Discussed the **design** of piping materials using a software program
4. Explained how to access **industry resources**

Questions?

Selecting Optimal Pressure Pipe Material(s) for Commercial Plumbing Systems

Thank you!

Courtesy GF Uponor

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