CHARLOTTE
PIPE AND FOUNDRY COMPANY

You can't beat the system.®

Cast Iron

INSTALLATION

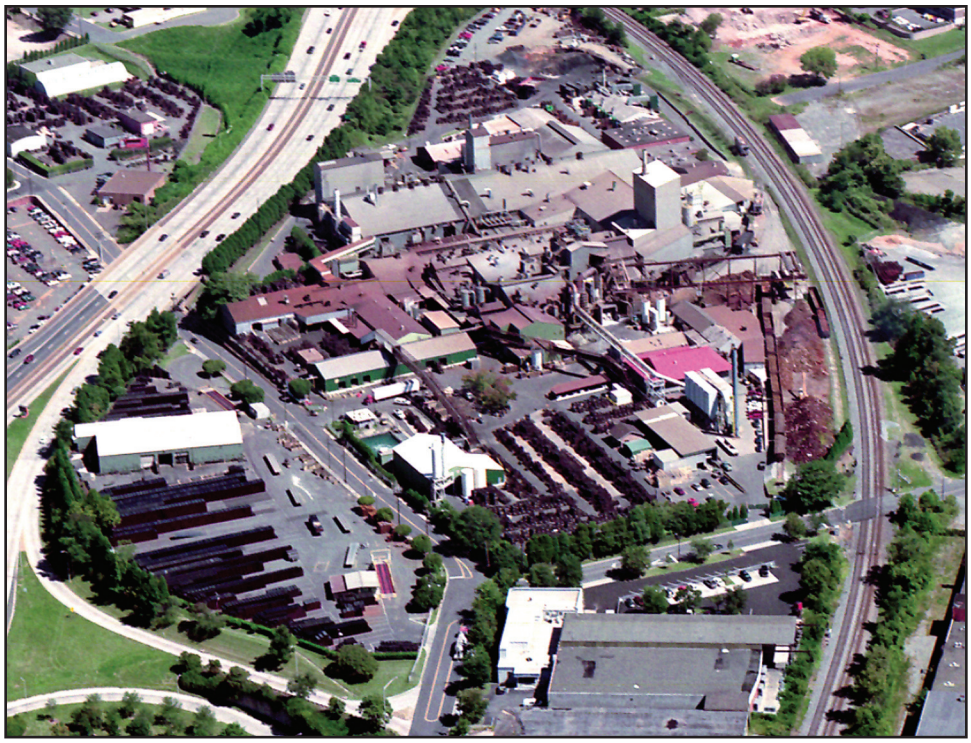
(Updated September 2008)

TECHNICAL MANUAL

INTRODUCTION

As the leading manufacturer of cast iron soil pipe and fittings, Charlotte Pipe and Foundry can be your one-stop source for all your cast iron piping system needs. We manufacture a full line of Service and Extra Heavy cast iron soil pipe and fittings from 2" - 15", and Double-Hub pipe from 2" - 6". We also manufacture a full line of No-Hub (hubless) pipe and fittings, 1½" - 15". All of our products are proudly **made in the U.S.A.** and meet or exceed all applicable ASTM and CISPI standards.

For more than a century, we have been relentless in our commitment to quality and service. Through the years, we have broadened and enhanced our product lines to meet customer demand. We've focused on continuous process improvement to serve you better. And we've invested millions in improving manufacturing efficiency, productivity and capacity to make our foundry one of the most modern in the world.



Charlotte Pipe and Foundry Company, Cast Iron Division

We appreciate your business and we look forward to serving your information needs. You may also find the technical information contained in this manual on our web site, www.charlottepipe.com.

You can't beat the system.®

TABLE OF CONTENTS

CHARLOTTE PIPE AND FOUNDRY COMPANY®

GENERAL INFORMATION

DESIGN AND ENGINEERING DATA

INSTALLATION

SOUNDPROOFING QUALITIES OF CAST IRON WITH RUBBER GASKET JOINTS

One of the most significant features of the combination of cast iron pipe and compression gasket and the hubless coupling joint is their sound-deadening qualities. The problem of noise is particularly acute in multi-family housing. Although soundproofing has become a major concern in construction design, certain plumbing products have been introduced which not only transmit noise, but may actually amplify it. The use of neoprene gaskets and hubless couplings with cast iron pipe and fittings significantly reduces noise and vibration. As a result of the composition and structure of the cast iron, sound is muffled rather than transmitted or amplified, and the neoprene separates the length of pipe and the unit of fittings so that they suppress any contact-related sound. The result is that objectionable plumbing noises are minimized.

ECONOMIC ADVANTAGES OF CAST IRON PIPE AND FITTINGS

The properties of cast iron soil pipe and fittings and the various joining methods demonstrate that cast iron affords a number of economic advantages. These advantages include performance, versatility, low cost installation, and product availability.

Performance

The performance and durability of cast iron pipe and fittings are superior to any other product used for sanitary and storm drain, waste, and vent piping. The choice is clear because service to the customer requires that performance constitutes the main reason for material selection, and in the matter of performance cast iron has no equal.

Versatility

Cast iron pipe and fittings are the most versatile sanitary and storm drain, waste, and vent piping material on the market. It is available with a variety of joining methods so that it can be installed efficiently throughout the plumbing drainage system, both above and below the floor and underground. It is adaptable for use in all types of building construction, including one and two story family homes, multiple units or apartment building, high-rise structures such as hotels and office buildings, and many commercial and industrial applications. The lead and oakum, neoprene compression gasket and hubless coupling can be used either individually or in combination in a given plumbing system in order to meet the needs of any specific condition. All three joining methods are available with a variety of pipe lengths and with a complete line of cast iron fittings.

Low Cost Installation

Cast iron pipe and fittings offer the advantages of low-cost installation.

- The speed and efficiency with which the compression gasket joint and hubless coupling joint can be made.
- 10 foot pipe reduce the number of joints in a plumbing system.
- Reduced waste as compared to hub and spigot pipe.
- Smaller outside diameter fits well within conventional 2x4 stud walls as compared to plastic pipe.
- Ease of fabricating in your shop.

Product Availability

Cast iron foundries are located in various sections of the country so that orders can be filled on short notice. Contractors need not be concerned about supply or shortages since the manufacturing capacity is very adequate and readily obtainable from Charlotte Pipe.

TYPES OF CAST IRON SOIL PIPE AND FITTINGS

Cast Iron Soil Pipe used in the United States is classified into two major types – **Hub and Spigot** and **No Hub (Hubless)**.

Hub and Spigot pipe and fittings have hubs into which the spigot (plain end) of the pipe or fitting is inserted. The joint is sealed with a rubber compression gasket or molten lead and oakum. Hub and Spigot pipe and fittings are available in two classes of thickness. These are classified as Service (SV) and Extra Heavy (XH). Because the additional wall thickness is added to the outside diameter, Service (SV) and Extra Heavy

(XH) have different outside diameters and are not readily interchangeable. These two different types of pipe and fittings can be connected using molten lead and oakum. Hub and Spigot pipe and fittings are made in accordance with ASTM A 74 and are available in 2" through 15" sizes. Compression gaskets, lubricant, and assembly tools are readily available for ease of installation.

Hubless cast iron pipe and fittings are simply pipe and fittings manufactured without a hub, in accordance with CISPI 301, and are available in 1½" through 15" sizes. The method of joining hubless pipe and fittings utilizes a shielded hubless coupling which consist of a neoprene rubber sleeve and a stainless steel shield that slips over the end of the pipe and fittings and is tightened with a torque wrench.

Resistance to Abrasion

Cast iron pipe and fittings are highly resistant to abrasion from sand, gravel, garbage disposal residue, dishwasher discharge, and debris being carried in suspension along the lower portion of the sewer or drain.

Uses

Cast iron soil pipe and fittings are used primarily in building construction for sanitary and storm drain, waste and vent piping applications. The product is installed in residential construction, hospitals, schools, and commercial and industrial structures. For this reason, the pattern of cast iron soil pipe shipments and sales is directly related to the pattern of building activity.

In buildings, the principal assembly of this piping is installed within the partitions and serves the tub, lavatory, and water closet fixtures. The main line in this assembly is the cast iron soil stack, which runs vertically from the building drain up through the structure and through the roof. Waste lines are connected to this main soil stack, and vent lines may also be tied in at a point above the highest fixture. In some installations vent lines are connected to a separate vent stack, which acts as the main source of air to and from the roof.

The building or house drain, the lowest horizontal piping in the drainage system, receives the discharge from the soil, waste, and drainage pipes from within the building and conveys the discharge to the building sewer. The building or house sewer, in turn, conveys the discharge outside of the structure to the point prescribed by the local plumbing code for joining of the city sewer, septic tank or other means of disposal.

Another use for cast iron soil pipe and fittings in building construction is for storm drainage from roofs, yards, areaways and courtyards. It is used for collecting subsoil drains, which are placed around the foundation for connection into the storm drainage system, or into a sump. It is also used for roof leaders, particularly when the roof leaders are placed within the building, pipe space, or other areas. Extensive use is made of cast iron soil pipe for storm drainage on high-rise buildings where large setbacks accumulate substantial amounts of rainwater and snow. At present, cast iron soil pipe is used in high rise building structures for drain, waste, and vent and sewer purposes without concern for building height and is, in fact, the preferred material. There are large numbers of uses for cast iron soil pipe other than in building construction.

Requirements For A Safe and Durable Drain, Waste and Vent System

The satisfactory performance of a piping system used for drain, waste, vent and sewer plumbing requires that the material possess the following important characteristics:

- Strength and rigidity
- Durability exceeding expected life of building
- Quiet operation, resistant to noise transmission
- Noncombustible and does not contribute to the spreading of flames
- High crush strength and ability to withstand traffic and trench loads
- Ability to withstand temperature extremes
- High corrosion resistance
- Low coefficient of expansion and contraction
- High abrasion resistance
- Leak-free joints that resist infiltration and exfiltration

Cast Iron Soil Pipe and Fittings Meet or Exceed All These Requirements

Tests of cast iron soil pipe and fittings for these properties reveal its superior characteristics as a material for drain, waste, vent, and sewer piping systems.

Performance

Cast iron has, for hundreds of years, been the premier piping material throughout the world for drain, waste, and vent plumbing applications. Cast iron can be cast in the form of pipe or fittings at low cost and has excellent strength properties. Unique corrosion resistance characteristics make it ideally suited for plumbing applications. Cast iron, because of the presence of free graphite, when exposed to corrosive conditions, leaves behind an insoluble layer of corrosion products that provide a barrier against additional corrosion.

Cast Iron is a generic term that identifies a large family of ferrous alloys. Cast irons are primarily alloys of iron that contain more than 2% carbon and 1% or more of silicon. Cast irons can be cast into intricate shapes because of their excellent fluidity. Because of the excellent properties obtainable with these low-cost engineering materials, cast irons find wide application in environments that demand good corrosion resistance. Services in which cast irons are used for their excellent corrosion resistance include water, storm, and sanitary drain, waste, and vent applications.

The majority of soils throughout the United States are non-corrosive to cast iron. Water and gas utilities in the United States have cast iron distribution mains with continuous service records of more than 100 years.

Quality gray iron castings like the ones produced by Charlotte Pipe and Foundry have an abundance of free graphite present in their microstructure. When Charlotte products are exposed to corrosive agents, an insoluble layer of corrosion products is left behind, which provides a durable barrier against additional corrosion. This enhanced corrosion resistance is not provided by lower quality gray iron castings, because they have an insufficient free graphite content, making them more prone to corrosion problems.

A small percentage of very special wastes may not be suitable for cast iron plumbing systems. Such waste streams can emanate from laboratories, some concentrated or undiluted carbonated soft drink sources, and sites where specific types of cleaning chemicals are discharged, particularly when the effluent is undiluted. The very low pH wastes from such sources can corrode exposed cast iron. Charlotte Pipe and Foundry has developed a new "Hot Dip" coating process for cast iron pipe that offers significant advantages over traditional bituminous coatings, including superior corrosion protection. Whether our coating or other coatings are used, we have found that plumbers do not always apply protective coatings to the end of cut pipe and fittings, thus leaving the system exposed to possibly corrosive elements.

The pH range for typical DWV systems is between 4.5 and 7. We suggest that the installer establish a uniform slope for horizontal drainage piping, but not less than permitted by local plumbing code and in compliance with good plumbing practices, to facilitate flushing of the system. If operating conditions yield an acidity level of pH 4.3 or less for an extended time, we recommend dilution of the waste stream to raise the pH. If this is not possible, we suggest that the system designer's look into a more suitable chemical waste system.

The National Bureau of Standards and the Cast Iron Pipe Research Association (now known as the Ductile Iron Pipe Research Association) have studied the underground corrosion of cast iron pipe for many years. As a result of these studies, a procedure has been developed for determining the need for any special corrosion protection. A simple and inexpensive method of providing such protection by means of polyethylene film has been developed. The information contained in American National Standard A 21.5, American Society for Testing and Materials A 674, and American Water Works Association Specification C 105 provides installation instructions and an appendix which details a ten point scale to determine if the soils are potentially corrosive to cast iron. Information on this standard is available from the Cast Iron Soil Pipe Institute and its member companies. It is also contained in the appendix to ASTM A 74 (Hub and Spigot Cast Iron Pipe and Fittings).

The corrosion of metals underground is an electrochemical phenomenon of two main types: galvanic and electrolytic.

Galvanic corrosion is self-generating and occurs on the surface of a metal exposed to an electrolyte (such as moist, salt-laden soil). The action is similar to that occurring in a wet or dry cell battery. Differences in electrical potential between areas on the surface of the metal (pipe) in contact with such soil may occur, for a variety of reasons including the joining of different metals (iron and copper or brass). Potential differences may also be due to the characteristics of the soil in contact with the pipe surface: e.g. pH, soluble salt, oxygen and moisture content, temperature and the presence of certain bacteria. Any one of a combination of these

factors may cause a small amount of electrical current to flow through the soil between areas on the pipe or metal surface. Where this current discharges into the soil from such an area, metal is removed from the pipe surface and corrosion occurs.

Electrolytic corrosion occurs when direct current from outside sources enters and the leaves an underground metal structure such as pipe. At that point where current leaves the metal surface to return to its source through the soil, metal is removed and corrosion occurs.

Over 95 percent of the soil in the United States are non-corrosive to cast iron. Those few soils that are somewhat corrosive to cast iron include natural soils containing high concentration of decomposing organic matter (swamps, peat bogs, etc.) alkalis or salt (tidal marshes).

JOINING METHOD FOR HUB AND SPIGOT CAST IRON PIPE AND FITTINGS

The Compression Joint

The compression joint is the result of research and development to provide an efficient, low cost method for joining hub and spigot cast iron pipe and fittings. The joint is not unique in application to cast iron soil pipe, since similar compression type gaskets have been used in pressure pipe joints for years. The compression joint uses hub and spigot pipe and fittings as does lead and oakum. The major difference is the one-piece neoprene rubber gasket.

When the spigot end of the pipe or fitting is pulled or drawn into the gasketed hub, the joint is sealed by displacement and compression of the neoprene gasket. The resulting joint is leak free, and it absorbs vibration and can be deflected up to 5 degrees without leaking or failure.

Compression gaskets sold by Charlotte Pipe are precision molded of durable neoprene. Note that service gaskets must be used with service weight pipe and fittings. Extra Heavy gaskets must be used with Extra Heavy pipe and fittings.

Standard specification for rubber gaskets for joining cast iron soil pipe and fittings is ASTM C 564. The properties of neoprene make it suitable for modern chemicals and acids, oil fats, greases. Additionally neoprene will not support combustion. ASTM C 564 gasket materials can be safely used up to 212° F. Joint deflection using a compression gasket has a maximum limit of up to 5 degrees. Maximum deflection should not exceed ½ inch per foot of pipe. This would allow 5 inches of deflection for a 10 foot piece of pipe and 2½ inches for 5 foot pipe. Installation should initially be completed in a straight line and then deflected to the appropriate amount. This helps assure a good tight joint. For more than 5 degrees of deflection, fittings should be used.

JOINING METHOD FOR HUB AND SPIGOT CAST IRON PIPE AND FITTINGS

The Lead and Oakum Joint (Caulked Joint)

Hub and spigot cast iron soil pipe and fittings joints can be made with oakum fiber and molten lead, which are leak-free, strong, and root-proof. The water proofing characteristics of oakum fiber have long been recognized by the plumbing trades, and when molten lead is poured over the oakum in cast iron soil pipe joint, it completely seals and locks the joint. This is due to the fact that the hot lead fills a groove in the bell end of the pipe or fitting, firmly anchoring the lead in place after cooling. To make a caulked joint, the spigot end of a pipe or fitting is placed inside the hub of another pipe or fitting. Oakum is placed around the spigot in the hub using a yarning tool and then the oakum is packed to the proper depth using a packing tool. Molten lead is then poured into the joint making sure the lead is brought up near the top of the hub. After the lead has cooled sufficiently, it should be caulked with a caulking tool to form a solid lead insert. If horizontal joints are to be made, a joint runner must be used to retain the molten lead. Use customary safety precautions when handling molten lead.

JOINING METHOD FOR HUBLESS CAST IRON PIPE AND FITTINGS

Shielded Hubless Coupling

The shielded coupling for hubless cast iron soil pipe and fittings provides a more compact installation without sacrificing the quality and performance of cast iron. The hubless coupling system typically uses a one-piece

Quantity of Oakum Packing Required Per Joint in Standard Hub and Spigot Cast Iron Soil Pipe

Pipe Size	Tarred or Untarred (Oiled) Twisted Oakum Packing, Pounds	Dry Unoiled, Twisted Oakum Packing Pounds (Approx.)	Sq. Braided Oakum Packing Pounds (Approx.) Using I Ring
2"	.14	.09	.07
3"	.16	.10	.08
4"	.18	.13	.10
5	.20	.15	.12
6"	.21	.16	.13
8"	.44	.33	.17
10"	.53	.40	.20
12"	.61	.46	.24
15"	.94	.71	.45

Lead Required to Caulk Cast Iron Soil Pipe Joints

		Service SV		Extra Heavy XH	
Pipe Size	Lead Ring Depth Inches	Cu. Ins.	Wt. Lbs.	Cu. Ins.	Wt. Lbs.
2"	1.00	2.81	1.15	2.91	1.19
3"	1.00	3.90	1.60	4.17	1.71
4"	1.00	4.98	2.04	5.25	2.15
5"	1.00	6.06	2.49	6.24	2.56
6"	1.00	7.15	2.93	7.42	3.04
8"	1.25	15.06	6.17	15.49	6.35
10"	1.25	18.90	7.75	19.34	7.93
12"	1.25	25.53	10.47	26.02	10.67
15"	1.50	43.09	17.67	43.38	17.80

neoprene gasket and a shield of stainless steel retaining clamps. Charlotte® hubless couplings are manufactured in accordance with CISPI 310, ASTM C 1277, and ASTM C 1540. Charlotte Super Duty couplings conform to ASTM C 1540. The great advantage of the system is that it permits joints to be made in limited access areas. The 300 series stainless steel, which is always used with hubless couplings, was selected because of its superior corrosion resistance. It is resistant to oxidation, warping and deformation, offers rigidity under tension with substantial tension strength, and yet provides sufficient flexibility. The shield is corrugated in order to grip the gasket sleeve and give maximum compression distribution to the joint. The stainless steel worm gear clamps compress the neoprene gasket to seal the joint. The neoprene gasket absorbs shock, vibration and completely eliminates galvanic action between cast iron and the stainless steel shield. Neoprene will not support combustion and can be safely used up 212° F. The neoprene sleeve is completely protected by a non-flammable stainless steel shield, and as a result a fire rating is not required. Joint deflection using a shielded hubless coupling has a maximum limit of up to 5 degrees. Maximum deflection should not exceed ½ inch per foot of pipe. This would allow 5 inches of deflection for a 10 foot piece of pipe. Installation should initially be completed in a straight line and then deflect to appropriate amount. This helps assure a good tight joint. For more than 5 degrees of deflection, fittings should be used.

HANDLING AND STORAGE OF CAST IRON PIPE AND FITTINGS

CHARLOTTE PIPE AND FOUNDRY COMPANY

HANDLING

Cast iron pipe and fittings are customarily shipped by flatbed truckloads. Cast iron will withstand the shock and stresses normally encountered in transit. The first step upon arrival of the material at the destination should be a thorough inspection for damage that may have occurred in transit. The shipment will usually be accompanied with a Bill of Lading and a packing slip. The purpose of the Bill of Lading is the legal transfer of title for the material from the manufacturer to the carrier and from the carrier to the installer or wholesaler receiving the shipment. It is very important that any damage or shortage of products should be noted on the Bill of Lading to ensure that any claim for damage will be honored. The Bill of Lading will reflect total pieces, bundles, or crates. The packing list will give specific description of each item shipped. It is necessary that the total pieces be checked and any discrepancies noted on the Bill of Lading before the carrier leaves the delivery destination. Notify Charlotte Pipe of the discrepancies as noted on the bill of lading as soon as possible. A copy of this document should be kept in a safe place if damage or shortages were noted. Charlotte Pipe ships its pipe pre-packaged in bundles and fittings in boxes for easy unloading. Care should be taken when unloading the unit. Shipping tags are attached to each bundle and box identifying the contents of each unit. These tags should not be removed as they will be useful later in locating items as they are needed.

Gray Iron Physical Properties

Tensile Strength	20,000 p.s.i. — 60,000 p.s.i. (21,000 p.s.i.)
Elastic Modulas (Young's modulus)	10 - 23 x 10^6 p.s.i.
Hardness (Brinell)	150 - 250 BHN
Thermal Conductivity	0.110 - 0.137 calories/cm^2/Sec/cm/ °C
Thermal Expansion	10 x 10^{-6} / °C 6 x 10^{-6} / °F
Density	0.25 - 0.28 lb./in^3 6.95 - 7.35 gm/cm^3
Specific Heat	0.13 BTU / lb / °F 0.13 cal / gm / °C

Composition of Gray Iron

The following are typical ranges of elements present in unalloyed gray cast iron normally produced in commercial practice:

Carbon (C)	2.60 - 3.85%
Silicon (Si)	1.25 - 2.90%
Manganese (Mn)	0.40 - 1.00%
Phosphorus (P)	0.02 - 0.90%
Sulfur (S)	0.04 - 0.20%

CAST IRON SOIL PIPE AND FITTINGS STANDARDS

TYPE PIPE / FITTING	STANDARD SPECIFICATION
SERVICE HUB and SPIGOT PIPE and FITTINGS	ASTM A 74 IAPMO LISTED ISO 9001, 2000 CERTIFIED
EXTRA HEAVY HUB and SPIGOT PIPE and FITTINGS	ASTM A74 IAPMO LISTED ISO 9001, 2000 CERTIFIED
HUBLESS PIPE and FITTINGS	CISPI 301 IAPMO LISTED ISO 9001, 2000 CERTIFIED
HUBLESS COUPLINGS	CISPI 310 ASTM C 1277
HUBLESS SUPER DUTY COUPLINGS	ASTM C 1540
CHARLOTTE SEAL GASKETS	ASTM C 564
WARCO- QUIK- TITE GASKET	ASTM C 564

SUGGESTED SPECIFICATION

System: **Service Cast Iron Soil Pipe and Fittings**

Scope: This specification covers Service Cast Iron pipe, fittings, and compression gaskets used in sanitary drain, waste, and vent (DWV), sewer, and storm drainage applications. This system is intended for use in nonpressure applications.

Specification: Service Cast Iron pipe and fittings shall be manufactured from gray cast iron with a tensile strength of not less than 21,000 psi. Compression gaskets shall be manufactured from an elastomer meeting the requirements of ASTM C 564.

Pipe and fittings shall comply with ASTM A 74. Compression gaskets shall comply with ASTM C 564. All pipe and fittings shall be made in the United States, and marked with the collective trademark of the Cast Iron Soil Pipe Institute, CISPI®, and listed by NSF® International. All pipe and fittings shall be of the same manufacturer. All systems shall utilize a separate waste and vent system.

Installation shall comply with the latest installation instructions published by Charlotte Pipe and Foundry and shall conform to all local plumbing, fire, and building code requirements. Joints shall be made with an elastomeric compression gaskets meeting the requirements of ASTM C 564 or lead and oakum. The system shall be hydrostatically (water) tested after installation to 4.3 psi. (10 feet of hydrostatic head). Testing with compressed air or gas is not recommended. Testing with compressed air or gas may result in injury or death.

Referenced Standards:

ASTM A 74	Cast Iron Soil Pipe and Fittings
ASTM C 564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings

Note: Latest revision of each standard applies.

Short Specification:

Hub and Spigot Cast Iron Soil Pipe and Fittings:

Hub and Spigot Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A 74. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute CISPI®, and listed by NSF® International. Pipe and fittings to be Service (SV). Joints can be made using a compression gasket manufactured from an elastomer meeting the requirements of ASTM C 564 or lead and oakum. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and local code requirements. The system shall be hydrostatically tested after installation to 10 ft. of head (4.3 psi maximum). Testing with compressed air or gas may result in injury or death. All pipe and fittings to be manufactured by Charlotte Pipe and Foundry Co.

SUGGESTED SPECIFICATION

System: **Extra Heavy Cast Iron Soil Pipe and Fittings**

Scope: This specification covers Extra Heavy Cast Iron pipe, fittings, and compression gaskets used in sanitary drain, waste, and vent (DWV), sewer, and storm drainage applications. This system is intended for use in nonpressure applications.

Specification: Extra Heavy Cast Iron pipe and fittings shall be manufactured from gray cast iron with a tensile strength of not less than 21,000 psi. Compression gaskets shall be manufactured from an elastomer meeting the requirements of ASTM C 564.

Pipe and fittings shall comply with ASTM A 74. Compression gaskets shall comply with ASTM C 564. All pipe and fittings shall be made in the United States, and marked with the collective trademark of the Cast Iron Soil Pipe Institute, CISPI®, and listed by NSF® International. All pipe and fittings shall be of the same manufacturer. All systems shall utilize a separate waste and vent system.

Installation shall comply with the latest installation instructions published by Charlotte Pipe and Foundry and shall conform to all local plumbing, fire, and building code requirements. Joints shall be made with an elastomeric compression gaskets meeting the requirements of ASTM C 564 or lead and oakum. The system shall be hydrostatically (water) tested after installation to 4.3 psi. (10 feet of hydrostatic head). Testing with compressed air or gas is not recommended. Testing with compressed air or gas may result in injury or death.

Referenced Standards:

ASTM A 74	Cast Iron Soil Pipe and Fittings
ASTM C 564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings

Note: Latest revision of each standard applies.

Short Specification:

Hub and Spigot Cast Iron Soil Pipe and Fittings:

Hub and Spigot Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A 74. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute CISPI® and listed by NSF® International. Pipe and fittings to be Extra Heavy (XH). Joints can be made using a compression gasket manufactured from an elastomer meeting the requirements of ASTM C 564 or lead and oakum. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and local code requirements. The system shall be hydrostatically tested after installation to 10 ft. of head (4.3 psi maximum). Testing with compressed air or gas may result in injury or death. All pipe and fittings to be manufactured by Charlotte Pipe and Foundry Co.

SUGGESTED SPECIFICATION

System: **Hubless Cast Iron Soil Pipe and Fittings**

Scope: This specification covers hubless Cast Iron pipe, fittings, and couplings used in sanitary drain, waste, and vent (DWV), sewer, and storm drainage applications. This system is intended for use in non-pressure applications.

Specification: Hubless Cast Iron pipe and fittings shall be manufactured from gray cast iron with a tensile strength of not less than 21,000 psi. Regular hubless couplings shall be shielded and conform to CISPI Standard 310 or ASTM C 1277, with an elastomeric gasket meeting the requirements of ASTM C 564. Super Duty hubless couplings shall be shielded and conform to ASTM C 1540, with an elastomeric gasket meeting the requirements of ASTM C 564.

Pipe and fittings shall comply with CISPI 301. Hubless couplings shall comply with ASTM C 564, and CISPI Standard 310 or ASTM C 1540. All pipe and fittings shall be made in the United States, and marked with the collective trademark of the Cast Iron Soil Pipe Institute, ®, and listed by NSF® International. All pipe and fittings shall be of the same manufacturer. All systems shall utilize a separate waste and vent system.

Installation shall comply with the latest installation instructions published by Charlotte Pipe and Foundry and shall conform to all local plumbing, fire, and building code requirements. Joints shall be made with hubless couplings and tightened using a calibrated torque wrench. The system shall be hydrostatically (water) tested after installation to 4.3 psi. (10 feet of hydrostatic head). Testing with compressed air or gas is not recommended. Testing with compressed air or gas may result in injury or death.

Referenced Standards:

ASTM C 564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
CISPI 301	Hubless Cast Iron Soil Pipe and Fittings
CISPI 310	Hubless Couplings for Cast Iron Soil Pipe and Fittings
ASTM C 1277	Hubless Couplings
ASTM C 1540	Hubless Super Duty Couplings

Note: Latest revision of each standard applies.

Short Specification:

Hubless Cast Iron Soil Pipe and Fittings:

Hubless Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to CISPI Standard 301. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute ® and listed by NSF® International. Hubless Couplings shall conform to CISPI Standard 310 for standard couplings or ASTM C 1540 for Super Duty couplings where indicated. Gaskets shall conform to ASTM C 564. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and local code requirements. Couplings shall be installed in accordance with the manufacturer's band tightening sequence and torque. Tighten bands with a properly calibrated torque limiting device. Test the system hydrostatically after installation to 10 ft. of head (4.3 psi maximum). Testing with compressed air or gas may result in injury or death. All pipe and fittings to be manufactured by Charlotte Pipe and Foundry Co.

SPECIFICATIONS
CHARLOTTE® CAST IRON SOIL PIPE AND FITTINGS

This is to verify that all Cast Iron Pipe and Fittings are manufactured in the United States by Charlotte Pipe and Foundry, Cast Iron Division, and conform to the following standards:

SERVICE WEIGHT HUB AND SPIGOT PIPE AND FITTINGS

All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI).
Listed by NSF® International.
ASTM A 74
CISPI HS 74
IAMPO Listed
ISO 9001, 2000 Certified

EXTRA HEAVY HUB AND SPIGOT PIPE AND FITTINGS

All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI).
Listed by NSF® International.
ASTM A 74
CISPI HS 74
IAMPO Listed
ISO 9001, 2000 Certified

HUBLESS PIPE AND FITTINGS

All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI).
Listed by NSF® International.
Cast Iron Soil Pipe Institute Standard No. 301
IAMPO Listed
ISO 9001, 2000 Certified

HUBLESS COUPLINGS

Cast Iron Soil Pipe Institute Standard No. 310
ASTM C 1277

HUBLESS SUPER DUTY COUPLINGS

ASTM C 1540

CHARLOTTE SEAL GASKETS

ASTM C 564
CISPI HSN

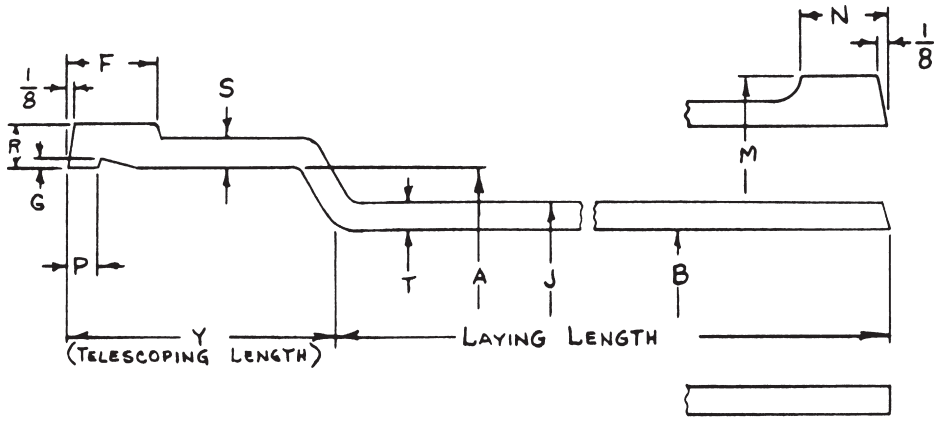
WARCO-QUIK-TITE GASKETS

ASTM C 564
CISPI HSN

Charlotte Pipe and Foundry Company

DIMENSIONS OF HUB AND SPIGOT FOR SERVICE CAST IRON SOIL PIPE

CHARLOTTE PIPE AND FOUNDRY COMPANY



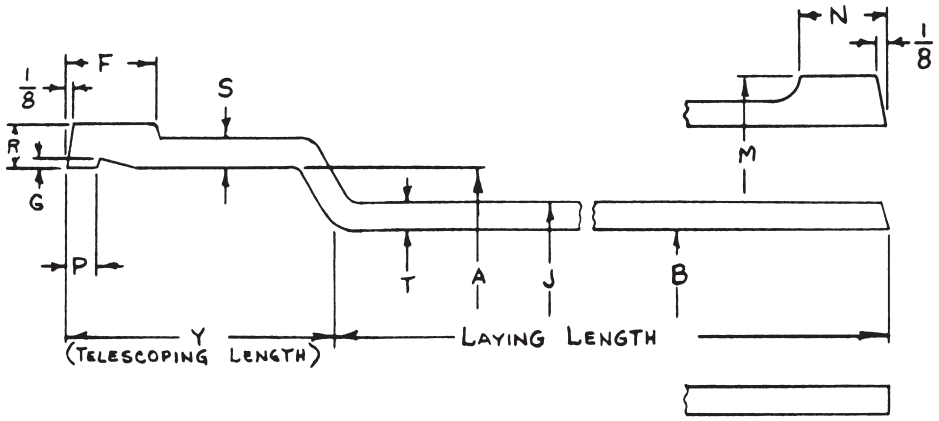
Service Cast Iron Soil Pipe

Size[A] Availability[B]	Inside Diameter of Hub[B]	Outside Diameter of Barrel	Telescoping Length	Inside Diameter of Barrel	Thickness of Barrel	
	A	J	Y	B	T	
					Nom	Min
2	2.94	2.30	2.50	1.96	0.17	0.14
3	3.94	3.30	2.75	2.96	0.17	0.14
4	4.94	4.30	3.00	3.94	0.18	0.15
5	5.94	5.30	3.00	4.94	0.18	0.15
6	6.94	6.30	3.00	5.94	0.18	0.15
8	9.25	8.38	3.50	7.94	0.23	0.17
10	11.38	10.50	3.50	9.94	0.28	0.22
12	13.50	12.50	4.25	11.94	0.28	0.22
15	16.95	15.88	4.25	15.16	0.36	0.30

Size[A]	Thickness of Hub		Width of Hub Bead	Distance from Lead Groove to End, Pipe and Fittings[B]	Depth of Lead Groove	
	Hub Body	Over Bead				
	S (min)	R (min)	F(min)	P	G (min)	G (max)
2	0.13	0.34	0.75 (0.63)	0.22	0.10	0.19
3	0.16	0.37	0.81 (0.63)	0.22	0.10	0.19
4	0.16	0.37	0.88 (0.63)	0.22	0.10	0.19
5	0.16	0.37	0.88 (0.63)	0.22	0.10	0.19
6	0.18	0.37	0.88 (0.63)	0.22	0.10	0.19
8	0.19	0.44	1.19 (1.06)	0.38	0.15	0.22
10	0.27	0.53	1.19 (1.06)	0.38	0.15	0.22
12	0.27	0.53	1.44 (1.31)	0.47	0.15	0.22
15	0.30	0.58	1.44 (1.31)	0.47	0.15	0.22

[A]Nominal inside diameter.
[B]For tolerances, see Page 19.

DIMENSIONS OF HUB AND SPIGOT METRIC AND ENGLISH



Service Cast Iron Soil Pipe

Size Availability in Inches (mm)	Barrel I.D. B in Inches (mm)	Hub I.D. A in Inches (mm)	Spigot O.D. J in Inches (mm)	T NOM in Inches (mm)	T MIN in Inches (mm)
2 (50)	1.96 (49.7)	2.94 (74.6)	2.30 (58.4)	.17 (4.3)	.14 (3.5)
3 (76)	2.96 (75.18)	3.94 (100.0)	3.30 (83.8)	.17 (4.3)	.14 (3.5)
4 (101)	3.94 (100.0)	4.94 (125.4)	4.30 (109.22)	.18 (4.5)	.15 (3.8)
5 (127)	4.94 (125.4)	5.94 (150.8)	5.30 (134.6)	.18 (4.5)	.15 (3.8)
6 (152)	5.94 (150.8)	6.94 (176.2)	6.30 (160.0)	.18 (4.5)	.15 (3.8)
8 (203)	7.94 (201.6)	9.25 (234.9)	8.38 (212.8)	.23 (5.8)	.17 (4.3)
10 (254)	9.94 (252.4)	11.38 (289.0)	10.50 (266.7)	.28 (7.1)	.22 (5.5)
12 (304)	11.94 (303.28)	13.50 (342.9)	12.50 (317.5)	.28 (7.1)	.22 (5.5)
15 (381)	15.16 (385.0)	16.95 (430.5)	15.88 (403.3)	.36 (9.1)	.30 (7.6)

Laying Lengths

5 feet =60 inches = 1.52m
10 feet = 120 inches = 3.04m

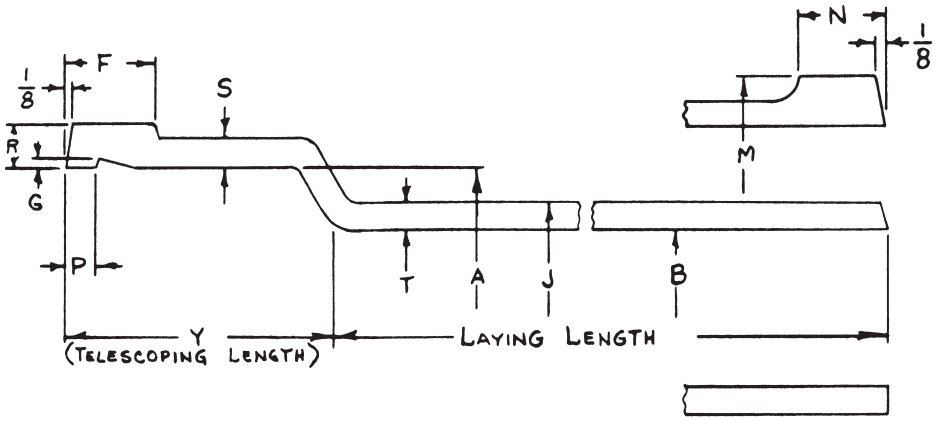
Metric Conversions

50mm Pipe Is 2 Inch Pipe
75mm Pipe Is 3 Inch Pipe
100mm Pipe Is 4 Inch Pipe
125mm Pipe Is 5 Inch Pipe
150mm Pipe Is 6 Inch Pipe
200mm Pipe Is 8 Inch Pipe
250mm Pipe Is 10 Inch Pipe
300mm Pipe Is 12 Inch Pipe
375mm Pipe Is 15 Inch Pipe

Dimensions other than nominal or trade sizes are converted on the exact factor of 25.4mm = 1 inch

DIMENSIONS OF HUB AND SPIGOT FOR EXTRA HEAVY CAST IRON SOIL PIPE

CHARLOTTE PIPE AND FOUNDRY COMPANY



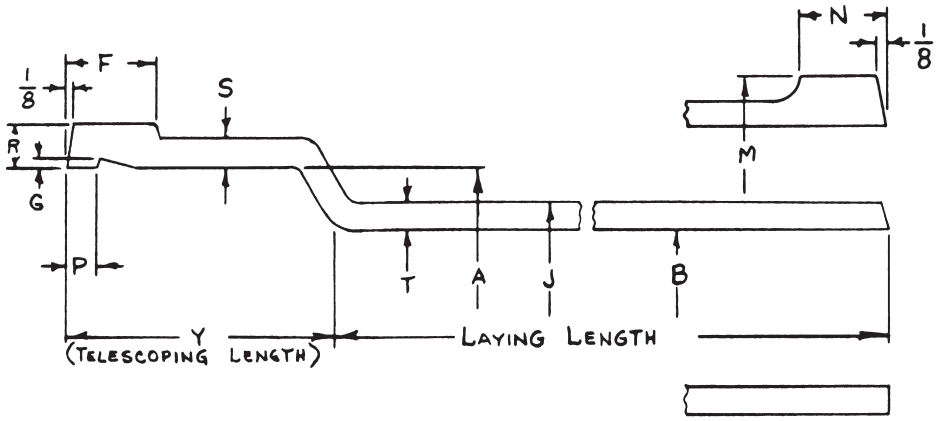
Extra Heavy Cast Iron Soil Pipe and Fittings:

Size[A] Availability[B]	Inside Diameter of Hub[B]	Outside Diameter of Barrel[B]	Telescoping Length[B]	Inside Diameter of Barrel[B]	Thickness of Barrel[B]	
	A	J	Y	B	T	
					Nom	Min
2	3.06	2.38	2.50	2.00	0.19	0.16
3	4.19	3.50	2.75	3.00	0.25	0.22
4	5.19	4.50	3.00	4.00	0.25	0.22
5	6.19	5.50	3.00	5.00	0.25	0.22
6	7.19	6.50	3.00	6.00	0.25	0.22
8	9.50	8.62	3.50	8.00	0.31	0.25
10	11.62	10.75	3.50	10.00	0.37	0.31
12	13.75	12.75	4.25	12.00	0.37	0.31
15	16.95	15.88	4.25	15.00	0.44	0.38

Size[A]	Thickness of Hub		Width of Hub Bead[B]	Distance from Lead Groove to End, Pipe and Fittings[B]	Depth of Lead Groove	
	Hub Body	Over Bead				
	S (min)	R (min)	F	P	G (min)	G (max)
2	0.18	0.37	0.75	0.22	0.10	0.19
3	0.25	0.43	0.81	0.22	0.10	0.19
4	0.25	0.43	0.88	0.22	0.10	0.19
5	0.25	0.43	0.88	0.22	0.10	0.19
6	0.25	0.43	0.88	0.22	0.10	0.19
8	0.34	0.59	1.19	0.38	0.15	0.22
10	0.40	0.65	1.19	0.38	0.15	0.22
12	0.40	0.65	1.44	0.47	0.15	0.22
15	0.46	0.71	1.44	0.47	0.15	0.22

[A]Nominal inside diameter.
[B]For tolerances, see Page 19.

DIMENSIONS OF HUB AND SPIGOT METRIC AND ENGLISH



Extra Heavy Cast Iron Soil Pipe and Fittings:

Size Availability in Inches (mm)	Barrel I.D. B in Inches (mm)	Hub I.D. A in Inches (mm)	Spigot O.D. J in Inches (mm)	T NOM in Inches (mm)	T MIN in Inches (mm)
2 (50)	2.00 (50.8)	3.06 (77.7)	2.38 (60.4)	.19 (4.8)	.16 (4.0)
3 (76)	3.00 (76.2)	4.19 (106.4)	3.50 (88.9)	.25 (6.3)	.22 (5.5)
4 (101)	4.00 (101.6)	5.19 (131.8)	4.50 (114.3)	.25 (6.3)	.22 (5.5)
5 (127)	5.00 (127.0)	6.19 (157.2)	5.50 (139.7)	.25 (6.3)	.22 (5.5)
6 (152)	6.00 (152.4)	7.19 (182.6)	6.50 (165.1)	.25 (6.3)	.22 (5.5)
8 (203)	8.00 (203.2)	9.50 (241.3)	8.62 (218.9)	.31 (7.8)	.25 (6.3)
10 (254)	10.00 (254.0)	11.62 (295.1)	10.75 (273.0)	.37 (9.3)	.31 (7.8)
12 (304)	12.00 (304.8)	13.75 (349.2)	12.75 (323.8)	.37 (9.3)	.31 (7.8)
15 (381)	15.00 (381.0)	16.95 (430.5)	15.88 (403.3)	.44 (11.1)	.38 (9.6)

Laying Lengths

5 feet =60 inches = 1.52m
10 feet = 120 inches = 3.04m

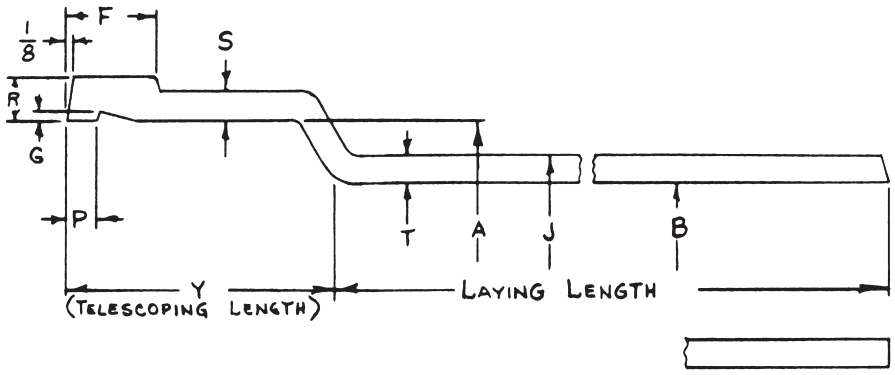
Metric Conversions

50mm Pipe Is 2 Inch Pipe
75mm Pipe Is 3 Inch Pipe
100mm Pipe Is 4 Inch Pipe
125mm Pipe Is 5 Inch Pipe
150mm Pipe Is 6 Inch Pipe
200mm Pipe Is 8 Inch Pipe
250mm Pipe Is 10 Inch Pipe
300mm Pipe Is 12 Inch Pipe
375mm Pipe Is 15 Inch Pipe

Dimensions other than nominal or trade sizes are converted on the exact factor of 25.4mm = 1 inch

DIMENSIONAL TOLERANCES FOR EXTRA HEAVY AND SERVICE CAST IRON SOIL PIPE & FITTINGS

CHARLOTTE PIPE AND FOUNDRY COMPANY



The tolerances set forth are intended for pipe and fittings designed for use with lead and oakum joints; however, these same tolerances may apply to pipe and fittings designed for use with a compression type gasket joint.

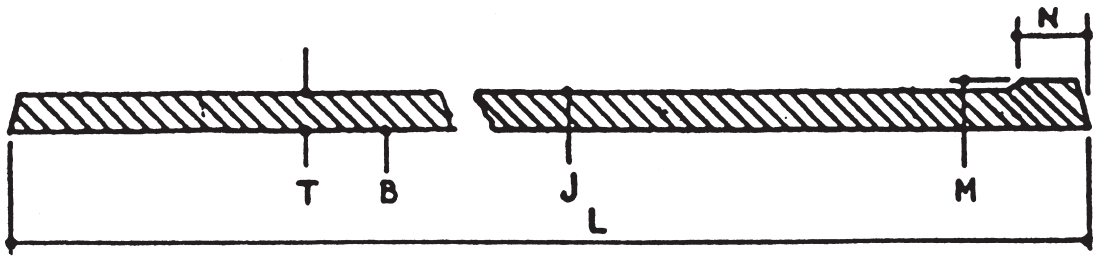
Size [A]	Inside Diameter of Hub	Outside Diameter of Barrel	Inside Diameter of Barrel	Tele-scoping Length	Laying Length			
							Fittings	
	A'	J	B	Y	Pipe, 2½-, 3½-, 5-ft Lengths	Pipe, 10-ft Lengths	Regular	Extra Long[B]
2	±0.06	±0.09	±0.09	±0.06	±1/4	±1/2	±1/8	±1/16
3	+0.09 −0.06	±0.09	±0.09	±0.06	±1/4	±1/2	±1/8	±1/16
4	+0.09 −0.06	±0.09	±0.09	±0.06	±1/4	±1/2	±1/8	±1/16
5	+0.09 −0.06	±0.09	±0.09	±0.06	±5/16	±5/8	±3/16	±3/32
6	+0.09 −0.06	±0.09	±0.09	±0.06	±5/16	±5/8.	±3/16	±3/32
8	±0.13	±0.13	±0.13	±0.13	±5/16	±5/8	±3/16	±3/32
10	±0.13	±0.13	±0.13	±0.13	±3/8	±3/4	±1/4	±1/8
12	±0.13	±0.19	±0.19	±0.19	±3/8	±3/4	±1/4	±1/8
15	±0.13	±0.19	±0.19	±0.19	±3/8	±3/4	±1/4	±1/8

Size	Width of Hub Bead	Distance from Lead Groove to End, Pipe and Fittings
	F	P
2	-0.13	±0.09
3	-0.13	±0.09
4	-0.13	±0.09
5	-0.13	±0.09
6	-0.13	±0.09
8	-0.13	±0.09
10	0.13	±0.09
12	-0.13	±0.11
15	-0.13	±0.11

[A] Nominal inside diameter.

[B] These tolerances apply to each foot of extra-long fittings in excess of regular laying lengths specified herein.

DIMENSIONS OF HUBLESS CAST IRON SOIL PIPE

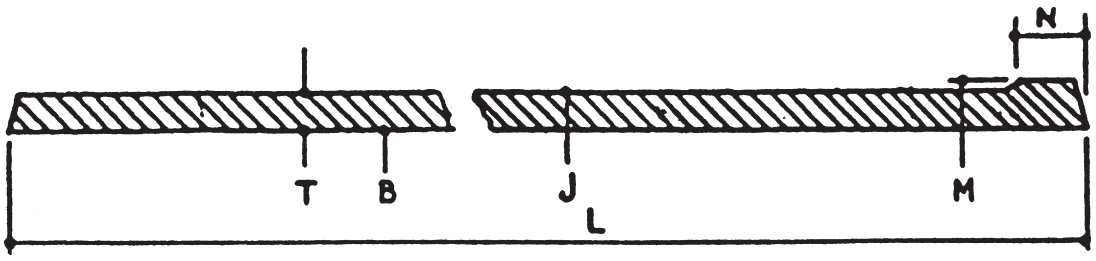


Size	Inside Diameter Barrel	Outside Diameter Barrel	Outside Diameter Spigot	Width Spigot Bead	Thickness of Barrel		Gasket Positioning Lug	Laying Length L	
	B	J	M	N (±.13)	T-Nom.	T-Min.	W	5 Foot (±.25)	10 Foot (±.50)
1 1/2	1.50 ±.09	1.90 ±.06	1.96 ±.06	.25	.16	.13	1.13	60	120
2	1.96 ±.09	2.35 ±.09	2.41 ±.09	.25	.16	.13	1.13	60	120
3	2.96 ±.09	3.35 ±.09	3.41 ±.09	.25	.16	.13	1.13	60	120
4	3.94± .09	4.38+.09 --.05	4.44± .09	.31	.19	.15	1.13	60	120
5	4.94 ±.09	5.30+.09 --.05	5.36 ±.09	.31	.19	.15	1.50	60	120
6	5.94 ±.09	6.30+.09 --.05	6.36 ±.09	.31	.19	.15	1.50	60	120
8	7.94±.13	8.38+.13 --.09	8.44±.09	.31	.23	.17	2.00	60	120
10	10.00±.13	10.56±09	10.62±.09	.31	.28	.22	2.00	60	120
12	11.94 ±.09	12.50 ±.09	12.62 ±.09	.31	.28	.22	2.75	60	120
15	15.11 ±.09	15.83±.09	16.12±.09	.31	.36	.30	2.75	60	120

NOTE: Pipe shall be cast with or without a spigot bead or gasket positioning lugs.

DIMENSIONS OF HUBLESS CAST IRON SOIL PIPE METRIC AND ENGLISH

CHARLOTTE PIPE AND FOUNDRY COMPANY



Size Availability in Inches (mm)	Barrel I.D. B in Inches (mm)	Barrel O.D. J in Inches (mm)	T NOM in Inches (mm)	T MIN in Inches (mm)	Laying Length L of 10 ft Pipe in Inches (m)
1-1/2 (38)	1.50±0.09 (38.1 ± 2.29)	1.90±0.06 (48.26 ± 1.52)	0.16 (4.0)	0.13 (3.3)	120 (3.04)
2 (50)	1.96 ±0.09 (49.8 ± 2.29)	2.35±0.09 (59.69 ± 2.29)	0.16 (4.0)	0.13 (3.3)	120 (3.04)
3 (76)	2.96 ± 0.09 (75.2 ± 2.29)	3.41 ± 0.09 (86.61 ± 2.29)	0.16 (4.0)	0.13 (3.3)	120 (3.04)
4 (101)	3.94±0.09 (100.08±2.29)	4.38+0.09-0.05 (111.25+2.291.27)	0.19 (4.8)	0.15 (3.81)	120 (3.04)
5 (127)	4.94 ± 0.09 (125.48 ± 2.29)	5.30 + 0.09 - 0.05 (134.62 + 2.29 - 1.27)	0.19 (4.8)	0.15 (3.81)	120 (3.04)
6 (152)	5.94±0.09 (150.88±2.29)	6.30+0.08-0.05 (160.02+2.29-1.27)	0.19 (4.8)	0.15 (3.81)	120 (3.04)
8 (203)	7.94±0.13 (201.68 ± 3.3)	8.38+0.130.09 (212.85 + 3.3 - 2.29)	0.23 (5.8)	0.17 (4.32)	120 (3.04)
10 (254)	10.00 ± 0.13 (254 ± 3.3)	10.56 ± 0.09 (268.22 ± 2.29)	0.28 (7.1)	0.22 (5.59)	120 (3.04)
12 (304)	11.94±0.09 (303.28± 2.29)	12.50±0.09 (317.5 ± 2.29)	0.28 (7.1)	0.22 (5.59)	120 (3.04)
15 (381)	15.11 ± 0.09 (383.79 ± 2.29)	1583 ± 0.09 (402.8 ± 2.29)	0.36 (9.1)	0.30 (7.62)	120 (3.04)

Laying Lengths

10 feet = 120 inches = 3.04m

Metric Conversions

50mm Pipe Is 2 Inch Pipe
75mm Pipe Is 3 Inch Pipe
100mm Pipe Is 4 Inch Pipe
125mm Pipe Is 5 Inch Pipe
150mm Pipe Is 6 Inch Pipe
200mm Pipe Is 8 Inch Pipe
250mm Pipe Is 10 Inch Pipe
300mm Pipe Is 12 Inch Pipe
375mm Pipe Is 15 Inch Pipe

Dimensions other than nominal or trade sizes are converted on the exact factor of 25.4mm = 1 inch

WHY YOU NEED TO SPECIFY CAST IRON PLUMBING FOR YOUR HOME

Protect Your Investment

For most of us, purchasing a home is the most important investment of our lives. Whether constructing a new dwelling, or altering a living space, perceptive homeowners are asking astute questions about the materials being used in their construction. They are inquisitive about options in windows, plumbing fixtures, interior decor, and more.

The value-conscious home buyer is looking beyond the frills and learning more about mechanical, plumbing, and electrical systems. These systems are responsible for today's high level of living comfort, but they can vary greatly in their quality and performance. Since these systems are usually concealed, homeowners with disappointing past experience are most likely to be mindful of the quality of the systems. The educated consumer often insists on up-graded electrical components, heating equipment, and plumbing products. Their experience has taught them to specify quality materials to avoid the aggravation and added cost of replacing systems that fail to satisfy their needs. We strongly recommend that first-time home buyers consider the meaningful benefits of buying higher quality materials. We invite you to consider the choices available when you select a drain, waste and vent (DWV) system for your home.

Before 1970, most DWV systems were constructed with cast iron materials. Since then, many residential plumbing contractors have installed plastic (PVC and ABS) DWV materials in homes. Because the DWV system is typically hidden within the walls, some home buyers are at first unaware of the type used in their home. Unfortunately, many have become acutely aware of the substitute materials due to the noise associated with these piping systems. Because of this problem, cast iron is now specified where effective noise suppression is sought. **This time-proven material is clearly the best choice for custom residences and quality-conscious spec homes.**

Long-Lasting Performance

For centuries, cast iron piping has conveyed waste and water throughout the Western world. The cast iron system installed in Versailles in 1623 still functions well today. The cast iron system installed in the White House in the 1800's still provides reliable service. Cast iron has proven its worth over the years. **Its service record is unmatched by any substitute material.**

The Quiet Pipe®

Cast iron piping is known for its quiet operation. Studies performed by the Cast Iron Soil Pipe Institute show that cast iron pipe and fittings, when installed with Neoprene-gasketed joints, are more than 750 percent more effective in silencing plumbing noise than other commonly used materials. This noise-silencing quality is a natural result of cast iron's dense molecular structure and its heavy mass. The owner of today's $200,000 home need not tolerate the noise of waste water gushing across the bedroom ceiling or trickling down through the living room wall. **The effective and simple solution is to install readily available cast iron piping.**

Easy to Install

Cast iron plumbing is installer-friendly. Since most cast iron systems are joined with compression gaskets or couplings, they are easy to adjust during installation and easy to modify during renovations. In contrast, plastic piping must be joined by solvent welding. When adjustments or alterations are needed, a portion of the system must be cut out and replaced with new components. Moreover, cast iron No-Hub systems fit neatly within today's stud walls, requiring slightly less space than plastic systems.

Tough, Durable and Safe

None of the commonly used substitute piping materials provide the strength of cast iron. Cast iron resists penetration by tree roots and rodents. Since cast iron has ten times the crush strength of today's thermoplastic materials, it is ideal for underground installations. No costly special bedding is required to support cast iron pipe, and it is unlikely to fail due to ground shifts. Cast iron is far more dimensionally stable than competing materials, meaning there is almost no chance of noise or failure due to thermal expansion and contraction. Cast iron is among the safest of plumbing materials since it will not burn or produce toxic fumes when exposed to fire. Cast iron is sanctioned by all national plumbing standards and building codes, and therefore meets all local building codes.

Environmentally Friendly

Since cast iron piping is made from recycled scrap iron and steel, its production removes debris from the landscape and landfills. Domestic companies that

manufacture cast iron piping have been energy conscious and ecologically aware for decades. **The cast iron piping that is right for your home is in tune with today's ecology-consciousness.**

Beware of Several Myths About Cast Iron

High Cost — Some builders will advise that cast iron piping drastically increases the cost of the drainage system. **Unless someone is overcharging, it will not.** Recent cost studies show that the wholesale cost difference between a combination cast iron and plastic waste system and an all-plastic system adds a very small amount to the per-bath cost. Quality-conscious homeowners need to ask, "Can I give up my home's peace and quiet over this small price difference?" Most will agree that a quiet drainage system is worth far more than the dollar amount. Knowledgeable builders know that a quiet drainage system is a strong selling feature and improves the home's future resale value.

Lack of Availability — It has been said that cast iron piping is unavailable. **This is not true.** Most plumbing wholesalers stock cast iron piping. For those that do not, they have immediate access to cast iron manufacturers which are strategically located across the United States. Most building sites are within one or two day's shipping time from a foundry.

Installation Difficulty — A final myth is that cast iron plumbing is difficult to install. **This is incorrect.** Cast iron plumbing is so prevalent in the United States that most plumbing contractors have installed a great deal of it. Ongoing plumber apprentice training programs include cast iron installation procedure as an essential part of their instruction.

The Best Value

Thank you for giving us the opportunity to tell you about the benefits of cast iron plumbing. **For new construction and renovations, cast iron provides outstanding overall value for your investment.** By specifying cast iron, you will receive quiet, durable and safe plumbing that has proven itself over centuries of use. **To receive the highest quality cast iron system available, specify "Charlotte."** Charlotte Pipe's cast iron pipe, fittings, gaskets, and connectors have been designed, engineered and manufactured to work well together as a system. An all-Charlotte cast iron system delivers maximum value and dependability. We look forward to serving you.

CHEMICAL RESISTANCE OF NEOPRENE

Fluid	Temperature	Rating
Acetic acid, 30%	RT**	A
Acetic acid, glacial	RT	B
Acetic anhydride	RT	A
Acetone	RT	B
Acetylene	RT	B
Aluminum chloride solutions	RT	A
Aluminum sulfate solutions	158°F. (70°C.)	A
Ammonia, anhydrous	RT	A
Ammonium hydroxide solutions	158°F. (70°C.)	A
Ammonium chloride solutions	RT	A
Ammonium sulfate solutions	158°F. (70°C.)	A
Amyl acetate	RT	C
Amyl alcohol	158°F. (70°C.)	A
Aniline	RT	C
Asphalt	RT	B
ASTM hydrocarbon test fluid	RT	X
ASTM No. 1 oil	RT	A
ASTM No. 3 oil	158°F. (70°C.)	B
ASTM reference fuel A	RT	A
ASTM reference fuel B	RT	C
ASTM reference fuel C	RT	C
Barium hydroxide solutions	158°F. (70°C.)	A
Benzaldehyde	RT	C
Benzene	RT	C
Benzoyl chloride	RT	C
Borax solutions	158°F. (70°C.)	A
Boric acid solutions	158°F. (70°C.)	A
Bromine, anhydrous liquid	RT	C
Butane	RT	A
Butyl acetate	RT	C
Butyraldehyde	RT	B
Butyric acid	RT	C
Calcium bisulfite solutions	158°F. (70°C.)	A
Calcium chloride solutions	RT	A
Calcium hydroxide solutions	158°F. (70°C.)	A
Calcium hypochlorite, 5%	RT	B
Calcium hypochlorite, 20%	RT	X
Carbon bisulfide	RT	C
Carbon dioxide	RT	A
Carbon monoxide	RT	A
Carbon tetrachloride	RT	C
Castor oil	158°F. (70°C.)	A
Chlorine gas, dry	RT	B
Chlorine gas, wet	RT	C
Chloroacetic acid	RT	A
Chlorobenzene	RT	X
Chloroform	RT	C
Chlorosulfonic acid	RT	C
Chromic acid, 10-50%	RT	C
Citric acid solutions	RT	A
Copper chloride solutions	RT	A
Copper sulfate solutions	RT	A
Cottonseed oil	RT	A
Creosote oil	RT	C
Cyclohexane	RT	C
Dibutyl phthalate	RT	C
Diethyl sebacate	RT	C
DOWTHERM A	RT	B
Ethyl acetate	RT	C

Fluid	Temperature	Rating
Ethyl alcohol	158°F. (70°C.)	A
Ethyl chloride	RT	B
Ethyl ether	RT	C
Ethylene dichloride	RT	C
Ethylene glycol	158°F. (70°C.)	A
Ethylene oxide	RT	X
Ferric chloride solutions	RT	A
Fluosilicic acid	158°F. (70°C.)	A
Formaldehyde, 40%	RT	A
Formaldehyde, 40%	158°F. (70°C.)	C
Formic acid	RT	A
FREON-11*	RT	A-B
FREON-11*	130°F. (54°C.)	B
FREON-12*	RT	A
FREON-12*	130°F. (54°C.)	A
FREON-22*	RT	A
FREON-22*	130°F. (54°C.)	A
FREON-113*	RT	A
FREON-113*	130°F. (54°C.)	A
FREON-114*	RT	A
FREON-114*	130°F. (54°C.)	T
Fuel oil	RT	A
Furfural	RT	B
Gasoline	Rt	B
Glue	158°F. (70°C.)	A
Glycerine	158°F. (70°C.)	A
n-Hexane	Rt	A
Hydraulic oils	RT	A
Hydrochloric acid, 20%	RT	A
Hydrochloric acid, 37%	RT	A
Hydrocyanic acid	RT	A
Hydrofluoric acid, 48%	RT	A
Hydrofluoric acid, 75%	RT	T
Hydrogen	RT	A
Hydrogen peroxide, 88 $^{1}/_{2}$%	RT	B
Hydrogen sulfide	RT	A
Isooctane	RT	A
Isopropyl alcohol	RT	A
Isopropyl ether	RT	C
JP-4	RT	C
JP-5	RT	X
JP-6	RT	X
Kerosene	RT	B
Lacquer solvents	RT	C
Lactic acid	RT	A
Linseed oil	RT	A
Lubricating oils	158°F. (70°C.)	B
Magnesium chloride solutions	158°F. (70°C.)	A
Magnesium hydroxide solutions	158°F. (70°C.)	A
Mercuric chloride solutions	RT	A
Mercury	RT	A
Methyl alcohol	158°F. (70°C.)	A
Methyl ethyl ketone	RT	X
Methylene chloride	100°F. (38°C.)	C
Mineral oil	RT	A
Mixed acids	RT	X
Naptha	RT	C
Napthalene	176°F. (80°C.)	C
Nitric acid, 10%	RT	B

CHEMICAL RESISTANCE OF NEOPRENE

CHARLOTTE PIPE AND FOUNDRY COMPANY®

Fluid	Temperature	Rating
Nitric acid, 30%	RT	C
Nitric acid, 60%	RT	X
Nitric acid, 70%	RT	C
Nitric acid, red fuming	RT	X
Nitrobenzene	RT	C
Oleic acid	RT	B
Oleum, 20%	RT	C
Palmitic acid	158°F. (70°C.)	B
Perchloroethylene	RT	X
Phenol	RT	B
Phosphoric acid, 20%	RT	T
Phosphoric acid, 60%	RT	A
Phosphoric acid, 70%	RT	T
Phosphoric acid, 85%	RT	A
Pickling solution (20% nitric acid, 4% HF)	RT	B-C
Pickling solution (17% nitric acid, 4% HF)	RT	X
Picric acid	RT	A
Potassium dichromate solutions	RT	A
Potassium hydroxide solutions	158°F. (70°C.)	A
Pyridine	RT	X
SAE No. 10 oil	RT	C
SKYDROL 500	RT	C
Soap solutions	158°F. (70°C.)	A
Sodium chloride solutions	RT	A
Sodium dichromate, 20%	RT	B
Sodium hydroxide, 46 $^{1}/_{2}$%	158°F. (70°C.)	A
Sodium hydroxide, 50%	RT	A
Sodium hydroxide, 73%	RT	T
Sodium hypochlorite, 5%	RT	T
Sodium hypochlorite, 20%	RT	B
Sodium peroxide solutions	RT	A
Soybean oil	RT	A
Stannic chloride	RT	B
Stannous chloride, 15%	158°F. (70°C.)	A
Stearic acid	158°F. (70°C.)	B
Sulfur, molten	RT	A
Sulfur dioxide, gas	RT	A
Sulfur dioxide, liquid	RT	A
Sulfur trioxide	RT	C
Sulfuric acid, up to 50%	158°F. (70°C.)	A
Sulfuric acid, 60%	RT	B
Sulfuric acid, 90%	RT	X
Sulfuric acid, 95%	RT	C
Sulfuric acid, fuming (20% oleum)	RT	C
Sulfurous acid	RT	X
Tannic acid, 10%	RT	A
Tartaric acid	158°F. (70°C.)	A
Toluene	RT	C
Tributyl phosphate	RT	C
Trichloroethylene	RT	C
Tricresyl phosphate	RT	X
Triethanolamine	158°F. (70°C.)	A
Trisodium phosphate solutions	RT	T
Tung oil	RT	A
Turpentine	RT	C
Water	212°F. (100°C.)	A
Xylene	RT	X
Zinc chloride solutions	RT	A

Rating Key:

A — Fluid has little or no effect on neoprene
B — Fluid has minor to moderate effect on neoprene
C — Fluid has severe effect on neoprene
T — No data — likely to be compatible
X — No data — not likely to be compatible

Unless otherwise noted, concentrations of aqueous solutions are saturated.

This tabulation is based on laboratory tests and records of actual service performance. **It should be used only as a guide.** Neoprene's degree of compatibility with a particular fluid in a given application will depend on variables such as temperatures, aeration, velocity of flow, duration of exposure, stability of the fluid, degree of contact, etc. For this reason, it is always advisable to test the material under actual service conditions before specification. If this is not practical, tests should be devised which simulate service conditions as closely as possible.

** 75°F. (24°C.)

TABLE 1
Slopes of Cast Iron Soil Pipe Sanitary Sewers
Required to Obtain Self-Cleaning Velocities of 2.0 and 2.5 Ft./Sec.
(Based on Mannings Formula with N =.012)

Pipe Size (In.)	Velocity (Ft./Sec.)	¼ FULL		½ FULL		¾ FULL		FULL	
		Slope (Ft./Ft.)	Flow (Gal./Min.)	Slope (Ft./Ft.)	Flow (Gal./Min.)	Slope (Ft./Ft.)	Flow (Gal./Min.)	Slope (Ft./Ft.)	Flow (Gal./Min.)
2.0	2.0	0.0313	4.67	0.0186	9.34	0.0148	14.09	0.0186	18.76
	2.5	0.0489	5.84	0.0291	11.67	0.0231	17.62	0.0291	23.45
3.0	2.0	0.0178	10.77	0.0107	21.46	0.0085	32.23	0.0107	42.91
	2.5	0.0278	13.47	0.0167	26.82	0.0133	40.29	0.0167	53.64
4.0	2.0	0.0122	19.03	0.0073	38.06	0.0058	57.01	0.0073	76.04
	2.5	0.0191	23.79	0.0114	47.58	0.0091	71.26	0.0114	95.05
5.0	2.0	0.0090	29.89	0.0054	59.79	0.0043	89.59	0.0054	119.49
	2.5	0.0141	37.37	0.0085	74.74	0.0067	11.99	0.0085	149.36
6.0	2.0	0.0071	43.18	0.0042	86.36	0.0034	129.54	0.0042	172.72
	2.5	0.0111	53.98	0.0066	107.95	0.0053	161.93	0.0066	214.90
8.0	2.0	0.0048	77.20	0.0029	154.32	0.0023	231.52	0.0029	308.64
	2.5	0.0075	96.50	0.0045	192.90	0.0036	289.40	0.0045	385.79
10.0	2.0	0.0036	120.92	0.0021	241.85	0.0017	362.77	0.0021	483.69
	2.5	0.0056	151.15	0.0033	302.31	0.0026	453.46	0.0033	604.61
12.0	2.0	0.0028	174.52	0.0017	349.03	0.0013	523.55	0.0017	698.07
	2.5	0.0044	218.15	0.0026	436.29	0.0021	654.44	0.0026	872.58
15.0	2.0	0.0021	275.42	0.0012	550.84	0.0010	826.26	0.0012	1101.68
	2.5	0.0032	344.28	0.0019	688.55	0.0015	1032.83	0.0019	1377.10

Flow velocity required to obtain a self cleaning drain, waste, and vent plumbing system is 2.0 to 2.5 feet per second.

Manning Roughness Factor ("N" Value)

Another flow coefficient that is used is the Manning "N" value. This coefficient relates to the interior wall smoothness of pipe and is used for liquids with a steady flow, at a constant depth, in a prismatic open channel.

Laboratory tests have shown that the "N" value for cast iron pipe ranges from .011 to .015. The adjacent table shows "N" values for other piping materials.

"N" Values For Typical Piping Materials

Piping Material	"N" Values
ABS and PVC	.008 - .012
Finished Concrete	.011 - .015
Unfinished Concrete	.013 - .017
Corrugated Metal	.021 - .027
Glass	.009 - .013
Clay	.011 - .017

FLOW THEORY AND CAPACITY

Just as structural analysis is used to predetermine the structural stability of buried cast iron soil pipe, hydraulic analysis is used to provide an adequate flow capacity for the sewage or drainage system in which the pipe is installed. Hydraulic analysis considers the variables that govern flow capacity, including the pipe diameter, the length of the sewer or drain line, the slope of the pipe, and the roughness or smoothness of the pipe's internal surface. All of these variables affecting flow in a particular system must be analyzed so that the pipe is sized and installed to efficiently carry the maximum volume of water expected to flow through the system under peak operating conditions.

The question, "How much water will flow through a certain size" is frequently asked regarding flow capacity. Unfortunately, the inquiry mentions only one of the variables that can materially alter the flow, and more complete information on the particular installation must be obtained before an accurate and useful response can be made. It is the purpose of this chapter to review flow theory and the determination of flow capacity and thereby present practical information relating to proper hydraulic design for cast iron soil pipe waste water systems.

Flow in Sewers and Drains

Most cast iron soil pipe in sewage and drainage systems flow only partially full (i.e., free surface flow or gravity flow), and would properly be termed "open channel." Since frictional losses are generally independent of pressure, the flow of water in both full pipes and open channels is governed by the same basic laws and expressed in formulas of the same general form.

The laws applying to conduit flow usually assume steady, uniform conditions, or an even distribution of liquid throughout the system. This continuity of flow, although generally not maintained over an extended period of time, is closer to the conditions likely to exist in cast iron soil pipe sewers – as opposed to those in drains, in which surge flow frequently occurs. It is customary, however, to utilize the same hydraulic principles to determine the flow in sewers and to estimate the capacities of sloping drains in and adjacent to buildings.

Because the amount of suspended solids in sewage is usually too small to have more than a negligible effect on the flow pattern, the flow of sewage in a clean conduit behaves in the same manner as the flow of water, with one possible exception: namely, that sewage could conceivably cause a change in surface condition or an accumulation of slime on the inner walls of the conduit over a period of years. This would have a long-term influence on the conduit's flow, altering its pattern from that found in a comparable conduit used to carry water. However, the many detergents commonly introduced into sewers tend to maintain their cleanliness, thus making water-flow measurements still applicable, even over the long term, to sewage-flow measurements in the same conduits.

Laminar Flow and Turbulent Flow

Two basic types of flow can occur in conduits used to transport fluids. The flow is termed **laminar** when the fluid moves, without eddies or cross currents, in straight lines parallel to the walls of the conduit. Once the flow velocity reaches a "critical" rate, cross currents set in causing the fluid to move through the conduit in an irregular manner, in which case the flow is said to be **turbulent.**

The Reynolds Number: The best criterion for determining the type of flow that prevails in a particular conduit under specified conditions is the Reynolds Number, conceived by Professor Osborne Reynolds of Owens College, Manchester, England and first used in 1883 to explain the flow of water in pipes. Reynolds determined that a general increase in the rate or velocity of flow eventually transforms it from laminar to turbulent and that the flow reverts back to laminar as its velocity gradually diminishes. By means of experiments using water at different temperatures this phenomenon was found to depend not only on the velocity of flow, but also on the viscosity and density of the fluid and the diameter of the pipe. Reynolds expressed it numerically as follows:

$$\frac{\text{diameter of the pipe x velocity x density of fluid}}{\text{viscosity of fluid}}$$

This expression, which can be written as DVp/u, is known as the **Reynolds Number**. It has no physical dimensions. It is a mere number, its value independent of the system of units (e.g., foot-second-pound) used to express its components. At low Reynolds numbers, when viscous forces are predominant, laminar flow occurs.

Assuming the flow velocity is less than critical, the tendency of the fluid to wet and adhere to the pipe walls and the viscosity of its adjacent layers contributes to streamlining the flow. However, once a certain value of the Reynolds number is reached the flow turns unstable and following a brief transition period becomes clearly turbulent. Extensive testing of commercial pipe samples of circular cross section has established that for Reynolds Numbers below a value of about 2,000 laminar flow can be expected. Whereas turbulent flow occurs at values above 3,000. The range between these critical numbers is referred to as the "transition zone."

As a general rule, turbulent flow is considered to be characteristic of all but an extremely limited number of cast iron soil pipe sewage and drainage systems, since the velocity of the flow of water in almost all installations results in Reynolds Numbers above 10,000. Laminar flow, which is more akin to the flow of water in very small tubes and to the flow of oil and other viscous liquids in commercial pipe, occurs in sewers and drains only at unusually low discharge rates and slopes. The predominance of turbulent flow has been established in extensive studies made by the National Bureau of Standards showing that turbulent flow occurs in 3 and 4 inch gravity drains at a slope of ¼ inch per foot for half-full or full conduit flow.

Premises Governing Flow Determination

Determination of the flow in cast iron soil pipe sewers and drains is based on the hydraulic premises discussed above, which can be restated as follows:

(1) The flow is of the open channel type with the conduit partially full and the top surface of the waste water exposed to the atmosphere.
(2) The flow is uniform with the mean velocity and depth of the waste water constant throughout the entire length of the conduit.
(3) The flow of sewage behaves in the same manner as the flow of drainage water.
(4) The flow is fully turbulent with the waste water moving through the conduit as a turbulent mass of fluid.

Figure 1 illustrates the cross section of a cast iron soil pipe open channel. It will be noted that the conduit is flowing only partially full with the top surface of the waste water exposed to normal atmospheric pressure. With D_S indicating the maximum depth of water in the cross section, the wetted perimeter, P, of the sewer or drain is represented by XYZ, the length of the line of contact between the wetted cross section and the surface of the channel. The hydraulic radius, r, of the sewer or drain is equal to a/P, the **cross sectional area of the stream** divided by the wetted perimeter.

Figure 2 provides a graphic representation of uniform flow in an open channel, showing the slopes of the hydraulic gradient, the energy gradient, and the invert. The **hydraulic gradient** represents the slope of the surface of the sewage or drainage water and depends on velocity head. The **energy gradient** is a graphical representation of total energy or total head, with the drop in the gradient H_f, providing a measure of lost head due to friction. The distance between the energy gradient and the hydraulic gradient indicates the total energy or velocity head, $V^2/2g$, remaining at any point along the sewer or drain line. The **invert** is a line that runs lengthwise along the base of the channel at the lowest point on its wetted perimeter, its slope established when the sewer or drain is installed.

When the flow between points 1 and 2 (in Figure 2) is uniform, then the depth, D_S, of the sewage or drainage water, the mean velocity, V, and the velocity head, $V^2/2g$, are constant throughout the entire length, L, and the slopes of the hydraulic gradient, the energy gradient and the invert are parallel.

Formulas for Flow Determination

The determination of flow in a waste water system centers around the relationship between the velocity of flow and the head or energy loss that results from friction. As the flow moves through the hydraulic system, it is retarded by friction and the loss of energy (i.e., the amount of energy that must be expended to overcome frictional resistance and maintain the flow). It should be noted that the smooth inner surface of cast iron soil pipe permits an efficient use of available energy, an important factor to consider in constructing a hydraulic system.

A number of formulas have been developed relating the velocity of flow and the loss of energy due to friction. The most prominent of these with application to open channel hydraulics was introduced by Manning (1890).

The Manning Formula: The Irish engineer, Robert Manning, in 1890 proposed the following equation for friction-controlled flow:

$$V = \frac{1.486}{n} r^{2/3} s^{1/2} \qquad (1)$$

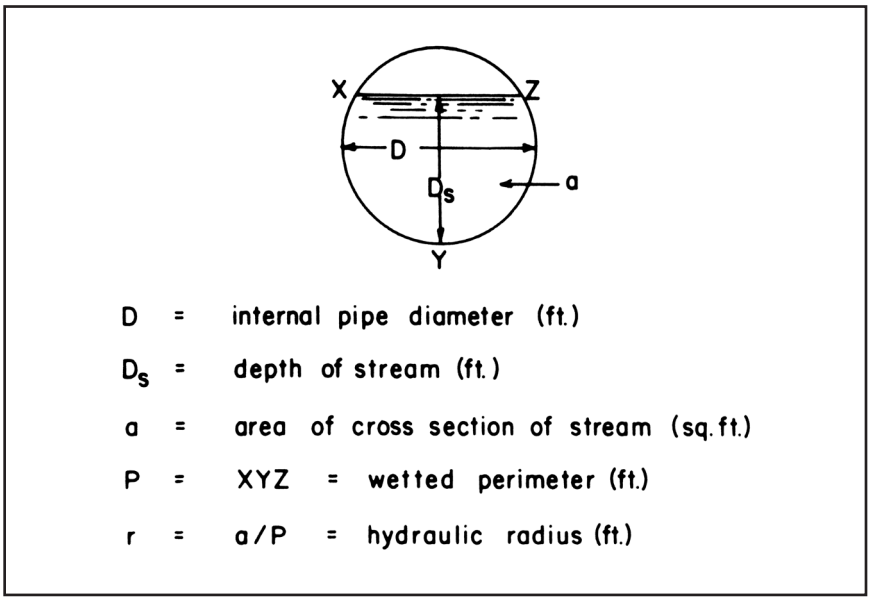


FIG. 1 – Cross Section of Cast Iron Soil Pipe Open Channel Sewer or Drain

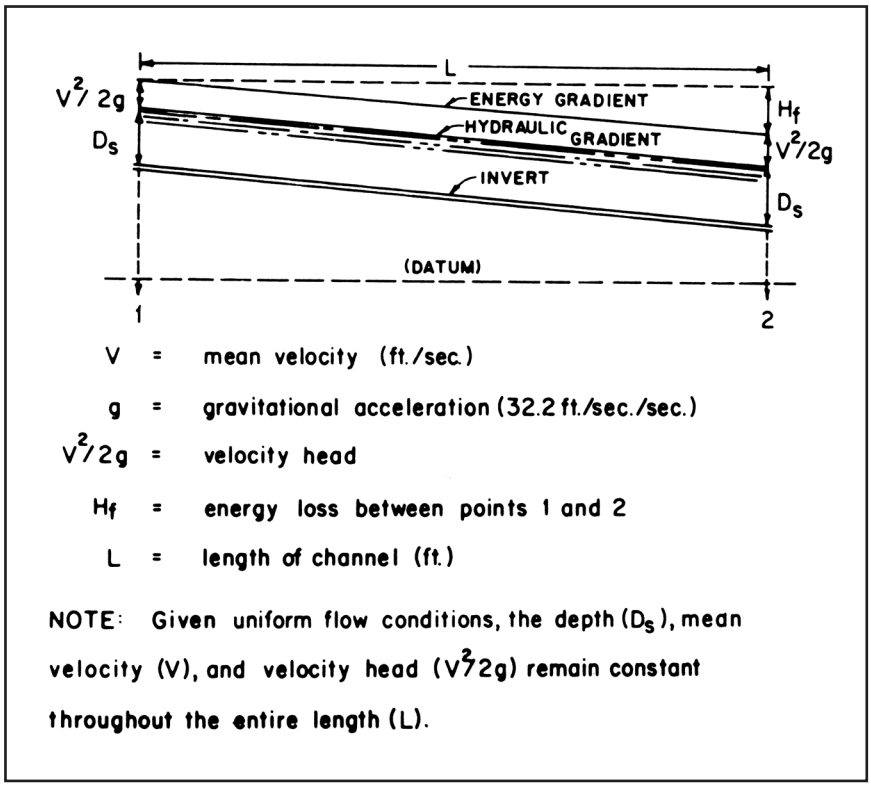


FIG. 2 – Uniform Flow of Open Channel Sewer or Drain

Over the years, the Manning formula has become widely recognized. It is the only empirical type of energy-loss formula that is extensively used to determine fully-turbulent, open channel flow. Among its advantages are the availability of numerous test results for establishing values of n, and its inclusion of the hydraulic radius, which makes it adaptable to flow determination in conduits of various shapes. The Manning formula, written in terms of discharge rate (Formula 2), has been employed in the remainder of this chapter to determine the flow capacity of cast iron soil pipe. Its derivation requires that both sides of Formula 1 be multiplied by the area of the cross section of the stream.

$$Q = \frac{1.486}{n} a r^{2/3} s^{1/2} \qquad (2)$$

where
Q = aV = discharge rate (cu. ft./sec.)
a = area of cross section of stream (sq. ft.)
r = roughness coefficient

Roughness Coefficient: Values of the roughness coefficient, n, in the Manning formula have been determined experimentally for various conduit materials, and a value of n = 0.012 is recommended for use in designing cast iron soil pipe hydraulic systems. Although lower, more favorable values of the coefficient are commonly obtained in controlled tests, particularly when coated pipe is used, the recommended value considers the possibility that bends and branch connections in an actual system may retard the flow.

Self-Cleansing Velocities: Table 1 is provided to assist in the design of cast iron soil pipe sanitary systems. It indicates the slopes required to obtain self-cleansing or scouring velocities at various rates of discharge. A **self-cleansing velocity**, or one sufficient to carry sewage solids along the conduit, permits the system to operate efficiently and reduces the likelihood of stoppages. A minimum velocity of 2 feet per second is the generally prescribed norm consistent with the removal of sewage solids, but a velocity of 2.5 feet per second can be used in cases where an additional degree of safety is desired.

In addition to designing self-cleaning velocities into sanitary sewers, it is considered good practice to impose an upper velocity limit of 10 feet per second in both sewers and drains. This restricts the abrasive action of sand and grit that may be carried through the system. However, because cast iron soil pipe is highly resistant to abrasion, it is most suitable for use where high velocity operation cannot be avoided.

Flow Capacity of Cast Iron Soil Pipe Sewers and Drains

The velocity and flow in cast iron soil pipe sewers and drains, computed by means of the Manning formula (Formula 2), are indicated in Table 2 and in Charts 1 through 4 inclusive. Flow capacities are provided for systems using pipe sizes 2 through 15 inches, installed at a full range of slopes from 0.0010 to 0.10 ft/ft and pipe fullness of one-quarter, one-half, three-quarters, and full. Both Table 2 and the flow diagrams are based on the value 0.012 for n, the roughness coefficient, and on the internal pipe diameters specified by ASTM A74.

Although Formula 2 expresses the flow or discharge in cubic feet per second, flow in cast iron soil pipe is commonly measured in gallons per minute, and consequently, the formula results have been multiplied by the conversion factor 448.86 (60 sec./min. x 7.481 gal./cu./ft.) to obtain the capacities indicated.

Design of Sewers and Drains

Formula 2, Table 2, and Charts 1 through 4 provide means to insure that cast iron soil pipe is adequately sized to accommodate the expected peak flow at a designed, self-cleansing velocity. The peak flow that governs design is that projected to occur in the future during the service life of the particular system.

The factors affecting peak flow vary with the type of system to be installed. In a sanitary sewer for domestic waste, the maximum quantity of sewage depends primarily upon the density and distribution of the population and its per capita use of water. In a sewer for commercial and industrial waste, it depends on the number and type of businesses to be serviced by the system. The peak load in a storm sewer, on the other hand, is determined by the duration and intensity of rainfall and the extent, condition and slope of streets and other areas requiring drainage.

For a particular hydraulic system, the factors affecting peak flow are analyzed by means of procedures in design handbooks. Unfortunately, this analysis is generally imperfect from the standpoint of system design. In most cases, current peak flow can be accurately quantified, but only a rough approximation can be made of future

TABLE 2
Velocity and Flow in Cast Iron Soil Pipe Sewers and Drains
(Based on Mannings Formula with N =.012)

Pipe Size (In.)	SLOPE (In./Ft.)	SLOPE (Ft./Ft.)	¼ FULL Velocity (Ft./Sec.)	¼ FULL Flow (Gal./Min.)	½ FULL Velocity (Ft./Sec.)	½ FULL Flow (Gal./Min.)	¾ FULL Velocity (Ft./Sec.)	¾ FULL Flow (Gal./Min.)	FULL Velocity (Ft./Sec.)	FULL Flow (Gal./Min.)
2.0	0.0120	0.0010	0.36	0.83	0.46	2.16	0.52	3.67	0.46	4.35
	0.0240	0.0020	0.51	1.18	0.66	3.06	0.74	5.18	0.66	6.15
	0.0360	0.0030	0.62	1.45	0.80	3.75	0.90	6.35	0.80	7.53
	0.0480	0.0040	0.72	1.67	0.93	4.33	1.04	7.33	0.93	8.69
	0.0600	0.0050	0.80	1.87	1.04	4.84	1.16	8.20	1.04	9.72
	0.0720	0.0060	0.88	2.04	1.13	5.30	1.27	8.98	1.13	10.65
	0.0840	0.0070	0.95	2.21	1.23	5.72	1.38	9.70	1.23	11.50
	0.0960	0.0080	1.01	2.36	1.31	6.12	1.47	10.37	1.31	12.29
	0.1080	0.0090	1.07	2.50	1.39	6.49	1.56	11.00	1.39	13.04
	0.1200	0.0100	1.13	2.64	1.47	6.84	1.64	11.59	1.47	13.75
	0.2400	0.0200	1.60	3.73	2.07	9.67	2.33	16.39	2.07	19.44
	0.3600	0.0300	1.96	4.57	2.54	11.85	2.85	20.07	2.54	23.81
	0.4800	0.0400	2.26	5.28	2.93	13.68	3.29	23.18	2.93	27.49
	0.6000	0.0500	2.53	5.90	3.28	15.29	3.68	25.92	3.28	30.74
	0.7200	0.0600	2.77	6.47	3.59	16.75	4.03	28.39	3.59	33.67
	0.8400	0.0700	2.99	6.98	3.88	18.10	4.35	30.66	3.88	36.37
	0.9600	0.0800	3.20	7.47	4.14	19.35	4.65	32.78	4.14	38.88
	1.0800	0.0900	3.39	7.92	4.40	20.52	4.93	34.77	4.40	41.24
	1.2000	0.1000	3.58	8.35	4.63	21.63	5.20	36.65	4.63	43.47
3.0	0.0120	0.0010	0.47	2.55	0.61	6.56	0.69	11.05	0.61	13.12
	0.0240	0.0020	0.67	3.61	0.86	9.28	0.97	15.63	0.86	18.55
	0.0360	0.0030	0.82	4.42	1.06	11.36	1.19	19.14	1.06	22.72
	0.0480	0.0040	0.95	5.11	1.22	13.12	1.37	22.10	1.22	26.24
	0.0600	0.0050	1.06	5.71	1.37	14.67	1.53	24.71	1.37	29.33
	0.0720	0.0060	1.16	6.25	1.50	16.07	1.68	27.07	1.50	32.13
	0.0840	0.0070	1.25	6.75	1.62	17.35	1.81	29.24	1.62	34.71
	0.0960	0.0080	1.34	7.22	1.73	18.55	1.94	31.26	1.73	37.11
	0.1080	0.0090	1.42	7.66	1.83	19.68	2.06	33.16	1.83	39.36
	0.1200	0.0100	1.50	8.07	1.93	20.74	2.17	34.95	1.93	41.49
	0.2400	0.0200	2.21	11.42	2.73	29.33	3.07	49.43	2.73	58.67
	0.3600	0.0300	2.60	13.98	3.35	35.93	3.76	60.53	3.35	71.86
	0.4800	0.0400	3.00	16.14	3.87	41.49	4.34	69.90	3.87	82.97
	0.6000	0.0500	3.35	18.05	4.32	46.38	4.85	78.15	4.32	92.77
	0.7200	0.0600	3.67	19.77	4.74	50.81	5.31	85.61	4.74	101.62
	0.8400	0.0700	3.96	21.36	5.12	54.88	5.74	92.47	5.12	109.76
	0.9600	0.0800	4.24	22.83	5.47	58.67	6.13	98.85	5.47	117.34
	1.0800	0.0900	4.50	24.22	5.80	62.23	6.51	104.85	5.80	124.46
	1.2000	0.1000	4.74	25.53	6.11	65.29	6.86	110.52	6.11	131.19

TABLE 2 - (Continued)
Velocity and Flow in Cast Iron Soil Pipe Sewers and Drains
(Based on Mannings Formula with N =.012)

Pipe Size (In.)	SLOPE		¼ FULL		½ FULL		¾ FULL		FULL	
	(In./Ft.)	(Ft./Ft.)	Velocity (Ft./Sec.)	Flow (Gal./Min.)	Velocity (Ft./Sec.)	Flow (Gal./Min.)	Velocity (Ft./Sec.)	Flow (Gal./Min.)	Velocity (Ft./Sec.)	Flow (Gal./Min.)
4.0	0.0120	0.0010	0.57	5.45	0.74	14.08	0.83	23.63	0.74	28.12
	0.0240	0.0020	0.81	7.70	1.05	19.91	1.17	33.42	1.05	39.77
	0.0360	0.0030	0.99	9.44	1.28	24.38	1.44	40.92	1.28	48.71
	0.0480	0.0040	1.15	10.90	1.48	28.16	1.66	47.26	1.48	56.25
	0.0600	0.0050	1.28	12.18	1.65	31.48	1.85	52.83	1.65	62.88
	0.0720	0.0060	1.40	13.34	1.81	34.48	2.03	57.88	1.81	68.89
	0.0840	0.0070	1.51	14.41	1.96	37.25	2.19	62.51	1.96	74.41
	0.0960	0.0080	1.62	15.41	2.09	39.82	2.34	66.83	2.09	79.54
	0.1080	0.0090	1.72	16.34	2.22	42.23	2.49	70.88	2.22	84.37
	0.1200	0.0100	1.81	17.23	2.34	44.52	2.62	74.72	2.34	88.93
	0.2400	0.0200	2.56	24.36	3.31	62.96	3.71	105.67	3.31	125.77
	0.3600	0.0300	3.14	29.84	4.05	77.11	4.54	129.42	4.05	154.04
	0.4800	0.0400	3.62	34.46	4.68	89.04	5.24	149.44	4.68	177.86
	0.6000	0.0500	4.05	38.52	5.23	99.55	5.86	167.08	5.23	198.86
	0.7200	0.0600	4.43	42.20	5.73	109.05	6.42	183.02	5.73	217.84
	0.8400	0.0700	4.79	45.58	6.19	117.79	6.94	197.69	6.19	235.29
	0.9600	0.0800	5.12	48.73	6.62	125.92	7.41	211.34	6.62	251.54
	1.0800	0.0900	5.43	51.68	7.02	133.56	7.86	224.15	7.02	266.80
	1.2000	0.1000	5.73	54.48	7.40	140.78	8.29	236.28	7.40	281.23
5.0	0.0120	0.0010	0.67	9.94	0.86	25.71	0.96	43.15	0.86	51.37
	0.0240	0.0020	0.94	14.06	1.22	36.35	1.36	61.02	1.22	72.65
	0.0360	0.0030	1.15	17.22	1.49	44.52	1.67	74.74	1.49	88.98
	0.0480	0.0040	1.33	19.88	1.72	51.41	1.93	86.30	1.72	102.75
	0.0600	0.0050	1.49	22.23	1.92	57.48	2.15	96.49	1.92	114.87
	0.0720	0.0060	1.63	24.35	2.11	62.97	2.36	105.70	2.11	125.84
	0.0840	0.0070	1.76	26.30	2.28	68.01	2.55	114.17	2.28	135.92
	0.0960	0.0080	1.88	28.12	2.43	72.71	2.72	122.05	2.43	145.31
	0.1080	0.0090	2.00	29.82	2.58	77.12	2.89	129.45	2.58	154.12
	0.1200	0.0100	2.10	31.44	2.72	81.29	3.05	136.45	2.72	162.46
	0.2400	0.0200	2.97	44.46	3.85	114.96	4.31	192.97	3.85	229.75
	0.3600	0.0300	3.64	54.45	4.71	140.80	5.28	236.34	4.71	281.38
	0.4800	0.0400	4.21	62.88	5.44	162.58	6.09	272.91	5.44	324.91
	0.6000	0.0500	4.70	70.30	6.08	181.77	6.81	305.12	6.08	363.26
	0.7200	0.0600	5.15	77.01	6.66	199.12	7.46	334.24	6.66	397.94
	0.8400	0.0700	5.56	83.18	7.19	215.07	8.06	361.02	7.19	429.82
	0.9600	0.0800	5.95	88.92	7.69	229.92	8.62	385.95	7.69	459.50
	1.0800	0.0900	6.31	94.31	8.16	243.92	9.14	409.36	8.16	487.37
	1.2000	0.1000	6.65	99.42	8.60	257.06	9.63	431.50	8.60	513.73

TABLE 2 - (Continued)
Velocity and Flow in Cast Iron Soil Pipe Sewers and Drains
(Based on Mannings Formula with N =.012)

Pipe Size (In.)	SLOPE (In./Ft.)	SLOPE (Ft./Ft.)	¼ FULL Velocity (Ft./Sec.)	¼ FULL Flow (Gal./Min.)	½ FULL Velocity (Ft./Sec.)	½ FULL Flow (Gal./Min.)	¾ FULL Velocity (Ft./Sec.)	¾ FULL Flow (Gal./Min.)	FULL Velocity (Ft./Sec.)	FULL Flow (Gal./Min.)
6.0	0.0120	0.0010	0.75	16.23	0.97	41.98	1.09	70.55	0.97	83.96
	0.0240	0.0020	1.06	22.95	1.37	59.37	1.54	99.77	1.37	118.74
	0.0360	0.0030	1.30	28.11	1.68	72.71	1.89	122.20	1.68	145.42
	0.0480	0.0040	1.50	32.46	1.94	83.96	2.18	141.10	1.94	167.92
	0.0600	0.0050	1.68	36.29	2.17	93.87	2.44	157.76	2.17	187.74
	0.0720	0.0060	1.84	39.75	2.38	102.83	2.67	172.81	2.38	205.66
	0.0840	0.0070	1.99	42.94	2.57	111.07	2.88	186.66	2.57	222.13
	0.0960	0.0080	2.13	45.90	2.75	118.74	3.08	199.55	2.75	237.47
	0.1080	0.0090	2.26	48.69	2.92	125.94	3.27	211.65	2.92	251.88
	0.1200	0.0100	2.38	51.32	3.07	132.75	3.44	223.10	3.07	265.50
	0.2400	0.0200	3.36	72.58	4.35	187.74	4.87	315.51	4.35	375.47
	0.3600	0.0300	4.12	88.89	5.32	229.93	5.97	386.42	5.32	459.86
	0.4800	0.0400	4.75	102.64	6.15	265.50	6.89	446.20	6.15	531.00
	0.6000	0.0500	5.32	114.76	6.87	296.84	7.70	498.87	6.87	593.68
	0.7200	0.0600	5.82	125.71	7.53	325.17	8.44	546.27	7.53	650.34
	0.8400	0.0700	6.29	135.78	8.13	351.22	9.11	590.27	8.13	702.45
	0.9600	0.0800	6.72	145.16	8.70	375.47	9.74	631.02	8.70	750.95
	1.0800	0.0900	7.13	153.96	9.22	398.25	10.33	669.30	9.22	796.50
	1.2000	0.1000	7.52	162.29	9.72	419.79	10.89	705.51	9.72	839.59
8.0	0.0120	0.0010	0.91	35.25	1.18	91.04	1.32	153.06	1.18	182.09
	0.0240	0.0020	1.29	49.85	1.67	128.75	1.87	216.46	1.67	257.51
	0.0360	0.0030	1.58	61.05	2.04	157.69	2.29	265.11	2.04	315.38
	0.0480	0.0040	1.83	70.50	2.36	182.09	2.64	306.12	2.36	364.17
	0.0600	0.0050	2.04	78.82	2.64	203.58	2.96	342.26	2.64	407.16
	0.0720	0.0060	2.24	86.34	2.89	223.01	3.24	374.92	2.89	446.02
	0.0840	0.0070	2.42	93.26	3.12	240.88	3.50	404.96	3.12	481.75
	0.0960	0.0080	2.58	99.70	3.34	257.51	3.74	432.92	3.34	515.02
	0.1080	0.0090	2.74	105.75	3.54	273.13	3.97	459.18	3.54	546.26
	0.1200	0.0100	2.89	111.47	3.73	287.90	4.18	484.02	3.73	575.81
	0.2400	0.0200	4.08	157.64	5.28	407.16	5.91	684.51	5.28	814.32
	0.3600	0.0300	5.00	193.06	6.46	498.66	7.24	838.35	6.46	997.33
	0.4800	0.0400	5.78	222.93	7.46	575.81	8.36	968.05	7.46	1151.62
	0.6000	0.0500	6.46	249.24	8.34	643.77	9.35	1082.31	8.34	1287.55
	0.7200	0.0600	7.07	273.03	9.14	705.22	10.24	1185.61	9.14	1410.44
	0.8400	0.0700	7.64	294.91	9.87	761.72	11.06	1280.60	9.87	1523.45
	0.9600	0.0800	8.17	315.27	10.55	814.31	11.83	1369.02	10.55	1628.63
	1.0800	0.0900	8.66	334.40	11.19	863.71	12.54	1452.07	11.19	1727.42
	1.2000	0.1000	9.13	352.4	11.80	910.43	13.22	1530.61	11.80	1820.86

TABLE 2 - (Continued)
Velocity and Flow in Cast Iron Soil Pipe Sewers and Drains
(Based on Mannings Formula with N =.012)

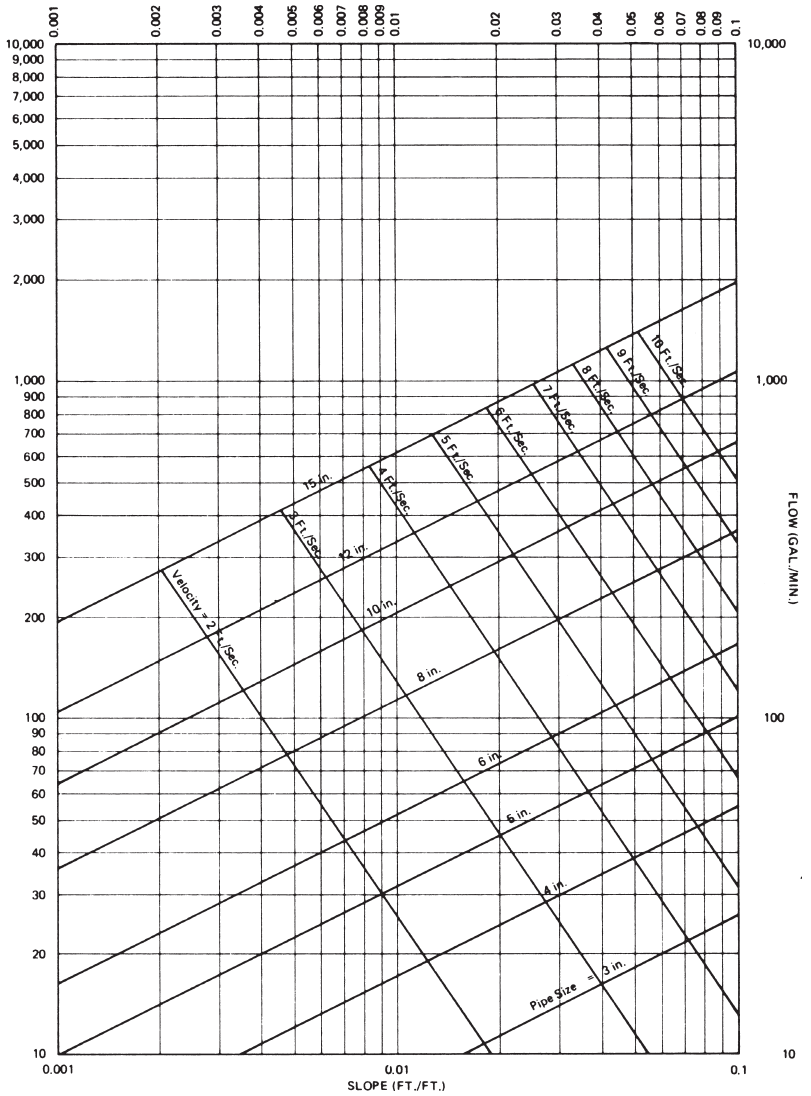
Pipe Size (In.)	SLOPE (In./Ft.)	SLOPE (Ft./Ft.)	¼ FULL Velocity (Ft./Sec.)	¼ FULL Flow (Gal./Min.)	½ FULL Velocity (Ft./Sec.)	½ FULL Flow (Gal./Min.)	¾ FULL Velocity (Ft./Sec.)	¾ FULL Flow (Gal./Min.)	FULL Velocity (Ft./Sec.)	FULL Flow (Gal./Min.)
10.0	0.0120	0.0010	1.06	64.08	1.37	165.75	1.54	278.56	1.37	331.51
	0.0240	0.0020	1.50	90.62	1.94	234.41	2.17	393.95	1.94	468.83
	0.0360	0.0030	1.84	110.99	2.37	287.10	2.66	482.48	2.37	574.19
	0.0480	0.0040	2.12	128.16	2.74	331.51	3.07	557.12	2.74	663.02
	0.0600	0.0050	2.37	143.29	3.07	370.64	3.43	622.88	3.07	741.28
	0.0720	0.0060	2.60	156.96	3.36	406.01	3.76	682.33	3.36	812.03
	0.0840	0.0070	2.80	169.54	3.63	438.55	4.06	737.01	3.63	877.09
	0.0960	0.0080	3.00	181.24	3.88	468.82	4.34	787.89	3.88	937.65
	0.1080	0.0090	3.18	192.24	4.11	497.26	4.61	835.69	4.11	994.53
	0.1200	0.0100	3.35	202.64	4.33	524.16	4.86	880.89	4.33	1048.32
	0.2400	0.0200	4.74	286.57	6.13	741.28	6.87	1245.77	6.13	1482.55
	0.3600	0.0300	5.80	350.98	7.51	907.88	8.41	1525.75	7.51	1815.75
	0.4800	0.0400	6.70	405.27	8.67	1048.32	9.71	1761.78	8.67	2096.65
	0.6000	0.0500	7.49	453.11	9.69	1172.06	10.86	1969.73	9.69	2344.13
	0.7200	0.0600	8.21	496.36	10.62	1283.93	11.90	2157.74	10.62	2567.86
	0.8400	0.0700	8.87	536.12	11.47	1386.80	12.85	2330.62	11.47	2773.61
	0.9600	0.0800	9.48	573.14	12.26	1482.55	13.74	2491.54	12.26	2965.11
	1.0800	0.0900	10.05	607.91	13.00	1572.49	14.57	2642.67	13.00	3144.97
	1.2000	0.1000	10.60	640.79	13.71	1657.55	15.36	2785.62	13.71	3315.09
12.0	0.0120	0.0010	1.20	104.53	1.55	270.34	1.74	454.27	1.55	540.68
	0.0240	0.0020	1.69	147.83	2.19	382.32	2.45	642.43	2.19	764.63
	0.0360	0.0030	2.07	181.05	2.68	468.24	3.01	786.82	2.68	936.48
	0.0480	0.0040	2.40	209.06	3.10	540.68	3.47	908.54	3.10	1081.35
	0.0600	0.0050	2.68	233.74	3.46	604.49	3.88	1015.78	3.46	1208.99
	0.0720	0.0060	2.93	256.05	3.79	662.19	4.25	1112.73	3.79	1324.38
	0.0840	0.0070	3.17	276.56	4.10	715.25	4.59	1201.88	4.10	1430.50
	0.0960	0.0080	3.39	295.66	4.38	764.63	4.91	1284.87	4.38	1529.27
	0.1080	0.0090	3.59	313.59	4.65	811.01	5.21	1362.81	4.65	1622.03
	0.1200	0.0100	3.79	330.56	4.90	854.88	5.49	1436.53	4.90	1709.77
	0.2400	0.0200	5.36	467.48	6.93	1208.99	7.76	2031.55	6.93	2417.98
	0.3600	0.0300	6.56	572.54	8.48	1480.71	9.50	2488.14	8.48	2961.41
	0.4800	0.0400	7.58	661.11	9.80	1709.77	10.98	2873.05	9.80	3419.54
	0.6000	0.0500	8.47	739.14	10.95	1911.58	12.27	3212.17	10.95	3823.17
	0.7200	0.0600	9.28	809.69	12.00	2094.03	13.44	3518.76	12.00	4188.07
	0.8400	0.0700	10.02	874.57	12.96	2261.81	14.52	3800.69	12.96	4523.63
	0.9600	0.0800	10.71	934.95	13.86	2417.98	15.52	4063.11	13.86	4835.96
	1.0800	0.0900	11.36	991.67	14.70	2564.65	16.46	4309.57	14.70	5129.30
	1.2000	0.1000	11.98	1045.31	15.49	2703.38	17.35	4542.69	15.49	5406.76

TABLE 2 - (Continued)
Velocity and Flow in Cast Iron Soil Pipe Sewers and Drains
(Based on Mannings Formula with N =.012)

Pipe Size (In.)	SLOPE (In./Ft.)	SLOPE (Ft./Ft.)	¼ FULL Velocity (Ft./Sec.)	¼ FULL Flow (Gal./Min.)	½ FULL Velocity (Ft./Sec.)	½ FULL Flow (Gal./Min.)	¾ FULL Velocity (Ft./Sec.)	¾ FULL Flow (Gal./Min.)	FULL Velocity (Ft./Sec.)	FULL Flow (Gal./Min.)
15.0	0.0120	0.0010	1.39	192.03	1.80	496.67	2.02	834.85	1.80	993.34
	0.0240	0.0020	1.97	271.58	2.55	702.40	2.86	1180.65	2.55	1404.79
	0.0360	0.0030	2.42	332.61	3.12	860.25	3.50	1445.99	3.12	1720.51
	0.0480	0.0040	2.79	384.07	3.61	993.34	4.04	1669.69	3.61	1986.67
	0.0600	0.0050	3.12	429.40	4.03	1110.58	4.52	1866.77	4.03	2221.17
	0.0720	0.0060	3.42	470.38	4.42	1216.58	4.95	2044.95	4.42	2433.17
	0.0840	0.0070	3.69	508.07	4.77	1314.06	5.35	2208.79	4.77	2628.12
	0.0960	0.0080	3.94	543.15	5.10	1404.79	5.72	2361.30	5.10	2809.58
	0.1080	0.0090	4.18	576.10	5.41	1490.01	6.06	2504.54	5.41	2980.01
	0.1200	0.0100	4.41	607.26	5.70	1570.60	6.39	2640.01	5.70	3141.21
	0.2400	0.0200	6.24	858.80	8.06	2221.17	9.04	3733.54	8.06	4442.34
	0.3600	0.0300	7.64	1051.81	9.88	2720.37	11.07	4572.64	9.88	5440.73
	0.4800	0.0400	8.82	1214.52	11.41	3141.21	12.78	5280.03	11.41	6282.41
	0.6000	0.0500	9.86	1357.88	12.75	3511.98	14.29	5903.25	12.75	7023.95
	0.7200	0.0600	10.80	1487.48	13.97	3847.18	15.65	6466.69	13.97	7694.35
	0.8400	0.0700	11.67	1606.66	15.09	4155.43	16.91	6984.82	15.09	8310.85
	0.9600	0.0800	12.47	1717.60	16.13	4442.33	18.07	7467.07	16.13	8884.66
	1.0800	0.0900	13.23	1821.78	17.11	4711.80	19.17	7920.03	17.11	9423.61
	1.2000	0.1000	13.94	1920.33	18.03	4966.68	20.21	8348.44	18.03	9933.35

CHART 1
Velocity and Flow In Cast Iron Soil Pipe Sewers and Drains
(Based On Manning's Formula With n = .012)

ONE-QUARTER FULL*



*Flow for 2 in. pipe is less than 10 GPM at slopes indicated.

CHART 2
Velocity and Flow In Cast Iron Soil Pipe Sewers and Drains
(Based On Manning's Formula With n = .012)

ONE-HALF FULL

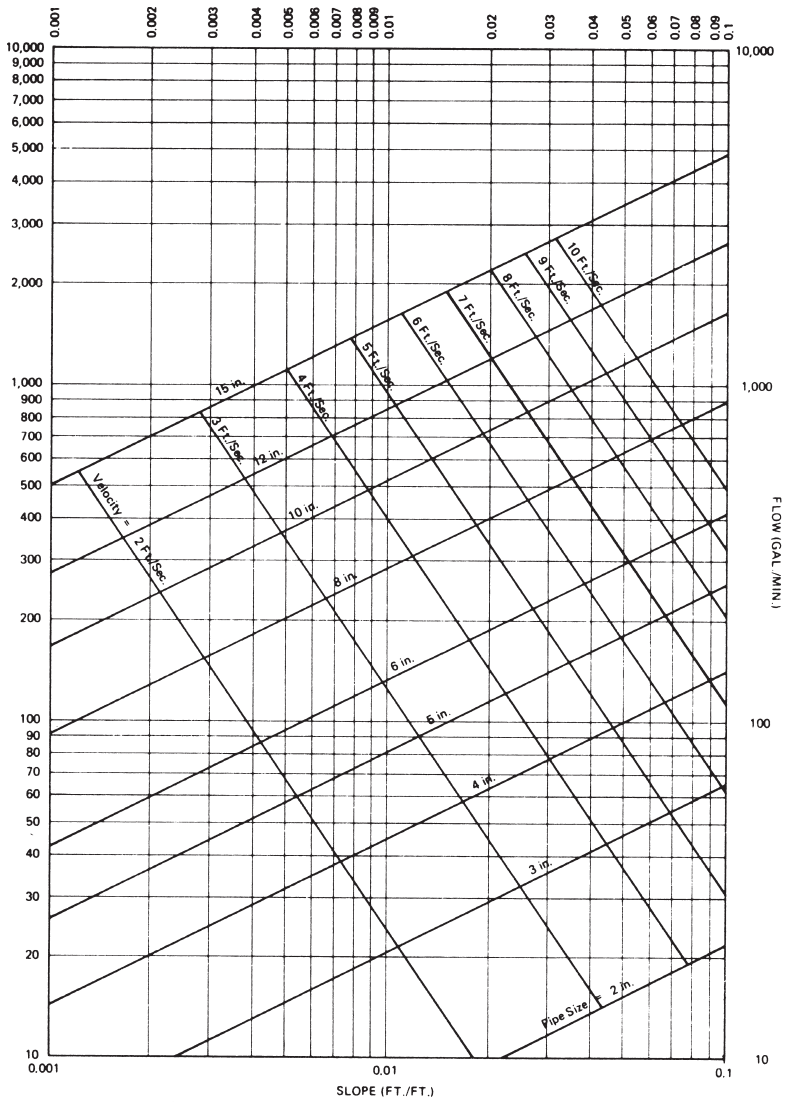


CHART 3
Velocity and Flow In Cast Iron Soil Pipe Sewers and Drains
(Based On Manning's Formula With n = .012)

THREE-QUARTERS FULL

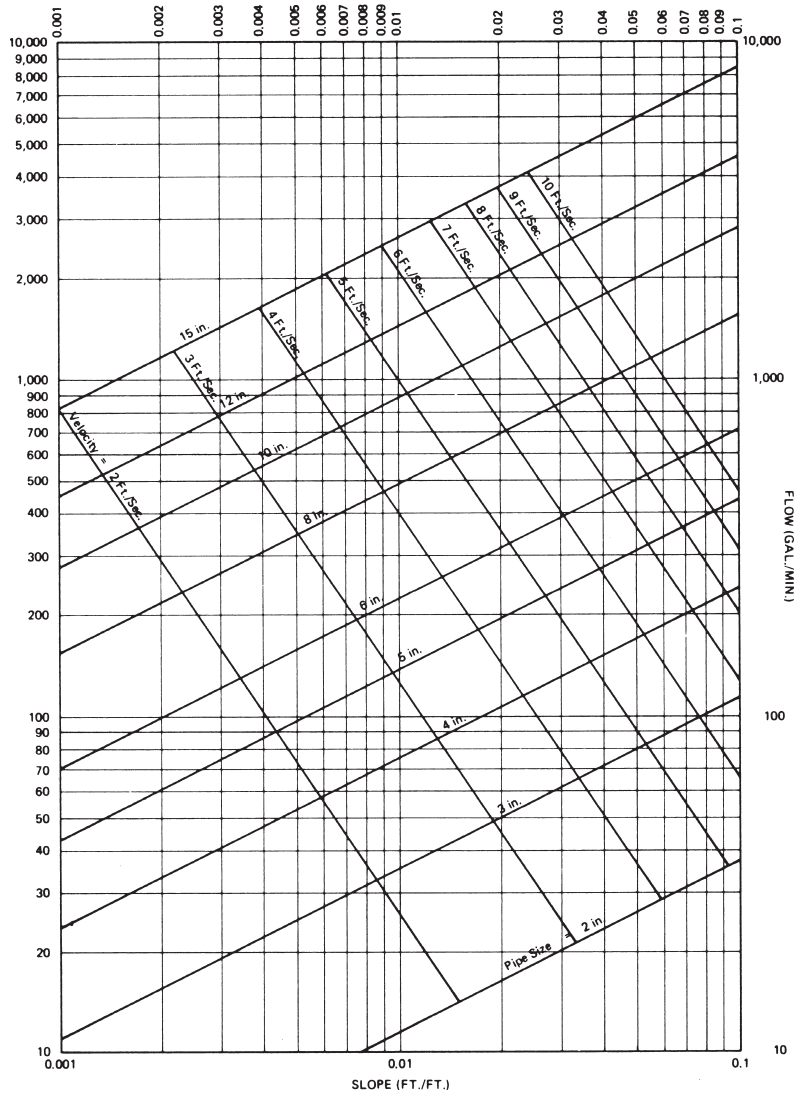
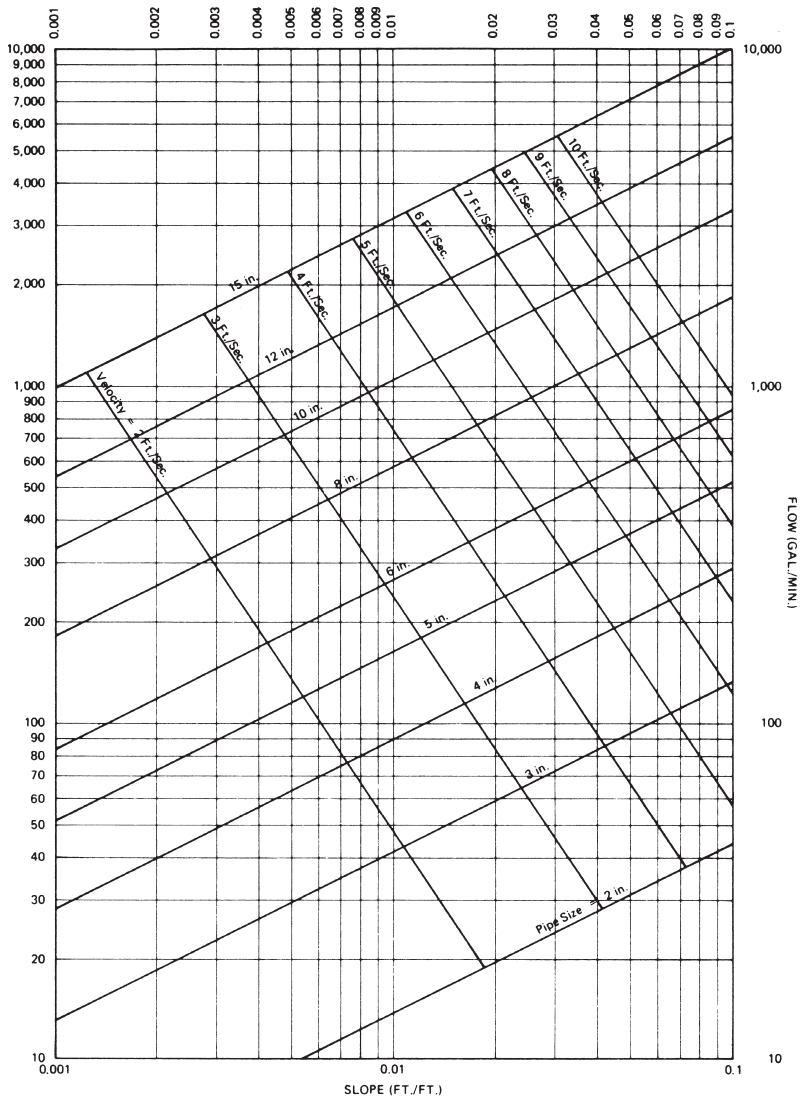


CHART 4
Velocity and Flow In Cast Iron Soil Pipe Sewers and Drains
(Based On Manning's Formula With n = .012)

FULL FLOW



peak flow, which is usually based on population trends and area development over a period of fifty or so years. This requires that provision be made for any unforeseen increase in runoff, and therefore, cast iron soil pipe hydraulic systems are most frequently designed for half-full operation at probable future peak flow. Greater or less than half-full operation can be employed, depending on design requirements and the relative accuracy with which future flow can be forecast.

The following example illustrates a typical computation involving the flow capacity of a cast iron soil pipe hydraulic system:

Example

An industrial plant site is to be serviced by a cast iron soil pipe sewer that must provide a flow capacity of 1,500 gallons per minute when operating half-full. This is the peak runoff that the plant is expected to generate in the future at projected maximum levels of production. Based on the grade and condition of the ground surface under which the sewer is to be installed, as well as the location of subsurface obstructions, a system slope of 0.01 ft./ft. is planned. Initially, a 15 inch pipe size is assumed, and it must be determined whether or not this will result in an adequate flow capacity, as well as an efficient operating velocity.

Given:

n = 0.012
D = 1.2500 ft.
a = 0.6136 sq. ft.
P = 1.9635 ft.
r = a/P = 0.3125 ft.
s = 0.01 ft./ft.

Solution

$$Q = \frac{1.486}{n} ar^{2/3} s^{1/2} \quad \text{(Manning Formula - 12)}$$

$$Q = \frac{1.486}{0.012} (0.6136) (0.3125^{2/3}) 0.01^{1/2}$$

$$Q = 123.833 (0.6136) (0.4605) 0.10$$

$$Q = 123.833 (0.282563) 0.10$$

$$Q = 3.4991 \text{ cu. ft./sec.}$$

GPM = Q x 7.481 Gal. per cu. ft. x 60 seconds
= 1570.60 gal./min.

This indicates that the pipe is adequately sized to provide a capacity (Q) of 1,500 gal./min. with the system flowing half-full.

In order to determine whether the system will operate at a velocity consistent with good design (i.e., between 2 and 10 ft./sec.), the following calculation is made:

V = Q/a
V = 3.4991/0.6136
V = 5.70 ft./sec.

Therefore, the system design provides both an adequate capacity and an efficient operating velocity.

The derivations of flow capacity and velocity made above by Formula 2 could have been obtained by referring to Table 2 or Chart 2. It will be noted that a number of possible designs frequently can be employed to satisfy a given capacity requirement, provided conditions at the construction site permit the designer latitude in selecting a system slope. The combination of pipe size and slope selected should most closely satisfy the capacity specified for the system and, if possible, also provide an efficient operating velocity.

UNDERGROUND INSTALLATION PROCEDURES

The physical properties of cast iron soil pipe and fitting make it the best drain, waste, and vent material for underground installation. Two key elements for proper underground installation are trench preparation and backfilling.

The trench should be wide enough for easy assembly of the joints. Total load on the pipe includes both earth load and truckload. Safety procedures in trenching should be observed, including provisions to avoid collapse of the trench wall. Cast iron being a rigid material does not depend upon sidefill for support. The trench bottom should be stable enough to support the complete barrel of the pipe. If possible the barrel of the pipe should rest on even and undisturbed soil. Holes should be provided at each joint for each hub or coupling to allow for continuous support of the barrel along the trench bottom. If the ditch must be excavated deeper than the depth of the drainage pipe, place and tamp backfill material to provide uniform support for the pipe barrel.

Many times in the installation of underground cast iron it is necessary to make adjustments to the direction of the drain line. Cast Iron soil pipe and neoprene compression gaskets will allow this through deflection in the joints. Installation should initially be completed in a straight line and then deflected to the appropriate amount. Maximum deflection should not exceed 1/2 inch per foot of pipe. This would allow 5 inches of deflection for a 10 foot piece of pipe. For changes in direction greater than these deflections an appropriate fitting should be used.

While backfilling, use cradling and partial backfilling of pipe to stabilize its position and maintain its correct alignment. While pouring slabs, stabilize piping securely to prevent any misalignment during the pour. Firmly secure all closet bends installed under a slab.

Where unstable soil requires the drain and waste line to be supported with hangers attached to the concrete slab, sway bracing should always be a part of the support system. Sway bracing will help keep the system in proper alignment and help eliminated movement from side to side.

Once the underground installation is completed, the section is ready for testing. **Charlotte Pipe recommends testing at 10 feet of hydrostatic (water) pressure (4.3 pounds per square inch.)** See testing and inspection. Because this portion of the system is usually the largest diameter pipe it is necessary to restrain the system or joints from movement at changes in direction and end of runs prior to testing. This may be done by partially backfilling and leaving the joints exposed for inspection or rodding and or bracing.

After testing is completed, the trench can be properly backfilled. When backfilling, care should be taken to protect the pipe from large rocks, stones, or frozen fill material that could damage the pipe. Cast iron soil pipe laid on a solid trench bottom does not require special backfilling or procedures.

Installer should always consider local conditions, codes, manufacturers instructions, and engineers instructions in any installation.

ABOVE GROUND INSTALLATION PROCEDURES

Installing Vertical Piping

1. Secure vertical piping at intervals sufficiently close to maintain correct pipe alignment and to support the weight of the pipe and its contents. Support stacks at their bases and at sufficient floor intervals to meet the requirements of local codes. Use approved riser clamps, floor clamps, or friction clamps for this purpose.
2. If vertical pipe is required to stand free of any support by design specifications, or if no structure is available for support and stability during construction, secure the piping in its proper position with metal stakes and braces fastened to the pipe.

Caution: Unsecured piping can fall and cause serious injury. Always support and secure piping to prevent injury. Wear protective clothing, including a hard hat.

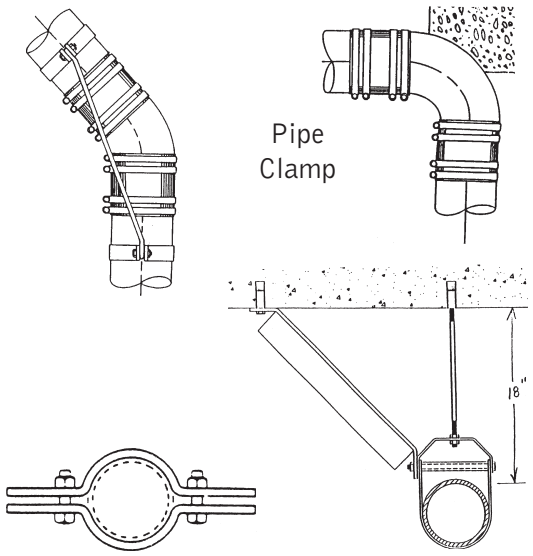
Installing Horizontal Piping—Suspended

1. Support horizontal piping and fittings at intervals sufficiently close to maintain correct pipe alignment and to prevent sagging or grade reversal. Support each length of pipe with an approved hanger located as close to the joint as possible, and not more than 18 inches from the joint. For 12" and 15" hubless pipe, hangers should be placed on both sides of the coupling when installing full 10 foot lengths. Installation requiring multiple joints within a four foot developed length shall be supported at every other or alternating couplings.

2. Support terminal ends of all horizontal runs or branches, and each change of direction or alignment, with an approved hanger.
3. Firmly secure all closet bends installed above ground.

Installing Horizontal Piping — Inside the Building

1. Most authorities and plumbing codes require that five-foot pipe be supported at five-foot intervals, and that ten-foot pipe be supported at ten-foot intervals. Support each length of pipe properly to prevent sagging and misalignment. **Support each length of pipe with an approved hanger located as close to the joint as possible, and not more than 18 inches from the joint. For 12" and 15" hubless pipe, hangers should be placed on both sides of the coupling when installing full 10 foot lengths. Installation requiring multiple joints within a four foot developed length shall be supported at every other or alternating couplings.**



2. When installing large-diameter horizontal piping (five inches or larger), substantially brace the system to prevent horizontal movement. Use sway bracing as needed to stabilize side movement of the piping system. Use blocks, rods, bracing, or other suitable methods at each branch opening or change in direction. Different types of bracing are shown above.

Installing Horizontal Fittings

1. Use hangers as required to provide proper alignment and grade. Install a hanger at every horizontal branch connection. **Always install hangers within 18 inches of the joint to maintain correct system alignment and to prevent structural sagging. For 12" and 15" Hubless pipe, hangers should be placed on both sides of the coupling when installing full 10 foot lengths. Installation requiring multiple joints within a four foot developed length shall be supported at every other or alternating couplings.** The correct use of hangers will provide proper piping system grade.
2. Use sway bracing, as needed, to stabilize hanging systems against undesirable horizontal movement. Sway bracing is a non-rigid form of structural support that is well suited to installations in which components hang from a height greater than 18 inches.
3. The following components should be stabilized from movement in any direction: closet bends; traps; trap-arms; all similar branches. Closet bends installed above ground must be stabilized. **Stabilize all vertical closet stubs against all vertical and horizontal movement.**
4. When a hubless blind plug is used for a required cleanout, the complete coupling and plug must be accessible for removal and replacement.
5. Use caulked lead and oakum or compression joints to connect closet rings, floor drains, shower drains, similar slip-over fittings, and hubless pipe and fittings to soil pipe hubs.

Installing Vertical Piping Attachments

- **Secure vertical piping properly. If vertical piping is to stand free of support, or if no structural element is available during construction, secure the piping with sturdy metal stakes or braces fastened to the pipe.**

CAUTION: Unsecured piping can fall and cause serious injury. Always support and secure piping to prevent injury. Wear protective clothing, including a hard hat.

- Secure vertical piping at intervals sufficiently close to maintain correct alignment and to support the weight of the piping and its contents. Support stacks at their bases. If over two stories in height, support stacks at their bases and at each floor with approved clamps.
- **Support the weight of vertical pipe risers at the point or points above and closest to their center of gravity.**

NOTE: The following procedures are intended only as general guidelines. Specific installation instructions and techniques may be required as a result of applicable plumbing and building codes, engineering specifications and instructions.

INSTALLATION PROCEDURES FOR CAST IRON SOIL PIPE AND FITTINGS

CHARLOTTE PIPE AND FOUNDRY COMPANY

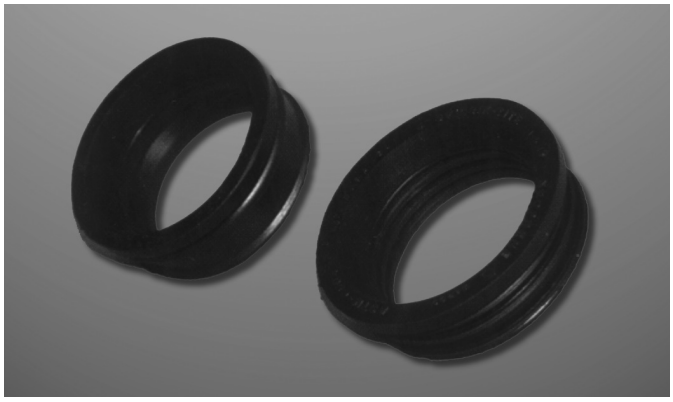
Employ the knowledge and skill of an expert, licensed plumbing contractor for the best possible installations. Follow good plumbing practices and observe all safety precautions. Cast iron soil pipe and fittings should be installed in accordance with all applicable local plumbing codes and regulations. Equally important, follow all appropriate engineering specifications, building regulations and manufacturers' instructions.

The following information is intended for use by licensed plumbing contractors and contains only suggested installation and testing procedures. The information is not meant to be a complete form of instruction.

Always take care during the installation of drain, waste and vent (DWV) systems to assure their satisfactory performance. Failure to follow proper installation practices, procedures, and techniques can result in system failure, property damage, or personal injury. Please read all of the following information.

Joining Methods for Cast Iron Soil Pipe

There are generally three methods for joining cast iron soil pipe. A compression gasket or a caulked joint is used to join hub and spigot cast iron soil pipe. A hubless coupling is used to join hubless cast iron soil pipe.



Compression Gaskets

A compression gasket is a molded one-piece gasket made of an elastomer that meets ASTM C 564. The physical characteristics of this elastomer help to insure that the gasket will not decay or deteriorate from contact with materials carried in the piping system, or from contact with the soil or air around the pipe. Most compression gaskets are made of neoprene, a chemically resistant material that is safe to use in contact with most substances found in plumbing systems. See pages 24-25 for chemical resistance of neoprene.

Charlotte compression gaskets are precision-molded of durable neoprene. **Note that Service gaskets must be used with Service pipe and fittings. Extra Heavy gaskets must be used with Extra Heavy pipe and fittings.**

Charlotte Pipe and Foundry Company strongly recommends that its cast iron bell and spigot pipe and fittings be joined with compression gaskets sold by our Company. Our hub and spigot pipe and fittings are manufactured to very specific manufacturing tolerances which conform to ASTM A 74. Our gaskets, produced in conformity with ASTM C 564, are especially designed to work with our pipe and fitting tolerances.

It has been the experience of our Company that gaskets designed by other manufacturers, even though they may be manufactured to the same consensus standards, may give less than satisfactory test and performance results. Consequently, failures in installations using gaskets not recommended by Charlotte Pipe® are not the responsibility of this company.

CAUTION: Use the proper safety procedures, protective eye-wear, clothing and equipment when making any compression gasket joint.

Making A Compression-Gasket Joint

1. Clean the hub and spigot so they are free of all dirt, mud, sand, gravel, and other foreign materials.
2. Remove sharp edges by filing or tapping with a ball-peen hammer. Insert the gasket into the hub. This may done by using one of three methods.

- **Double Folding:** Squeeze the gasket together with both hands, then insert it into the hub. As you withdraw your hands, the gasket will unfold, or snap into proper position.

INSTALLATION PROCEDURES FOR CAST IRON SOIL PIPE AND FITTINGS

- **Thumb Fold:** Hold the outside circumference of the gasket and press thumbs down and in, as though turning the gasket inside out. Place the gasket into the hub and release it, allowing it to snap into proper position.

- **Drive-In:** Place the gasket into the hub as far as possible, then tap the gasket's outer lip with a rubber mallet or flat board until it becomes seated. This method works best on two- or three-inch gaskets.

3. Regardless of which insertion method you use, the gasket must be completely inserted into the hub. Only the gasket's flange which shows identification information should remain exposed outside the hub.
4. Lubricate the gasket following the lubrication manufacturer's specific recommendations. For small-diameter pipe and fittings (2" - 4"), coat the inside of the gasket with lubricant using a paint brush or rag, and then coat the outside of the spigot. **Do not apply regular lubricant to the inside of the cast iron hub, or to the outside of the gasket.**

For large-diameter pipe and fittings (5" - 15"), we recommend that you use an adhesive lubricant.

CAUTION: Keep adhesive lubricant from touching eyes or skin. Provide good ventilation when using adhesive lubricant. Read and carefully follow the manufacturer's application and safety instructions, particularly when working around sources of heat, sparks or open flames. In case of an accident, follow hazardous warning and medical treatment statement shown on the product's label.

Adhesive lubricant should be applied to the inner surfaces of the gasket, and to the components' hub and spigot. Note that the use of adhesive lubricant does not take the place of proper joint restraint, when required.

- **About Pipe Joint Lubricants:** Regular lubricant is a flax-based compound that makes joining easy. It lowers the amount of force needed to join components by reducing friction. **When you need to join large-diameter (5" through 15") components, we recommend that you use adhesive lubricant.** Adhesive lubricant contains a neoprene-based adhesive which helps bond the components being joined.

5. Align the pipe so that it is straight, then push or pull the spigot through all the sealing rings of the gasket. Charlotte plain-end pipe is manufactured with beveled ends to make insertion easy. As the spigot barrel is forced into the gasket, the gasket is compressed and completely seals the joint in both displacement and compression. When seated correctly, you will feel the spigot end of the pipe "bottom" in the hub. You may use the tool of your choice to seat the spigot into the hub. We recommend that you use Charlotte Pipe pulling tool (part # EPT-920) which is well-designed and readily available through your local plumbing supplier.
   - **Vertical Position Assembly.** Using Charlotte Pipe pulling tool (part # EPT-920) for a vertical position assembly, place the yoke behind the hub. Fasten the chain through the slot and hook it on the pipe end. Pull the handle to assemble the joint.
   - **Horizontal Position Assembly.** For a horizontal position assembly, place the yoke behind the hub. Wrap the chain around the barrel of the pipe and fasten the chain through the slot. Pull the handle to assemble the joint.

Disassembly Of A Compression-Gasket Joint

- **Disassembly of Joint.** Should you need to take apart a joint, follow these instructions: place the yoke in front of the hub; hook the chain around the barrel of the pipe; place the chain in the slot in the end of the bar; push the handle to dissemble the joint. (See photo at top of next column.)

Installing Fittings with Compression-Gasket Joints

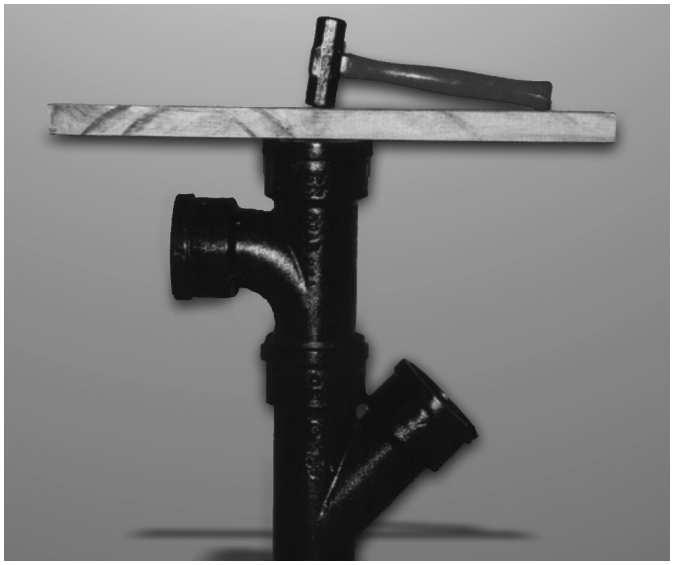
There are several techniques that may be used to assemble fitting compression-gasket joints. Review the following ones to determine which best suits your needs.

CAUTION: Use the proper safety procedures, protective eye-wear, clothing and equipment when making any compression gasket joint.

- **Using Charlotte Pipe Part # EPT 920.** Begin by installing the gasket into the hub as described earlier, lubricate, and then align the spigot. Next, place

yoke behind the hub and adjust the slide bar to the length of the fitting. Pull the handle to assemble the joint. When seated correctly, you will feel the fitting "bottom" in the hub.

- **Using a Lead Maul.** Almost all plain-end fittings may be installed by driving them into place with a lead maul or a mallet. After installing and lubricating the gasket, align the spigot and strike the fitting on its driving lug, or across its full hub, with a lead maul. Driving lugs are standard on all Charlotte plain-end bends and they make joining easy. The fitting may be struck as hard as necessary, since the lead maul will deform before damaging the fitting.



- **Using a Mallet.** If you prefer to use a mallet, place a wooden block over the fitting's hub. After installing and lubricating the gasket, align the spigot and strike the wooden block with the mallet until the spigot is properly seated.
- **Joining by Jolting.** Pre-assembly of fittings and short lengths of pipe can be done by jolting on a piece of wood or other sturdy surface. After installing and lubricating the gasket, align the spigot in the gasket, then push or pull the spigot into the gasket as far as you can. Next, jolt the assembly on a piece of wood or other sturdy surface until the spigot "bottoms" in the hub.
- **Using a Pry-Bar.** A pry-bar can speed installations, particularly on long runs of straight pipe being installed below ground. After installing and lubricating the gasket, align the spigot in the gasket, then apply the pry-bar to force the pipe through seal. It is correctly seated when it "bottoms" in the hub.
- **Making Adjustments.** You can reposition a fitting's alignment after forming a compression- gasket joint. Turning the fitting does not damage Charlotte compression gaskets when non- adhesive lubricant has been correctly used. **However, if adhesive lubricant has been used and allowed to set, repositioning the fitting will damage the adhesive quality of the joint.**

- **Disassembly of Joint.** Should you need to take apart a compression-gasket joint, follow these instructions: place the yoke in front of the hub; hook the chain around the fitting; place the chain in the slot in the end of the bar; push the handle to dissemble the joint.
- **Cold Weather Installations.** All elastomers tend to stiffen as their ambient temperature drops. Charlotte® compression gaskets will perform best if kept above 50 degrees F. To make joining easy in cold conditions, keep gaskets in warm water until

ready for use. Cold gaskets which have become stiff can quickly be made pliable by bringing them into a heated space, or immersing in warm water.

Important Reminders and Helpful Hints about Compression Gasket Joints

- Use only Charlotte "plain-end" pipe and fittings with Charlotte compression gaskets.
- Service pipe and fittings must be joined with Service gaskets. Extra Heavy pipe and fittings must be joined with Extra Heavy gaskets.
- Before inserting the gasket, make sure that the hub is clear of all dirt and other foreign materials that would interfere with assembly.
- Lubricate the inside of the gasket and the outside of the spigot.
- When installing large-diameter pipe (5" - 15"), we recommend using adhesive type lubricant.
- Make certain that the pipe or fitting is in good alignment (not cocked) before pulling the plain- end spigot into the gasket.
- The spigot must pass through both seals until it "bottoms" firmly in the base of the hub.
- If pipe is cut in the field and you are having difficulty making it bottom, you may be snagging the gasket with the pipe's cut end. To solve this problem, smooth the sharp spigot by filing.
- To make joining easy in cold conditions, keep gaskets in warm water until ready for use.
- If adhesive lubricant has been used and allowed to set, repositioning the pipe or fitting will damage the adhesive quality of the joint.

Making Caulked Joints

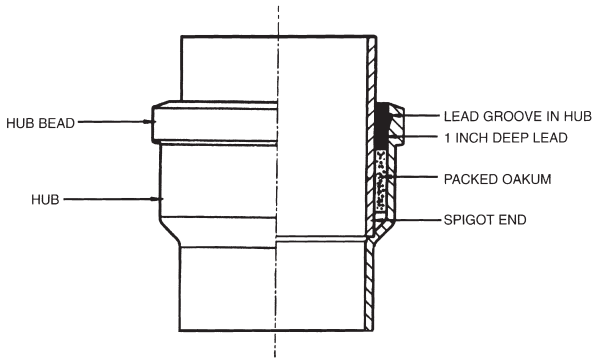
A caulked joint may also be used to join hub and spigot cast iron soil pipe, as follows:

1. Place the spigot end of a pipe or fitting inside the hub of another pipe or fitting and align correctly, making sure that all surfaces are clean and dry.
2. Place oakum into the joint using a yarning iron.
3. Pack the oakum to the proper depth using a packing iron.
4. Pour molten lead into the joint, filling it to the top of the hub. **For a horizontal joint, use a joint runner to retain the molten lead in the hub.**

CAUTION: Use all appropriate safety precautions and wear protective eye-wear, clothing and equipment when making a caulked joint. Handling molten lead can be dangerous, therefore follow all customary safety precautions, including the use of eye protection equipment.

DANGER: Molten lead may explode when placed in contact with liquids, including water, so exercise extreme caution when handling molten lead.

5. After the lead has cooled somewhat and solidified, the joint is ready to be caulked. Caulk the joint with inside and outside caulking irons. Caulking the joint sets the lead and makes a leak-free joint.



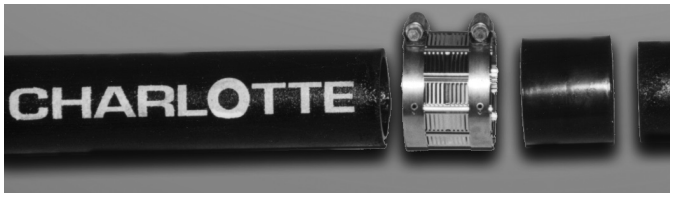
THE HUBLESS JOINT

No-Hub couplings are used to connect cast iron pipe and fittings manufactured in accordance with Cast Iron Soil Pipe Institute standard 301 (CISPI 301). Standard No-Hub couplings are manufactured to CISPI 310 and ASTM C 1277. Super Duty No-Hub couplings are manufactured to ASTM C 1540. The couplings are composed of a stainless-steel shield, clamp assembly, and an elastomeric sealing sleeve conforming to the requirements of ASTM C 564.

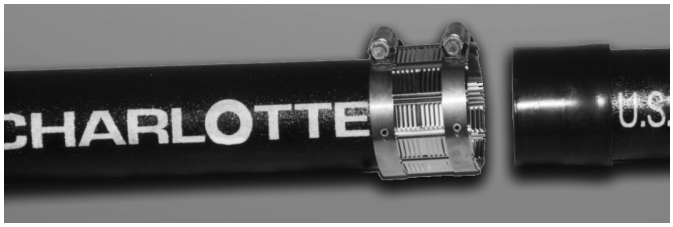
IMPORTANT NOTE: Charlotte Pipe does not recommend or warranty installations joined with unshielded hubless couplings. Charlotte Pipe strongly recommends that its cast iron pipe and fittings be joined with shielded hubless couplings manufactured in accordance with CISPI 310, ASTM C 1277, or ASTM C 1540. Failures in installations using couplings not recommended by Charlotte Pipe or not conforming to CISPI 310, ASTM C 1277 or ASTM C 1540 are not the responsibility of this company.

Charlotte Pipe and Foundry Super Duty couplings are manufactured to the requirements of ASTM C 1540. The dimensions specified in ASTM C 1540 result in couplings that extend beyond the "W" dimension of No-Hub pipe fittings in 1.5- through 6-inch diameters. All Charlotte Pipe and Foundry NH fittings are manufactured to the requirements of ASTM A 888 and CISPI 301 which require a gasket positioning lug and raised lettering. Therefore, ASTM C 1540 couplings will extend beyond the gasket positioning lug and may also cover raised lettering on some fittings.

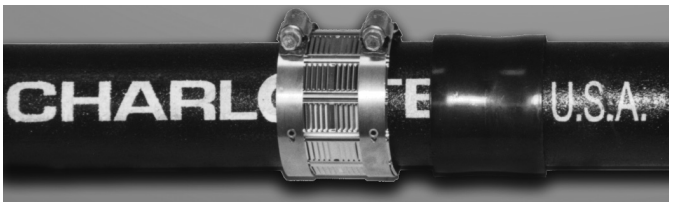
Making Hubless Joints



1. Lay out components as shown.



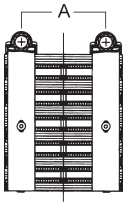
2. Place the neoprene sleeve on the end of the pipe or fitting, firmly seating the pipe or fitting end against the integrally-molded shoulder inside the sleeve. Also place the stainless-steel shield on the other component you're joining. Note: If you are working with a fitting, make sure the neoprene sealing sleeve makes contact with its positioning lug.



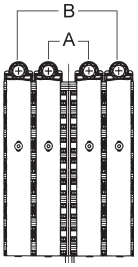
3. Insert the other component you're joining into the other side of the neoprene sealing sleeve, firmly seating the pipe or fitting end against the integrally-molded shoulder inside the sleeve.

4. Slide the clamp assembly into position over the neoprene sleeve and use the following procedures to tighten to manufacturer's recommended torque requirements using a properly calibrated torque wrench:

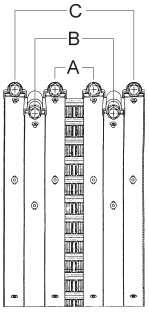
- For sizes 1-1/2" through 4" (coupling has two bands): Take the slack out of the clamp alternately and firmly, then tighten in the same sequence with a preset torque wrench.



- For sizes 5", 6", 8" and 10" (coupling has four bands): First take the slack out of the two inside clamps alternately and firmly, then repeat the process on the two outside clamps; finally tighten in the same sequence with a preset torque wrench.



- For sizes 12" and 15" (coupling has six bands): First take the slack out of the two inside bands alternately and firmly, then continue to the middle two bands and repeat the process; then repeat the process with the two outside bands; finally tighten in the same sequence with a preset torque wrench.



- For Super Duty coupling tightening sequence, see latest price sheet.

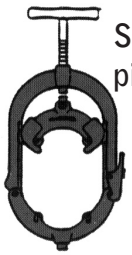
METHODS OF CUTTING CAST IRON SOIL PIPE

CAUTION: Proper safety procedures including eye protection, safety clothing and protective equipment should be used while cutting pipe.

There are several methods of cutting cast iron soil pipe. They may be grouped into two basic categories: those that require external power for their operation and those that require only hand operation. Methods that require external power are primarily used in fabrication work or high-volume cutting operations. Examples of this type of equipment include the abrasive saw (sometimes called a chop saw), the power hack saw, and the electrically-actuated hydraulic snap cutter. The abrasive saw is the most efficient tool for cutting 8″ and larger pipe.

Caution: Equipment using electric power can be dangerous. Always review and carefully follow the manufacturers' operating and safety instructions.

There are two types of hand-powered cutting tools used in the industry today. The **standard steel pipe cutter** uses cutting wheels specifically designed to cut cast iron soil pipe.



Standard steel pipe cutter.

The **snap cutter** is the tool most commonly used to cut cast iron soil pipe in the field. Several types of snap cutter are available.

Cutting Cast Iron Soil Pipe with a Snap Cutter

The following procedure has been found to produce consistently good cuts:

1. Measure the required pipe length and mark it for the cut.
2. Position the snap cutter's chain squarely around the pipe to assure that the cut is straight. Set the chain so that the maximum number of cutting wheels come into contact with the pipe.
3. Score the pipe by applying pressure on the handles, which causes the cutting wheels to indent the pipe's surface. Scoring the pipe prior to the actual cut is the key to making a straight, clean cut. If a piece of pipe is unusually tough, score it several times before making the final cut.
4. Rotate the pipe a few degrees within the chain. Then apply quick final pressure with the handles to complete the cut.

Cutting Cast Iron Soil Pipe with a Hammer and Cold Chisel

CAUTION: This method can be dangerous. Therefore, take customary safety precautions including wearing safety glasses and protective clothing.

Soil pipe may be cut with a hammer and cold chisel. This method is very time consuming and should only be used if snap cutters are not available. The procedure is as follows:

1. Measure the length to be cut and mark the cut line around the pipe's circumference.
2. Place the mark to be cut on a two by four so the edge of the board is directly under the mark.
3. Cut a grove around the pipe's circumference by striking the chisel with the hammer continuously along the mark.
4. Continue cutting as described in step three until the pipe is completely cut. This may require cutting around the circumference several times.

TESTING AND INSPECTION

It is important to test all cast iron piping installations for leaks after the roughing-in has been completed. Before making the test, the installer should notify the inspector of the local administrative authority having jurisdiction over plumbing installations. Leave concealed work uncovered until the required tests are performed and the system receives approval.

Various procedures are used to test installed cast iron soil pipe and fitting systems. They include the use of water (hydrostatic), air, smoke, and peppermint.

For testing purposes, the system should be properly restrained at all bends, changes of direction, and ends of runs.

CAUTION: Use the proper safety procedures, equipment, eye-wear, and clothing during any testing procedure.

In all installations, installers should be aware of local conditions, codes and regulations. Comply with all local codes, regulations, manufacturers' instructions and architect/engineer specifications.

The Water Test

This is the most common type of test used to inspect a completed cast iron soil pipe installation. Sometimes called the hydrostatic test, it is the test most recommended by plumbing codes. Its purpose is to check the installation for leaks at the joints and to correct these prior to putting the system into service. Use the following steps to perform a water test:

1. Since visual inspection of the system is required, conduct this test prior to enclosing above-ground installations, or backfilling below-ground installations.
2. Isolate each floor or section being tested by inserting plugs into the test tees in the stacks.
3. Plug or cap all other openings with test plugs or test caps.
4. **Make sure that all bends, changes of direction, and ends of runs are properly restrained before beginning the test procedure.** This is important because the test exerts a thrust force on these locations that is equal to the hydrostatic pressure multiplied by the area. Please refer to the thrust force table below for a summary of these values. **If**

Thrust or Displacement Forces Encountered in Hydrostatic Testing of Cast Iron Soil Pipe

Pipe Size		1½″	2″	3″	4″	5″	6″	8″	10″
Head, Feet of Water	Pressure PSI	Thrust lb.	Thrust lb.	Thrust lb.	Thrust lb.	Thrust lb.	Thrust lb.	Thrust lb.	Thrust lb.
10	4.3	12	19	38	65	95	134	237	377
20	8.7	25	38	77	131	192	271	480	762
30	13.0	37	56	115	196	287	405	717	1139
40	17.3	49	75	152	261	382	539	954	1515
50	21.7	62	94	191	327	479	676	1197	1900
60	26.0	74	113	229	392	574	810	1434	2277
70	30.3	86	132	267	457	668	944	1671	2654
80	34.7	99	151	306	523	765	1082	1914	3039
90	39.0	111	169	344	588	860	1216	2151	3416
100	43.4	123	188	382	654	957	1353	2394	3801
110	47.7	135	208	420	719	1052	1487	2631	4178
120	52.0	147	226	458	784	1147	1621	2868	4554
AREA, OD, $in.^2$		2.84	4.34	8.81	15.07	22.06	31.17	55.15	87.58

Thrust = Pressure x Area

not restrained, the thrust force will result in joint movement or separation, causing failure of the test.

5. Fill the system with water at its highest point. Do this slowly to allow any trapped air to escape as the water level rises. **Failure to remove entrapped air may cause faulty test results, so be sure all entrapped air has been removed to obtain reliable test results.**
6. As water fills a vertical pipe, it creates hydrostatic pressure. This pressure increases as the height of the water in the vertical pipe increases. **Charlotte Pipe recommends water testing with ten feet of hydrostatic pressure (4.3 pounds per square inch).**
7. After filling the stack to ten feet of head, visually inspect the section you are testing for any leaks around its joints.
8. In hubless systems, leaks can often be traced to hubless couplings that were not tightened properly to the recommended torque. In these cases, correctly tightening the couplings should eliminate the leak.
9. If leaks are detected in hub and spigot systems, disassemble the joints and check to determine if the correct installation procedures were used.
10. Water test each portion of the system for 15 minutes. This is sufficient time for any problems to be detected.
11. After a successful test, drain the system and prepare the next section for testing.

The Smoke Test

Should a smoke test be specified by an engineer, architect, or plumbing code, proceed as follows:

1. Permanently connect all fixtures and fill all traps with water.
2. Be prepared to test all parts of the plumbing drainage and ventilation system.
3. Close all windows in the building until the test has been completed.
4. Fill the system with a thick, penetrating smoke that has been generated by one or more smoke producing machines.

DANGER: Do not use chemical mixtures for producing smoke — they may be dangerous and cause severe personal injury.

5. When smoke begins to appear at the stack opening on the roof, close off that opening.
6. Continue filling the system with smoke until a pressure equal to one inch of water is built up.
7. Maintain this pressure for fifteen minutes or longer, as required to test the entire system.
8. Check all components of the system to insure that smoke is not escaping. **Smoke should not be visible at any point, connection, or fixture.**

The Peppermint Test

This test is most often used in older installations to detect faulty plumbing.

1. Permanently connect all fixtures and fill all traps with water.
2. Be prepared to test all parts of the plumbing drainage and ventilation system.
3. Close all windows in the building until the test has been completed.
4. Mix two ounces of peppermint oil with one gallon of hot water.
5. Pour the mixture into the system's roof opening.
6. Tightly close the roof opening.
7. Have a person other than the one that poured the mixture into the system inspect the system for any odor of peppermint.
8. Inspect all system points, connections, and fixtures. **There should be no odor of peppermint within the building.**

DO NOT USE CHARLOTTE PIPE PRODUCTS FOR COMPRESSED AIR OR GASES

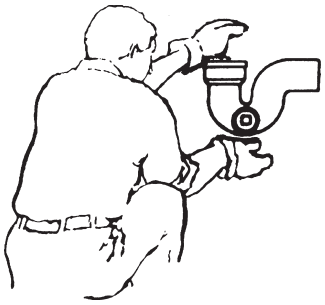
Charlotte Pipe and Foundry Company products are not intended to be used for distribution or storage of compressed air or gases. Uses of Charlotte Pipe products in inappropriate applications could result in product failure, serious injury or death.

Air or Gas Testing - Not Recommended

DANGER: Charlotte Pipe and Foundry **does not** recommend air testing. Pipe and fitting materials under air or gas pressure can explode, causing serious injury or death. Charlotte Pipe will not be responsible or liable for injury or death to persons or damage to property or for claims for labor and / or materials arising from any alleged failure of our products during testing with air or compressed gases.

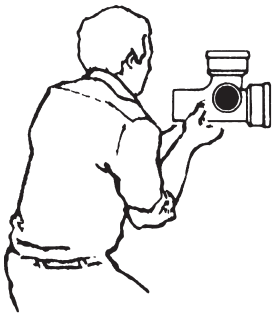
How to Determine Right or Left Hand Inlets

Use the following illustrations and descriptions to determine whether a fitting has a right or left hand inlet.



Right Hand Illustrated

- **Closet Bends and P Traps** — Place the inlet upright near you, with the spigot facing away. If the side inlet is on your right, it is a right hand inlet.



Right Hand Illustrated

- **All Branch Fittings** — Place the spigot near you, with the branch facing upwards. If the side inlet is on your right, it is a right hand inlet.
- **All Bends** — Place the fitting upright, with the spigot near you. If the side inlet is on your right, it is a right hand inlet.

A New Coating for Improved Performance

Charlotte Pipe's single-hub Service and Extra Heavy pipe, and all Hubless pipe now receive a new "Hot Dip" coating process. The Hot Dip coating provides numerous advantages over traditional bituminous coatings:

- **A higher softening point**
- **Greater abrasion resistance**
- **A hard, glossy, non-tacky surface**
- **Superior corrosion protection.**

The end result is pipe that is more environmentally friendly to manufacture, easier to handle, and more durable than pipe coated with traditional bituminous coatings. For more complete information on Charlotte Pipe's new Hot Dip coating, see the cast iron price sheet section of our Complete Catalog for the brochure, "Cast Iron Soil Pipe and Fittings," (BR-CI).

Painting Charlotte's Cast Iron Soil Pipe

If desired, Charlotte Pipe's cast iron soil pipe and fittings can be painted to coordinate with surrounding surfaces.

CAUTION: Carefully review and follow the paint manufacturer's instructions. Be very careful regarding ventilation and eye or skin contact. Use extreme caution near sparks, heat or open flames. In case of accident, follow the hazardous warning and treatment statement printed on the paint container label.

Follow these steps for a high-quality painted finish:

1. Clean the pipe's surface of all dirt, oil and grease.
2. Apply a primer coat of high-quality, oil-based primer paint. Allow it to dry according to the paint manufacturer's specifications.
3. Apply a top coat of high-quality, oil-based enamel paint. Allow the painted components to dry according to the paint manufacturer's specifications before handling them.

Features and Benefits of Neoprene Gaskets

- **Resistant to Physical Abuse** — Products made of neoprene naturally resist abrasion and other types of physical abuse. This makes neoprene gaskets tough, resilient, and well-suited for the rigors of piping installation.
- **Resistant to Compression Set** — Neoprene is highly resistant to permanent deformation (compression set), even when heavily loaded for an extended period of time. This makes neoprene gaskets seal tightly during the long service life of a cast iron DWV system.
- **Heat Resistance** — Neoprene withstands temperatures up to 212 degrees F without softening or significant loss of physical properties. This makes neoprene gaskets ideally suited to drainage applications, even in commercial applications where relatively high discharge temperatures are experienced.
- **Flame Resistance** — Neoprene will not propagate a flame and it is self-extinguishing when removed from a flame (although it will burn when placed in a direct flame). Thus, neoprene gaskets support the fire-resistant qualities of cast iron plumbing.
- **Cold Resistance** — Neoprene becomes slightly less flexible in the cold, but it does not lose its dependable operating characteristics in normal atmospheric temperatures. This means neoprene gaskets may be installed in winter and will function dependability, even in cold operating conditions.
- **Fungal Resistance** — Neoprene does not loose its excellent physical properties due to fungal growth, and it can be compounded to provide no nourishment for fungal growth. This allows neoprene gaskets to give dependable performance in the conditions commonly found in their service environment.
- **Environmental Resistance** — Neoprene is highly resistant to ozone, sunlight, and other outdoor influences. Thus, neoprene gaskets stand up well under normal storage and service conditions.
- **Chemical Resistance** — Neoprene is resistant to a wide range of chemicals, including many that are commonly found in soil: agricultural chemicals, industrial chemicals, sea water, oil, and gasoline. Thus, neoprene gaskets are well-suited for underground installations. A guide to the chemical resistance of neoprene is shown on pages 24 and 25.

Components of the DWV System

Cast iron soil pipe is primarily used in the construction of buildings. It serves well in sanitary drain, storm drain, waste line, and vent line applications. The product is widely used in commercial, industrial, and residential construction. Common examples include hospitals, schools, stadiums, prisons, and private dwellings. Cast iron soil pipe is the primary DWV material used in high-rise building construction.

Inside homes and buildings, sanitary piping is installed within partitions and is connected to tubs, lavatories, water closets, and other fixtures. The main component of the DWV system is called the **cast iron soil stack**. This is the vertical piping line that runs upward from the building drain, continues up through the structure, and penetrates the plane of the roof. **Waste lines** convey waste from the fixtures to the main stack. **Vent lines** are the system's source of outside air, which allows the system to function properly by preventing a vacuum from forming. Vent lines are tied into the system at a point above the highest fixture. In some installations, vent lines are connected to a separate vent stack.

A lower section of horizontal piping within the structure's DWV system is called **the drain**. It receives discharge from the upper portion of the system and carries it to the **building's sewer**. The building sewer routes discharge to the point outside the structure prescribed by the local plumbing code, where it connects to the **city sewer**, or a **septic tank**.

Within the area of building construction, cast iron soil pipe and fittings are widely used for storm drainage from roofs, yards, areaways, and courts. Cast iron piping is used for collecting runoff from sub-soil drains, which are positioned around the foundation. These drains relieve the foundation from groundwater by channeling it into a storm drainage system, or a sump pump.

Soil pipe also serves well as roof leaders and storm drains. The design specifications for high-rise structures with large setbacks often call for soil pipe to carry large amounts of rain water and snow melt. Outside the area of building construction and storm drainage, cast iron piping is used in condensate lines, bridge drainage, and swimming pool drainage lines.

Requirements for a High-Quality Drain, Waste and Vent System

A high-quality DWV system must possess the following performance characteristics:

- **Strength and Rigidity**
- **Durability**
- **Quiet Operation**
- **Non-combustibility**
- **High Crush Strength**
- **High Temperature Resistance**
- **High Corrosion Resistance**
- **High Abrasion Resistance**
- **Low Expansion/Contraction**
- **Leak-free Joints**

Cast iron soil pipe and fittings possess all these qualities, delivering outstanding performance in all critical areas.

System

Service (SV) Cast Iron Soil Pipe

Installation Instructions

CP&F Installation Procedures

Pipe & Fitting Standards

ASTM A 74
CISPI HS 74

Charlotte Seal & Quik-Tite Gasket Standards

ASTM C 564
CISPI HSN

Dimensional Standard

Soil Pipe Dimensional Standard per ASTM A 74

- Soil pipe is close dimensionally to Sch. 40 IPS, but it is **NOT** the same.

Material Description

Gray Cast Iron

Maximum Working Temperature

212°F

- 212°F is the maximum working temperature for neoprene pipe gaskets.

Maximum Working Pressure

0 (zero) PSI.

- Cast Iron is not a pressure rated piping system.
- Neoprene compression gaskets are not rated for pressure.
- Recommended test is 10 feet of hydrostatic pressure, which equals 4.3 PSI.

Joining Method

Hub & Spigot Mechanical Joint

- Neoprene Charlotte Seal Gasket.
- Neoprene Warco Quik-Tite Gasket.
- Lead & Oakum Caulked Joint.

Thermal Expansion

0.745 inches per 100' of pipe with a 100°F temperature rise.

- Expansion joints are not required, as the CI's expansion rate is almost exactly the same as steel or concrete.

Special Considerations

- **DO NOT air test.**
- Store gaskets at 50°F or above for easier installation.
- Do not expose to acid waste with a pH below 4.3.

FAQ's

Q: **Can SV gaskets be used with XH pipe?**
A: No. XH gaskets must be used with XH pipe. SV gaskets must be used with SV pipe.

Q: **Can a fitting be repositioned after installation?**
A: Yes. With Charlotte Seal or Quik-Tite Gaskets a fitting can be repositioned after installation.

Q: **Which is better, regular or adhesive lubricant?**
A: **Adhesive lubricant** contains a neoprene based adhesive that bonds the gasket to the pipe. Adhesive is recommended on large diameter (5"-15") pipe and fittings. Apply to both the I.D. of hub & I.D. of gasket.
Regular lubricant makes joining easier, but does not help seal. Apply only to the I.D. of gasket and the O.D. of pipe or fitting spigot.

Q: **Why should I buy my gaskets from CP&F?**
A: 1) CP&F gaskets are manufactured from neoprene. It is possible to manufacture gaskets from lesser quality materials.
2) CP&F products are manufactured to nominal standards. Other products may not be manufactured to the same tight dimensional standards.
3) CP&F cannot guarantee the quality or suitability of products that it does not furnish.

Q: **How does CP&F coat its pipe and fittings?**
A: Pipe and fittings are dipped in a water based asphaltic coating.
Small dia.: 110 microns thick I.D., 210 microns O.D.
Large dia.: 180 microns I.D., 325 microns O.D. (average thickness).

System

Service (SV) Cast Iron Soil Pipe

Product Offering / Data

Product	Length	Size	Depth of Hub	Hub ID	Barrel ID	Barrel OD	Nom Wall	Max Crush Load (lbs/ft)	Weight Per Piece (lbs.)
Single Hub Service Weight	5'	2"	2.50	2.94	1.96	2.30	0.17	7680	22
		3"	2.75	3.94	2.96	3.30	0.17	5226	31
		4"	3.00	4.94	3.94	4.30	0.18	4451	41
		5"	3.00	5.94	4.94	5.30	0.18	3582	53
		6"	3.00	6.94	5.94	6.30	0.18	2997	68
		8"	3.50	9.25	7.94	8.38	0.23	3674	101
		10"	3.50	9.25	9.94	10.50	0.28	4342	151
		12"	4.25	13.50	11.94	12.50	0.28	3632	186
		15"	4.25	16.96	15.16	15.88	0.36	4727	288
	30"	8"	3.50	9.25	7.94	8.38	0.23	3674	59
		10"	3.50	9.25	9.94	10.50	0.28	4342	92
		12"	4.25	13.50	11.94	12.50	0.28	3632	107
		15"	4.25	16.96	15.16	15.88	0.36	4727	149
Double Hub Service Weight	5'	2"	2.50	2.94	1.96	2.30	0.17	7680	22
		3"	2.75	3.94	2.96	3.30	0.17	5226	31
		4"	3.00	4.94	3.94	4.30	0.18	4451	42
		5"	3.00	5.94	4.94	5.30	0.18	3582	57
		6"	3.00	6.94	5.94	6.30	0.18	2997	70
Single Hub Service Weight	10'	2"	2.50	2.94	1.96	2.30	0.17	7680	41
		3"	2.75	3.94	2.96	3.30	0.17	5226	60
		4"	3.00	4.94	3.94	4.30	0.18	4451	79
		5"	3.00	5.94	4.94	5.30	0.18	3582	100
		6"	3.00	6.94	5.94	6.30	0.18	2997	124
		8"	3.50	9.25	7.94	8.38	0.23	3674	181
		10"	3.50	9.25	9.94	10.50	0.28	4342	260
		12"	4.25	13.50	11.94	12.50	0.28	3632	346
		15"	4.25	16.96	15.16	15.88	0.36	4727	525
Double Hub Service Weight	30"	2"	2.50	2.94	1.96	2.30	0.17	7680	14
		3"	2.75	3.94	2.96	3.30	0.17	5226	18
		4"	3.00	4.94	3.94	4.30	0.18	4451	27

EXTRA HEAVY FACT SHEET

CHARLOTTE PIPE AND FOUNDRY COMPANY

System

Extra Heavy (XH) Cast Iron Soil Pipe

Installation Instructions

CP&F Installation Procedures

Pipe & Fitting Standards

ASTM A 74
CISPI HS 74

Charlotte Seal & Quik-Tite Gasket Standards

ASTM C 564
CISPI HSN

Dimensional Standard

Soil Pipe Dimensional Standard per ASTM A 74

- Soil pipe is close dimensionally to Sch. 40 IPS, but it is **NOT** the same.

Material Description

Gray Cast Iron

Maximum Working Temperature

212°F

- 212°F is the maximum working temperature for neoprene pipe gaskets.

Maximum Working Pressure

0 (zero) PSI.

- Cast Iron is not a pressure rated piping system.
- Neoprene compression gaskets are not rated for pressure.
- Recommended test is 10 feet of hydrostatic pressure, which equals 4.3 PSI.

Joining Method

Hub & Spigot Mechanical Joint

- Neoprene Charlotte Seal Gasket.
- Neoprene Warco Quik-Tite Gasket.
- Lead & Oakum Caulked Joint.

Thermal Expansion

0.745 inches per 100' of pipe with a 100°F temperature rise.

- Expansion joints are not required, as the CI's expansion rate is almost exactly the same as steel or concrete.

Special Considerations

- **DO NOT air test.**
- Store gaskets at 50°F or above for easier installation.
- Do not expose to acid waste with a pH below 4.3.

FAQ's

Q: **What advantage does XH Soil Pipe offer?**
A: CP&F recommends hub & spigot pipe underground because of its rigid joint. In addition to the rigid joint, XH pipe offers **heavier wall, increased corrosion resistance and greater crush strength**. Important for pipe buried under roads - live loads.

Q: **Can SV gaskets be used with XH pipe?**
A: No. XH gaskets must be used with XH pipe. SV gaskets must be used with SV pipe.

Q: **Can a fitting be repositioned after installation?**
A: Yes. With Charlotte Seal or Quik-Tite Gaskets a fitting can be repositioned after installation.

Q: **Which is better, regular or adhesive lubricant?**
A: **Adhesive lubricant** contains a neoprene based adhesive that bonds the gasket to the pipe. Adhesive is recommended on large diameter (5"-15") pipe and fittings. Apply to both the I.D. of hub & I.D. of gasket.
Regular lubricant makes joining easier, but does not help seal. Apply only to the I.D. of gasket and the O.D. of pipe or fitting spigot.

Q: **Why should I buy my gaskets from CP&F?**
A: 1) CP&F gaskets are manufactured from neoprene. It is possible to manufacture gaskets from lesser quality materials.
2) CP&F products are manufactured to nominal standards. Other products may not be manufactured to the same tight dimensional standards.
3) CP&F cannot guarantee the quality or suitability of products that it does not furnish.

EXTRA HEAVY FACT SHEET

System

Extra Heavy (XH) Cast Iron Soil Pipe

Product Offering / Data

Product	Length	Size	Depth of Hub	Hub ID	Barrel ID	Barrel OD	Nom Wall	Max Crush Load (lbs/ft)	Weight Per Piece (lbs.)
Single Hub Extra Heavy	5'	2"	2.50	3.06	2.00	2.38	0.19	9331	25
		3"	2.75	4.19	3.00	3.50	0.25	10885	44
		4"	3.00	5.19	4.00	4.50	0.25	8324	60
		5"	3.00	6.19	5.00	5.50	0.25	6739	74
		6"	3.00	7.19	6.00	6.50	0.25	5660	81
		8"	3.50	9.50	8.00	8.62	0.31	6546	141
		10"	3.50	11.62	10.00	10.75	0.37	7465	197
		12"	4.25	13.75	12.00	12.75	0.37	6259	245
		15"	4.25	16.95	15.00	15.88	0.44	7097	350
	30"	8"	3.50	9.50	8.00	8.62	0.31	6546	76
		10"	3.50	11.62	10.00	10.75	0.37	7465	113
		12"	4.25	13.75	12.00	12.75	0.37	6259	136
		15"	4.25	16.95	15.00	15.88	0.44	7097	197
Double Hub Extra Heavy	5'	2"	2.50	3.06	2.00	2.38	0.19	9331	26
		3"	2.75	4.19	3.00	3.50	0.25	10885	45
		4"	3.00	5.19	4.00	4.50	0.25	8324	60
		5"	3.00	6.19	5.00	5.50	0.25	6739	80
		6"	3.00	7.19	6.00	6.50	0.25	5660	85
Single Hub Extra Heavy	10'	2"	2.50	3.06	2.00	2.38	0.19	9331	45
		3"	2.75	4.19	3.00	3.50	0.25	10885	84
		4"	3.00	5.19	4.00	4.50	0.25	8324	105
		5"	3.00	6.19	5.00	5.50	0.25	6739	134
		6"	3.00	7.19	6.00	6.50	0.25	5660	157
		8"	3.50	9.50	8.00	8.62	0.31	6546	246
		10"	3.50	11.62	10.00	10.75	0.37	7465	375
		12"	4.25	13.75	12.00	12.75	0.37	6259	471
		15"	4.25	16.95	15.00	15.88	0.44	7097	676
Double Hub Extra Heavy	30"	2"	2.50	3.06	2.00	2.38	0.19	9331	15
		3"	2.75	4.19	3.00	3.50	0.25	10885	26
		4"	3.00	5.19	4.00	4.50	0.25	8324	33

System

Hubless Cast Iron Soil Pipe

Installation Instructions

CP&F Installation Procedures

Pipe & Fitting Standards

CISPI 301

Charlotte Hubless Coupling Standards

ASTM C 564
ASTM C 1277
ASTM C 1540
CISPI 3IO

Dimensional Standard

- Soil pipe is close dimensionally to Sch. 40 IPS, but it is **NOT** the same.

Material Description

Gray Cast Iron

Maximum Working Temperature

212°F

- 212°F is the maximum working temperature for neoprene hubless pipe gaskets.

Maximum Working Pressure

0 (zero) PSI.

- Cast Iron is not a pressure rated piping system.
- Hubless Couplings are not rated for pressure.
- Recommended test is 10 feet of hydrostatic pressure, which equals 4.3 PSI.

Joining Method

Mechanical Joint.

- Neoprene hubless coupling with stainless steel shield.

Thermal Expansion

0.745 inches per 100' of pipe with a 100°F temperature rise.

- Expansion joints are not required, as the CI's expansion rate is almost exactly the same as steel or concrete.

Special Considerations

- **DO NOT air test.**
- Store hubless couplings at 50°F or above for easier installation.
- Tighten to manufacturer's recommended torque.
- Alternately tighten inner stainless steel bands first, then alternately tighten outer bands.
- Do not expose to acid waste with a pH below 4.3, or undiluted carbonated soft drinks.

FAQ's

Q: **Why should I buy my Hubless Couplings from CP&F?**

A: 1) CP&F couplings are manufactured from neoprene. It is possible to manufacture gaskets from lesser quality materials.
2) CP&F products are manufactured to nominal standards. Other products may not be manufactured to the same tight dimensional standards.
3) CP&F cannot guarantee the quality or suitability of products that it does not furnish.

Q: **Can a Hubless system with Hubless Couplings be buried?**

A: Yes. CP&F's hubless couplings are manufactured from neoprene and 300 series nickel chromium stainless steel and require no more protection against corrosion than the pipe itself.

Q: **Why is Charlotte's gray cast so resistant to corrosion?**

A: CP&F's gray cast iron contains an abundance of free graphite. Results in an insoluble corrosion resistant layer that forms after initial exposure to corrosive agents.

Q: **How does CP&F coat its pipe and fittings?**

A: Pipe and fittings are dipped in a water based asphaltic coating.
Small dia.: 110 microns thick I.D., 210 microns O.D.
Large dia.: 180 microns I.D., 325 microns O.D. (average thickness).

System

Hubless Cast Iron Soil Pipe

Product Offering / Data

Size	Product	Length	Barrel ID	Barrel OD	Nom Wall	Max Crush Load (lbs/ft)	Weight Per Piece (lbs.)
1 1/2"	No Hub	10'	1.50	1.90	0.16	8328	29
2"			1.96	2.35	0.16	6617	38
3"			2.96	3.35	0.16	4542	54
4"			3.94	4.38	0.19	4877	71
5"			4.94	5.30	0.19	3999	98
6"			5.94	6.30	0.19	3344	118
8"			7.94	8.38	0.23	3674	165
10"			10.00	10.56	0.28	4317	255
12"			11.94	12.50	0.28	3632	318
15"			15.11	15.83	0.36	4727	493

FACTS ABOUT NEOPRENE GASKETS ASTM C 564

CHARLOTTE PIPE AND FOUNDRY COMPANY

- **Resistance to Physical Abuse**

  Products made from neoprene are tough, strong and resilient, and have excellent resistance to abrasions and other forms of mechanical abuse. More importantly, they retain these properties under a wide range of service conditions.

- **Resistance to Compression Set**

  Neoprene is well known for its low degree of permanent deformation (or compression set), even under heavy loading for long periods. Properly compounded neoprene gaskets not only provides a positive seal, but will retain this sealing capacity for many years of service.

- **Resistance to Chemicals, Oil, Grease**

  Neoprene is one of the few elastomers well suited to direct burial, because it will withstand the natural corrosive components of soil as well as the oil, gasoline, and industrial chemicals, sea water and other foreign substances with which soil often becomes saturated . In addition, neoprene is highly resistant to deterioration from organic waste, asphalt and bitumastic pipe coating compounds, acids, alkalis, fat, and a broad range of common chemicals. This means that a drainage system sealed with neoprene can be used for industrial or agricultural as well as household service.

- **Heat Resistance**

  Properly compounded neoprene can operate at temperatures well over the boiling point of water without softening or significant loss of properties. Neoprene gaskets are commonly used in piping systems carrying hot water.

- **Low Temperature Properties**

  Although all rubber materials, including neoprene, tend to stiffen at low temperatures, neoprene gaskets are readily installed in winter weather. Once in place, a neoprene gasket should provide adequate service at -40° F, a temperature far below any encountered in normal service.

- **Weatherability, Storage Life**

  Neoprene's superior resistance to deterioration from ozone, sunlight and weather accounts for its excellent aging characteristics. This means that gaskets of neoprene will not crack during storage on the shelf or in the field.

- **Flame Resistance**

  Neoprene will not propagate flame. Though it will burn in direct flame, it is self extinguishing when the flame is removed.

- **Hardness Range**

  Hardness of neoprene in our compression gaskets is generally in the range of 50 to 60 plus or minus 5.

- **Maximum Working Temperature**

  The maximum working temperature for neoprene is 212° F.

- **Maximum Working Pressure**

  0 (zero) PSI
  - Hubless Couplings are not rated for pressure.
  - Charlotte Seal and Quik-Tite gaskets are not rated for pressure.

Neoprene's balanced combination of outstanding properties assure a positive seal that will provide many years of trouble-free service.

HUBLESS COUPLINGS FACT SHEET

System

Hubless Couplings (Regular)

Features

- Bi-directional corrugation helps eliminate wrinkling and bunching.
- Bi-directional shield corrugation provides exceptional grip on the gasket to minimize movement.
- Clamps use mechanical interlocking housing to band construction. One-piece housing cannot come apart under high loading.
- Floating eyelets clamp-to-shield construction provides uniform take-up by permitting the band to move independently of the shield.
- The maximum working temperature for neoprene is 212° F.
- Hubless Couplings are not rated for pressure.

Materials

- Band - Type 301 AISI Stainless Steel 1/2" wide
- Screw Housing - Type AISI 301 Stainless Steel
- Screw - Type 305 AISI Stainless Steel
- Shield - Type 301 AISI Stainless Steel

Specifications

- Couplings conform to the requirements of:
  - CISPI 310
  - ASTM C 1277
  - UPC Listed
- Gaskets conform with ASTM C 564

Size	Shield Width	Shield Thickness	Clamp Width	Number of Clamps
1½" - 4"	2.13"	.0075" +/- .001"	.500"	2
5" - 6"	3.00"	.0075" +/- .001"	.500"	4
8" - 10"	4.00"	.0075" +/- .001"	.500"	4

Hubless Clamp and Gasket Installation

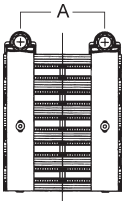
- Slide the clamp and shield assembly into position making sure the integrally molded shoulder in the center of the gasket butts against both ends of the material. At this point, it is recommended to take the slack out of the clamp and shield assembly by pre-tightening the clamps with a wrench "hand tight".

- Final tightening should be done with a preset torque wrench using the following procedure.

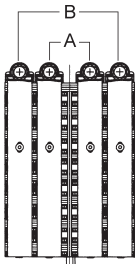
- Coupling sizes 1½" through 4" are 2.13 inches wide and have two bands. Tighten alternately and firmly to manufacturer's recommended torque.

- Coupling sizes 5" and 6" are 3 inches wide and have four bands. Sizes 8" and 10" are 4 inches wide and have four bands. Sizes 12" and 15" are 5.50 inches wide and have six bands. First the inner bands (A) are to be tightened alternately and firmly to manufacturer's recommended torque. The middle bands (B) are to be tightened alternately and firmly to manufacturer's recommended torque. Finally the outer bands (C) are to be tightened alternately and firmly to manufacturer's recommended torque.

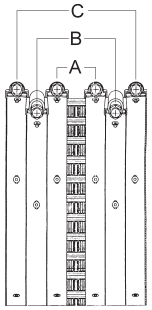
Tightening Sequence



1½" - 4"



5" - 10"



12" & 15"

System

Hubless Couplings (Super Duty)

Features

- AISI 304 STAINLESS STEEL SUPER DUTY CORRUGATED SHIELD: The Super Duty 4000 all stainless steel coupling balances the desire for a more rigid joint with the need to provide a superior positive seal which can accommodate possible disparities of No Hub pipe and fittings. This has been accomplished by a coupling with a Super Duty corrugated shield of sufficient width to accommodate additional surface-bearing sealing clamps.
- The maximum working temperature for neoprene is 212° F.
- Hubless Couplings are not rated for pressure.
- The dimensions specified in ASTM C 1540 result in couplings that extend beyond the "W" dimension of No-Hub pipe fittings in 1.5- through 6-inch diameters. Therefore, ASTM C 1540 couplings will extend beyond the gasket positioning lug and may also cover raised lettering on some fittings.

Materials

- Band - Type 304 AISI Stainless Steel 9/16" wide
- Screw Housing - Type 304 AISI Stainless Steel
- Screw - Type 305 AISI Stainless Steel 3/8" Hex Head Unslotted
- Shield - Type 304 AISI Stainless Steel

Specifications

- Couplings conform to the requirements of:
  - ASTM C 1540
- Gaskets conform with ASTM C 564

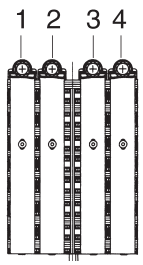
Size	Shield Width	Shield Thickness	Clamp Width	Number of Clamps
1½" - 4"	3.00"	.016"	.562"	4
5" - 10"	4.00"	.016"	.562"	6
*12" - 15"	5.50"	.0075" +/- .001"	.625"	6

*12 and 15" furnished in Heavy Duty No-Hub Coupling.

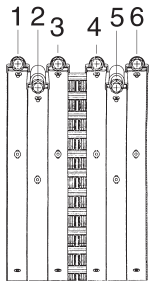
Super Duty Hubless Clamp and Gasket Installation

- A properly calibrated torque wrench set at 80-inch pounds should always be used when installing Super Duty 4000 coupling for joining No Hub pipe and fittings.
  1. Pipe should have square cuts.
  2. Firmly seat both ends of pipe/fittings against the internal molded shoulder in the center of gasket.
  3. Super Duty coupling size 1-1/2 through 4" are three inches wide and have four sealing bands. Starting on the side with the smaller diameter torque as follows: 2, 1-2, 1-3, 4-3, 4-2-1-3-4.
  4. Super Duty couplings sizes 5 through 10" are four inches wide and have six sealing bands. Starting on the side with the smaller diameter torque as follows: 3, 2, 1-3, 2, 1-4, 5, 6-4, 5, 6-3, 2, 1, 4, 5, 6.
  5. Heavy Duty couplings sizes 12 and 15" are five and one half inches wide with six sealing bands. Starting on the side with the smaller diameter torque as follows: 3, 2, 1-3, 2, 1-4, 5, 6-4, 5, 6-3, 2, 1, 4, 5, 6.

Tightening Sequence



Sizes 1½" - 4"



Sizes 5" - 15"

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM	TITLE
A 74	SPECIFICATION FOR **CAST IRON** SOIL **PIPE AND FITTINGS** HUB AND SPIGOT (SERVICE AND EXTRA HEAVY)
SCOPE:	THIS SPECIFICATION COVERS CAST IRON PIPE AND FITTINGS USED IN SANITARY DRAIN, WASTE, AND VENT (DWV), SEWER, AND STORM DRAINAGE APPLICATION. THIS SYSTEM IS INTENDED FOR USE IN NONPRESSURE APPLICATIONS.
C 564	SPECIFICATION FOR **RUBBER GASKETS** FOR CAST IRON SOIL PIPE AND FITTINGS
SCOPE:	THIS SPECIFICATION COVERS PREFORMED RUBBER GASKETS USED TO SEAL JOINTS IN CAST IRON SOIL PIPE AND FITTINGS.
C 1277	SPECIFICATION FOR **COUPLING** FOR USE IN CONNECTION WITH HUBLESS CAST IRON PIPE AND FITTINGS FOR SANITARY AND STORM DRAIN, WASTE, AND VENT PIPING APPLICATION (**REGULAR HUBLESS COUPLING**)
SCOPE:	THE PURPOSE OF THIS SPECIFICATION IS TO ESTABLISH CRITERIA FOR MATERIAL DIMENSIONS AND TOLERANCES FOR ONE TYPE OF COUPLING USED IN HUBLESS CAST IRON SOIL PIPE AND FITTING FOR SANITARY AND STORM DRAIN, WASTE AND VENT PIPING APPLICATIONS.
C 1540	SPECIFICATION FOR **SHIELDED COUPLINGS** JOINING HUBLESS CAST IRON SOIL PIPE AND FITTINGS (**SUPER DUTY COUPLINGS**)
SCOPE:	THIS SPECIFICATION COVERS THE EVALUATING OF THE PERFORMANCE OF SHIELDED HUBLESS COUPLINGS TO JOIN CAST IRON SOIL PIPE AND FITTINGS.

CAST IRON SOIL PIPE INSTITUTE

CISPI	TITLE
301	SPECIFICATION FOR **HUBLESS** CAST IRON SOIL **PIPE AND FITTINGS** FOR SANITARY AND STORM DRAIN, WASTE, AND VENT PIPING APPLICATIONS
SCOPE:	THE PURPOSE OF THIS STANDARD IS TO ESTABLISH STANDARDS COVERING MATERIAL, DIMENSIONS, AND TOLERANCE FOR PIPE AND FITTINGS FOR HUBLESS CAST IRON SANITARY AND STORM DRAIN, SANITARY WASTE, AND VENT PIPING APPLICATIONS.
310	SPECIFICATION FOR **COUPLING** FOR USE IN CONNECTION WITH HUBLESS CAST IRON PIPE AND FITTINGS FOR SANITARY AND STORM DRAIN, WASTE, AND VENT PIPING APPLICATION (**REGULAR HUBLESS COUPLING**)
SCOPE:	THE PURPOSE OF THIS SPECIFICATION IS TO ESTABLISH CRITERIA FOR MATERIAL DIMENSIONS AND TOLERANCES FOR ONE TYPE OF COUPLING USED IN HUBLESS CAST IRON SOIL PIPE AND FITTING FOR SANITARY AND STORM DRAIN, WASTE AND VENT PIPING APPLICATIONS.

General Information and Limited Warranty

We are pleased to present our catalogue for use in ordering Charlotte Pipe and Foundry Company® (Charlotte Pipe®) Products.

To determine current prices, please refer to the list prices shown in this catalogue. You may seek further clarification from our local manufacturers' agent or the factory sales office.

All prices in this catalogue and supplementary price schedules are **subject to change without notice. Orders will be billed at the prevailing price at the time of shipment.**

In line with general practice, all products are shipped at the purchaser's risk. Claims for damage in transit must be filed with the carrier involved or this office **within 10 days** after receipt of the product. Shipment should be carefully examined on arrival before signing a receipt. A signed bill of lading or delivery ticket with no exceptions noted will indicate that the count, description, and condition are satisfactory.

A charge of 25% plus all transportation costs will be assessed for placing any product back in Charlotte Pipe's stock which is not proved to be defective in manufacture. Products shipped in error by Charlotte Pipe will be replaced or credit will be issued at the discretion of Charlotte Pipe at no additional cost to the purchaser. Claims for errors in shipment or defects in manufacture must be made within ten (10) days after receipt of the product. Damaged products shall be held for inspection if so requested by Charlotte Pipe. Products not noted as damaged and not reported to Charlotte Pipe within 10 days after receipt by customers shall be deemed to have been received in good order. Products made by other manufacturers, unless sold by Charlotte Pipe, will not be accepted for return. Such products returned to our plant freight prepaid will receive credit at *scrap value*.

All quotations, sales, and agreements are subject to strikes, accidents, transportation failures or other causes beyond our control.

Any tax, effective under present or future laws, shall be added as an extra to the price of the product and shall be paid by the purchaser.

Possession of product information or price sheets shall not be construed as an offer to sell the product listed.

Charlotte Pipe products are manufactured to the applicable ASTM standard. Charlotte Pipe and Foundry **cannot** accept responsibility for the performance, dimensional accuracy, or compatibility of pipe, fittings, gaskets, or couplings not manufactured or sold by Charlotte Pipe and Foundry.

Limited Warranty

Charlotte Pipe and Foundry Company® (Charlotte Pipe®) Products are warranted to be free from manufacturing defects and to conform to currently applicable ASTM standards for a period of five years from date of delivery. Buyer's remedy for breach of this warranty is limited to replacement of, or credit for, the defective product. This warranty excludes any expense for removal or reinstallation of any defective product and any other incidental, consequential, or punitive damages. **This limited warranty is the only warranty made by seller and is expressly in lieu of all other warranties, express and implied, including any warranties of merchantability and fitness for a particular purpose.** No statement, conduct or description by Charlotte Pipe or its representative, in addition to or beyond this Limited Warranty, shall constitute a warranty. This Limited Warranty may only be modified in writing signed by an officer of Charlotte Pipe.

This Limited Warranty will not apply if:

1) The Products are used for purposes other than their intended purpose as defined by local plumbing and building codes, and the applicable ASTM standard.

2) The Products are not installed in good and workmanlike manner consistent with normal industry standards; installed in compliance with the latest instructions published by Charlotte Pipe and good plumbing practices; and installed in conformance with all local plumbing, fire and building code requirements.

3) The Products fail due to defects or deficiencies in design, engineering, or installation of the piping system of which they are a part.

4) The Products have been the subject of modification; misuse; misapplication; improper maintenance or repair; damage caused by the fault or negligence of anyone other than Charlotte Pipe; or any other act or event beyond the control of Charlotte Pipe.

5) The Products fail due to the freezing of water in the Products.

6) The Products fail due to contact with chemical agents, fire stopping materials, thread sealant, plasticized vinyl products, or other aggressive chemical agents that are not compatible.

7) Pipe outlets, sound attenuation systems or other devices are permanently attached to the surface of Charlotte PVC, ABS or CPVC products with solvent cement or adhesive glue.

Any product proved to be defective in manufacture will be replaced F.O.B. point of original delivery, or credit issued, at the discretion of Charlotte Pipe. **Purchaser must obtain written permission and/or a return goods authorization** and instructions for return shipment to Charlotte Pipe of any product claimed defective, shipped in error or excess of inventory needs.

All products alleged to be defective **must** be made available to Charlotte Pipe at the following address for verification, inspection and determination of cause:

Charlotte Pipe and Foundry Company
Attention: Warranty Department
P.O. Box 35430
Charlotte, North Carolina 28235

WARNING: Charlotte Pipe products are **not** to be used with compressed air or gases. Charlotte Pipe **does not recommend** that piping systems that include its products be tested with compressed air or gases.

05/30/08

PO Box 35430 Charlotte, NC 28235 USA 704/348-6450 800/572-4199 FAX 800/553-1605

www.charlottepipe.com

CONVERSION CHART

The Conversion of Fractions to Decimals

Fraction	Decimal	Fraction	Decimal
1/64	0.015625	33/64	0.515625
1/32	0.031250	17/32	0.53125
3/64	0.046875	35/64	0.546875
1/16	0.062500	9/16	0.5625
5/64	0.078125	37/64	0.578125
3/32	0.937500	19/32	0.59375
7/64	0.109375	38/64	0.609375
1/8	0.125000	5/8	0.625
9/64	0.140625	41/64	0.640625
5/32	0.156250	21/32	0.65625
11/64	0.171900	43/64	0.67187
3/16	0.187500	11/16	0.6875
13/64	0.203100	45/64	0.70312
7/32	0.218800	23/32	0.71875
15/64	0.234375	47/64	0.734375
1/4	0.250000	3/4	0.75
17/64	0.265625	49/64	0.765625
9/32	0.281250	25/32	0.78125
19/64	0.296875	51/64	0.79875
5/16	0.312500	13/16	0.8125
21/64	0.328125	53/64	0.82125
11/32	0.343750	27/32	0.84375
23/64	0.359375	55/64	0.859375
3/8	0.375000	7/8	0.875
25/64	0.398625	57/64	0.890625
13/32	0.406250	29/32	0.90625
27/64	0.421875	59/64	0.921875
7/16	0.437500	15/16	0.9375
29/64	0.453125	61/64	0.953125
15/32	0.468750	31/32	0.96875
31/64	0.484375	63/64	0.984375
1/2	0.500000	1"	1

A BRIEF HISTORY

In 1901 W. Frank Dowd built a small foundry in Charlotte, North Carolina to produce cast iron pipe and fittings for plumbing in the newly industrialized, post-war south. Armed with wheelbarrows, shovels, and muscle, the foundry's twenty-five workers produced eight to ten tons of cast iron soil pipe and fittings a day.

W. Frank Dowd, II took over management of the company upon his father's death in 1926. Over the next two decades, he worked hard to expand the marketing territory of Charlotte Pipe and Foundry and lay the groundwork for strong customer relations and service that remains the hallmark of the company.

His two sons, W. Frank Dowd, Jr. and Roddey Dowd, Sr. joined the company in the early 1950s and presided over the mechanization of the soil pipe facilities. This sweeping modernization kept Charlotte Pipe at the forefront of the cast iron industry when many of its competitors were floundering.

Today, the founder's great grandsons Frank Dowd, IV and Roddey Dowd, Jr. continue the strong commitment to manufacturing quality products and delivering excellent customer service. An experienced group of officers helps provide effective leadership. Combined, the 12-member team has more than 230 years of service dedicated to the company. Through their commitment, and by working together efficiently, this team ensures that Charlotte Pipe is on track to serve its customers' needs.

As we look forward to our second century of business in the plumbing industry, the company faces new challenges. But the one constant set by the founder remains the same: Make the best quality products, and back them up with excellent service.

You can't beat the system.®

CHARLOTTE
PIPE AND FOUNDRY COMPANY

PO BOX 35430
CHARLOTTE
NORTH CAROLINA 28235
PHONE (704) 348-6450
(800) 438-6091
FAX (800) 553-1605
LITERATURE BY FAX (800) 745-9382
WWW.CHARLOTTEPIPE.COM