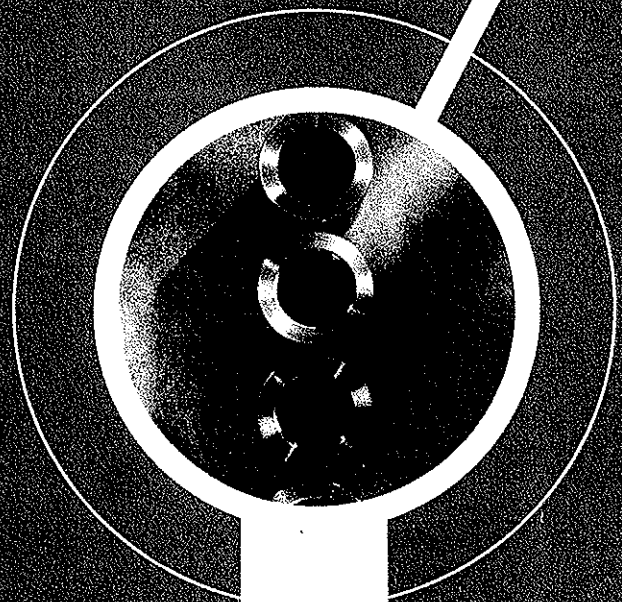
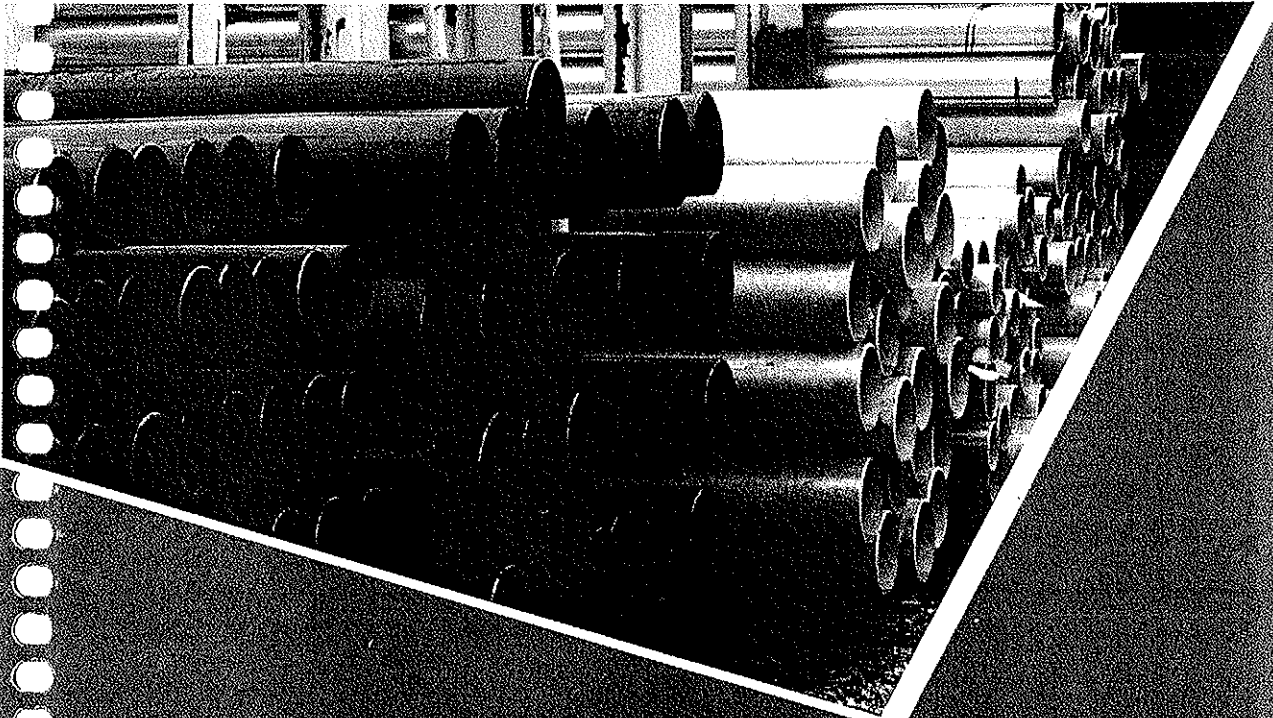


Basics of PHCP/Industrial PVF

# Introduction to Steel, Stainless Steel, Iron Pipe and Fittings<sup>®</sup>



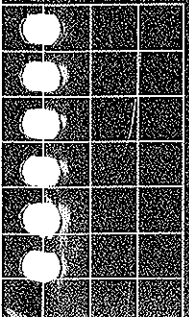
**BOOK #2**

CERTIFICATE COURSE  
**SECOND EDITION**

**ProductPro<sup>®</sup>**

*The Standard in Product Knowledge Solutions*

*A publication by ASA Education Foundation*





## **Basics of PHCP/Industrial PVF**

# **Introduction to Steel, Stainless Steel, Iron Pipe and Fittings®**

*from the*

**ASA Education Foundation**

*Introduction to Steel, Stainless Steel, Iron Pipe and Fittings® provides new warehouse, counter and sales personnel with basic knowledge needed to accurately pick and take orders as well as service customers. Employees quickly master the components and functions of supply and DWV systems, identify the types and characteristics of pipe, and recognize the types of fittings and their uses.*

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## Welcome to the *ProductPro*® *Product Knowledge Training* series!

The plumbing-heating-cooling-piping and industrial PVF industry is an important one. The products we sell keep people healthy, comfortable and productive. In the United States, there are about 4,000 PHCP/industrial PVF wholesaler-distributor locations; they generate billions of dollars in wholesale sales. It is an exciting and very competitive industry, and running a successful company requires cooperative efforts from educated and motivated employees.

To sell products in such a competitive atmosphere, it is crucial that all employees understand the products being sold. The pipe, valves, fittings and industrial product lines are the bread and butter of the industry. Whether a customer needs a replacement part for a toilet, a new furnace, or the pipe for a sophisticated processing plant, she/he will certainly need pipe, valves, fittings and other industrial products. Employees need to be knowledgeable enough to provide customers with the products they need to keep their plants running and their employees productive.

### *What you will learn from this training.*

In the *ProductPro*® courses, you will learn about a wide variety of basic products. You will learn what the products are and how they are used. You will pick up the vocabulary needed to talk intelligently about the products so you can help your customers and communicate effectively with your colleagues. You will learn how to order or specify each type of product. In addition, you will learn about some products that your own company does not carry so when your customer requests them you will be able to offer an alternative product or find the product from another source.

### *How the course is organized.*

The *ProductPro*® courses are divided into separate chapters, with each one covering a particular category of products. After reading each chapter, you will test your progress with short quizzes that you can correct yourself. The course provides a glossary of terms at the back of the book to help you expand your industry vocabulary and make you more valuable to both your company and your customers. The glossary terms are also highlighted in the text.

At the end of each self-correcting quiz, you will find *Applying What You've Learned* exercises, which will help you apply the new information you have learned to your own company.

Once you understand the basic concepts presented, know the important facts and can confidently get the answers right on all the quizzes, you are ready to take the final course exam.

### **THIS COURSE INCLUDES AN ONLINE FINAL EXAM**

This course is limited to a single user. When you are ready to take the final exam to earn your Certificate of Completion, please contact ASA at [info@asa.net](mailto:info@asa.net). ASA staff will contact you about how to register for the exam.

## *Some hints for successful course completion*

### *Read the learning objectives*

Read the learning objectives at the beginning of each course. They will tell you what you should know when you complete the course. Go back after you read the chapter material and ask yourself if you feel confident in your command of the material. If you are not, reread anything that you did not understand. Ask questions of your supervisor or colleagues to help clarify the material you did not “get” the first time.

### *Search for the important ideas*

Use a highlighter marker or a pen to highlight or underline the most important points as you read. Think about how each idea relates to the rest of the chapter. Write notes in the margins about points you don’t understand or about how the material you read applies to your own company.

### *Ask lots of questions*

Ask your supervisor or mentor about any points you do not understand. Especially ask if the products you are studying are carried by your company, how well they sell and how important they are in the overall inventory.

### *Apply what you are learning to your job*

Always think about what you have just read or learned. Compare your company’s products to the products you have read about in the book. Do the *Applying What You’ve Learned* exercises using the real setting of your job.

### *Pace yourself in your studying*

Don’t try to complete the course all at once. You will more effectively remember what you learn if you make sure you understand each chapter thoroughly before you move on to the next. Take some time to “plug in” the already-acquired new information before acquiring more new information.

*Be proud of what you have accomplished*

When you successfully complete the course, be sure to proudly display your course certificate. You earned it.

*Commit to learning something new every day*

This course is just one step in developing your professional knowledge and your career skills. Read industry trade journals, study the manufacturers' literature and attend any training the manufacturers offer. Listen to what company and industry experts say. Continue to enthusiastically take any additional training your company offers.

Visit the ASA Education website at [www.asa.net](http://www.asa.net) regularly to find out about other learning opportunities to advance your career.



## Acknowledgements

Developing new editions of the *ProductPro® Product Knowledge Training* courses is an ambitious undertaking. In this course, many individuals shared their expertise, input and resources to significantly improve the interest and energy in the program. Of special value were those wholesaler/distributors who opened up their warehouses so the Foundation could take photographs and develop illustrations of products and plumbing layouts. Mark Ardente of Ardente Supply and Stan Dreyfuss of S G Supply Company were especially generous in this regard. Christian Corraera expertly photographed needed product and constructed accurate and expert illustrations. Others, such as Colin Perry of Rampart P&H Supply, Inc., Sally Hutchens from Winwholesale, Inc., Marty Riback from Riback Supply, Inc., Victor Kitchen of Frischkorn, Inc., and Gary Cartright of Piping and Equipment, Inc., thoroughly and diligently reviewed the course instruction, quizzes, illustrations and final exam to ensure accurate and highly readable instruction. Their expertise and experience ensure that the content demonstrates a high level of real world applications that immediately can be put to work in employees' day-to-day duties.

The Foundation also needs to express its very special gratitude to the visionaries who established and led the charge to develop the Karl E. Neupert Endowment Fund. Contributions that established the Fund were provided by hundreds of manufacturers, wholesalers and individuals who recognized the need for a permanent endowment fund that would ensure the ASA Education Foundation's ability to provide programs needed by the industry in perpetuity. Their generous contributions continue to make a major impact on the education and training opportunities available to the industry. We are deeply grateful for their commitment.

- The ASA Education Foundation



## Table of Contents

<b>Chapter 1: Steel Pipe and Fittings</b> .....	<b>1 - 32</b>
Learning Objectives .....	1
Classifications of Steel Pipe .....	3 - 8
Review of Classifications of Steel Pipe .....	9 - 10
Steel Pipe Ends and Fittings .....	11 - 14
Review of Steel Pipe Ends and Fittings .....	15 - 16
Understanding Pipe Schedules .....	17 - 25
Review of Understanding Pipe Schedules .....	26 - 27
Answers to the Review Questions .....	29 - 32
<b>Chapter 2: Stainless Steel Pipe and Fittings</b> .....	<b>33 - 70</b>
Learning Objectives .....	33
Characteristics of Stainless Steel Pipe .....	35 - 38
Review of Characteristics of Stainless Steel Pipe .....	39 - 40
Classifications of Stainless Steel Pipe .....	41 - 45
Review of Classifications of Stainless Steel Pipe .....	46 - 47
Specifications of Stainless Steel Pipe .....	48 - 54
Review of Specifications of Stainless Steel Pipe .....	55 - 56
Stainless Steel Fittings .....	57 - 63
Review of Stainless Steel Fittings .....	64 - 65
Answers to Review Questions .....	67 - 70

*continued*



## Table of Contents

<b>Chapter 3: Introduction to Iron Pipe and Fittings</b> .....	<b>71 - 108</b>
Learning Objectives .....	71
Types of Iron Pipe and Fittings .....	73 - 76
Review of Types of Iron Pipe and Fittings .....	77 - 78
Cast Iron Soil Pipe .....	79 - 83
Review of Cast Iron Soil Pipe .....	84 - 85
Hub and Spigot Fittings .....	86 - 93
Review of Hub and Spigot Fittings .....	94 - 95
No Hub Fittings .....	96 - 101
Review of No Hub Fittings .....	102 - 103
Answers to Review Questions .....	105 - 108
<b>Glossary of Terms</b> .....	<b>111 - 134</b>
<b>Index</b> .....	<b>135 - 155</b>



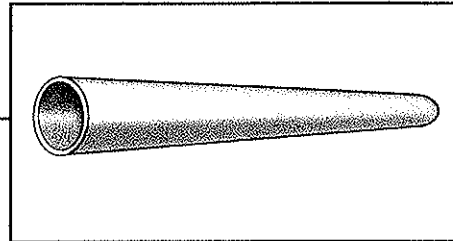
## 1

## STEEL PIPE AND FITTINGS

### LEARNING OBJECTIVES

*When you finish this Chapter, you will be able to:*

1. Discuss three basic classifications of steel pipe
2. Explain common uses for the types of steel pipe
3. Describe different types of steel pipe ends, fittings and how they are joined
4. Interpret pipe schedules and pipe flanges and stencils
5. Describe how pipe is shipped and stored



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## Classifications of Steel Pipe

Steel pipe has many advantages. It is durable, reasonable in price and provides for quiet operation of the plumbing system. It has great strength and rigidity, so that fewer hangers are needed in long runs. Steel pipe also radiates heat evenly, which makes it useful in many applications. In addition, it permits connections by threading, welding and mechanical couplings.

Steel pipe can be classified by:

- **SURFACE COATING**
- **MANUFACTURING PROCESSES**
- **USAGE APPLICATIONS.**

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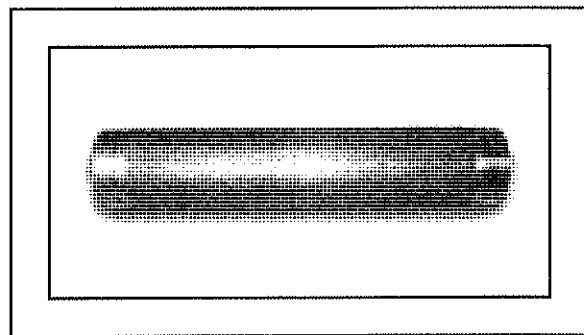
## Classification of Steel Pipe by Surface Coating

One way to classify steel pipe is by surface coating. The two most common types of steel pipe, as determined by surface coating, are:

- **BLACK STEEL PIPE**
- **GALVANIZED STEEL PIPE.**

**BLACK STEEL PIPE** (Blk. St.) is commonly coated with a varnish-type oil. This finish – which gives the pipe its black color – protects the pipe during transportation and initial storage. Black steel pipe lacks resistance to corrosion. As a result, it is not used in applications involving potable water, or for drain waste or vent lines. It is sometimes called “black iron” pipe and is used for gas and oil distribution inside and outside the house, for steam systems and for hot water circulation in boiler systems.

BLACK STEEL PIPE

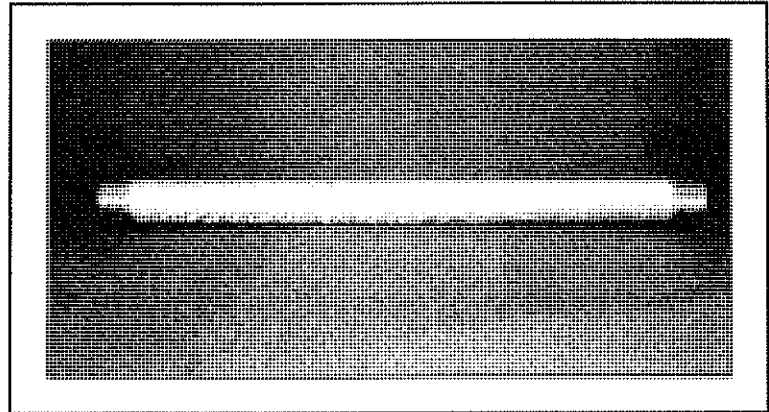


PVF 2.1.01

**GALVANIZED STEEL PIPE** (Gal. St.) is dipped in heated zinc, which greatly reduces its tendency to corrode and extends its life expectancy. The zinc coating makes galvanized steel pipe appear gray or silver in color. It is not used in gas lines since natural gas causes the zinc to flake off and clog the system.

Also, it is not frequently used within the water supply lines since the water's minerals react with the galvanized material to create a scale. The scale builds up over time and will eventually clog the pipe. That is why some older homes suffer from low water pressure. Hard water, in particular, decreases the life of steel pipe. The most popular use of galvanized piping today is for mechanical applications like hand-rails or for replacement of existing pipe.

GALVANIZED STEEL PIPE



PVF 2.1.02

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## Classification by Manufacturing Processes

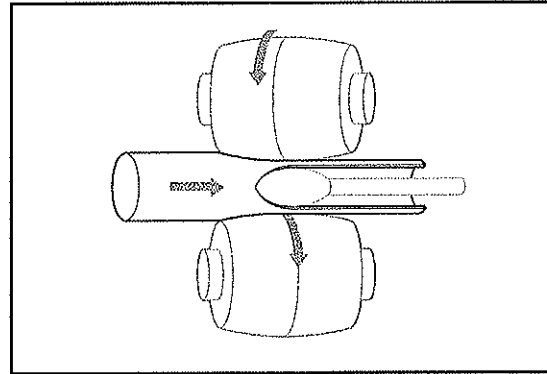
Steel pipe is also sometimes classified or identified by the way it is manufactured. While there are many ways of manufacturing steel pipe and tube, most fall into two groups:

- **SEAMLESS TUBE AND PIPE PRODUCTION**
- **WELDED TUBE AND PIPE PRODUCTION**
  - Continuous weld
  - Electric resistance weld (ERW).

**SEAMLESS STEEL PIPE** begins as a solid, cylindrical piece of steel called the “billet.” This piece is heated, punched by and drawn over a mandrel (a center forming pin that is inserted into the punched piece) and then moved through a series of rollers until the desired size of pipe is reached.

This produces pipe with no seam, which provides greater strength, and is commonly used in high-pressure and high-temperature situations. In sizes smaller than 2 inches, seamless pipe is commonly referred to as pressure tubing. Seamless pipe is excellent for high-pressure/high-temperature applications and can be produced with very heavy wall thickness.

SEAMLESS STEEL PIPE PRODUCTION



PVF 2.1.04

**WELDING** is a method of joining metals by heating and/or pounding the edges of metal strips against each other until the metal is soft enough to flow together, bonding in a seam or weld. Currently, about two-thirds of the world’s steel pipe and tube production is manufactured by welding processes.

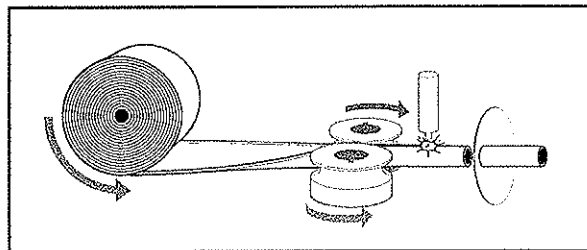
The most common pipe welding processes are:

- **CONTINUOUS WELD**
- **ELECTRIC RESISTANCE WELD (ERW).**

**CONTINUOUS WELD PIPE** (also called continuous butt weld pipe) is formed by a process in which skelp (a hot strip of steel) is changed from a flat ribbon to a round shape. The edges are then closed by heat from the skelp and pressure by rollers to form a seam or weld.

Continuous weld steel pipe is the fastest to produce and is reasonably priced. It is intended for use in low- and medium-pressure systems, but is not suitable for high-pressure applications.

CONTINUOUS WELD PIPE PRODUCTION

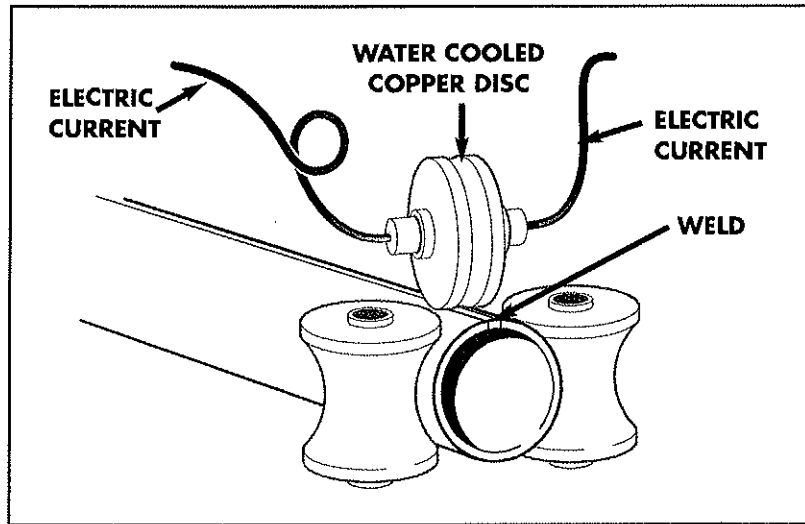


PVF 2.1.05

Pipe made through the **ELECTRIC RESISTANCE WELD (ERW)** method is cold-formed on rollers. Then a combination of pressure from the rollers and heat from an electrical current form the seam of the weld joint.

Electric resistance weld pipe comes in long lengths and is limited to a maximum wall of 1/2". It is commonly used in low- and medium-pressure systems.

ELECTRIC RESISTANCE WELD (ERW) PIPE PRODUCTION



PVF 2.1.06

## Classification by Usage Application

In addition to classification by coating type and manufacturing process, steel pipe is classified by the way it's used. There are five common types of steel pipe, which are categorized by end use/application:

- **STANDARD PIPE**
- **LINE PIPE**
- **OIL COUNTRY TUBULAR GOODS**
- **PRESSURE TUBE**
- **MECHANICAL TUBE.**

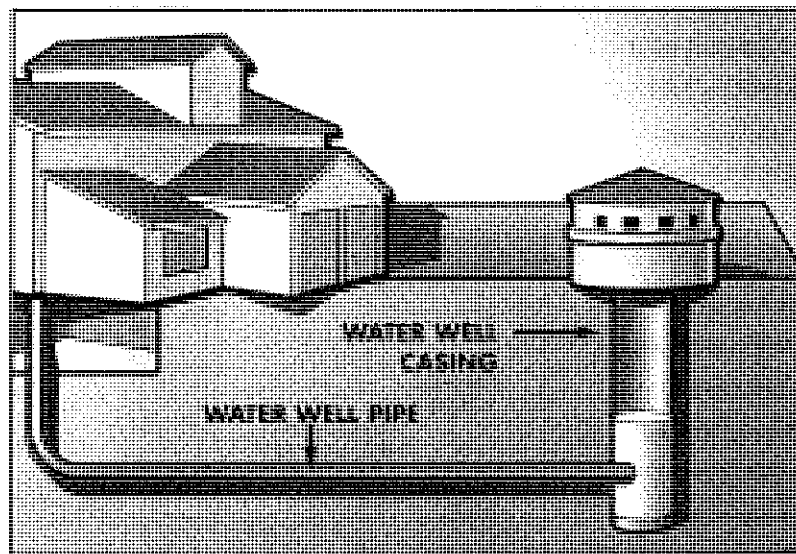
**STANDARD PIPE** is used for many plumbing, heating and industrial purposes. It can carry steam, water, gas or air. It is produced in continuous weld, ERW and seamless processes.

The following businesses would use standard pipe:

- Plumbers
- Mechanical contractors
- Industrial PVF
- Refining, chemical and petrochemical.

**WATER WELL PIPE** is an example of a standard pipe used with a well supply source.

WATER WELL PIPE



PVF 2.1.08

Water well pipe is used in the drilling and production of water, but not the transportation of water.

Water well pipe consists of the four following types:

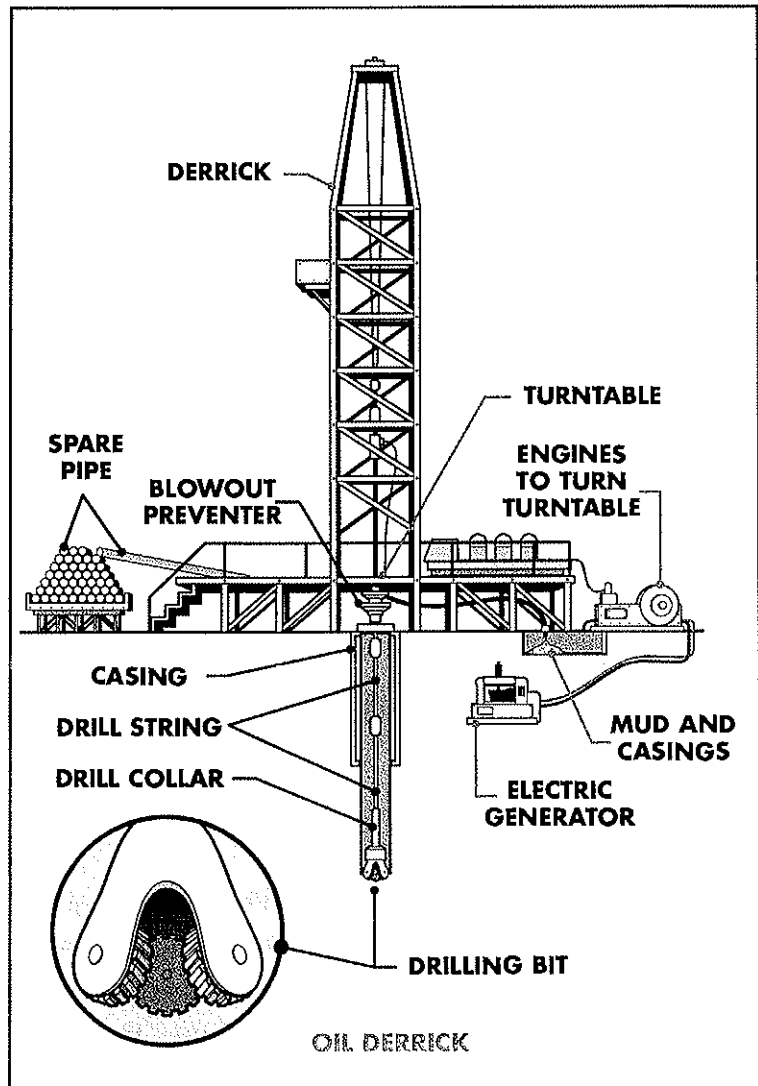
- **WATER WELL CASING** can be continuous weld, ERW or seamless. It has walls that are lighter and thinner than standard pipe. Water well casing is used to line or encase a drilled well, so the loose sand and gravel does not collapse into the borehole. Since the walls are thinner, the threads are relatively shallow or short.
- **DRIVEN WELL PIPE** can be continuous weld, ERW or seamless. It is usually threaded and coupled galvanized pipe.
- **REAMED AND DRIFTED WATER WELL PIPE** can be continuous weld, ERW or seamless. It is made especially for water well use and may be driven. It has threaded and recessed couplings, and is reamed on the ends to ensure inside clearance.
- **DRIVE PIPE** is only seamless or ERW. It is used in water wells for driving into the ground or forcing into a hole to prevent caving of the wells' walls. The ends of the pipe are specially threaded so the end can butt up tight in the coupling when the joint is made.

**LINE PIPE** is generally intended for use by the oil and gas industry for the conveyance of oil and gas. It is used in crude oil, natural gas, petroleum products, water pipeline and slurry pipe applications. Line pipe is produced to American Petroleum Institute's (API) specification 5L and 5LX, and is offered in both welded and seamless.

**OIL COUNTRY TUBULAR GOODS** are used by the petroleum industry in the drilling and operation of gas and oil wells. Oil country tubular goods encompass the following:

- **DRILL PIPE** is used as a rotating stem for drill bits, to drill the well, and as a conveyance for air or drilling mud to lubricate the drill bit and convey cuttings to the surface.
- **CASING** is used as a structural retainer for the walls of a gas or oil well to resist collapse from external pressures.
- **TUBING** is used to convey oil and gas to the surface and must be made from steel of adequate strength to support its own weight.

PETROLEUM INDUSTRY PIPE



PVF 2.1.09

**PRESSURE TUBE** is seamless steel pipe with a diameter of under 2 inches IPS. It carries fluids at high temperatures or high pressure. Pressure tube is commonly used when high pressure and heat are involved, such as in heat exchangers, steam lines, condensers and boilers.

**MECHANICAL TUBE** is used in structural or machinery applications, such as fencing and hand railing, and other low-pressure applications. Mechanical tube does not have to withstand as much internal pressure as steel pipe that carries liquids or gases.

## REVIEW OF CLASSIFICATIONS OF STEEL PIPE

*Answers appear on page 31*

1. Potable water should **not** be carried by which type of pipe?
  - a. Black steel
  - b. Galvanized steel
  
2. Galvanized steel pipe's most popular use today is:
  - a. In gas lines
  - b. For mechanical applications like handrails or for replacement of existing pipe
  
3. For which of these applications is seamless steel pipe most likely to be used?
  - a. Low-pressure/low-temperature
  - b. High-pressure/high-temperature
  
4. Welding:
  - a. Is a method of joining metals by heating and/or pounding the edges of metal strips together
  - b. Produces pipe with no seam
  
5. Which type of pipe is very commonly used for plumbing, heating and industrial purposes?
  - a. Pressure tube
  - b. Standard pipe
  
6. What is an example of a standard pipe used with a well supply source?
  - a. Water well pipe
  - b. Line pipe
  
7. Which type of pipe would boiler lines probably be made of?
  - a. Mechanical tube
  - b. Pressure tube
  
8. Some of the common pipe welding processes used are:

\_\_\_\_\_ and \_\_\_\_\_  
\_\_\_\_\_.

## REVIEW OF CLASSIFICATIONS OF STEEL PIPE

*Answers appear on page 31*

9. Four types of water well pipe are: \_\_\_\_\_  
 casing, \_\_\_\_\_ pipe, \_\_\_\_\_  
 \_\_\_\_\_ water well pipe, and  
 \_\_\_\_\_.
10. \_\_\_\_\_ is generally intended for use by  
 the oil and gas industry for the conveyance of oil and gas.
11. \_\_\_\_\_  
 \_\_\_\_\_ are used by the petroleum industry in the drilling and  
 operation of gas and oil wells, and encompasses the drill pipe, casing and tubing.
12. \_\_\_\_\_ is used in structural or machinery  
 applications such as fencing or hand railing.

## APPLYING WHAT YOU HAVE LEARNED:

*By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.*

- A. Who are your company's major types of customers that purchase black steel and galvanized steel pipe?

---



---

- B. Who are your company's major types of customers for pressure tube?

---



---



## Steel Pipe Ends and Fittings

Steel pipe comes with several different types of ends. The ends of the pipe determine how the pipe will be joined. The common types of ends are:

- **PLAIN ENDS**
- **BEVELED ENDS**
- **GROOVED ENDS**
- **THREADED ENDS.**

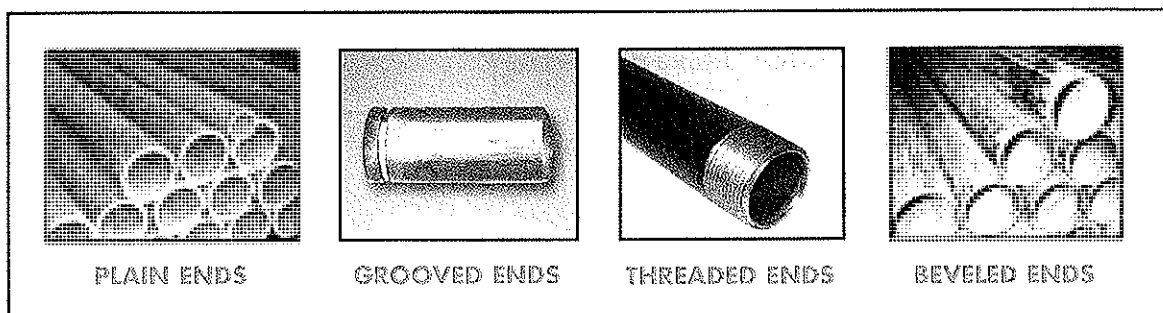
**PLAIN END PIPE** is a pipe with no threads that is cut straight across and left as is with no special treatment. Plain end pipe is joined mechanically or by socket weld fittings. This type of pipe end is abbreviated as "PE" in specifications. (Plain end pipe is sometimes used to describe beveled end pipe.)

**BEVELED END PIPE** is joined by welding. The wall of the pipe end is cut at a slant to allow space for molten metal when the pipe is joined. Beveled end pipe is abbreviated "BE."

A **GROOVED END PIPE** has a groove that is either rolled or cut. Rolled groove is the most common. It is formed by rolling a groove into a pipe without removing any metal. Cut groove is formed by a narrow cut (groove) that is cut like a band into the outside wall. Grooved pipe is joined by special fittings to connect the grooved ends, and it takes a coupling that always comes with a gasket. Grooved fittings are usually not threaded, but some adapters combine grooved and threaded ends.

**THREADED PIPE ENDS** have a series of regularly spaced grooves (threads) that allow the pipe to be connected using a threaded coupling.

### STEEL PIPE ENDS

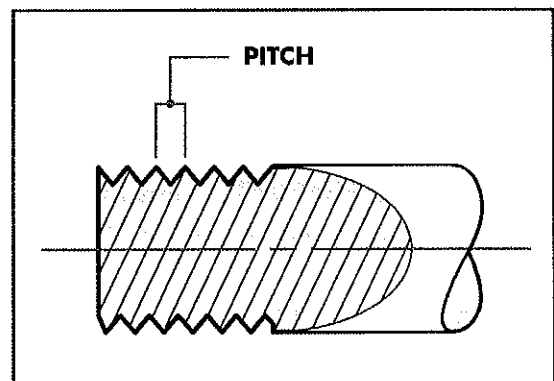


Steel pipe may be threaded at one or both ends. The abbreviation **TOE** indicates that the pipe is threaded at one end. Pipe threaded at both ends is labeled **TBE**.

The threads for steel pipe conform to rigid industry standards. The **AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)** sets the standards for steel pipe threads. Standards for threads on line pipe are set by the **AMERICAN PETROLEUM INSTITUTE (API)**. Pipe threads must be clean and smooth-cut, with the correct taper and pitch to make tight joints possible.

**PITCH** is the distance from the point on one thread to the point on the next thread. Pitch is measured by threads per inch. Standard pipe and line pipe 2 1/2 inches or more in diameter are threaded with eight threads per inch. This allows the pipe to go forward one inch when it is turned eight times. The pitch on pipe with smaller diameters varies with the diameter.

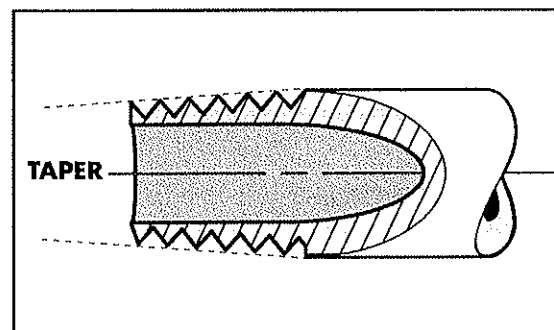
PITCH



PVF 2.1.13

The threads on standard steel pipe are tapered. **TAPERING** is a gradual change in the depth of the threads. Taper threading is cut deep into the pipe surface at the very end of the pipe and it gradually enlarges to the end of the thread surface. Except for drive pipe threads, all pipe threads are tapered 3/4 inches per foot. Drive pipe threads are tapered 1/2 inch per foot.

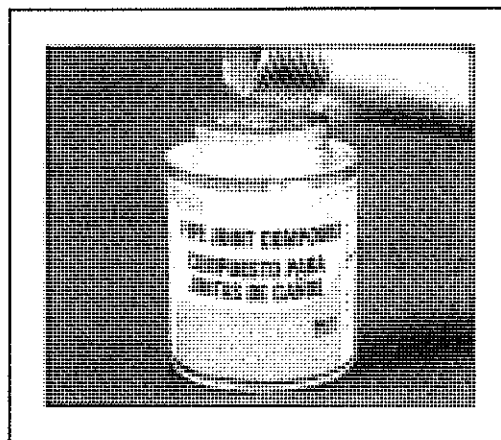
TAPER



PVF 2.1.14

A thread lubricant, called **PIPE DOPE** or pipe compound, is often applied to threaded pipe ends. Pipe dope acts as a lubricant and a sealer of the joint. The thread lubricant should always be applied to the male threads. If it is applied to the female threads in a fitting, some of the compound may be forced into the fitting.

PIPE DOPE

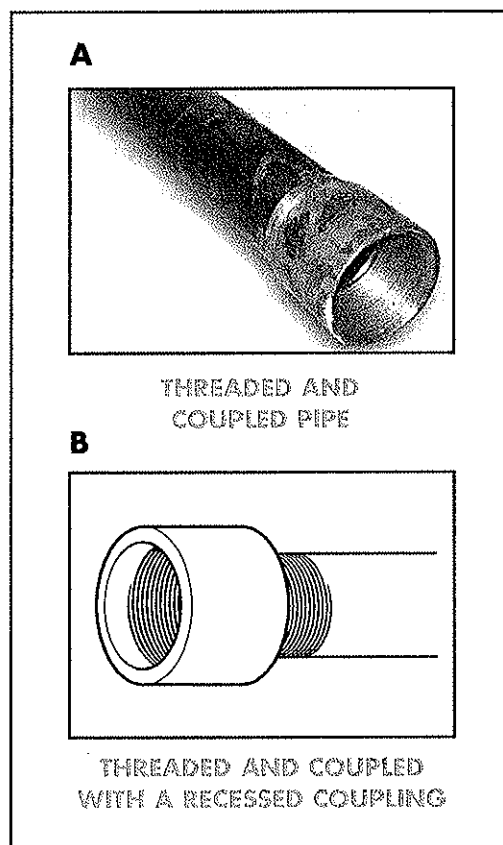


PVF 2.1.15

**THREADED AND COUPLED END PIPE** is also available. The end is first threaded and then a coupling is attached. Threaded and coupled pipe may be straight-threaded or taper-threaded. Threaded and coupled end pipe is specified as "T&C." Another variation of this type of end is ST&C, which stands for short thread and coupled. For oil field applications, there is also LT&C, or long thread and coupled.

Some kinds of threaded and coupled pipe come with recessed couplings. A **RECESSED COUPLING** is a coupling in which the threads do not come all the way out to the edge of the coupling. The recess helps to center the pipe in the coupling and guide it into the threads. It also covers the incomplete threads on the pipe, which reduces the possibilities of corrosion.

THREADED AND COUPLED PIPE



PVF 2.1.16

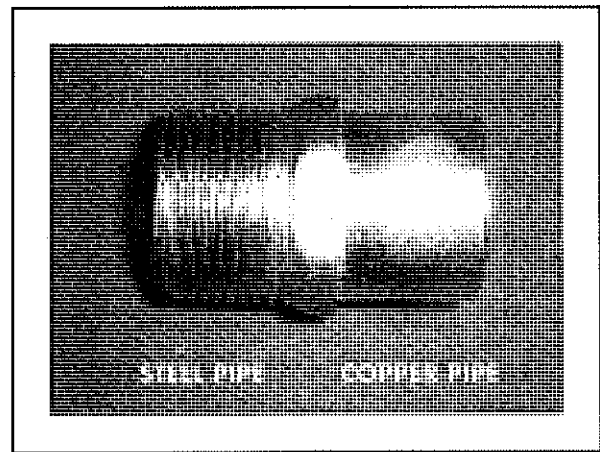
Many different types of fittings are used with steel pipe, including ells, tees and reducers. The specifications for a fitting depends upon the:

- **JOINING METHOD TO BE USED**
- **MATERIAL FROM WHICH THE PIPE IS MADE**
- **DIAMETER(S) OF THE PIPE TO BE JOINED**
- **PRESSURE REQUIREMENTS.**

---

Fittings used to join threaded steel pipe must have threaded ends. These fittings are also called **THREADED FITTINGS**. Because steel is an iron alloy, fittings for steel pipe are often made of cast iron or malleable iron. Steel, cast iron and malleable iron may be placed next to one another without fear of corrosion or galvanic action. However, if steel pipe is to be joined to copper or plastic pipe, an **ADAPTER** or transition fitting must be used to join these unlike materials.

ADAPTER



PVF 2.1.17

Always check manufacturers' literature, project specs and local building codes to be certain of the types of fittings that can be used with steel pipe.

---

## REVIEW OF STEEL PIPE ENDS AND FITTINGS

*Answers appear on page 31*

1. Which type of pipe would be joined by welding?
  - a. Beveled pipe
  - b. Grooved pipe
  
2. Which type of pipe has no threads, is cut straight across and left as is with no special treatment?
  - a. Grooved pipe
  - b. Plain pipe
  
3. The type of pipe end that takes a coupling which always comes with a gasket is ...
  - a. Threaded
  - b. Grooved
  
4. What organization sets the standards for standard steel pipe threads?
  - a. API
  - b. ANSI
  
5. What is measured in threads per inch?
  - a. Taper
  - b. Pitch
  
6. The type of fitting in which the threads do not come all the way out to the edge is ...
  - a. Recessed coupling
  - b. Tapered coupling
  
7. An adapter must be used in which situation below?
  - a. Joining steel pipe to steel pipe
  - b. Joining steel to copper pipe
  
8. \_\_\_\_\_ have a series of regularly spaced grooves (threads) that allow the pipe to be connected using a threaded coupling.
  
9. The abbreviation \_\_\_\_\_ indicates that the pipe is threaded at one end, and the pipe threaded at both ends is labeled \_\_\_\_\_.

## REVIEW OF STEEL PIPE ENDS AND FITTINGS

*Answers appear on page 31*

10. Standards for threads on line pipe are set by the \_\_\_\_\_  
\_\_\_\_\_.
11. \_\_\_\_\_ is a gradual change in the depth of the threads.
12. A thread lubricant, called \_\_\_\_\_ or pipe compound, is often applied to threaded pipe ends.
13. In \_\_\_\_\_, the end is first threaded and then a coupling is attached.
14. \_\_\_\_\_ are the fittings used to join threaded steel pipe.

## APPLYING WHAT YOU HAVE LEARNED:

*By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.*

- A. Look at a piece of threaded and coupled pipe. How do your customers use this type of pipe?

---



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- B. Is the groove in the grooved pipe you sell rolled groove or cut groove?

---



---

## Understanding Pipe Schedules

For many years, pipe manufacturers increased pipe strength for higher-pressure applications by increasing the size of the pipe wall. This increased both the strength and the weight of the pipe, which was specified by the three basic weight categories:

- STANDARD
- EXTRA STRONG
- DOUBLE EXTRA STRONG.

Then the American National Standards Institute (ANSI) developed a listing to classify steel pipe according to **WALL THICKNESS** for different pressure applications. An ANSI listing to indicate standards for steel pipe is called a **PIPE SCHEDULE**.

Today's steel pipe is manufactured according to size, weight and wall thickness standards developed by ANSI. Pipe schedules often will list pipe specifications for both ANSI's schedule numbers and the previously developed weight categories. For example, on the next page you will find a schedule that consists of the ANSI standards schedule 5-160, and standard weight (STD), extra strong (EH) double extra strong (Dble. EH).

The numbers across the top, from left to right under "Weight and Dimensions" are the schedule numbers along with the abbreviations for standard (STD), extra heavy (EH) and double extra heavy (Dble. EH). The numbers listed vertically, top to bottom along the outside left edge, are the NPS sizes. The next column in (to the right) lists the Outside Diameters (ODs). The numbers in the individual cells gives the wall thickness of the pipe. Some schedules also list the weight per foot of the pipe in individual cells.

NPS 1/8-inch through 10 inches, the wall thickness for schedule 40 and STD pipe are the same

INTERPRETATION OF STEEL PIPE SCHEDULE

NPS 1/8-inch through 8 inches, the wall thickness for schedule 80 and EH pipe are the same

Pipe Size Inches or NPS	OD in Inches	Weights and Dimensions of Seamless and Welded Steel Pipe (P.E.)*													
		5	10	20	30	40	STD <sup>1</sup>	60	80	EH <sup>2</sup>	100	120	140	160	Dble. EH <sup>3</sup>
1/8	.405	.035	.049			.068	.068		.095	.095					
1/4	.540	.049	.065			.088	.088		.119	.119					
3/8	.675	.049	.065			.091	.091		.126	.126					
1/2	.840	.065	.083			.109	.109		.147	.147				.187	.294
3/4	1.050	.065	.083			.113	.113		.154	.154				.218	.308
1	1.315	.065	.109			.133	.133		.179	.179				.250	.358
1 1/4	1.660	.065	.109			.140	.140		.191	.191				.250	.382
1 1/2	1.900	.065	.109			.145	.145		.200	.200				.281	.400
2	2.375	.065	.109			.154	.154		.218	.218				.343	.436
2 1/2	2.875	.083	.120			.203	.203		.276	.276				.375	.552
3	3.500	.083	.120			.216	.216		.300	.300				.437	.600
3 1/2	4.000	.083	.120			.226	.226		.318	.318					.636
4	4.500	.083	.120			.237	.237	.281	.337	.337		.437		.531	.674
4 1/2	5.000						.247			.355					.710
5	5.563	.109	.134			.258	.258		.375	.375		.500		.625	.750
6	6.625	.109	.134			.280	.280		.432	.432		.562		.718	.864
7	7.625						.301			.500					.875
8	8.625	.109	.148	.250	.277	.322	.322	.406	.500	.500	.593	.718	.812	.906	.875
9	9.625						.342			.500					
10	10.750	.134	.165	.250	.307	.365	.365	.500	.594	.500	.719	.844	1.000	1.125	
11	11.750						.375			.500					
12	12.750	.165	.180	.250	.330	.406	.375	.562	.688	.500	.844	1.000	1.125	1.312	
14	14.000		.250	.312	.375	.437	.375	.594	.750	.500	.938	1.094	1.250	1.406	
16	16.000		.250	.312	.375	.500	.375	.656	.844	.500	1.031	1.219	1.438	1.594	
18	18.000		.250	.312	.437	.562	.375	.750	.938	.500	1.156	1.375	1.562	1.781	

Up to 12" OD is approximately, but not exactly, the same as NPS 14" and larger OD is the same as NPS

The wall thickness for schedule 80 increases, while the wall thickness for EH pipe remains the same

The wall thickness for schedule 40 increases, while the wall thickness for STD pipe remains the same

\* Note: Pipe Schedule classifies steel pipe according to wall thickness.

<sup>1</sup>STD = Standard Weight · <sup>2</sup>EH = Extra Strong · <sup>3</sup>Dble. EH = Double Extra Strong



## Nominal Pipe Size

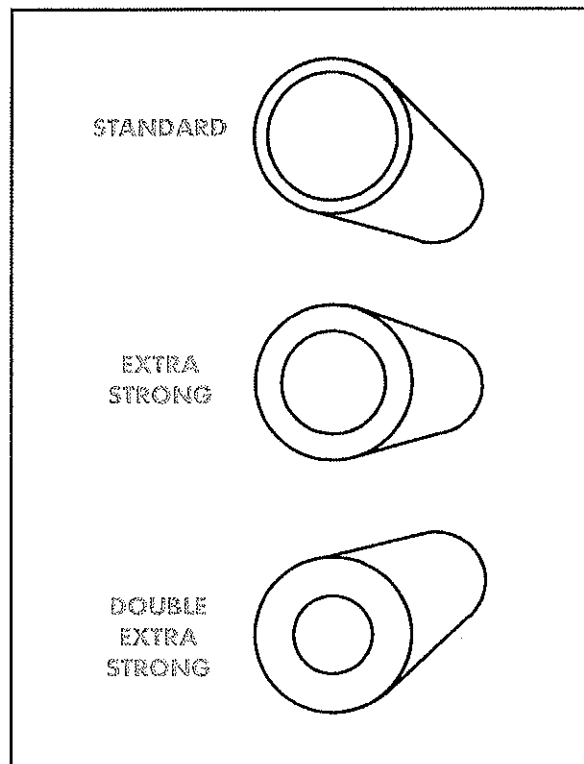
**NOMINAL PIPE SIZE (NPS)** is the industry standard size. It approximates the actual dimensions of the pipe. For instance, in the schedule shown on page 18, the standard weight 1-inch steel pipe has an outside diameter of about 1.315 inches. The OD is approximately, but not exactly, 1 inch. However, it is still called a "1-inch pipe" to simplify communications when ordering.

Note that the outside diameter is the same (1.315 inches) for the schedules and the standard, extra strong and double extra strong weights. Because the outside diameter is the same, standard fittings for 1-inch pipe can be used for schedule 40, 80 and 160 pipe as well as the three weights. Since the outside diameter remains the same even though the wall thicknesses increases, the inside diameter will get smaller.

## Pipe Weights

As we discussed in the beginning of this section, steel pipe comes in three basic weight classes: standard wall (STD), extra strong wall (XS) and double extra strong wall (XXS). The last two designations are sometimes referred to as extra heavy wall (XH) and double extra heavy wall (XXH). The difference in weight is based on the thickness of the walls which are used in high pressure or temperature applications. Abbreviations for pipe weights commonly used in pipe schedules may vary from schedule to schedule. A summary of the common weight abbreviations are listed in the table on the next page.

PIPE WEIGHTS



PVF 2.1.20

## ABBREVIATIONS FOR STEEL PIPE WEIGHTS

Weight	Listed as	Listed as	Also called	Listed as	Listed as
Standard	STD	S			
Extra strong	ES	XS	Extra heavy	EH	XH
Double extra strong	Dble. ES	XXS	Double extra heavy	Double EH	XXH

PVF 2.1.21

## Grade of Steel

In addition to specifying pipe by schedule, pipe is also specified by the strength or grade of steel that is expressed as grade A, B or C. Grade B is the common standard used by most manufacturers. It is important to remember that Grade C, not Grade A, is the strongest grade.

**GRADE** defines the mechanical properties of the steel, including tensile strength and minimum yield strength:

- **TENSILE STRENGTH** refers to the steel's ability to resist being pulled apart.
- **YIELD STRENGTH** indicates the ability of the pipe to withstand pressure.

Tensile strength and yield strength are expressed in **PSI** (pounds per square inch).

## CHARACTERISTICS OF GRADES OF STEEL PIPE

Grade A	Grade B	Grade C
Lowest tensile strength: 48,000 psi	Higher tensile strength: 60,000 psi	Highest tensile strength: 70,000 psi or greater
Lowest yield strength: 30,000 psi	Higher yield strength: 35,000 psi	Highest yield strength: 40,000 psi
Softer, more easily bent	Most commonly used because of the broad range of overlapping chemical and physical properties	Used in special applications where pressure is important factor
Used in limited applications because of lower strength	Satisfactory for nearly all applications using carbon steel, which is the most common kind of steel	
	Universally used as standard by all pipe manufacturers	

PVF 2.1.19

## Specifying Pipe and Using the Pipe Schedule

Typically all pipe is ordered by "NPS" (Nominal Pipe Size) and the pipe schedule that provides a formal listing of pipe wall thickness to allow the use of standard fittings. However, the key to understanding and properly using pipe schedules is understanding when schedules 40 and 80 are the same as standard wall (STD) and extra heavy wall (EH), and when they differ.

## Schedule 40 and Standard Wall

When you look at the pipe schedule (page 18) for schedule 40 and standard wall (STD) pipe, you will notice that the wall thicknesses for schedule 40 and standard wall are the same for NPS 1/8-inch through 10 inches. For example, the wall thickness for 6-inch NPS schedule 40 (sch 40) and 6-inch NPS standard wall (STD) are both .280.

At 12 inches (there is no 11-inch schedule 40 pipe in the schedule), the wall thickness for schedule 40 increases as the size of the pipe increases, while the wall thickness for standard pipe remains the same at .375.

This is important because a plumbing system assembled with 12-inch schedule 40 pipe will be stronger than 12-inch standard pipe. If 12-inch standard pipe were assembled into a system requiring 12-inch schedule 40 pipe, it might fail.

---

## Schedule 80 and Extra Heavy Wall

A similar situation exists with schedule 80 (page 18) and extra heavy wall (EH) pipe. They have the same wall thicknesses for NPS 1/8-inch through 8 inches. Again using a 6-inch example, 6-inch NPS schedule 80 and 6-inch NPS extra heavy wall would both have a wall thicknesses of .432.

At 10 inches (there is no 9-inch schedule 80 pipe in the schedule), the wall thickness for schedule 80 increases as the size of the pipe increases, while the wall thicknesses for extra heavy (EH) pipe remains the same at .500.

---

## NPS and OD

For NPS of 14 inches and larger the "NPS" and the actual "OD" are the same.

## Wall Standards and Pipe Markings

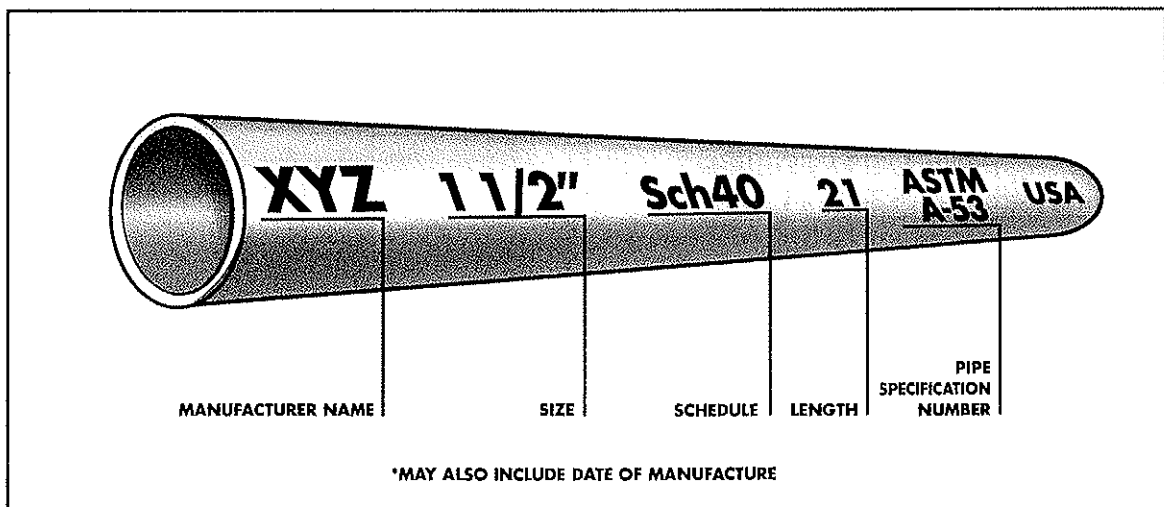
In addition to the standards set in ANSI pipe schedules, pipe specifications are made by several different groups and government bodies. Two groups that set standards for pipe are ASTM International (ASTM) and the American Petroleum Institute (API).

Steel pipe that has been manufactured according to ASTM or API standards will be stenciled, stamped or tagged by the manufacturer.

While the type and sequence of the information provided may vary from manufacturer to manufacturer, the stencil or stamp will usually show the length, NPS, weight per foot, specifications, the name of the manufacturer, and the process and type of steel used.

Here is an example:

STENCILED OR STAMPED PIPE



PVF 2.1.25

## Shipping Steel Pipe

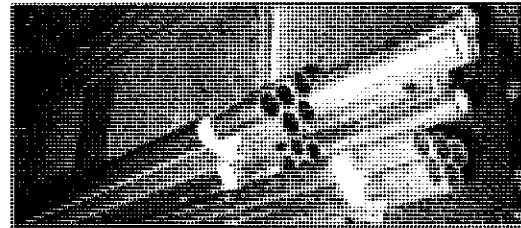
Steel pipe may be shipped in lengths that have been cut to meet customer specifications. However, most manufacturers ship steel pipe in two ways:

- **UNIFORM LENGTH**
- **RANDOM LENGTH.**

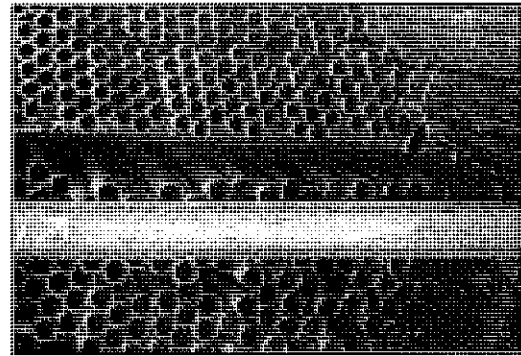
Pipe shipped in **UNIFORM LENGTH** will all be the same length. Pipe shipped in **RANDOM LENGTH** will be of different lengths, but all are generally between 16 and 45 feet long.

Pipe sizes 1 1/2 inches and smaller in diameter are more commonly shipped in **SINGLE RANDOM LENGTHS** up to 22 feet long. **DOUBLE RANDOM LENGTHS** are more commonly shipped in larger diameter pipe. The pipe in these shipments will be of different lengths, from 36 to 44 feet. Shipping in double random length is more common in pipe sizes over 1 1/2 inches in diameter.

### COMMON SHIPPING METHODS FOR STEEL PIPE



**RANDOM**



**UNIFORM**

**PVF 2.1.24**

Depending upon the manufacturer and the type of pipe, pipe 1 1/2 inches through 8 inches in diameter may be shipped in **BUNDLES**. The weight and number of pieces in each bundle are different. Steel pipe over 1 1/2 inches will be stenciled or stamped as explained above.

---

### **Storage of Steel Pipe**

Steel pipe should be housed in a closed area to avoid the chance of rust. If no warehouse or shed is available, the pipe should be covered. Care should be taken in handling the pipe to prevent nicks or damage to threads.

---

## REVIEW OF UNDERSTANDING PIPE SCHEDULES

*Answers appear on page 32*

1. The American National Standards Institute (ANSI) developed a schedule to classify steel pipe according to:
  - a. Wall thickness
  - b. Weight
  
2. Nominal Pipe Size is:
  - a. The industry standard size that approximates the actual dimensions of the pipe.
  - b. The industry standard size that accurately gives the actual dimensions of the 1/8-inch to 12-inch pipe.
  
3. To what type of steel pipe specification do the abbreviations STD, XS and XXH refer?
  - a. Yield strength
  - b. Weight
  
4. Double EH means the same as which choice below?
  - a. XXS
  - b. XH
  
5. Which of the following statements is true?
  - a. Grade C steel pipe has the lowest tensile strength
  - b. Grade A steel pipe has the lowest yield strength
  
6. Which of these terms refers to the steel's ability in steel pipe to resist being pulled apart?
  - a. Tensile strength
  - b. Malleability
  
7. Schedule 40 and standard wall (STD) are the same for:
  - a. 1/8-inch NPS through 10 inches
  - b. 10-inch NPS and above
  
8. Throughout what size range is the wall thickness of schedule 80 pipe the same as extra heavy :
  - a. 1/8-inch NPS through 8 inches
  - b. 8-inch NPS and above







# **ANSWERS TO REVIEW QUESTIONS**

## **CHAPTER 1 STEEL PIPE**



## Answers for REVIEW OF CLASSIFICATIONS OF STEEL PIPE (pages 9 - 10)

- |    |  |     |   |
|----|--|-----|---|
| 1. | a. Black steel   | 7.  | b. Pressure tube  |
| 2. | b. For mechanical applications like handrails or for replacement of existing pipe              | 8.  | Continuous weld, electric resistance weld               |
| 3. | b. High-pressure/high-temperature  | 9.  | Water well, driven well, reamed and drifted, drive pipe |
| 4. | a. Is a method of joining metals by heating and/or pounding the edges of metal strips together | 10. | Line pipe   |
| 5. | b. Standard pipe   | 11. | Oil country tubular goods                               |
| 6. | a. Water well pipe   | 12. | Mechanical tube   |

*Applying What You Learned:*

- A. No answer needed  
 B. Varies by location

## Answers for REVIEW OF STEEL PIPE ENDS AND FITTINGS (pages 15 - 16)

- |    |                                 |     |                                    |
|----|---------------------------------|-----|------------------------------------|
| 1. | a. Beveled pipe                 | 9.  | TOE, TBE                           |
| 2. | b. Plain pipe                   | 10. | American Petroleum Institute (API) |
| 3. | b. Grooved                      | 11. | Taper                              |
| 4. | b. ANSI                         | 12. | Pipe dope                          |
| 5. | b. Pitch                        | 13. | Threaded and coupled pipe end      |
| 6. | a. Recessed coupling            | 14. | Threaded fittings                  |
| 7. | b. Joining steel to copper pipe |     |                                    |
| 8. | Threaded pipe ends              |     |                                    |

*Applying What You Learned:*

- A. Varies by location  
 B. Varies by location

## Answers for REVIEW OF UNDERSTANDING PIPE SCHEDULES (pages 26 - 27)

1. a. Wall thickness
2. a. The industry standard size that approximates the actual dimensions of the pipe.
3. b. Weight
4. a. XXS
5. b. Grade A steel pipe has the lowest yield strength
6. a. Tensile strength
7. a. 1/8-inch NPS through 10 inches
8. a. 1/8-inch NPS through 8 inches
9. a. Uniform length
10. Pipe schedule
11. Grade
12. Random length
13. Bundles

*Applying What You Learned:*

- A. No answer needed
- B. No answer needed

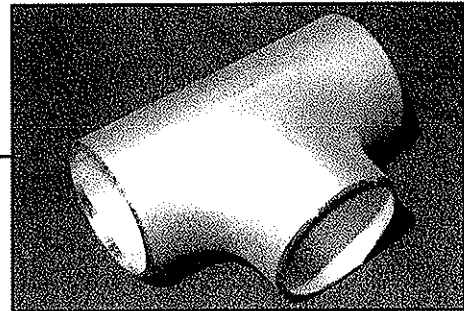
# 2

## STAINLESS STEEL PIPE AND FITTINGS

### LEARNING OBJECTIVES

*When you finish this Chapter, you will be able to:*

1. Define characteristics and advantages of stainless steel
2. Understand classifications of stainless steel pipe into alloy groups, types, series and grades
3. Define specifications for stainless steel pipe and tube
4. Define stainless steel fittings and describe the various joining methods for stainless steel.



STAINLESS STEEL PIPE AND FITTINGS

STAINLESS STEEL PIPE AND FITTINGS

STAINLESS STEEL PIPE AND FITTINGS





## Characteristics of Stainless Steel Pipe

In Chapter 1, you studied galvanized and black steel pipe, which are the two most common types of carbon steel pipe. Carbon steel pipe contains carbon and manganese as its major alloys.

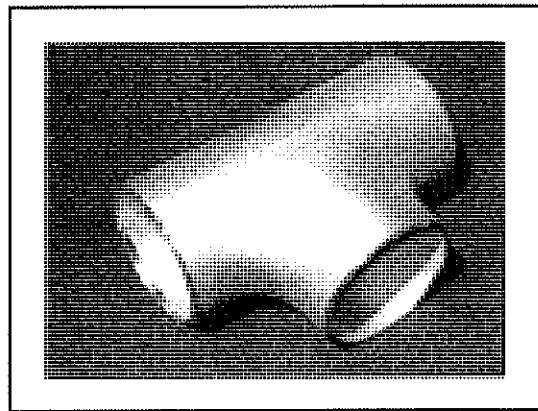
In this chapter, you will learn about stainless steel, which contains chromium as a major alloy. **CHROMIUM** gives stainless steel its major advantage – corrosion resistance, or stainless, qualities.

---

## Uses of Stainless Steel Pipe, Valves and Fittings

Stainless steels get their **CORROSION RESISTANCE** by the formation of a very thin surface film, called the **PASSIVE FILM**, which forms on the pipe's surface in the presence of oxygen. Stainless steel should be provided with a high-oxygen environment to maintain its corrosion-resistant properties. Therefore, special steps must be taken during all stages of fabrication, storage and handling to protect the passive film that allows the corrosion resistance of stainless steel.

STAINLESS STEEL FITTING



PVF 2.2.01

Currently, there are many kinds of stainless steel, each with its own special characteristics and uses. Here we will discuss only the kinds of stainless steel commonly used to make pipe and fittings for the plumbing, heating, cooling and industrial markets.

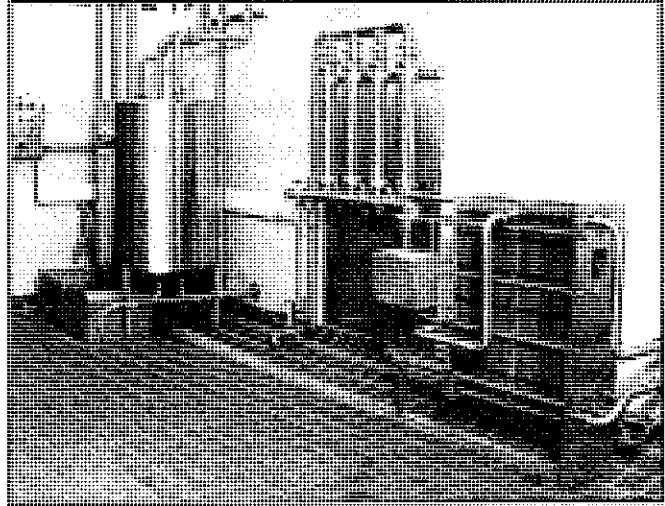
Stainless steel pipe and fittings are often specified for industrial piping systems like processing plants, factories, refineries, power plants and laboratories, because stainless steel is easily kept clean, even when used to carry corrosive materials.

---

In many cases, the stainless steel is polished before use to ensure a smooth surface for product purity. Because there are no corrosion particles to flake off and contaminate fluids flowing through the pipe, the FDA approves stainless steel for use in industries producing products that will be used for human consumption. These include:

- Breweries
- Dairies
- Laboratories
- Food processing plants
- Pharmaceutical plants producing medicines and drugs.

STAINLESS STEEL PIPING IN THE FOOD INDUSTRY



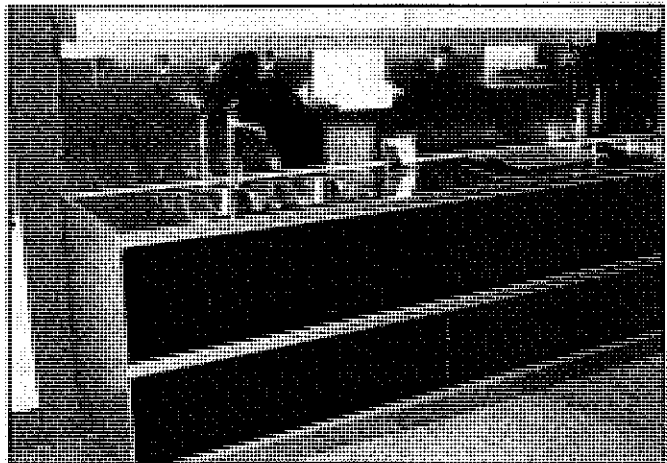
PVF 2.2.02

When it is polished, stainless steel pipe often can be identified by its bright gleam and attractive appearance. The end use of stainless steel determines the degree to which it is to be polished.

Highly polished stainless steel is often used for:

- Architectural and ornamental purposes because of its attractive appearance and because it can be produced in various shapes
- Steel tubing on modern furniture or on playground equipment
- Producing hospital and restaurant equipment and for handrails and grab bars.

STAINLESS STEEL COUNTER



PVF 2.2.03

## Advantages of Stainless Steel Pipe

The important advantages of using stainless steel pipe include the following:

- Stainless steel is **HEAT RESISTANT**, which is very important for industrial uses such as in nuclear power plants and refineries
- Stainless steel is **DURABLE** and is not easily broken or shattered
- Stainless steel will withstand **HIGH PRESSURES**
- Stainless steel is used for **GREAT STRENGTH** and **RESISTANCE**, in extreme temperatures and extreme corrosion conditions.

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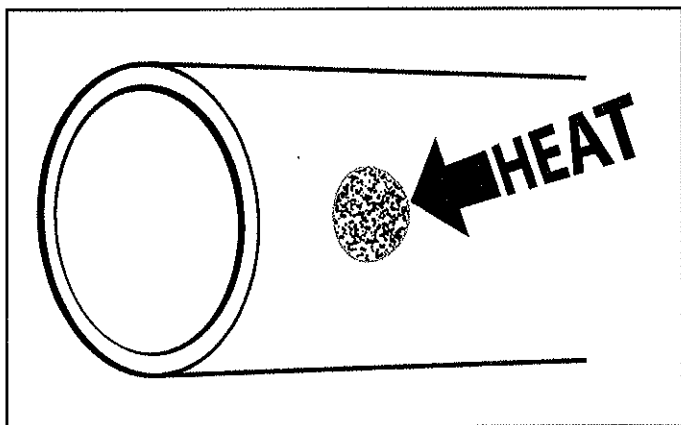
## Stainless Steel and High Temperatures

In cases where high temperatures will be used during an industrial process or in situations requiring welding, the type of stainless steel must be carefully chosen. This is because some stainless steels are susceptible to a heat-related problem that is known by many names, including **CARBIDE PRECIPITATION**, **SENSITIZATION** OR **INTERGRANULAR CORROSION**.

When this occurs, some of the carbon atoms combine with some of the chromium atoms. This forms chromium carbide grains that can then “precipitate out” (separate out) which causes a loss of chromium and a reduction in corrosion resistance.

When this carbide precipitation occurs, the pipe is said to have become **SENSITIZED**. If it has been caused by welding, it is called **WELD DECAY**.

CARBIDE PRECIPITATION



PVF 2.2.04

Sensitization can sometimes be reversed by a special process that includes reheating the sensitized steel to re-dissolve the carbide and then rapidly cooling the steel. The process for reversing sensitization of stainless steel varies with the kind of stainless steel.

Two methods to avoid carbide precipitation include:

- Choosing **LOW-CARBON STAINLESS STEEL**. Low-carbon stainless steel is commonly referred to as “L” grade stainless steel.
- Choosing a stainless steel that contains special alloys to prevent carbide precipitation. These are called **STABILIZED STAINLESS STEELS**.

---

## Choosing Stainless Steel Pipe

The selection of stainless steel may be based on corrosion resistance, fabrication characteristics, availability and mechanical properties (abrasion resistance, creep, ductility, friction resistance, elasticity, hardness, impact resistance, stiffness and strength) in specific temperature ranges and product costs. However, **CORROSION RESISTANCE AND MECHANICAL PROPERTIES** are usually the most important factors in selecting a type of stainless steel for a given application.

---

REVIEW OF CHARACTERISTICS  
OF STAINLESS STEEL PIPE

*Answers appear on page 69*

1. What gives stainless steel its “stainless” quality?
  - a. Carbon
  - b. Chromium
  
2. What does the passive film on stainless steel pipe do?
  - a. Prevents corrosion
  - b. Protects against excessive heat
  
3. Which application is the least likely to use stainless steel pipe?
  - a. Food processing plants
  - b. Residential plumbing systems
  
4. Some stainless steels are susceptible to a heat-related problem which is called by many names, including:
  - a. Rusting
  - b. Carbide precipitation
  
5. What is the advantage of using stainless steel pipe?
  - a. In extreme temperatures and extreme corrosion conditions, stainless steels are used for great strength and resistance.
  - b. Stainless steel pipe is easy to store.
  
6. What happens to stainless steel pipe when sensitization occurs?
  - a. It becomes shinier.
  - b. It becomes less corrosion-resistant in certain areas.
  
7. What is the most important factor in selecting a type of stainless steel for a given application?
  - a. Corrosion resistance and mechanical properties
  - b. Fabrication characteristics
  
8. Stainless steels that contain special alloys to prevent carbide precipitation are called:
  - a. Precipitant-free stainless steels
  - b. Stabilized stainless steels

**REVIEW OF CHARACTERISTICS  
OF STAINLESS STEEL PIPE***Answers appear on page 69*

9. Stainless steel should be provided with a high-oxygen environment to maintain the \_\_\_\_\_ properties.
10. When carbide precipitation has occurred, the pipe is said to have become \_\_\_\_\_, and if it has been caused by welding, it is called \_\_\_\_\_.
11. Carbide precipitation is also defined as \_\_\_\_\_  
or \_\_\_\_\_.

**APPLYING WHAT YOU HAVE LEARNED:**

*By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.*

- A. List the alloy groups that the stainless steel you sell fits into.

---

---

- B. List two applications for which your company sells stainless steel pipe.

---

---

## Classifications of Stainless Steel Pipe

While there are more than 250 different stainless steels, the grades of stainless steel most commonly used for pipe and fittings are divided into **THREE MAIN FAMILIES** or alloy groups that are discussed in this section. These alloy groups, or families, have been developed to combine chemical and mechanical properties required to meet specific customer application needs. The alloy groups include the straight chromium group, chromium-nickel group and chromium-nickel-manganese group.

---

### Alloy Groups or Families

#### 1. STRAIGHT CHROMIUM GROUP

The first group is called the **STRAIGHT CHROMIUM GROUP** because chromium (Cr) is the only alloy added in large enough amounts to affect the performance of the steel.

The straight chromium group includes two types of stainless steel: ferritic stainless steel and martensitic stainless steel. These two types contain different amounts of chromium.

**FERRITIC STAINLESS STEEL** is used in:

- Pipe for the petroleum industry
- Pipe to carry nitric acid.

**MARTENSITIC STAINLESS STEEL** is a small category of stainless steel that is generally not used to make pipe. However, it is extensively used in:

- Cutlery
- Sports knives
- Multipurpose tools.

Ferritic and martensitic stainless steel are not as high in corrosion resistance as the chromium-nickel and chromium-nickel-manganese groups.

---

## 2. CHROMIUM-NICKEL GROUP

The basic formula for the chromium-nickel group is 18% chromium (Cr) and 8% nickel (Ni). Because of this basic formula, it is often called **18-8 STAINLESS STEEL**.

Chromium-nickel stainless steel is widely used in pipe. Most of the stainless steel pipe sold is chromium-nickel pipe.

The chromium-nickel group includes an **AUSTENITIC STAINLESS STEEL** type, which gets its high resistance to corrosion from its substantial nickel content and higher level of chromium.

It is used in:

- Reactor tanks
  - Process water piping
  - Heat exchangers.
- 

## 3. CHROMIUM-NICKEL-MANGANESE GROUP

The basic formula is 18% Cr, 5% Ni, and 8% manganese (Mn). Some stainless steel pipe may be made from chromium-nickel-manganese stainless steel.

The chromium-nickel-manganese group includes an **AUSTENITIC STAINLESS STEEL** type that is used in:

- Railroad freight cars (picture of truck or freight cars)
- Truck trailers
- Other bulk transport equipment where there is a need for a good combination of corrosion resistance, strength, toughness and ease of fabrication.



## Stainless Steel Classified by Series and Grades

The **AMERICAN IRON AND STEEL INSTITUTE** (AISI) has classified the three alloy groups into three series and assigned each series a number:

- Straight chromium group: Series 400
- Chromium-nickel group: Series 300
- Chromium-nickel-manganese group: Series 200

Each series is further divided into “types” or “grades,” with each type being assigned a three-digit number. As you will see later in this chapter, the types or grades are important specifications that are used when processing orders from customers.

For example, within Series 400 you will see the following grades: 405, 409, 430. These are just a few of the many grades available within Series 400. Some AISI-type numbers have letters at the end to indicate a formula change. The letter “L” indicates that the amount of carbon has been lowered to prevent carbide precipitation that might occur during the welding process.

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## Relationship Between Alloy Groups, Stainless Steel Types, Series and Grades

The terms **AUSTENITIC** and **FERRITIC STAINLESS STEEL** will be often seen in manufacturers’ listings of the materials offered in the pipe they sell. The term **MARTENSITIC STAINLESS STEEL** might not be seen because it is generally not used to make pipe. These terms are not usually used in the day-to-day processing of orders.

The table below summarizes the relationship between alloy groups, stainless steel types, series and grades.

RELATIONSHIPS BETWEEN ALLOY GROUP,  
STAINLESS STEEL TYPES, SERIES AND GRADES

ALLOY GROUP	Straight Chromium (Chromium-Iron)		Chromium-Nickel	Chromium-Nickel- Manganese
Stainless Steel Types	Martensitic	Ferritic	Austenitic	
AISI Series #	Series 400		Series 300	Series 200
AISI Type (Note that these grades are just a few of the many grades available within each Series)	410 414	405 430	302, 304, 304L 316, 316L	202, 204, 204L

PVF 2.2.05

## Additional Stainless Steel Alloys

While there are currently more than a hundred formulations for stainless steel, new alloys that increase strength, corrosion resistance and adaptability to a wider variety of applications are constantly being developed. Two of the more recently developed alloys are precipitation-hardening and duplex stainless steel.

**PRECIPITATION-HARDENING STAINLESS STEEL** offers increased strength, ease of heat treatment and corrosion resistance. Precipitation-hardening may include grades of 17-4 (type 630), 17-7 (type 631), 13-8 and others.

It is used in following applications:

- Aerospace
- Chemical and petrochemical
- Food processing applications
- Aerospace components, flat springs
- Retaining rings, springs and aircraft bulkheads.

**DUPLEX STAINLESS STEEL** combines the toughness of austenitic steel with the improved corrosion resistance of ferritic steels. This new alloy helps improve productivity, cost effectiveness and safety for businesses that operate in especially difficult and hostile environments such as offshore drilling. Duplex stainless steel may include grades such as ASTM 2205, NITRONIC 19D and others.

It is used in following applications:

- Tubing
  - Water heater tanks
  - Heat exchangers
  - Pipe
  - Pressure vessels
  - Tanks
  - Fans
  - Shafts and press rolls.
-

**REVIEW OF CLASSIFICATIONS  
OF STAINLESS STEEL PIPE***Answers appear on page 69*

1. How is stainless steel pipe classified?
  - a. By length
  - b. By major alloys
  
2. The straight chromium group includes two types of stainless steel:
  - a. Ferritic and martensitic stainless steel
  - b. Ferritic and austenitic stainless steel
  
3. What does "18-8 stainless steel" refer to?
  - a. Chromium-nickel group
  - b. Chromium-nickel-manganese group
  
4. The chromium-nickel-manganese group includes:
  - a. Ferritic and austenitic stainless steel
  - b. Austenitic stainless steel
  
5. To what series does 18-8 stainless steel belong?
  - a. 200 series
  - b. 300 series
  
6. The American Iron and Steel Institute (AISI) has classified the three alloy groups into what three series?
  - a. Series 300, 200, 100
  - b. Series 400, 300, 200
  
7. To what does the "L" in 304L stainless steel refer?
  - a. Low carbon
  - b. Low chromium
  
8. Two of the more recently developed alloys include:
  - a. Precipitation-hardening and duplex stainless steel
  - b. Precipitation and hardening stainless steel

REVIEW OF CLASSIFICATIONS  
OF STAINLESS STEEL PIPE

Answers appear on page 69

9. \_\_\_\_\_ is a small category of stainless steel that is not used to make pipe.
10. Each series is further divided into \_\_\_\_\_ or \_\_\_\_\_, with each type being assigned a three-digit number.

APPLYING WHAT YOU HAVE LEARNED:

*By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.*

- A. Look above at Questions 8 and 9. Are the answers to those questions also the types of stainless steel pipe that your company sells the most of?

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- B. Look at the catalog listings (in print or on the Internet website) for your stainless steel pipe manufacturer or supplier. How many **types** of stainless pipe does that company offer?

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## Specifications of Stainless Steel Pipe

Standards for the production of stainless steel pipe have been set by several organizations. Efforts are continuing toward developing international standards for stainless steel.

When ordering a stainless steel pipe, it is necessary to be familiar with industry standards and specifications.

- **AMERICAN IRON AND STEEL INSTITUTE (AISI).** This organization developed the standards for the **CHEMICAL FORMULAS** to which each grade of stainless steel is manufactured.
  - **ASTM INTERNATIONAL (ASTM).** Formerly known as American Society for Testing Materials, this organization sets standards for many kinds of technical products. ASTM adopted the AISI chemical standards into its own standards for the production, testing and marking of pipe.
  - **THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME).** The standards set by this group for the production of stainless steel pipe are much like those from ASTM. These standards, however, are sometimes more demanding than ASTM standards.
- 

## Classification by Manufacturing Process

Stainless steel pipe is available as either:

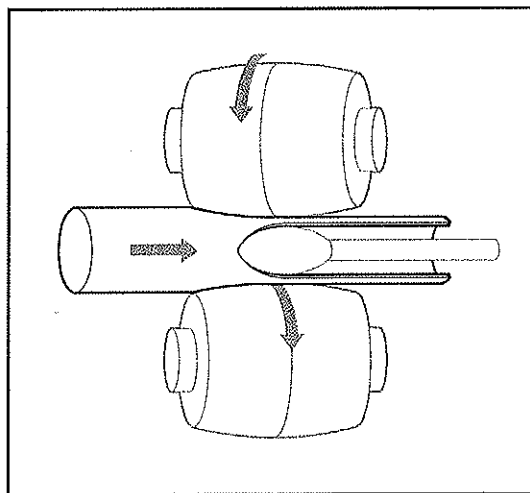
- **WELDED**
- **SEAMLESS PIPE.**

These terms refer to the method by which the pipe is manufactured.

Like carbon steel, **SEAMLESS STAINLESS STEEL PIPE** begins as a solid cylinder of steel called a billet. This piece of steel may be heated before being punched and drilled at its center, drawn over a mandrel and then moved through a series of rollers until the desired size is obtained. This process results in a seamless product.

Seamless stainless steel pipe is available in sizes from 1/4 inch to 12 inches in schedules 5S, 10S, 40S, 80S, 160S, and XXH (double extra heavy). The "S" next to the schedule number indicates that the schedule is for stainless steel.

#### SEAMLESS STEEL PIPE PRODUCTION

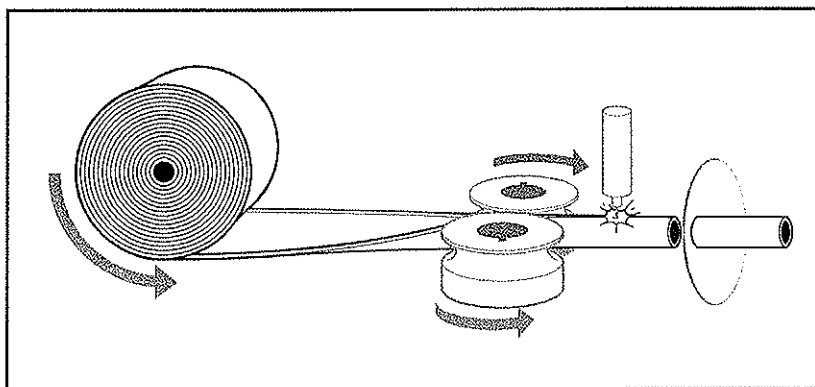


PVF 2.2.06

**WELDED STAINLESS STEEL PIPE** is made by rolling a flat piece of steel into a long cylinder and then welding the edges together. This process forms a seam in the place where the pipe is welded. Various welding processes can be used. The welding method chosen depends upon the particular type of stainless steel and the end use of the pipe.

Welded stainless steel pipe is available from 1/4 inch to 24 inches in schedules 5S, 10S, 40S, 80S, 160S, and XXH.

#### WELDED PIPE PRODUCTION



PVF 2.2.07

## Specifying Stainless Steel Pipe

When processing orders for stainless steel pipe, it is important to list the specifications in the correct order. The order is:

SPECIFICATION	EXAMPLE
• Nominal pipe size or IPS size	12 inches
• Schedule #	10S*
• Type	T-304 (stainless steel type or grade)
• Steel composition	Stainless
• Manufacture	Seamless or welded
• ASTM #	A-312 (manufactured in accordance with this specifications)

So an order for 1,000 feet of the above-specified steel would read like this:  
1,000 feet 12-inch schedule 10S, T-304 stainless steel welded pipe to ASTM A-312.

\*The "S" in the schedule number indicates stainless pipe. The "S" indication is important because the ***wall thicknesses of stainless steel pipe may be different than the thicknesses of carbon steel pipe*** with the same schedule numbers.



Below is a sample of a pipe schedule for stainless steel pipe.

#### SCHEDULE FOR STAINLESS STEEL PIPE

Manufactured in accordance to: ASTM A312/ SA312 – 1/2 inch through 24 inches  
(indicates the formula according to which the pipe was manufactured)

304L & 316L Stainless Steel (indicates the type or grade)

Nominal	Dime	SC 5		SC 10		SC 40	
		WALL THK	LBS /FT	WALL THK	LBS /FT	WALL THK	LBS /FT
1/2	0.8	.065	.54	.083	.68	.109	.86
3/4	1.0	.065	.69	.083	.87	.113	1.1
1	1.3	.065	.88	.109	1.40	.133	1.7
1 1/4	1.6	.065	1.10	.109	1.80	.140	2.3
1 1/2	1.9	.065	1.30	.109	2.10	.145	2.7
2	2.3	.065	1.60	.109	2.70	.154	3.7
2 1/2	2.8	.083	2.50	.120	3.60	.203	5.9
3	3.5	.083	3.10	.120	4.40	.216	7.7
4	4.5	.083	3.95	.120	5.80	.237	10.9
5	5.5	.109	6.50	.134	8.20	.258	14.8
6	6.6	.109	7.80	.134	9.38	.280	19.2
8	8.6	.109	9.92	.148	13.40	.322	28.9
10	10.0	.134	15.19	.165	18.65	.365	40.9
12	12.0	.156	21.17	.180	24.16	.375	50.1

PVF 2.2.09

## Specifying Stainless Steel Tube

Stainless steel tube differs from stainless steel pipe in that:

- Stainless steel tube is manufactured to different ASTM standards than stainless steel pipe
- Stainless steel tube has a different wall thickness than stainless steel pipe
- Stainless steel tube is generally specified by outside diameter (OD), while stainless steel pipe is specified by NPS or IPS
- Wall thickness of stainless steel tube is specified by gauge (GA), while stainless steel pipe is specified by schedule #
- The walls in a stainless steel tube schedule list the approximate weight per foot of the tube.

SCHEDULE FOR STAINLESS STEEL TUBE

Nominal	Dimension						
	OD	16 GA (.062)	14GA (.078)	12GA (.109)	11GA (.125)	10GA (.140)	8GA (.172)
1	1.000	.65	-	-	-	-	-
1 1/4	1.250	.82	-	-	-	-	-
1 1/2	1.500	1.0	-	-	-	-	-
2	2.000	1.3	-	-	-	-	-
2 1/2	2.500	1.7	-	-	-	-	-
3	3.000	2.2	2.6	3.4	3.7	-	-
4	4.000	3.0	3.4	4.6	5.0	-	-
5	5.000	3.8	4.3	5.9	6.7	7.5	-
6	6.000	4.5	5.2	6.9	8.1	9.0	-
8	8.000	6.0	6.9	9.3	10.8	12.1	-
10	10.000	7.5	8.6	11.6	13.6	15.2	18.8

PVF 2.2.10

## Shipping Stainless Steel Pipe

Stainless steel pipe may be shipped in 20-foot lengths, 21-foot lengths or random lengths, depending upon the standard to which it is manufactured.

- Welded stainless steel pipe to ASTM A-778 is normally shipped in uniform 20-foot lengths.
- Welded stainless steel pipe to ASTM A-312 is normally shipped in 21-foot lengths, although it is occasionally shipped in random lengths of 17 to 24 feet.
- Seamless stainless steel pipe is shipped in random lengths.

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## Storage and Care of Stainless Steel Pipe

Great care must be taken to ensure that stainless steel is kept free of contaminants that can damage the passive film that gives stainless steel its corrosion resistance.

Attention must continually be given to contamination prevention at all stages of handling, including during fabrication, storage, transferring and shipping.

Ferrous metals (iron of any kind, carbon steel, non-stainless steel) are especially contaminating and must NOT touch stainless steel. If iron comes into contact with the stainless steel, some of the iron's molecules will remain on the stainless steel surface. These iron molecules will then combine with oxygen in the air to form iron oxide (rust).

In addition to the surface rust, it will prevent oxygen from reaching the chromium, which will destroy the passive film in that area, thereby eliminating the corrosion resistance properties in that area and allowing the pipe to rust further.

Stainless steel pipe must NEVER be stored with regular carbon steel pipe because of this iron contamination problem.

Anything that prevents oxygen from reaching the chromium in stainless steel – including such contaminants as dirt, oil and fingerprints – can interfere with the formation of the passive chromium oxide film.

## Important Precautions for Storing and Handling Stainless Steel Pipe

Stainless steel pipe may be shipped in 20-foot lengths, 21-foot lengths or random lengths, depending upon the standard to which it is manufactured.

- The stainless steel pipe should not touch the steel tailgate of the truck or steel on the forklift because the contact may cause iron to be transferred from the carbon steel, which will damage the passive film on the stainless pipe.
  - Great care also must be taken in handling the material on the loading dock. Some manufacturers place plastic end caps on the pipe ends to protect the pipe from damage or contamination.
  - The warehouse storage area for stainless steel pipe should be chosen carefully so no liquids, rust particles or other foreign substances can drop onto the stainless steel pipe.
  - Care should be taken to avoid contamination of stainless steel pipe by oils from hands or fingerprints or by other substances such as food, drinks and cigarette ashes.
  - Stainless steel pipe must be stored only on wood racks or stainless steel-cladded racks. Cladded racks have strips of stainless steel running perpendicular to the pipe. This allows the pipe to touch only the stainless steel strips, which prevents contamination from occurring. Standard pipe racks can be converted to cladded racks by attaching stainless steel strips to all the areas that actually touch the stainless pipe.
-

REVIEW OF SPECIFICATIONS  
OF STAINLESS STEEL PIPE

Answers appear on page 70

1. The organization that developed the standards for the chemical formulas to which each grade of stainless steel is manufactured is:
  - a. American Iron and Steel Institute (AISI)
  - b. American Society of Mechanical Engineers (ASME)
  
2. Stainless steel pipe is available as:
  - a. Welded pipe only
  - b. Welded and seamless pipe
  
3. Stainless steel tube:
  - a. Has the same wall thickness as stainless steel pipe
  - b. Is generally specified by outside diameter (OD), while stainless steel pipe is specified by schedule #.
  
4. Like carbon steel, \_\_\_\_\_ pipe begins as a solid cylinder of steel called a billet.
  
5. Stainless steel pipe must never be stored with regular carbon steel pipe, because of \_\_\_\_\_ contamination problem.
  
6. \_\_\_\_\_ is made by rolling a flat piece of steel into a long cylinder and welding the edges together.
  
7. Stainless steel pipe must be stored only on wood racks or stainless steel \_\_\_\_\_.
  
8. In the tube schedules, the wall thickness and weights are listed by \_\_\_\_\_, rather than by pipe schedules.

**REVIEW OF SPECIFICATIONS  
OF STAINLESS STEEL PIPE***Answers appear on page 70***APPLYING WHAT YOU HAVE LEARNED:**

*By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.*

- A. List the lengths of stainless steel pipe that you usually carry.

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- B. Describe the precautions your company takes to protect stainless pipe from contamination.

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## Stainless Steel Fittings

Stainless steel pipe can be specified with a number of different end types, each requiring different types of fitting ends.

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## Stainless Steel Pipe Ends

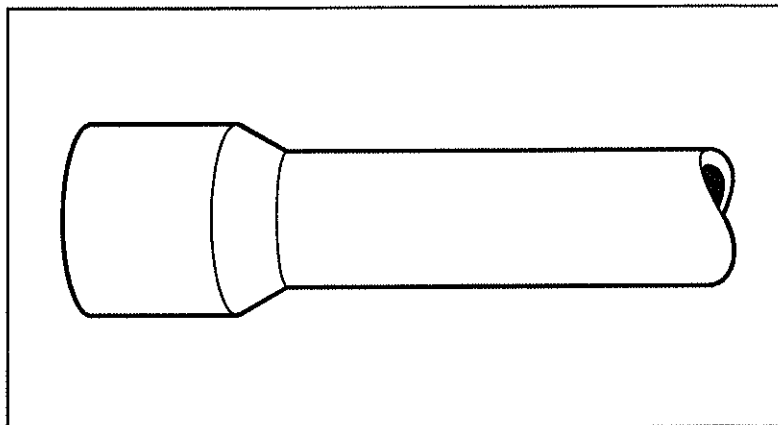
Stainless steel pipe comes with the following ends:

- PLAIN
- BEVELED
- GROOVED
- THREADED
- BELLED.

Only stainless pipe with heavier walls (schedule 40 and heavier) come with threaded ends. Stainless steel grooved pipe ends on schedules 5 and 10, which are light walled, have smoother grooves than carbon steel grooved pipe ends because they are rolled, not cut, into the pipe.

Stainless steel pipe also comes with belled ends. Belled ends look much like the hub ends of DWV pipe. Belled ends are usually supplied in schedules 5 and 10 light walled pipe.

BELLED PIPE END



PVF 2.2.12

## Joining Stainless Steel Pipe and Tube

As always, it is important to become familiar with your manufacturers' literature so you will know what pipe and fittings meet the specifications of your customers' jobs.

Depending upon the type of pipe and use for which the pipe is intended, stainless steel pipe may be joined by:

- **THREADING** (schedule 40 and heavier walled pipe)
- **WELDING**
- **FLANGES**
- **BRAZING** (stainless steel tubing fittings of small diameters).

There are several kinds of welding techniques used with stainless steel. When welding is the method to be used, the possibility of weld decay (carbide precipitation) must be considered as well as meeting pipe and fittings specifications.

The welding method used depends upon:

- Pressure requirements
- Kind of pipe selected
- How the pipe will be used.

There are **TWO TYPES OF FITTINGS** used in welding stainless steel pipe joints:

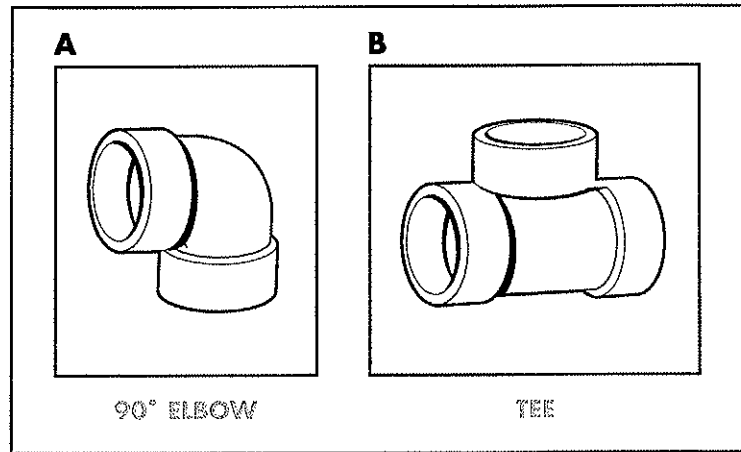
- **SOCKET WELD FITTINGS**
- **BUTT WELD FITTINGS.**



A **SOCKET WELD FITTING** has a recessed end, or socket, to accept the pipe it will be joining. The pipe is welded into the socket, which reinforces the joint.

Socket weld fittings are often called for when stainless steel pipe is to be used in high-pressure applications, such as when it carries steam that is produced in an industrial process. Socket weld fittings are used with various pipe schedules and are commonly available in sizes of 1/8 inch to 4 inches, with larger sizes available to order.

SOCKET WELD FITTINGS



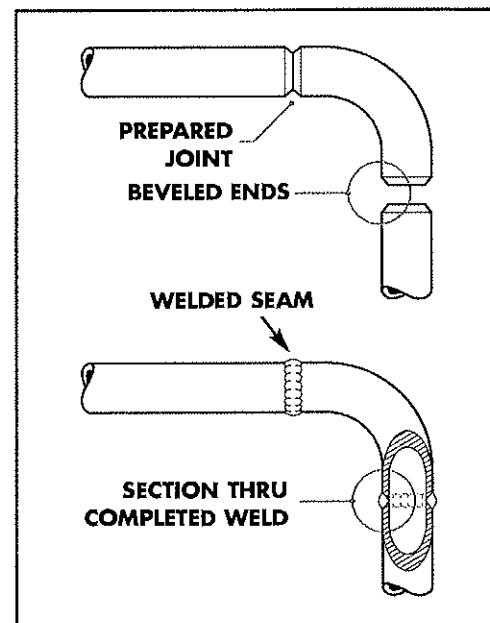
PVF 2.2.13

**BUTT WELD FITTINGS** must be the same diameter and wall thickness as the pipe they connect. Both the fitting end and the pipe end are usually beveled so the ends of the pipe and fitting are butted together, forming a groove to hold the weld filler.

Butt welding is one of the most popular joining methods. There are many advantages of using butt welding. Among them are:

- Lower overall cost
- Very little maintenance is required
- No bolts to be tightened, no gaskets to replace
- No threads that can develop leaks
- They have a smooth line and neat appearance that is unbroken by flanges, threads or sockets
- They are stronger than threaded or flanged joints.

BUTT WELD JOINT



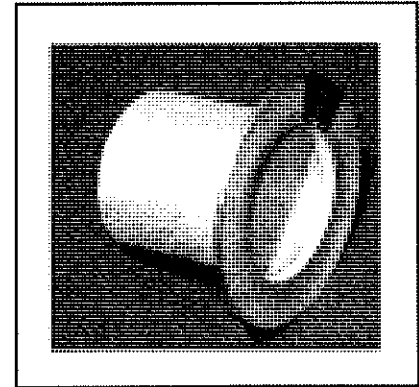
PVF 2.2.14

Butt weld fittings are used with all schedules of stainless steel pipe. They are commonly available in sizes of 1/2 inch to 48 inches. Larger sizes are made to order.

**STUB END** is a type of butt weld fitting. An example is shown on the right.

**BRAZING** is sometimes used to join stainless steel tubing and small-diameter fittings.

STUB END FITTING



PVF 2.2.15

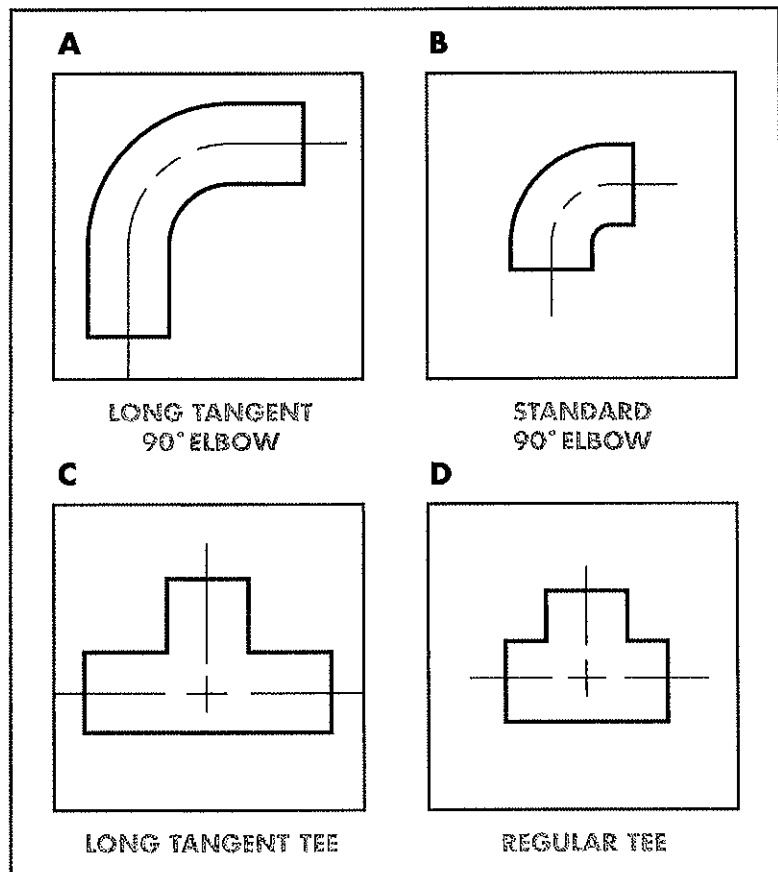
## Long Tangent Fittings

One unusual type of fitting that is used only with stainless steel pipe is the **LONG TANGENT FITTING**.

These fittings provide clearance when joining pipe on a job site that is in hard-to-reach places or must fit around other pipe. Some examples of long tangent fittings are shown here.

Notice how they compare with the other fittings shown.

LONG TANGENT FITTINGS



PVF 2.2.16

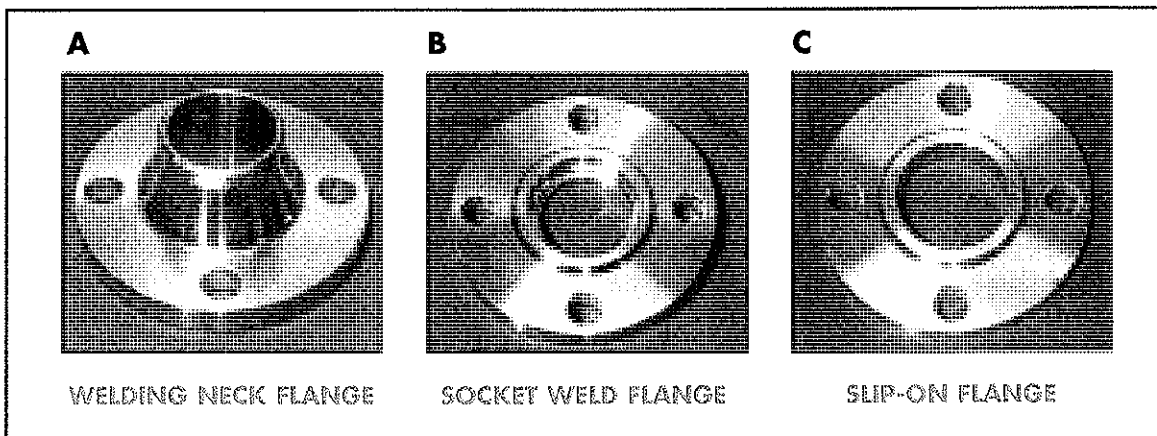
## Flanges

A **FLANGE** is a metal disc with a hole in the center and bolt holes around the rim. A flanged joint is formed when a flange is attached to the end of each piece of pipe to be joined. The two flanges are then bolted together, usually with a gasket between them. There are six types of stainless steel flanges with which you should become familiar. Each is joined differently. Three are welded to the pipe to be joined; the other three are not.

The six types of flanges are:

- Welding neck flange
- Socket weld flange
- Slip-on flange
- Threaded flange
- Blind flange
- Lap joint flange.

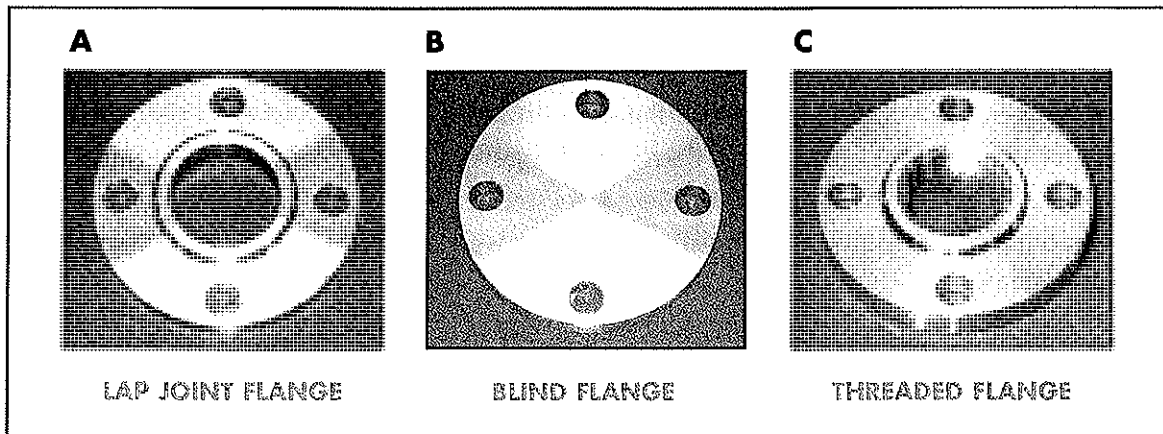
### FLANGES THAT ARE WELDED TO THE PIPE



PVF 2.2.16

The **WELDING NECK FLANGE** is connected to a stainless steel pipe or fitting with a butt weld. With a **SOCKET WELD FLANGE**, the stainless steel pipe is slipped into the recessed end of the flange and then welded on the outside. A **SLIP-ON FLANGE** slips over the pipe and is held in place by one or two welds.

## FLANGES THAT ARE NOT WELDED TO THE PIPE



PVF 2.2.18

**LAP JOINT FLANGES** are used in conjunction with stainless steel stub ends. They are bolted over a stub end that has been welded to stainless steel pipe. A lap joint flange is free floating and can be used to join a pipeline that can later be separated if desired. The **BLIND FLANGE** is made with no hole in the center and is used to end a stainless steel pipeline. It is bolted to another flange to seal off the line. A **THREADED FLANGE** has female threads that mate with the male threads of pipe.

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Stainless steel fittings are manufactured to standards set by ASTM International (ASTM), the American Society of Mechanical Engineers (ASME) and **MANUFACTURERS' STANDARDIZATION SOCIETY (MSS)**.

To preserve the corrosion resistance of stainless steel pipe, it is important to use stainless steel fittings. Stainless steel fittings come in many of the same shapes and sizes as fittings for carbon steel pipe, such as elbows, caps, reducers, tees, flanges and others.

Whenever it is necessary to join two unlike metals, such as steel and copper, an adapter fitting must be used to help prevent galvanic corrosion. **GALVANIC CORROSION** can occur as the result of an electrical current that may be generated between the unlike metals and carried by the fluid in the pipe.

If your company carries stainless steel pipe and fittings, be sure to study your manufacturers' literature carefully to become familiar with the many different types and their uses.

You will also need to follow your manufacturers' guidelines regarding the transportation and storage of your stainless steel products. This way you can be assured that the passive film making the pipe corrosion resistant is always protected.

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## REVIEW OF STAINLESS STEEL FITTINGS

*Answers appear on page 70*

1. Which joining method can only be used on stainless steel pipe that is schedule 40 or heavier walled?
  - a. Brazing
  - b. Threading
  
2. Butt weld fittings:
  - a. Have recessed ends, or sockets, to accept the pipe they will be joining
  - b. Must be the same diameter and wall thickness as the pipe they connect
  
3. If stainless steel pipe is to be used for a high-pressure application, such as steam under pressure, which type of joining would probably be used?
  - a. Socket weld fittings
  - b. Butt weld fittings
  
4. What is brazing sometimes used for?
  - a. Joining a flange to a stainless steel pipe
  - b. Joining stainless steel tube to a fitting
  
5. \_\_\_\_\_ are made to provide clearance when joining pipe on a job site that is in hard-to-reach places or must fit around other pipe.
  
6. A \_\_\_\_\_ is a metal disc with a hole in the center and bolt holes around the rim.
  
7. The \_\_\_\_\_ would be used to connect to a stainless steel pipe or fitting with a butt weld.
  
8. The stainless steel pipe is slipped into the recessed end of the \_\_\_\_\_ and then welded on the outside.

## REVIEW OF STAINLESS STEEL FITTINGS

*Answers appear on page 70*

9. A \_\_\_\_\_ slips over the pipe and is held in place by one or two welds.
10. \_\_\_\_\_ are used in conjunction with stainless steel stub ends.
11. The \_\_\_\_\_ is made with no hole in the center and is used to end a stainless steel pipeline.
12. A \_\_\_\_\_ has female threads that mate with the male threads of pipe.
13. Stainless steel fittings are manufactured to standards set by ASTM International (ASTM), the American Society of Mechanical Engineers (ASME) and \_\_\_\_\_.
14. \_\_\_\_\_ can occur as the result of an electrical current that may be generated between the unlike metals and carried by the fluid in the pipe.

## APPLYING WHAT YOU HAVE LEARNED:

*By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.*

- A. List the types of stainless steel flanges your company carries.

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- B. Pick up a long tangent 90° elbow and regular 90° elbow and compare the two to see how much difference there really is.

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# **ANSWERS TO REVIEW QUESTIONS**

## **CHAPTER 2**

### **STAINLESS STEEL PIPE AND FITTINGS**

### STAINLESS STEEL PIPE AND FITTINGS

STAINLESS STEEL PIPE AND FITTINGS

Answers for REVIEW OF CHARACTERISTICS OF  
STAINLESS STEEL PIPE (pages 39 - 40)

1. b. Chromium
2. a. Prevents corrosion
3. b. Residential plumbing systems
4. b. Carbide precipitation
5. a. In extreme temperatures and extreme corrosion conditions, stainless steels are used for great strength and resistance.
6. b. It becomes less corrosion-resistant in certain areas.
7. a. Corrosion resistance and mechanical properties
8. b. Stabilized stainless steels
9. Corrosion resistant
10. Sensitized, weld decay
11. Sensitization, intergranular corrosion

*Applying What You Learned:*

- A. Varies by location
- B. Varies by location

Answers for REVIEW OF CLASSIFICATIONS OF  
STAINLESS STEEL PIPE (pages 46 - 47)

1. b. By major alloys
2. a. Ferritic and martensitic stainless steel
3. a. Chromium-nickel group
4. b. Austenitic stainless steel
5. b. 300 series
6. b. Series 400, 300, 200
7. a. Low carbon
8. a. Precipitation-hardening and duplex stainless steel
9. Martensitic stainless steel
10. Types, grades

*Applying What You Learned:*

- A. Varies by location
- B. Varies by manufacturer or supplier

Answers for REVIEW OF SPECIFICATIONS OF  
STAINLESS STEEL PIPE (pages 55 - 56)

- |    |   |    |                             |
|----|---|----|-----------------------------|
| 1. | a. American Iron and Steel<br>Institute (AISI)  | 4. | Seamless stainless steel    |
| 2. | b. Welded and seamless pipe   | 5. | Iron                        |
| 3. | b. Is generally specified by<br>outside diameter (OD),<br>while stainless steel pipe is<br>specified by schedule #. | 6. | Welded stainless steel pipe |
|    |   | 7. | Cladded racks               |
|    |   | 8. | Gauge                       |

*Applying What You Learned:*

- A. Varies by location  
B. Varies by location

Answers for REVIEW OF STAINLESS STEEL FITTINGS (pages 64 - 65)

- |    |  |     |   |
|----|--|-----|---|
| 1. | b. Threading   | 8.  | Socket weld flange                              |
| 2. | b. Must be the same diameter<br>and wall thickness as the<br>pipe they connect | 9.  | Slip-on flange                                  |
| 3. | a. Socket weld fittings  | 10. | Lap joint flanges                               |
| 4. | b. Joining stainless steel tube<br>to a fitting                                | 11. | Blind flange                                    |
| 5. | Long tangent fitting   | 12. | Threaded flange                                 |
| 6. | Flange   | 13. | Manufacturers' Standardization<br>Society (MSS) |
| 7. | Welding neck flange  | 14. | Galvanic corrosion                              |

*Applying What You Learned:*

- A. Varies by location  
B. No answer needed

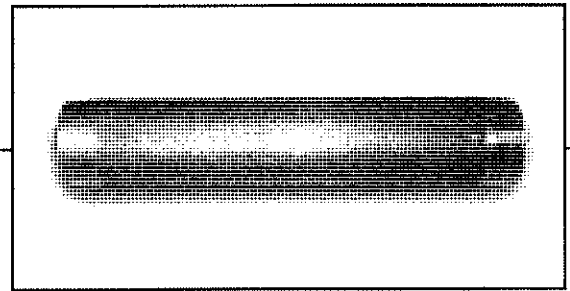
# 3

## IRON PIPE AND FITTINGS

### LEARNING OBJECTIVES

*When you finish this Chapter, you will be able to:*

1. Recognize and use basic terms related to iron pipe and fittings
2. Define characteristics and uses of cast iron, malleable iron and ductile iron
3. Relate the differences between iron pressure pipe and soil or drainage pipe
4. Explain cast iron soil pipe hub and no hub classifications and their applications
5. Identify various types of cast iron soil pipe fittings and their applications.



# IRON PIPE

# AND FITTINGS



## Types of Iron Pipe and Fittings

Iron has several advantages as a material for pipe and fittings:

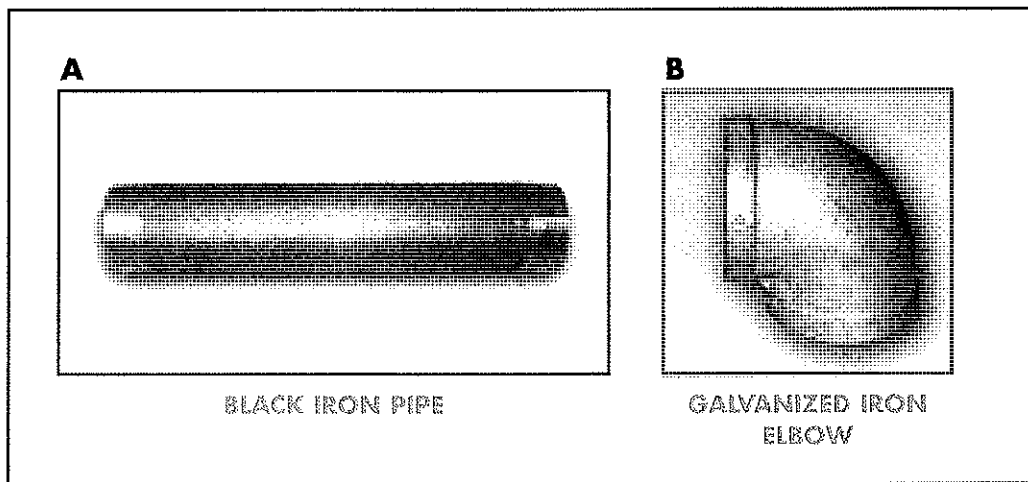
- Great strength, which makes it hard to crush or pierce
- Strong resistance to corrosion, abrasion
- Good sound insulation
- Capability of being joined by a variety of methods
- Long life.

---

## Classification of Iron Pipe by Surface Coating

Like steel pipe, iron pipe comes with two surface finishes. Iron that is coated with a varnish base oil is referred to as **BLACK**. Iron that is coated with a protective layer of zinc is **GALVANIZED** (sometimes called "gray"). However, cast iron is often referred to as "gray iron" whether it is black or galvanized.

BLACK AND GALVANIZED IRON



BLACK IRON PIPE

GALVANIZED IRON  
ELBOW

PVF 2.3.01

## Classification of Iron Pipe and Fittings by Manufacturing Process

The iron used in pipe and fittings comes in three forms:

- **CAST IRON**
- **MALLEABLE IRON**
- **DUCTILE IRON.**

**CAST IRON** is a combination of iron, carbon and silicon. It's called "cast" iron because it must be shaped by casting in a mold. Cast iron cannot be hammered or shaped by rollers. Today, most cast iron pipe is soil pipe, although in the past it was also used for pressure pipe.

**MALLEABLE IRON** is an iron alloy in which the amount of carbon has been controlled to make the metal more easily molded than cast iron. The word "malleable" means that it is capable of being extended or shaped with a hammer or by the pressure of rollers. It is more flexible and resistant to vibration, shock and temperature changes than cast iron. It is used to produce fittings.

**DUCTILE IRON** is an iron alloy to which magnesium has been added to make it stronger. The word "ductile" means that it is capable of being molded, drawn or hammered thin. Like malleable iron, it is used to produce pressure pipe. Ductile iron is a more cost-effective alternative to malleable iron.

Advantages of ductile iron pipe and fittings include:

- Strength and toughness even if the walls are thin
- Good corrosion resistance
- It will bend (but not break) under stress
- Great resistance to pressure, impact and shock.



## CHARACTERISTICS OF IRON PIPE BY MANUFACTURING PROCESS

Type of Pipe	Chemical Makeup	Manufacture	Advantages	Used to produce
Cast iron	Iron, carbon, silicon	<ul style="list-style-type: none"> <li>• Cast in a mold</li> <li>• Cannot be shaped by hammer or rollers.</li> </ul>	<ul style="list-style-type: none"> <li>• Sound insulation</li> <li>• Resistance to corrosion</li> <li>• Variety of joining methods</li> <li>• Long life</li> </ul>	Soil pipe
Malleable iron	Controlled amount of carbon	<ul style="list-style-type: none"> <li>• Molded</li> <li>• Can be shaped by hammer or rollers</li> </ul>	In addition to advantages of cast iron: <ul style="list-style-type: none"> <li>• More flexible than cast iron</li> <li>• More resistant to vibrations or shock</li> <li>• Responds to temperature changes more slowly</li> </ul>	Fittings
Ductile iron	Magnesium added for strength	<ul style="list-style-type: none"> <li>• Can be molded, drawn or hammered thin</li> </ul>	In addition to advantages of cast iron: <ul style="list-style-type: none"> <li>• Very strong and tough even with thin walls</li> <li>• Will bend, not break, under stress</li> <li>• Great resistance to pressure, impact &amp; shock</li> </ul>	Pressure pipe

PVF 2.3.02

## Classification of Iron Pipe by Pressure Applications

Iron pipe is also classified by how it is used in relation to pressure.

**PRESSURE PIPE** is pipe that is used to transfer liquids under pressure. It is used in supply systems, such as municipal water distribution, pump stations or virtually anywhere in which a system is operated under pressure. The pressure pipe is heavier and has thicker walls than soil pipe used in the DWV systems that will be discussed later.

Pressure pipe made from cast iron is used mostly for underground water mains. However, to a great extent, cast iron pressure pipe has been replaced with ductile iron and plastic. Ductile iron's extra strength and toughness make that pressure pipe a more popular choice for pressure applications.

Malleable iron and ductile iron pressure pipe and fittings also are more often the choice when the piping is subject to vibration, shock or rapid changes in temperature.

**SOIL PIPE OR DRAINAGE PIPE** is pipe used in DWV systems, which are always open to the atmosphere rather than closed and pressurized. A DWV system relies only on the forces of gravity and atmospheric pressure to keep liquids flowing through the pipe. For this reason, there is very little internal pressure on drainage pipe.

Cast iron is one type of pipe used in DWV systems; it is particularly likely to be found in older buildings or structures that are taller than two stories. For other DWV systems, another type of pipe such as plastic is frequently used. The type of pipe used for DWV systems is often specified by plumbing or building codes. You should become familiar with the kinds of supply and DWV pipe used in your area.

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## Uses of Iron Fittings

Because they can be used in so many applications, iron fittings come in many different styles. Cast, ductile and malleable iron fittings are used with cast, ductile iron pipe. They are also used with steel pipe.

Some catalogs list iron fittings according to the different types of ends required for various joining methods. Other catalogs have separate listings for special DWV fittings that will meet the unique needs of a particular plumbing system.

REVIEW OF TYPES  
OF IRON PIPE AND FITTINGS

*Answers appear on page 107*

1. Which of the following gives galvanized pipe its protective gray coating?
  - a. Aluminum
  - b. Zinc
  
2. Which of the following statements is true about cast iron pipe?
  - a. It is resistant to corrosion, abrasion and chemicals
  - b. It can be shaped by hammering and rolling
  
3. At the present time, cast iron is mainly used to produce:
  - a. Pressure pipe
  - b. Soil pipe
  
4. Ductile iron is used to produce:
  - a. Pressure pipe
  - b. Soil pipe
  
5. Pressure pipe is used in:
  - a. Supply systems
  - b. DWV systems
  
6. Soil pipe:
  - a. Is used in supply systems
  - b. Depends on the forces of gravity and atmospheric pressure to keep liquids flowing through the pipe.
  
7. One of the advantages that malleable iron has over cast iron is:
  - a. It has better corrosion resistance
  - b. It provides greater resistance to vibration or shock

REVIEW OF TYPES  
OF IRON PIPE AND FITTINGS

Answers appear on page 107

APPLYING WHAT YOU HAVE LEARNED:

*By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.*

- A. List the kinds of pipe used for DWV systems in your area.

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- B. Find out which of the three kinds of iron pipe your company sells the most.

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## Cast Iron Soil Pipe

The most common applications for cast iron soil pipe are in drainage or DWV systems, although plastic pipe and copper tube are also used for drainage pipe.

As we have already mentioned, the term for cast iron pipe used in DWV systems is **CAST IRON SOIL PIPE** or **DRAINAGE PIPE**. While some engineering societies recognize the use of this term with other types of pipe (for example, plastic soil pipe), the term “soil pipe” is more commonly understood as cast iron pipe that is used in DWV systems.

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## Cast Iron Soil Pipe Applications

There are various methods available for joining cast iron soil pipe and fittings. This makes it possible for cast iron soil pipe and fittings to be installed throughout the plumbing drainage system, both above and below the floor and underground. Cast iron soil pipe and fittings are used mostly in building construction for sanitary and storm drain, waste and vent piping applications. Cast iron soil pipe and fittings are most commonly installed in hospitals, schools, commercial and industrial structures.

At the present time, cast iron soil pipe use is commonly preferred — and often required by code — in high-rise building construction for drain, waste, vent and sewer purposes.

Cast iron soil pipe is manufactured in compliance with the standards monitored by the Cast Iron Soil Pipe Institute and ASTM International (formerly known as the American Society for Testing and Materials). Soil pipe bears the collective trademark of these organizations.

## Cast Iron Soil Pipe Installation

Cast iron soil pipe is installed within partitions and serves the tub, lavatory and water closet fixtures. The **CAST IRON SOIL STACK** is the main line in this assembly, 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. This venting keeps a vacuum from forming that would prevent the flow of waste through the system. In some installations, vent lines are connected to a separate vent stack that acts as the main source of air to and from the roof.

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## Cast Iron Soil Pipe Joints

Cast iron soil pipe joints are produced to provide rigidity under normal conditions while still allowing enough flexibility under adverse conditions — such as building sway, footing settlement, ground shift or wall creepage — in order to permit pipe movement without breakage or joint leakage.

Advantages of cast iron pipe for DWV systems are:

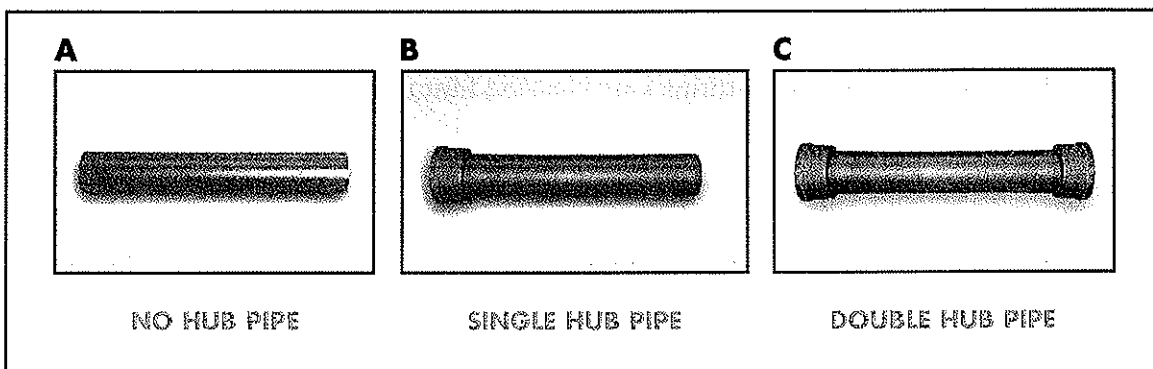
- Resists corrosion
- Insulates noise
- Can be used in long runs with smooth, recessed joints so no waste is caught at the joints
- Meets all building and plumbing codes
- Fire resistant
- Strong and rigid
- High resistance to abrasion from gravel, sand, glass particles, dishwasher discharge, garbage disposal residue and debris being carried in suspension, both at low and high speed.

## Classification of Soil Pipe by End Type

Soil pipe is available in three end types:

- NO HUB (HUBLESS)
- HUB & SPIGOT
- DOUBLE HUB PIPE.

THREE TYPES OF SOIL PIPE ENDS

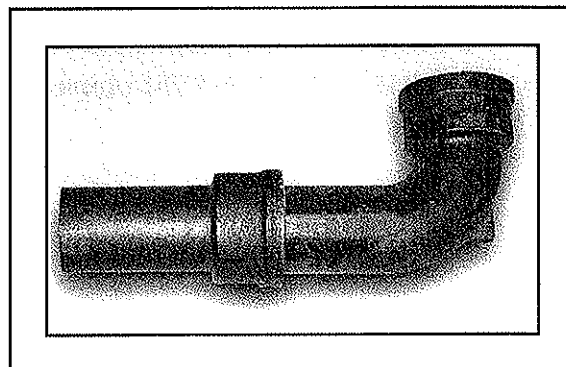


PVF 2.3.05

**NO HUB PIPE**, or hubless pipe, is soil pipe with plain ends. The ends of no hub pipe are joined by a clamp and gasket connector. In this application, the clamp and gasket connector is commonly referred to as a hubless coupling or a "no hub coupling." No hub pipe is most commonly used in in-wall and other above-ground applications. However, in some areas of United States no hub pipe is becoming more commonly used in underground applications in place of the traditionally used hub & spigot pipe.

**HUB & SPIGOT PIPE** has a hub at one end and a spigot (plain end) at the other. The **HUB** is a female end. The male **SPIGOT** fits inside the female hub with either a rubber gasket or lead and oakum process for a close, smooth connection. The preferential use of hub & spigot pipe seems to be in underground drainage. Hub & spigot pipe is especially preferred over no hub pipe when joint integrity, corrosion, overall cost and installation issues are a concern.

HUB & SPIGOT PIPE



PVF 2.3.06

**DOUBLE HUB PIPE** is used for short, fitted pieces. When a piece of double hub pipe is cut in the field, it results in two usable pieces of single hub pipe.

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## Soil Pipe Specifications

No hub and hub & spigot soil pipe and fittings come with the following wall thicknesses:

- No hub soil pipe and fittings come in one wall thickness
- Hub & spigot pipe and fittings are classified into two wall thicknesses:
  - ▣ **SERVICE (SV)**
  - ▣ **EXTRA HEAVY (XH).**

Service and extra heavy pipe applications are determined by the ability of service and extra heavy pipe to withstand external loads. The external loads are listed as maximum crushing loads for each size of service and extra heavy pipe. This determines the type and the size of the pipe for the given application.

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## Pipe Length

Soil pipe is made in three lengths: 42 inches, 5 feet and 10 feet.

- **SINGLE HUB PIPE** comes in all three lengths
- **DOUBLE HUB** comes in 5' and 30" length
- **NO HUB (OR HUBLESS)** pipe comes in only 10' lengths.



## Ordering Soil Pipe

The nominal pipe size (size by which pipe is ordered) for soil pipe is based on the inside diameter (ID) of the pipe. Service and extra heavy pipe with the same nominal pipe size (NPS) will have the same inside diameter but different outside diameters because of the different wall thicknesses.

For example, extra heavy (XH) pipe has a greater wall thickness than service (SV) pipe and a larger outside diameter. Therefore, extra heavy pipe (XH) will need extra heavy (XH) fittings so the outside diameters will match and permit connection.

In order to connect systems with extra heavy (XH) pipe to systems with service (SV) pipe, an adapter needs to be used.

- **NO HUB SOIL PIPE** comes in diameters from 1 1/2" to 10".
- **SINGLE AND DOUBLE HUB SOIL PIPE** can be ordered from 2" to 15".

Below is a table of commonly available cast iron soil pipe.

SOIL PIPE SPECIFICATIONS

Pipe End	Weight	Length	Nominal Pipe Size (ID)
No hub	One weight only	10' only	1 1/2" to 10"
Hub & spigot	Service weight Extra heavy	42"; 5'; 10'	2" to 15"
Double hub	Service weight Extra heavy	30" and 5'	2" to 15"

PVF 2.3.08

**REVIEW OF CAST IRON SOIL PIPE***Answers appear on page 107*

1. Cast iron soil pipe is also called:
  - a. Drainage pipe
  - b. Pressure pipe
  
2. Most cast iron soil pipe and fittings are installed in:
  - a. Hospitals, schools, commercial and industrial structures
  - b. Residential applications
  
3. Cast iron soil pipe joints:
  - a. Provide considerable flexibility under normal conditions
  - b. Allow for smooth flow of waste through a long run
  
4. Which statement is true about cast iron soil pipe?
  - a. It has low internal resistance to internal abrasion
  - b. It is fire resistant
  
5. Cast iron soil pipe comes as:
  - a. Hub & spigot only
  - b. Hub & spigot, no hub (hubless) and double hub pipe
  
6. Hub & spigot pipe is joined:
  - a. By a clamp and gasket connector
  - b. When the male spigot fits inside the female hub
  
7. No hub soil pipe comes in:
  - a. One wall thickness
  - b. Service (SV) and extra heavy (XH) wall thicknesses
  
8. Hub & spigot pipe comes in:
  - a. One wall thickness
  - b. Service (SV) and extra heavy (XH) wall thicknesses

**REVIEW OF CAST IRON SOIL PIPE***Answers appear on page 107*

9. Cast iron soil pipe is ordered by:
- NPS based on the outside diameter (OD)
  - NPS based on the inside diameter (ID)
10. Service (SV) and extra heavy (XH) pipe weight:
- Need fittings designed for their specific weight
  - Can use the same fittings

**APPLYING WHAT YOU HAVE LEARNED:**

*By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.*

- A. Which of the following does your company sell the most:
- No hub pipe
  - Hub & spigot (SV)
  - Hub & spigot (XH)
- B. If your company sells hub & spigot pipe, what joining methods are commonly used by your customers?

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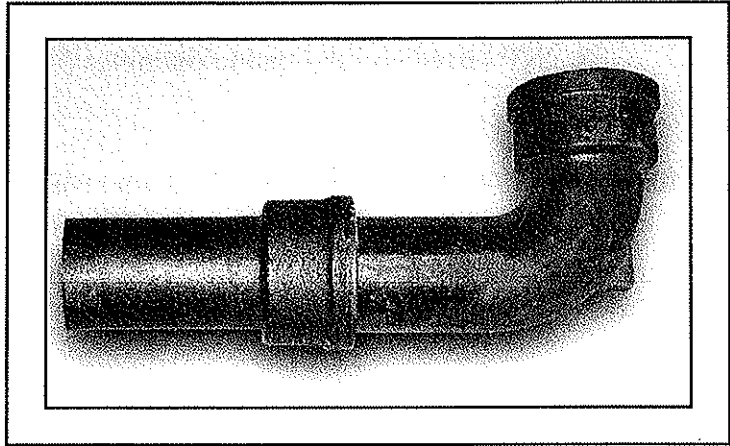
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## Hub & Spigot Fittings

Cast iron soil pipe may be joined by iron hub & spigot fittings. A male spigot end is inserted into a female hub end to form a smooth line of flow for waste materials. This connection is called a **HUB & SPIGOT JOINT**.

Hub & spigot fittings come in service weight and extra heavy weight. However, not all manufacturers make all fittings in both weights.

HUB & SPIGOT JOINT

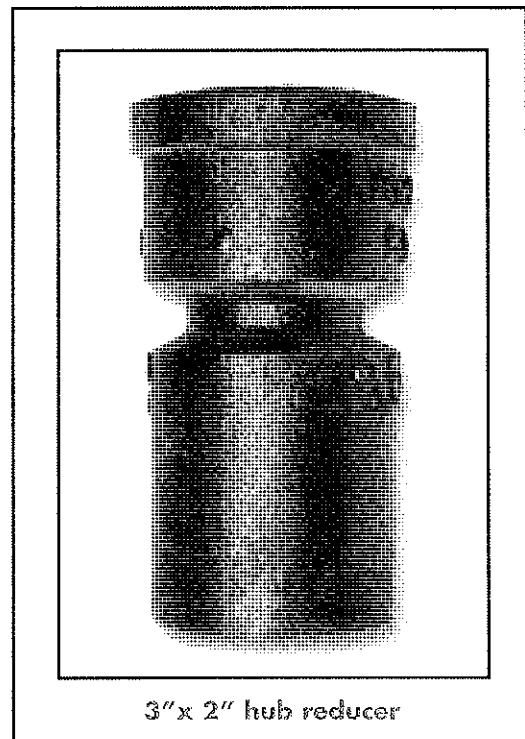


PVF 2.3.09

## Hub Reducers

Soil pipe fittings can be reducing fittings, like the one to the right. A reducer joins pipe of one diameter to pipe of a smaller diameter to reduce the flow. The specs for the fitting to the right would be a 3" x 2" hub reducer. In some areas, a customer might ask for 3" x 2" (SV) hub reducer. The larger diameter is always stated first.

HUB REDUCER



3" x 2" hub reducer

PVF 2.3.10

## Hub Increases

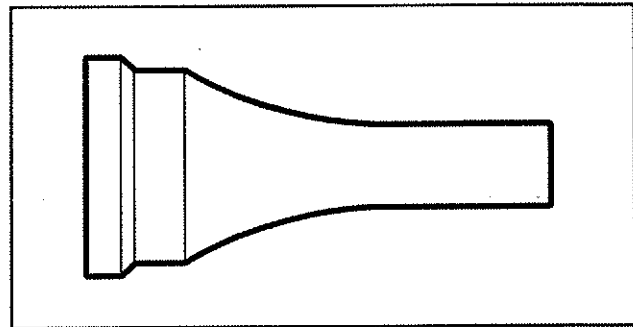
An **INCREASER** joins pipe of one diameter to pipe of a larger diameter to increase the flow.

There are three styles of increasers:

- **REGULAR INCREASER**
- **LONG PLAIN INCREASER**
- **LONG TAPPED INCREASER.**

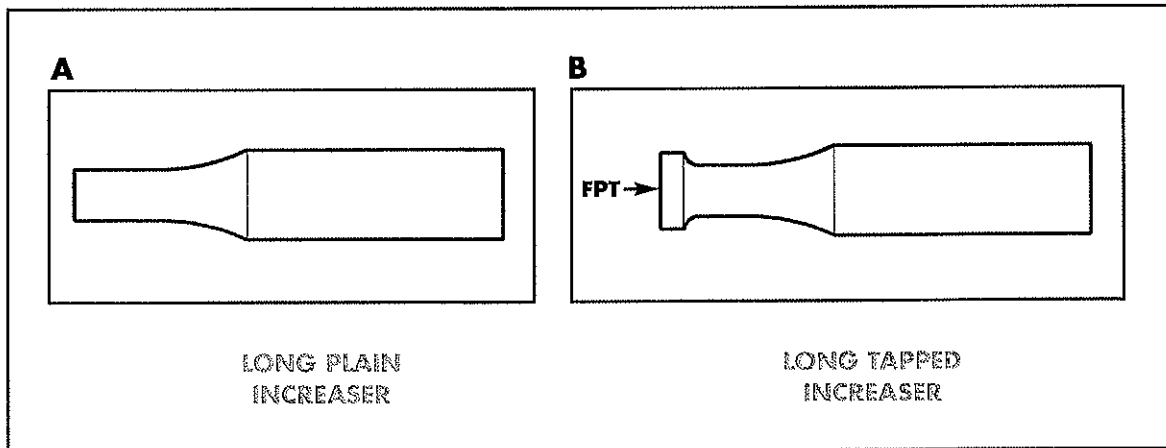
With a regular increaser like on the right, the smaller-diameter spigot end of the increaser is joined to the hub of the smaller-diameter pipe. Another piece of soil pipe with a larger diameter is joined to the hub end of the increaser.

REGULAR INCREASER



PVF 2.3.11

LONG INCREASERS

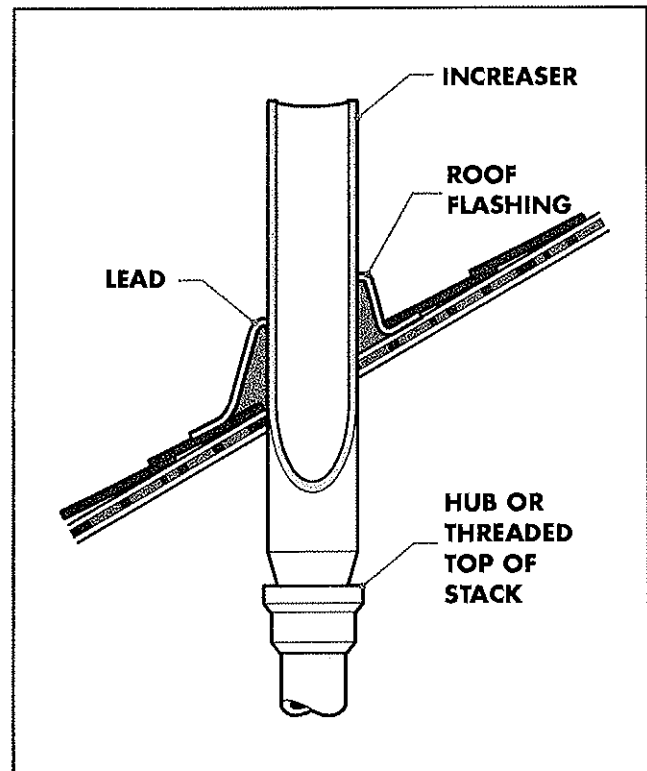


PVF 2.3.12

Openings with female pipe threads (FPT) are called **TAPPED OPENINGS**. The smaller end of the long tapped increaser shown above (B) has female pipe threads. This increaser is used when transitioning from hub & spigot to steel pipe thread.

The increaser in the drawing to the right is joined to the vent stack before it goes through the roof. The vent stack allows the flow of waste fumes from the DWV system. A larger-size pipe is needed above the heated area of the building to prevent frost buildup from closing the vent opening. The length of the long plain increaser shown on page 87 (A) saves another joint before going through the roof.

LONG INCREASER



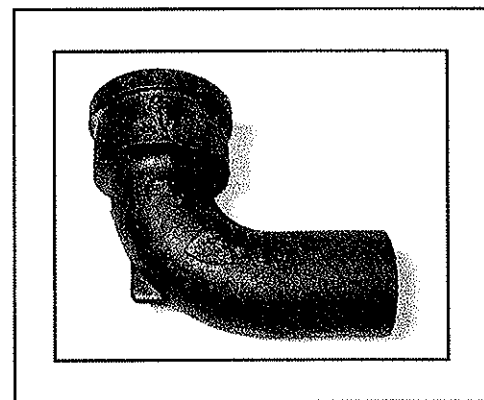
PVF 2.3.13

## Hub & Spigot Bends

Soil pipe elbow fittings are called **BENDS**. The fitting below, which makes a 90° turn, is called a 1/4 (quarter) bend. A 1/4 bend is one-fourth (90°) of a full circle (360°).

The specs for a bend first list the size of the opening and then the type of bend. The bend to the right would be ordered as a 3" 1/4 bend.

QUARTER BEND



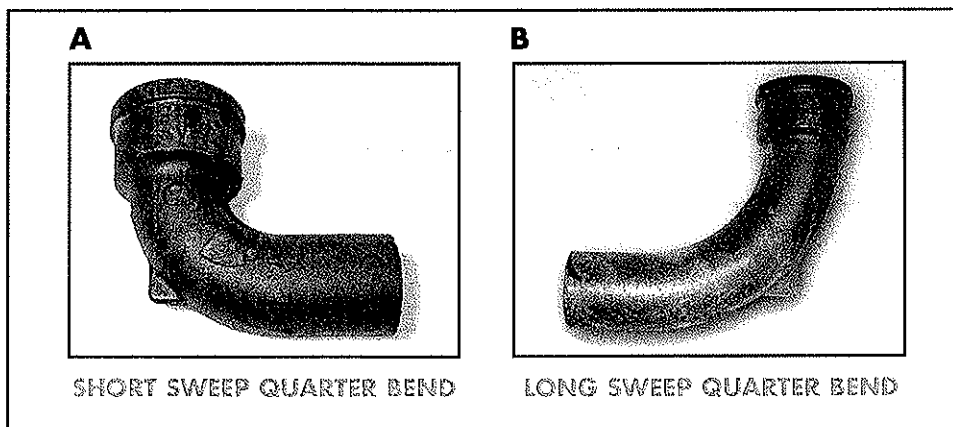
PVF 2.3.14

Soil pipe bends come in five angles:

- 1/4 BEND
- 1/5 BEND
- 1/6 BEND
- 1/8 BEND
- 1/16 BEND.

Quarter bends come with different sweeps. The **SWEEP** is the distance it takes to make the turn. The sweep is also called the radius of the bend. The greater the sweep, the more gentle or smoother the turn. There is less turbulence as the flow changes direction in a long sweep bend. Some manufacturers produce both short and long sweep reducing bends.

SHORT SWEEP AND LONG SWEEP QUARTER BENDS

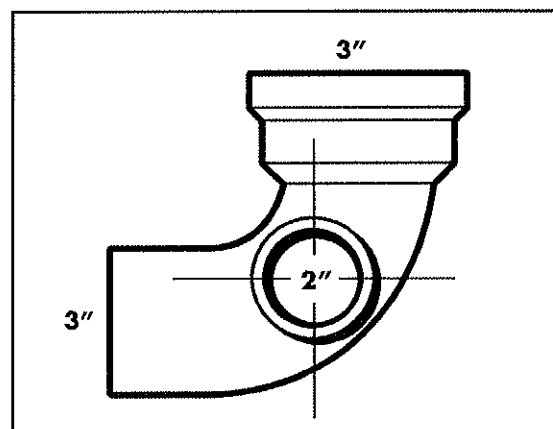


PVF 2.3.16

A 1/4 bend can also come with a **side INLET**, which is the opening that allows the flow to join the run. The inlet can be on either the left side or the right side. A left inlet is to the left of the flow, a right inlet to the right.

The bend shown to the right would be specified as a 3" 1/4 bend with 2" left side inlet.

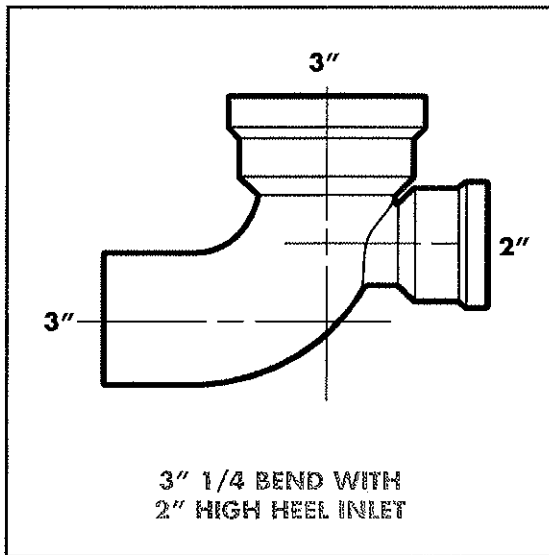
QUARTER BEND WITH SIDE INLET



PVF 2.3.17

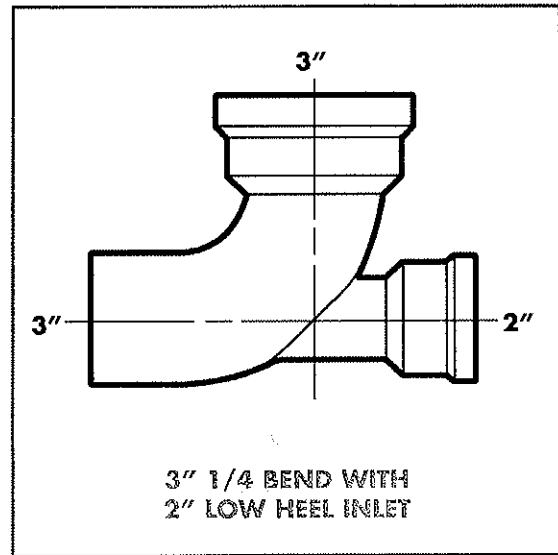
A 1/4 bend can also have an inlet in the heel of the fitting. The inlet can be low on the heel of the fitting (a low heel inlet) or high on the heel of the fitting (a high heel inlet).

QUARTER BEND WITH  
A HIGH HEEL INLET



PVF 2.3.18A

QUARTER BEND WITH  
A LOW HEEL INLET



PVF 2.3.18B

The specs for bends with inlets are given in this order:

1. **THE SIZE** of the run openings
2. **THE TYPE** of bend (1/4, 1/8, etc.)
3. **THE SIZE** of the inlet
4. **THE SIDE** of the inlet (left, right, high heel, low heel).

An example of how a bend would be specified when ordering is as follows:  
4" (SV) or (hub & spigot) 1/4 Bend with 3" high heel inlet.

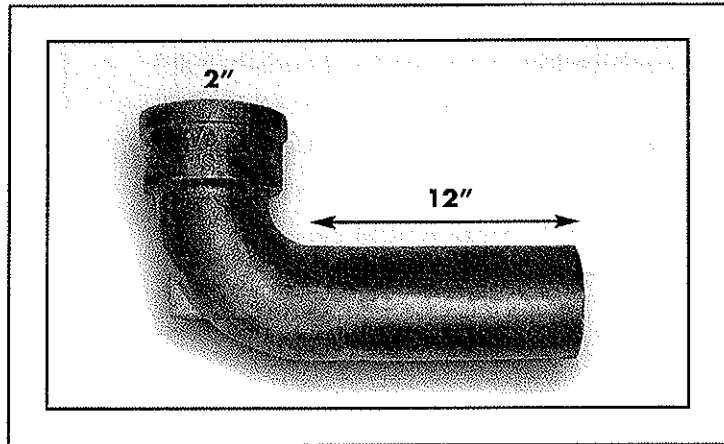
Quarter bends may have female pipe threads (FPT) on one end; such bends are called **TAPPED BENDS**. In this case, you might order a 3" tapped 1/4 bend.



Quarter bends also come in long sizes. In a **LONG BEND**, the length is not in the sweep, but in the total length of the fitting.

The specs for a long bend include the diameter of the pipe and the length of the bend. The specs for the bend to the right would be: a 2"x 12" long 1/4 bend.

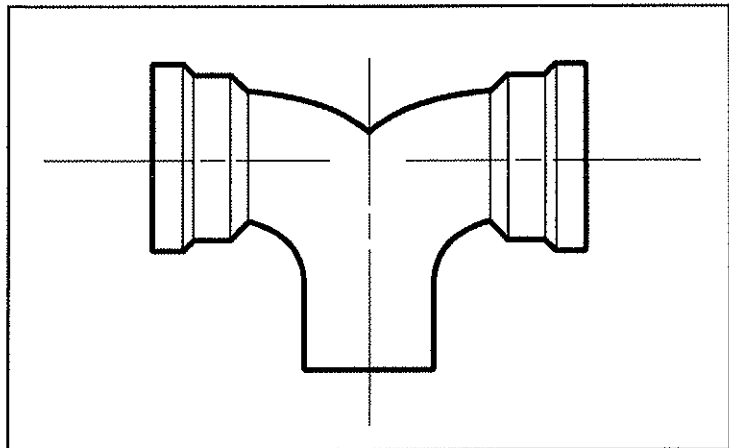
LONG QUARTER BEND



PVF 2.3.19

A **DOUBLE QUARTER BEND**, sometimes called a **TWIN ELL**, joins two branch lines to the main waste line at 90° angles. The double quarter bend to the right has two hubs and one spigot end. Double quarter bends are ordered by the size of the pipe to be joined.

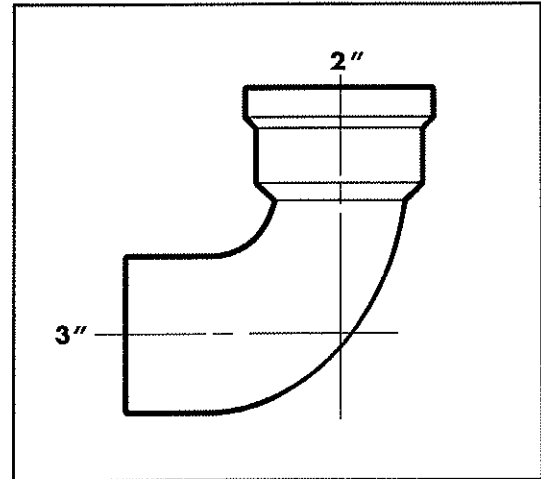
DOUBLE QUARTER BEND



PVF 2.3.20

**REDUCING BENDS** join pipe of one diameter to pipe of a smaller diameter. Specifications for reducing bends begin with the largest opening. Some manufacturers produce short and long sweep reducing bends. The specs for the bend shown to the right would be: 3"x 2" reducing 1/4 bend.

REDUCING BEND



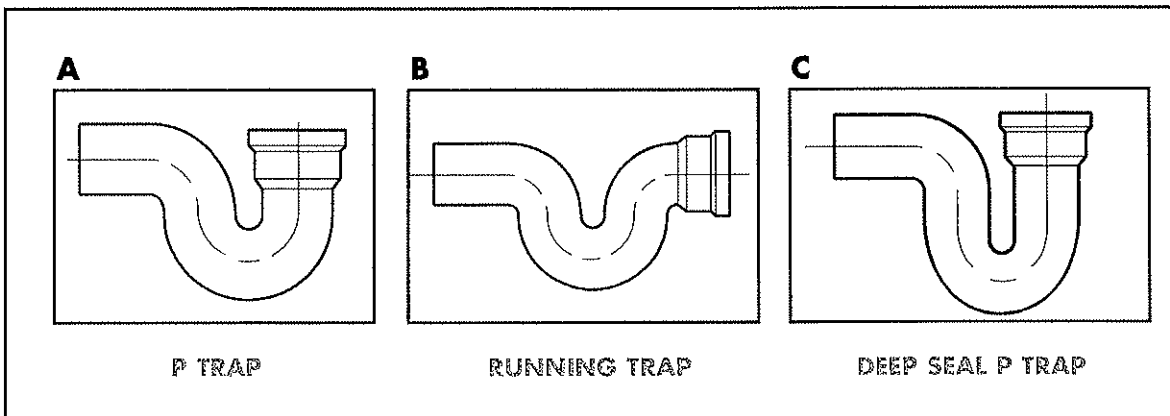
PVF 2.3.21

## Hub & Spigot Traps

There are many different hub "P" traps. Among them are:

- P TRAP
- RUNNING TRAP
- DEEP SEAL P TRAP.

HUB P TRAPS



PVF 2.3.21A

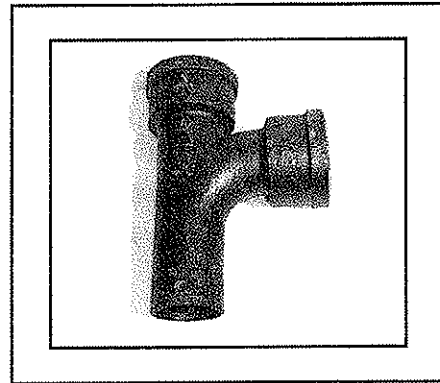
## Hub & Spigot Tees

A **SANITARY TEE** (often called a “san tee”) is used in the wet or waste portion of the DWV system. A san tee has a sweep in the branch inlet that aids in passing waste into the main soil line.

A san tee also may come with side openings. The example to the right shows a san tee with side inlet.

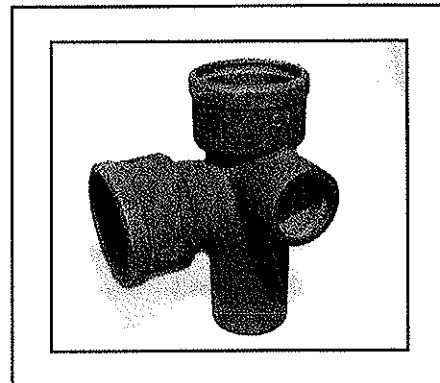
A **TEST TEE**, also referred to as a **CLEAN OUT TEE**, is used in the main drain inside a building. It has a large opening that allows insertion of a device called a test plug. The test plug is used to check the DWV system for leaks. Once the test is completed, a plug is used to close the opening.

SANITARY TEE



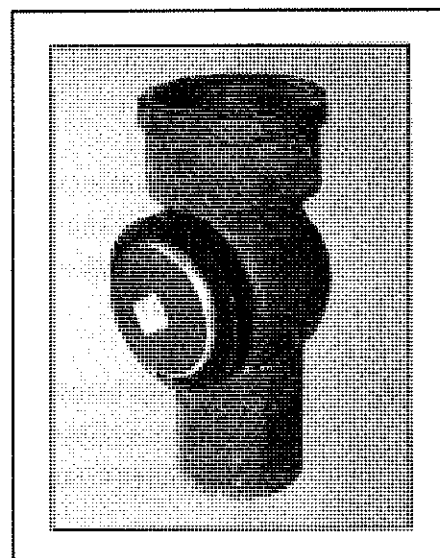
PVF 2.3.21B

SAN TEE WITH SIDE INLET



PVF 2.3.21C

TEST TEE WITH PLUG



PVF 2.3.21D

## REVIEW OF HUB &amp; SPIGOT FITTINGS

*Answers appear on page 108*

1. Tapped openings of an increaser utilize what type of thread:
  - a. MPT
  - b. FTP
  
2. A bend with a long sweep will tend to:
  - a. Increase turbulence of the flow as it changes direction
  - b. Decrease turbulence of the flow as it changes direction
  
3. Hub & spigot increasers come as:
  - a. Regular increaser and long plain increaser only
  - b. Regular increaser, long plain increaser and long tapped increaser
  
4. A 90° elbow may be called:
  - a. 1/8 bend
  - b. 1/4 bend
  
5. Sanitary tees are used in the:
  - a. Wet or waste portion of the DWV system
  - b. Dry or vent portion of the DWV system
  
6. A side inlet is:
  - a. The opening that allows the flow to join the run
  - b. Only found on a 1/6 bend
  
7. In a long quarter bend, the length measured is the:
  - a. Sweep of the fitting
  - b. Total length of the fitting
  
8. Hub & spigot traps come in:
  - a. Many variations
  - b. Regular P traps only

## REVIEW OF HUB &amp; SPIGOT FITTINGS

*Answers appear on page 108*

## APPLYING WHAT YOU HAVE LEARNED:

*By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.*

- A. List how many kinds of bends (from question 4 above) that you carry. Try to get your hands on one of each and compare the angles of flow.
- \_\_\_\_\_
- \_\_\_\_\_
- B. Look at a catalog from one of your supplier manufacturers. Do they offer both long sweep and short sweep quarter bends?
- \_\_\_\_\_
- \_\_\_\_\_
- C. Pick up 2" 1/4 bend and a 2" short sweep 1/4 bend and compare the radius of the turn.
- \_\_\_\_\_
- \_\_\_\_\_

## No Hub Fittings

No hub fittings are available in many of the same configurations as hub & spigot fittings. They are generally specified in the same manner as hub & spigot fittings.

---

## No Hub Reducers

As with hub & spigot fittings, the specifications for no hub reducers begin with the larger diameter.

## No Hub Bends

No hub bends are available in most of the same designs as the hub & spigot bends, including:

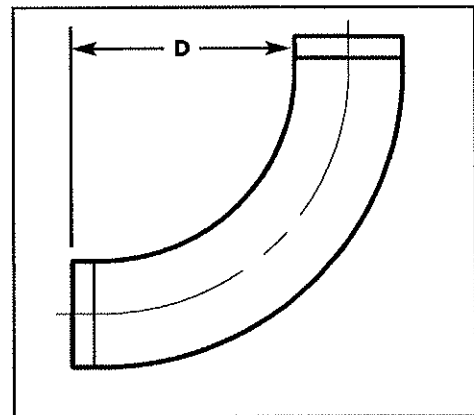
- 1/4 BEND
- 1/5 BEND
- 1/6 BEND
- 1/8 BEND
- 1/16 BEND.

Like hub & spigot bends, no hub bends are ordered according to the size of the pipe to be joined.

No hub 1/4 bends also come with short or long sweep. Sweep fittings are ordered by the diameter of the pipe, but many catalogs also list short or long sweep.

In the drawing to the right, the sweep is indicated by the letter "D."

SWEEP DIMENSION IN NO HUB BEND



PVF 2.3.22

The 1/4 and 1/8 bends also are available as long bends. These fittings are specified in the same manner as hub & spigot long bends.

No hub quarter bends also come with side openings. Depending on how the fitting is installed, a side opening can be on either the right or left side. No hub 1/4 bends also can be ordered with heel inlets. The size of the run opening is given first, followed by the size of the inlet.

Some no hub 1/4 bends are tapped at one end. The female pipe threads in cast iron are called IPS (iron pipe size) threads.

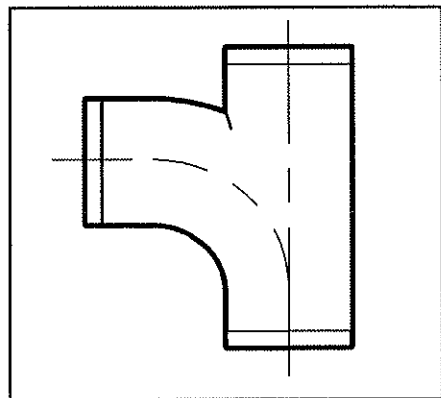
## No Hub Tees

A **SANITARY TEE** (often called a “san tee”) is used in the wet or waste portion of the DWV system. A san tee has a sweep in the branch inlet that aids in passing waste into the main soil line.

A san tee may also come with side openings. The side opening may be at a 45° angle above the center. Also, san tees may have openings at 90° angles on center or above center.

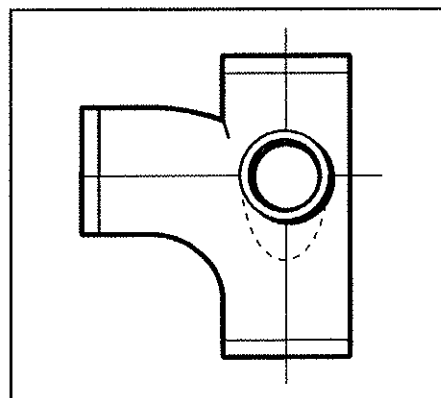
The fitting to the right is a 3” no hub san tee with a 2” 90° left side inlet.

SANITARY TEE



PVF 2.3.23

SAN TEE WITH 90°  
SIDE OPENING ON CENTER



PVF 2.3.24

The spec sheet for a san tee with a side opening indicates the:

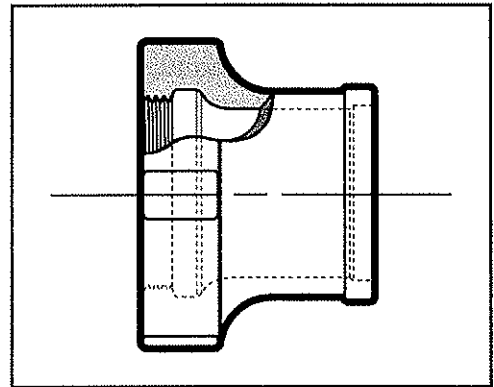
- **DIAMETER** of the run
- **THE SIZE, ANGLE** and **LOCATION** of the opening.

A **TEST TEE**, also referred to as a **CLEAN OUT TEE**, is used in the main drain inside a building. The test tee has a large plug opening. The regular plug is removed and a special "test plug" is inserted to test the DWV system for leaks. Once the test is completed, the original plug is reinserted to close the opening.

## No Hub Adapters

No hub fittings include a variety of adapters. A **TAP EXTENSION PIECE** adapts no hub pipe to a threaded connector. The no hub end is specified by diameter. The tapped end is specified by IPS.

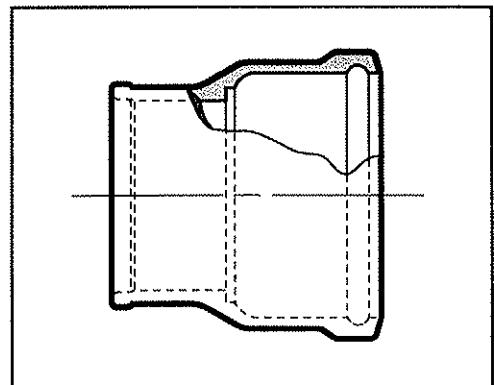
TAP EXTENSION PIECE



PVF 2.3.26

The **HUB ADAPTER** joins a no hub soil pipe to hub & spigot soil pipe. Hub adapters are ordered by the diameter of the no hub end.

HUB ADAPTER



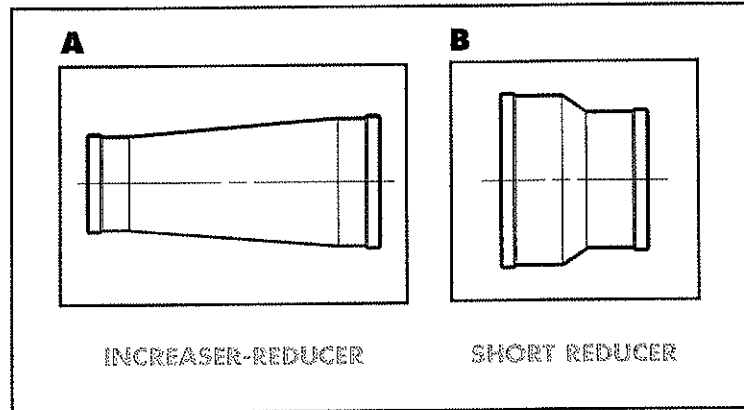
PVF 2.3.27



## No Hub Increasing and Reducing Fittings

Like hub & spigot fittings, there are no hub increasing and reducing fittings. Fitting A to the right is a 2" x 3" no hub increaser-reducer. Fitting B is a 2" x 1 1/2" no hub short reducer. The specification for a short reducer gives the larger diameter first.

NO HUB INCREASERS AND REDUCERS



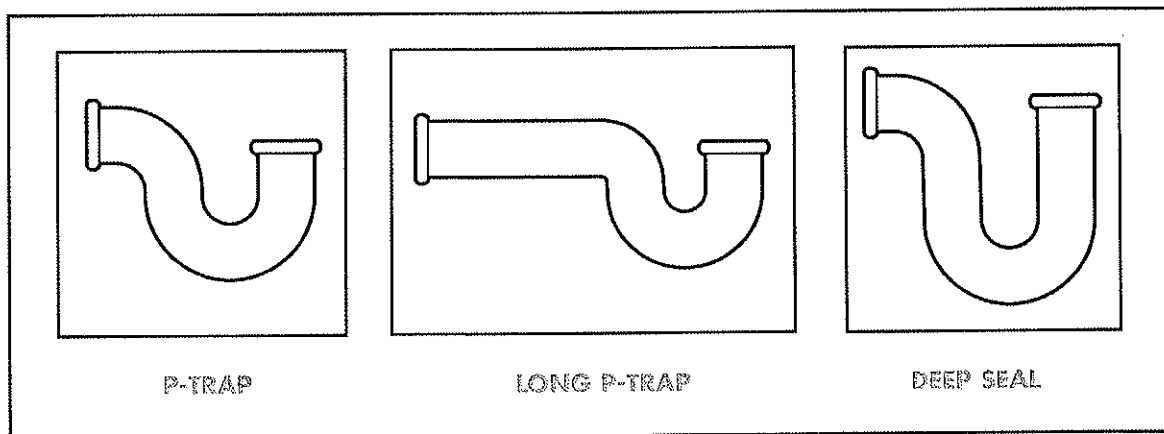
PVF 2.3.28

## No Hub Traps

There are different types of no hub P-traps. Among them are:

- P-TRAP
- LONG P-TRAP
- DEEP SEAL

NO HUB P TRAPS

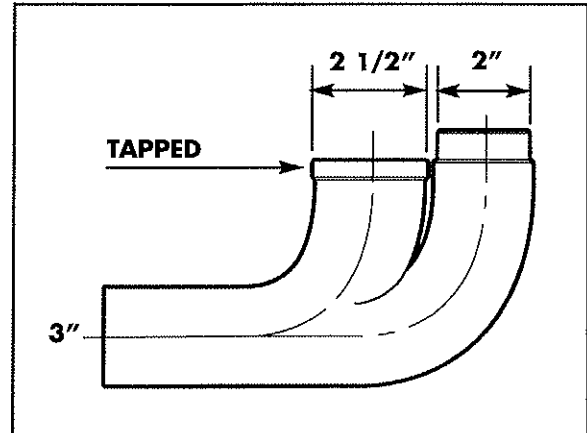


PVF 2.3.29

A number of no hub fittings are used to connect waste lines and vent lines to the main stack. A **STACK BASE** has one tapped inlet, which is used as a cleanout and is closed with a plug.

The specifications for a stack base begin with the diameters of the run openings, followed by the IPS of the tapped inlet. The fitting to the right is a 3" x 2" x 2 1/2" IPS stack base.

STACK BASE (REDUCING)



PVF 2.3.30

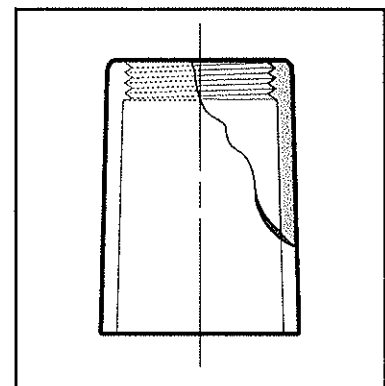
## Special Use Fittings

In addition to the commonly used hub and no hub reducers, bends, tees and traps already discussed, there are fittings used for unique and special applications. You might find special fittings such as: DWV tees, Ys, closet bends and others. Some might be hub or no hub. Some may be tapped – another word for threaded. These fittings are often listed in a “special” section of manufacturers’ catalogs. Since not all manufacturers provide all possible “special” fittings, a distributor may have to search more than one manufacturer’s catalog to meet the customer’s request.

Here are few examples of special fittings:

The special fitting to the right is a tapped spigot. It is used when transitioning from no hub to steel pipe thread.

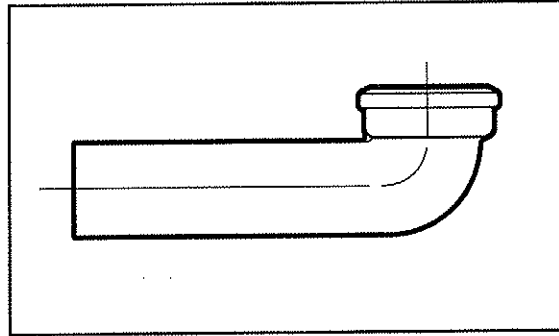
TAPPED SPIGOT



PVF 2.3.31

There are many types of closet bends. The drawing to the right is an example of a closet bend that is a "special" fitting called **BASE HUB END CLOSET BENDS LOW HUB**.

BASE HUB END CLOSET BENDS LOW HUB



PVF 2.3.32

There might be other "special" variations of no hub sanitary tees, no hub wyes and hub closet bends. However, it would not be possible to discuss all of them since they are special fittings that will vary from manufacturer to manufacturer.

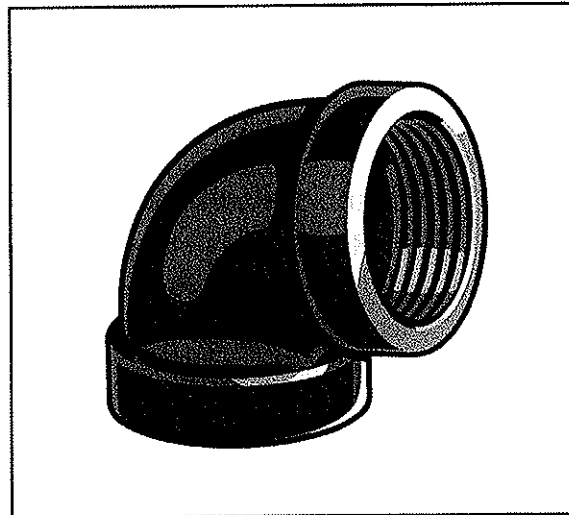
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## Cast Iron Threaded DWV Fittings

Threaded cast iron DWV fittings, commonly referred to as Durham fittings, were used years ago with galvanized steel pipe for drain lines. At the present time, use of threaded fittings is usually limited to the repair of a system that was originally constructed with threaded DWV cast iron fittings.

To the right is an example of a cast iron threaded DWV fitting.

90° ELBOW



PVF 2.3.43

**REVIEW OF NO HUB FITTINGS***Answers appear on page 108*

1. A no hub bend with a heel inlet is specified in the following manner:
  - a. The size of the run opening is given first, then the size of the inlet
  - b. The size of the inlet is given first, then the size of the run opening
  
2. When no hub 1/4 bends are tapped, they are tapped at:
  - a. One end
  - b. Both ends
  
3. A no hub san tee:
  - a. Has no sweep in the branch inlet
  - b. Always has a sweep in the branch inlet
  
4. A no hub test tee:
  - a. Uses a permanent test plug to monitor operations of the DWV system
  - b. Uses a temporary plug to check the DWV system
  
5. Hub adapters connect:
  - a. No hub soil pipe to hub & spigot soil pipe
  - b. No hub soil pipe to a no hub soil pipe
  
6. No hub traps come:
  - a. In many variations
  - b. Only in regular P trap size
  
7. Cast iron threaded DWV fittings are generally used for:
  - a. Repair of a system that was originally constructed with threaded DWV cast iron fittings.
  - b. Newer construction that requires the extra strength of threaded fittings

## REVIEW OF NO HUB FITTINGS

*Answers appear on page 108*

## APPLYING WHAT YOU HAVE LEARNED:

*By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.*

- A. Look at your inventory: Compare the hub & spigot bends and the no hub bends you carry. Do you carry all the same kinds (1/4 bends, 1/8 bends, etc.) in both?

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- B. Which type of P-trap does your company sell the most?

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- C. Discuss with your supervisor what kind of special fittings are carried by your company.

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- D. Since there are many types of closet bends, discuss with your Supervisor and list the three that are most commonly sold by your company or required by local plumbing codes.

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# **ANSWERS TO REVIEW QUESTIONS**

## **CHAPTER 3 IRON PIPE AND FITTINGS**

1. The pipe shall be of the type specified in the schedule of materials and shall conform to the requirements of the applicable specification.

2. The pipe shall be furnished in lengths of 20 feet, unless otherwise specified.

3.



## Answers for REVIEW OF TYPES OF IRON PIPE AND FITTINGS (page 77)

1. b. Zinc
2. a. It is resistant to corrosion, abrasion and chemicals
3. b. Soil pipe
4. a. Pressure pipe
5. a. Supply systems
6. b. Depends on the forces of gravity and atmospheric pressure to keep liquids flowing through the pipe.
7. b. It provides greater resistance to vibration or shock

*Applying What You Learned:*

- A. Varies by location
- B. Varies by location.

## Answers for REVIEW OF CAST IRON SOIL PIPE (pages 84 - 85)

1. a. Drainage pipe
2. a. Hospitals, schools, commercial and industrial structures
3. b. Allow for smooth flow of waste through a long run
4. b. It is fire resistant
5. b. Hub & spigot, no hub (hubless) and double hub pipe
6. b. When the male spigot fits inside the female hub
7. a. One wall thickness
8. b. Service (SV) and extra heavy (XH) wall thicknesses
9. b. NPS based on the inside diameter (ID)
10. a. Need fittings designed for their specific weight

*Applying what you Learned:*

- A. No answer needed
- B. Varies by location

## Answers for REVIEW OF HUB &amp; SPIGOT FITTINGS (pages 94 - 95)

1. b. FPT
2. b. Decrease turbulence of the flow as it changes direction
3. b. Regular increaser, long plain increaser and long tapped increaser
4. b. 1/4 bend
5. a. Wet or waste portion of the DWV system
6. a. The opening that allows the flow to join the run
7. b. Total length of the fitting
8. a. Many variations

*Applying What You Learned:*

- A. Varies by location
- B. Depends upon manufacturer
- C. Discuss

## Answers for REVIEW OF NO HUB FITTINGS (pages 102 - 103)

1. a. The size of the run opening is given first, then the size of the inlet
2. a. One end
3. b. Always has a sweep in the branch inlet
4. b. Uses a temporary plug to check the DWV system
5. a. A no hub soil pipe to hub & spigot soil pipe
6. a. In many variations
7. a. Repair of a system that was originally constructed with threaded DWV cast iron fittings

*Applying What You Learned:*

- A. Varies by location
- B. Varies by location
- C. Discuss
- D. Discuss

**CONGRATULATIONS!**

***You are now ready to take the Final Exam***



# **GLOSSARY OF TERMS**

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**Actual Pipe Size:** The measurement equal to the outside diameter of pipe.

**Adapter:** A transition fitting used to connect two pieces of pipe that require different joining methods.

**AISI:** *SEE* American Iron and Steel Institute

**American Iron and Steel Institute (AISI):** The organization that classifies stainless steel by alloy groups into three series: 400, 300, 200.

**American National Standards Institute (ANSI):** A standard-setting organization that sets specifications for many products, including standard steel pipe threads.

**American Petroleum Institute:** Organization that sets standards for pipe used in the petroleum industry.

**American Society for Testing and Materials:** *SEE* ASTM International.

**American Society of Mechanical Engineers (ASME):** An organization that sets standards for many products, including stainless steel pipe.

**ANSI:** *SEE* American National Standards Institute.

**API:** *SEE* American Petroleum Institute.

**ASME:** *SEE* American Society of Mechanical Engineers.

**ASTM International (ASTM):** Organization that sets standards and specifications for many products, including steel pipe. Formerly called American Society for Testing and Materials.

**Alloy group:** A kind of stainless steel classified according to its major alloy content. The three alloy groups of stainless steel are the straight chromium group, the chromium-nickel group and the chromium-nickel-manganese group.

**Austenitic stainless steel:** A type of stainless steel belonging to either the chromium-nickel alloy group or the chromium-nickel-manganese alloy group. The term austenitic refers to a particular molecular structure.

**BE:** *SEE* beveled end.

**Belled end:** A type of pipe end that is available on light-walled stainless steel pipe. Belled ends look much like hub ends on DWV pipe.

**Bend:** Soil pipe elbow fitting. Bends are specified by how many bends it would take to complete a circle. It would take four 1/4 bends (90° each) to complete a full circle of 360°. *SEE ALSO* Closet bend; Long bend; Long sweep bend.

**Beveled pipe end (BE):** Type of pipe joined by welding. The wall of the pipe end is cut at a slant to allow space for molten metal when the pipe is joined.

**Billet round:** Solid bar of steel that is pierced in the center to form a seamless pipe or tube.

**Black:** Description for iron or steel pipe and fittings coated with a varnish-based oil.



**Black iron pipe:** Iron pipe that is coated with a varnish-type oil to protect the pipe during shipping and initial storage.

**Black steel pipe:** Steel pipe that is coated with a varnish-type oil to protect the pipe during shipping and initial storage. Sometimes called *plain pipe* or *black iron*.

**Blk. St.:** Abbreviation to indicate black steel pipe.

**Blind flange:** A flange made with no center hole, which is bolted to another flange to end a pipeline.

**Brazing:** A joining method in which the joining metal has a lower melting temperature than the metals being joined.

**Bundles:** Method of shipping standard pipe of 1 1/2" to 8" in diameter. Weight and number of pieces is different in each bundle.

**Bundling schedule:** A pipe schedule showing what lengths of pipe will be shipped together in a bundle.

**Butt weld:** Weld that is formed when two beveled pipe ends with the same diameter and wall thickness are permanently welded together. A butt weld may also join a beveled pipe end and a beveled fitting. *SEE ALSO* Continuous weld.

**Butt weld fitting:** A fitting used for a butt-welded joint. *SEE ALSO* Stub end fitting.

**Carbide precipitation:** A chemical process in which carbon and chromium atoms combine when some kinds of stainless steel are exposed to high temperatures or touch iron or steel. Chromium carbide grains are formed that separate out (precipitate out) from the steel, which causes a loss of chromium and a reduction in corrosion resistance. Also called *sensitization* and *intergranular corrosion*. SEE ALSO Weld decay.

**Cast iron:** An alloy of iron, carbon and silicon, which in the manufacturing process must be cast in a mold for shaping.

**Cast Iron Soil Pipe Institute (CISPI):** The organization that sets and monitors the standards for cast iron soil pipe.

**Cast iron soil stack:** The main line in the assembly, which runs vertically from the building drain up through the structure and through the roof.

**Chromium (Cr):** The alloy that gives stainless steel its "stainless" (corrosion-resistant) quality.

**Chromium-nickel group:** A kind of austenitic stainless steel, widely used in pipe. It contains chromium and nickel as its major alloys.

**Chromium-nickel-manganese group:** A kind of austenitic stainless steel, which contains chromium, nickel and manganese as the major alloys. Some stainless steel pipe may be made from chromium-nickel-manganese stainless steel.

**Cladded racks:** Special storage racks for stainless steel pipe. The racks are made from iron, with strips of stainless steel running perpendicular to the pipe so the pipe will never touch the iron. Cladded racks are used to prevent carbide precipitation.

**Cleanout tee:** A fitting made with a double sweep so a sewer rod can be used in both directions. Sometimes called a *twin*.

**Closet bend:** A DWV fitting used to join the water closet to the main soil stack.

**Continuous butt weld:** *SEE* Continuous weld.

**Continuous weld:** A method for manufacturing steel pipe during which skelp (a hot strip of steel) is changed from a flat ribbon to a round shape. The edges are then closed by heat from the skelp and pressure by rollers to form a seam or weld. Also called *continuous butt weld*.

**Cr:** The chemical symbol for chromium.

**Cross:** A fitting that has four openings in the same plane at 90° angles to each other. Sometimes called a *double tee*. *SEE ALSO* Sanitary cross; Straight cross; Straight sanitary cross.

**Dble EH:** *SEE* Double extra heavy.

**Dble XS:** *SEE* Double extra heavy.

**Drill pipe:** Pipe used as a rotating stem for drill bits, to drill the well, and as a conveyance for air or drilling mud to lubricate the drill bit and convey cuttings to the surface.

**Double extra heavy (Dble EH or XXH):** Refers to the heaviest-weight steel pipe. Also called *Double Extra Strong (XXS or Dble XS)*.

Double extra strong: *SEE* Double extra heavy.

Double hub: Soil pipe with a hub at each end.

Double quarter bend: A fitting that joins two branch lines to the main waste line at 90° angles. It has two hub ends and one spigot end. Also sometimes called *twin ell*.

Double random length: More common method of shipping pipe in sizes 1 1/2 inches and over. The pipe in these shipments will be of different lengths, but the shortest is 22 feet.

Double Y: A fitting that joins two branch lines to the main run at 45° angles.

Drainage pipe: Pipe used in DWV (Drain, Waste and Vent) piping systems. Also called *soil pipe*.

Drive pipe: Seamless or ERW water well pipe with specially threaded ends to promote a tight joint with the coupling; used for driving into the ground in water well applications.

Driven well pipe: Welded or seamless galvanized standard weight pipe, usually threaded and coupled. Used for well applications.

Ductile iron: An iron alloy to which magnesium is added to make the alloy strong so it can be molded, drawn or hammered thin.

Duplex stainless steel: An alloy that helps improve productivity, cost effectiveness and safety for businesses that operate in especially difficult and hostile environments such as offshore drilling.

DWV: Abbreviation for Drain-Waste-Vent systems.

EH: *SEE* Extra heavy.

18-8 stainless steel: Term used to refer to the 300 series of austenitic stainless steel alloys, in which the basic formula is 18% chromium and 8% nickel.

Electric resistance weld (ERW): A method for manufacturing steel pipe in which the combination of pressure from the rollers and heat from an electrical current form the seam of the weld joint.

ERW: Abbreviation for electric resistance weld.

ES: *SEE* Extra heavy.

Extra heavy: A reference to pipe with walls heavier than standard weight. Sometimes called "extra strong," and it may be abbreviated as ES or XS or EH or XH.

FDA: *SEE* Food and Drug Administration.

Ferritic stainless steel: A type of straight chromium stainless steel. The term "ferritic" refers to a particular molecular structure.

Flange: A metal disc fitting with a hole in the center and bolt holes around the rim. *SEE ALSO* Blind flange; Lap joint flange; Slip-on flange; Socket weld flange; Threaded flange; Welding neck flange.

**Flanged joint:** A joint formed when a flange is attached to the end of each pipe to be joined and the flanges are bolted together with a gasket between them.

**Food and Drug Administration (FDA):** Government agency that regulates industries producing products for human consumption.

**FPT:** Abbreviation for female pipe threads.

**GA:** Abbreviation for gauge.

**Gal. St.:** Abbreviation for galvanized steel.

**Galvanic corrosion:** Corrosion caused when an electrical current is generated between two unlike metals and then carried by the fluid in the pipe.

**Galvanized:** Iron or steel pipe and fittings coated with a protective zinc layer (also called *gray*).

**Galvanized steel pipe:** Steel pipe that is given a hot zinc coating, which protects the pipe from abrasive and corrosive materials and rust.

**Gauge (GA):** Specification term for the wall thickness of stainless steel tube.

**Grade:** 1) a measurement of the mechanical properties of steel, including tensile and yield strengths; steel pipe is graded A, B or C. 2) In stainless steel pipe, "grade" is sometimes used in place of "type."

Gray: *SEE* Galvanized.

Grooved pipe end: Pipe that has a groove that is either rolled or cut. Rolled groove is formed by rolling a groove into a pipe without removing any metal. Cut groove is formed by a narrow cut (groove) that is cut like a band into the outside wall.

Heel inlet: Inlet on the back of an elbow or bend. *SEE ALSO* High heel inlet; Low heel inlet.

High heel inlet: An inlet placed high on the back of the fitting.

Hub: A bell-shaped female pipe end on cast iron pipe, usually joined with a male spigot end to form a hub & spigot joint.

Hub adapter: A fitting that joins no hub soil pipe to a spigot connector of hub & spigot pipe.

Hub & spigot joint: The connection made when cast iron soil pipe is joined by iron hub & spigot fittings.

Hub & spigot pipe: Cast iron soil pipe which has a bell-shaped female end called the hub and a plain male end called the spigot.

Hubless pipe: *SEE* No-hub pipe.

ID: Abbreviation for inside diameter.

**Increaser:** Soil pipe fitting used to join pipe of one diameter to pipe of a larger diameter. Commonly joined to the vent stack to enlarge the vent stack before it goes through the roof and, therefore, help prevent frost buildup from closing the vent opening. There are three styles of increasers: regular, long plain and long tapped.

**Inlet:** An opening that allows flow to join the run. *SEE ALSO* Heel inlet; Side inlet.

**Intergranular corrosion:** *SEE* Carbide precipitation.

**Inverted Y:** A Y that joins a branch vent line from below to the main vent stack.

**Iron-chromium group:** *SEE* Straight chromium group.

**Iron oxide:** A combination of iron and oxygen molecules known as "rust."

**Iron Pipe Size (IPS):** A sizing system for indicating pipe size. The NPS sizing terminology is more common. IPS may be used in ordering cast iron soil pipe, in which case IPS refers to the inside diameter.

**L:** Indicator used to identify low-carbon stainless steel.

**Lap joint flange:** A free-floating flange bolted over a stub end fitting that has been welded to stainless steel pipe. A lap joint flange can be used to join a pipeline that may later be separated.

**Line pipe:** Steel pipe used to carry gas and oil.



**Long bend:** A bend that has its extra length in the straight portion of the fitting, rather than in the sweep.

**Long sanitary tee:** A sanitary tee in which length has been added to the main run.

**Long sweep bend:** A bend in which the sweep (radius) is longer to create a gentle turn.

**Long tangent fitting:** A fitting, used only with stainless steel pipe, in which the straight ends of the fitting have been made longer to make it easier to install the fitting in hard-to-reach locations.

**Long turn ell:** A threaded cast iron DWV elbow in which length is added in the curved portion between the ends to create a smooth turn.

**Low-carbon stainless steel:** Stainless steel in which the amount of carbon has been reduced, often to help control carbide precipitation. This steel is often identified by an "L" in the specifications.

**Low heel inlet:** Inlet placed low on the back of a fitting.

**MSS:** *SEE* Manufacturers' Standardization Society of The Valves and Fittings Industry.

**Malleable iron:** Iron alloy in which the amount of carbon has been controlled to make the iron more easily molded than cast iron. It is also possible to shape malleable iron by hammering or rolling. It is used to produce fittings.

**Manufacturers' Standardization Society of The Valves and Fittings Industry (MSS):** An organization that participates in setting standards for valves and fittings.

**Martensitic stainless steel:** A kind of straight chromium stainless steel. Martensitic refers to a particular molecular structure.

**Mechanical properties:** The properties that involve the relationship between stress and strain. For example, the degree of elasticity, tensile strength and fatigue limit.

**Mechanical tube:** Steel pipe used in structural and machinery applications where there is little or no internal pressure.

**Mn:** Chemical symbol for manganese.

**MPT:** Abbreviation for Male Pipe Threads.

**Ni:** Chemical symbol for nickel.

**No hub pipe:** Cast iron soil pipe with plain ends. The ends of the no hub pipe are joined by a clamp and gasket connector. Also called *hubless pipe*.

**Nominal Pipe Size (NPS):** The industry standard size that approximates the actual dimensions of the pipe. For instance, if the standard weight 1-inch steel pipe has an outside diameter of about 1.315 inches, the OD is approximately, but not exactly, 1 inch. However, it is still called a "1 -inch pipe" to simplify communications when ordering.

**OD:** Abbreviation for outside diameter.

**Oil country tubular goods:** Pipe products used by the petroleum industry in the drilling and operation of gas and oil wells. Oil country tubular goods include casing, drill pipe and oil well tubing.

**Passive film:** The thin transparent protective chromium oxide film that forms on the surface of stainless steel pipe and enables the stainless to resist corrosion.

**PE:** *SEE* Plain end.

**Pipe compound:** *SEE* Pipe dope.

**Pipe dope:** A compound of plastic-type materials used to lubricate pipe threads and improve the joint seal. Sometimes called *pipe compound*, *thread compound* or *thread lubricant*.

**Pipe schedule:** A listing developed by American National Standards Institute (ANSI) to classify steel pipe according to wall thickness for different pressure applications. Pipe schedule indicates standards for steel pipe.

**Pitch:** The distance from the point on one thread to the point on the next thread. Pitch is measured by threads per inch. Standard pipe and line pipe with diameters of 2 1/2" or greater are threaded eight threads per inch.

**Plain pipe end (PE):** Pipe ends with no threads, cut straight across with the ends left as they are cut and without further end treatment.

**Plain pipe:** *SEE* Black steel pipe.

**Precipitation-hardening stainless steel:** More recently developed alloy that offers increased strength, ease of heat treatment and corrosion resistance.

**Pressure pipe:** Pipe designed to transfer liquids under pressure. Often called *supply pipe*. *SEE ALSO* Supply pipe.

**Pressure tube:** Seamless steel pipe with a diameter of under 2" IPS used to carry fluids at high temperatures and pressure.

**Psi:** Abbreviation for pounds per square inch (of pressure).

**P-trap:** A fitting shaped like the letter "P" in which liquid remains in the curved portion and prevents the flow of sewer gases back into the building.

**Radius:** 1) In fittings, this term refers to the length of the curved portion of a fitting, the distance it takes to make a turn. In bends, the radius is called the sweep. 2) When referring to a circle or pipe diameter, the radius is half the diameter, that is, from the outside edge of the circle to the center point.

**Random length:** Shipping method by which pipe is shipped in different lengths generally between 16 and 45 feet long.

**Reamed and drifted water well pipe:** Continuous weld, ERW or seamless pipe. It is made especially for water well use and may be driven. It has threaded and recessed couplings, and is reamed on the ends to ensure inside clearance.

**Recessed coupling:** A coupling in which the threads do not come all the way to the edge of the coupling.

**Reducer:** Fitting that joins pipe of one diameter to pipe of a smaller diameter to reduce the flow. Most types of fittings are available as reducers. Also called a *reducing fitting*.

**Reducing bend:** A bend that joins pipe of one diameter to pipe of smaller diameter.

**Reducing fitting:** *SEE Reducer.*

**Running trap:** A cast iron trap with an inlet and outlet of 4" or more in diameter set on a horizontal straight line run. Between the inlet and outlet is a U-shaped curve, which drops deeper than the pipe openings, in which liquid stands and blocks sewer gases from seeping back into the DWV system.

**S:** 1) An abbreviation used for standard weight pipe. 2) In stainless steel pipe schedules, the S stands for "stainless."

**Sanitary cross:** A DWV cross in which the branches have sweeps. *SEE ALSO* Straight sanitary cross.

**Sanitary tee:** A tee with a sweep in the branch inlet, used in the wet or soil-and-waste portion of a DWV system. Also called a san tee. *SEE ALSO* Long sanitary tee; Sanitary cross; Straight sanitary cross; Tapped san tee.

**San tee:** *SEE* Sanitary tee.

**Screwed fittings:** *SEE* Threaded fittings.

**Seamless pipe:** A pipe created when a solid cylindrical billet of steel is heated, punched, drilled at its center, and drawn through a series of rollers to the desired size, thereby producing a pipe without a seam or weld.

**Sensitization:** *SEE* Carbide precipitation.

**Sensitized pipe:** Stainless steel pipe in which carbide precipitation has occurred, reducing the corrosion-resistance of the pipe.

**Series:** The number assigned to an alloy group of stainless steel by AISI. For example, Series 300 is chromium-nickel stainless steel. A series is further subdivided by types.

**Short sweep bend:** A bend that takes a relatively small distance (compared to the long sweep bend) to make the turn.

**Side inlet:** An inlet on the side (left or right) of a bend or elbow fitting.

**Single hub pipe:** Soil pipe with one hub end and a spigot at the other end.

**Single random length:** Shipping method by which pipe is more commonly shipped in pipe sizes 1 1/2 inches and smaller in diameter, up to 22 feet in length.

**Slip-on flange:** A flange that slips over a stainless steel pipe and is held in place by one or two welds.

**Socket weld fitting:** A fitting with a recessed end, or socket, into which the pipe fits for a welded joint.

**Socket weld flange:** Flange that is slipped into the recessed end and is then welded on the outside.

**Soil pipe:** Cast iron pipe used in DWV (Drain, Waste and Vent) systems. Also called *Drainage Pipe*.

**Spigot:** A male pipe end that fits inside a hub for a close smooth connection.

**ST&C:** Abbreviation for short thread and coupled pipe.

**Stabilized stainless steel:** Stainless steel to which a special alloy has been added to attract carbon atoms and prevent carbide precipitation.

**Stack base:** A curved DWV fitting that has one tapped inlet, which is used as a cleanout and is closed with a plug. The fitting is used to connect waste lines or revent lines to the main stack.

**Stainless steel:** Steel that contains chromium as a primary alloy to make it especially resistant to corrosion. *SEE ALSO* Low-carbon stainless steel; Stabilized stainless steel.

**Standard pipe:** One of the classifications of steel pipe, and it can carry steam, water, gas or air. It is used for many plumbing, heating and industrial purposes.

**Standard weight (STD or S):** The lightest weight steel pipe.

**STD:** Abbreviation for standard weight pipe.

**Straight chromium group:** A group of stainless steels that contains chromium as its major alloy.

**Straight cross:** A cross in which all four openings are the same diameter.

**Straight sanitary cross:** A sanitary straight cross with no sweep in the branch inlets.

**Straight Y:** A Y in which all three openings are the same diameter.

**Stub end:** A type of butt weld fitting.

**Supply pipe:** Pipe that carries fluids into a building. Since supply systems are under pressure, supply pipe is often called pressure pipe. *SEE ALSO* Pressure pipe.

**Sweep:** The term used for the radius of a bend, the distance it takes to make the turn.

**T & C:** Abbreviation for threaded and coupled pipe ends.

**Tap extension piece:** A DWV no hub fitting with one tapped end that adapts no hub pipe to a threaded connector.

**Taper:** A gradual change in the depth of threads on threaded pipe, with the deepest threads cut at the very end of the pipe. Standard pipe (except drive pipe) is tapered 3/4" per foot. Drive pipe is tapered 1/2" per foot.

**Tapped:** Having an end with female pipe threads (FPT).

**Tapped san tee:** A sanitary tee with FPT on the inlet.

**TBE:** Abbreviation for threaded both ends (pipe ends).

**Tensile strength:** The ability of steel to resist being pulled apart.

**Test tee:** A DWV fitting with a large opening into which a test plug is inserted to test the DWV system for leaks; test tees are used in the main drain just inside the wall of a building. Also referred to as *Clean Out Tee*.

**Thread compound:** *SEE* Pipe dope.



Thread lubricant: *SEE* Pipe dope.

Threaded and coupled end pipe: Pipe end that is threaded and has a coupling attached.

Threaded fittings: Fittings that have threads (FPT or MPT) cut into them so they can be joined with a threaded pipe or another threaded fitting. Sometimes called *Screwed fittings*.

Threaded flange: A flange with female pipe threads that is screwed to stainless steel threaded pipe.

Threaded pipe end: Pipe that has a series of regularly spaced grooves (threads) that allow the pipe to be connected using a threaded coupling.

TOE: Abbreviation indicating that the pipe is threaded at one end.

Three-way ell: An elbow that has two inlets with female pipe threads (FPT). Available only as a cast iron DWV fitting.

T-304: *SEE* Type 304 stainless steel

T-316: *SEE* Type 316 stainless steel.

Twin (cleanout tee): *SEE* Cleanout tee.

Twin Ell: *SEE* Double quarter bend.

**Type:** A subclass of a series/alloy group of stainless steel. For example, Type 304 stainless steel is a special individual class of Series 300 stainless steel. Types also are called "*grades*."

**Type 304 stainless steel:** A type of 18-8 stainless steel. The most widely used stainless steel for pipe and fittings. Also called *T-304*.

**Type 316 stainless steel:** A type of chromium-nickel stainless steel that has molybdenum added to lessen pitting; the second most commonly used stainless steel for pipe and fittings. Also called *T-316*.

**Uniform length:** Shipping method in which pipe shipped is all the same length.

**Upright Y:** A DWV fitting that joins a waste line coming from above to the main waste stack.

**Vent tee:** A tee with no sweep in the branch inlet, used in the vent portion of a DWV system.

**Water well casing:** Steel pipe produced by the electric weld or seamless process with walls thinner than standard weight pipe; used to encase a drilled well.

**Water well pipe:** Category of standard pipe used with a well supply source.

**Weld decay:** Carbide precipitation that occurs in stainless steel as the result of heat of welding.

**Welded pipe:** Pipe that is made by rolling a flat piece of steel into a long cylinder and welding the edges together, forming a seam where the pipe is welded.

**Welded stainless steel pipe:** Pipe made by rolling a flat piece of steel into a long cylinder and then welding the edges together. This process forms a seam in the place where the pipe is welded.

**Welding:** A method of joining metals by heating and/or pounding the edges of metal strips against each other until the metal is soft enough to flow together, bonding in a seam or weld. *SEE ALSO* Continuous weld; Electric resistance weld.

**Welding neck flange:** A flange used with stainless steel, which is connected with a butt weld.

**Wye:** *SEE* Y.

**XXII:** *SEE* Double extra heavy.

**XXS:** *SEE* Double extra heavy.

**Y (wye):** A fitting that joins three sections of pipe, with one section at a 45° angle. *SEE ALSO* Inverted Y; Upright Y.

**Yield strength:** The ability of pipe to withstand pressure, expressed in psi. (pounds per square inch).



# INDEX

THE INDEX

**A**

- abrasion, 80
- adapter fittings, 63, 83
- adapters
  - hub, 98
  - no hub, 98
- AISI (American Iron and Steel Institute), 43, 48
- alloy groups for stainless steel, 41–45
- American Iron and Steel Institute (AISI), 43, 48
- American National Standards Institute (ANSI), 12, 17
- American Petroleum Institute (API), 7, 12, 23
- American Society of Mechanical Engineers (ASME), 48, 62
- angles
  - for san tees, 98
  - for soil pipe, 89
- ANSI (American National Standards Institute), 12, 17
- API (American Petroleum Institute), 7, 12, 23
- API 5L specification, 7
- API 5LX specification, 7
- ASME (American Society of Mechanical Engineers), 48, 62
- ASTM A-312 specification, 50, 51, 53
- ASTM A-778 specification, 53
- ASTM International
  - cast iron soil pipe, 79
  - stainless steel fittings, 62
  - stainless steel pipe, 48
  - stainless steel tube, 52
  - steel pipe, 23
- austenitic stainless steel
  - duplex stainless steel and, 45
  - relationships between alloy groups, 43–44
  - uses for, 42

**B**

- base hub end closet bends low hub, 101
- belled pipe end, 57

## bends

- closet, 101
- 1/8, 96, 97
- 1/5, 96
- fittings and, 88
- hub & spigot, 88–92
- no hub, 96–97
- quarter, 97
- 1/4, 96, 97

## beveled pipe end

- butt weld fittings and, 59
- stainless steel pipe, 57
- steel pipe, 11

## billet, 5, 49

## black iron pipe, 3, 73

## black steel pipe, 3

## blind flange, 61, 62

## brazing, 58, 60

## bundles, shipping pipes in, 25

## butt weld fittings

- about, 59–60
- stainless steel pipe and, 58
- welding neck flange and, 61

## C

## carbide precipitation

- ANSI specification, 43
- stainless steel and, 37–38, 58

## carbon

- cast iron and, 74–75
- malleable iron and, 74

## carbon steel, 50, 53

## casing

- oil country pipe, 8
- water well, 7



- cast iron pipe
  - about, 74–75
  - corrosion resistance, 14, 80
  - DWV systems and, 76
  - fittings for, 76, 101
  - as gray iron, 73
  - pressure pipe from, 74, 76
  - soil pipe (*SEE* soil pipe)
  - strength of, 80
  - threaded fittings, 101
- Cast Iron Soil Pipe Institute, 79
- cast iron soil pipe joints, 80
- cast iron soil stack, 80
- chromium
  - stainless steel and, 35, 41–43
  - surface rust and, 53
- chromium-nickel group, 42, 43
- chromium-nickel-manganese group, 42, 43
- chromium oxide film, 53
- cladded racks, 54
- clean out tee, 93, 98
- closet bends, 101
- contamination, 53, 54
- continuous butt weld pipe, 5
- continuous weld
  - about, 4–5
  - standard pipe and, 6, 7
- copper, 63
- corrosion resistance
  - cast iron and, 14, 80
  - chromium-nickel group, 42
  - of ductile iron, 74
  - of duplex stainless steel, 45
  - galvanic, 63
  - hub & spigot pipe and, 81
  - of malleable iron pipe, 14
  - resistance to, 38, 44

- of stainless steel, 35, 37, 38, 44, 53, 62
- of steel pipe, 14
- straight chromium group, 41
- couplings
  - grooved pipe end and, 11
  - no hub, 81
  - recessed, 7, 13, 61
- cut groove, 11

## D

- deep seal P trap, 92, 99
- diameters
  - of hub ends, 98
  - increasers and, 87
  - inside, 83
  - outside, 19, 22, 52, 83
  - reducing bends and, 92
  - san tees and, 98
  - of steel pipe fittings, 14
- Double extra heavy wall (XXH) weight class, 19–20
- Double extra strong wall (XXS) weight class, 19–20
- double hub pipe, 81–83
- double quarter bend, 91
- double random length, 24
- drainage pipe. *SEE* soil pipe
- drifted water well pipe, 7
- drill pipe, 8
- drive pipe, 7, 12
- driven well pipe, 7
- ductile iron pipe, 74–76
- duplex stainless steel, 45
- durability of stainless steel, 37
- Durham fittings, 101
- DWV systems
  - cast iron pipe and, 76
  - cast iron threaded DWV fittings, 101
  - sanitary tees and, 93, 97

soil pipe and, 79, 80  
stainless steel pipe ends and, 57  
test plug and, 93, 98  
vent stacks and, 88

## E

EH weight class, 20–22  
18-8 stainless steel, 42  
1/8 bend, 89, 96, 97  
electric currents, 63  
electric resistance weld (ERW), 7  
ERW (electric resistance weld), 4, 6, 7  
ES weight class, 20–21  
external loads, 82  
Extra heavy wall (EH/XH) weight class, 19–22  
Extra heavy (XH) wall thickness, 82, 83  
Extra strong wall (XS) weight class, 19–20

## F

FDA (Food and Drug Administration), 36  
female end. *SEE* hub  
female pipe threads (FPT), 87, 90, 97  
female threads, 13, 62  
ferritic stainless steel  
    about, 41, 43–44  
    duplex stainless steel and, 45  
ferrous metals, 53  
1/5 bend, 89, 96  
fire resistance, 80  
fittings. *SEE ALSO* bends  
    adapter, 63, 83  
    butt weld, 58–61  
    for cast iron pipe, 76, 101  
    ductile iron, 74, 76  
    Durham, 101  
    hub & spigot, 86

- iron, 76
- long tangent, 60
- malleable iron and, 74–75
- no hub, 96–101
- pipe schedule and, 21
- plain pipe end and, 11
- socket weld, 11, 58, 59
- for soil pipe, 79
- special use, 100–101
- stainless steel, 57–63
- for steel pipe, 11–14, 63, 76
- stub end, 60
- sweep, 96
- threaded, 14, 101
- flanges
  - butt weld fittings and, 59
  - as joining method, 58
  - types of, 61–63
- Food and Drug Administration (FDA), 36
- food industry, 36
- FPT (female pipe threads), 87, 90, 97

## G

- galvanic corrosion, 63
- galvanized iron elbow, 73
- galvanized iron pipe, 73
- galvanized steel pipe
  - about, 3, 4
  - cast iron threaded DWV fittings and, 101
  - driven well pipe and, 7
- gaskets
  - grooved pipe and, 11
  - hub & spigot pipe and, 81
  - no hub pipe and, 81
- gauge (GA), 52

grade  
  L grade stainless steel, 38  
  of stainless steel, 43–44, 51  
  of steel pipe, 20–21

gravity, 76

gray iron, 73

grooved pipe end

  butt weld fittings and, 59

  stainless steel pipe, 57

  steel pipe, 11

## H

hard water, 4

heat resistance of stainless steel, 37

heel inlet, 90, 97

high heel inlet, 90

high pressure, 37

high temperatures, 37–38

hub & spigot bends, 88–92

hub & spigot fittings, 86

hub & spigot joint, 86

hub & spigot pipe

  about, 81

  specifications, 82–83

  tapped openings and, 87

hub & spigot soil pipe, 98

hub & spigot tees, 93

hub & spigot traps, 92

hub adapter, 98

hub (female end). *SEE ALSO* entries beginning with hub & spigot

  about, 81, 86

  belled end and, 57

  hub adapter and, 98

increasers, 87–88

reducers, 86

hubless pipe. *SEE* no hub pipe

**I**

ID (inside diameter), 83

increasers

hub, 87–88

no hub, 99

inlets

heel, 90, 97

quarter bends and, 89–90

side, 89, 93, 97

stack base and, 100

inside diameter (ID), 83

intergranular corrosion, 37

IPS (iron pipe size)

female pipe threads by, 97

stack base and, 100

stainless steel tube by, 52

tap extension piece and, 98

iron fittings, 76

iron oxide (rust), 53, 54

iron pipe. *SEE ALSO* cast iron pipe

classification by manufacturing process, 74–75

classification by pressure applications, 76

classification by surface coating, 73

ductile, 74–76

galvanized, 73

malleable, 14, 74–76

stainless steel and, 53

iron pipe size. *SEE* IPS

**J**

joining methods. *SEE ALSO* pipe ends

cast iron soil pipe and fittings, 79

double ell, 91

increasers and, 87

stainless steel pipe and tube, 58–63

steel pipe, 14

joint integrity, 81

joints

  hub & spigot, 86

  lap joint flange, 61, 62

  recessed, 80

  soil pipe, 80

## L

L grade stainless steel, 38

lap joint flange, 61, 62

length

  random, 24, 53, 54

  of soil pipe, 82–83

  uniform, 24, 53

line pipe

  about, 6, 7

  pitch of, 12

  standards for threads on, 12

long bends, 97

Long P-trap, 99

long plain increaser, 87–88

long quarter bend, 91

long sweep quarter bend, 89

long sweep reducing bends, 92

long tangent fitting, 60

long tangent tee, 60

long tapped increaser, 87

low-carbon stainless steel, 38

low heel inlet, 90

lubricants, 13

## M

magnesium, 74–75

male end (spigot), 81. *SEE ALSO* entries beginning with hub & spigot

malleable iron pipe

- about, 74–75
- corrosion resistance of, 14
- fittings for, 76
- pressure pipe and, 76
- mandrel, 5, 49
- manganese, 42
- Manufacturers' Standardization Society (MSS), 62
- manufacturing process
  - iron pipe classified by, 74–75
  - stainless steel pipe classified by, 48–59
  - steel pipe classified by, 4–6, 48
- martensitic stainless steel, 41, 43–44
- maximum crushing loads, 82
- mechanical properties, 38
- mechanical tube, 6, 8
- MSS (Manufacturers' Standardization Society), 62

## N

- nickel, 42
- 90° elbow, 59, 60, 88
- no hub adapter, 98
- no hub bends, 96–97
- no hub coupling, 81
- no hub fittings, 96–101
- no hub increasers, 99
- no hub P-traps, 99
- no hub pipe
  - gaskets and, 81
  - pipe length, 82–83
  - tapped spigot and, 100
- no hub quarter bends, 97
- no hub reducers, 96, 99
- no hub soil pipe, 98



no hub tees, 97–98  
no hub traps, 99–100  
noise insulation, 80  
NPS (nominal pipe size)  
  about, 19  
  pipe schedule and, 17, 21–22  
  soil pipe and, 83  
  stainless steel pipe and, 52



OD (outside diameter). *SEE* outside diameter  
oil country pipe, 6, 8  
oil derrick, 8  
outside diameter (OD)  
  normal pipe size and, 19  
  NPS and, 22  
  soil pipes and, 83  
  stainless steel tube and, 52  
oxygen, 53

## P

P trap, 92, 99  
passive film  
  about, 35  
  contaminants and, 53  
  damaging, 54  
  protecting, 63  
pipe  
  cast iron (*SEE* cast iron pipe)  
  iron (*SEE* iron pipe)  
  stainless steel (*SEE* stainless steel pipe)  
  steel (*SEE* steel pipe)  
pipe compound, 13  
pipe dope, 13

- pipe ends *SEE ALSO* joining methods
  - belled, 57
  - beveled, 11, 57, 59
  - butt weld fittings and, 59
  - cast iron classification by, 81–82
  - grooved, 11, 57, 59
  - iron fittings and, 76
  - plain, 11, 57
  - plastic end caps on, 54
  - stainless steel, 57
  - thread lubricant for, 13
  - threaded (*SEE* threaded pipe ends)
- pipe schedules
  - about, 17
  - grade of steel and, 20–21
  - nominal pipe size and, 19, 21
  - pipe markings, 23
  - pipe weights and, 19–20
  - shipping steel pipe, 24–25
  - socket weld fittings and, 59
  - for stainless steel pipe, 51
  - for stainless steel tube, 52
  - understanding, 17–18
  - using, 21–22
  - wall standards, 23
- pipe weights of steel pipe, 19–20
- pitch, 12
- plain pipe end, 11, 57
- plastic, DWV systems and, 76
- polish of stainless steel, 36
- precipitation-hardening stainless steel, 44
- pressure applications, iron pipe by, 76
- pressure pipe, 74–76
- pressure requirements
  - steel pipe fittings and, 14
  - welding method and, 58
  - yield strength and, 20–21

pressure tube, 5, 6, 8  
PSI (pounds per square inch), 20–21

## Q

quarter bends  
  about, 88–89  
  inlets and, 89–90  
  long sizes, 91  
  no hub, 96, 97  
  sweeps and, 89

## R

racks, cladded, 54  
random length, shipping pipe in, 24, 53, 54  
reamed water well pipe, 7  
recessed couplings  
  about, 13  
  socket weld flange and, 61  
  water well pipe, 7  
recessed joints, 80  
recessed socket, 59  
reducers  
  hub, 86  
  no hub, 96, 99  
regular increaser, 87  
resistance of stainless steel, 37  
rolled groove, 11  
running trap, 92  
rust (iron oxide), 53, 54

## S

S weight class, 20–21  
san tee with side inlet, 93  
sanitary tee (san tee), 93, 97–98

- schedule 5, 57
- schedule 10, 57
- schedule 40, 21–22, 57, 58
- schedule 80, 21–22
- schedule number, 52
- sealers, 13
- seamless steel tube and pipe production
  - about, 4–5
  - line pipe and, 7
  - pressure tube and, 8
  - seamless stainless steel pipe, 48, 49, 53
  - standard pipe and, 6, 7
- sensitization, stainless steel and, 37–38
- Series 200 (stainless steel), 43
- Series 300 (stainless steel), 43
- Series 400 (stainless steel), 43
- series of stainless steel, 43–44
- Service (SV) wall thickness, 82, 83
- shipping
  - stainless steel pipe, 53, 54
  - steel pipe, 24–25
- shock, 74–75
- short reducer, 99
- short sweep quarter bend, 89
- short sweep reducing bends, 92
- side inlet, 89, 93, 97
- silicon, 74–75
- single hub pipe, 81–83
- single random length, 24
- 1/16 bend, 89, 96
- 1/6 bend, 89, 96
- skelp, 5
- slip-on flange, 61
- socket weld fittings, 11, 58, 59
- socket weld flange, 61
- soil pipe (cast iron)
  - about, 76, 79

- angles for, 89
- applications for, 79
- classification by end type, 81–82
- DWV systems and, 79
- elbow fittings (*SEE* bends)
- ordering, 83
- standards for, 79
- types of, 74–75
- soil pipe joints, 80
- soil stack, 80
- specifications
  - ANSI, 43
  - API, 7
  - ASTM, 50, 51, 53
  - double hub pipe, 82–83
  - hub & spigot pipe, 82–83
  - no-hub pipe, 82–83
  - for stainless steel pipe, 48–51
  - for stainless steel tube, 52
- spigot (male end), 81. *SEE ALSO* entries beginning with hub & spigot
- stabilized stainless steel, 38
- stack base, 100
- stainless steel pipe
  - carbide precipitation, 37–38, 53
  - characteristics of, 35–38
  - choosing, 38
  - classifications of, 41–45
  - classified by manufacturing process, 48–59
  - corrosion resistance, 35, 37, 38, 44, 53, 62
  - fittings, 57–63
  - iron pipe and, 53
  - pipe schedules for, 51
  - and rust, 53, 54
  - shipping, 53
  - specifications of, 48–51
  - storing and handling, 53–54
  - welding techniques for, 58

- stainless steel pipe ends, 57
- stainless steel tube, 52
- stamped pipe, 23, 25
- standard pipe, 6-7, 12
- Standard wall (STD) weight class, 19-22
- Std weight class, 19-22
- steel pipe. *SEE ALSO* stainless steel pipe
  - adapter fittings and, 63
  - classification by manufacturing process, 4-6, 48
  - classification by surface coating, 3-4
  - classification by usage application, 6-8
  - corrosion resistance of, 14
  - grades of, 20-21
  - iron fittings and, 76
  - pipe schedules, 17-23
  - shipping, 24-25
  - standards, 12, 17
  - stenciled or stamped, 23, 25
  - storage of, 25
  - tapped openings and, 87
  - tapped spigot and, 100
  - types of ends and fittings, 11-14
- stenciled pipe, 23, 25
- storage
  - of stainless steel pipe, 53-54
  - of steel pipe, 25
- straight chromium group, 41, 43
- strength
  - of butt weld fittings and, 59
  - of cast iron pipe, 80
  - of ductile iron, 74-75, 76
  - of stainless steel, 37, 44
  - of steel pipe, 20-21
- stress, ductile iron and, 74-75
- stub ends, 60, 62
- surface coating
  - iron pipe classification by, 73

- passive film as, 35
- steel pipe classified by, 3–4
- SV wall thickness, 82, 83
- sweep
  - about, 89
  - long sweep reducing bends, 92
  - no hub bend, 96
  - sanitary tee and, 97
- sweep fittings, 96

## T

- tap extension piece, 98
- tapering, 12
- tapped bends, 90
- tapped openings, 87
- tapped spigot, 100
- TBE (threaded at both ends), 12
- T&C (threaded and coupled) end pipe, 13
- tees
  - hub & spigot, 93
  - long tangent, 60
  - no hub, 97–98
  - socket weld fittings, 59
- temperature
  - malleable iron and, 74–75
  - stainless steel and, 37–38
- tensile strength of steel pipe, 20–21
- test plug, 93, 98
- test tee, 93, 98
- threaded and coupled (T&C) end pipe, 13
- threaded at both ends (TBE), 12
- threaded at one end (TOE), 12
- threaded fittings, 14, 101
- threaded flange, 61, 62
- threaded pipe ends
  - as joining method, 58
  - line pipe, 12

- stainless steel, 57
- steel pipe, 7, 11–13
- threads per inch, 12
- TOE (threaded at one end), 12
- traps
  - hub & spigot, 92
  - no hub, 99–100
- tube weights, 52
- tubing, oil country pipe, 8
- twin ell, 91
- types
  - of flanges, 61–63
  - of iron pipe, 73–76
  - of soil pipe, 74–75, 81–82
  - of stainless steel, 43–44, 51
  - of steel pipe ends and fittings, 11–14

## U

- uniform length, shipping pipe in, 24, 53
- usage applications, steel pipe by, 6–8

## V

- vacuum, 80
- varnish base oil, 73
- vent stack, 80, 88
- vibration, malleable iron and, 74–75

## W

- wall thickness
  - about, 17
  - butt weld fittings and, 59
  - pipe weights and, 19–22
  - soil pipes and, 82–83
  - stainless steel pipe and, 50
  - stainless steel tube and, 52



- water well casing, 7
- water well pipe, 7
- weight classes, 19–22
- weld decay
  - about, 37
  - ANSI specification, 43
  - stainless steel pipe and, 58
- welded stainless steel pipe, 48, 49, 53
- welded tube and pipe production. *SEE ALSO* carbide precipitation
  - about, 5
  - AISI-type classification and, 43
  - beveled pipe end, 11
  - butt weld fittings, 58–61
  - continuous weld, 4–7
  - electric resistance weld, 4, 6, 7
  - flanges and, 61
    - as joining method, 58, 59
    - line pipe and, 7
    - socket weld fittings, 11, 58, 59
    - welded stainless steel pipe, 48, 49, 53
- welding neck flange, 61

## X

- XH wall thickness, 82, 83
- XH weight class, 19–20
- XS weight class, 20–21
- XXH weight class, 19–20
- XXS weight class, 20–21

## Y

- yield strength of steel pipe, 20–21

## Z

- zinc coating, 3, 73



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Basics of PHCP/Industrial PVF

# Introduction to Steel, Stainless Steel, Iron Pipe and Fittings<sup>®</sup>

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- Explain the basic types and uses of steel, stainless steel and iron fittings
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- Interpret pipe schedules, pipe stamps and stencils
- Describe different types of steel, stainless steel and iron pipe ends, fittings and how they are joined
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