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ASTM

ASTM International

100 Barr Harbor Drive, P.O. Box C700 West Conshohocken, PA 19428-2959

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C1277—15: Specification for Shielded Coupling Joining Hubless Cast-iron Soil Pipe and Fittings

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C1440—08(2013): Specification for Thermoplastic Elastomeric (TPE) Gasket Materials for Drain, Waste, and Vent (DWV), Sewer, Sanitary and Storm Plumbing Systems

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C1460—2012: Specification for Shielded Transition Couplings for Use with Dissimilar DWV Pipe and Fittings Above Ground

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C1461—08(2013): Specification for Mechanical Couplings Using Thermoplastic Elastomeric (TPE) Gaskets for Joining Drain, Waste and Vent (DWV) Sewer, Sanitary and Storm Plumbing Systems for Above and Below Ground Use

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D3212—07(2013): Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

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A W S

American Welding Society
8669 NW 36 Street, #130
Miami, FL 33166

A5.8M/A5.8—2011: Specifications for Filler Metals for Brazing and Braze Welding

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AWWA

American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235

C104/A21.4—13: Cement-mortar Lining for Ductile-iron Pipe and Fittings
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CISPI

Cast Iron Soil Pipe Institut
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Mundelein, IL 6006

301—12: Specification for Hubless Cast-iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications
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310—12: Specification for Coupling for Use in Connection with Hubless Cast-iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications
705.3.3

CSA

CSA Group
8501 East Pleasant Valley Road
Cleveland, OH 44131-5516

A257.1M—14: Non-reinforced Circular Concrete Culvert, Storm Drain, Sewer Pipe and Fittings

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A257.2M—14: Reinforced Circular Concrete Culvert, Storm Drain, Sewer Pipe and Fittings

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A257.3M—14: Joints for Circular Concrete Sewer and Culvert Pipe, Manhole Sections and Fittings Using Rubber Gaskets

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ASME A112.18.2—2015/CSA B125.2—2015: Plumbing Waste Fittings

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B182.4—15: Profile Polyvinylchloride PVC Sewer Pipe and Fittings

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B182.8—15: Profile Polyethylene (PE) Storm Sewer and Drainage Pipe and Fittings

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B481.3—12: Sizing, Selection, Location and Installation of Grease Interceptors

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B483.1—07(R2012): Drinking Water Treatment Units

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B602—15: Mechanical Couplings for Drain, Waste and Vent Pipe and Sewer Pipe

705.2.1, 705.3.3, 705.4, 705.10.1, 705.11, 705.12.2, 705.16

IAPMO

IAPMO Group
4755 E. Philadelphia Street
Ontario, CA 91761 USA

Z1001—2014: Prefabricated Gravity Grease Interceptors

1003.3.7

CSA B45.5—17/IAPMO Z124—2017: Plastic Plumbing Fixtures

407.1, 418.1, 419.1, 419.2, 421.1, 422.1, 424.1, 425.1

IAPMO/ANSI Z1157—2014: Ball Valves

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ICC

International Code Council, Inc.
500 New Jersey Ave, NW
6th Floor
Washington, DC 20001

A117.1—2009: Accessible and Usable Buildings and Facilities

Deleted

IBC—18: International Building Code®

201.3, 202, 307.1, 307.2, 307.3, 308.2, 309.1, 309.2, 310.1, 310.3, 315.1, 403.1, Table 403.1, 403.1.2, 403.3.1, 403.4, 404.1, 407.3, 421.6, 502.4, 606.5.2, 1106.5, 1301.9.3, 1303.6, 1402.1

IEBC—18: International Existing Building Code

102.2.1

IECC—18: International Energy Conservation Code®

313.1, 607.2.1, 607.5

IFC—18: International Fire Code®

201.3, 1201.1, 1301.1.1

IFGC—18: International Fuel Gas Code®

101.2, 201.3, 502.1, 502.1.1

IMC—18: International Mechanical Code®

201.3, 307.6, 310.1, 502.1, 502.1.1, 612.1, 1202.1

IPSDC—18: International Private Sewage Disposal Code®

701.2

IRC—18: International Residential Code®

101.2

ICC 900/SRCC 300—2015: Solar Thermal System Standard

502.1

ISEA

International Safety Equipment Association
1901 N. Moore Street, Suite 808
Arlington, VA 22209

ANSI/ISEA Z358.1—2014: Emergency Eyewash and Shower Equipment

411.1

MSS

Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
127 Park St. NE
Vienna, VA 22180-4602

SP-67—2011: Butterfly Valves

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SP-70—2013: Gray Iron Gate Valves, Flanged and Threaded Ends

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SP-71—2013: Gray Iron Swing Check Valves, Flanged and Threaded Ends

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SP-72—2010a: Ball Valves with Flanged or Butt-welding Ends for General Service

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SP-78—2013: Cast Iron Plug Valves, Flanged and Threaded Ends

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SP-80—2013: Bronze Gate, Globe, Angle and Check Valves

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SP-110—2010a: Ball Valves, Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

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SP-122—2012: Plastic Industrial Ball Valves

Table 605.7

SP-139—2014: Copper Alloy Gate, Globe, Angle and Check Valves for Low Pressure/Low Temperature Plumbing Applications

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NFPA

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471

51—18: Design and Installation of Oxygen-fuel Gas Systems for Welding, Cutting and Allied Processes

Deleted

55—16: Compressed Gases and Cryogenic Fluids Code

Deleted

70—17: National Electric Code

502.1, 504.3, 1113.1.3

99—18: Health Care Facilities Code

Deleted

NGWA

National Ground Water Association
601 Dempsey Road
Westerville, OH 43081

ANSI/NGWA 01—14: Water Well Construction Standard
602.3.1

NSF

NSF International
789 N. Dixboro Road
P.O. Box 130140
Ann Arbor, MI 48105

3—2012: Commercial Warewashing Equipment
409.1

14—2015: Plastic Piping System Components and Related Materials
303.3, Table 605.3, Table 605.4, 611.3

18—2012: Manual Food and Beverage Dispensing Equipment
Deleted

42—2015: Drinking Water Treatment Units-Aesthetic Effects
611.1, 611.3

44—2015: Residential Cation Exchange Water Softeners
611.1, 611.3

50—2015: Equipment for Swimming Pools, Spas, Hot Tubs and Other Recreational Facilities
1302.8.1

53—2015: Drinking Water Treatment Units—Health Effects
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58—2015: Reverse Osmosis Drinking Water Treatment Systems
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61—2015: Drinking Water System Components—Health Effects
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62—2015: Drinking Water Distillation Systems
611.1

184—2014: Residential Dishwashers
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350—2014: Onsite Residential and Commercial Water Reuse Treatment Systems
1302.6.1

359—2011: Valves for Cross-linked Polyethylene (PEX) Water Distribution Tubing Systems
Table 605.7

372—2011: Drinking Water Systems Components—Lead Content
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PDI

Plumbing and Drainage Institute
800 Turnpike Street, Suite 300
North Andover, MA 01845

PDI G101 (2012): Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data

1003.3.5

PDI G102 (2009): Testing and Certification for Grease Interceptors with Fog Sensing and Alarm Devices

1003.3.5

PSAI

Portable Sanitation Association International
2626 E. 82nd Street, Suite 175
Bloomington, MN 55425

PSAI/ANSI Z4.3—16: Minimum Requirements for Nonsewered Waste-disposal Systems

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TCNA

Tile Council of North America
100 Clemson Research Boulevard
Anderson, SC 29625

TCNA_A118.10—99: Specifications for Load Bearing, Bonded, Waterproof Membranes for Thin Set Ceramic Tile and Dimension Stone Installation

421.5.2.5, 421.5.2.6

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096

399—2008: Drinking-Water Coolers—with revisions through October 2013

410.1

430—2009: Waste Disposers—with revisions through September 2015

416.1

508—99: Industrial Control Equipment—with revisions through October 2013

314.2.3

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426.1

ANSI

American National Standards Institute
25 West 43rd Street, Fourth Floor
New York, NY 10036

Standard Reference Number	Title	Referenced in code section number
Z4.3—95	Minimum Requirements for Nonsewered Waste-Disposal Systems	311.1
Z21.22—99 (R2003)	Relief Valves for Hot Water Supply Systems with Addenda Z21.22a-2000(R2003) and Z21.22b-2001(R2003)	504.2, 504.5
Z124.1—95	Plastic Bathtub Units	407.1
Z124.2—95	Plastic Shower Receptors and Shower Stalls	417.1
Z124.3—95	Plastic Lavatories	416.1, 416.2
Z124.4—96	Plastic Water Closet Bowls and Tanks	420.1
Z124.6—97	Plastic Sinks	415.1, 418.1
Z124.9-94	Plastic Urinal Fixtures	419.1

Arlington, VA 22203

ARI

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reference in code
number Title section number
1010—02 Self-contained, Mechanically Refrigerated Drinking-water Coolers 410.1
American Society of Mechanical Engineers
Three Park Avenue

New York, NY 10016-5990

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A112.1.3—2000 Air Gap Fittings for Use with Plumbing Fixtures, Appliances and Appurtenances. . . . . 608.13.1, Table 608.1
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American Society of Sanitary Engineering
901 Canterbury Road, Suite A
Westlake, OH 44145 **ASSE**

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1001 02 Performance Requirements for Atmospheric Type Vacuum Breakers. . . . . 425.2, Table 608.1, 608.13.6
1002 99 Performance Requirements for Antisiphon Fill Valves (Ballcocks) for Gravity
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1003 01 Performance Requirements for Water Pressure Reducing Valves 604.8
1004 90 Performance Requirements for Backflow Prevention Requirements for Commercial Dishwashing Machines 409.1
1005 99 Performance Requirements for Water Heater Drain Valves 501.3
1006 89 Performance Requirements for Residential Use Dishwashers 409.1
1007 92 Performance Requirements for Home Laundry Equipment. 406.1, 406.2
1008 89 Performance Requirements for Household Food Waste Disposer Units 413.1
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1012 02 Performance Requirements for Backflow Preventers with
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1013 99 Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced
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1024 04 Performance Requirements for Dual Check Valve Type Backflow Preventers
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1051 02 Performance Requirements for Individual and Branch Type Air Admittance Valves for Sanitary Drainage Systems-
Fixture and Branch Devices 917.1
1052 93 Performance Requirements for Hose Connection Backflow Preventers. . . . . Table 608.1, 608.13.6
1055 97 Performance Requirements for Chemical Dispensing Systems. 608.13.9
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1060 96 Performance Requirements for Outdoor Enclosures for Backflow Prevention Assemblies 608.14.1
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5020—98 Performance Requirements for Testing Pressure Vacuum Breaker Assembly (PVBA) 312.9.2
5047—98 Performance Requirements for Testing Reduced Pressure Detector Fire Protection
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5048—98 Performance Requirements for Testing Double Check Valve Detector Assembly (DCDA). 312.9.2
5052—98 Performance Requirements for Testing Hose Connection Backflow Preventers. 312.9.2
5056—98 Performance Requirements for Testing Spill Resistant Vacuum Breaker 312.9.2

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959

ASTM

Standard Referenced
Reference in code
Number Title section number

A 53/A 53M—02 Specification for Pipe, Steel, Black and Hot-dipped, Zinc-coated Welded and Seamless. . . . . Table 605.3, Table 605.4, Table 702.1
A 74—04a Specification for Cast-iron Soil Pipe and Fittings . . . . .Table 702.1, Table 702.2, Table 702.3, Table 702.4, 708.2, Table 1102.4, Table 1102.5, Table 1102.7
A 312/A 312M—04a Specification for Seamless and Welded Austenitic Stainless Steel Pipes. . . . . Table 605.4, Table 605.5, Table 605.6, 605.23.2
A 733—03 Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples . . . . Table 605.8
A 778—01 Specification for Welded Unannealed Austenitic Stainless Steel Tubular Products . . . . .Table 605.4, Table 605.5, Table 605.6
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B 42—02e01 Specification for Seamless Copper Pipe, Standard Sizes . . . . Table 605.3, Table 605.4, Table 702.1
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B 75—02 Specification for Seamless Copper Tube . . . . .Table 605.3, Table 605.4, Table 702.1, Table 702.2, Table 702.3, Table 1102.4
B 88—03 Specification for Seamless Copper Water Tube . . . . .Table 605.3, Table 605.4, Table 702.1, Table 702.2, Table 702.3, Table 1102.4
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B 302—02 Specification for Threadless Copper Pipe, Standard Sizes. . . . . Table 605.3, Table 605.4, Table 702.1
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B 447—02 Specification for Welded Copper Tube. . . . . .Table 605.3, Table 605.4
B 687—99 Specification for Brass, Copper and Chromium-plated Pipe Nipples. . . . . .Table 605.8
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B 828—02 Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings. 605.14.3, 605.15.4, 705.9.3, 705.10.3
C 4—03 Specification for Clay Drain Tile and Perforated Clay Drain Tile . . . . Table 702.3, Table 1102.4, Table 1102.5
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C 443—03 Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets 705.6, 705.16
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D 2235—01 Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings . . . 605.10.2, 705.2.2, 705.7.2

D 2239—03 Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter . . . Table 605.3

D 2241—04a Specification for Poly (Vinyl Chloride) (PVC) Pressure-rated Pipe (SDR Series) . . . Table 605.3

D 2282—99e01 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR) . . . Table 605.3

D 2464—99 Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80. . . . Table 605.5, Table 1102.7

D 2466—02 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 . . . Table 605.5, Table 1102.7

D 2467—04 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 . . . Table 605.5, Table 1102.7

D 2468—96a Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40 . . . Table 605.5, Table 1102.7

D 2564—02 Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems . . . 605.21.2, 705.8.2, 705.14.2

D 2609—02 Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe. . . . Table 605.5, Table 1102.7

D 2657—97 Standard Practice for Heat Fusion-joining of Polyolefin Pipe and Fitting . . . 605.19.2, 605.20.2, 705.16.1

D 2661—02 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings . . . Table 702.1, Table 702.2, Table 702.3, Table 702.4, 705.2.2, 705.7.2, Table 1102.4, Table 1102.7

D 2662—96a Specification for Polybutylene (PB) Plastic Pipe (SDR-PR) Based on Controlled Inside Diameter . . . Table 605.3

D 2665—04ae01 Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings . . . Table 702.1, Table 702.2, Table 702.3, Table 702.4, Table 1102.4, Table 1102.7

D 2666—96a Specification for Polybutylene (PB) Plastic Tubing . . . Table 605.3

D 2672—96a(2003) Specification for Joints for IPS PVC Pipe Using Solvent Cement . . . Table 605.3

D 2729—96a Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings . . . Table 1102.5

D 2737—03 Specification for Polyethylene (PE) Plastic Tubing . . . Table 605.3

D 2751—96a Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings . . . Table 702.3, Table 1102.7

D 2846/D 2846M—99 Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot and Cold Water Distribution Systems. . . . Table 605.3, Table 605.4, 605.16.2

ASTM—continued

D 2855—96(2002) Standard Practice for Making Solvent-cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings . . . 605.21.2, 705.8.2, 705.14.2

D 2949—01a Specification for 3.25-in Outside Diameter Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings . . . Table 702.1, Table 702.2, Table 702.3

D 3034—04 Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings. . . . Table 702.3, Table 702.4, Table 1102.7

D 3139—98 Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals . . . 605.10.1, 605.21.1

D 3212—96a(2003) Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals . . . 705.2.1, 705.7.1, 705.8.1, 705.14.1

D 3309—96a(2002) Specification for Polybutylene (PB) Plastic Hot and Cold Water Distribution Systems . . . Table 605.3, Table 605.4, 605.19.2, 605.19.3

D 3311—02 Specification for Drain, Waste and Vent (DWV) Plastic Fittings Patterns . . . Table 702.4, Table 1102.7

D 4068—01 Specification for Chlorinated Polyethlene (CPE) Sheeting for Concealed Water-Containment Membrane . . . 417.5.2.2

D 4551—96(2001) Specification for Poly (Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane . . . 417.5.2.1

F 405—97 Specification for Corrugated Polyethylene (PE) Tubing and Fittings. . . . Table 1102.5

F 409—02 Specification for Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings . . . 424.1.2, Table 1102.7

F 437—99 Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80. . . . Table 605.5, Table 1102.7

F 438—04 Specification for Socket-type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40. . . . Table 605.5, Table 1102.7

F 439—02e01 Specification for Socket-type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80. . . . Table 605.5, Table 1102.7

F 441/F 441M—02 Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80 . . . Table 605.3, Table 605.4 Table 605.5

F 442/F 442M—99 Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR). . . . Table 605.3, Table 605.4, Table 605.5

F 477—02e01 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe. . . . 605.22, 705.16

F 493—04 Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings . . . 605.16.2

F 628—01 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core . . . Table 702.1, Table 702.2, Table 702.3, Table 702.4, 705.2.2, 705.7.2, Table 1102.4, Table 1102.7

F 656—02 Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings . . . 605.21.2, 705.8.2, 705.14.2

F 714—03 Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter . . . Table 702.3

F 876—04 Specification for Cross-linked Polyethylene (PEX) Tubing . . . . .Table 605.3
F 877—02e01 Specification for Cross-linked Polyethylene (PEX) Plastic Hot and Cold Water
Distribution Systems . . . . .Table 605.3, Table 605.4, Table 605.5, Table 605.17.2
F 891—00e01 Specification for Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core. . . . . Table 702.1,
Table 702.2, Table 702.3, Table 702.4, Table 1102.4, Table 1102.5, Table 1102.7
F 1281—03 Specification for Cross-linked Polyethylene/Aluminum/Cross-Linked Polyethylene
(PEX-AL-PEX) Pressure Pipe . . . . .Table 605.3, Table 605.4
F 1282—03 Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe. . . . . . Table 605.3, Table 605.4
F 1412—01 Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage . . . . Table 702.2, Table 702.4, 705.17.1
F 1488—03 Specification for Coextruded Composite Pipe. . . . . .Table 702.1, Table 702.2, Table 702.3
F 1807—04 Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked
Polyethylene (PEX) Tubing. . . . . .Table 605.5, 605.17.2
F 1866—98 Specification for Poly (Vinyl Chloride) (PVC) Plastic Schedule 40 Drainage and
DWV Fabricated Fittings . . . . .Table 702.4
F 1960—04a Specification for Cold Expansion Fittings with PEX Reinforcing Rings for use with
Cross-linked Polyethylene (PEX) Tubing . . . . .Table 605.5
F 1974—04 Specification for Metal Insert Fittings for Polyethylene/Aluminum/Polyethylene and Cross-linked
Polyethylene/Aluminum/Cross-linked Polyethylene Composite Pressure Pipe. . . . . .Table 605.5
F 1986—00a Specification for Multilayer Pipe, Type 2, Compression Fittings and Compression Joints for Hot and Cold
Drinking Water Systems . . . . .Table 605.3, Table 605.4, Table 605.5
F 2080—04 Specifications for Cold-expansion Fittings with Metal Compression-sleeves for
Cross-linked Polyethylene (PEX) Pipe . . . . .Table 605.5
F 2159—03 Specification for Plastic Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked
Polyethylene (PEX) Tubing. . . . . .Table 605.5
F 2389—04 Specification for Pressure-rated Polypropylene (PP) Piping Systems . . . . Table 605.3, Table 605.4, Table 605.5, 605.21

American Welding Society
550 N.W. LeJeune Road
Miami, FL 33126 **AWS**

Standard Referenced
Reference in code
Number Title section number
A5.8—04 Specifications for Filler Metals for Brazing and Braze Welding. 605.12.1, 605.14.1, 605.15.1, 705.4.1, 705.9.1, 705.10.1

American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235 **AWWA**

Standard Referenced
Reference in code
Number Title section number
C104—98 Standard for Cement-mortar Lining for Ductile-Iron
Pipe and Fittings for Water. 605.3, 605.5
C110—98 Standard for Ductile-iron and Gray-iron Fittings,
3 Inches through 48 Inches, for Water . . . . .Table 605.5, Table 702.4, Table 1102.7
C111—00 Standard for Rubber-gasket Joints for Ductile-iron
Pressure Pipe and Fittings 605.13
C115—99 Standard for Flanged Ductile-iron Pipe with Ductile-iron or Gray-iron Threaded Flanges. . . . . Table 605.3
C151/A21.51—02 Standard for Ductile-iron Pipe, Centrifugally Cast for Water. . . . . .Table 605.3
C153—00 Standard for Ductile-iron Compact Fittings for Water Service. . . . . .Table 605.5
C510—00 Double Check Valve Backflow Prevention Assembly . . . . .Table 608.1, 608.13.7
C511—00 Reduced-pressure Principle Backflow Prevention Assembly. . . . . .Table 608.1, 608.13.2, 608.16.2
C651—99 Disinfecting Water Mains 610.1
C652—02 Disinfection of Water-storage Facilities 610.1

Cast Iron Soil Pipe Institute
5959 Shallowford Road, Suite 419
Chattanooga, TN 37421 **CISPI**

Standard Referenced
Reference in code
Number Title section number
301—04a Specification for Hubless Cast-iron Soil Pipe and Fittings for Sanitary and
Storm Drain, Waste and Vent Piping Applications. . . . . Table 702.1, Table 702.2, Table 702.3, Table 702.4,
Table 1102.4, Table 1102.5, Table 1102.7
310—04 Specification for Coupling for Use in Connection with Hubless Cast-iron Soil Pipe and Fittings
for Sanitary and Storm Drain, Waste and Vent Piping Applications 705.5.3

Canadian Standards Association
178 Rexdale Blvd.

Rexdale (Toronto), Ontario, Canada M9W 1R3 CSA

Standard Reference Number	Title	Referenced in code section number
B45.1—02	Ceramic Plumbing Fixtures	408.1, 416.1, 418.1, 419.1, 420.1
B45.2—02	Enameled Cast-iron Plumbing Fixtures	407.1, 415.1, 416.1, 418.1
B45.3—02	Porcelain Enameled Steel Plumbing Fixtures	407.1, 416.1, 418.1
B45.4—02	Stainless-steel Plumbing Fixtures	415.1, 416.1, 418.1, 420.1
B45.5—02	Plastic Plumbing Fixtures	407.1, 416.2, 417.1, 419.1, 420.1, 421.1
B45.9—99	Macerating Systems and Related Components	712.4.1
B45.10—01	Hydromassage Bathtubs	421.1
B64.1.2—01	Vacuum Breakers, Pressure Type (PVB)	Table 608.1, 608.13.5
B64.2.1—01	Vacuum Breakers, Hose Connection Type (HCVB) with Manual Draining Feature	Table 608.1, 608.13.6
B64.2.1.1—01	Vacuum Breakers, Hose Connection Dual Check Type (HCDVB)	Table 608.1, 608.13.6
B64.3.1—01	Backflow Preventers, Dual Check Valve Type with Atmospheric Port for Carbonators (DCAPC)	Table 608.1, 608.16.1
B64.4.1—01	Backflow Preventers, Reduced Pressure Principle Type for Fire Sprinklers (RPF)	Table 608.1, 608.13.2
B64.5—01	Backflow Preventers, Double Check Type (DCVA)	Table 608.1, 608.13.7
B64.5.1—01	Backflow Preventers, Double Check Type for Fire Systems (DCVAF)	Table 608.1 608.13.7
B64.6—01	Backflow Preventers, Dual Check Valve Type (DuC)	605.3.1, Table 608.1

CSA—continued

Standard Reference Number	Title	Referenced in code section number
B64.7—94	Vacuum Breakers, Laboratory Faucet Type (LFVB)	Table 608.1, 608.13.6
B64.10/B64.10.1—01	Manual for the Selection and Installation of Backflow Prevention Devices/Manual for the Maintenance and Field Testing of Backflow Prevention Devices	312.9.2
B79—94(2000)	Floor, Area and Shower Drains, and Cleanouts for Residential Construction	412.1
B125—01	Plumbing Fittings	424.1, 424.3, 424.4, 425.3.1, 425.5, 607.4, Table 608.1
B137.1—02	Polyethylene Pipe, Tubing and Fittings for Cold Water Pressure Services	Table 605.3
B137.2—02	PVC Injection-moulded Gasketed Fittings for Pressure Applications	Table 605.5, Table 1102.7
B137.3—02	Rigid Poly (Vinyl Chloride) (PVC) Pipe for Pressure Applications	Table 605.3, 605.21.2, 705.8.2, 705.14.2
B137.5—02	Cross-linked Polyethylene (PEX) Tubing Systems for Pressure Applications—with Revisions through September 1992	Table 605.3, Table 605.4
B137.6—02	CPVC Pipe, Tubing and Fittings for Hot and Cold Water Distribution Systems—with Revisions through May 1986	Table 605.3, Table 605.4
B137.11—02	Polypropylene (PP-R) Pipe and Fittings for Pressure Applications	Table 605.3, Table 605.4, Table 605.5
B181.1—02	ABS Drain, Waste and Vent Pipe and Pipe Fittings	Table 702.1, Table 702.2, Table 702.4, 705.2.2, 705.7.2, 715.2
B181.2—02	PVC Drain, Waste, and Vent Pipe and Pipe Fittings—with Revisions through December 1993	Table 702.1, Table 702.2, 705.8.2, 705.14.2, 715.2
B182.1—02	Plastic Drain and Sewer Pipe and Pipe Fittings	705.8.2, 705.14.2, Table 1102.4
B182.2—02	PVC Sewer Pipe and Fittings (PSM Type)	Table 702.3, Table 1102.4, Table 1102.5
B182.4—02	Profile PVC Sewer Pipe and Fittings	Table 702.3, Table 1102.4, Table 1102.5
B182.6—02	Profile Polyethylene Sewer Pipe and Fittings for Leak-proof Sewer Applications	Table 1102.5
B182.8—02	Profile Polyethylene Storm Sewer and Drainage Pipe and Fittings	Table 1102.5
CAN3-B137.8M—99	Polybutylene (PB) Piping for Pressure Applications—with Revisions through July 1992	Table 605.3, Table 605.4, 605.19.2, 605.19.3
CAN/CSA-A257.1M—92	Circular Concrete Culvert, Storm Drain, Sewer Pipe and Fittings	Table 702.3, Table 1102.4
CAN/CSA-A257.2M—92	Reinforced Circular Concrete Culvert, Storm Drain, Sewer Pipe and Fittings	Table 702.3, Table 1102.4
CAN/CSA-A257.3M—92	Joints for Circular Concrete Sewer and Culvert Pipe, Manhole Sections and Fittings Using Rubber Gaskets	705.6, 705.16
CAN/CSA-B64.1.1—01	Vacuum Breakers, Atmospheric Type (AVB)	425.2, Table 608.1, 608.13.6
CAN/CSA-B64.2—01	Vacuum Breakers, Hose Connection Type (HCVB)	Table 608.1, 608.13.6
CAN/CSA-B64.2.2—01	Vacuum Breakers, Hose Connection Type (HCVB) with Automatic Draining Feature	Table 608.1, 608.13.6
CAN/CSA-B64.3—01	Backflow Preventers, Dual Check Valve Type with Atmospheric Port (DCAP)	Table 608.1, 608.13.3, 608.16.2
CAN/CSA-B64.4—01	Backflow Preventers, Reduced Pressure Principle Type (RP)	Table 608.1, 608.13.2, 608.16.2
CAN/CSA-B64.10—01	Manual for the Selection, Installation, Maintenance and Field Testing of Backflow Prevention Devices	312.9.2
CAN/CSA-B137.9—02	Polyethylene/Aluminum/Polyethylene Composite Pressure Pipe Systems	Table 605.3
CAN/CSA-B137.10M—02	Cross-linked Polyethylene/Aluminum/Polyethylene Composite Pressure Pipe Systems	Table 605.3, Table 605.4
CAN/CSA-B181.3—02	Polyolefin Laboratory Drainage Systems	Table 702.1, Table 702.2
CAN/CSA-B182.4—02	Profile PVC Sewer Pipe and Fittings	Table 702.3, Table 1102.4, Table 1102.5
CAN/CSA-B602—02	Mechanical Couplings for Drain, Waste and Vent Pipe and Sewer Pipe	705.2.1, 705.5.3, 705.6, 705.7.1, 705.14.1, 705.15, 705.16

International Code Council
500 New Jersey, NW
6th Floor
Washington, D.C. 20001 ICC

Standard Referenced
Reference in code
Number Title section number

IBC—06 International Building Code® . . . . 201.3, 305.4, 307.1, 307.2, 307.3, 308.2, 309.1, 310.1, 310.3, 403.1, Table 403.1, 404.1, 407.3, 417.6, 502.6, 606.5.2, 1106.5

ADMIN—06 International Code Council Electrical Code®—Administrative Provisions 201.3, 502.1, 504.3, 1113.1.3

IEBC—06 International Existing Building Code 101.2

IECC—06 International Energy Conservation Code 313.1, 607.2, 607.2.1

IFC—06 International Fire Code® 201.3, 1201.1

IFGC—06 International Fuel Gas Code® 101.2, 201.3, 502.1

IMC—06 International Mechanical Code® 201.3, 307.6, 310.1, 422.9, 502.1, 612.1, 1202.1

IPSDC—06 International Private Sewage Disposal Code® 701.2

IRC—06 International Residential Code® 101.2

Industry Safety Equipment Association
1901 N. Moore Street, Suite 808

ISEA Arlington, VA 22209

Standard Referenced
Reference in code
Number Title section number

Z358.1—03 Emergency Eyewash and Shower Equipment. 411.1

National Fire Protection Association
Batterymarch Park

NFPA Quincy, MA 02269

Standard Referenced
Reference in code
Number Title section number

50—01 Bulk Oxygen Systems at Consumer Sites. 1202.1

51—02 Design and Installation of Oxygen-fuel Gas Systems for Welding, Cutting and Allied Processes 1202.1

70—05 National Electrical Code 502.1, 504.3, 1113.1.3

99C—02 Gas and Vacuum Systems 1202.1

NSF International
789 Dixboro Road

NSF Ann Arbor, MI 48105

Standard Referenced
Reference in code
Number Title section number

3—2003 Commercial Warewashing Equipment 409.1

14—2003 Plastic Piping System Components and Related Materials 303.3, 611.3

18—2004 Manual Food and Beverage Dispensing Equipment. 426.1

42—2002e Drinking Water Treatment Units—Aesthetic Effects 611.1, 611.3

44—2004 Residential Cation Exchange Water Softeners 611.1, 611.3

53—2002e Drinking Water Treatment Units—Health Effects 611.1, 611.3

58—2004 Reverse Osmosis Drinking Water Treatment Systems 611.2

61—2003e Drinking Water System Components—Health Effects. 424.1, 605.3, 605.4, 605.5, 611.3

62—2004 Drinking Water Distillation Systems 611.1

Plumbing and Drainage Institute
800 Turnpike Street, Suite 300

PDI North Andover, MA 01845

Standard Referenced
Reference in code
Number Title section number

G101(2003) Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data. 1003.3.4

Underwriters Laboratories, Inc.
333 Pfingsten Road

UL Northbrook, IL 60062-2096

Standard Referenced
reference in code
number Title section number

UL508—99 Industrial Control Equipment. 314.2.3

DRAFT

PLUMBING PERMIT FEE SCHEDULE

Permit Issuance

For issuing each permit ....$________

For issuing each supplemental permit...________

Unit Fee Schedule

For each plumbing fixture or trap or set of fixtures on one trap (including water, drainage piping and backflow protection thereof). . . . . ______

For each building sewer and each trailer park sewer . . . . ______

Rainwater systems—per drain (inside building). . . . . ______

For each cesspool (where permitted) . . . . ______

For each private sewage disposal system . . . . ______

For each water heater and/or vent . . . . ______

For each industrial waste pretreatment interceptor including its trap and vent, excepting kitchen-type grease interceptors functioning as fixture traps . . . . ______

For installation, alteration or repair of water-piping and/or water-treating equipment, each . . . . ______

For repair or alteration of drainage or vent piping, each fixture . . . . ______

For each lawn sprinkler system on any one meter including backflow protection devices therefor . . . . ______

For atmospheric-type vacuum breakers not included in Item 2:

1to5. . . . . ______

over5, each . . . . ______

For each backflow protective device other than atmospheric-type vacuum breakers:

2 inches (51 mm) and smaller . . . . ______Over 2 inches (51 mm) . . . . ______

Other Inspections and Fees

Inspections outside of normal business hours . . . . ______per hour (minimum charge two hours)

Reinspection fee assessed under provisions of Section 107.3.3. . . . . ______ each

Inspections for which no fee is specifically indicated . . . . ______ per hour (minimum charge one-half hour)

Additional plan review required by changes, additions or revisions to approved plans (minimum charge one-half hour) . . . . .per hour

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APPENDIX B
RATES OF RAINFALL FOR VARIOUS CITIES

Rainfall rates, in inches per hour, are based on a storm of one-hour duration and a 100-year return period. The rainfall rates shown in the appendix are derived from Figure 1106.1.

Alabama:
- Birmingham 3.8
- Huntsville 3.6
- Mobile 4.6
- Montgomery 4.2

Alaska:
- Fairbanks 1.0
- Juneau 0.6

Arizona:
- Flagstaff 2.4
- Nogales 3.1
- Phoenix 2.5
- Yuma 1.6

Arkansas:
- Fort Smith 3.6
- Little Rock 3.7
- Texarkana 3.8

California:
- Barstow 1.4
- CrescentCity 1.5
- Fresno 1.1
- Los Angeles 2.1
- Needles 1.6
- Placerville 1.5
- San Fernando 2.3
- San Francisco 1.5
- Yreka 1.4

Colorado:
- Craig 1.5
- Denver 2.4
- Durango 1.8
- Grand Junction 1.7
- Lamar 3.0
- Pueblo 2.5

Connecticut:
- Hartford 2.7
- NewHaven 2.8
- Putnam 2.6

Delaware:
- Georgetown 3.0
- Wilmington 3.1

District of Columbia:
- Washington 3.2

Florida:
- Jacksonville 4.3
- Key West 4.3
- Miami 4.7
- Pensacola 4.6
- Tampa 4.5

Georgia:
- Atlanta 3.7
- Dalton 3.4
- Macon 3.9
- Savannah 4.3
- Thomasville 4.3

Hawaii:
- Hilo 6.2
- Honolulu 3.0
- Wailuku 3.0

Idaho:
- Boise 0.9
- Lewiston 1.1
- Pocatello 1.2

Illinois:
- Cairo 3.3
- Chicago 3.0
- Peoria 3.3
- Rockford 3.2
- Springfield 3.3

Indiana:
- Evansville 3.2
- Fort Wayne 2.9
- Indianapolis 3.1

Iowa:
- Davenport 3.3
- Des Moines 3.4
- Dubuque 3.3
- Sioux City 3.6

Kansas:
- Atwood 3.3
- DodgeCity 3.3
- Topeka 3.7
- Wichita 3.7

Kentucky:
- Ashland 3.0
- Lexington 3.1
- Louisville 3.2
- Middlesboro 3.2
- Paducah 3.3

Louisiana:
- Alexandria 4.2
- Lake Providence 4.0
- New Orleans 4.8
- Shreveport 3.9

Maine:
- Bangor 2.2
- Houlton 2.1
- Portland 2.4

Maryland:
- Baltimore 3.2
- Hagerstown 2.8
- Oakland 2.7
- Salisbury 3.1

Massachusetts:
- Boston 2.5
- Pittsfield 2.8
- Worcester 2.7

Michigan:
- Alpena 2.5
- Detroit 2.7
- Grand Rapids 2.6
- Lansing 2.8
- Marquette 2.4
- Sault Ste. Marie 2.2

Minnesota:
- Duluth 2.8
- Grand Marais 2.3
- Minneapolis 3.1
- Moorhead 3.2
- Worthington 3.5

Mississippi:
- Biloxi 4.7
- Columbus 3.9
- Corinth 3.6
- Natchez 4.4
- Vicksburg 4.1

Missouri:
- Columbia 3.2
- Kansas City 3.6
- Springfield 3.4
- St. Louis 3.2

Montana:
- Ekalaka 2.5
- Havre 1.6
- Helena 1.5
- Kalispell 1.2
- Missoula 1.3

Nebraska:
- North Platte 3.3
- Omaha 3.8
- Scottsbluff 3.1
- Valentine 3.2

Nevada:
- Elko 1.0
- Ely 1.1
- Las Vegas 1.4
- Reno 1.1

New Hampshire:
- Berlin 2.5
- Concord 2.5
- Keene 2.4

New Jersey:
- Atlantic City 2.9
- Newark 3.1
- Trenton 3.1

New Mexico:
- Albuquerque 2.0
- Hobbs 3.0
- Raton 2.5
- Roswell 2.6
- Silver City 1.9

New York:
- Albany 2.5
- Binghamton 2.3
- Buffalo 2.3
- Kingston 2.7
- NewYork 3.0
- Rochester 2.2

North Carolina:
- Asheville 4.1
- Charlotte 3.7
- Greensboro 3.4

Wilmington 4.2

North Dakota:

Bismarck 2.8
Devils Lake 2.9
Fargo 3.1
Williston. 2.6

Ohio:

Cincinnati. 2.9
Cleveland. 2.6
Columbus. 2.8
Toledo 2.8

Oklahoma:

Altus. 3.7
Boise City. 3.3
Durant 3.8
Oklahoma City. 3.8

Oregon:

Baker 0.9
Coos Bay 1.5
Eugene 1.3
Portland 1.2

Pennsylvania:

Erie. 2.6
Harrisburg 2.8
Philadelphia 3.1
Pittsburgh. 2.6
Scranton. 2.7

Rhode Island:

Block Island 2.75
Providence 2.6

South Carolina:

Charleston 4.3
Columbia 4.0
Greenville. 4.1

South Dakota:

Buffalo 2.8
Huron. 3.3
Pierre 3.1
Rapid City 2.9
Yankton 3.6

Tennessee:

Chattanooga. 0.5
Knoxville 3.2
Memphis 3.7
Nashville 3.3

Texas:

Abilene. 3.6
Amarillo. 3.5
Brownsville 4.5
Dallas. 4.0
DelRio. 4.0
ElPaso 2.3
Houston 4.6
Lubbock. 3.3
Odessa 3.2
Pecos 3.0
San Antonio 4.2

Utah:

BrighamCity 1.2
Roosevelt 1.3
SaltLakeCity. 1.3
St. George. 1.7

Vermont:

Barre 2.3
Bratteboro 2.7
Burlington 2.1
Rutland. 2.5

Virginia:

Bristol 2.7
Charlottesville 2.8
Lynchburg 3.2
Norfolk. 3.4
Richmond. 3.3

Washington:

Omak 1.1
Port Angeles. 1.1
Seattle 1.4
Spokane 1.0
Yakima. 1.1

West Virginia:

Charleston 2.8
Morgantown. 2.7

Wisconsin:

Ashland 2.5
Eau Claire. 2.9
Green Bay 2.6
LaCrosse 3.1
Madison. 3.0
Milwaukee 3.0

Wyoming:

Cheyenne 2.2
Fort Bridger 1.3
Lander 1.5
New Castle 2.5
Sheridan. 1.7
Yellowstone Park 1.4

GRAY WATER RECYCLING SYSTEM

Note: Section 301.3 of this code requires all plumbing fixtures that receive water or waste to discharge to the sanitary drainage system ofthe structure. In order to allowfor the utilization ofa gray water system, Section 301.3 should be revised to read asfollows:

301.3 Connections to drainage system. All plumbing fixtures, drains, appurtenances and appliances used to receive or discharge liquid wastes or sewage shall be directly connected to the sanitary drainage system of the building or premises, in accordance with the requirements of this code. This section shall not be construed to prevent indirect waste systems required by Chapter 8.

Exception: Bathtubs, showers, lavatories, clothes washers and laundry trays shall not be required to discharge to the sanitary drainage system where such fixtures discharge to an approved gray water system for flushing of water closets and urinals or for subsurface landscape irrigation.

SECTION C101 GENERAL

C101.1 Scope. The provisions of this appendix shall govern the materials, design, construction and installation of gray water systems for flushing of water closets and urinals and for subsurface landscape irrigation (see Figures 1 and 2).

C101.2 Definition. The following term shall have the meaning shown herein.

GRAY WATER. Waste discharged from lavatories, bathtubs, showers, clothes washers and laundry trays.

C101.3 Permits. Permits shall be required in accordance with Section 106.

C101.4 Installation. In addition to the provisions of Section C101, systems for flushing of water closets and urinals shall comply with Section C102 and systems for subsurface landscape irrigation shall comply with Section C103. Except as provided for in Appendix C, all systems shall comply with this code.

C101.5 Materials. Above-ground drain, waste and vent piping for gray water systems shall conform to one of the standards listed in Table 702.1. Gray water underground building drainage and vent pipe shall conform to one of the standards listed in Table 702.2.

C101.6 Tests. Drain, waste and vent piping for gray water systems shall be tested in accordance with Section 312.

C101.7 Inspections. Gray water systems shall be inspected in accordance with Section 107.

C101.8 Potable water connections. Only connections in accordance with Section C102.3 shall be made between a gray water recycling system and a potable water system.

C101.9 Waste water connections. Gray water recycling systems shall receive only the waste discharge of bathtubs, showers, lavatories, clothes washers or laundry trays.

C101.10 Collection reservoir. Gray water shall be collected in an approved reservoir constructed of durable, nonabsorbent and corrosion-resistant materials. The reservoir shall be a closed and gas-tight vessel. Access openings shall be provided to allow inspection and cleaning of the reservoir interior.

C101.11 Filtration. Gray water entering the reservoir shall pass through an approved filter such as a media, sand or diatomaceous earth filter.

C101.11.1 Required valve. A full-open valve shall be installed downstream of the last fixture connection to the gray water discharge pipe before entering the required filter.

C101.12 Overflow. The collection reservoir shall be equipped with an overflow pipe having the same or larger diameter as the influent pipe for the gray water. The overflow pipe shall be indirectly connected to the sanitary drainage system.

C101.13 Drain. A drain shall be located at the lowest point of the collection reservoir and shall be indirectly connected to the sanitary drainage system. The drain shall be the same diameter as the overflow pipe required in Section C101.12.

C101.14 Vent required. The reservoir shall be provided with a vent sized in accordance with Chapter 9 and based on the diameter of the reservoir influent pipe.

SECTION C102 SYSTEMS FOR FLUSHING WATER CLOSETS AND URINALS

C102.1 Collection reservoir. The holding capacity of the reservoir shall be a minimum of twice the volume of water required to meet the daily flushing requirements of the fixtures supplied with gray water, but not less than 50 gallons (189 L). The reservoir shall be sized to limit the retention time of gray water to a maximum of 72 hours.

C102.2 Disinfection. Gray water shall be disinfected by an approved method that employs one or more disinfectants such as chlorine, iodine or ozone.

C102.3 Makeup water. Potable water shall be supplied as a source of makeup water for the gray water system. The potable water supply shall be protected against backflow in accordance with Section 608. There shall be a full-open valve located on the makeup water supply line to the collection reservoir.

C102.4 Coloring. The gray water shall be dyed blue or green with a food grade vegetable dye before such water is supplied to the fixtures.

C102.5 Materials. Distribution piping shall conform to one of the standards listed in Table 605.4.

C102.6 Identification. Distribution piping and reservoirs shall be identified as containing nonpotable water. Piping identification shall be in accordance with Section 608.8.

~~SECTION C103~~
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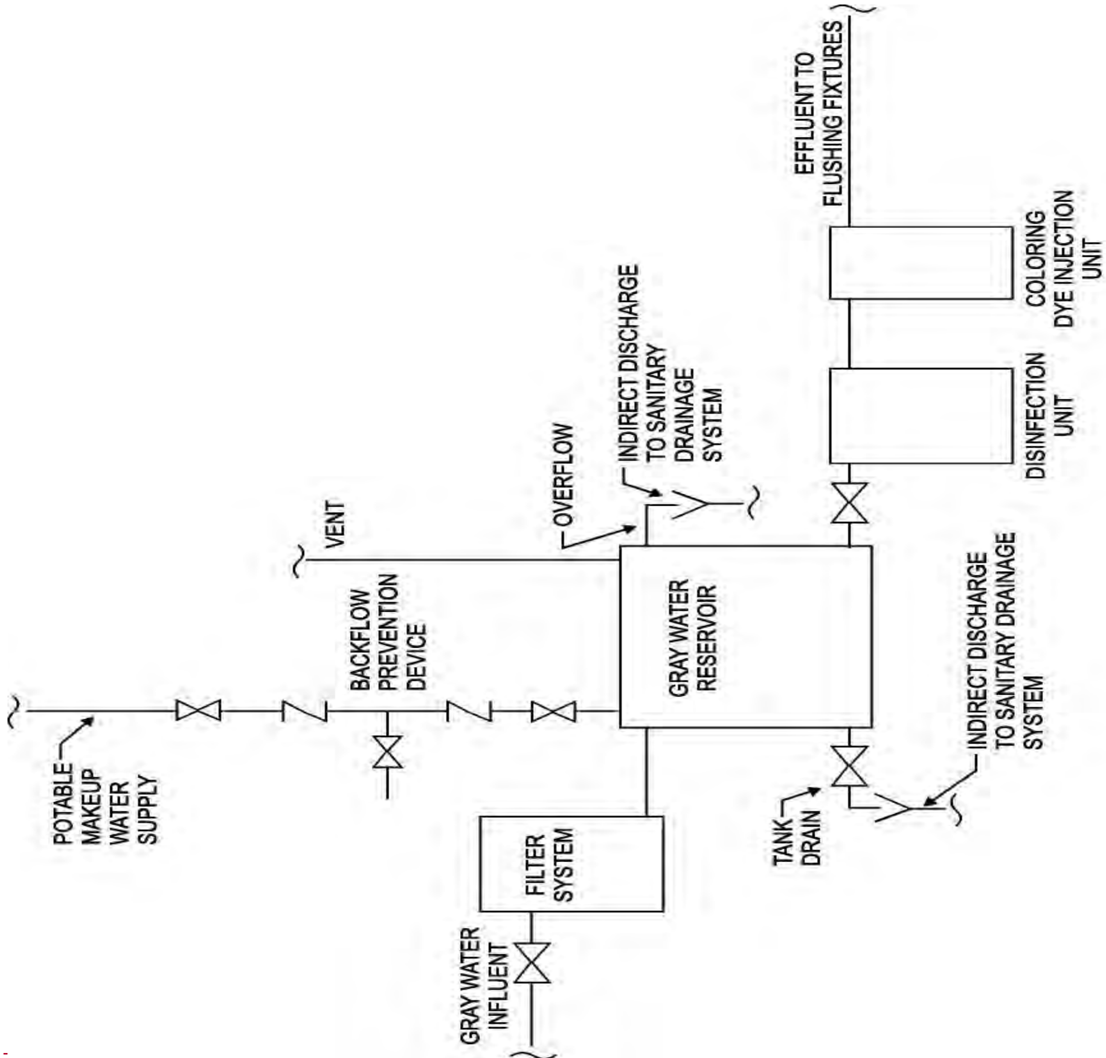


FIGURE 2
GRAY WATER RECYCLING SYSTEM FOR FLUSHING WATER CLOSETS AND URINALS

APPENDIX D
DEGREE DAY AND DESIGN TEMPERATURES

This appendix is informative and is not part of the code.

User note:
About this appendix: *This code refers to the 97.5 percent winter design temperature for directing the code user to requirements for design ofthe plumbing system. Appendix D provides such temperatures for many major cities in the United States.*

TABLE D101
DEGREE DAY AND DESIGN TEMPERATURES[a] FOR CITIES IN THE UNITED STATES

STATE	STATION[b]	HEATING DEGREE DAYS (yearly total)	DESIGN TEMPERATURES Winter $97^1/_2$%	Summer Dry bulb $2^1/_2$%	Summer Wet bulb $2^1/_2$%	DEGREES NORTH LATITUDE[c]
AL	Birmingham	2,551	21	94	77	33°30′
	Huntsville	3,070	16	96	77	34°40′
	Mobile	1,560	29	93	79	30°40′
	Montgomery	2,291	25	95	79	32°20′
AK	Anchorage	10,864	-18	68	59	61°10′
	Fairbanks	14,279	-47	78	62	64°50′
	Juneau	9,075	1	70	59	58°20′
	Nome	14,171	-27	62	56	64°30′
AZ	Flagstaff	7,152	4	82	60	35°10′
	Phoenix	1,765	34	107	75	33°30′
	~~Tuscon~~Tucson	1,800	32	102	71	33°10′
	Yuma	974	39	109	78	32°40′
AR	Fort Smith	3,292	17	98	79	35°20′
	Little Rock	3,219	20	96	79	34°40′
	Texarkana	2,533	23	96	79	33°30′
CA	Fresno	2,611	30	100	71	36°50′
	Long Beach	1,803	43	80	69	33°50′
	Los Angeles	2,061	43	80	69	34°00′
	Los Angeles[d]	1,349	40	89	71	34°00′
	Oakland	2,870	36	80	64	37°40′
	Sacramento	2,502	32	98	71	38°30′
	San Diego	1,458	44	80	70	32°40′
	San Francisco	3,015	38	77	64	37°40′
	San Francisco[d]	3,001	40	71	62	37°50′
CO	Alamosa	8,529	-16	82	61	37°30′
	Colorado Springs	6,423	2	88	62	38°50′
	Denver	6,283	1	91	63	39°50′
	Grand Junction	5,641	7	94	63	39°10′
	Pueblo	5,462	0	95	66	38°20′
CT	Bridgeport	5,617	9	84	74	41°10′
	Hartford	6,235	7	88	75	41°50′
	New Haven	5,897	7	84	75	41°20′
DE	Wilmington	4,930	14	89	76	39°40′
DC	Washington	4,224	17	91	77	38°50′

(continued)

TABLE D101—continued
DEGREE DAY AND DESIGN TEMPERATURES[a] FOR CITIES IN THE UNITED STATES

STATE	STATION[b]	HEATING DEGREE DAYS (yearly total)	DESIGN TEMPERATURES			DEGREES NORTH LATITUDE[c]
			Winter	Summer		
			97 1/2%	Dry bulb 2 1/2%	Wet bulb 2 1/2%	
	Daytona	879	35	90	79	29°10′
	Fort Myers	442	44	92	79	26°40′
	Jacksonville	1,239	32	94	79	30°30′
	Key West	108	57	90	79	24°30′
	Miami	214	47	90	79	25°50′
	Orlando	766	38	93	78	28°30′
	Pensacola	1,463	29	93	79	30°30′
	Tallahassee	1,485	30	92	78	30°20′
	Tampa	683	40	91	79	28°00′
	West Palm Beach	253	45	91	79	26°40′
	Athens	2,929	22	92	77	34°00′
	Atlanta	2,961	22	92	76	33°40′
	Augusta	2,397	23	95	79	33°20′
GA	Columbus	2,383	24	93	78	32°30′
	Macon	2,136	25	93	78	32°40′
	Rome	3,326	22	93	78	34°20′
	Savannah	1,819	27	93	79	32°10′
HI	Hilo	0	62	83	74	19°40′
	Honolulu	0	63	86	75	21°20′
	Boise	5,809	10	94	66	43°30′
ID	Lewiston	5,542	6	93	66	46°20′
	Pocatello	7,033	-1	91	63	43°00′
	Chicago (Midway)	6,155	0	91	75	41°50′
	Chicago (O'Hare)	6,639	-4	89	76	42°00′
	Chicago[d]	5,882	2	91	77	41°50′
IL	Moline	6,408	-4	91	77	41°30′
	Peoria	6,025	-4	89	76	40°40′
	Rockford	6,830	-4	89	76	42°10′
	Springfield	5,429	2	92	77	39°50′
	Evansville	4,435	9	93	78	38°00′
	Fort Wayne	6,205	1	89	75	41°00′
IN	Indianapolis	5,699	2	90	76	39°40′
	South Bend	6,439	1	89	75	41°40′
	Burlington	6,114	-3	91	77	40°50′
	Des Moines	6,588	-5	91	77	41°30′
IA	Dubuque	7,376	-7	88	75	42°20′
	Sioux City	6,951	-7	92	77	42°20′
	Waterloo	7,320	-10	89	77	42°30′
	Dodge City	4,986	5	97	73	37°50′
	Goodland	6,141	0	96	70	39°20′
KS	Topeka	5,182	4	96	78	39°00′
	Wichita	4,620	7	98	76	37°40′
	Covington	5,265	6	90	75	39°00′
KY	Lexington	4,683	8	91	76	38°00′
	Louisville	4,660	10	93	77	38°10′
	Alexandria	1,921	27	94	79	31°20′
	Baton Rouge	1,560	29	93	80	30°30′
LA	Lake Charles	1,459	31	93	79	30°10′
	New Orleans	1,385	33	92	80	30°00′
	Shreveport	2,184	25	96	79	32°30′

(continued)

TABLE D101—continued
DEGREE DAY AND DESIGN TEMPERATURES[a] FOR CITIES IN THE UNITED STATES

STATE	STATION[b]	HEATING DEGREE DAYS (yearly total)	DESIGN TEMPERATURES			DEGREES NORTH LATITUDE[c]
			Winter	Summer		
			$97^{1}/_{2}\%$	Dry bulb $2^{1}/_{2}\%$	Wet bulb $2^{1}/_{2}\%$	
ME	Caribou	9,767	-13	81	69	46°50′
	Portland	7,511	-1	84	72	43°40′
MD	Baltimore	4,654	13	91	77	39°10′
	Baltimore[d]	4,111	17	89	78	39°20′
	Frederick	5,087	12	91	77	39°20′
MA	Boston	5,634	9	88	74	42°20′
	Pittsfield	7,578	-3	84	72	42°30′
	Worcester	6,969	4	84	72	42°20′
MI	Alpena	8,506	-6	85	72	45°00′
	Detroit (City)	6,232	6	88	74	42°20′
	Escanaba[d]	8,481	-7	83	71	45°40′
	Flint	7,377	1	87	74	43°00′
	Grand Rapids	6,894	5	88	74	42°50′
	Lansing	6,909	1	87	74	42°50′
	Marquette[d]	8,393	-8	81	70	46°30′
	Muskegon	6,696	6	84	73	43°10′
	Sault Ste. Marie	9,048	-8	81	70	46°30′
MN	Duluth	10,000	-16	82	70	46°50′
	Minneapolis	8,382	-12	89	5	44°50′
	Rochester	8,295	-12	87	75	44°00′
MS	Jackson	2,239	25	95	78	32°20′
	Meridian	2,289	23	95	79	32°20′
	Vicksburg[d]	2,041	26	95	80	32°20′
MO	Columbia	5,046	4	94	77	39°00′
	Kansas City	4,711	6	96	77	39°10′
	St. Joseph	5,484	2	93	79	39°50′
	St. Louis	4,900	6	94	77	38°50′
	St. Louis[d]	4,484	8	94	77	38°40′
	Springfield	4,900	9	93	77	37°10′
MT	Billings	7,049	-10	91	66	45°50′
	Great Falls	7,750	-15	88	62	47°30′
	Helena	8,129	-16	88	62	46°40′
	Missoula	8,125	-6	88	63	46°50′
NE	Grand Island	6,530	-3	94	74	41°00′
	Lincoln[d]	5,864	-2	95	77	40°50′
	Norfolk	6,979	-4	93	77	42°00′
	North Platte	6,684	-4	94	72	41°10′
	Omaha	6,612	-3	91	77	41°20′
	Scottsbluff	6,673	-3	92	68	41°50′
NV	Elko	7,433	-2	92	62	40°50′
	Ely	7,733	-4	87	59	39°10′
	Las Vegas	2,709	28	106	70	36°10′
	Reno	6,332	10	92	62	39°30′
	Winnemucca	6,761	3	94	62	40°50′
NH	Concord	7,383	-3	87	73	43°10′
NJ	Atlantic City	4,812	13	89	77	39°30′
	Newark	4,589	14	91	76	40°40′
	Trenton[d]	4,980	14	88	76	40°10′

(continued)

TABLE D101—continued
DEGREE DAY AND DESIGN TEMPERATURES[a] FOR CITIES IN THE UNITED STATES

STATE	STATION[b]	HEATING DEGREE DAYS (yearly total)	DESIGN TEMPERATURES			DEGREES NORTH LATITUDE[c]
			Winter	Summer		
			97½%	Dry bulb 2½%	Wet bulb 2½%	
NM	Albuquerque	4,348	16	94	65	35°00′
	Raton	6,228	1	89	64	36°50′
	Roswell	3,793	18	98	70	33°20′
	Silver City	3,705	10	94	64	32°40′
NY	Albany	6,875	-1	88	74	42°50′
	Albany[d]	6,201	1	88	74	42°50′
	Binghamton	7,286	1	83	72	42°10′
	Buffalo	7,062	6	85	73	43°00′
	NY (Central Park)[d]	4,871	15	89	75	40°50′
	NY (Kennedy)	5,219	15	87	75	40°40′
	NY(LaGuardia)	4,811	15	89	75	40°50′
	Rochester	6,748	5	88	73	43°10′
	Schenectady[d]	6,650	1	87	74	42°50′
	Syracuse	6,756	2	87	73	43°10′
NC	Charlotte	3,181	22	93	76	35°10′
	Greensboro	3,805	18	91	76	36°10′
	Raleigh	3,393	20	92	77	35°50′
	Winston-Salem	3,595	20	91	75	36°10′
ND	Bismarck	8,851	-19	91	71	46°50′
	Devils Lake[d]	9,901	-21	88	71	48°10′
	Fargo	9,226	-18	89	74	46°50′
	Williston	9,243	-21	88	70	48°10′
OH	Akron-Canton	6,037	6	86	73	41°00′
	Cincinnati[d]	4,410	6	90	75	39°10′
	Cleveland	6,351	5	88	74	41°20′
	Columbus	5,660	5	90	75	40°00′
	Dayton	5,622	4	89	75	39°50′
	Mansfield	6,403	5	87	74	40°50′
	Sandusky[d]	5,796	6	91	74	41°30′
	Toledo	6,494	1	88	75	41°40′
	Youngstown	6,417	4	86	73	41°20′
OK	Oklahoma City	3,725	13	97	77	35°20′
	Tulsa	3,860	13	98	78	36°10′
OR	Eugene	4,726	22	89	67	44°10′
	Medford	5,008	23	94	68	42°20′
	Portland	4,635	23	85	67	45°40′
	Portland[d]	4,109	24	86	67	45°30′
	Salem	4,754	23	88	68	45°00′
PA	Allentown	5,810	9	88	75	40°40′
	Erie	6,451	9	85	74	42°10′
	Harrisburg	5,251	11	91	76	40°10′
	Philadelphia	5,144	14	90	76	39°50′
	Pittsburgh	5,987	5	86	73	40°30′
	Pittsburgh[d]	5,053	7	88	73	40°30′
	Reading[d]	4,945	13	89	75	40°20′
	Scranton	6,254	5	87	73	41°20′
	Williamsport	5,934	7	89	74	41°10′
RI	Providence	5,954	9	86	74	41°40′
SC	Charleston	2,033	27	91	80	32°50′
	Charleston[d]	1,794	28	92	80	32°50′
	Columbia	2,484	24	95	78	34°00′

(continued)

APPENDIX D

TABLE D101—continued
DEGREE DAY AND DESIGN TEMPERATURES[a] FOR CITIES IN THE UNITED STATES

STATE	STATION[b]	HEATING DEGREE DAYS (yearly total)	DESIGN TEMPERATURES			DEGREES NORTH LATITUDE[c]
			Winter	Summer		
			97½%	Dry bulb 2½%	Wet bulb 2½%	
SD	Huron	8,223	-14	93	75	44°30′
	Rapid City	7,345	-7	92	69	44°00′
	Sioux Falls	7,839	-11	91	75	43°40′
TN	Bristol	4,143	14	89	75	36°30′
	Chattanooga	3,254	18	93	77	35°00′
	Knoxville	3,494	19	92	76	35°50′
	Memphis	3,232	18	95	79	35°00′
	Nashville	3,578	14	94	77	36°10′
TX	Abilene	2,624	20	99	74	32°30′
	Austin	1,711	28	98	77	30°20′
	Dallas	2,363	22	100	78	32°50′
	El Paso	2,700	24	98	68	31°50′
	Houston	1,396	32	94	79	29°40′
	Midland	2,591	21	98	72	32°00′
	San Angelo	2,255	22	99	74	31°20′
	San Antonio	1,546	30	97	76	29°30′
	Waco	2,030	26	99	78	31°40′
	Wichita Falls	2,832	18	101	76	34°00′
UT	Salt Lake City	6,052	8	95	65	40°50′
VT	Burlington	8,269	-7	85	72	44°30′
VA	Lynchburg	4,166	16	90	76	37°20′
	Norfolk	3,421	22	91	78	36°50′
	Richmond	3,865	17	92	78	37°30′
	Roanoke	4,150	16	91	74	37°20′
WA	Olympia	5,236	22	83	66	47°00′
	Seattle-Tacoma	5,145	26	80	64	47°30′
	Seattle[d]	4,424	27	82	67	47°40′
	Spokane	6,655	2	90	64	47°40′
WV	Charleston	4,476	11	90	75	38°20′
	Elkins	5,675	6	84	72	38°50′
	Huntington	4,446	10	91	77	38°20′
	Parkersburg[d]	4,754	11	90	76	39°20′
WI	Green Bay	8,029	-9	85	74	44°30′
	La Crosse	7,589	-9	88	75	43°50′
	Madison	7,863	-7	88	75	43°10′
	Milwaukee	7,635	-4	87	74	43°00′
WY	Casper	7,410	-5	90	61	42°50′
	Cheyenne	7,381	-1	86	62	41°10′
	Lander	7,870	-11	88	63	42°50′
	Sheridan	7,680	-8	91	65	44°50′

All data were extracted from the 1985 ASHRAE Handbook, Fundamentals Volume.
Design data developed from airport temperature observations unless noted.
Latitude is given to the nearest 10 minutes. For example, the latitude for Miami, Florida, is given as 25º50′, or 25 degrees 50 minutes.
Design data developed from office locations within an urban area, not from airport temperature observations.

APPENDIX E
SIZING OF WATER PIPING SYSTEM

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

User note:

About this appendix: *The sizing of water service and water distribution piping is not specified in Chapter 6 as it is left up to the designer of the system with the code official approving the design method. Appendix E provides several methods that could be used by a system designer.*

SECTION E101
GENERAL

1101.1 Scope.

E101.1.1 This appendix outlines two procedures for sizing a water piping system (see Sections E103.3 and E201.1). The design procedures are based on the minimum static pressure available from the supply source, the head charges in the system caused by friction and elevation, and the rates of flow necessary for operation of various fixtures.

E101.1.2 Because of the variable conditions encountered in hydraulic design, it is impractical to specify definite and detailed rules for sizing of the water piping system. Accordingly, other sizing or design methods conforming to good engineering practice standards are acceptable alternatives to those presented herein.

SECTION E102
INFORMATION REQUIRED

E102.1 Preliminary. Obtain the necessary information regarding the minimum daily static service pressure in the area where the building is to be located. If the building supply is to be metered, obtain information regarding friction loss relative to the rate of flow for meters in the range of sizes likely to be used. Friction loss data can be obtained from most manufacturers of water meters.

E102.2 Demand load.

E102.2.1 Estimate the supply demand of the building main and the principal branches and risers of the system by totaling the corresponding demand from the applicable part of Table E103.3(3).

E102.2.2 Estimate continuous supply demands in gallons per minute (L/m) for lawn sprinklers, air conditioners, etc., and add the sum to the total demand for fixtures. The result is the estimated supply demand for the building supply.

SECTION E103
SELECTION OF PIPE SIZE

E103.1 General. Decide from Table 604.3 what is the desirable minimum residual pressure that should be maintained at the highest fixture in the supply system. If the highest group of fixtures contains flush valves, the pressure for the group should not be less than 15 pounds per square inch (psi) (103.4 kPa) flowing. For flush tank supplies, the available pressure should not be less than 8 psi (55.2 kPa) flowing, except blowout action fixtures must not be less than 25 psi (172.4 kPa) flowing.

E103.2 Pipe sizing.

E103.2.1 Pipe sizes can be selected according to the following procedure or by other design methods conforming to acceptable engineering practice and approved by the administrative authority. The sizes selected must not be less than the minimum required by this code.

E103.2.2 Water pipe sizing procedures are based on a system of pressure requirements and losses, the sum of which must not exceed the minimum pressure available at the supply source. These pressures are as follows:

Pressure required at fixture to produce required flow. See Sections 604.3 and 604.5.

Static pressure loss or gain (due to head) is computed at 0.433 psi per foot (9.8 kPa/m) of elevation change.

Example: Assume that the highest fixture supply outlet is 20 feet (6096 mm) above or below the supply source. This produces a static pressure differential of 20 feet by 0.433 psi/foot (2096 mm by 9.8 kPa/m) and an 8.66 psi (59.8 kPa) loss.

Loss through water meter. The friction or pressure loss can be obtained from meter manufacturers.

Loss through taps in water main.

Losses through special devices such as filters, softeners, backflow prevention devices and pressure regulators. These values must be obtained from the manufacturers.

Loss through valves and fittings. Losses for these items are calculated by converting to equivalent length of piping and adding to the total pipe length.

Loss due to pipe friction can be calculated when the pipe size, the pipe length and the flow through the pipe are known. With these three items, the friction loss can be determined. For piping flow charts not included, use manufacturers' tables and velocity recommendations.

Note: For the purposes of all examples, the following metric conversions are applicable:

1 cubic foot per minute = 0.4719 L/s 1 square foot = 0.0929 m_2

1 degree = 0.0175 rad

1 pound per square inch = 6.895 kPa 1 inch = 25.4 mm

1 foot = 304.8 mm

1 gallon per minute = 3.785 L/m

E103.3 Segmented loss method. The size of water service mains, branch mains and risers by the segmented loss method, must be determined according to water supply demand [gpm (L/m)], available water pressure [psi (kPa)] and friction loss caused by the water meter and developed length of pipe [feet (m)], including equivalent length of fittings. This design procedure is based on the following parameters:

Calculates the friction loss through each length of the pipe. Based on a system of pressure losses, the sum of which must not exceed the minimum pressure available at the street main or other source of supply.

Pipe sizing based on estimated peak demand, total pressure losses caused by difference in elevation, equipment, developed length and pressure required at most remote fixture, loss through taps in water main, losses through fittings, filters, backflow prevention devices, valves and pipe friction.

Because of the variable conditions encountered in hydraulic design, it is impractical to specify definite and detailed rules for sizing of the water piping system. Current sizing methods do not address the differences in the probability of use and flow characteristics of fixtures between types of occupancies. Creating an exact model of predicting the demand for a building is impossible and final studies assessing the impact of water conservation on demand are not yet complete. The following steps are necessary for the segmented loss method.

Preliminary. Obtain the necessary information regarding the minimum daily static service pressure in the area where the building is to be located. If the building supply is to be metered, obtain information regarding friction loss relative to the rate of flow for meters in the range of sizes to be used. Friction loss data can be obtained from manufacturers of water meters. It is essential that enough pressure be available to overcome all system losses caused by friction and elevation so that plumbing fixtures operate properly. Section 604.6 requires the water distribution system to be designed for the minimum pressure available taking into consideration pressure fluctuations. The lowest pressure must be selected to guarantee a continuous, adequate supply of water. The lowest pressure in the public main usually occurs in the summer because of lawn sprinkling and supplying water for air-conditioning cooling towers. Future demands placed on the public main as a result of large growth or expansion should also be considered. The available pressure will decrease as additional loads are placed on the public system.

Demand load. Estimate the supply demand of the building main and the principal branches and risers of the system by totaling the corresponding demand from the applicable part of Table E103.3(3). When estimating peak demand sizing methods typically use water supply fixture units (w.s.f.u.)[see Table E103.3(2)]. This numerical factor measures the load-producing effect of a single plumbing fixture of a given kind. The use of such fixture units can be applied to a single basic probability curve (or table), found in the various sizing methods [Table E103.3(3)]. The fixture units are then converted into gallons per minute (L/m) flow rate for estimating demand.

2.1. Estimate continuous supply demand in gallons per minute (L/m) for lawn sprinklers, air conditioners, etc., and add the sum to the total demand for fixtures. The result is the estimated supply demand for the building supply. Fixture units cannot be applied to constant use fixtures such as hose bibbs, lawn sprinklers and air conditioners. These types of fixtures must be assigned the gallon per minute (L/m) value.

Selection of pipe size. This water pipe sizing procedure is based on a system of pressure requirements and losses, the sum of which must not exceed the minimum pressure available at the supply source. These pressures are as follows:

3.1. Pressure required at the fixture to produce required flow. See Section 604.3 and Section 604.5.

3.2. Static pressure loss or gain (because of head) is computed at 0.433 psi per foot (9.8 kPa/m) of elevation change.

3.3. Loss through a water meter. The friction or pressure loss can be obtained from the manufacturer.

3.4. Loss through taps in water main [see Table E103.3(4)].

3.5. Losses through special devices such as filters, softeners, backflow prevention devices and pressure regulators. These values must be obtained from the manufacturers.

3.6. Loss through valves and fittings [see Tables E103.3(5) and E103.3(6)]. Losses for these items are calculated by converting to equivalent length of piping and adding to the total pipe length.

3.7. Loss caused by pipe friction can be calculated when the pipe size, the pipe length and the flow through the pipe are known. With these three items, the friction loss can be determined using Figures E103.3(2) through E103.3(7). When using charts, use pipe inside diameters. For piping flow charts not included, use manufacturers'

tables and velocity recommendations. Before attempting to size any water supply system, it is necessary to gather preliminary information which includes available pressure, piping material, select design velocity, elevation differences and developed length to most remote fixture. The water supply system is divided into sections at major changes in elevation or where branches lead to fixture groups. The peak demand must be determined in each part of the hot and cold water supply system which includes the corresponding water supply fixture unit and conversion to gallons per minute (L/m) flow rate to be expected through each section. Sizing methods require the determination of the "most hydraulically remote" fixture to compute the pressure loss caused by pipe and fittings. The hydraulically remote fixture represents the most downstream fixture along the circuit of piping requiring the most available pressure to operate properly. Consideration must be given to all pressure demands and losses, such as friction caused by pipe, fittings and equipment, elevation and the residual pressure required by Table 604.3. The two most common and frequent complaints about the water supply system operation are lack of adequate pressure and noise.

Problem: What size Type L copper water pipe, service and distribution will be required to serve a two-story factory building having on each floor, back-to-back, two toilet rooms each equipped with hot and cold water? The highest fixture is 21 feet (6401 mm) above the street main, which is tapped with a 2-inch (51 mm) corporation cock at which point the minimum pressure is 55 psi (379.2 kPa). In the building basement, a 2-inch (51 mm) meter with a maximum pressure drop of 11 psi (75.8 kPa) and 3-inch (76 mm) reduced pressure principle backflow preventer with a maximum pressure drop of 9 psi (621 kPa) are to be installed. The system is shown by Figure E103.3(1). To be determined are the pipe sizes for the service main and the cold and hot water distribution pipes.

Solution: A tabular arrangement such as shown in Table E103.3(1) should first be constructed. The steps to be followed are indicated by the tabular arrangement itself as they are in sequence, columns 1 through 10 and lines A through L.

Step 1

Columns 1 and 2: Divide the system into sections breaking at major changes in elevation or where branches lead to fixture groups. After point B [see Figure E103.3(1)], separate consideration will be given to the hot and cold water piping. Enter the sections to be considered in the service and cold water piping in Column 1 of the tabular arrangement. Column 1 of Table E103.3(1) provides a line-by-line recommended tabular arrangement for use in solving pipe sizing.

The objective in designing the water supply system is to ensure an adequate water supply and pressure to all fixtures and equipment. Column 2 provides the pounds per square inch (psi) to be considered separately from the minimum pressure available at the main. Losses to take into consideration are the following: the differences in elevations between the water supply source and the highest water supply outlet, meter pressure losses, the tap in main loss, special fixture devices such as water softeners and backflow prevention devices and the pressure required at the most remote fixture outlet. The difference in elevation can result in an increase or decrease in available pressure at the main. Where the water supply outlet is located above the source, this results in a loss in the available pressure and is subtracted from the pressure at the water source. Where the highest water supply outlet is located below the water supply source, there will be an increase in pressure that is added to the available pressure of the water source.

Column 3: According to Table E103.3(3), determine the gpm (L/m) of flow to be expected in each section of the system. These flows range from 28.6 to 108 gpm. Load values for fixtures must be determined as water supply fixture units and then converted to a gallon-per-minute (gpm) rating to determine peak demand. When calculating peak demands, the water supply fixture units are added and then converted to the gallon-per-minute rating. For continuous flow fixtures such as hose bibbs and lawn sprinkler systems, add the gallon-per-minute demand to the intermittent demand of fixtures. For example, a total of 120 water supply fixture units is converted to a demand of 48 gallons per minute. Two hose bibbs x 5 gpm demand = 10 gpm. Total gpm rating = 48.0 gpm + 10 gpm = 58.0 gpm demand.

Step 2

Line A: Enter the minimum pressure available at the main source of supply in Column 2. This is 55 psi (379.2 kPa). The local water authorities generally keep records of pressures at different times of day and year. The available pressure can also be checked from nearby buildings or from fire department hydrant checks.

Line B: Determine from Table 604.3 the highest pressure required for the fixtures on the system, which is 15 psi (103.4 kPa), to operate a flushometer valve. The most remote fixture outlet is necessary to compute the pressure loss caused by pipe and fittings, and represents the most downstream fixture along the circuit of piping requiring the available pressure to operate properly as indicated by Table 604.3.

Line C: Determine the pressure loss for the meter size given or assumed. The total water flow from the main through the service as determined in Step 1 will serve to aid in the meter selected. There are three common types of water meters; the pressure losses are determined by the American Water Works Association Standards for displacement type, compound type and turbine type. The maximum pressure loss of such devices takes into

consideration the meter size, safe operating capacity (gpm) and maximum rates for continuous operations (gpm). Typically, equipment imparts greater pressure losses than piping.

Line D: Select from Table E103.3(4) and enter the pressure loss for the tap size given or assumed. The loss of pressure through taps and tees in pounds per square inch (psi) are based on the total gallon-per-minute flow rate and size of the tap.

Line E: Determine the difference in elevation between the main and source of supply and the highest fixture on the system. Multiply this figure, expressed in feet, by 0.43 psi (2.9 kPa). Enter the resulting psi loss on Line E. The difference in elevation between the water supply source and the highest water supply outlet has a significant impact on the sizing of the water supply system. The difference in elevation usually results in a loss in the available pressure because the water supply outlet is generally located above the water supply source. The loss is caused by the pressure required to lift the water to the outlet. The pressure loss is subtracted from the pressure at the water source. Where the highest water supply outlet is located below the water source, there will be an increase in pressure which is added to the available pressure of the water source.

Lines F, G and H: The pressure losses through filters, backflow prevention devices or other special fixtures must be obtained from the manufacturer or estimated and entered on these lines. Equipment such as backflow prevention devices, check valves, water softeners, instantaneous or tankless water heaters, filters and strainers can impart a much greater pressure loss than the piping. The pressure losses can range from 8 psi to 30 psi.

Step 3

Line I: The sum of the pressure requirements and losses that affect the overall system (Lines B through H) is entered on this line. Summarizing the steps, all of the system losses are subtracted from the minimum water pressure. The remainder is the pressure available for friction, defined as the energy available to push the water through the pipes to each fixture. This force can be used as an average pressure loss, as long as the pressure available for friction is not exceeded. Saving a certain amount for available water supply pressures as an area incurs growth, or because of aging of the pipe or equipment added to the system is recommended.

Step 4

Line J: Subtract Line I from Line A. This gives the pressure that remains available from overcoming friction losses in the system. This figure is a guide to the pipe size that is chosen for each section, incorporating the total friction losses to the most remote outlet (measured length is called developed length).

Exception: When the main is above the highest fixture, the resulting psi must be considered a pressure gain (static head gain) and omitted from the sums of Lines B through H and added to Line J.

The maximum friction head loss that can be tolerated in the system during peak demand is the difference between the static pressure at the highest and most remote outlet at no-flow conditions and the minimum flow pressure required at that outlet. If the losses are within the required limits, then every run of pipe will also be within the required friction head loss. Static pressure loss is the most remote outlet in feet x0.433 = loss in psi caused by elevation differences.

Step 5

Column 4: Enter the length of each section from the main to the most remote outlet (at Point E). Divide the water supply system into sections breaking at major changes in elevation or where branches lead to fixture groups.

Step 6

Column 5: When selecting a trial pipe size, the length from the water service or meter to the most remote fixture outlet must be measured to determine the developed length. However, in systems having a flush valve or temperature controlled shower at the top most floors the developed length would be from the water meter to the most remote flush valve on the system. A rule of thumb is that size will become progressively smaller as the system extends farther from the main source of supply. Trial pipe size may be arrived at by the following formula:

Line J: (Pressure available to overcome pipe friction) x 100/equivalent length of run total developed length to most remote fixture x percentage factor of 1.5 (note: a percentage factor is used only as an estimate for friction losses imposed for fittings for initial trial pipe size) = psi (average pressure drops per 100 feet of pipe).
For trial pipe size see Figure E 103.3(3) (Type L copper) based on 2.77 psi and a 108 gpm = $2^1/_2$ inches. To determine the equivalent length of run to the most remote outlet, the developed length is determined and added to the friction losses for fittings and valves. The developed lengths of the designated pipe sections are as follows:

A - B 54 ft

B - C 8 ft

C - D 13 ft

D - E 150 ft

Total developed length = 225 ft

The equivalent length of the friction loss in fittings and valves must be added to the developed length (most remote outlet). Where the size of fittings and valves is not known, the added friction loss should be approximated. A general rule that has been used is to add 50 percent of the developed

length to allow for fittings and valves. For example, the equivalent length of run equals the developed length of run (225 ft x 1.5 = 338 ft). The total equivalent length of run for determining a trial pipe size is 338 feet.

Example: 9.36 (pressure available to overcome pipe friction) x100/ 338 (equivalent length of run = 225 x 1.5) = 2.77 psi (average pressure drop per 100 feet of pipe).

Step 7

Column 6: Select from Table E103.3(6) the equivalent lengths for the trial pipe size of fittings and valves on each pipe section. Enter the sum for each section in Column 6. (The number of fittings to be used in this example must be an estimate.) The equivalent length of piping is the developed length plus the equivalent lengths of pipe corresponding to friction head losses for fittings and valves. Where the size of fittings and valves is not known, the added friction head losses must be approximated. An estimate for this example is found in Table E.1.

Step 8

Column 7: Add the figures from Column 4 and Column 6, and enter in Column 7. Express the sum in hundreds of feet.

Step 9

Column 8: Select from Figure E103.3(3) the friction loss per 100 feet (30 480 mm) of pipe for the gallon-per-minute flow in a section (Column 3) and trial pipe size (Column 5). Maximum friction head loss per 100 feet is determined on the basis of total pressure available for friction head loss and the longest equivalent length of run. The selection is based on the gallon-per-minute demand, the uniform friction head loss, and the maximum design velocity. Where the size indicated by hydraulic table indicates a velocity in excess of the selected velocity, a size must be selected which produces the required velocity.

Step 10

Column 9: Multiply the figures in Columns 7 and 8 for each section and enter in Column 9.
Total friction loss is determined by multiplying the friction loss per 100 feet (30 480 mm) for each pipe section in the total developed length by the pressure loss in fittings expressed as equivalent length in feet. Note: Section C-F should be considered in the total pipe friction losses only if greater loss occurs in Section C-F than in pipe section D-E. Section C-F is not considered in the total developed length. Total friction loss in equivalent length is determined in Table E.2.

Step 11

Line K: Enter the sum of the values in Column 9. The value is the total friction loss in equivalent length for each designated pipe section.

Step 12

Line L: Subtract Line J from Line K and enter in Column 10.The result should always be a positive or plus figure. If it is not, repeat the operation using Columns 5, 6, 8 and 9 until a balance or near balance is obtained. If the difference between Lines J and K is a high positive number, it is an indication that the pipe sizes are too large and should be reduced, thus saving materials. In such a case, the operations using Columns 5,6,8 and 9 should again be repeated.
The total friction losses are determined and subtracted from the pressure available to overcome pipe friction for trial pipe size. This number is critical as it provides a guide to whether the pipe size selected is too large and the process should be repeated to obtain an economically designed system.

Answer: The final figures entered in Column 5 become the design pipe size for the respective sections. Repeating this operation a second time using the same sketch but considering the demand for hot water, it is possible to size the hot water distribution piping. This has been worked up as a part of the overall problem in the tabular arrangement used for sizing the service and water distribution piping. Note that consideration must be given to the pressure losses from the street main to the water heater (Section A-B) in determining the hot water pipe sizes.

TABLE E.1

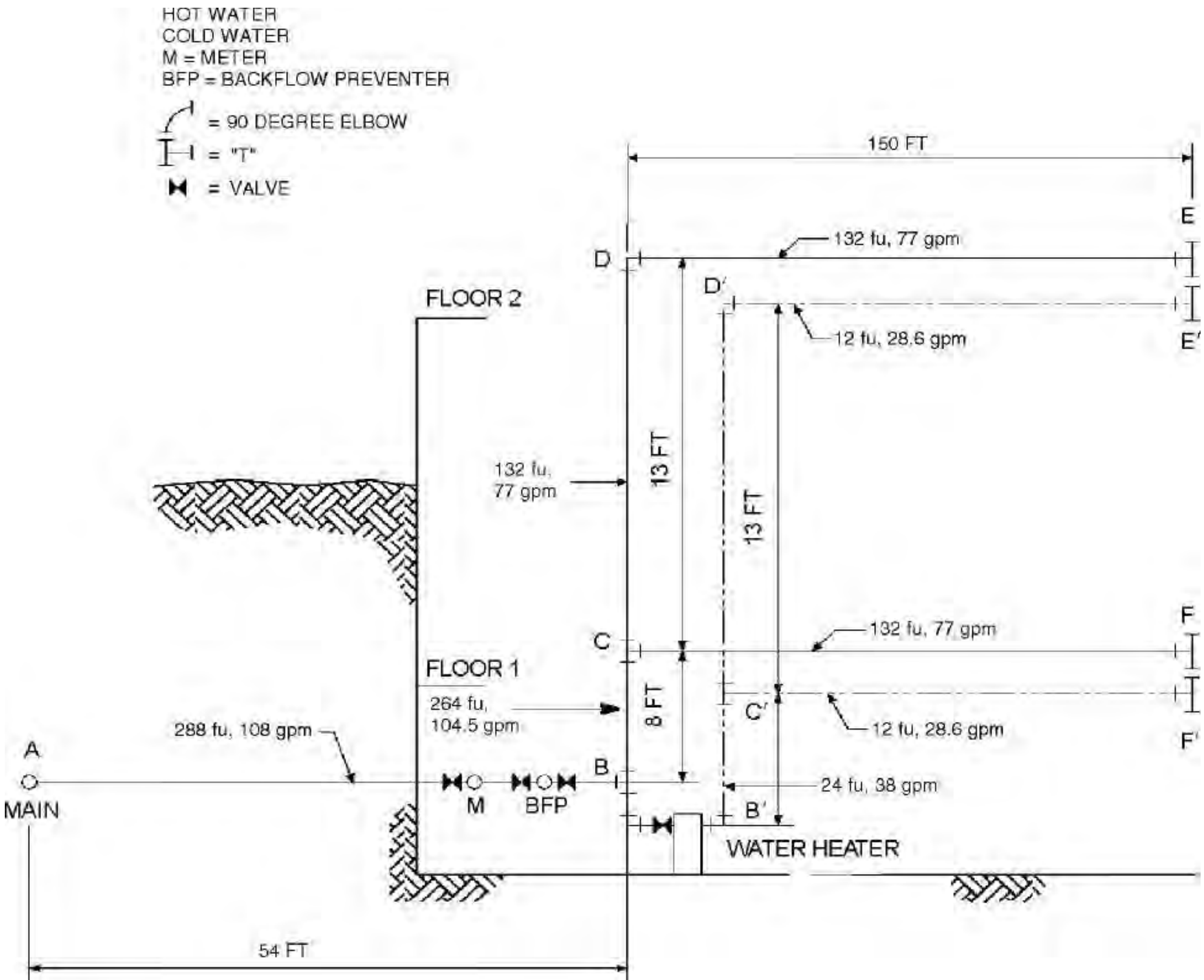
COLD WATER PIPE SECTION	FITTINGS/VALVES	PRESSURE LOSS EXPRESSED AS EQUIVALENT LENGTH OF TUBE (feet)	HOT WATER PIPE SECTION	FITTINGS/VALVES	PRESSURE LOSS EXPRESSED AS EQUIVALENT OF TUBE (feet)
A-B	3-2 1/2″ Gate valves	3	A-B	3-2 1/2″ Gate valves	3
	1-2 1/2″ Side branch tee	12		1-2 1/2″ Side branch tee	12
B-C	1-2 1/2″ Straight run tee	0.5	B-C	1-2″ Straight run tee	7
				1-2″ 90-degree ell	0.5
C-F	1-2 1/2″ Side branch tee	12	C-F	1-1 1/2″ Side branch tee	7
C-D	1-2 1/2″ 90-degree ell	7	C-D	1-1/2″ 90-degree ell	4
D-E	1-2 1/2″ Side branch tee	12	D-E	1-1 1/2″ Side branch tee	7

For SI: 1 foot = 304.8 mm, inch = 25.4 mm.

TABLE E.2

PIPE SECTIONS	FRICTION LOSS EQUIVALENT LENGTH (feet)	
	Cold Water	Hot Water
A-B	0.69 × 3.2 = 2.21	0.69 × 3.2 = 2.21
B-C	0.085 × 3.1 = 0.26	0.16 × 1.4 = 0.22
C-D	0.20 × 1.9 = 0.38	0.17 × 3.2 = 0.54
D-E	1.62 × 1.9 = 3.08	1.57 × 3.2 = 5.02
Total pipe friction losses (Line K)	5.93	7.99

For SI: 1 foot = 304.8 mm, 1 gpm = 3.785 L/m.



For SI: 1 foot = 304.8 mm, 1 gpm = 3.785 L/m.

FIGURE E103.3(1)
EXAMPLE-SIZING

APPENDIX E

TABLE E103.3(1)
RECOMMENDED TABULAR ARRANGEMENT FOR USE IN SOLVING PIPE SIZING PROBLEMS

COLUMN	1		2	3	4	5	6	7	8	9	10
Line	Description		Lb per square inch (psi)	Gal. per min through section	Length of section (feet)	Trial pipe size (inches)	Equivalent length of fittings and valves (feet)	Total equivalent length col. 4 and col. 6 (100 feet)	Friction loss per 100 feet of trial size pipe (psi)	Friction loss in equivalent length col. 8 x col. 7 (psi)	Excess pressure over friction losses (psi)
A	Service and cold water distribution piping[a]	Minimum pressure available at main . . 55.00									
B		Highest pressure required at a fixture (Table 604.3). .15.00									
C		Meter loss 2 meter. 11.00									
D		Tap in main loss 2 tap (Table E103A) . 1.61									
E		Static head loss 21 43 psi. 9.03									
F		Special fixture loss backflow preventer 9.00									
G		Special fixture loss—Filter. 0.00									
H		Special fixture loss—Other. 0.00									
I		Total overall losses and requirements (Sum of Lines B through H) 45.64									
J		Pressure available to overcome pipe friction (Line A minus Lines B to H) 9.36									
	DESIGNATION Pipe section (from diagram) Cold water Distribution piping	FU. 264									
		AB 288		108.0	54	$2^1/_2$	15.00	0.69	3.2	2.21	—
		BC 264		104.5	8	$2^1/_2$	0.5	0.85	3.1	0.26	—
		CD 132		77.0	13	$2^1/_2$	7.00	0.20	1.9	0.38	—
		C F. . .[b] . . 1. . 3. . .2. .		77.0	150	$2^1/_2$	12.00	1.62	1.9	3.08	—
		DE[b]. 132		77.0	150	$2^1/_2$	12.00	1.62	1.9	3.08	—
K	Total pipe friction losses (cold)			—	—	—	—	—	—	5.93	—
L	Difference (Line J minus Line K)			—	—	—	—	—	—	—	3.43
	Pipe section (from diagram)	AB. 288		108.0	54	21/2	12.00	0.69	3.3	2.21	—
	Diagram	B C 24		38.0	8	2	7.5	0.16	1.4	0.22	—
	Hot water	CD. 12		28.6	13	$1^1/_2$	4.0	0.17	3.2	0.54	—
	Distribution	C F 12		28.6	150	$1^1/_2$	7.00	1.57	3.2	5.02	—
	Piping	DE. 12		28.6	150	$1^1/_2$	7.00	1.57	3.2	5.02	—
K	Total pipe friction losses (hot)			—	—	—	—	—	—	7.99	—
L	Difference (Line J minus Line K)			—	—	—	—	—	—	—	1.37

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psi = 6.895kPa, 1 gpm = 3.785 L/m.
To be considered as pressure gain for fixtures below main (to consider separately, omit from "I" and add to "J").
To consider separately, in K use C-F only if greater loss than above.

TABLE E103.3(2)
LOAD VALUES ASSIGNED TO FIXTURES[a]

FIXTURE	OCCUPANCY	TYPE OF SUPPLY CONTROL	LOAD VALUES, IN WATER SUPPLY FIXTURE UNITS (wsfu)		
			Cold	Hot	Total
Bathroom group	Private	Flush tank	2.7	1.5	3.6
Bathroom group	Private	Flushometer valve	6.0	3.0	8.0
Bathtub	Private	Faucet	1.0	1.0	1.4
Bathtub	Public	Faucet	3.0	3.0	4.0
Bidet	Private	Faucet	1.5	1.5	2.0
Combination fixture	Private	Faucet	2.25	2.25	3.0
Dishwashing machine	Private	Automatic	—	1.4	1.4
Drinking fountain	Offices, etc.	3/8 valve	0.25	—	0.25
Kitchen sink	Private	Faucet	1.0	1.0	1.4
Kitchen sink	Hotel, restaurant	Faucet	3.0	3.0	4.0
Laundry trays (1 to 3)	Private	Faucet	1.0	1.0	1.4
Lavatory	Private	Faucet	0.5	0.5	0.7
Lavatory	Public	Faucet	1.5	1.5	2.0
Service sink	Offices, etc.	Faucet	2.25	2.25	3.0
Shower head	Public	Mixing valve	3.0	3.0	4.0
Shower head	Private	Mixing valve	1.0	1.0	1.4
Urinal	Public	1 flushometer valve	10.0	—	10.0
Urinal	Public	3/4 flushometer valve	5.0	—	5.0
Urinal	Public	Flush tank	3.0	—	3.0
Washing machine (8 lb)	Private	Automatic	1.0	1.0	1.4
Washing machine (8 lb)	Public	Automatic	2.25	2.25	3.0
Washing machine (15 lb)	Public	Automatic	3.0	3.0	4.0
Water closet	Private	Flushometer valve	6.0	—	6.0
Water closet	Private	Flush tank	2.2	—	2.2
Water closet	Public	Flushometer valve	10.0	—	10.0
Water closet	Public	Flush tank	5.0	—	5.0
Water closet	Public or private	Flushometer tank	2.0	—	2.0

For SI: 1 inch = 25.4 mm, 1 pound = 0.454 kg.
a. For fixtures not listed, loads should be assumed by comparing the fixture to one listed using water in similar quantities and at similar rates. The assigned loads for fixtures with both hot and cold water supplies are given for separate hot and cold water loads and for total load. The separate hot and cold water loads being three-fourths of the total load for the fixture in each case.

APPENDIX E

TABLE E103.3(3)
TABLE FOR ESTIMATING DEMAND

SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSH TANKS			SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSH VALVES		
Load	Demand		Load	Demand	
(Water supply fixture units)	(Gallons per minute)	(Cubic feet per minute)	(Water supply fixture units)	(Gallons per minute)	(Cubic feet per minute)
1	3.0	0.04104	—	—	—
2	5.0	0.0684	—	—	—
3	6.5	0.86892	—	—	—
4	8.0	1.06944	—	—	—
5	9.4	1.256592	5	15.0	2.0052
6	10.7	1.430376	6	17.4	2.326032
7	11.8	1.577424	7	19.8	2.646364
8	12.8	1.711104	8	22.2	2.967696
9	13.7	1.831416	9	24.6	3.288528
10	14.6	1.951728	10	27.0	3.60936
11	15.4	2.058672	11	27.8	3.716304
12	16.0	2.13888	12	28.6	3.823248
13	16.5	2.20572	13	29.4	3.930192
14	17.0	2.27256	14	30.2	4.037136
15	17.5	2.3394	15	31.0	4.14408
16	18.0	2.90624	16	31.8	4.241024
17	18.4	2.459712	17	32.6	4.357968
18	18.8	2.513184	18	33.4	4.464912
19	19.2	2.566656	19	34.2	4.571856
20	19.6	2.620128	20	35.0	4.6788
25	21.5	2.87412	25	38.0	5.07984
30	23.3	3.114744	30	42.0	5.61356
35	24.9	3.328632	35	44.0	5.88192
40	26.3	3.515784	40	46.0	6.14928
45	27.7	3.702936	45	48.0	6.41664
50	29.1	3.890088	50	50.0	6.684
60	32.0	4.27776	60	54.0	7.21872
70	35.0	4.6788	70	58.0	7.75344
80	38.0	5.07984	80	61.2	8.181216
90	41.0	5.48088	90	64.3	8.595624
100	43.5	5.81508	100	67.5	9.0234
120	48.0	6.41664	120	73.0	9.75864
140	52.5	7.0182	140	77.0	10.29336
160	57.0	7.61976	160	81.0	10.82808
180	61.0	8.15448	180	85.5	11.42964
200	65.0	8.6892	200	90.0	12.0312
225	70.0	9.3576	225	95.5	12.76644
250	75.0	10.026	250	101.0	13.50168

(continued)

APPENDIX E

TABLE E103.3(3)—continued
TABLE FOR ESTIMATING DEMAND

SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSH TANKS			SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSH VALVES		
Load	Demand		Load	Demand	
(Water supply fixture units)	(Gallons per minute)	(Cubic feet per minute)	(Water supply fixture units)	(Gallons per minute)	(Cubic feet per minute)
275	80.0	10.6944	275	104.5	13.96956
300	85.0	11.3628	300	108.0	14.43744
400	105.0	14.0364	400	127.0	16.97736
500	124.0	16.57632	500	143.0	19.11624
750	170.0	22.7256	750	177.0	23.66136
1,000	208.0	27.80544	1,000	208.0	27.80544
1,250	239.0	31.94952	1,250	239.0	31.94952
1,500	269.0	35.95992	1,500	269.0	35.95992
1,750	297.0	39.70296	1,750	297.0	39.70296
2,000	325.0	43.446	2,000	325.0	43.446
2,500	380.0	50.7984	2,500	380.0	50.7984
3,000	433.0	57.88344	3,000	433.0	57.88344
4,000	535.0	70.182	4,000	525.0	70.182
5,000	593.0	79.27224	5,000	593.0	79.27224

For SI: 1 inch = 25.4 mm, 1 gallon per minute = 3.785 L/m, 1 cubic foot per minute = 0.28 m^3 per minute.

TABLE E103.3(4)
LOSS OF PRESSURE THROUGH TAPS AND TEES IN POUNDS PER SQUARE INCH (psi)

GALLONS PER MINUTE	SIZE OF TAP OR TEE (inches)						
	$^5/_8$	$^3/_4$	1	$1^1/_4$	$1^1/_2$	2	3
10	1.35	0.64	0.18	0.08	—	—	—
20	5.38	2.54	0.77	0.31	0.14	—	—
30	12.10	5.72	1.62	0.69	0.33	0.10	—
40	—	10.20	3.07	1.23	0.58	0.18	—
50	—	15.90	4.49	1.92	0.91	0.28	—
60	—	—	6.46	2.76	1.31	0.40	—
70	—	—	8.79	3.76	1.78	0.55	0.10
80	—	—	11.50	4.90	2.32	0.72	0.13
90	—	—	14.50	6.21	2.94	0.91	0.16
100	—	—	17.94	7.67	3.63	1.12	0.21
120	—	—	25.80	11.00	5.23	1.61	0.30
140	—	—	35.20	15.00	7.12	2.20	0.41
150	—	—	—	17.20	8.16	2.52	0.47
160	—	—	—	19.60	9.30	2.92	0.54
180	—	—	—	24.80	11.80	3.62	0.68
200	—	—	—	30.70	14.50	4.48	0.84
225	—	—	—	38.80	18.40	5.60	1.06
250	—	—	—	47.90	22.70	7.00	1.31
275	—	—	—	—	27.40	7.70	1.59
300	—	—	—	—	32.60	10.10	1.88

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kpa, 1 gallon per minute = 3.785 L/m.

APPENDIX E

TABLE E103.3(5)

ALLOWANCE IN EQUIVALENT LENGTHS OF PIPE FOR FRICTION LOSS IN VALVES AND THREADED FITTINGS (feet)

FITTING OR VALVE	PIPE SIZE (inches)							
	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3
45-degree elbow	1.2	1.5	1.8	2.4	3.0	4.0	5.0	6.0
90-degree elbow	2.0	2.5	3.0	4.0	5.0	7.0	8.0	10.0
Tee, run	0.6	0.8	0.9	1.2	1.5	2.0	2.5	3.0
Tee, branch	3.0	4.0	5.0	6.0	7.0	10.0	12.0	15.0
Gate valve	0.4	0.5	0.6	0.8	1.0	1.3	1.6	2.0
Balancing valve	0.8	1.1	1.5	1.9	2.2	3.0	3.7	4.5
Plug-type cock	0.8	1.1	1.5	1.9	2.2	3.0	3.7	4.5
Check valve, swing	5.6	8.4	11.2	14.0	16.8	22.4	28.0	33.6
Globe valve	15.0	20.0	25.0	35.0	45.0	55.0	65.0	80.0
Angle valve	8.0	12.0	15.0	18.0	22.0	28.0	34.0	40.0

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad.

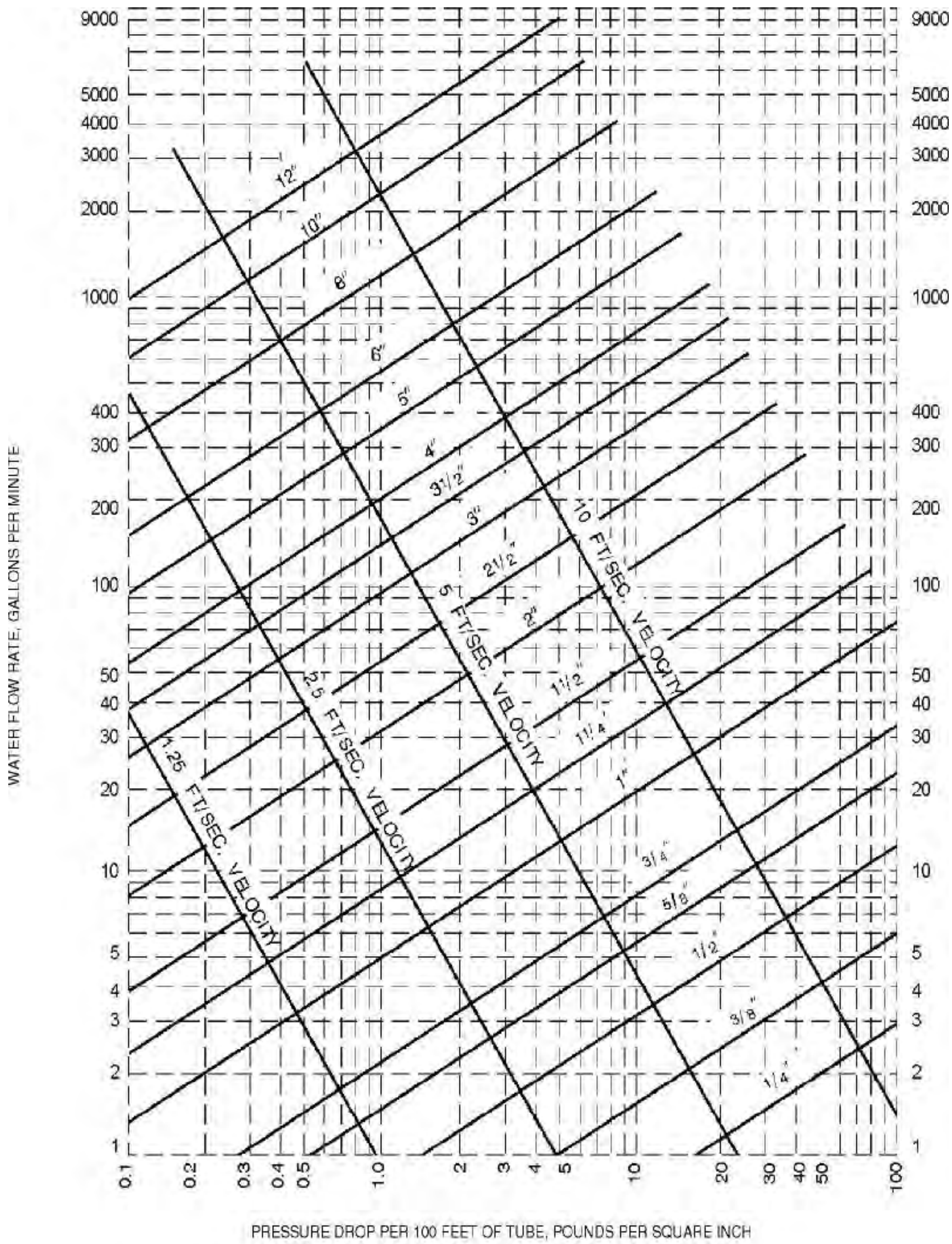
TABLE E103.3(6)

PRESSURE LOSS IN FITTINGS AND VALVES EXPRESSED AS EQUIVALENT LENGTH OF TUBE[a] (feet)

NOMINAL OR STANDARD SIZE (inches)	FITTINGS					VALVES			
	Standard Ell		90-Degree Tee						
	90 Degree	45 Degree	Side Branch	Straight Run	Coupling	Ball	Gate	Butterfly	Check
3/8	0.5	—	1.5	—	—	—	—	—	1.5
1/2	1	0.5	2	—	—	—	—	—	2
5/8	1.5	0.5	2	—	—	—	—	—	2.5
3/4	2	0.5	3	—	—	—	—	—	3
1	2.5	1	4.5	—	—	0.5	—	—	4.5
1 1/4	3	1	5.5	0.5	0.5	0.5	—	—	5.5
1 1/2	4	1.5	7	0.5	0.5	0.5	—	—	6.5
2	5.5	2	9	0.5	0.5	0.5	0.5	7.5	9
2 1/2	7	2.5	12	0.5	0.5	—	1	10	11.5
3	9	3.5	15	1	1	—	1.5	15.5	14.5
3 1/2	9	3.5	14	1	1	—	2	—	12.5
4	12.5	5	21	1	1	—	2	16	18.5
5	16	6	27	1.5	1.5	—	3	11.5	23.5
6	19	7	34	2	2	—	3.5	13.5	26.5
8	29	11	50	3	3	—	5	12.5	39

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad.

a. Allowances are for streamlined soldered fittings and recessed threaded fittings. For threaded fittings, double the allowances shown in the table. The equivalent lengths presented above are based on a C factor of 150 in the Hazen-Williams friction loss formula. The lengths shown are rounded to the nearest half-foot.

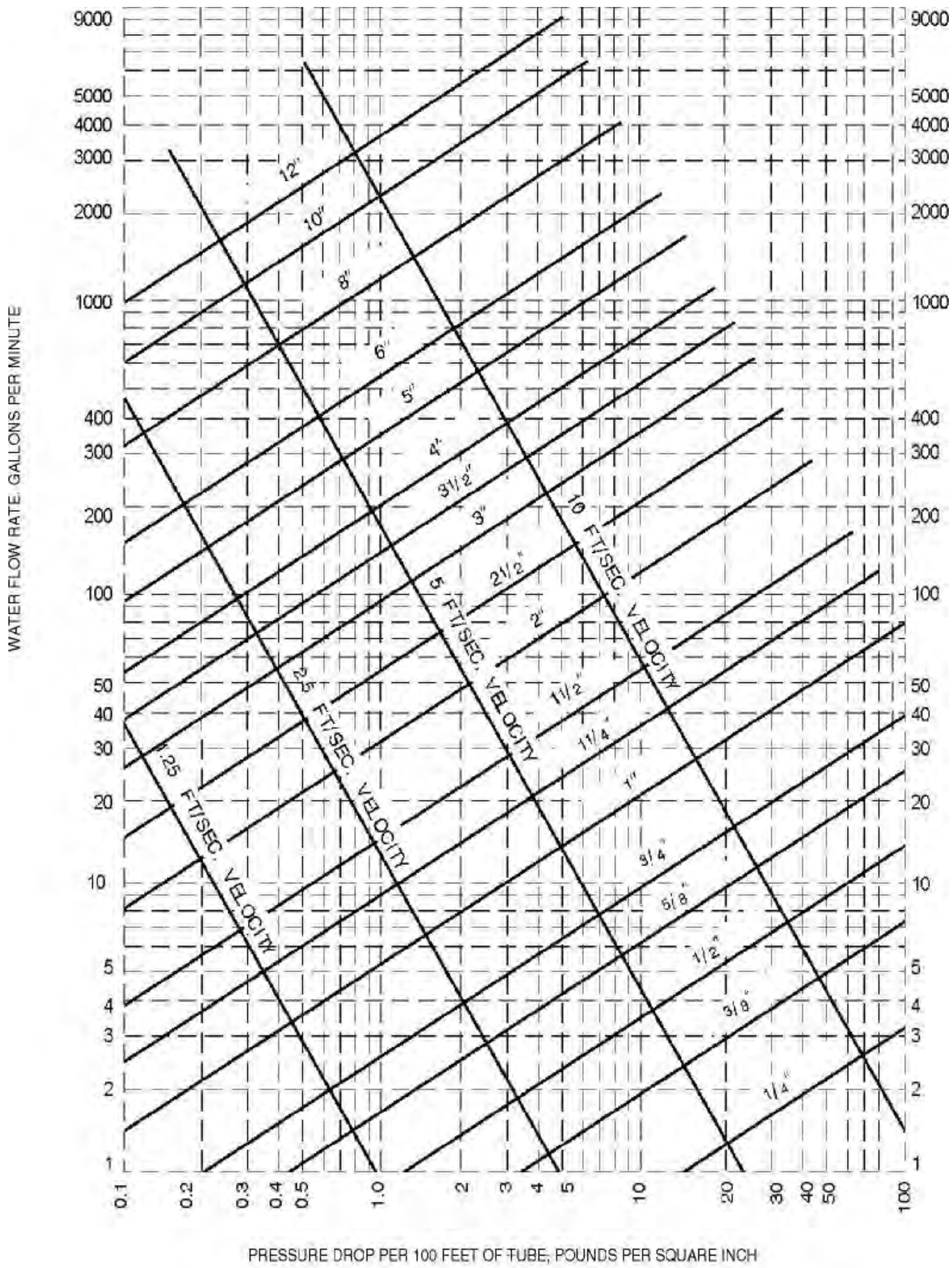


Note: Fluid velocities in excess of 5 to 8 feet/second are not usually recommended.

FIGURE E103.3(2)
FRICTION LOSS IN SMOOTH PIPE[a] (TYPE K, ASTM B 88 COPPER TUBING)

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gpm = 3.785 L/m, 1 psi = 6.895 kPa,
1 foot per second = 0.305 m/s.

a. This chart applies to smooth new copper tubing with recessed (streamline) soldered joints and to the actual sizes of types indicated on the diagram.

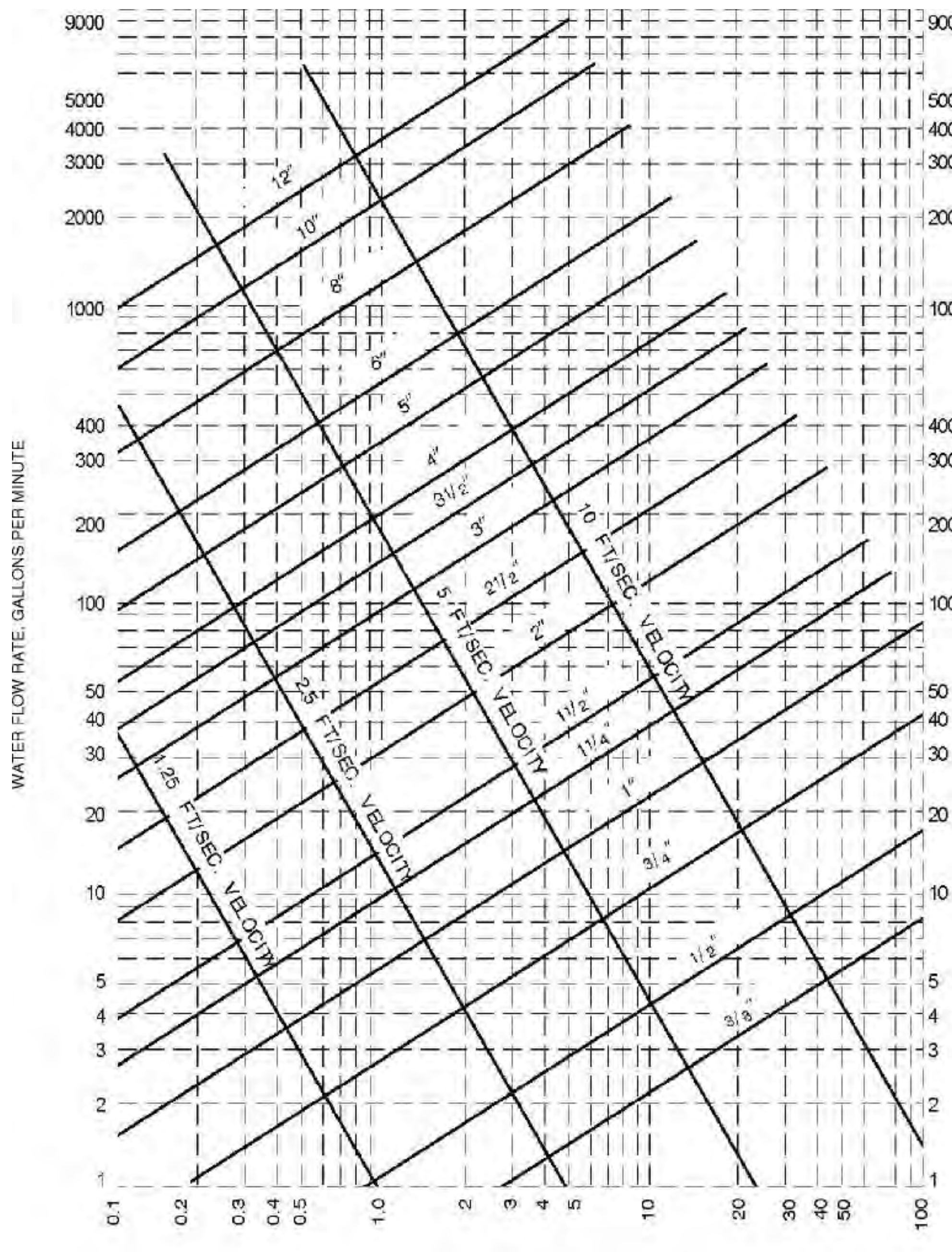


Note: Fluid velocities in excess of 5 to 8 feet/second are not usually recommended.

FIGURE E103.3(3)
FRICTION LOSS IN SMOOTH PIPE[a] (TYPE L, ASTM B 88 COPPER TUBING)

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gpm = 3.785 L/m, 1 psi = 6.895 kPa,
1 foot per second = 0.305 m/s.

a. This chart applies to smooth new copper tubing with recessed (streamline) soldered joints and to the actual sizes of types indicated on the diagram.



Note: Fluid velocities in excess of 5 to 8 feet/second are not usually recommended.

FIGURE E103.3(4)
FRICTION LOSS IN SMOOTH PIPE[a] (TYPE M, ASTM B 88 COPPER TUBING)

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gpm = 3.785 L/m, 1 psi = 6.895 kPa,
1 foot per second = 0.305 m/s.

a. This chart applies to smooth new copper tubing with recessed (streamline) soldered joints and to the actual sizes of types indicated on the diagram.

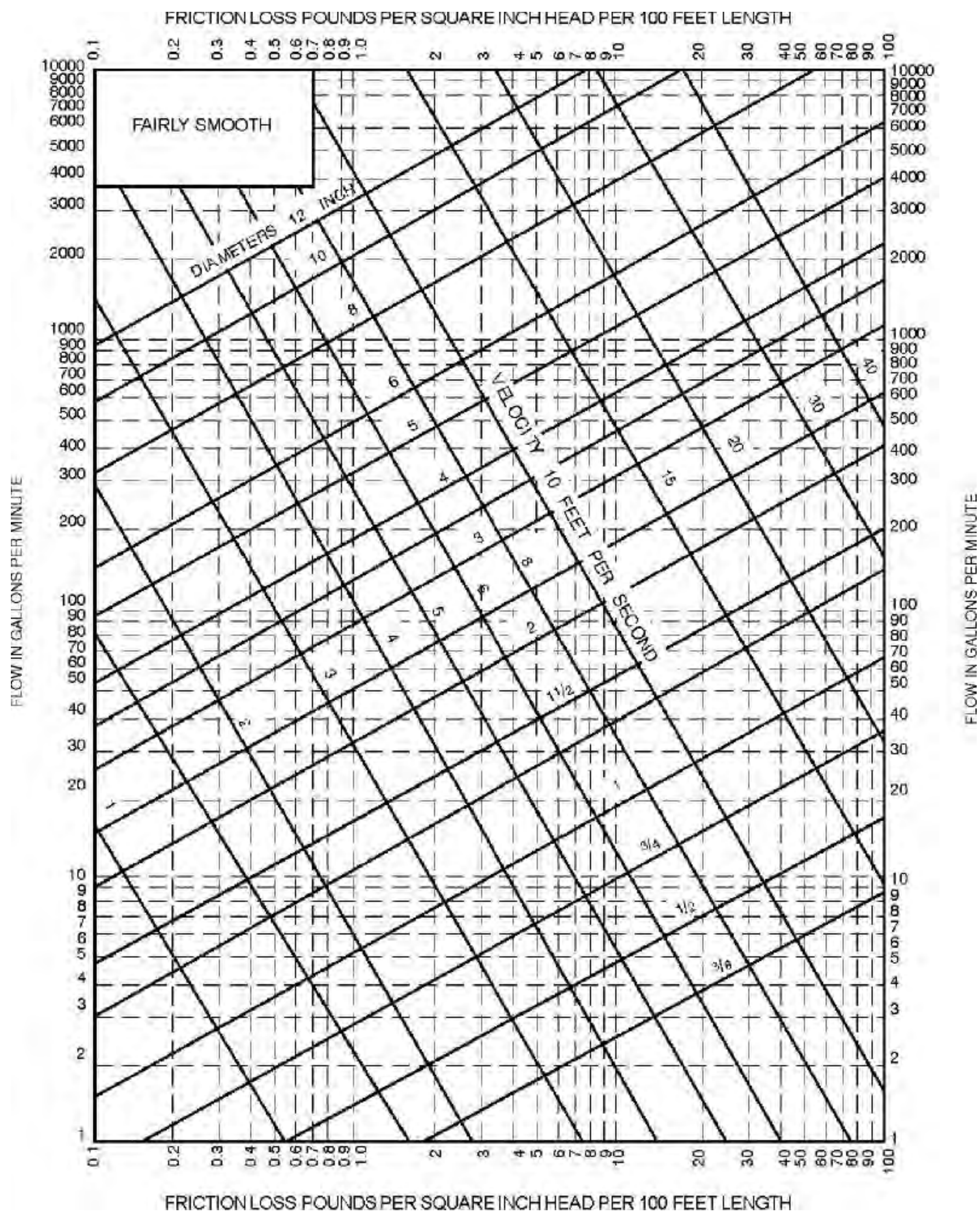


FIGURE E103.3(5)
FRICTION LOSS IN FAIRLY SMOOTH PIPE[a]

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gpm = 3.785 L/m, 1 psi = 6.895 kPa,
1 foot per second = 0.305 m/s.

a. This chart applies to smooth new steel (fairly smooth) pipe and to actual diameters of standard-weight pipe.

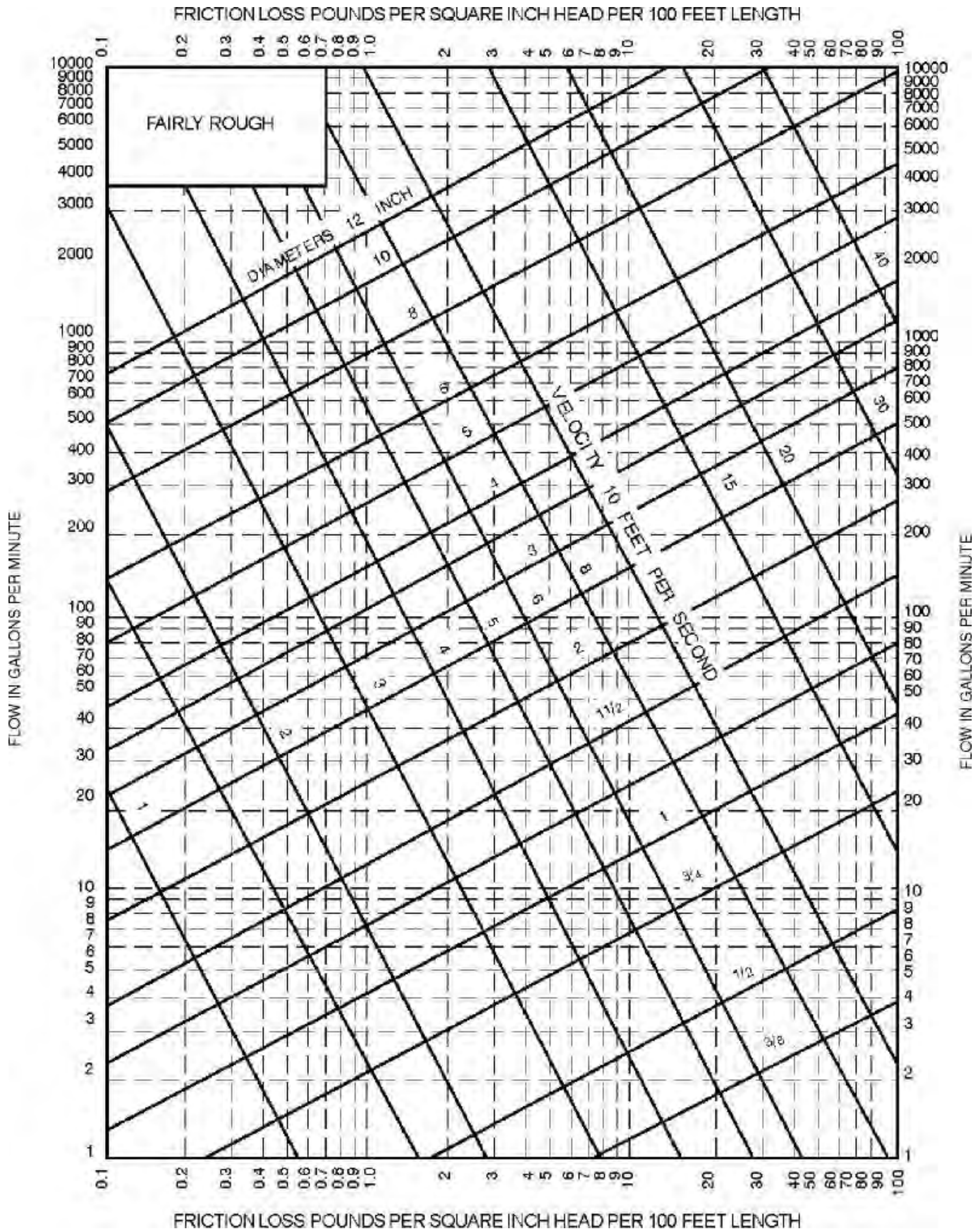


FIGURE E103.3(6)
FRICTION LOSS IN FAIRLY ROUGH PIPE[a]

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gpm = 3.785 L/m, 1 psi = 6.895 kPa,
1 foot per second = 0.305 m/s.

a. This chart applies to fairly rough pipe and to actual diameters which in general will be less than the actual diameters of the new pipe of the same kind.

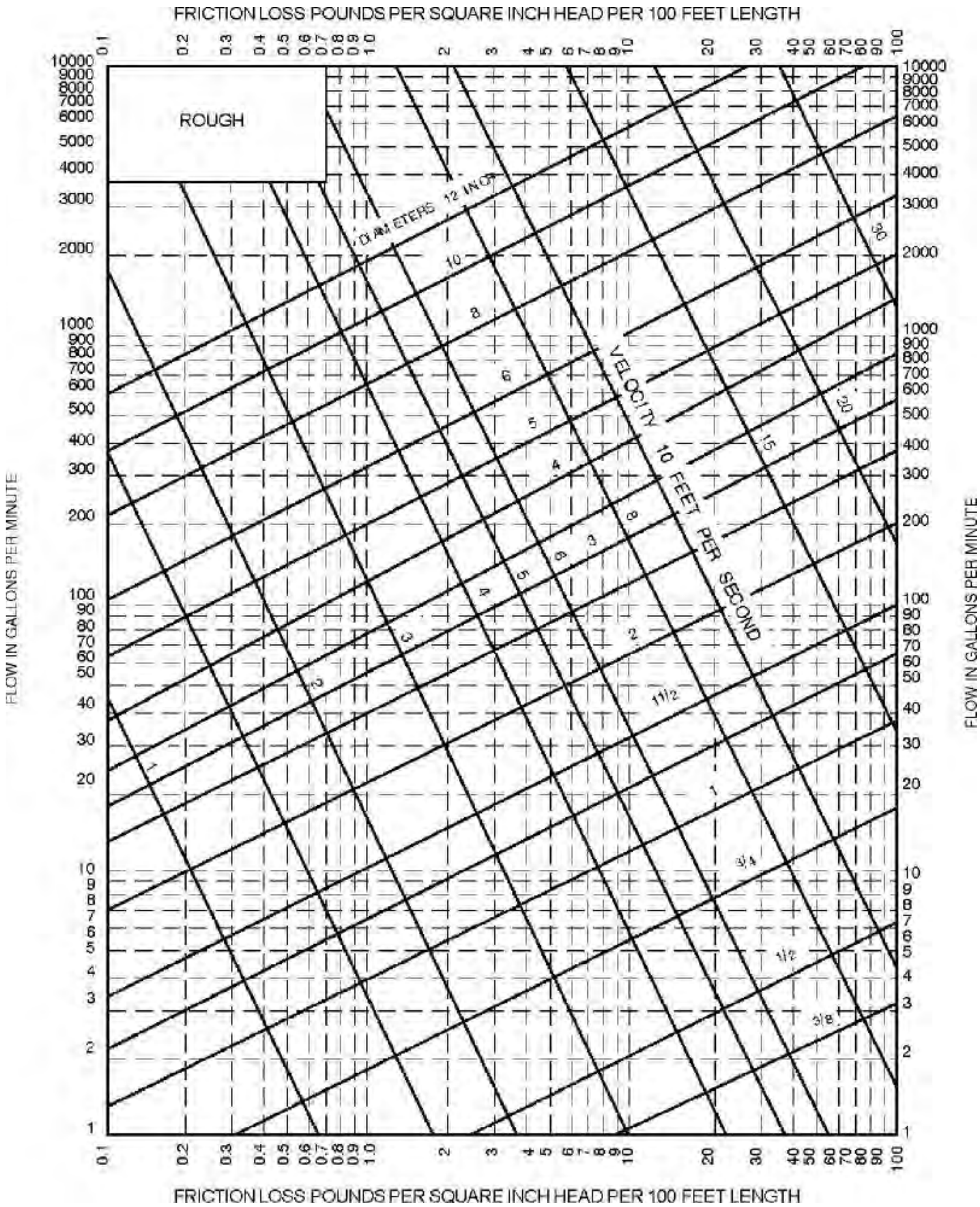


FIGURE E103.3(7)
FRICTION LOSS IN FAIRLY ROUGH PIPE[a]

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gpm = 3.785 L/m, 1 psi = 6.895 kPa, 1 foot per second = 0.305 m/s.
a. This chart applies to very rough pipe and existing pipe and to their actual diameters.

SECTION E201
SELECTION OF PIPE SIZE

E 201.1 Size of water-service mains, branch mains and risers. The minimum size water service pipe shall be $^3/_4$ inch (19.1 mm). The size of water service mains, branch mains and risers shall be determined according to water supply demand [gpm (L/m)], available water pressure [psi (kPa)] and friction loss due to the water meter and developed length of pipe [feet (m)], including equivalent length of fittings. The size of each water distribution system shall be determined according to the procedure outlined in this section or by other design methods conforming to acceptable engineering practice and approved by the code official:

Supply load in the building water-distribution system shall be determined by total load on the pipe being sized, in terms of water-supply fixture units (w.s.f.u.), as shown in Table E103.3(2). For fixtures not listed, choose a w.s.f.u. value of a fixture with similar flow characteristics.

Obtain the minimum daily static service pressure [psi (kPa)] available (as determined by the local water authority) at the water meter or other source of supply at the installation location. Adjust this minimum daily static pressure [psi (kPa)] for the following conditions:

2.1. Determine the difference in elevation between the source of supply and the highest water supply outlet. Where the highest water supply outlet is located above the source of supply, deduct 0.5 psi (3.4 kPa) for each foot (0.3 m) of difference in elevation. Where the highest water supply outlet is located below the source of supply, add 0.5 psi (3.4 kPa) for each foot (0.3 m) of difference in elevation.

2.2. Where a water pressure reducing valve is installed in the water distribution system, the minimum daily static water pressure available is 80 percent of the minimum daily static water pressure at the source of supply or the set pressure downstream of the pressure reducing valve, whichever is smaller.

2.3. Deduct all pressure losses due to special equipment such as a backflow preventer, water filter and water softener. Pressure loss data for each piece of equipment shall be obtained through the manufacturer of such devices.

2.4. Deduct the pressure in excess of 8 psi (55 kPa) due to installation of the special plumbing fixture, such as temperature controlled shower and flushometer tank water closet.

Using the resulting minimum available pressure, find the corresponding pressure range in Table E201.1.

The maximum developed length for water piping is the actual length of pipe between the source of supply and the most remote fixture, including either hot (through the water heater) or cold water branches multiplied by a factor of 1.2 to compensate for pressure loss through fittings.

Select the appropriate column in Table E201.1 equal to or greater than the calculated maximum developed length.

To determine the size of water service pipe, meter and main distribution pipe to the building using the appropriate table, follow down the selected "maximum developed length" column to a fixture unit equal to, or greater than the total installation demand calculated by using the "combined" water supply fixture unit column of Table E201.1. Read the water service pipe and meter sizes in the first left-hand column and the main distribution pipe to the building in the second left-hand column on the same row.

To determine the size of each water distribution pipe, start at the most remote outlet on each branch (either hot or cold branch) and, working back toward the main distribution pipe to the building, add up the water supply fixture unit demand passing through each segment of the distribution system using the related hot or cold column of Table E201.1. Knowing demand, the size of each segment shall be read from the second left-hand column of the same table and maximum developed length column selected in Steps 1 and 2, under the same or next smaller size meter row. In no case does the size of any branch or main need to be larger than the size of the main distribution pipe to the building established in Step 4.

SECTION E202
DETERMINATION OF PIPE VOLUMES

E202.1 Determining volume of piping systems. Where required for engineering design purposes, Table E202.1 shall be used to determine the approximate internal volume of water distribution piping.

TABLE E201.1
MINIMUM SIZE OF WATER METERS, MAINS AND DISTRIBUTION PIPING
BASED ON WATER SUPPLY FIXTURE UNIT VALUES (w.s.f.u.)

METER AND SERVICE PIPE (inches)	DISTRIBUTION PIPE (inches)	MAXIMUM DEVELOPMENT LENGTH (feet)									
Pressure Range 30 to 39 psi		40	60	80	100	150	200	250	300	400	500
3/4	1/2[a]	2.5	2	1.5	1.5	1	1	0.5	0.5	0	0
3/4	3/4	9.5	7.5	6	5.5	4	3.5	3	2.5	2	1.5
3/4	1	32	25	20	16.5	11	9	7.8	6.5	5.5	4.5
1	1	32	32	27	21	13.5	10	8	7	5.5	5
3/4	1 1/4	32	32	32	32	30	24	20	17	13	10.5
1	1 1/4	80	80	70	61	45	34	27	22	16	12
1 1/2	1 1/4	80	80	80	75	54	40	31	25	17.5	13
1	1 1/2	87	87	87	87	84	73	64	56	45	36
1 1/2	1 1/2	151	151	151	151	117	92	79	69	54	43
2	1 1/2	151	151	151	151	128	99	83	72	56	45
1	2	87	87	87	87	87	87	87	87	87	86
1 1/2	2	275	275	275	275	258	223	196	174	144	122
2	2	365	365	365	365	318	266	229	201	160	134
2	2 1/2	533	533	533	533	533	495	448	409	353	311

METER AND SERVICE PIPE (inches)	DISTRIBUTION PIPE (inches)	MAXIMUM DEVELOPMENT LENGTH (feet)									
Pressure Range 40 to 49 psi		40	60	80	100	150	200	250	300	400	500
3/4	1/2[a]	3	2.5	2	1.5	1.5	1	1	0.5	0.5	0.5
3/4	3/4	9.5	9.5	8.5	7	5.5	4.5	3.5	3	2.5	2
3/4	1	32	32	32	26	18	13.5	10.5	9	7.5	6
1	1	32	32	32	32	21	15	11.5	9.5	7.5	6.5
3/4	1 1/4	32	32	32	32	32	32	32	27	21	16.5
1	1 1/4	80	80	80	80	65	52	42	35	26	20
1 1/2	1 1/4	80	80	80	80	75	59	48	39	28	21
1	1 1/2	87	87	87	87	87	87	87	78	65	55
1 1/2	1 1/2	151	151	151	151	151	130	109	93	75	63
2	1 1/2	151	151	151	151	151	139	115	98	77	64
1	2	87	87	87	87	87	87	87	87	87	87
1 1/2	2	275	275	275	275	275	275	264	238	198	169
2	2	365	365	365	365	365	349	304	270	220	185
2	2 1/2	533	533	533	533	533	533	533	528	456	403

(continued)

TABLE E201.1—continued
MINIMUM SIZE OF WATER METERS, MAINS AND DISTRIBUTION PIPING BASED ON WATER SUPPLY FIXTURE UNIT VALUES (w.s.f.u.)

METER AND SERVICE PIPE (inches)	DISTRIBUTION PIPE (inches)	MAXIMUM DEVELOPMENT LENGTH (feet)									
Pressure Range 50 to 60 psi		40	60	80	100	150	200	250	300	400	500
$^3/_4$	$^1/_2$[a]	3	3	2.5	2	1.5	1	1	1	0.5	0.5
$^3/_4$	$^3/_4$	9.5	9.5	9.5	8.5	6.5	5	4.5	4	3	2.5
$^3/_4$	1	32	32	32	32	25	18.5	14.5	12	9.5	8
1	1	32	32	32	32	30	22	16.5	13	10	8
$^3/_4$	$1^1/_4$	32	32	32	32	32	32	32	32	29	24
1	$1^1/_4$	80	80	80	80	80	68	57	48	35	28
$1^1/_2$	$1^1/_4$	80	80	80	80	80	75	63	53	39	29
1	$1^1/_2$	87	87	87	87	87	87	87	87	82	70
$1^1/_2$	$1^1/_2$	151	151	151	151	151	151	139	120	94	79
2	$1^1/_2$	151	151	151	151	151	151	146	126	97	81
1	2	87	87	87	87	87	87	87	87	87	87
$1^1/_2$	2	275	275	275	275	275	275	275	275	247	213
2	2	365	365	365	365	365	365	365	329	272	232
2	$2^1/_2$	533	533	533	533	533	533	533	533	353	486

METER AND SERVICE PIPE (inches)	DISTRIBUTION PIPE (inches)	MAXIMUM DEVELOPMENT LENGTH (feet)									
Pressure Range Over 60		40	60	80	100	150	200	250	300	400	500
$^3/_4$	$^1/_2$[a]	3	3	3	2.5	2	1.5	1.5	1	1	0.5
$^3/_4$	$^3/_4$	9.5	9.5	9.5	9.5	7.5	6	5	4.5	3.5	3
$^3/_4$	1	32	32	32	32	32	24	19.5	15.5	11.5	9.5
1	1	32	32	32	32	32	28	28	17	12	9.5
$^3/_4$	$1^1/_4$	32	32	32	32	32	32	32	32	32	30
1	$1^1/_4$	80	80	80	80	80	80	69	60	46	36
$1^1/_2$	$1^1/_4$	80	80	80	80	80	80	76	65	50	38
1	$1^1/_2$	87	87	87	87	87	87	87	87	87	84
$1^1/_2$	$1^1/_2$	151	151	151	151	151	151	151	144	114	94
2	$1^1/_2$	151	151	151	151	151	151	151	151	118	97
1	2	87	87	87	87	87	87	87	87	87	87
$1^1/_2$	2	275	275	275	275	275	275	275	275	275	252
2	2	365	368	368	368	368	368	368	368	318	273
2	$2^1/_2$	533	533	533	533	533	533	533	533	533	533

For SI: 1 inch = 25.4, 1 foot = 304.8 mm.
a. Minimum size for building supply is $^3/_4$-inch pipe.

TABLE E202.1
INTERNAL VOLUME OF VARIOUS WATER DISTRIBUTION TUBING

	OUNCES OF WATER PER FOOT OF TUBE								
Size Nominal, Inch	Copper Type M	Copper Type L	Copper Type K	CPVC CTS SDR 11	CPVC SCH 40	CPVC SCH 80	PE-RT SDR 9	Composite ASTM F 1281	PEX CTS SDR 9
3/8	1.06	0.97	0.84	N/A	1.17	—	0.64	0.63	0.64
1/2	1.69	1.55	1.45	1.25	1.89	1.46	1.18	1.31	1.18
3/4	3.43	3.22	2.90	2.67	3.38	2.74	2.35	3.39	2.35
1	5.81	5.49	5.17	4.43	5.53	4.57	3.91	5.56	3.91
1 1/4	8.70	8.36	8.09	6.61	9.66	8.24	5.81	8.49	5.81
1 1/2	12.18	11.83	11.45	9.22	13.20	11.38	8.09	13.88	8.09
2	21.08	20.58	20.04	15.79	21.88	19.11	13.86	21.48	13.86

For SI: 1 ounce = 0.030 liter.

APPENDIX G

VACUUM DRAINAGE SYSTEM[RM37]

SECTION G101
VACUUM DRAINAGE SYSTEM

G101.1 Scope. This appendix provides general guidelines for the requirements for vacuum drainage systems.

G101.2 General requirements.

G101.2.1 System design. Vacuum drainage systems shall be designed in accordance with manufacturer's recommendations. The system layout, including piping layout, tank assemblies, vacuum pump assembly and other components/designs necessary for proper function of the system shall be per manufacturer's recommendations. Plans, specifications and other data for such systems shall be submitted to the local administrative authority for review and approval prior to installation.

G101.2.2 Fixtures. Gravity-type fixtures used in vacuum drainage systems shall comply with Chapter 4 of this code.

G101.2.3 Drainage fixture units. Fixture units for gravity drainage systems which discharge into or receive discharge from vacuum drainage systems shall be based on values in Chapter 7 of this code.

G101.2.4 Water supply fixture units. Water supply fixture units shall be based on values in Chapter 6 of this code with the addition that the fixture unit of a vacuum-type water closet shall be "1."

G101.2.5 Traps and cleanouts. Gravity-type fixtures shall be provided with traps and cleanouts in accordance with Chapters 7 and 10 of this code.

G101.2.6 Materials. Vacuum drainage pipe, fitting and valve materials shall be as recommended by the vacuum drainage system manufacturer and as permitted by this code.

G101.3 Testing and demonstrations. After completion of the entire system installation, the system shall be subjected to a vacuum test of 19 inches (483 mm) of mercury and shall be operated to function as required by the administrative authority and the manufacturer. Recorded proof of all tests shall be submitted to the administrative authority.

G101.4 Written instructions. Written instructions for the operations, maintenance, safety and emergency procedures shall be provided by the building owner as verified by the administrative authority.

APPENDIX H

RULES AND REGULATIONS PERTAINING TO PLUMBING AND[A38]/OR NATURAL GAS INSPECTOR CERTIFICATION

SECTION I
AUTHORITY

The following regulation is duly adopted and promulgated by the Arkansas State Board of Health pursuant to the Authority expressly conferred by the laws of the State of Arkansas in Act 200 of 1951 as amended and Act 96 of 1913 as amended. The Department may exercise such powers as are reasonably necessary to carry out the provisions of Act 200 of 1951 as amended. It may, among other things, issued restricted licenses limited to gas fitter, residential and governmental maintenance, service line installation, solar mechanic and hospital maintenance licenses providing that the licenses has demonstrated competency for the particular phase of plumbing for which the person is licensed and providing that the Board has adopted regulations defining restrictions in the type of work allowed, geographical area served, and term of that type of restricted license.

SECTION II
PURPOSE

To ensure that the construction, installation and maintenance of plumbing and/or natural gas has in connection with all buildings in this State to be safe, sanitary and such as to safeguard the public health.

SECTION III
DEFINITIONS

The State Board means the Arkansas State Board of Health.

The Department means the Plumbing and Natural Gas Section of the Arkansas.

Plumbing Inspector means a person qualified for testing and inspecting all aspects of sanitary plumbing and gas installation as defined under Act 200 of 1951 as amended and have a plumbing inspectors application on file with the Arkansas Plumbing and Natural Gas Section.

Gas Inspector means a person qualified for testing and inspection all aspects of gas installation as defined under Act 200 of 1951 as amended and have a plumbing inspectors application on file with the Arkansas Plumbing and Natural Gas Section.

State Committee of Plumbing Examiners means people designated by the Board of Health to determine the eligibility of applicants for various types of plumbing and gas licenses in accordance with Act 200 of 1951, as amended.

SECTION IV
ELIGIBILITY FOR CERTIFICATION

(a) Any duly appointed plumbing inspector, assistant plumbing inspector, gas inspector, when such appointment is made by state, county, city, town, water district, water association, sewer district, sewer association, or any water, or gas utility, shall be eligible for certification by the Department.

SECTION V
QUALIFICATIONS

(a) In order to be examined for a Certified Plumbing and/or Natural Gas Inspector, an applicant must:

(1) Be able to read and write.

(2)Be currently employed as a Plumbing Inspector by a city, town, county, or other municipality within the State of Arkansas that has adopted or is adopting the State Plumbing Code by regulation or ordinance.

SECTION VI
EXAMINATIONS

(a) Examinations will be given on an as needed basis by the Department at various times and places. The examination will cover the Arkansas ~~State~~ Plumbing and Natural Gas Code, as amended. A score of 70% or greater is considered a passing score.

SECTION VII
TERMS OF CERTIFICATION AND RENEWALS

All certificates (licenses) for plumbing inspectors shall be renewed each year. Applications for renewal shall be accompanied by the proper fee and proof of eight (8) hours of refresher training issued by the Department.

Training obtained other than from the Arkansas Inspector's Training School may be accepted toward original licensing for renewal with approval of the Department.

SECTION VIII
REVOCATION OF LICENSE

The State Committee of Plumbing Examiners may on its own motion make investigations and conduct hearing and may on its own motion or upon a complaint in writing and duly signed and verified by the complainant, suspend, revoke or assess a civil penalty in the amount of $1,000.00 per violation and each day may be deemed a separate violation for purposes of penalty assessments. Any plumbing and/or natural gas inspector's certificate for failing to provide inspections at least equal to the minimum requirements of the Department, any rule or order prescribed by the Board or has demonstrated incompetence to act as an inspector. The licensee shall be duly notified within thirty (30) days of the violation and full hearing under the

Administrative Procedures Regulation of the Arkansas Department of Health.

The Department may suspend any plumbing and/or natural gas inspector certification for non-payment of the prescribed fees, or if the inspector fails to obtain annual training as prescribed by these regulations.

SECTION IX
HEARINGS

In the case of each final order issued by the Department, any affected party may within thirty (30) days of such order submit a written request for a hearing to the Director of the Department.

NOTICE: All hearings will be scheduled within a reasonable time and held after reasonable notice has been provided to all known affected parties.

SECTION X
SEVERABILITY

If any provision of these Regulations, or the application thereof to any person is held invalid, such invalidity shall not affect other provisions or applications of these Regulations which can give effect without the invalid provisions of applications, and to this end the provisions hereto are declared

to be severable.

SECTION XI
REPEAL

All Regulations and parts of Regulations in conflict herewith are hereby repealed

~~RULES AND REGULATIONS PERTAINING TO AIR ADMITTANCE VALVES (AAV) FOR D.W.V. VENTING SYSTEMS~~

~~*Appendix I has been repealed in its entirety.*~~

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