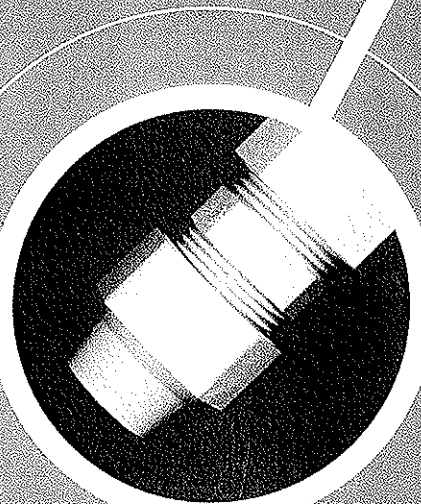
EDUCATION FOUNDATION

AMERICAN SUPPLY ASSOCIATION

Basics of PHCP/Industrial PVF

Introduction to Copper Tube, Plastic Pipe and Fittings©



BOOK #3

CERTIFICATE

SECOND E

ProductPro®

The Standard in Product Knowledge Solutions

Basics of PHCP/Industrial PVF

Introduction to Copper Tube, Plastic Pipe and Fittings©

from the

ASA Education Foundation

Introduction to Copper Tube, Plastic 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.

ProductPro®

The Standard in Product Knowledge Solutions

HEADQUARTERS

ASA Education Foundation
222 Merchandise Mart Plaza
Suite 1400
Chicago, IL 60654

tel: 312.464.0090
fax: 312.464.0091
web: asa.net
e-mail: info@asaef.org

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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 their customers with the products needed to keep their operations 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. That way, 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, and each chapter contains separate sections that cover a particular category of products. After reading each section within the given 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 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* that 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.

How to complete the course.

The final exam is in a multiple-choice format. The exam includes approximately 60 questions in an exam booklet along with an answer sheet. Your supervisor may give you the exam after you have finished the course, or she/he may have given it to you along with the course materials when you started the course.

In taking the exam, keep in mind that there is only one correct answer per question. Please be sure to transfer your answers to the answer sheet provided and complete all the registration information at the top of the answer sheet. The answer sheet can then be mailed or faxed to the ASA Education Foundation. Within about three weeks, you will receive your exam results and a certificate of completion if you successfully pass the exam.

Some hints for successful course completion

Read the learning objectives

Read the learning objectives at the beginning of each course. They outline 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 unsure, 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 the material. 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 Foundation website at 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. Stan Dreyfus of S&G Supply was especially generous in this regard. Christian Correrra expertly photographed needed product and constructed accurate and expert illustrations. Others, such as Colin Perry of Rampart P&H Supply, Inc., Steve Swartzenberg of Cerro Flow Products, Inc., Andrew G. Kireta of Copper Development Association Inc., Eugene E. Trantham of Nibco, John Hansen of Mueller Industries, Inc., Robert Vick of Nibco, Rick Church of Plastic Piping Educational Foundation, Dave DeAngelis of IPEX, David Sell of Creline-Northwest, LLC, and Joseph Poehling of First Supply LLC, thoroughly and diligently reviewed the course content to ensure content validity and reliability. Also, their expertise and experience ensured 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 expresses 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

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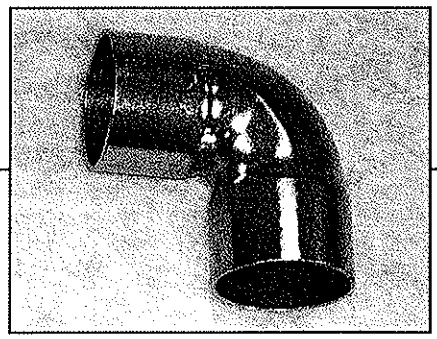
1 COPPER TUBE AND FITTINGS

LEARNING OBJECTIVES

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

1. List and discuss the advantages of copper tube
2. Describe the materials and process used in manufacturing copper tube
3. Explain the major types and uses of copper tube and pipe
4. Specify and order copper tube and fittings
5. Discuss applications and general recommendations for different types of copper tube
6. Describe different types of cooper fittings and their uses
7. Explain different copper tube joining methods.



COPPER TUBE AND FITTINGS

Copper Tube and Pipe

COPPER is a reddish metal that is durable, yet soft and easily shaped. Copper tube and pipe are widely used in plumbing, heating, cooling, refrigeration and industrial applications.

Advantages of Copper Tube and Pipe

Copper pipe and tube are popular in the above-listed applications for a number of reasons.

1. Copper is lighter than most other metals, which results in:
   - Lower transportation costs
   - Easier handling and installation.

2. Copper provides excellent value because:
   - Copper tube can be easily bent and formed, and is available in long runs of as much as 100 feet, making it often possible to eliminate elbows and joints and thereby reduce installation time
   - Its long-term performance and reliability are cost effective over years of use
   - Lower space requirements reduce storage costs
   - Its resistance to corrosion and scaling reduces maintenance costs and increases customer satisfaction
   - Smooth bends and thin tube walls permit the tube to follow the contours of almost any angle requiring less wall and ceiling space.

3. Copper is easy to join because:
   - Copper tube can be joined with (soldered) capillary fittings that save material and make smooth, neat, strong and leak-proof joints
   - No extra thickness or weight is necessary to make up for material removed by threading (only for roll thread applications; not for cut thread applications)
   - New pipe joining methods are making the process even more efficient.

4. Copper is safe because:
   - Copper tube will not burn or support combustion, decompose to toxic gases or carry fire through floors, walls and ceilings
   - Volatile organic compounds are not required for installation.

5. Copper is dependable because:

- Copper tube is produced to well-defined standards, and is accepted by virtually every plumbing code
- Copper tube has been manufactured and installed in the U.S. for more than 75 years.

Manufacturing of Copper Tube

MATERIAL USED TO MANUFACTURE COPPER TUBE

Tube made of pure copper is relatively soft. As a result, small amounts of alloying elements are added to improve copper's strength and other characteristics. An alloying element could be tin, zinc, aluminum, manganese, nickel, silicon or others. Copper tube for plumbing and mechanical applications is commonly made of copper alloy consisting of 99.9% copper and 0.04% phosphorus.

The three most common types of tube are:

- **PURE COPPER**
- **BRONZE,** which is made by adding tin to copper
- **BRASS,** which is made by adding zinc to copper.

Other copper alloys are selected carefully to manufacture products that meet the demands of given conditions.

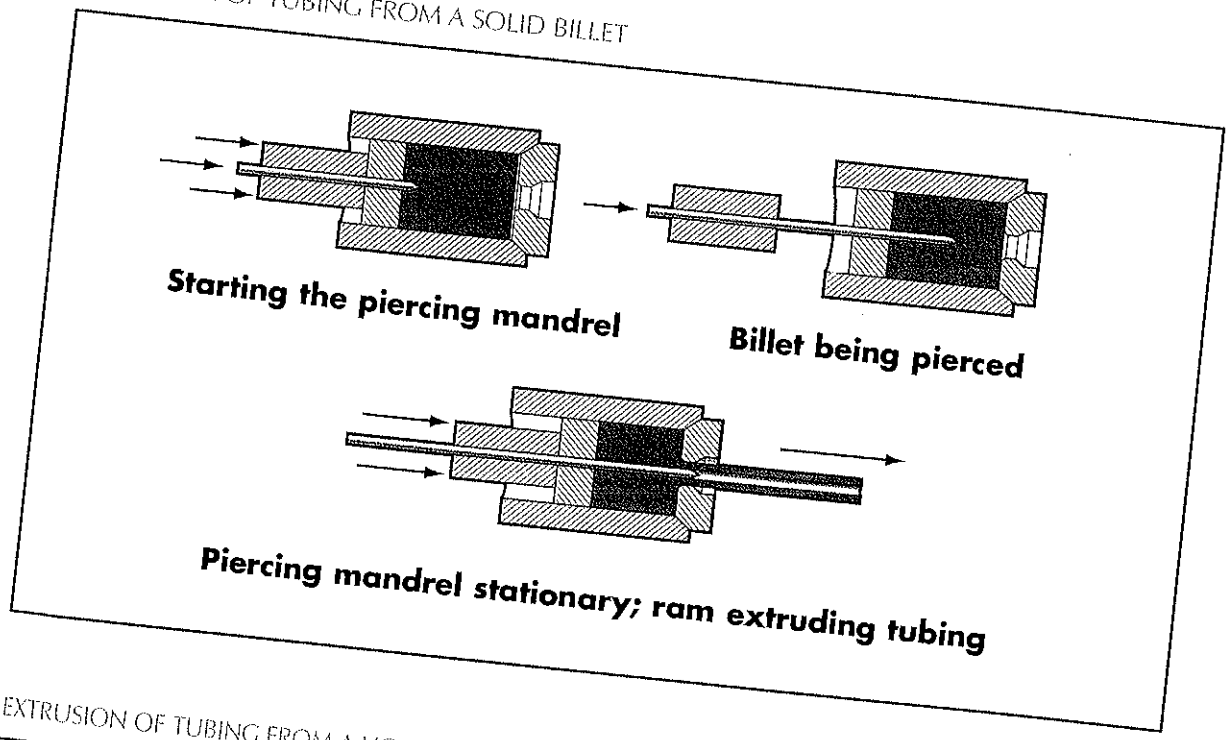
Copper alloys are used to produce pipe, valves and fittings in supply systems carrying potable water, process water or other aqueous fluids. In this industry, piping made of copper is almost always called "tube." While copper pipe is available, it is not commonly used. The main difference between copper pipe and tube is wall thickness — copper pipe is heavy wall and can be threaded, while copper tube is thin wall and is not meant to be threaded.

Also, copper alloys are used for automobile radiators, heat exchangers and home heating systems. Pure copper is used for cables and wires, electrical contacts and a wide variety of other parts that are required to pass electrical current.

MANUFACTURING PROCESS FOR COPPER PLUMBING TUBE

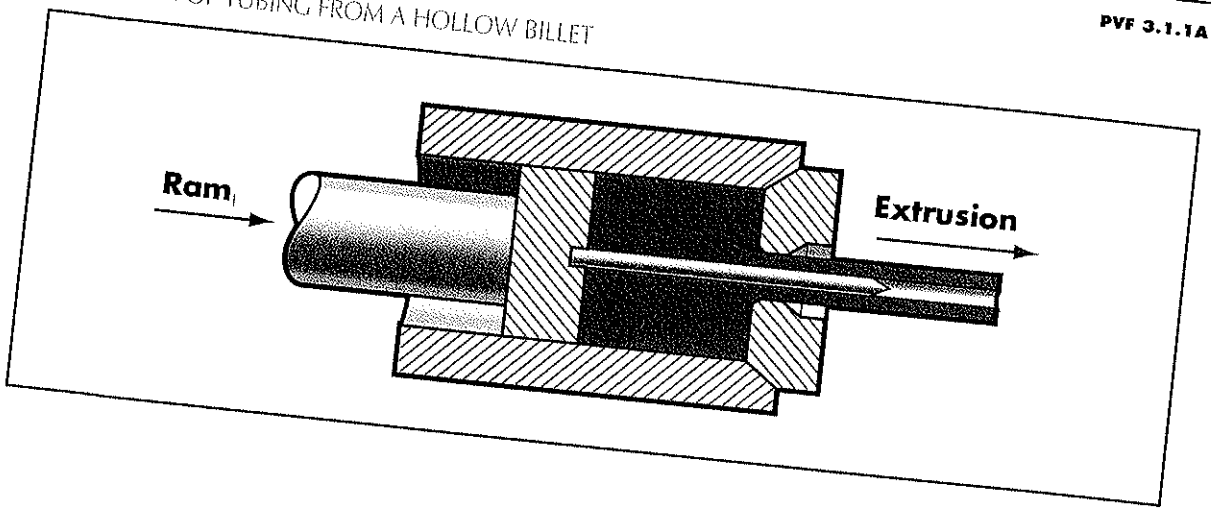
The manufacture of copper plumbing tube begins with a solid 2-foot-long x 9-inch-diameter copper section called a **BILLET** that is heated to a very high temperature. A pointed rod called a **PIERCING MANDREL** is driven through the center of the billet to create the inside wall of the plumbing tube. This step is not needed if the billet is cast as a tube round or a tube shell. Piercing can take place either just before or at the time of extrusion. **EXTRUSION** is the process by which the heated billet is forced over the mandrel and through the hole in the die, creating a long hollow tube. The hole in the die forms the outside wall of the tube.

EXTRUSION OF TUBING FROM A SOLID BILLET



PVF 3.1.1A

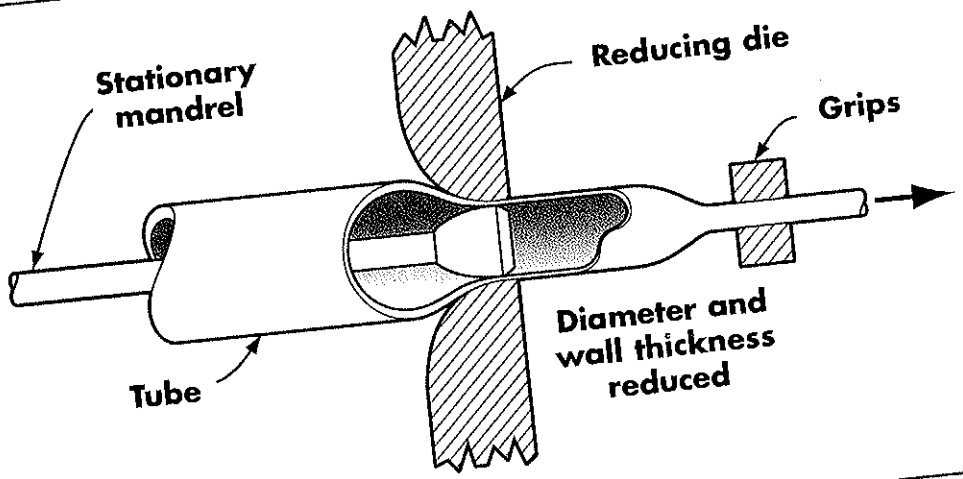
EXTRUSION OF TUBING FROM A HOLLOW BILLET



PVF 3.1.1B

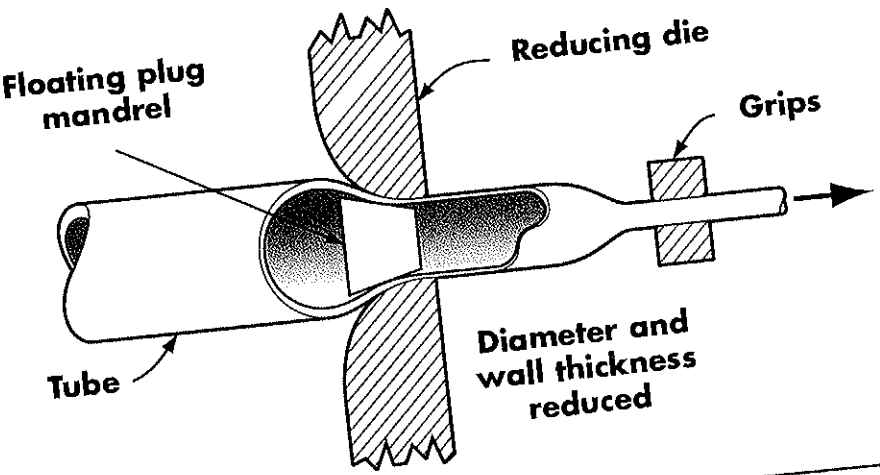
The next step is **DRAWING** — the process that involves pulling the hollow tube through a series of hardened steel dies of gradually decreasing diameters. As the tube is pulled through the dies, the mandrel (placed inside the tube) and die act together to reduce the tube's outside diameter and wall thickness. This process is repeated if necessary to reduce the tube to a smaller outside diameter dimension or a lighter wall.

TUBE DRAWING OVER FIXED MANDREL



PVF 3.1.2

TUBE DRAWING OVER A FLOATING PLUG MANDREL



PVF 3.1.3

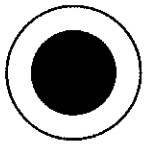
Manufacturing Options

Because copper tube is manufactured with different characteristics, a wide variety of applications and special tube types are possible. These characteristics include O.D. (outside diameter), wall thickness, temper and straight lengths or coils.

WALL THICKNESS STANDARDS

The ASTM has established four wall thickness standards and color codes for copper plumbing tube:

TYPE K, L, M AND DWV WALL THICKNESSES

TUBE TYPE	Wall Thickness		Color Code
TYPE K		Heaviest wall thickness for pressure applications	Green
TYPE L		Standard wall thickness for pressure applications	Blue
TYPE M		Lightest wall thickness for pressure applications	Red
TYPE DWV		Lighter than K, L, M for Drain, Wast & Vent applications	Yellow

PVF 3.1.4

Types K, L and M have thicker walls than DWV, because they are used in supply systems and must be able to handle higher internal pressure than DWV tube, which is never used in a supply system. Copper tube may be manufactured in one or more of the above thicknesses. To see other tube types, see summary table on page 22.

TEMPER

Regardless of its final temper, when copper tube is manufactured it is originally drawn **TEMPER**, which refers to the hardness of the tube and how difficult it is to bend. The tube's final temper can be either hard or soft:

- **DRAWN** (hard) — All straight length tube is drawn temper copper
- **ANNEALED** (soft) — Coils and some types of straight lengths are annealed (heat treated) after manufacture. In this method, hard drawn tube is processed through an annealing furnace that softens the drawn tube by exposing it to high temperature (above 800°F) for a set period of time.

Both drawn and annealed tube is manufactured from the same copper. This means they have similar properties and are suitable for carrying potable water. Since annealing reduces the mechanical strength of the tube, annealed (soft) tube has lower pressure ratings than drawn (hard) tube.

Certain types of copper tube come in both drawn and annealed forms. The chart below summarizes the tempers available for each type of copper tube.

TEMPERS OF COPPER TUBE			
TUBE TYPE	Color Code*	Drawn (Hard)	Annealed (Soft)
TYPE K	Green	X	X
TYPE L	Blue	X	X
TYPE M	Red	X	N/A
TYPE DWV	Yellow	X	N/A
ACR TUBE	Blue	X	X
MEDICAL GAS TUBE	Green (K) or Blue (L)	X	N/A
THREADLESS PIPE	Gray	X	N/A

* *See Color Coding on page 26*

STRAIGHT LENGTH OR COILS

Tube can be produced in STRAIGHT LENGTHS or COILS or BOTH. Tube that is to be sold in straight lengths is passed through a series of straightening rolls. For tube sold in coils, the rolls are set to provide a coil of tube with a radius appropriate to its end use. In general, coils are made as small as possible to reduce shipping costs without making the tube susceptible to kinking.

REVIEW OF COPPER TUBE AND PIPE

Answers appear on page 63

1. Copper tube and pipe are widely used in:
   a. Plumbing, heating and cooling only
   b. Plumbing, heating, cooling, refrigeration and industrial applications

2. Which of the following is an advantage of using copper tube and pipe?
   a. Resistance to corrosion and scaling reduce maintenance costs and increase customer satisfaction
   b. Resistance to moist acidic soil conditions

3. Copper can be considered a good value because:
   a. Initial purchase costs are lower than most other piping materials
   b. Transportation and installation costs are lower due to copper's light weight and bendability

4. Copper is considered a safe material because:
   a. Copper will not burn and produce toxic gases in a fire
   b. It has been used in plumbing installation for more than 75 years

5. The most common types of tube are:
   a. Pure copper tube and brass
   b. Pure copper tube, bronze and brass

6. Brass tube is made by:
   a. Adding zinc to copper b. Adding tin to copper

7. The difference between copper tube and pipe is:
   a. They have different wall thickness — copper pipe is heavy wall and can be threaded, while copper tube is thin wall and is not meant to be threaded.
   b. There are no differences; they are the same

REVIEW OF COPPER TUBE AND PIPE

Answers appear on page 63

8. What is the impact of the annealing process on the strength of copper tube?
   a. It increases the strength and pressure rating of the tube
   b. It decreases the strength and pressure rating of the tube

9. Four wall thickness standards and color codes that have been established by ASTM for copper plumbing tube are:
   a. Types K, L, M and N
   b. Types K, L, M and DWV

10. Which tube type has the heaviest wall thickness?
   a. Type K
   b. Type M

11. Copper tube is manufactured in the following temper(s):
   a. Drawn (hard) only
   b. Drawn (hard) and annealed (soft)

12. When producing copper tube in coils, the radius of the coil is kept as small as possible while avoiding kinking because:
   a. Small coils are easier to work with
   b. Small coils have lower shipping and handling costs

REVIEW OF COPPER TUBE AND PIPE

Answers appear on page 63

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 copper tube?

_____

_____

B. What specific types of copper tube does your company carry?

_____

_____

Types and Uses of Copper Tube

There are many types of copper tube. While there are several different ways of classifying copper tube, it is usually grouped by its most common uses. These include:

- **PLUMBING TUBE**
  - Water tube
  - DWV tube
  - Medical gas tube
  - Fuel gas tube
- **REFRIGERATION and ACR TUBE**
- **INDUSTRIAL PVF**
  - Copper pipe
  - Threadless copper pipe (TP)
  - Brass pipe

EACH TYPE OF COPPER TUBE AND PIPE IS MANUFACTURED ACCORDING TO:

- Specific ASTM and other standards requirements
- Its own specific temper(s) (drawn or annealed or both)
- Intended applications and uses
- Desired wall thicknesses
- Form (straight lengths or coils)
- Lengths.

The following are some of the different types of tube available and their uses.

Plumbing Tube

COPPER WATER TUBE is commonly used for plumbing, air conditioning and refrigeration applications in residential, commercial and institutional installations, as well as in a wide variety of other applications.

These applications are specified by wall thicknesses (K, L and M). (See summary table on page 22.) Not every tube will be available in every wall thickness. It is important to check the local plumbing code to ensure the acceptable product is selected.

For example:

- **TYPE K** (the thickest wall) is used in high-pressure applications for general heating and plumbing. Type K is also used in underground service lines that connect the city water main to the residence (home). It would be installed by plumbing contractors, utilities or water works contractors.

- **TYPE L** (the intermediate wall thickness) is used for medium-pressure applications in interior hot and cold water lines, steam heating and condensate return lines. In some areas, Type L is also used for underground service lines from the city main to the residence (home). In addition to plumbing contractors, Type L can be installed by utilities or water works contractors.

- **TYPE M** (the thinnest wall) is used for hot and cold water lines in residences and low-pressure steam or hot water heat lines. It is not generally recommended for underground use.

TYPES K AND L ARE MANUFACTURED IN:

- Drawn temper (hard)
- Annealed temper (soft).

TYPE M IS ONLY MANUFACTURED IN:

- Drawn temper (hard).

COPPER WATER TUBE OF DRAWN (HARD) TEMPER is required to be identified with a color stripe (color coding) that contains the manufacturer's name or trademark, type of tube and nation of origin. The color coding, as mentioned earlier, is:

- **TYPE K** is color coded green
- **TYPE L** is color coded blue
- **TYPE M** is color coded red.

ANNEALED (SOFT) COILS or **ANNEALED STRAIGHT LENGTHS** are not required to be identified with a color coding. However, all drawn or annealed temper copper water tube is incised. This means that at intervals not greater than 18 inches, the outer diameter of the tube is stamped with the manufacturer's name or trademark and the type of tube. While color coding is not required for annealed coils, the box or carton can be color coded to indicate the tube type.

COPPER DRAINAGE OR DWV TUBE (LIGHTER THAN TYPES K, L AND M) is a type of plumbing tube used for sanitary Drainage, Waste & Vent systems and other non-pressure plumbing applications. Its wall thickness is less than Types K, L and M, and it is often referred to as DWV tube. Much of the DWV tube now produced is used to maintain existing copper DWV systems because many newer DWV systems use plastic or cast iron rather than copper DWV pipe. Plumbing and mechanical codes govern the types of products that may be used in specific applications. Local codes should always be consulted.

DWV COPPER TUBE IS PRODUCED IN:

- Drawn hard temper only
- Nominal sizes 1 1/4 inches through 8 inches
- 10-foot and 20-foot lengths are usually available.

DWV COPPER TUBE CAN BE IDENTIFIED BY:

- An incised mark containing the manufacturer's name or trademark and "DWV" at intervals not greater than 18 inches
- A continuous yellow stripe (color coding) containing the manufacturer's name or trademark, nation of origin and DWV repeated at intervals.

MEDICAL GAS TUBE (TYPE K OR L) is a type of tube that is specially cleaned and capped to maintain a clean interior surface that is acceptable for use with nonflammable medical gases and some other high-purity applications. Medical gas tube comes in either Type K or L wall thicknesses, 1/4-inch through 8-inches diameter (nominal) and is drawn (hard) temper only.

MEDICAL GAS TUBE IS IDENTIFIED BY:

- Continuous green stripe for Type K
- Continuous blue stripe for Type L.

Medical gas tube is incised or stamped with the type of tube, manufacturer's name or trademark. In addition, medical gas tube is required to be marked in the color appropriate for Type K (green) or Type L (blue) with one or more of the following indicators that the tube is suitable for medical gas use: "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED."

FUEL GAS TUBE (TYPE GAS), while not commonly used or produced in the U.S., this type of tube is often used in Canada for fuel gas installations of natural gas or liquefied petroleum (LP). It is produced in the same wall thickness as Type L, and in the following tempers:

- Annealed (soft) temper
- Drawn (hard) temper.

Coils may be provided in 60- or 100-foot lengths, while straight lengths may be provided in 12- or 20-foot lengths. Longer lengths may be provided when there is a prior agreement between the manufacturer or supplier and the purchaser.

This tube is required to be permanently incised with the mark "Type Gas" and the name or trademark of the manufacturer. In addition, drawn (hard) temper straight lengths of this tube are identified by a yellow colored stripe.

In the U.S., copper water tube or ACR tube is code-approved for use in fuel gas systems. Both Types K and L tube are allowable, with Type L usually specified for interior distribution systems and Type K used for underground lines.

Refrigeration and ACR Tube

The production of air conditioning and refrigeration tube must follow special internal cleanliness and dehydration requirements. In addition, the tube's ends must be capped and sealed. This tube, usually called ACR tube, is available in:

- Straight lengths (hard ACR tube is color coded blue only, Type L)
- Annealed coils.

ACR TUBE IS MARKED IN THE FOLLOWING WAY:

- Coils – The name or trademark of the manufacturer and ACR is permanently incised at intervals on each tube.
- Hard straight lengths – The name or trademark of the manufacturer and a mark indicating either L or ACR is incised at repeated intervals. Hard straight lengths are also marked with a blue coding that contains the manufacturer's name or trademark, nation of origin, outside diameter and ACR.
- *Note:* Since the internal cleanliness requirements are identical, it is common to find hard drawn, straight length copper tube that is marked as both medical gas and ACR tube. For example, a tube may be supplied with the marking: 1 1/2" Type L OXY 1 5/8" ACR (or something similar to indicate that the tube meets the requirements of both standards).

Industrial PVF

Copper and brass pipe are also available for use in higher-pressure systems, or in specialized systems where heavier wall thicknesses are required. They are not commonly used for general and plumbing applications, where copper tube more than adequately meets the requirements. In some cases — especially in high-rise construction where large pipe sizes are required — copper, brass or threadless copper pipe are specified for plumbing and mechanical risers. This is because high static pressure is found in these systems due to the height of the buildings. Copper and brass pipe are available in various alloys, sizes and tempers.

COPPER PIPE, an industrial type of pipe, is different from threadless copper pipe (TP pipe) discussed later in the chapter. Although they can both be used in the same applications and piping systems, the choice on which one to use comes down to flow rate and joining method. Copper pipe has a thicker wall than threadless copper pipe and can be threaded.

Copper pipe is almost pure copper, and is usually supplied in the same alloy as copper tube. It comes in the following wall thicknesses:

- Regular wall thickness
- Extra strong wall thickness.

The standard length for copper pipe is 12 feet. Copper pipe is suitable for:

- Plumbing
- Boiler feed lines
- Refrigeration and similar purposes.

Joints in copper pipe can be threaded, flanged or brazed to fittings of the proper joint configuration.

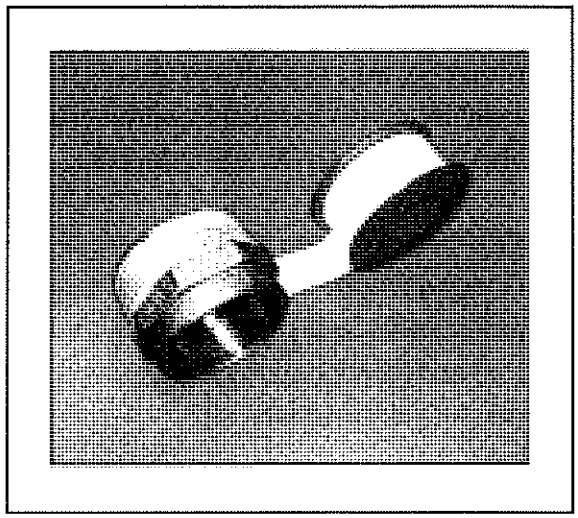
Copper pipe can be threaded by an installer at the job site to make **THREADED COPPER PIPE**. Special applications, such as ship building, require threaded copper pipe.

It is available in:

- Both regular and extra strong wall thickness
- Nominal 1/8 inch to 12 inches.

Once copper pipe is threaded, it can be joined with a pipe tape sealer or pipe dope sealer. The joining process includes cleaning internal and external threads, applying tape or dope, and then screwing the joint together.

PIPE TAPE



PVF 3.1.5

THREADLESS COPPER PIPE has a thinner wall than copper pipe, because it is not intended to be threaded. The thinner wall allows for a higher flow rate than the same-sized copper pipe. Threadless copper pipe is often referred to as **TP** pipe.

IT IS MANUFACTURED IN:

- Drawn temper (hard) only.

While the outside diameter of threadless copper pipe is the same as Schedule 40 pipe, its wall thickness is much less.

THREADLESS COPPER PIPE IS AVAILABLE IN THE FOLLOWING LENGTHS:

- 20-foot length for sizes 1/4 inch to 10 inches
- 15-foot length for size 12 inches.

Threadless copper pipe is required by ASTM standards to be identified with a gray colored stripe throughout its length. This stripe contains the manufacturer's name or trademark, nation of origin and TP. It is also required to be incised with the manufacturer's name or trademark and TP at intervals not less than 1 1/2 feet throughout its entire length.

THREADLESS COPPER PIPE IS USUALLY JOINED BY:

- Brazed socket-cup type fittings
- Socket-cup type flanges.

BRASS PIPE, an industrial type of pipe also called **RED BRASS PIPE**, is available in:

- Both regular and extra strong wall thickness
- Standard lengths of 12 feet and 20 feet.

BRASS PIPE IS USED FOR:

- Water supply
- Water distribution.

Joints in red brass pipe can be threaded, flanged or brazed to fittings of the appropriate joint configuration.

FITTINGS IN SMALLER SIZES, NORMALLY THOSE BELOW 2-INCH DIAMETERS, ARE:

- Screwed cast copper alloy
- Brazed cup cast copper alloy.

FITTINGS ABOVE 2 INCHES IN DIAMETER ARE NORMALLY:

- Threaded
- Flanged
- Brazed
- Grooved mechanical joint fittings are employed in some cases.

Plastic-Coated Copper Tube

Plastic-coated copper tube has been available for specialty applications for several years. Recently, marketing efforts have increased and plastic-coated copper tube is achieving greater acceptance in several areas of the U.S.

Plastic-coated copper tube is available in the following types:

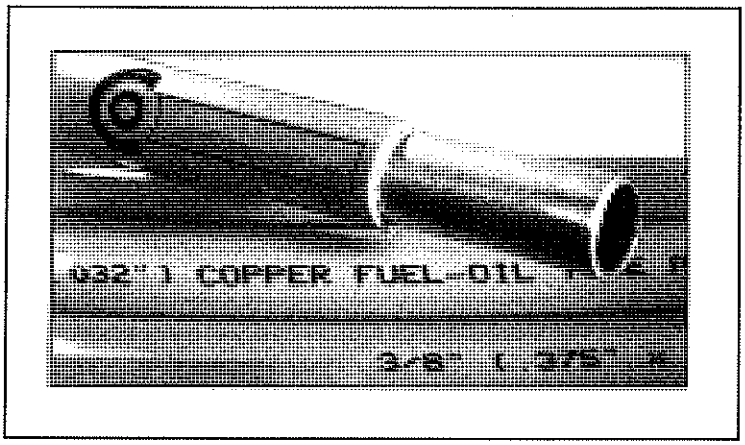
- **NATURAL GAS & LP/GAS TUBE**
- **FUEL OIL TUBE**
- **POTABLE WATER TUBE.**

Plastic-coated potable water tube provides added corrosion protection for potable water lines in both plumbing and municipal applications. It is available in Types L and K and in both coils and straight lengths.

This type of copper tube is plastic coated on the outside. The plastic coating provides corrosion protection for buried installations in areas with acidic soil conditions.

Plastic-coated copper tube has built-in leak detection grooves that can aid in eliminating on-site SLEEVING required by codes in many areas.

PLASTIC-COATED COPPER TUBE



PVF 3.1.6

SUMMARY OF ALL THE COPPER TUBE TYPES AND THEIR APPLICATIONS

Classification according to usage	Copper Tube Type and Pipe	Application
Plumbing Tube	WATER TUBE TYPE K This type of copper tube has the heaviest wall thickness	• Domestic water service and distribution • Fire protection • Solar • Fuel/fuel oil • Fuel gas systems (natural gas or LP gas) • HVAC • Snow melting
	WATER TUBE TYPE L This type of copper tube has the standard wall thickness	• Domestic water service and distribution • Solar • Fire protection • Fuel/fuel oil • Fuel gas systems (natural or LP gas) • HVAC • Snow melting
	Water Tube Type M This type of copper tube has the lightest wall thickness	• Domestic water service and distribution • Solar • Fire protection • Fuel/fuel oil • HVAC • Snow melting
	Copper Drainage Tube (lighter wall thickness than Types K, L and M) Often referred to as "DWV" tube	• Drain, waste, vent • Solar • HVAC (drain lines)
	Medical Gas Tube Type K or L	• Installation of nonflammable medical gases (and in some cases high-purity applications) where the gases being delivered are not considered flammable
	Fuel Gas Tube Type Gas	• Fuel gas installations of natural gas or liquefied petroleum (LP) gas
Refrigeration & ACR Tube Sometimes called "refer" or "ACR" tube	ACR Tube Hard ACR color coded blue only Refrigeration tube in coil form is generally referred to as "refer"	• Air conditioning • Refrigeration • Natural gas • Liquefied petroleum (LP) gas
Industrial PVF	Copper Pipe and Threadless Copper Pipe (color coded gray)	• Domestic water supply and distribution • Condenser/cooling water systems • Boiler • Boiler feed lines • Refrigeration and similar purposes
	Brass Pipe	• Water supply • Water distribution

REVIEW OF TYPES AND USES OF COPPER TUBE

Answers appear on page 63

1. Plumbing tube is:
   a. A category that encompasses copper water tube, DWV tube, medical gas tube and fuel gas tube
   b. A category that encompasses ACR tube and copper pipe

2. Copper water tube comes in the following types:
   a. Types K, L and M
   b. Types K and L

3. Color coding is:
   a. Required for the identification of annealed (soft) coils or annealed straight lengths
   b. Required for the identification of copper water tube of drawn (hard) temper

4. The type of copper tube used for sanitary drainage, waste and vent systems and other non-pressure plumbing applications is:
   a. Copper drainage or DWV tube
   b. Type L tube

5. The type of tube that is specially cleaned and capped to maintain a clean interior surface is:
   a. Type M tube
   b. Medical gas tube

6. Fuel gas tube is:
   a. Produced in the same wall thickness as Type L
   b. Produced in the same wall thickness as Type M

7. Refrigeration and ACR tube:
   a. Requires special internal cleanliness, dehydration requirements, capping and sealing the ends
   b. Is color coded red

REVIEW OF UNDERSTANDING PIPE SCHEDULES

Answers appear on page 64

8. Copper and brass pipe are commonly used in:
   a. Residences and small commercial operations
   b. Higher pressure or specialized systems where heavier wall thicknesses are required

9. Copper pipe:
   a. Has a thicker wall than threadless copper pipe and can be threaded
   b. Cannot be used in the same applications and piping systems as threadless copper pipe

10. Brass pipe is most likely used for:
    a. Drainage, waste and vent systems
    b. Water supply and distribution

11. Plastic-coated copper tube:
    a. Has plastic coating on the outside that provides corrosion protection for buried installation in areas with acidic soil conditions
    b. Is available as potable water tube only

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 is your company's major type of customer that buys Medical Gas Tube?

_____

_____

B. Look at a piece of ACR tube. How do your customers use this type of tube?

_____

_____

Copper Tube's Specifications

ASTM Standard for Copper Tubing

Each copper tube type is manufactured according to a national standard established by ASTM International (formerly American Society for Testing and Materials). ASTM is the largest standards development organization and is a source for technical standards for materials, products, systems and services.

NSF 61

NSF 61 is a compliance certification that copper tube and wrot fittings used for potable water systems must meet as a result of the U.S. Safe Drinking Water Act (1996) and the Lead and Copper Rule (1991). NSF 61 is administered by NSF International (formerly the National Sanitation Foundation).

Ordering Copper Tube

When copper tube is ordered from a wholesaler/distributor, a number of specifications are provided. Accurate processing of the order requires complete information and specifications including:

- Type of tube (K, L, M, ACR, Refrigeration) and ASTM standard #
- O.D. size or nominal size
- Temper
- Length
- Straight length or coil.

Copper Tube and Pipe Coding

Some copper tube is permanently incised in accordance with governing specifications to show the tube type and name or trademark of the manufacturer. In addition to incised markings, hard tube will have this information within a color stripe that might be referred to as color coding. The color stripe or coding includes the type of tube, name or trademark of the manufacturer and country of origin. This is repeated at set intervals along the entire length of the pipe to ensure that cut pieces of pipe display the required information.

The table on the right lists the type of tube and designated color stripe or coding.

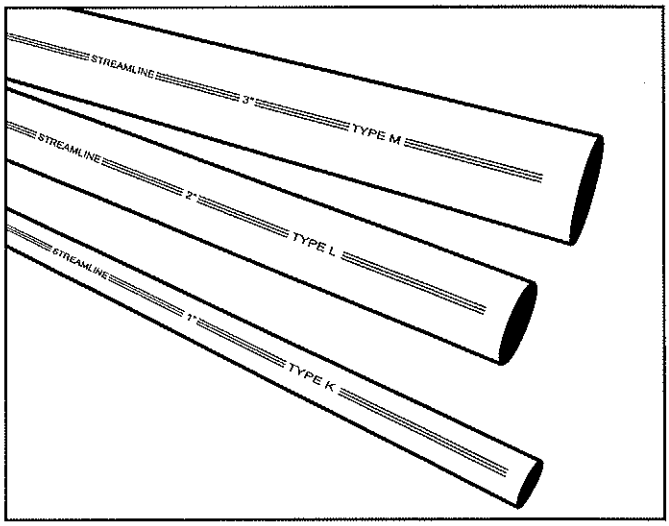
Copper Tube and Pipe Type	Color Coding
TYPE K	Green
TYPE L	Blue
TYPE M	Red
TYPE DWV^	Yellow
ACR*	Blue
MEDICAL GAS	Green (K) or Blue (L)
FUEL GAS^	Yellow
THREADLESS COPPER PIPE	Gray

* *Hard ACR tube is color marked only. Soft ACR tube may not carry any color markings.*

^ *DWV is 1 1/4 inches and larger. Fuel gas (G/Gas) tube is up to 1 1/8 inches.*

PVF 3.1.51

COPPER TUBE AND PIPE CODING



PVF 3.1.7

Nominal Pipe Size (NPS) and Copper Tube

Types K, L, M, DWV and oxygen tube have actual outside diameters that are 1/8-inch larger than the nominal (standard) size by which tube is ordered. For example, a 1/2-inch Type M tube has an actual outside diameter of 5/8 inch. This example is shown in the partial table to the right.

DIMENSIONS FOR
TYPES K, L, M, MEDICAL GAS[1] AND DWV[2] TUBE

Nominal or Standard Size	Outside Diameter in All Types
1/4″	0.375″
3/8″	0.500″
1/2″	0.625 or 5/8″
5/8″	0.750″

PVF 3.1.52

[1] *Medical Gas tube is only available in sizes from 1/4 through 8-inch nominal*

[2] *DWV tube only available in sizes from 1 1/4-inch through 8-inch nominal.*

ACR tube for air conditioning and refrigeration service and G/Gas tube for natural gas and propane systems are designated by their actual outside diameter. For example, a 1/2-inch ACR tube has an actual outside diameter of 1/2 inch. ACR tube standard size equals the actual outside diameter. See the partial table to the right.

DIMENSIONS FOR ACR TUBE

Standard Size	Outside Diameter
1/8″	0.125 or 1/8″
3/16″	0.187 or 3/16″
1/4″	0.250 or 1/4″
5/16″	0.312 or 5/16″
3/8″	0.375 or 3/8″
1/2″	0.500 or 1/2″
5/8″	0.625 or 5/8″

PVF 3.1.53

Joining Copper Tube

SOLDERED JOINTS with CAPILLARY FITTINGS are used in plumbing for water supply lines and sanitary drainage.

BRAZED JOINTS with CAPILLARY FITTINGS are used where greater strength is required or where service temperatures are as high as 350°F (176°C). Brazing is the required joining method for refrigeration piping.

MECHANICAL JOINTS involving flared tube ends are often used for underground tubing, joints where the use of heat is impractical and joints that may have to be disconnected from time to time.

Copper tube also may be joined by butt-welding without the use of fittings. Care must be taken to use proper welding procedures.

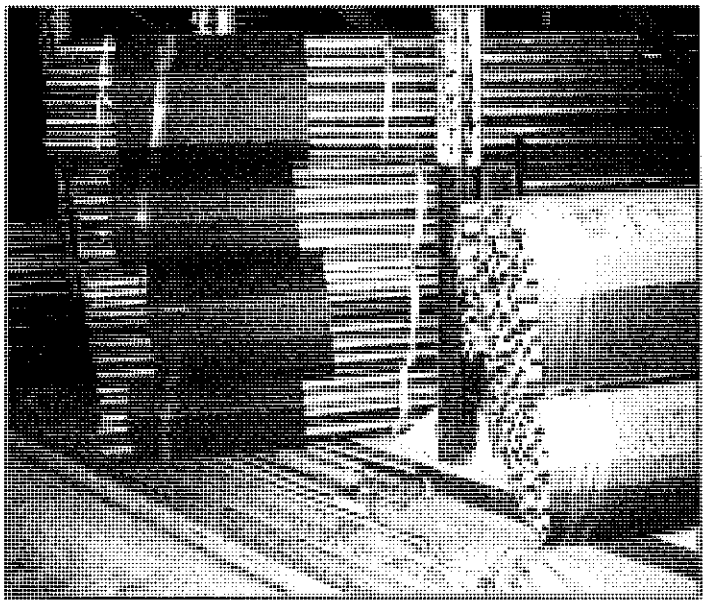
In addition, copper tube may be swaged, a common practice in refrigeration installations. This eliminates the use of a fitting by using a tool to expand the tube end to a diameter and depth that will accommodate another tube end and form a lap joint for brazing. Copper joining methods are discussed in detail at the end of this chapter.

Storing and Shipping Copper Tube

Copper tube is shipped in both straight lengths and coils. The color code for straight lengths appears on the tube. The color code for coils, while not required, may appear on the cartons.

Since copper tube is more valuable and easily damaged than most other types of pipe, special care should be taken to protect it from damage and theft. Copper tube should be stored in areas where it is not likely to be crushed, scratched or damaged by employees, customers or motorized equipment. Small-diameter straight lengths of copper tube are especially susceptible.

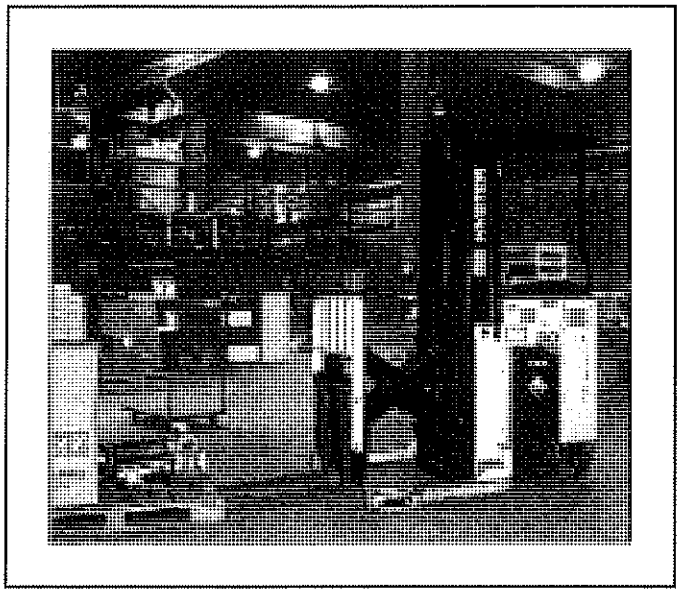
STORING COPPER TUBE



PVF 3.1.8

Many companies store their copper tube inside the warehouse to minimize damage and prevent theft. Due to its dimensions, straight length tube is shipped using slings that can be handled by specially equipped fork trucks. Copper tube in coil form is typically shipped on pallets.

FORK TRUCK



PVF 3.1.9

Using Manufacturers' Catalogs

Manufacturers' catalogs – whether accessed electronically through an industry data base or in hard copy – usually provide information for inside sales, counter and purchasing personnel concerning tube type, nominal size, I.D., O.D., wall thickness, temper, and other characteristics and specifications for available copper tube. Information concerning bundle/sling quantities for ordering straight length tube are usually included.

This information, as well as details on the design, specification, installation and use of copper piping systems, can also be found in the Copper Development Association's *Copper Tube Handbook* that is available at no charge on their website at www.copper.org.

It's important that you become familiar with catalogs and sales literature provided by your manufacturers so you are able use these materials to find the information you need about particular products.

Selecting the Right Tube for the Job

The designer or engineer is the person who chooses the type of copper tube for use in specific applications. Formability, strength and other mechanical factors often determine the choice. Plumbing and mechanical codes dictate what types may be used. However, there are some common applications of copper tube that are described in the table below.

Application	Recommended copper tube
Underground Water Services	Use **TYPE K** or **L HARD** for straight lengths joined with fittings, and **TYPE K** or **L SOFT** where coils are more convenient.
Water Distribution Systems	Use **TYPE M** residential or **TYPE L** commercial as code requires.
Chilled Water Mains	Use **TYPE L** or **M** for all sizes.
Drainage and Vent Systems	Use **TYPE DWV** for above and below ground waste, soil and vent lines, roof and building drains, and sewers.
Heating	For radiant panel and hydronic heating and for snow melting systems, use **TYPE L** soft temper where coils are formed in place or prefabricated; **TYPE L** or **M** where straight lengths are used. For water heating and low-pressure steam, use **TYPE L** or **M** for all sizes. For condensate return lines, **TYPE L** is used.
Fuel Oil, LP and Natural Gas Services	Use **TYPE GAS**, **TYPE L** or **TYPE ACR** tube with flared or brazed joints in accessible locations.
Nonflammable Medical Gas Systems	Use Medical Gas tube **TYPE K** or **L**, cleaned for oxygen service.
Air-Conditioning and Refrigeration Systems	Copper is the preferred material for use with most refrigerants. Use **TYPE L, ACR** or as specified.
Ground Source Heat Pump Systems	Use **TYPE L** or **ACR** where the ground coils are formed in place or prefabricated, or as specified.
Fire Sprinkler Systems	Use **TYPE L** or **M** hard. Where bending is required, **TYPE K** or **L** are recommended. **TYPES K, L** and **M** are all accepted by NFPA.
Low-Temperature Applications	Use copper tube of a type determined by rated internal working pressures at room temperature.
Compressed Air	Use copper tube of **TYPES K, L** or **M** determined by the rated internal working pressures. Brazed joints are recommended.
Natural Gas	For above-ground natural gas and propane systems, use **TYPE L** tube meeting ASTM B88. For underground lines, **TYPE K** copper tube or plastic-coated **TYPE L** tube is required.

PVF 3.1.54

REFER TO LOCAL CODES TO DETERMINE WHICH TUBE IS REQUIRED IN YOUR AREA.

REVIEW OF COPPER TUBE'S SPECIFICATIONS

Answers appear on page 64

1. NSF 61 is a:
   a. Manufacturing standard
   b. Certification that documents the tube's compliance with certain requirements of the U.S. Safe Drinking Water Act

2. Copper tube is:
   a. Incised to show the tube type and name or trademark of the manufacturer
   b. Always incised and color coded

3. Types K, L, M, DWV and Oxygen tube have outside diameters that are:
   a. The same as the nominal (standard) size
   b. 1/8 inch larger than the nominal (standard) size

4. The type of joints used with refrigeration piping are:
   a. Soldered joints b. Brazed joints

5. Mechanical joints:
   a. Require heat as part of their joining process
   b. Are frequently used for underground tubing

6. Copper tube is shipped in:
   a. Both straight lengths and coils
   b. Straight lengths only

7. Which tube type is recommended for chilled water mains?
   a. Type L or M for all sizes b. Type K or L for all sizes

8. Which tube type is recommended for low-temperature applications?
   a. Type L only
   b. Tube type should be determined by the rated internal working pressures at room temperature

REVIEW OF COPPER TUBE'S SPECIFICATIONS

Answers appear on page 64

9. Which tube type is recommended for water heating and low-pressure steam?
   a. Type L or M for all sizes b. Type K or M for all sizes

10. The right tube for the job:
    a. Would be selected based on formability, strength and other mechanical factors only
    b. Cannot be selected without referring to the local codes that determine which tube is required

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 some of your company's Type K, L and M copper water tube. List the color stripe, incised markings and write down the meaning of the markings for each type of tube.

_____

_____

B. Describe your company's requirements for storing copper tube?

_____

_____

Wrot and Cast Copper Fittings

Copper and copper alloy fittings come as wrot or cast copper fittings. The fittings are selected for specific job applications based on the type of tube used. Each copper fitting is manufactured according to a national standard established by ASME (American Society of Mechanical Engineers) or MSS (Manufacturers' Standardization Society).

Copper and copper alloy fittings used in pressure applications (such as water supply lines) can be either wrot or cast. **WROT COPPER FITTINGS** are made from copper tube, which is formed (wrought) into the desired shape. These fittings may be labeled "wrot" or "wrought." Wrought copper pressure fittings are available in a wide range of sizes and types. They can be joined by either soldering or brazing. Wrought fittings are preferred where brazing is the joining method.

CAST COPPER FITTINGS are made from a copper alloy and formed in a mold. Cast copper pressure fittings are available in all standard tube sizes and in a limited variety of types to cover the needs of plumbing and mechanical systems. They can be connected by either soldering or brazing. The choice between cast and wrought fittings is largely a matter of availability and the user's preference.

The fittings reviewed in this section usually come in both wrot and cast copper. However, not every manufacturer offers all fittings in both wrot and cast forms. Check your manufacturers' catalogs to see which ones you carry.

Applications

The most common wrot and cast copper fittings and their applications include:

- **PRESSURE APPLICATIONS**
  - Cast copper solder joint pressure fittings
  - Wrot copper solder joint pressure fittings
- **DRAIN, WASTE AND VENT APPLICATIONS**
  - Cast copper solder joint drainage fittings
  - Wrot copper solder joint drainage fittings
- **COLD WATER SERVICE APPLICATIONS**
  - Flared copper fittings.

The use of fittings is not limited to these three application categories. Some of the many other applications include:

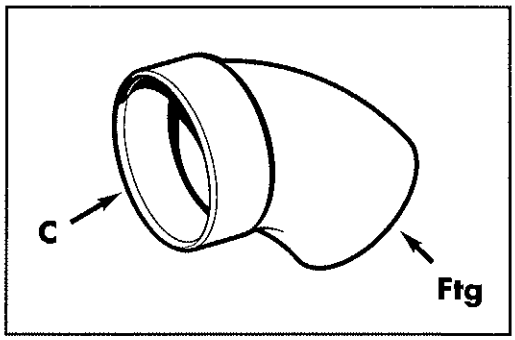
- Heating
- Fuel oil, LP and natural gas services
- Nonflammable medical gas systems
- Air conditioning and refrigeration systems
- Ground source heat pump systems
- Fire sprinkler systems
- Low-temperature applications
- Compressed air
- Natural gas.

Copper Fitting Ends

The following abbreviations are used in specifications to indicate ends on other fittings. Copper fittings that are to be soldered are said to have solder "cups," which come in two types:

- C = Female solder cup
- Ftg = Male solder end

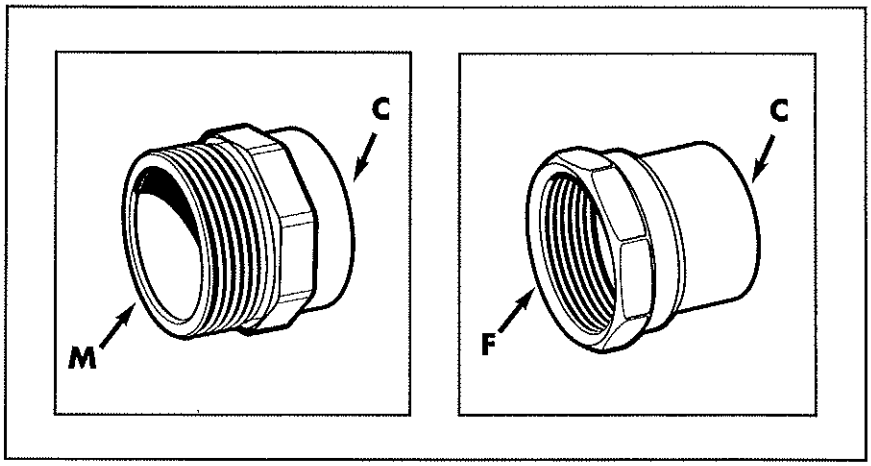
FEMALE SOLDER CUP AND MALE SOLDER END



PVF 3.1.10

Copper fittings that are to be joined by threading use the abbreviations F for female pipe threads and M for male pipe threads.

MALE, FEMALE THREADED ENDS AND FEMALE SOLDER CUPS



PVF 3.1.11

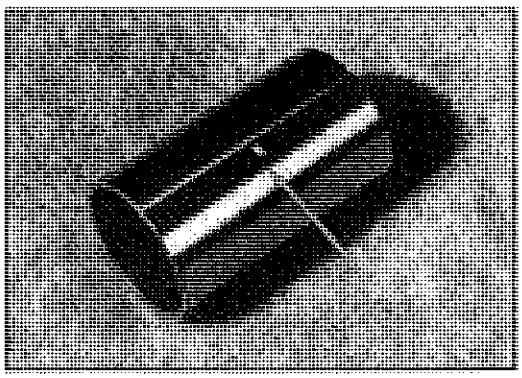
Wrot and Cast Pressure Fittings

There are many different wrot and cast pressure fittings. Just like supply systems of materials like steel, copper systems include the wide range of pipe, valves and fittings needed to assemble a complete supply system. However, some of the terms used to describe copper fittings are unique to copper. When discussing copper fittings, industry professionals describe the alloy, manufactured form, combination of end types as well as the type, form, size and other specifications. The examples that follow describe some of the commonly available fittings using terms that are appropriate for copper. Some examples of wrot and cast pressure fittings are copper couplings, bushings and adapters.

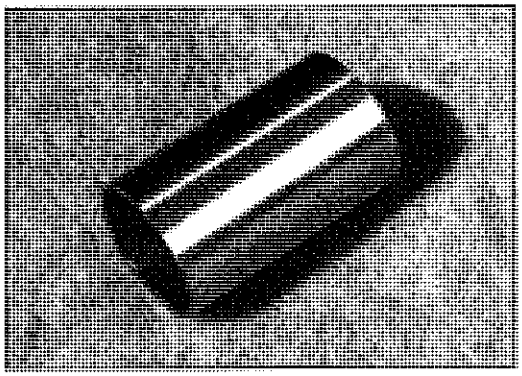
COPPER COUPLINGS

Copper couplings come as both wrot and cast. They are also available with or without stops. A COUPLING WITH A STOP is designed to control the distance the tube fits into the fitting. Stops may be rolled or dimpled. The COUPLING WITHOUT A STOP is called a "REPAIR COUPLING" or "SLIP COUPLING."

COPPER COUPLINGS



Coupling With Dimpled Stop

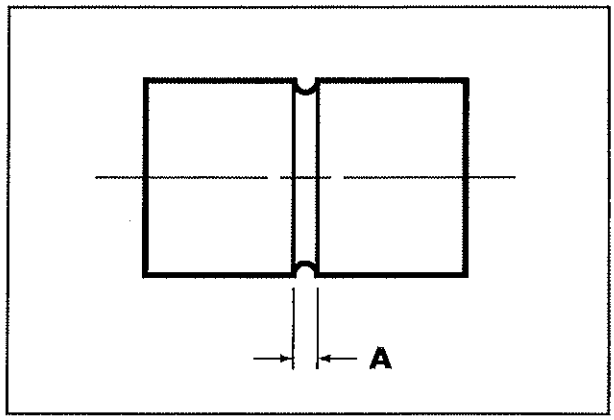


Coupling Without Stop

PVF 3.1.12 & PVF 3.1.13

In a catalog, a dimension diagram will indicate the length of the fitting to the stop, which is known as the laying length or takeoff. In the diagram to the right, dimension "A" indicates the length of the stop. If A is 1/16 inch, the coupling will add 1/16 inch to the length of the run.

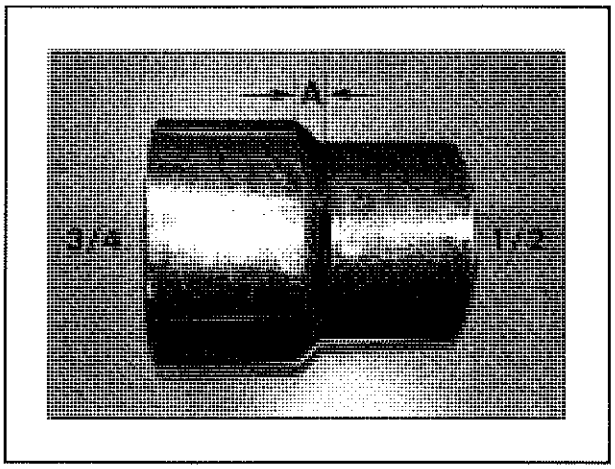
COUPLING WITH ROLLED TUBE STOP - DIMENSION DIAGRAM



PVF 3.1.14

Copper wrot and cast reducing couplings, called **REDUCERS**, also are available. The dimension diagram for a reducer will indicate the space between the end of the larger tube and the end of the smaller one. In the diagram to the right, "A" is the space between the ends of the two tubes when they are inserted into the reducer. This reducing coupling will add 1/8 inch to the length of the pipe run.

REDUCING COUPLING

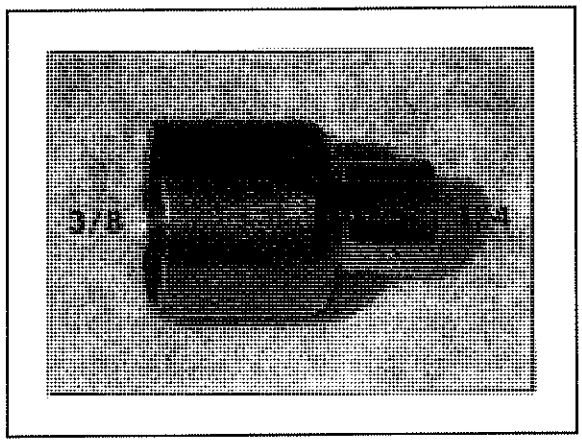


PVF 3.1.15

Specifications for reducing couplings are given with the larger opening first. The types of ends also are included in the specification. The reducing coupling shown above is a 3/4" x 1/2" C x C.

A **FITTING REDUCER** is used to connect one fitting (such as a tee) that joins two lengths of pipe to a third section of pipe that has a smaller diameter. The larger end of the fitting reducer is inserted into a socket in the fitting. This end of the reducer is called a "fitting connector." The smaller cup end extends beyond the socket of the tee and fits over the third tube to be joined. A fitting reducer is often called an "extended bushing."

EXTENDED BUSHING



PVF 3.1.16

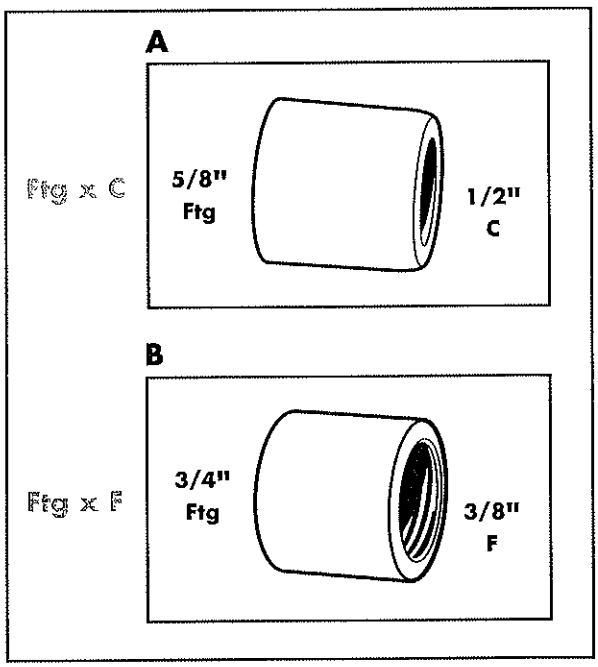
The specifications for a fitting reducer list the **FITTING END** first. The extended bushing in the illustration above would be ordered as a 3/8" x 1/4" copper fitting reducer.

Two types of flush bushings also are available. A **FLUSH BUSHING** is inserted into a fitting socket so tube with smaller diameter can be connected to the run. When properly inserted, the bushing is almost even or "flush" with the face of the socket and may not be very visible from the outside.

FLUSH BUSHING

The two types of flush bushings are shown in the dimension drawings below. The larger end of each is a fitting connector.

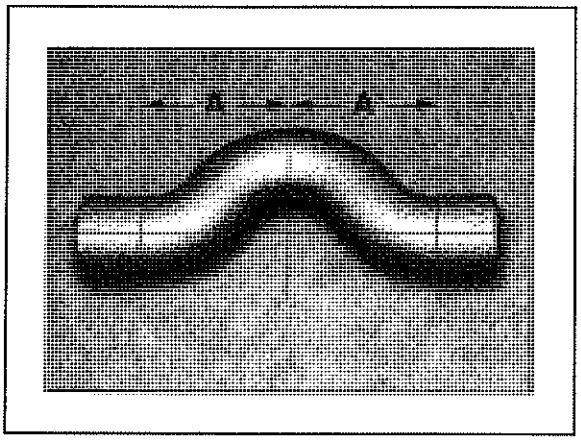
Flush bushing specifications list the fitting end first. The specifications for the bushing A to the right would be a 5/8" x 1/2" Ftg x C flush bushing. The bushing B below would be a 3/4" x 3/8" Ftg x F bushing.



PVF 3.1.17

A **CROSSOVER** fitting allows one run of pipe to pass over another. Crossovers have sockets at each end to join the fitting to the ends of copper tube. The specifications for a crossover indicate the size of the pipe and the type of ends. The sample pictured to the right is a 1/2" C x C crossover. Dimension A in this illustration indicates the length from one pipe end to the center of the crossover. The length of the run would be increased by two times A.

CROSSOVER



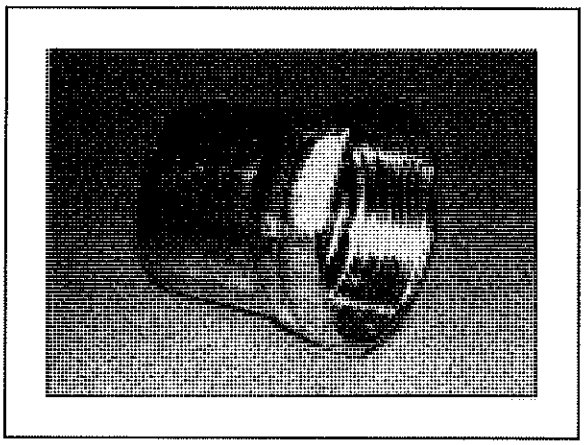
PVF 3.1.18

There are several types of wrot and cast copper adapters. **ADAPTERS** are often used to allow copper tube (which is often soldered) to be connected to a threaded connection. An adapter may have several different combinations of ends, including two female ends or one male and one female end.

One end of a **FITTING ADAPTER** might have a fitting connection end Ftg that will be inserted into a fitting socket. The other end may have a MPT, FPT or hose threads.

The example to the right is a C x F adapter or female solder cup by female pipe threads.

FITTING ADAPTER



PVF 3.1.19

ELBOWS

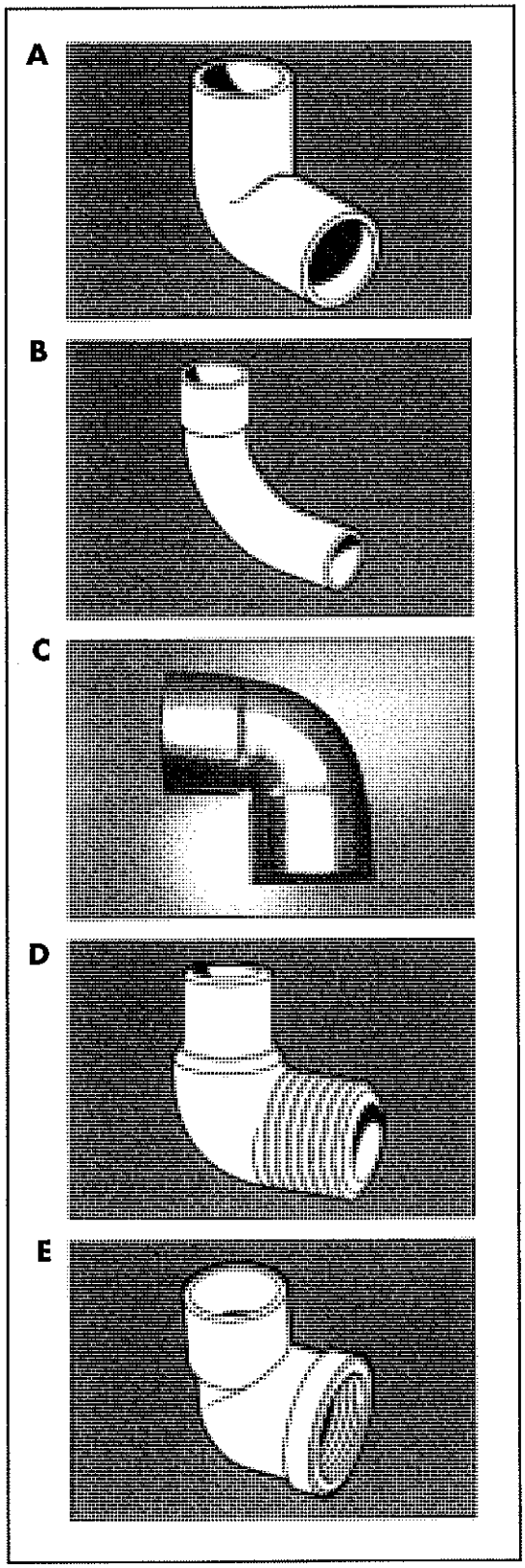
There are 90° and 45° ells in both wrot and cast copper. The 90° and 45° ells may have five different combinations of ends:

A. Ftg x Ftg
B. Ftg x C
C. C x C
D. Ftg x M (cast elbows only)
E. C x F (cast elbows only).

These abbreviations stand for the following:

- Ftg = Male solder end
- C = Female solder cup
- M = Male NPT thread
- F = Female NPT thread.

WROT AND CAST COPPER ELBOWS

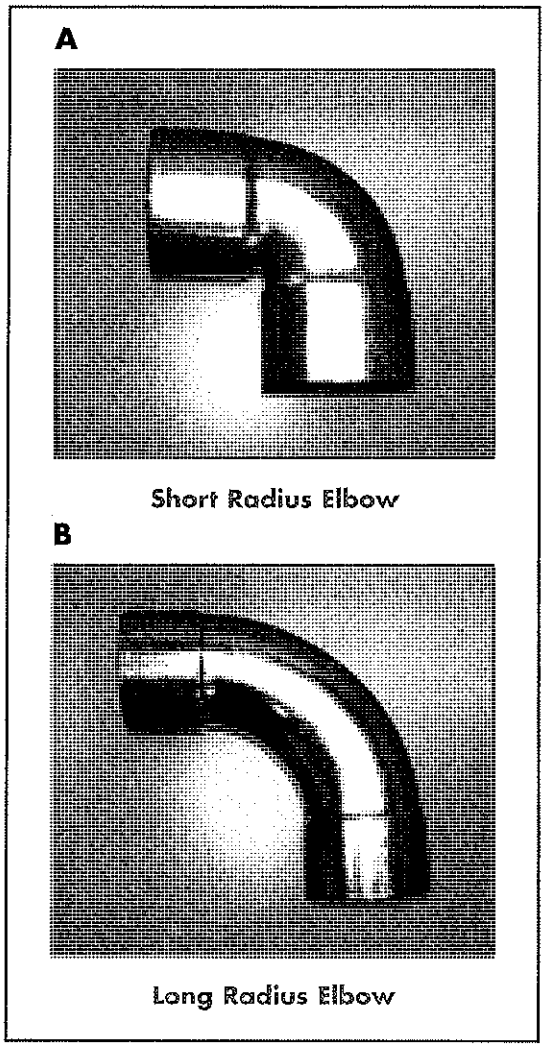


Wrot and cast copper 90° ells come in **SHORT RADIUS ELLS, INTERMEDIATE RADIUS ELLS** and **LONG RADIUS ELLS**. The long radius fittings are longer, making the change of direction with a gentler curve. Short and long radius ells also may be called "short turn" or "long turn" by your customers.

When a customer uses the word "ell" with-out any other description, he is probably referring to the short radius 90° ell – the most common ell.

Note that there are other wrot and cast copper fittings. Be sure to study your manufacturers' catalogs to become familiar with the copper fittings you stock. Review the dimension drawings to help you understand how to find the measurements that are important to your customers.

SHORT AND LONG RADIUS ELBOWS



PVF 3.1.21

REVIEW OF WROT AND CAST COPPER FITTINGS

Answers appear on page 65

1. Copper and copper alloy pressure fittings come as:
   a. Wrot only
   b. Wrot or cast

2. Wrot copper fittings are joined by:
   a. Brazing only
   b. Soldering or brazing

3. Cast copper fittings are made from:
   a. Copper alloy and formed in a mold
   b. Copper tube and formed into the desired shape

4. The abbreviation "C" stands for:
   a. Male solder end
   b. Female solder cup

5. The abbreviation "Ftg" stands for:
   a. Female solder cup
   b. Male solder end

6. Extended bushing is another name for:
   a. Fitting reducer
   b. Coupling with a stop

7. A coupling without a stop is called:
   a. Repair coupling or slip coupling
   b. Stop free coupling

8. Flush bushing can come with:
   a. C – female solder cup only
   b. C – female solder cup and F – female pipe threads

9. A crossover fitting:
   a. Allows one run of pipe to pass over another
   b. Has a socket at one end and threading at the other

REVIEW OF WROT AND CAST COPPER FITTINGS

Answers appear on page 65

10. Which of the following statements about an adapter is TRUE?
    a. Has only one combination of ends – one male and one female end
    b. Allows copper to be joined to a different material

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. Take a look at a wrot copper fitting and a cast copper fitting. Describe the differences that you see between these two fittings?

_____

_____

B. Does your company sell coupling with rolled tube stop or coupling with dimpled tube stop?

_____

_____

Cast Pressure and Copper DWV Fittings

Cast Pressure Fittings

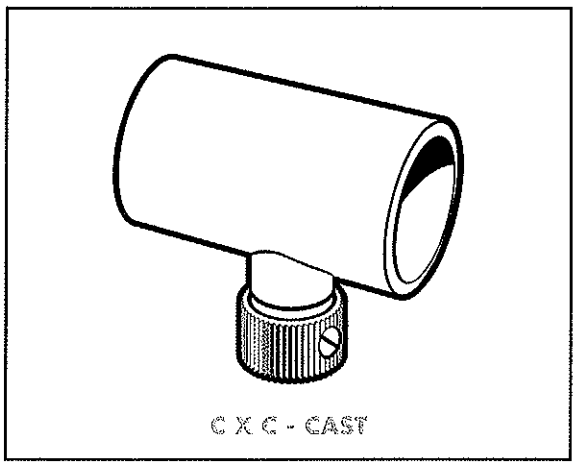
While many copper pressure fittings are available as wrot or cast, some are available as cast only. These fittings are formed in molds from copper alloys, including brass and bronze. The specifications for the alloys used are provided in manufacturers' catalogs.

Since there are many different types of pressure fittings that come as cast only, it is not possible to discuss all of them here. As a result, we will provide you with only some examples. Refer to manufacturers' catalogs to become familiar with all available cast fittings.

CAST COUPLINGS AND ADAPTERS

Many common threaded couplings are available in cast copper. The coupling pictured to the right is a drain coupling, which comes in cast, but not wrot form. A DRAIN COUPLING has a drain in the opening between the two copper tubes being joined. The drain has a threaded cap that may be loosened to permit the release of fluid or air.

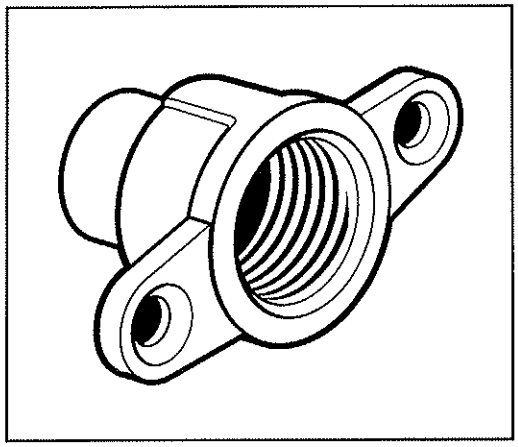
CAST DRAIN COUPLING



PVF 3.1.22

Some cast adapters are made especially to be attached to a wall or a stud. "High set" (sometimes spelled "hy-set") or **HIGH EAR ADAPTERS** have mounting lugs or "ears" above the fitting opening. An adapter with a lug on each side of the run opening is called a **DROP ADAPTER** or "sill cock adapter." Specifications for eared adapters list the size of the opening followed by the type of openings. The illustration to the right shows a 1" C x F drop adapter.

DROP ADAPTER

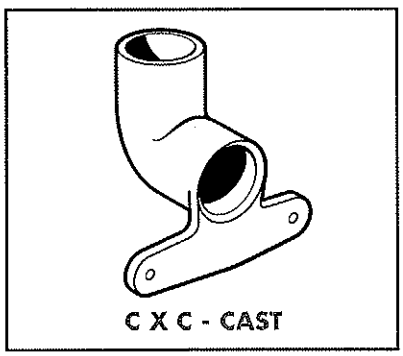


PVF 3.1.23

CAST ELBOWS

Cast copper pressure ells come in more styles than wrot ells. There are two types of mounting ells. The **DROP EAR ELBOW** has lug mounts behind the heel. The **HIGH SET ELBOW** has lug mounts at one of the openings. The ends of drop ells can have a solder cup or male or female pipe threads. Remember that if the sizes of the openings of any ell are different, both must be given in the specifications.

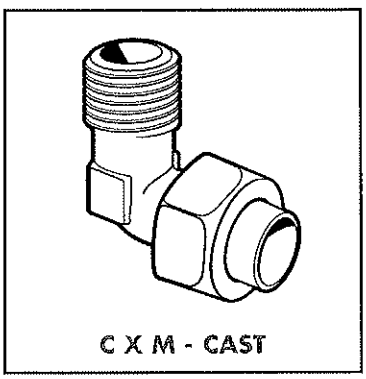
90° HY-SET ELBOW



PVF 3.1.24

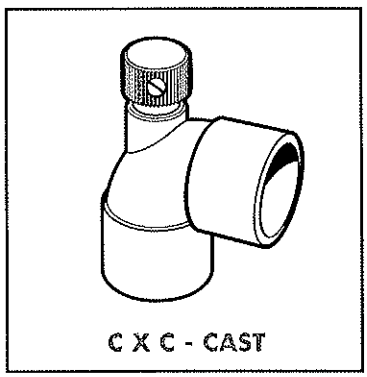
A **UNION ELL** has a union connection at one end. Union ells may have socket cup or threaded ends. A **VENT ELBOW** has an opening that allows the installation of a vent to let air or gas escape from the line.

UNION ELBOW



PVF 3.1.25 A

VENT ELBOW

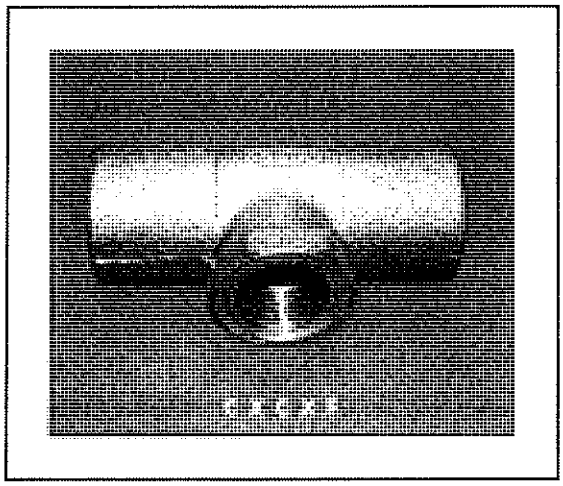


PVF 3.1.25 B

CAST TEES, CROSSES AND YS

Cast solder tees are available with all solder end openings or with one or more threaded openings, such as the 1/2" C x C x F tee shown to the right. Cast tees also come with mounts for securing the fitting to a wall or stud. An example of this type of tee would be a 1/2" C x C x C high set tee.

CAST SOLDER TEE

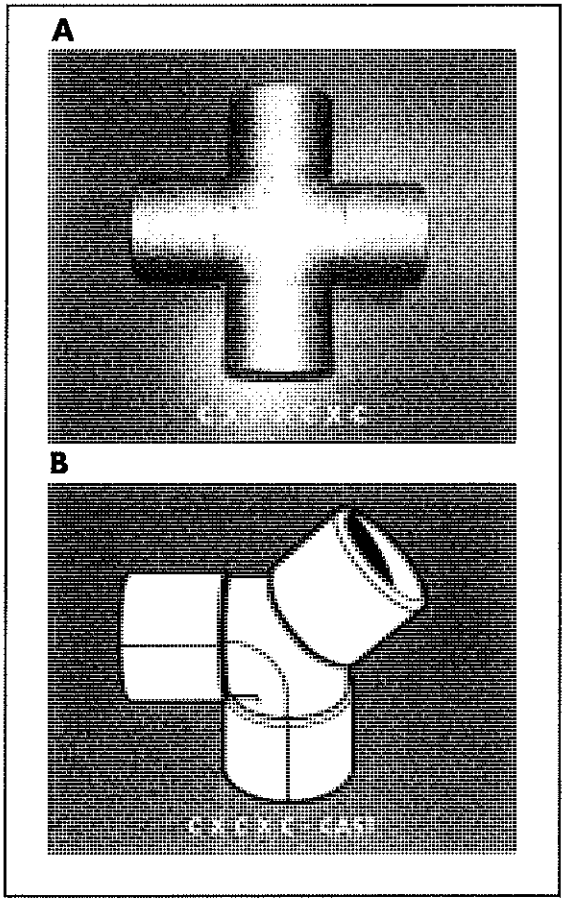


PVF 3.1.26

Other common cast fittings are crosses and cast Y fittings. There are two types of cast Y fittings: 45° and 90° Ys. The difference between 45° and 90° Ys is the degree of the angle between the paired ends. The bottom illustration B to the right shows 90° Y.

The use and joining methods determine which standards a fitting must meet. Standards for the manufacturing of cast fittings are set by several agencies including the **AMERICAN SOCIETY OF MECHANICAL ENGINEERS** (ASME), the **AMERICAN NATIONAL STANDARDS INSTITUTE** (ANSI), the **AMERICAN WATER WORKS ASSOCIATION** (AWWA), the **MANUFACTURERS' STANDARDIZATION SOCIETY** (MSS), and other government or industry organizations.

CROSS (A) AND 90°Y (B)



PVF 3.1.27

Copper DWV Fittings

There are two types of DWV fittings used with copper tube: cast bronze fittings and wrot copper fittings. **CAST DWV FITTINGS** used in copper DWV systems are made of cast bronze. After the fittings are cast, the joint sections are machined to provide the smooth connections required in DWV systems. **WROT DWV FITTINGS** are made by bending, enlarging or drawing branch openings out of existing copper tube.

As is true of all DWV fittings, cast and wrot copper DWV fittings are designed to allow smooth passage of the flow. The internal diameter (I.D.) at the end of any socket opening on a DWV fitting is slightly larger, so when the connection is made there will be no "bump" at the edge of the pipe inside the fitting. This design means that there will be a smooth flow of waste through the fitting.

Following are some examples of cast and wrot DWV fittings. Refer to the manufacturers' catalogs to become familiar with all available cast and wrot DWV fittings.

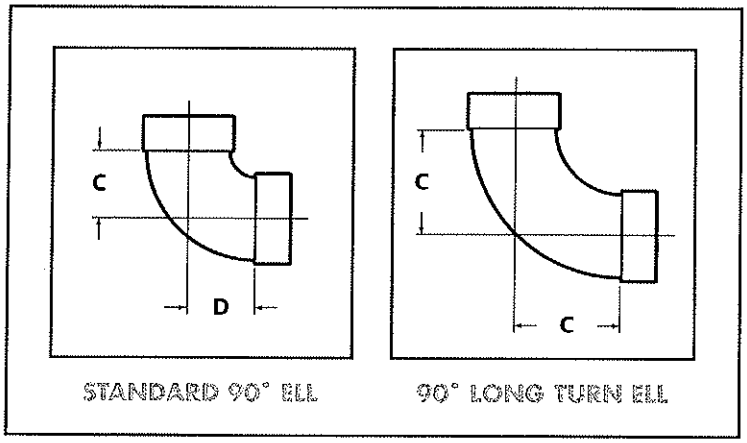
COPPER DWV ELBOWS

A major category of copper DWV fittings is elbows. These fittings are called "bends" in soil pipe systems. Copper DWV elbows are available in five angles:

- 90° elbow
- 60° elbow
- 45° elbow
- 22 1/2° elbow
- 11 1/4° elbow

Copper DWV elbows come in long turns (sometimes called "LONG RADIUS ELBOWS") and extra-long turns. Liquids passing through a 90° long turn ell take longer to change direction than liquids passing through a standard 90° ell. The length of that turn (called the "sweep" in soil pipe fittings) is even greater in an EXTRA-LONG TURN ELL.

STANDARD VS LONG TURN ELBOW



PVF 3.1.28

CLOSET ELBOWS, like cast iron closet bends, join the water closet to the main soil stack. Closet ells can be a solder cup type or slip type; they come in different lengths. There are also reducing closet ells and closet ells with tapped inlets that can be attached to the drain lines of the lavatory and bathtub.

COPPER DWV TEES, BUSHINGS, COUPLINGS AND ADAPTERS

Copper DWV tees come in many of the same styles as cast iron DWV tees, including fitting tees, trap tees and other standard tees with different types of ends. However, there is no special group of copper DWV vent tees. The same copper DWV tees are used for both drainage and vent applications.

Copper DWV bushings connect copper tube of one diameter to copper fittings of another diameter. A copper DWV bushing may be an extended bushing or flush bushing.

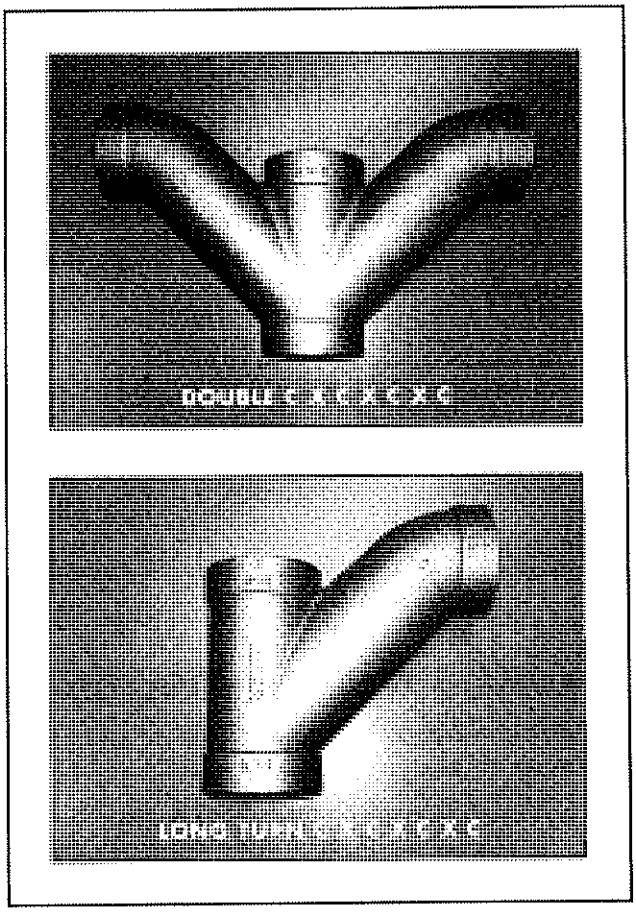
Couplings are not used to connect soil pipe, which has hub–and-spigot ends. But copper DWV couplings are used to join copper tube.

Copper adapters come in several styles. Some are used to connect copper tube to hub-and-spigot or no-hub soil pipe. Others connect copper tube to plastic or steel pipe and fittings.

COPPER DWV TYs

The **TY** (sometimes written as "Ty") copper fitting is a combination of a tee and a Y (wye) fitting. Some people think of it as a combination tee and bend — in soil pipe, this would be called a "combination 1/8 bend." The Y arm is gently curved to allow a smooth flow of waste. The TY also is available in long turn or double-long turn styles.

TYS



PVF 3.1.30

REVIEW OF CAST PRESSURE AND COPPER DWV FITTINGS

Answers appear on page 65

1. Some copper pressure fittings are available as cast only.
   a. True b. False

2. Drain couplings come as:
   a. Cast only b. Wrot only

3. A drop ear elbow has:
   a. Solder cup end only
   b. Solder cup or male or female pipe threads

4. DWV fittings come as:
   a. Cast bronze fittings and wrot copper fittings
   b. Cast brass fittings and wrot copper fittings

5. The internal diameter (I.D.) at the end of any socket opening on a DWV fitting is slightly larger so:
   a. When the connection is made there is a smooth flow of waste through the fitting
   b. It is easy to make the connection

6. Copper DWV elbows are available as:
   a. Long and extra-long radius elbows
   b. Short radius, long and extra-long radius elbows

7. Extra-long turn ell has:
   a. The same sweep as the long turn elbow
   b. Greater sweep than long turn elbow

REVIEW OF CAST PRESSURE AND COPPER DWV FITTINGS

Answers appear on page 65

8. Copper DWV elbows are available as:
   a. Drainage applications only
   b. Drainage and vent applications

9. TY copper fittings are available in:
   a. Long turn or short turn styles
   b. Long turn or double-long turn styles

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. What copper pressure fittings does your company offer in cast form only?

_____

_____

B. What is the major customer group for the copper DWV fittings that your company carries?

_____

_____

Copper Tube Joining Methods

In order to educate customers, it is important for industry professionals to know about existing and new copper tube joining methods.

Copper tube can be joined by several methods. For this reason, copper fittings come in a variety of end types. SOLDERING and BRAZING, the two methods that involve heat, are the most popular ways of joining copper tube. A mechanical joining method offers a practical alternative to soldering and brazing. This method uses joints, compression fittings, copper pressed fittings and copper push fittings. However, there are additional joining methods that might involve t-drill, epoxy bonded, threaded, or push-to-connect and roll-grooved joints.

Soldered Joints (Soldering Copper Tube)

Soldering is a process that joins base metals using a filler metal (solder) that melts at a lower temperature than the base metals (below 840°F). Most soldering is done with solders that melt at temperatures ranging from approximately 350°F to 600°F.

A suitable FLUX, a substance used to promote fusion, must be used when making a solder joint (step 7 below). Flux acts as a cleaning and wetting agent, and when properly applied, it permits uniform spreading of the molten solder over the surfaces to be joined.

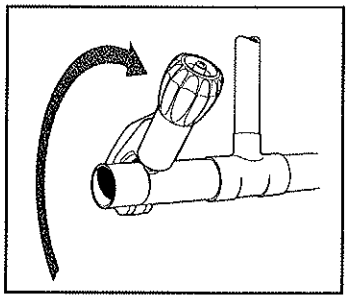
To make satisfactory joints, the following sequence of joint preparation and operation, based on ASTM standards should be followed:

1. Measuring and cutting
2. Reaming and/or deburring
3. Cleaning
4. Fluxing
5. Assembly and support
6. Heating
7. Applying the solder
8. Cooling and cleaning.

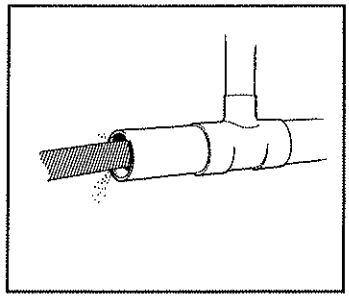
This process produces leak-tight soldered joints between copper and copper alloy tube and fittings. The soldering process is illustrated in more details on the next page.

SOLDERING PROCESS

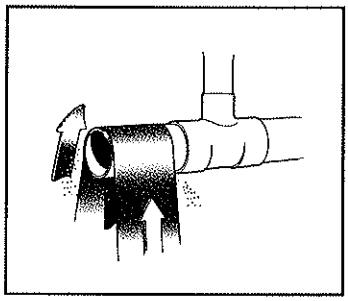
Step 1
CUTTING



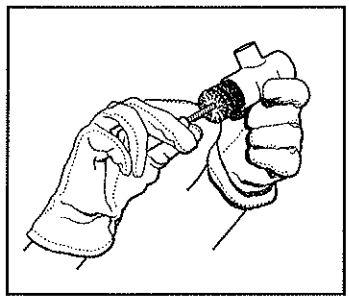
Step 2
REAMING



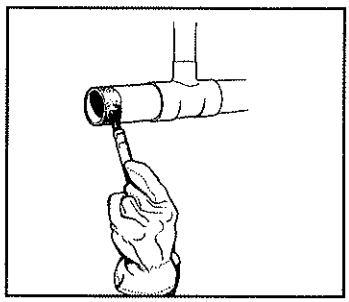
Step 3
CLEANING: SAND CLOTH



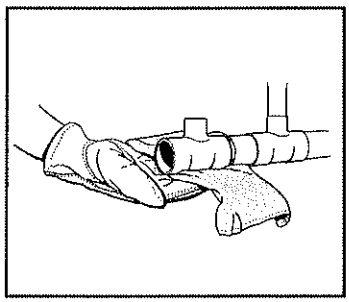
Step 4
CLEANING: FITTING BRUSH



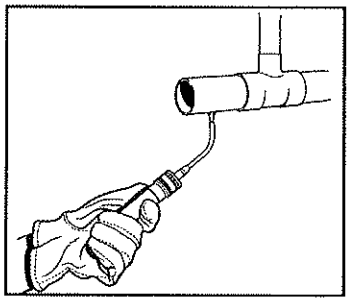
Step 5
FLUXING: TUBE



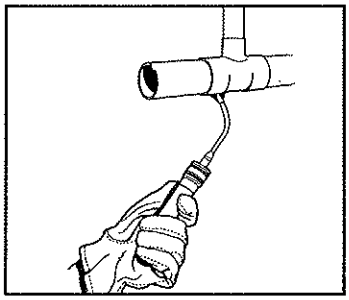
Step 6
REMOVING EXCESS FLUX



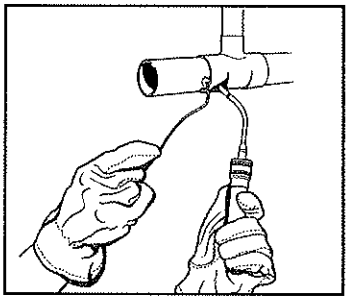
Step 7
PRE-HEATING TUBE



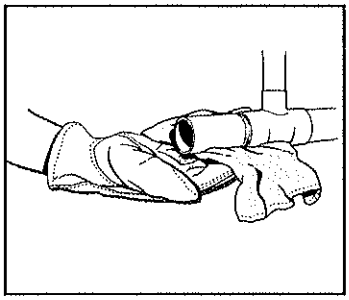
Step 8
PRE-HEATING FITTING



Step 9
SOLDERING



Step 10
CLEANING



PVF 3.1.31

When joining copper tube to valves with solder cups, the same soldering procedure should be followed. However, it is generally recommended that valves be soldered in a slightly open position. This prevents the dangerous buildup of steam or vapors in the valve, damage to the valve seats and permanently soldering the valve closed. To achieve a slightly open position, the valve should be closed completely and then opened slightly prior to soldering. Following soldering, the valve should be tested to ensure that it is in proper working condition.

Soldered joints with capillary fittings are used in plumbing applications for water lines and for sanitary drainage.

Brazed Joints (Brazing Copper Tube)

Brazing is another joining process for connecting copper tube and fittings. It involves filler metals that melt above 840°F at temperatures between 1,100°F and 1,550°F. This range is much higher than the temperatures used for solders that were covered in the previous section.

The temperature at which a filler metal starts to melt on heating is the **SOLIDUS TEMPERATURE**. The **LIQUIDUS TEMPERATURE** is the higher temperature at which the filler metal is completely melted. The liquidus temperature is the minimum temperature at which brazing will take place. The difference between solidus and liquidus is the pasty or working melting range. It may be of importance when selecting a filler metal.

To make satisfactory joints, the following procedure should be used (the same as that for making soldered joints):

1. Measuring and cutting
2. Reaming
3. Cleaning
4. Fluxing
5. Assembly and support
6. Heating
7. Applying the brazing allo
8. Cooling and cleaning
9. Troubleshooting and testing.

Brazed joints with capillary fittings are used where greater joint strength is required or where service temperatures are as high as 350°F. Brazing is preferred, and often required, for joints in refrigeration piping. Brazing is also required for medical gas piping systems.

Mechanical Joints (Mechanical Joining Method)

In some cases, mechanical joining offers practical alternatives to soldering and brazing large-diameter tube, as well as providing easier or flame-free installation of smaller-diameter tube.

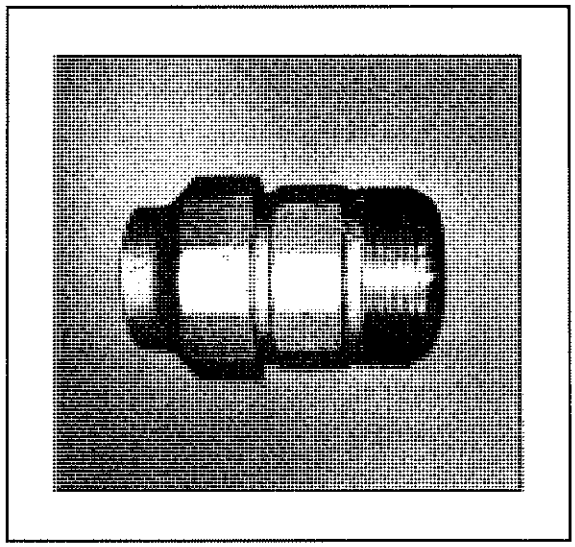
One such method to ease the installation of larger-diameter applications is roll-grooved systems. These are specifically available for copper tube in sizes from 2 inches through 6 inches. Included are couplings, grooved copper 45° and 90° degree elbows, straight tees and grooved flange adapters.

OTHER COMMON MECHANICAL JOINING METHODS INCLUDE:

- Flared fittings
- Compression fittings
- Copper press fittings
- Copper push-fit fittings.

FLARED FITTINGS are made of cast brass or bronze. They are commonly used to join soft temper copper tubing in underground service pipes or where pipes must be cleaned often. The machined end of the flared fitting and the collar are then tightened onto the fitting. This ensures a tight joint between the tube and the fitting.

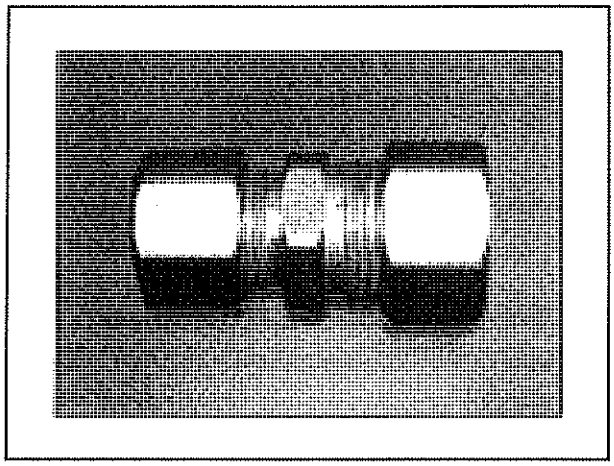
FLARED FITTING



PVF 3.1.32

COMPRESSION FITTINGS consist of two or more pipe hubs. Compression fittings are most frequently used as conversion fittings under fixtures where they join rigid supply lines to flexible copper supply tubes.

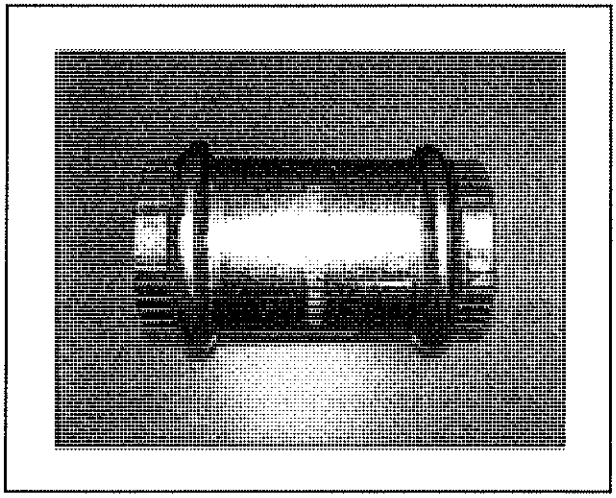
COMPRESSION FITTING



PVF 3.1.33

COPPER PRESS FITTINGS are used in the joining method called copper press system. The press connect copper fittings look like normal copper fittings. The only difference is the little hump located in the socket of each joint. Inside the fitting is an o-ring. The location of the hump in the socket is different among the various manufacturers.

COPPER PRESS FITTING



PVF 3.1.34

The press connect joining method includes the following steps:

- Cut and ream (deburr) the copper tubing
- Inspect tube for outside diameter scratches that could cause the o-ring to leak
- Insert pipe completely into the socket of the press fitting
- Place the press tool over the humped area of the joint and pull the trigger.

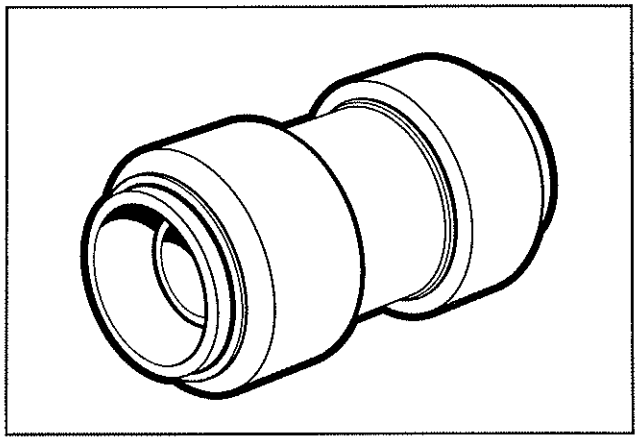
The tool applies about 2,000 pounds of pressure to the fitting when joining the pipe and fitting. There is no cleaning of the copper, no flux and no soldering.

The manufacturers have tested these joints to 800 psi, which is 10 times higher than the maximum pressure anticipated for a copper tubing system.

The potential advantage of the copper pressed fitting system is the speed of installation (includes only the clamp time, not the preparation time), which may be faster than joining with a solder system. Also, this type of installation can be handled by less-experienced installers.

COPPER PUSH-FIT FITTINGS are used in the joining method called copper push-fit or push to connect systems. The push connect copper fittings look like adaptations of the normal copper or cast copper alloy fittings. The only difference are mechanical sealing devices (lock rings and gaskets/o-rings) located in the socket of each joint. These systems are designed to allow joining of the copper tube to the fitting without the use of any tools. Depending on the manufacturer, these joints can be either removable or non-removable.

COPPER PUSH-FIT FITTING



PVF 3.1.35

THE PROPER METHOD FOR INSTALLING THESE JOINTS IS:

- Cut and ream the copper tubing
- Chamfer the O.D. of the tube end to prevent damage to the o-ring/gasket
- Mark the end of the tubing to indicate the proper depth of insertion
- Place the tube in the fitting and push until the mark is located at the face of the fitting cup (indicating full insertion into the fitting).

Additional Joining Methods

In addition to gas-fueled torches for soldering and brazing, **ELECTRIC RESISTANCE HAND TOOLS** may be used for joining copper tube and fittings.

There are several additional joining methods, including:

- **T-DRILL JOINING METHOD** involves a hand tool designed to quickly pull tee connections and outlets from the run of the tube. This reduces the number of tee fittings and brazed joints. The resulting branch outlet joint must be brazed.

- **EPOXY BONDED JOINTS** are a relatively recent development (some are NSF approved and some are not). A two-part, fast-curing, epoxy-based adhesive is used to join copper tube and capillary fittings for water distribution systems. It also may be used in copper fire sprinkler systems (excluding dry systems), or installations where an open flame may not be appropriate.

- **THREADED JOINTS** have both the external and internal NPT threads. These joints are used to adapt copper tube to equipment that has threads or to add copper tube to existing iron pipe installations or to other threaded connections.

REVIEW OF COPPER TUBE JOINING METHODS

Answers appear on page 66

1. What are the joining methods that require heat?
   a. Soldering and brazing
   b. Soldering and pressing

2. Flared joints are an example of:
   a. Brazing
   b. Mechanical joining method

3. A flux is a:
   a. Substance used to promote fusion
   b. Substance that would be used during the cooling and cleaning stage

4. Brazing requires:
   a. More heat than soldering
   b. Less heat than soldering

5. The joining method that is required for medical gas piping systems is:
   a. Soldering
   b. Brazing

6. Mechanical joining method:
   a. Is another name for soldering
   b. Offers practical alternatives to soldering and brazing large-diameter tube and easier or flame-free installations of smaller-diameter tube

7. Which fittings are commonly used to join soft temper copper tubing in underground service pipes or where pipes must be cleaned often?
   a. Flared fittings
   b. Compression fittings

8. Copper press fittings:
   a. Require cleaning of copper and flux
   b. Can be handled by less-experienced installers

REVIEW OF COPPER TUBE JOINING METHODS

Answers appear on page 66

9. T-drill joining method involves:
   a. Hand tool designed to quickly pull tee connections and outlets from the run of the tube
   b. Epoxy-based adhesive

10. Epoxy bonded joints:
   a. Are used to adapt copper tube to equipment that has threads
   b. May be used in copper fire sprinkler systems

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. What copper tube joining method seems to be most often used by your customers?

_____

_____

B. What are the newest copper fittings that your company carries?

_____

_____

ANSWERS TO REVIEW QUESTIONS

CHAPTER 1

COPPER TUBE AND FITTINGS

Answers for REVIEW OF COPPER TUBE AND PIPE (pages 10 - 12)

1. b. Plumbing, heating, cooling, refrigeration and industrial applications
2. a. Resistance to corrosion and scaling reduce maintenance costs and increase customer satisfaction
3. b. Transportation and installation costs are lower due to copper's light weight and bendability
4. a. Copper will not burn and produce toxic gases in a fire
5. b. Pure copper tube, bronze and brass
6. a. Adding zinc to copper
7. a. They have different wall thickness – copper pipe is heavy wall and can be threaded while copper tube is thin wall and is not meant to be threaded
8. b. It decreases the strength and pressure rating of the tube
9. b. Types K, L, M and DWV
10. a. Type K
11. b. Drawn (hard) and annealed (soft)
12. b. Small coils have lower shipping and handling costs

Applying what you have learned:

A. Discuss

B. Discuss

Answers for REVIEW OF TYPES AND USES OF COPPER TUBE (pages 23 - 24)

1. a. A category that encompasses copper water tube, DWV tube, medical gas tube and fuel gas tube
2. a. Types K, L and M
3. b. Required for the identification of copper water tube of drawn (hard) temper
4. a. Copper drainage or DWV tube
5. b. Medical gas tube
6. a. Produced in the same wall thickness as Type L
7. a. Requires special internal cleanliness, dehydration requirements, capping and sealing the ends

8. b. Higher pressure or specialized systems where heavier wall thicknesses are required
9. a. Has a thicker wall than threadless copper pipe and can be threaded
10. b. Water supply and distribution
11. a. Has plastic coating on the outside that provides corrosion protection for buried installation in areas with acidic soil conditions

Applying what you have learned:

A. Discuss

B. Discuss

Answers for REVIEW OF COPPER TUBE'S SPECIFICATIONS (pages 31 - 32)

1. b. Certification that documents the tube's compliance with certain requirements of the U.S. Safe Drinking Water Act
2. a. Incised to show the tube type and name or trademark of the manufacturer
3. b. 1/8 inch larger than the nominal (standard) size
4. b. Brazed joints
5. b. Are frequently used for underground tubing
6. a. Both straight lengths and coils
7. a. Type L or M for all sizes
8. b. Tube type should be determined by the rated internal working pressures at room temperature
9. a. Type L or M for all sizes
10. b. Cannot be selected without referring to the local codes that determine which tube is required

Applying what you have learned:

A. Discuss

B. Discuss

Answers for REVIEW OF WROT AND CAST COPPER FITTINGS (pages 41 - 42)

1. b. Wrot or cast
2. b. Soldering or brazing
3. a. Copper alloy and formed in a mold
4. b. Female solder cup
5. b. Male solder end
6. a. Fitting reducer
7. a. Repair coupling or slip coupling
8. b. C – female solder cup and F – female pipe threads
9. a. Allows one run of pipe to pass over another
10. b. Allows copper to be joined to a different material

Applying what you have learned:

A. Discuss

B. Discuss

Answers for REVIEW OF CAST PRESSURE AND COPPER DWV FITTINGS (pages 49 - 50)

1. a. True
2. a. Cast only
3. b. Solder cup or male or female pipe threads
4. a. Cast bronze fittings and wrot copper fittings
5. a. When the connection is made there is a smooth flow of waste through the fitting
6. a. Long and extra-long radius elbows
7. b. Greater sweep than long turn elbow
8. b. Drainage and vent applications
9. b. Long turn or double-long turn styles

Applying what you have learned:

A. Discuss

B. Discuss

Answers for REVIEW OF COPPER TUBE JOINING METHODS (pages 58 - 59)

1. a. Soldering and brazing
2. b. Mechanical joining method
3. a. Substance used to promote fusion
4. a. More heat than soldering
5. b. Brazing
6. b. Offers practical alternatives to soldering and brazing large-diameter tube and easier or flame-free installations of smaller-diameter tube
7. a. Flared fittings
8. b. Can be handled by less-experienced installers
9. a. Hand tool designed to quickly pull tee connections and outlets from the run of the tube
10. b. May be used in copper fire sprinkler systems

Applying what you have learned:

A. Discuss

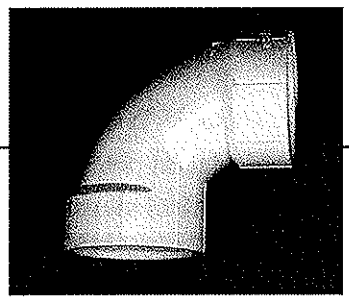
B. Discuss

2 PLASTIC PIPE AND FITTINGS

LEARNING OBJECTIVES

After completing this chapter, you will be able to:

1. Discuss the advantages and characteristics of plastic pipe and tube.
2. Describe the materials and process used in manufacturing plastic pipe and tube.
3. Explain plastic pipe O.D.- and I.D.-controlled systems and standards.
4. Explain the major types and uses of plastic pipe and tube.
5. Discuss applications and general recommendations for different types of plastic pipe and tube.
6. Describe different types of plastic fittings and their uses.
7. Explain different plastic pipe and tube joining methods.



Plastic Pipe

Much of today's plastic pipe was developed in the years leading up to and during World War II. Some of the plastic pipe was introduced into piping systems as early as the 1930s. In the United States, plastic piping systems began obtaining wide acceptance in the late 1950s and early 1960s. Since then, plastic pipe usage has increased at an incredible rate.

At the present time, plastic pipe is used for residential, commercial and industrial piping applications.

Plastic pipe is mainly used for water mains; hot and cold water distribution; drain, waste, vent (DWV); sewer; gas distribution; irrigation; conduit; fire sprinkler; and process piping systems. Underground piping systems makes up the largest part of the market.

Advantages of plastic pipe

The main advantages of using plastic pipe are:

- **CORROSION RESISTANCE** – Plastic pipe is corrosion resistant, which means it can be buried in typical acidic, alkaline, wet or dry soils. Protective coatings are not required.
- **CHEMICAL RESISTANCE** – The variety of materials available allows a wide range of chemical solutions to be handled successfully by plastic piping.
- **LOW THERMAL CONDUCTIVITY** – Low thermal conductivity of the wall of plastic piping may eliminate or greatly reduce the need for pipe insulation to control sweating.
- **FLEXIBILITY** – In general, plastic piping is more flexible than metal piping. This allows for more efficient installation techniques.
- **LOW FRICTION LOSS** – Because the interior surface of plastic pipe is generally very smooth, less power may be required to transmit fluids in plastic pipe.
- **LONG-TERM PERFORMANCE** – Due to the minimal effects of chemicals that naturally exist in nature, there is very little change in the physical characteristics of plastic pipe over years.
- **LIGHT WEIGHT** – Most plastic piping systems are 1/6 the weight of steel piping, which often allows for some unique, cost-saving installation procedures.

- VARIETY OF JOINING METHODS – Plastic pipe can be joined by various methods, allowing plastic pipe to be adapted easily to most field conditions.
- LOW MAINTENANCE – Plastic pipe systems require very little maintenance because there is no rusting, pitting or scaling.

Manufacture of plastic pipe

CHEMICAL BACKGROUND OF PLASTIC

Plastic is made up of a RESIN OR POLYMER together with other additives. The resin or polymer gives plastic its main characteristics and usually its name. Manufacturers add pigments, stabilizers, lubricants, etc., prior to processing.

There are two basic types of plastic:

- THERMOPLASTICS – Plastics can be repeatedly softened and remolded by heat and pressure. Most of the common plastic piping material for plumbing applications is thermoplastic, including ABS, CPVC, PE, PVC, Polypropylene and Nylon that will be discussed later in the chapter. They are formed using a combination of heat and pressure.
- THERMOSETS – Plastics cannot be resoftened after being subjected to heat and pressure. Some of the common thermoset materials that are used to make pipe and fittings include PEX and PVDF. PEX is unique, because it starts as a thermoplastic but becomes a thermoset after being made into a pipe.

MANUFACTURING PROCESS FOR PLASTIC

Plastics are available in the form of bars, tubes, sheets, coils and blocks that can be fabricated to specification. However plastic products are commonly manufactured from plastic powders using following processes:

- COMPRESSION MOLDING
- TRANSFER MOLDING
- INJECTION MOLDING
- EXTRUSION MOLDING.

In **COMPRESSION MOLDING** materials are placed immediately into mold cavities, where the application of heat and pressure first makes them plastic and then hardens them.

In **TRANSFER MOLDING** the compound is plasticized by outside heating and then poured into a mold where it is cooled and allowed to harden. This process is used for designs with complex shapes and great variations in wall thickness.

INJECTION MOLDING is the most common method of producing plastic fittings. The plastic powder is melted in a crew-type chamber by the combination of heat and friction. Then a plunger action forces it into cold molds, where the product cools and is ejected in a rigid shape. The operations take place at rigidly controlled temperatures and intervals.

EXTRUSION MOLDING is the most common method of plastic pipe manufacture. It employs heating, a screw cylinder, pressure and an extrusion die through which the molten plastic is sent. It then exits in continuous form to be cut in lengths or coiled.

Pipe Sizing Systems

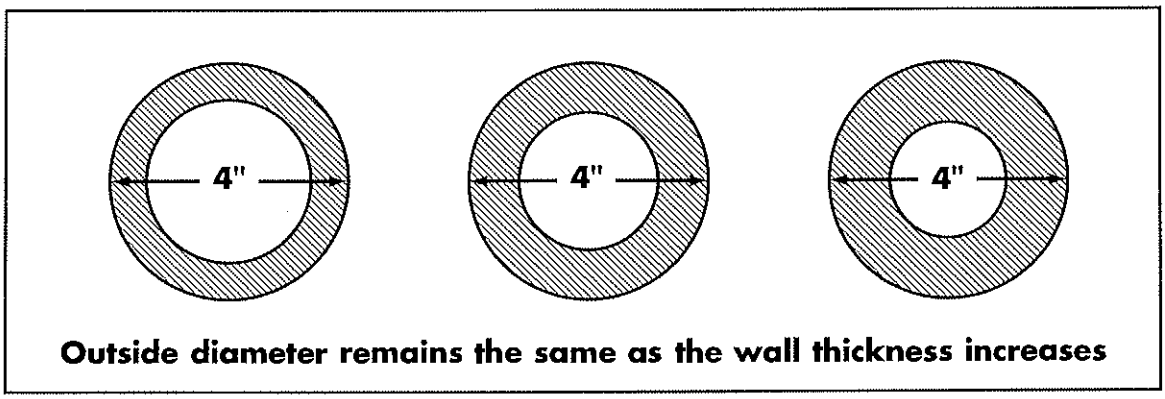
Manufacturers of plastic pipe have adopted many of the same terms as metal pipe to identify the nominal sizes, and also have developed some of their own. The plastic pipe size systems can be divided into two categories:

- O.D. – Outside Diameter controlled
- I.D. – Inside Diameter controlled.

O.D. – OUTSIDE DIAMETER CONTROLLED

In an O.D.-controlled system, couplings or sockets join to the outer surface of the pipe. For O.D.-controlled pipe or tube, a standard outside diameter is established for each nominal pipe size regardless of pressure ratings. Therefore, any wall thickness changes needed for different pressure ratings will affect the inside diameter.

O.D.-CONTROLLED SYSTEM



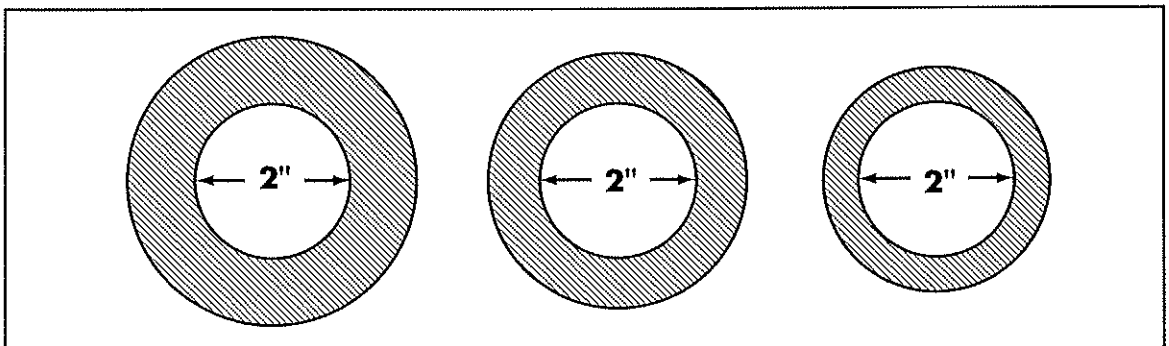
Outside diameter remains the same as the wall thickness increases

PVF 3.2.1

I.D. – INSIDE DIAMETER CONTROLLED

For I.D.-controlled pipe or tube, a standard inside diameter for each nominal size is established and the wall thickness affects the outside diameter. The I.D.-controlled pipe or tube uses insert fittings. These fittings are inserted into the tube. The fittings' barbed outside diameter grabs the inside diameter of the tube. Final sealing is made by compressing a gear-type clamp over the tubing at the point of the barbs. Insert fittings also can transition from tube to a threaded connection by way of barb/thread/spigot combinations.

I.D.-CONTROLLED SYSTEM



Inside diameter remains the same as the wall thickness increases

PVF 3.2.2

Plastic Pipe Standards

Most of the ASTM standards for plastic pipe are based on:

- IPS (Iron Pipe Size) outside diameter-controlled system (O.D.)
- CTS (Copper Tube Size) outside diameter-controlled system (O.D.)
- Sewer pipe size outside diameter-controlled system (O.D.)
- Pipe or tube inside diameter-controlled (I.D.) system
- CI (AWWA C900) outside diameter-controlled system (O.D.).

IPS (IRON PIPE SIZE) O.D. SYSTEM

IPS is an O.D. (outside diameter) controlled dimensioning system developed by the steel pipe industry. Pipe is designated by its "nominal size," which is roughly the pipe I.D. (inside diameter). Iron Pipe Size O.D. plastic pipe is made with both "Schedule" and Standard Dimension Ratio or "SDR" (defined below) wall thicknesses.

IPS O.D. PLASTIC PIPE is available in:

- **SDR** wall thicknesses
- **SCHEDULE** wall thicknesses.

IPS O.D. PLASTIC PIPE – SDR WALL THICKNESSES

However, in the SDR system defined below, all sizes within the same SDR as expressed by SDR and a number carry the same pressure rating. With SDR systems, the lower the SDR number the higher the pressure rating. SDR systems are commonly used in irrigation and waterworks.

In order to provide pipe with an equal pressure rating over the whole range of sizes, the plastic pipe industry developed the **STANDARD DIMENSION RATIO (SDR) SYSTEM** that sizes plastic pipe according to pressure ratings. The SDR, sometimes called the DR, is defined as the ratio of the wall thickness to the controlled diameter, either I.D. or O.D.

SDR=O.D./WALL THICKNESS or **SDR=I.D./WALL THICKNESS**

Therefore, for a given SDR the pressure rating for all diameters is the same, provided the material is the same, so the relative strength is consistent at any given O.D. In the SDR system the pressure ratings increase in 25 percent increments. So, in the example below, the next higher pressure rating after 160 psi is 200 psi (160 x 1.25 = 200)

SDR RATIO INCREASE

ASTM SDR AND PRESSURE RATINGS FOR PVC 1120, 1220 & 2120 PLASTIC PIPE	
SDR	Pressure Rating
26	160 psi
21	200 psi
17	250 psi
13.5	315 psi

PVF 3.2.3

IPS O.D. PLASTIC PIPE – PIPE SCHEDULE WALL THICKNESSES

IPS (IRON PIPE SIZE) O.D. plastic pipe is also available in pipe Schedule thicknesses. It is identified as SCHEDULE 40 (thinnest walls, called STANDARD PIPE), SCHEDULE 80 (called EXTRA STRONG), or SCHEDULE 120 (thickest walls, referred to as DOUBLE EXTRA STRONG.) These pipe Schedules based on wall thickness allow for different pressure ratings per size of pipe. For example, 2" Schedule 80 pipe will have a higher pressure rating than Schedule 40 pipe. In addition, smaller-diameter pipe will have higher pressure ratings than larger-diameter pipe in the same Schedule. As an example, 2" Schedule 80 pipe will have a pressure rating of 280 psi while 6" Schedule 80 pipe will have a pressure rating of 180 psi. Schedule pipe is commonly used in plumbing and industrial applications where a specific mechanical strength is desired.

Schedule 40 plastic pipe is generally too thin to be threaded. In Schedule 80 and Schedule 120 pipe, the inside diameter decreases as the walls get thicker and the outside diameter stays the same so a standard size fitting can be used for all three wall thicknesses.

Looking at the dimensions in Schedule 40 and Schedule 80 for PVC pipe you will see that the outside diameter (O.D.) for any given nominal pipe size is the same for both Schedule 40 and Schedule 80 pipe. For example, both a 1" Schedule 40 and a 1" Schedule 80 pipe have identical outside diameters, whereas the Schedule 40 inside diameter is 1.029 compared to the Schedule 80's 0.936 inside diameter.

SCHEDULE 40 PIPE DIMENSIONS

Nominal Size	Average Outside Diameter Inches	Average Inside Diameter Inches	Wall Thickness Inches		Pipe Wall Cross-Sectional Area Inches^2	Inside Diameter Area Inches^2
			Nom.	Min.		
1/2	0.840	0.602	0.119	0.109	0.270	0.285
3/4	1.050	0.804	0.123	0.113	0.358	0.508
1	1.315	1.029	0.143	0.133	0.527	0.832
1 1/4	1.660	1.360	0.150	0.140	0.712	1.453
1 1/2	1.900	1.590	0.155	0.145	0.850	1.986
2	2.375	2.047	0.164	0.154	1.139	3.291
2 1/2	2.875	2.445	0.215	0.203	1.797	4.695
3	3.500	3.042	0.229	0.216	2.353	7.268
4	4.500	3.998	0.251	0.237	3.351	12.554
6	6.625	6.031	0.297	0.280	5.904	28.567
8	8.625	7.942	0.341	0.322	8.887	49.539
10	10.750	9.976	0.387	0.365	12.599	78.164
12	12.750	11.889	0.430	0.406	16.662	111.015

** Do not thread Schedule 40 pipe. Use appropriate fittings for threaded assembly.*

PVF 3.2.4

SCHEDULE 80 PIPE DIMENSIONS

Nominal Size	Average Outside Diameter Inches	Average Inside Diameter Inches	Wall Thickness Inches		Pipe Wall Cross-Sectional Area Inches
			Nom.	Min.	
1/4	0.540	0.282	0.129	0.119	0.167
1/2	0.840	0.526	0.157	0.147	0.337
3/4	1.050	0.722	0.164	0.154	0.457
1	1.315	0.936	0.189	0.179	0.670
1 1/4	1.660	1.255	0.202	0.191	0.927
1 1/2	1.900	1.476	0.212	0.200	1.124
2	2.375	1.913	0.231	0.218	1.556
2 1/2	2.875	2.290	0.292	0.276	2.373
3	3.500	2.864	0.318	0.300	3.179
4	4.500	3.786	0.357	0.337	4.647
6	6.625	5.709	0.458	0.432	8.873
8	8.625	7.565	0.530	0.500	13.479
10	10.750	9.493	0.628	0.593	19.985
12	12.750	11.294	0.728	0.687	27.495

PVF 3.2.5

Plastic pipe is made to IPS dimensions by many manufacturers. The most widespread types are made from ABS, CPVC, PE and PVC, although manufacturers generally do not make all of these types of plastic pipe. Therefore, it is important to check the catalogs carefully.

CTS (COPPER TUBE SIZE) O.D. SYSTEM

The CTS (Copper Tube Size) system is a measuring system for plastic tube. It is an O.D.-controlled dimensioning system developed by the copper tube industry. The tubes are designated by "nominal size" and the true O.D. is the nominal size plus 1/8 inch. As an example, a 1/2 inch CTS pipe would have a 5/8 inch outside diameter (1/2 + 1/8 = 5/8). Various SDR wall thicknesses are available, which changes the I.D. SDR refers to standard dimension ratio.

SEWER PIPE SIZE O.D. SYSTEM

Sewer Pipe Size is an O.D.-controlled dimensioning system developed by the plastic pipe industry for use in sewers in a number of applications. Pipe is designated by its "nominal size" (approximate I.D.). Several SDR- or DR-controlled wall thicknesses are available. The SDR or DR refers to the actual mathematical ratio of the outside diameter to the wall thicknesses. Therefore, the pipe with the smaller diameter in relation to its wall thickness will have the lower SDR number and greater strength, as illustrated below.

EXAMPLES OF SEWER WALL THICKNESS AVAILABLE

SDR 41	Thinnest
SDR 35	Standard, most commonly found
SDR 26	Heavier
SDR 23.5	Uncommon, but available and thickest

PVF 3.2.53

PIPE OR TUBE I.D. SYSTEM

Some plastic pipe and tube use a dimensioning system in which I.D., rather than O.D., is controlled. In these systems, the O.D. increases or decreases while the I.D. stays the same. In I.D.-controlled systems, when the wall thickness increases, the O.D. will increase and when the wall thickness decreases, the O.D. will decrease. Controlling the I.D. permits the use of insert fittings. All I.D.-controlled products use an SDR or DR wall thickness concept based on the ratio of the **I.D. (NOT THE O.D.)** to the wall thickness.

All of the ASTM products standards based on I.D.-controlled pipe or tube include (SIDR-PR) in the title. The system was developed for use with insert fittings.

AWWA STANDARDS

In addition to the ASTM standards, there are American Water Works Association (AWWA) standards for both PVC and PE types of plastic pipe. Use of AWWA standards is voluntary and is intended to represent a consensus of the water supply industry that the product described will provide satisfactory service.

REVIEW OF PLASTIC PIPE

Answers appear on page 121

1. Plastic pipe is mainly used for:
   a. Drain, waste and vent only
   b. Water mains; hot and cold water distribution; drain, waste, vent (DWV); sewer; gas distribution; irrigation; conduit; fire sprinkler; and process piping

2. Which of the following is an advantage of using plastic pipe?
   a. Plastic pipe is universal, therefore the same plastic pipe can be used for water distribution and DWV systems, regardless of the type
   b. Plastic pipe is corrosion resistant, therefore it can be buried in typical acidic, alkaline, wet or dry soils

3. Thermoplastics:
   a. Is a type of plastic that can be repeatedly softened and remolded by heat and pressure
   b. Is a type of plastic that cannot be resoftened after being subjected to heat and pressure

4. Injection-molding is:
   a. A process that is used for designs with complex shapes and great variations in wall thickness
   b. The most common method of producing plastic fittings

5. Extrusion molding is:
   a. The most common method of plastic pipe manufacturers
   b. The most common method of producing plastic fittings

6. In an O.D.-controlled system:
   a. Wall thickness changes needed for different pressure ratings will affect the inside diameter
   b. Wall thickness changes needed for different pressure ratings will affect the outside diameter

REVIEW OF PLASTIC PIPE

Answers appear on page 121

7. In an I.D.-controlled system:
   a. Wall thickness changes needed for different pressure ratings will affect the inside diameter
   b. Wall thickness changes needed for different pressure ratings will affect the outside diameter

8. IPS, one of the ASTM standards, is an:
   a. I.D.-controlled system
   b. O.D.-controlled system

9. IPS is available:
   a. In Schedule wall thickness only
   b. In both SDR and Schedule wall thicknesses

10. 2″ Schedule 80 plastic pipe will have:
    a. Higher pressure ratings than Schedule 40 pipe
    b. Lower pressure ratings than Schedule 40 pipe

11. Within the same pipe Schedule, smaller-diameter plastic pipe will have:
    a. The same pressure ratings as larger-diameter plastic pipe
    b. Higher pressure ratings than larger-diameter plastic pipe

12. Insert fittings are used with:
    a. O.D.-controlled systems
    b. I.D.-controlled systems

13. CTS is an O.D.-controlled system for:
    a. Plastic tube
    b. Plastic pipe

14. In an I.D.-controlled system, when the wall thickness increases, the O.D. will:
    a. Increase
    b. Decrease

REVIEW OF PLASTIC PIPE

Answers appear on page 121

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. Compare a piece of Schedule 40 and Schedule 80 2" plastic pipe. Measure the inside and outside diameters. Notice how the O.D. is the same between Schedule 40 and Schedule 80 2" plastic pipe, and how the I.D. differs between these two. Why is there a difference in I.D. between these two fittings?

_____

_____

B. Pick up three pieces of I.D.-controlled plastic fittings and find a piece of I.D.-controlled pipe. Notice how the insert fitting fits or is inserted into the pipe. How does this differ from the way O.D. systems work?

_____

_____

Types of Plastic Pipe and Tube

There are many different plastic piping products, however, we will only discuss the plastic piping products that are most commonly used for residential, commercial and industrial piping applications.

The most common plastic piping products used for **RESIDENTIAL AND COMMERCIAL** plumbing applications are listed below. There are also limited industrial uses for these pipe products.

- ABS pipe (Acrylonitrile Butadiene Styrene)
- CPVC pipe (Chlorinated Polyvinyl Chloride)
- PE pipe (Polyethylene)
- PEX tubing (Cross-Linked Polyethylene)
- PVC pipe (Polyvinyl Chloride).

The most common plastic piping products used for **INDUSTRIAL** applications are:

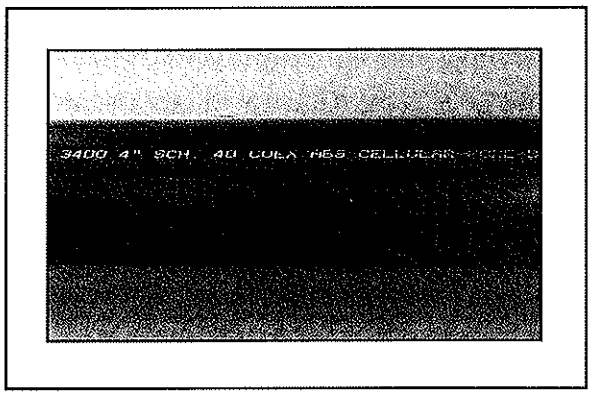
- PP (Polypropylene)
- PVDF (Polyvinylidene Fluoride)
- Composites such as PEX-AL-PEX and PE-AL-PE.

The particular strength, pressure rating, flexibility, chemical compatibility and other characteristics of each type of plastic pipe determine its suitability for specific applications.

ABS Pipe

ABS pipe and fittings have become a leading material for DWV applications, because it offers an outstanding combination of properties. ABS is resistant to breakage even in cold temperatures. ABS pressure pipe is also available for certain industrial applications.

ABS PIPE WITH MARKINGS



PVF 3.2.7

ABS PIPE IN DWV APPLICATIONS MAY BE USED:

- In buried or above-ground installations
- Outdoors if the pipe contains pigments to shield against ultraviolet radiation.

ABS PIPE IS AVAILABLE IN:

- 10- and 20-foot lengths
- 12-foot lengths in Canada
- Solid wall and **CELLULAR CORE** pipe construction in Schedule 40 dimensions that can be used interchangeably for DWV applications.

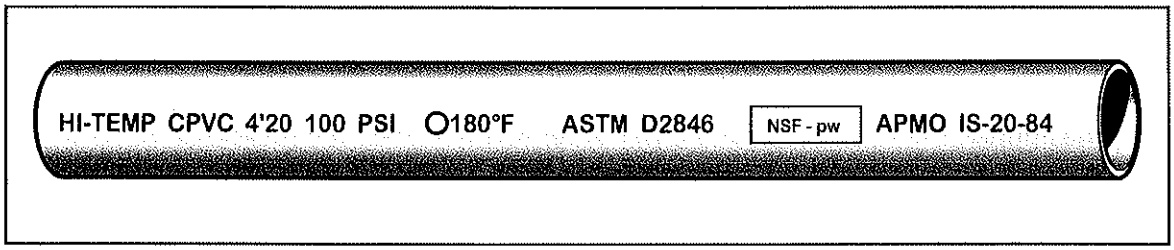
CELLULAR CORE construction involves the simultaneous extrusion of at least three layers of material into the pipe wall: a solid outer layer, a cellular core intermediate layer and a solid inner layer. The result is lighter, somewhat less costly, pipe that is satisfactory for DWV applications.

Specifying ABS pipe is a relatively easy task as the pipe wall of Schedule 40 ABS DWV pipe has the same wall thickness and outside diameter as Schedule 40 (IPS) steel pipe.

CPVC Pipe

CPVC pipe applications are for hot and cold potable water distribution, corrosive fluid handling and fire suppression systems. Since CPVC materials do not support combustion, they cannot burn without an external fuel source. This property makes CPVC pipe an alternative to steel and copper pipe for fire sprinkler applications.

CPVC PIPE WITH MARKINGS



PVF 3.2.8

CPVC and PVC pipe (discussed later) and fittings products should not be used in piping systems intended to store/or convey compressed air or other gases.

Industrial CPVC pipe is manufactured by extrusion in sizes from 1/4" to 12" diameter to Schedule 40 and Schedule 80 standards.

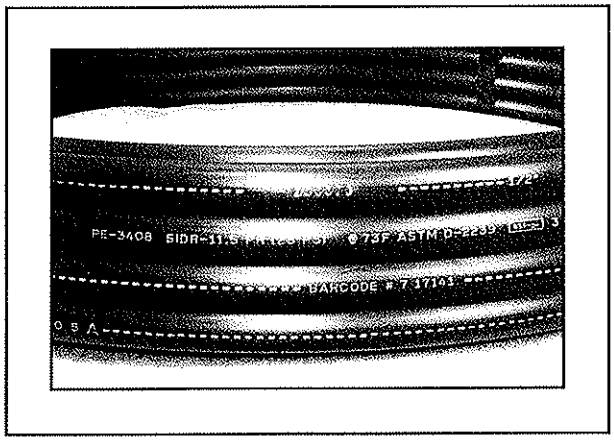
CPVC pipe for plumbing systems is manufactured by extrusion in nominal sizes 1/4" through 2" copper tube size (CTS) dimensions.

CPVC pipe and fittings are produced by many manufacturers, and are available in Schedule 40 and Schedule 80 dimensions. Additionally, CPVC tubing is suitable for potable hot and cold water distribution. The tubing is based on copper water tube sizes (O.D.) and IPS pipe (O.D.), with SDR 11 wall thicknesses.

PE Pipe

PE pipe offers advantages as a piping material. PE's light weight, flexibility, chemical resistance, overall toughness and longevity make it an ideal piping material for a broad variety of applications such as potable water service or distribution lines, natural gas distribution, lawn sprinklers, sewers, waste disposal and drainage lines. PE piping also can be used in low temperatures without the risk of becoming brittle and breaking easily. Thus, a major application for certain PE piping formulations is for low-temperature heat transfer applications such as ice rinks and geothermal ground source heat pump piping.

PE PIPE WITH MARKINGS



PVF 3.2.9

PE PLASTIC PIPE IS AVAILABLE IN:

- Sizes ranging from 1/2" to 63"
- Rolled coils of various lengths
- Straight lengths up to 40 feet.

PE IS AVAILABLE IN A VARIETY OF WALL THICKNESSES, BASED ON THREE DIMENSIONING SYSTEMS:

- Iron Pipe Size Outside Diameter
- Iron Pipe Size Inside Diameter
- Copper Tube Size Outside Diameter
- CI (AWWA C900) Outside Diameter.

PE PIPE IS AVAILABLE IN MANY FORMS AND COLORS SUCH AS THE FOLLOWING:

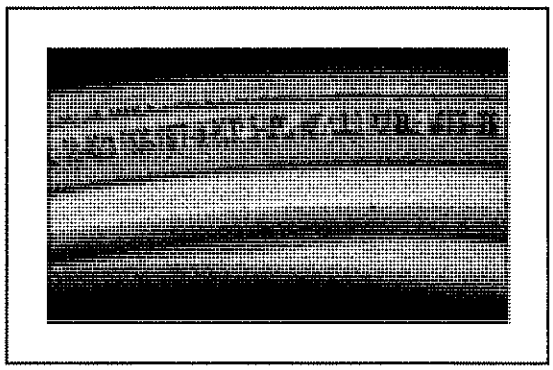
- Single extrusion colored or black pipe
- Black pipe with coextruded color striping
- Black or natural pipe with a co-extruded colored layer.

PEX Tubing

PEX tubing has been used in hot and cold water distribution systems and for hydronic radiant heating in Europe for many years. Introduced into the United States in the 1980s, PEX has replaced Polybutylene (PB) as the most widely-used flexible plumbing tubing.

PEX tubing can be used in potable water distribution systems provided it has been tested in accordance with the governing standard, meets the requirements of **NSF/ANSI STANDARD 61**, and bears proper certification from a recognized testing agency. PEX tubing is also widely used for heat transfer applications – both low temperature (radiant floor heating, snow melting and ice rinks), as well as distribution piping for temperatures up to 200°F (hot-water baseboard, convectors, radiators and others.).

PEX PIPE WITH MARKINGS



PVF 3.2.10

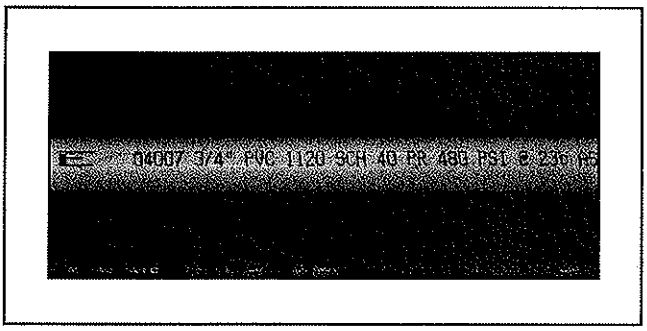
PEX TUBING IS AVAILABLE IN:

- Nominal sizes from 1/4" – 2" diameter to copper tube size
- CTS O.D.-controlled
- The wall thickness based on Standard Dimension Ratio 9 (SDR9) values
- Coils and straight lengths.

PVC Piping

PVC piping is the most widely used plastic material.

PVC PIPE WITH MARKINGS



PVF 3.2.11

PVC PIPING IS USED FOR:

- Drain waste vent (DWV)
- Sewers
- Water mains
- Water service lines
- Irrigation
- Various industrial installations.

PVC PIPE IS:

- Available in variety of sizes and dimensions
- Sold in straight lengths of 10, 13, 14, 20 and 40 feet (13 and 14 feet are for sewer applications)
- Available in both solid wall and cellular core construction.

PVC cannot burn without an external fuel source because the material does not support combustion. PVC piping systems components are manufactured in a variety of colors to make identification of application easy.

COMMON COLORS (ALTHOUGH NOT UNIVERSAL) ARE:

- White for DWV and some low-pressure applications, usually Schedule 40 and SDR
- White, blue and dark gray for cold water piping
- Green for sewer service
- Dark gray for cold fluid industrial pressure applications, usually Schedule 80
- Light purple for reclaimed water applications.

Plastic Piping Products Applications

The table below shows the general categories of piping applications of plastic piping materials covered by national consensus standards. Note that plumbing codes should be checked to find out which materials and products may be used for each application, what products standards apply and whether there are any special provisions regarding the use of the materials. Also, various manufacturers may exempt certain specific applications from these general applications categories. Thus, reference must be made as well to a manufacturer's application instructions before installing.

PLASTIC PIPE APPLICATIONS

PIPING APPLICATION	ABS	CPVC	PE	PEX	PVC
Drain, waste & vent (DWV)	X				X
Tubular waste	X				X
Water piping	X	X	X	X	X
Hot & cold water distribution		X		X	
Outside sewers & drains	X		X		X
Septic fields – Sub – Soil			X		X
Gas piping			X		
Chemical waste piping		X	X		X
Industrial process piping	X	X	X		X
Fire sprinkler piping		X		X	
Compressed* air system	X		X		

* *Plastics are not to be used for compressed air systems, with the exception of a few specialty products adequate for compressed air systems that are produced by several manufacturers.*

PVF 3.2.12

OTHER APPLICATIONS

Some of the other residential, commercial and industrial applications for plastic pipe are as follows:

- Swimming pool piping
- Chilled water systems
- Irrigation
- Ice melting
- Radiant floor heating
- Process piping
- Water well construction
- Roof drains
- Foundation de-watering
- Chemical fluid handling
- Air pollution control
- Aquariums
- Environmental protection
- Fire water mains
- And many others.

Non-Pressure and Pressure Applications

The primary plumbing applications in which plastic piping is used are:

- Non-pressure applications
- Pressure applications.

NON-PRESSURE APPLICATIONS

Besides offering low installed costs, plastic pipe is attractive for non-pressure applications (DWV and sewer) because the smooth inner walls assure high GRAVITY FLOW RATES and minimize the chances of developing stoppages. Plastic sewer pipes have adequate strength for earth loads and high chemical resistance, which means a long life when used for sewer installation.

NON-PRESSURE APPLICATIONS ARE AS FOLLOWS:

- Building drain, waste and vent (DWV)
- Building sewers and drains
- Septic systems
- Water wells – used to line the wells
- Some furnace venting (low-temperature applications).

ABS, PVC and PE plastic pipe materials are commonly used for those applications.

PRESSURE APPLICATIONS

Plastic pressure piping can be used for many industrial heating and cooling installations, gas distribution, irrigation and water supply. Plastic pipe that is acceptable for pressure applications is tested at varying stress levels, pressures, pressure surges and temperatures over time to ensure the pipe is strong enough for the desired application. Rigorous testing helps ensure that pipe will perform under pressure conditions with an additional built-in safety factor. Non-pressure pipe should never be used for a pressure application.

PRESSURE APPLICATIONS ARE AS FOLLOWS:

- Water service
- Hot and cold water distribution
- General liquid distribution
- Industrial service.

ABS, PE and PVC materials are all available with 73°F (room temperature) stress rating for use in pressure piping. PE piping is used extensively for cold water service lines and water distribution systems outside the building.

PEX and CPVC materials are suitable for temperatures up to 180°F and cold water applications.

WARNING:

Pressurized (compressed air or other compressed gases) contain large amounts of stored energy, which present serious safety hazards should a system fail for any reason. Unless otherwise specified by the manufacturer, do not use or test plastic piping systems or components with compressed air or other gases.

REVIEW OF TYPES OF PLASTIC PIPE AND TUBE

Answers appear on page 122

1. ABS pipe and fittings are the leading material for:
   a. DWV applications
   b. Piping systems intended to convey compressed air

2. The type of plastic pipe used for hot and cold potable water distribution, corrosive fluid handling and fire suppression systems, is:
   a. PEX b. CPVC

3. The type of pipe that can be used in low temperatures without risk of becoming brittle and breaking easily is:
   a. PE b. PEX

4. Hydronic radiant heating uses:
   a. PE b. PEX

5. What is the most widely used plastic material?
   a. PVC b. PE

6. Building sewers and drains are considered:
   a. Non-pressure applications
   b. Pressure applications

7. All plastic pipe is acceptable for pressure applications.
   a. False b. True

8. PEX and CPVC materials are suitable for temperatures:
   a. Up to 73°F b. Up to 180°F

REVIEW OF TYPES OF PLASTIC PIPE AND TUBE

Answers appear on page 122

9. Unless otherwise specified by the manufacturer, plastic piping systems:
   a. Must be tested with compressed air or other gases
   b. Must not be tested with compressed air or other gases

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. What types of plastic pipe and tube does your company carry?

_____

_____

B. List two of your customers that often buy PVC pipe. How do they use it?

_____

_____

Other Important Characteristics of Plastic Pipe

Some of the other important characteristics of plastic pipe are flexibility, pressure rating, nontoxic properties, markings, colors and others.

Rigid and Flexible Plastic Pipe

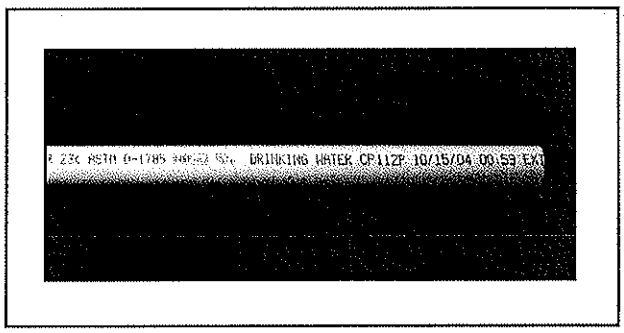
Plastic pipe is classified as either:

- rigid
- flexible.

RIGID PLASTIC PIPE

RIGID PLASTIC PIPE includes ABS, CPVC and PVC that is usually available in 10-foot and 20-foot straight lengths. Rigid pipe is usually sold in straight, uniform lengths. However, there is an exception to this general classi-fication: CPVC and PVC are also available in coils in many of the smaller sizes.

RIGID PLASTIC PIPE



PVF 3.2.13

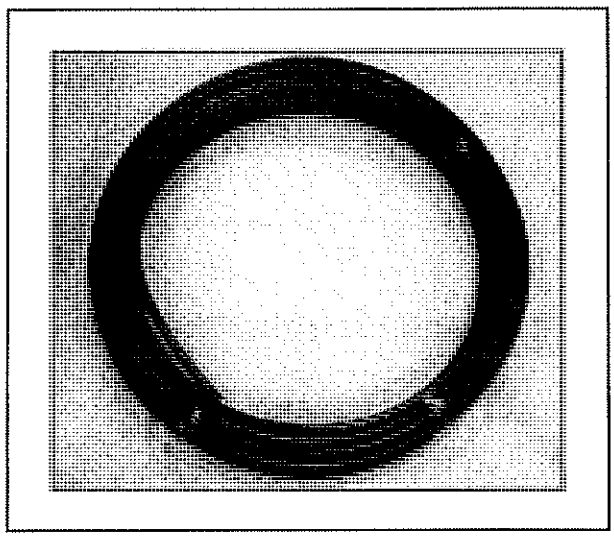
Straight plastic pipe, when installed in the horizontal position, can be supported with hangers at a spacing of every few feet. Also, the straight, rigid lengths assure a uniform slope for gravity drain lines so that sags and traps are not formed in the line. Sags and traps can permit stoppages to form.

FLEXIBLE PLASTIC PIPE

FLEXIBILITY refers to how much the pipe can be bent. Flexible plastic pipe and tube can be easily bent.

FLEXIBLE PLASTIC PIPE includes PE and PEX pipe, and is available in coils of various lengths. In many cases, special coil lengths can be ordered for tubing that is to be placed in radiant heat floor slabs, snow-melting slabs or geothermal ground loops. In addition to being sold in coils, PE and PEX also are available in 20-foot and sometimes 40-foot straight lengths.

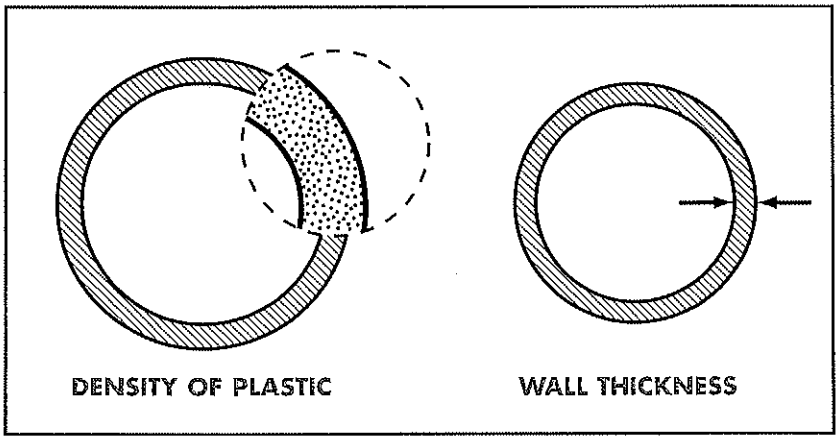
FLEXIBLE PLASTIC PIPE



PVF 3.2.14

Strength is another important characteristic of plastic pipe. **STRENGTH** is measured by the density of the plastic material and the thickness of the pipe wall.

DENSITY OF PLASTIC & WALL THICKNESS



PVF 3.2.15

Pressure Rating

The next important characteristic of plastic pipe is the pressure rating. The **PRESSURE RATING** of plastic pipe is the designated working pressure that can be handled continuously at a given temperature by the pipe. This is normally expressed as pounds per square inch (**PSI**) at 73.4°F.

THE PRESSURE RATING IS BASED UPON THE:

- Strength of the material (partly related to the density of the plastic)
- Pipe diameter
- Wall thickness.

Several types of plastic pipe can be used at elevated temperatures. However, high temperatures reduce the amount of pressure the pipe can withstand. Excessive heat will deform thermoplastics and will change the shape of the pipe, tube or fitting. Many manufacturers' catalogs will include a **TEMPERATURE CORRECTION FACTOR CHART GLOSSARY** that provides a simple way to calculate how much the elevated temperature will reduce the pressure rating. See the chart below that shows temperature correction factors for fittings.

FITTINGS TEMPERATURE CORRECTION FACTORS

Operating Temperature, °F	FACTORS	
	PVC	CPVC-CTS
70	1.00	1.00
80	0.90	0.96
90	0.75	0.92
100	0.62	0.85
110	0.50	0.77
120	0.40	0.70
130	0.30	0.55
140	0.22	0.50
150	N.R.	0.47
160	N.R.	0.40
170	N.R.	0.32
180	N.R.	0.25
200	N.R.	0.18
210	N.R.	0.15

N.R. = Not Recommended

PVF 3.2.50

Plastic Pipe and Tube Nontoxic Properties

Since plastic piping systems have been approved for potable water applications, all plastic potable water piping materials and products are tested and listed for compliance to NSF/ANSI Standards 14 and 61. The NSF mark, or other recognized third-party certification marks (CSA, IAPMO, UL and Intertek), certifies to installers, users and regulators that the product meets the requirements of NSF/ANSI Standard 14 for performance and the NSF/ANSI Standard 61 for health effects. Products marked as being compliant with NSF/ANSI Standard 61 have only been evaluated as meeting the requirements of NSF 61 for health effects.

Plastic Pipe Marking

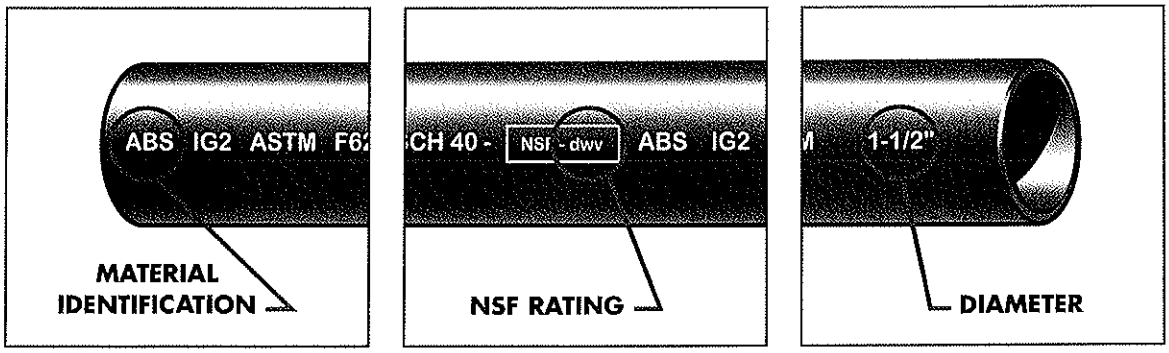
The standards for plastic pipe generally require that the product be marked so that it can be readily identified, even if cut in short pieces. Most of the standards require the following information:

- The manufacturer's name or trademark
- The standard to which it conforms
- Pipe size
- Resin type
- DWV if for drainage
- SDR number or Schedule number
- If the pipe is for potable water, a laboratory seal or mark attesting to suitability for potable water
- Operating pressure rating at 73°F.

IN ADDITION TO THE ABOVE, THE FOLLOWING INFORMATION IS SHOWN:

- Third-party certification mark, which is not required by the standard, but may be required by some codes and jurisdictions
- The ABS standards that differ on the maximum marking interval distance; some call for 2 feet and others not more than 1.5 meters (5 feet).

PLASTIC PIPE MARKINGS



PVF 3.2.51

PLASTIC PIPE COLORS

Plastic pipe is available in a variety of colors. KEEP IN MIND, however, that pipe color is not always a reliable factor in determining proper application. The table below shows generally used colors for identification and different applications.

PLASTIC PIPE COLORS AND GENERAL APPLICATIONS

Application	Generally Used Color
Gas Distribution	• Formerly bright orange or tan • Now yellow or black with yellow stripes
Water Distribution	• Black, light blue, white, clear or gray
Sewers	• Green, white, black or gray
DWV	• Black, white, tan or gray
Hot and Cold Water Distribution	• Tan, red, white, blue, silver or clear
Cable Duct	• Variety of colors
Fire Sprinklers	• Orange
Industrial Process	• Dark gray/PVC, light gray/CPVC
Reclaimed Water	• Purple or brown (local jurisdiction may set requirements)
Conduit	• Light gray

PVF 3.2.17

NOTE THAT YOU SHOULD NOT RELY ON COLOR TO IDENTIFY THE PIPING APPLICATION. READ THE PRINTING ON THE PIPE.

Plastic Pipe Joining Methods

Plastic pipe can be joined by a number of methods. For each material, there are several appropriate methods. The most common include:

- Solvent cementing
- Elastomeric sealing gasket
- Mechanical fitting joining
- Flanges
- Heat fusion joining
- Threaded joints.

This variety of joining methods allows plastic pipe to be adapted easily to most field conditions. Plastic pipe joining methods will be discussed in detail later in the chapter.

Storage and Handling

Pipe and fittings shall be stored in such a manner to prevent physical damage to the materials. Exposing CPVC-CTS and PEX piping to sunlight, such as during construction, should be minimized. Refer to the manufacturer's recommendations. Protective additives are added to the formulation and production of PVC and CPVC Schedule 40 and 80 piping. These additives greatly reduce the effect of ultraviolet light in outdoor applications. In general, this type of piping is adequately protected from UV exposure, however coating the piping with water-based Latex paint offers additional security. Refer to the manufacturer's recommendations. Pipe lengths and coils should be properly transported to avoid dragging pipe ends, and should not be dropped or thrown from trucks or trailers.

REVIEW OF OTHER IMPORTANT CHARACTERISTICS OF PLASTIC PIPE

Answers appear on page 122

1. ABS, CPVC and PVC are:
   a. Rigid plastic pipe
   b. Flexible plastic pipe

2. PE and PEX are:
   a. Rigid plastic pipe
   b. Flexible plastic pipe

3. The pressure rating is normally expressed as:
   a. Pr
   b. Psi

4. The pressure rating is based upon the:
   a. Strength of the material only
   b. Strength of the material, pipe diameter and wall thickness

5. The NSF mark:
   a. Certifies to the installers, users and regulators that the product meets the requirements of pressure rating
   b. Certifies to the installers, users and regulators that the product meets the requirements of NSF/ANSI Standard 14 for performance and the NSF/ANSI Standard 61 for health effects

6. Plastic pipe is available in a variety of colors, and pipe color is:
   a. A reliable factor in determining proper application
   b. Not always a reliable factor in determining proper application

7. Exposure to sunlight:
   a. Should be minimized when using CPVC-CTS and PEX material
   b. Has no effect on any of the plastic pipe

8. Solvent cementing is:
   a. One of the joining methods for plastic pipe
   b. One of the joining methods that is rarely used with plastic pipe

REVIEW OF OTHER IMPORTANT CHARACTERISTICS OF PLASTIC PIPE

Answers appear on page 122

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 two applications for which your company sells flexible plastic pipe.

_____

_____

B. Describe the precautions your company takes to protect plastic pipe from damage.

_____

_____

Plastic Pipe Fittings

Types of Plastic Pipe Fittings

Plastic pipe fittings are made from the following materials:

- ABS
- CPVC
- PE
- PS
- PVC
- Nylon (Insert Fittings)
- PVDF – Industrial
- PP – Industrial.

Plastic Fittings Uses

Most plastic fittings may be used in both buried and above-ground applications. They also may be used outdoors if the material contains stabilizers and UV inhibitors to shield against ultraviolet radiation. Some jurisdictions or manufacturers may require the system to be painted with a water-based Latex paint to protect against UV exposure.

Plastic fittings are used for:

- DWV – drain, waste & vent (ABS & PVC)
- Sewer & drain – (PVC & PS)
- Water mains – (PVC)
- Water service lines – (CPVC, PVC & PE)
- Irrigation – (PVC & PE)
- Conduit – (PVC & PE)
- Fire sprinkler – (CPVC)
- Pressure & drainage (PP & PVDF)
- Various industrial applications (ALL).

Markings

Plastic fitting markings will generally include:

- The manufacturer's name or trademark
- The standard to which it conforms
- Fitting size
- Resin type
- Item specific identifier
- Mold cavity specific identifier
- DWV if for drainage
- SDR number or Schedule number
- If the fitting is for potable water, a laboratory seal or mark attesting to suitability for potable water.

On some of the smaller fittings, some of the information can be left off due to the constraints of size.

Sizes

Plastic fittings come in the following sizes:

- Copper tube sizes 1/4"–2" (CTS)
- Schedule 40 pipe up to nominal size 12" (Sch 40/IPS/DWV)
- Schedule 80 pipe up to nominal size 12" (Sch 80)
- Sewer & drain sizing 3"–12" plus
- Gasketed sewer sizing 6"–12" plus.
- PE piping systems nominal size 1/4"–over 60" (SDR, Sch 40, CTS)

Joining Methods

There are several common methods of joining fittings and pipe. They are:

- Solvent cements and primers
- Mechanical threads
- Barbed inserts with clamping rings
- Heat fusion
- Other mechanical methods.

Different joining methods will be discussed in detail later in this chapter.

Terms for Plastic Fittings Ends

The names for plastic DWV fittings vary among manufacturers. Fittings may be labeled with a variety of different abbreviations. The list below shows some common catalog abbreviations for the ends of plastic pressure and DWV fittings.

COMMON CATALOG ABBREVIATIONS

Abbreviations	Explanations
FIPT	Female Iron Pipe Thread
FPT	Female Pipe Thread
MIPT	Male Iron Pipe Thread
MPT	Male Pipe Thread
SLIP	Female Socket
H	Hub
SP	Male connection, same size as pipe O.D.

PVF 3.2.18

Examples of Plastic Pipe Fittings

There are many different plastic pipe fittings. The examples that follow describe some of the commonly available plastic pipe fittings:

- ABS and PVC DWV fittings
- PVC Schedule 40 pressure fittings
- PVC Schedule 80 pressure fittings
- CPVC-CTS pressure fittings

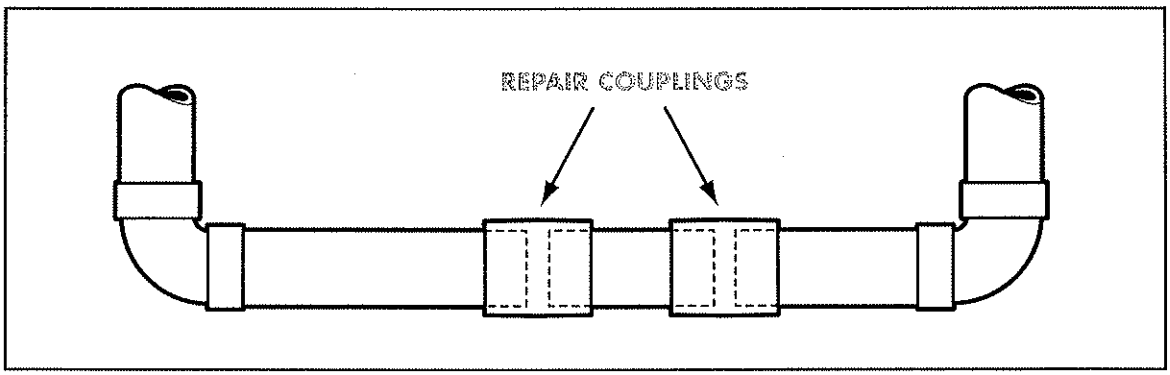
ABS AND PVC DWV FITTINGS

This section will cover several different ABS and PVC DWV fittings.

DWV fittings can be identified by their shallow hub, as compared to a pressure fitting.

A **REPAIR COUPLING** is a coupling without a center stop; it is used to rejoin pipe that has been cut to solve some problem in a piping system. For example, a repair coupling may be needed to reconnect pipe that has been cut to remove a blockage or section damaged by freezing. A repair coupling can be slipped over the cut end of the pipe. The pipe ends are then lined up, the repair coupling is positioned and the solvent welded into place.

REPAIR COUPLINGS



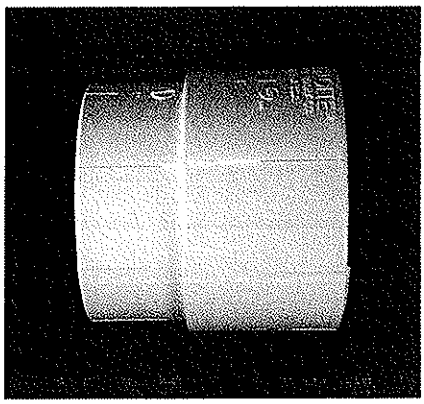
PVF 3.2.19

ADAPTERS

Like any adapters, plastic DWV adapters are used to connect pipe and fittings that require different joining methods and also to connect pipe of different materials. There are several types of adapters. Plastic DWV adapters are available to connect plastic with clay, steel, copper or cast iron.

A **SOIL PIPE ADAPTER** has two hub connectors, one for the soil pipe and the other for the plastic DWV spigot.

SOIL PIPE ADAPTER

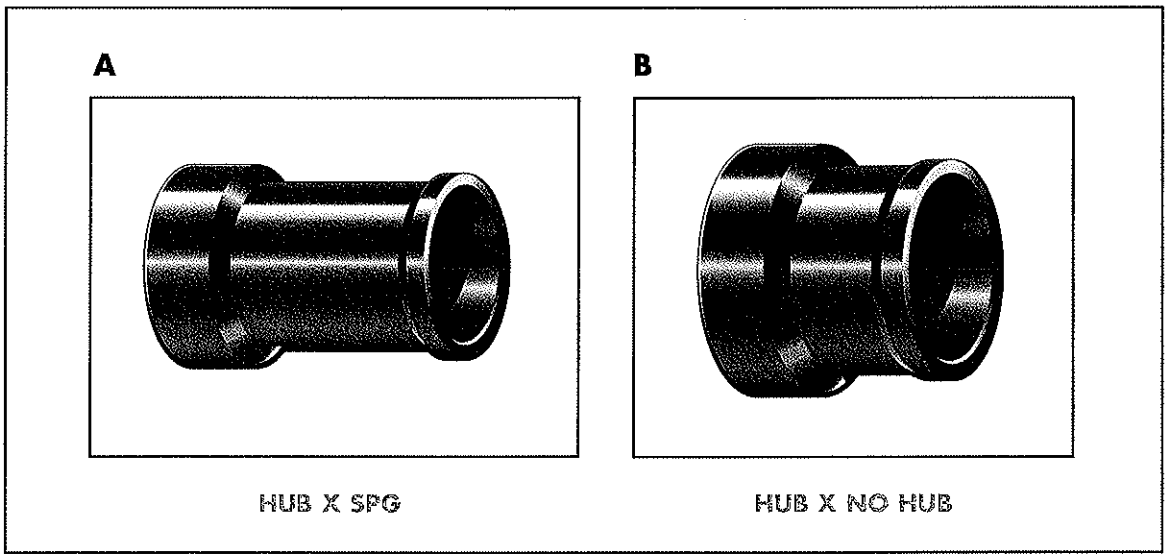


HUB X HUB

PVF 3.2.20

The **SOIL PIPE ADAPTER** to the bottom left A joins soil pipe to a plastic spigot. The adapter on the bottom right B joins a plastic DWV spigot to no-hub soil pipe.

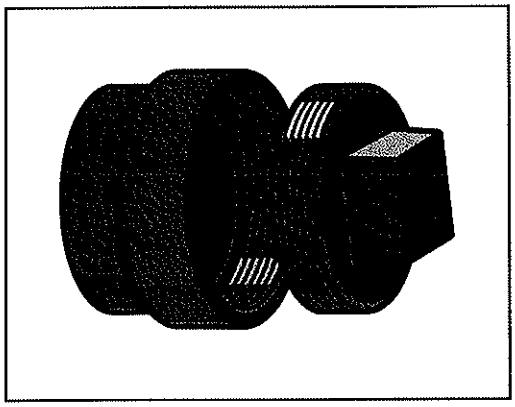
SOIL PIPE ADAPTERS



PVF 3.2.21 A & B

A **CLEANOUT ADAPTER** has one threaded opening, which is closed by a plug. The plug allows cleanout when needed. The spigot end of the adapter is solvent welded to the hub of the cleanout outlet on a tee.

CLEANOUT ADAPTER

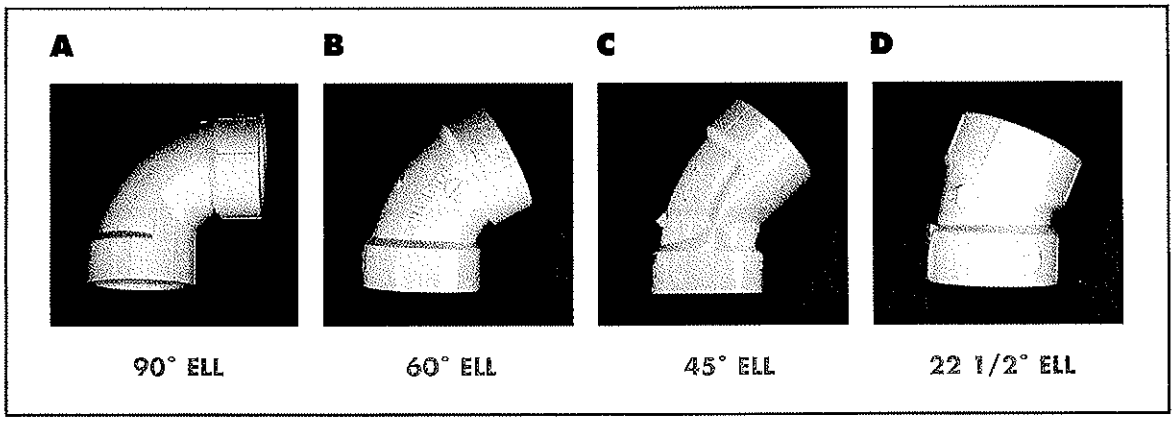


PVF 3.2.22

ELBOWS

Elbow fittings may also be called **BENDS** in plastic DWV fittings, as they are in cast iron soil pipe fittings. Some of the examples of plastic DWV elbows are as follows:

ELBOWS

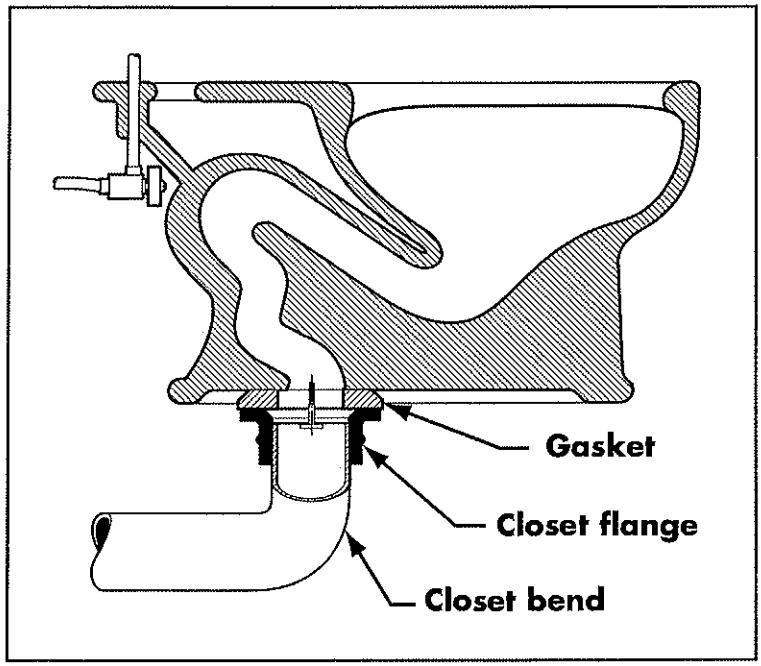


PVF 3.2.23

OTHER ABS AND PVC DWV FITTINGS

A **CLOSET FLANGE** connects the water closet and the sealing gasket to the main DWV line through the closet bend. Closet flanges are ordered by diameter. The closet flange shown below is joined to the closet bend by solvent welding.

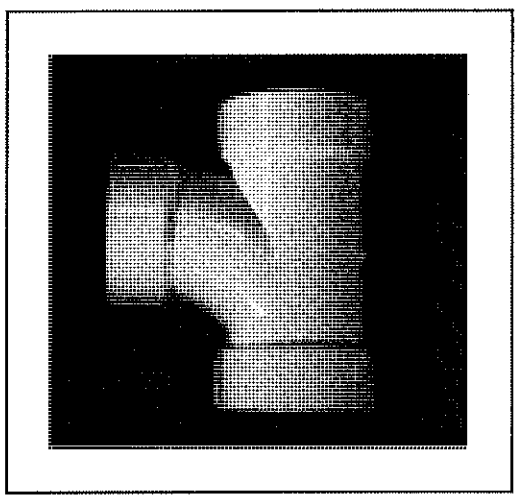
CLOSET FLANGE



PVF 3.2.24B

A FIXTURE TEE, also known as a **SANITARY TEE**, is similar to a vent tee. The fixture tee has just enough sweep in the branch to allow for the smooth flow of waste. It joins the main run to the drain piping for a fixture. A fixture tee can be a straight tee with three openings of the same size. Or it can be a reducing fitting, with the diameter of the inlet smaller than the diameter of the run. It can also be a double tee, which has two branch connections.

FIXTURE TEE



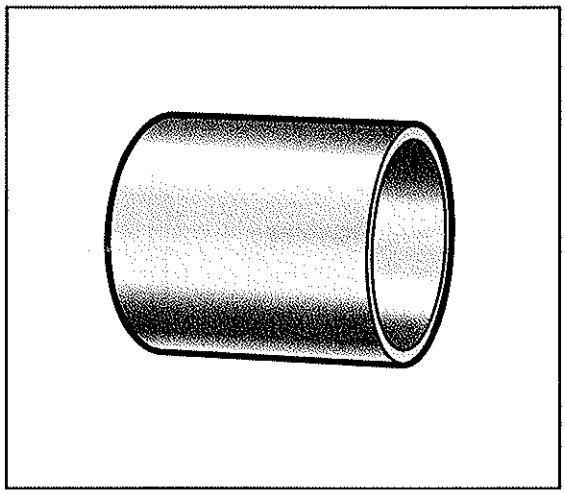
PVF 3.2.25

PVC SCHEDULE 40 AND SCHEDULE 80 PRESSURE FITTINGS

There are also PVC Schedule 40 and 80 pressure fittings that are designated for pressure system applications. PVC Schedule 40 pressure fittings differ from PVC Schedule 80 pressure fittings in wall thickness and color. PVC Schedule 40 pressure fittings are white and are used in lower-pressure and drainage applications. PVC Schedule 80 pressure fittings are gray, and their better corrosion resistance allows them to be used for higher-pressure applications. Here are two examples.

PVC SCHEDULE 40 PRESSURE FITTING

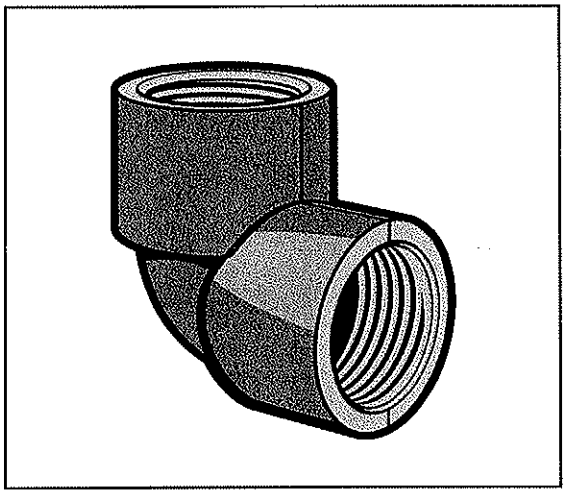
COUPLING



PVF 3.2.26

PVC SCHEDULE 80 PRESSURE FITTING

THREADED 90° ELL



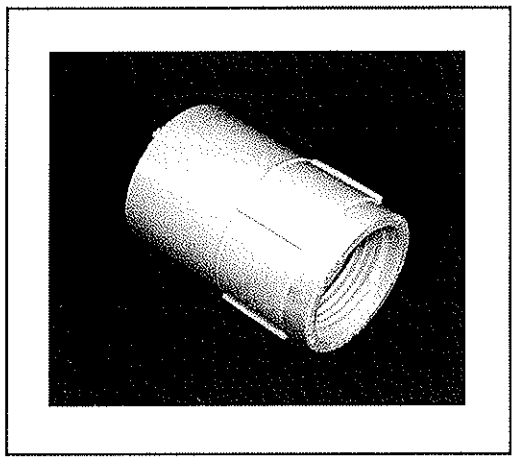
PVF 3.2.27

CPVC-CTS Pressure Fittings

CPVC-CTS pressure fittings have been successfully used in hot- and cold-water distribution systems. There are different CPVC-CTS pressure fittings available, however here we will give you only two examples of the commonly available CPVC-CTS pressure fittings.

Special transition fittings or joints are used whenever CPVC piping is connected to a metal valve, fitting or other material. These special transition fittings can have many forms, one of which might be a **FEMALE ADAPTER.**

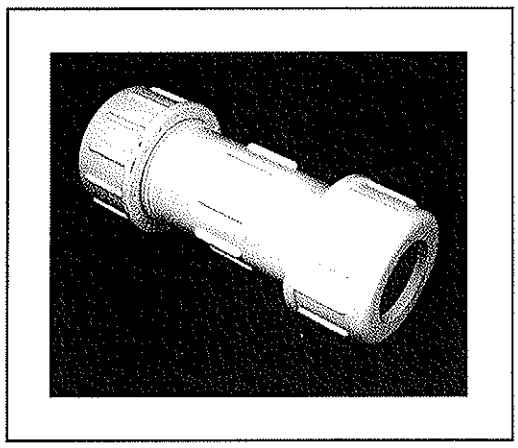
FEMALE ADAPTER



PVF 3.2.28

COMPRESSION FITTINGS allow components to be assembled by screwing the pieces together without special tools. Compression fittings employ a nut and ferrule (ring). When the nut is tightened, it forces the ferrule to compress around the plain end of the pipe and form a watertight seal. Generally, they are not recommended for high-pressure applications.

COMPRESSION FITTING



PVF 3.2.29

REVIEW OF PLASTIC PIPE FITTINGS

Answers appear on page 123

1. SP stands for:
   a. Spigot
   b. Male connection

2. FPT stands for:
   a. Female Iron Pipe Thread
   b. Female Pipe Thread

3. Plastic fittings come in the following Copper Tube Sizes:
   a. 1/4"– 2"
   b. 3" – 12"

4. A soil pipe adapter has:
   a. One hub connector
   b. Two hub connectors

5. A cleanout adapter:
   a. Has a plug that allows cleanout when needed
   b. Has a plug that has a limited number of times it can be removed for cleanout

6. A plastic DWV elbow is:
   a. Available as a 22 1/2° elbow
   b. Not available as a 22 1/2° elbow

7. A plastic closet flange is joined to the closet bend by:
   a. Brazing
   b. Solvent welding

8. PVC Schedule 40 pressure fittings and PVC Schedule 80 pressure fittings:
   a. Differ in wall thickness and color
   b. Are the same color but have a different wall thicknesses

REVIEW OF PLASTIC PIPE FITTINGS

Answers appear on page 123

9. Compression fittings:
   a. Are generally recommended for high-pressure applications
   b. Allow components to be assembled by screwing the pieces together without special tools

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 type of plastic fittings that your company carries.

_____

_____

B. Look at the soil pipe adapter. How do your customers use this type of fitting?

_____

_____

Plastic Pipe Joining Methods

As mentioned earlier in this chapter, plastic pipe can be joined by a number of methods. Some of the most common methods are:

- SOLVENT CEMENTING
- ELASTOMERIC SEALING GASKET
- MECHANICAL FITTING JOINING
- FLANGES
- HEAT FUSION JOINING
- THREADED JOINTS.

Solvent Cementing

Plastic ABS, CPVC and PVC pipe and fittings are primarily joined by solvent cementing. However, mechanical joints also are available and they will be discussed later.

PE and PEX pipe and fittings cannot be joined with solvent cements.

Solvent cement joining requires the following:

- Pipe or tube end
- Fitting socket or pipe bell.

The inside of the socket end is tapered from a diameter slightly larger than the pipe O.D. at the entry to a diameter slightly smaller than the O.D. at the root of the socket. The pipe stops more or less midway in the socket.

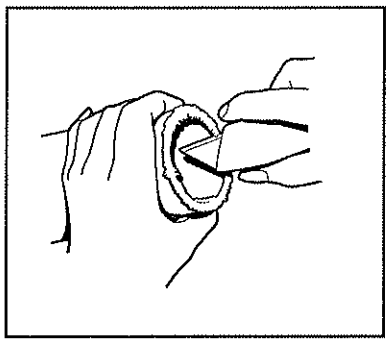
Solvent cement is applied in a full, even layer to the outside diameter of the pipe end for a distance slightly greater than the depth of the socket. It is applied in a medium layer to the inside of the socket, and in a second full even layer to the outside diameter of the pipe. The pipe is then pushed into the socket, while rotating the fitting a 1/4 turn, until it bottoms about halfway into the socket. There are some codes that require a primer to be applied before the solvent cement. The function of the primer is to both clean and soften the bonding surfaces.

This process bonding is done by the means of chemical fusion. Solvents contained in the primer and cement softens and dissolves the surfaces to be joined.

Once the pipe and fittings are assembled, a chemical weld occurs that strengthens over time as the solvents evaporate. As a general rule of thumb, it is recommended that joined parts not be moved for 24 hours to allow the joint to cure. Weather conditions will affect the rate of curing; therefore, one should consult the manufacturer's installation recommendations for times.

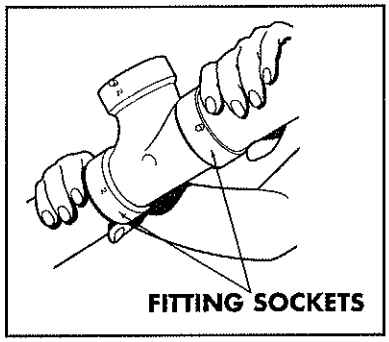
SOLVENT CEMENTING PROCESS

Step 1



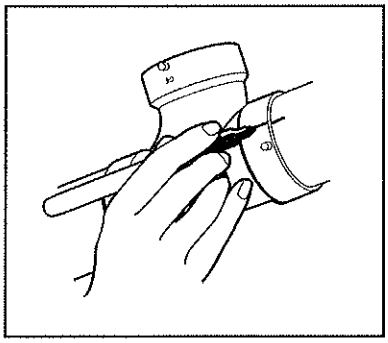
Remove rough burrs on cut ends of plastic pipe, using a utility knife.

Step 2



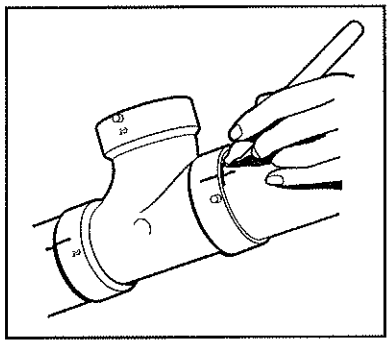
Test-fit all pipe and fittings. Pipe should fit tightly against the bottom of the fitting sockets.

Step 3



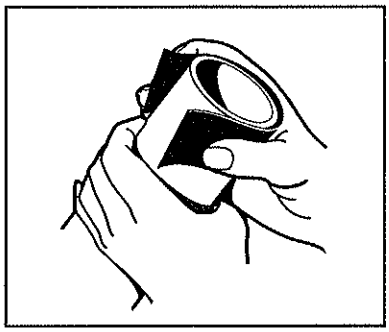
Make alignment marks across each joint with a felt-tipped pen.

Step 4



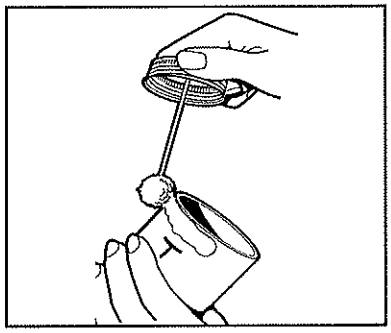
Mark depth of the fitting socket on the pipe. Take pipe apart.

Step 5



Clean ends of pipe and the fitting sockets with emery cloth.

Step 6

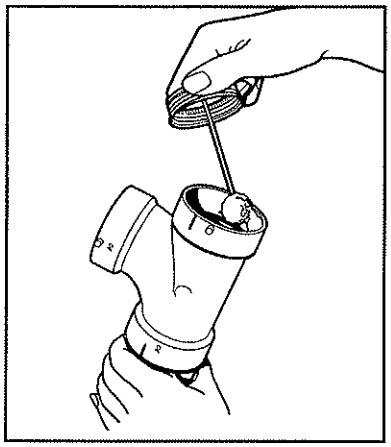


Apply plastic pipe primer to the ends of the pipe. Primer dulls glossy surfaces and ensures a good seal.

PVF 3.2.30

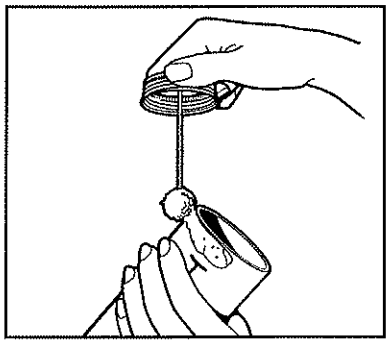
SOLVENT CEMENTING PROCESS

Step 7



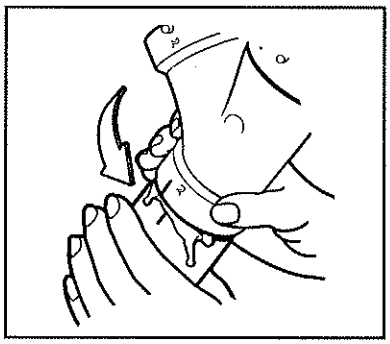
Apply plastic pipe primer to the insides of the fitting sockets.

Step 8



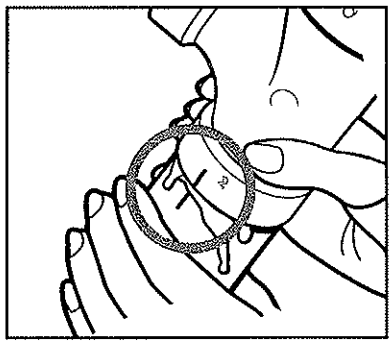
Solvent-glue each joint by applying a thick coat of solvent glue to end of pipe. Apply a thin coat of solvent glue to inside surface of fitting socket. **Work quickly:** Solvent glue hardens in about 30 seconds!

Step 9



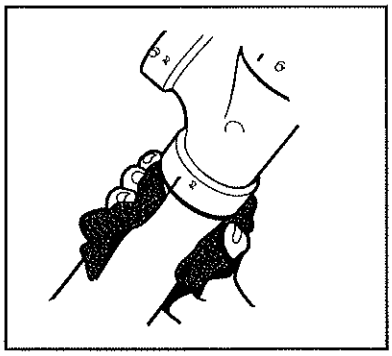
Quickly position pipe and fitting so that alignment marks are offset by about 2 inches. Force pipe into fitting until the end fits flush against the bottom of the socket. Twist pipe into alignment.

Step 10



Spread solvent by twisting the pipe until marks are aligned. Hold pipe in place for about 20 seconds to prevent joint from slipping.

Step 11



Wipe away excess solvent glue with a rag. Do not disturb joint for 30 minutes after gluing.

PVF 3.2.30

SAFE HANDLING PROCEDURES

The cements, primers and cleaners contain solvents that catch fire easily. Therefore, these products should be kept away from all sources of ignition, such as sparks, heat and open flames.

Also, prolonged breathing of solvent vapors must be avoided. When pipe and fittings are being joined in partially enclosed areas, a ventilating device must be used to ensure a proper level of fresh air.

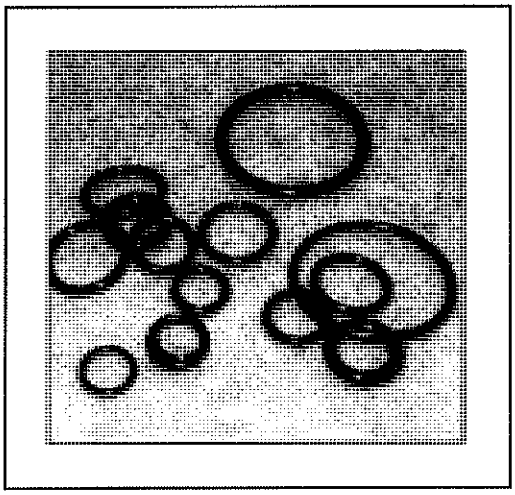
Elastomeric Sealing Gasket

Most of the underground PVC pressure and sewer piping is joined by means of:

- **ELASTOMERIC O-RING OR SEAL.**

An elastomeric o-ring or seal is held within a hub, with the pipe inserted into the ring. The pipe is cut into a desired length and the end is smoothed, beveled or chamfered (grooved) on the outside. A lubricant is applied to the pipe end, and the pipe is inserted into the hub and gasket with a quick push. Gasketed piping systems require restraint. Water movement will move the pipe. To compensate, either a restraining device or a thrust-block must be installed.

ELASTOMERIC O-RING OR SEAL



PVF 3.2.31

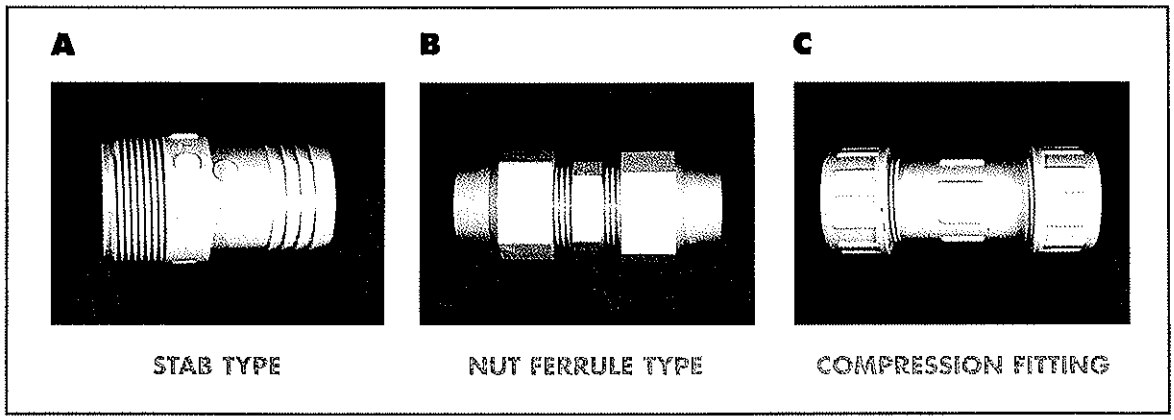
Mechanical Fitting Joining

PE and PEX tubing is often joined by mechanical means. PEX systems use mechanical connections such as insert and crimp, cold expansion or other types of mechanical connections.

The different types of mechanical fittings are:

- **CRIMP RING TYPE** – A crimp ring surrounding the tube and insert fitting is compressed by a special crimp tool after assembly. The crimp ring version is a one-time assembly, which means that it must be destroyed to disassemble this joint.
- **NUT FERRULE TYPE** – A threaded nut is tightened onto a matching thread that compresses the tube or a ferrule over the insert as it is tightened. The threaded assembly can be taken apart and reassembled as necessary.
- **STAB TYPE** – As plastic pipe or tubing is cut, the end is chamfered, the stab depth is marked on the pipe or tubing, and then it is stabbed into the fitting.
- **INSERT FITTINGS** – Insert fittings are fittings that are inserted into the tube. The fitting's barbed outside diameter grabs the inside diameter of the tube. Final sealing is made by compressing a gear-type clamp over the tubing at the point of the barbs. Insert fittings also can transition from tube to a threaded connection by way of barb/thread/spigot combinations.
- **COMPRESSION FITTINGS** — Compression fittings allow components to be assembled by screwing the pieces together without special tools. Compression fittings employ a nut and ferrule (ring), which, when the nut is tightened, forces the ferrule to compress around the plain end of the pipe to form a watertight seal. Compression fittings are not recommended for high-pressure applications.

EXAMPLES OF SOME MECHANICAL FITTINGS



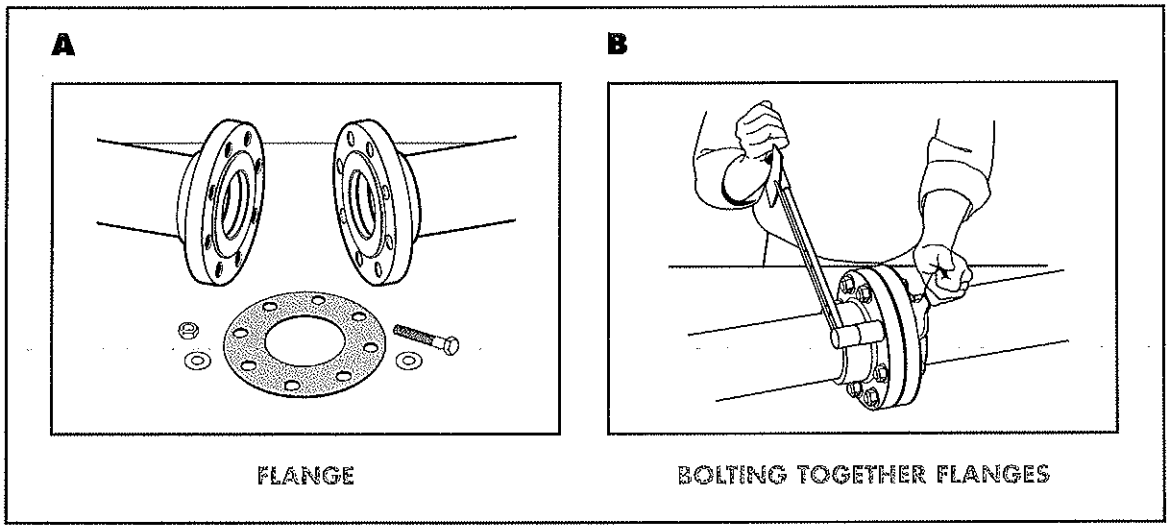
PVF 3.2.32

Always check on the product label or in the manufacturer's literature or instructions to make sure that the mechanical fitting joining system is recommended for the intended application type of service.

Flanges

CPVC and PVC pipe can be joined by bolting together flanges that are attached to the pipe end (usually by solvent-cement joint). A thin, flat gasket is placed between the flange faces to make a leak-tight joint. Care must be taken to bolt the flanges together in the manner recommended by the manufacturer to develop a tight joint and avoid damaging flanges.

BOLTING TOGETHER FLANGES



PVF 3.2.33

Heat Fusion Joining

PE pipe can be joined by the heat fusion joining method. PP and PVDF utilize some of the same methods of connection. There are four types of heat fusion joints:

- **BUTT FUSION** – Accomplished by heating the two ends of pipe or tubing to the required temperature in special heating devices, and then quickly pushing the ends together with a controlled force
- **SOCKET FUSION** – Similar to butt fusion except that different heating tools are required
- **SADDLE FUSION** – Similar to butt fusion except that different heating tools are required
- **ELECTRO FUSION** – The required temperature and heating time are controlled by passing current through an electrical resistance wire embedded in the socket.

Threaded Joints

There are some plastic pipe fittings that are threaded on one end and have a plastic male (spigot) or female (socket) on the other. These fittings are used as adapters to join one piping material to another.

Schedule 80 CPVC and PVC plastic pipe can be threaded; however, this requires use of special dies. Threading pipe reduces its working pressure by 50 percent. The rated working pressure of stems assembled with threaded joints will be less than the working pressure with solvent cement joints. The advantage of this method is that disassembly is easily done when needed. Threading Schedule 40 pipe is not recommended. Threading PP pressure pipe will render its function to almost drainage limitations.

REVIEW OF PLASTIC PIPE JOINING METHODS

Answers appear on page 123

1. One of the most common plastic pipe joining methods is:
   a. Solvent cementing b. Brazing

2. ABS, CPVC and PVC pipe and fittings are primarily joined by:
   a. Solvent cementing b. Flanges

3. Most of the underground PVC pressure and sewer piping is joined by means of:
   a. Stab type joint b. Elastomeric o-ring or seal

4. PE and PEX tubing is often joined using:
   a. Mechanical connections b. Heat fusion

5. Crimp ring type is an example of a:
   a. Threaded joint b. Mechanical fitting

6. CPVC and PVC pipe can be joined by bolting together:
   a. Flanges b. Sockets

7. PE pipe can be joined by:
   a. Heat fusion joining method
   b. Elastomeric sealing gasket

8. The advantage of threaded joints is that:
   a. Threaded joints are stronger than solvent welded joints
   b. Disassembly is easily done when needed

REVIEW OF PLASTIC PIPE JOINING METHODS

Answers appear on page 123

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 preferred plastic pipe joining method used by two or three different types of customers.

_____

_____

B. List some of the newer plastic fittings that your company carries.

_____

_____

ANSWERS TO REVIEW QUESTIONS

CHAPTER 2

PLASTIC PIPE AND FITTINGS

Answers for REVIEW OF PLASTIC PIPE (pages 78 - 80)

1. b. Water mains; hot and cold water distribution; drain, waste, vent (DWV); sewer; gas distribution; irrigation; conduit; fire sprinkler; and process piping.
2. b. Plastic pipe is corrosion resistant, therefore it can be buried in typical acidic, alkaline, wet or dry soils.
3. a. Is a type of plastic that can be repeatedly softened and remolded by heat and pressure.
4. b. The most common method of producing plastic fittings.
5. a. The most common method of plastic pipe manufacturers.
6. a. Wall thickness changes needed for different pressure ratings will affect the inside diameter.
7. b. Wall thickness changes needed for different pressure ratings will affect the outside diameter.
8. b. O.D.-controlled system
9. b. In both SDR and Schedule wall thickness
10. a. Higher pressure ratings than Schedule 40 pipe
11. b. Higher pressure ratings than larger-diameter plastic pipe
12. b. I.D.-controlled systems
13. a. Plastic tube
14. a. Increase

Applying what you have learned:

A. Discuss

B. Discuss

Answers for REVIEW OF TYPES OF PLASTIC PIPE AND TUBE (pages 89 - 90)

1. a. DWV applications
2. b. CPVC
3. a. PE
4. b. PEX
5. a. PVC
6. a. Non-pressure applications
7. a. False
8. a. Up to 180°F
9. b. Must not be tested with compressed air or other gases

Applying what you have learned:

A. Discuss

B. Discuss

Answers for REVIEW OF OTHER IMPORTANT CHARACTERISTICS OF PLASTIC PIPE (pages 97 - 98)

1. a. Rigid plastic pipe
2. b. Flexible plastic pipe
3. b. Psi
4. b. Strength of the material, pipe diameter and wall thickness
5. b. Certifies to the installers, users and regulators that the product meets the requirements of NSF/ANSI Standard 14 for performance and the NSF/ANSI Standard 61 for health effects
6. b. Not always a reliable factor in determining proper application
7. a. Should be minimized when using CPVC-CTS and PEX material
8. a. One of the joining methods for plastic pipe

Applying what you have learned:

A. Discuss

B. Discuss

Answers for REVIEW OF PLASTIC PIPE FITTINGS (pages 108 - 109)

1. b. Male connection
2. b. Female pipe thread
3. a. 1/4"-2"
4. b. Two hub connectors
5. a. Has a plug that allows cleanout when needed
6. a. Available as a 22 1/2° elbow
7. b. Solvent welding
8. a. Differ in wall thickness and color
9. b. Allow components to be assembled by screwing the pieces together without special tools

Applying what you have learned:

A. Discuss

B. Discuss

Answers for REVIEW OF PLASTIC PIPE JOINING METHODS (pages 117 - 118)

1. a. Solvent cementing
2. a. Solvent cementing
3. b. Elastomeric o-ring or seal
4. a. Mechanical connections
5. b. Mechanical fitting
6. a. Flanges
7. a. Heat fusion joining method
8. b. Disassembly is easily done when needed

Applying what you have learned:

A. Discuss

B. Discuss

CONGRATULATIONS!

You are now ready to take the Final Exam

GLOSSARY OF TERMS

ABS (acrylonitrile-butadiene-styrene) pipe: Plastic pipe that has a hard, smooth interior surface; resists chemicals; is not affected by contact with water or soil; and has high strength even at low temperatures.

ACR tube: Copper tube used in **a**ir **c**onditioning and **r**efrigeration systems.

Adapter: A fitting used to connect different kinds of pipe or tube that require different joining methods. For example, connecting a threaded pipe to a tube that cannot be threaded, or connecting pipe of two different materials. The term is often used interchangeably with *transition fitting*.

American National Standards Institute (ANSI): National standards-setting organization that develops standards for fittings, as well as other products from many industries.

ANSI: *SEE* American National Standards Institute.

American Society of Mechanical Engineers (ASME): An organization that sets standards for the manufacturing of cast fittings.

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

American Water Works Association (AWWA): An organization that sets standards for fittings and various other products related to water systems.

Annealed copper tube: Pipe made of copper that has been heated to relax the stresses in the metal and make the tube soft and easy to bend.

ASME: *SEE* American Society of Mechanical Engineers.

ASTM International (ASTM): An organization that sets standards for pipe and tube, as well as many other products in various industries. Formerly called American Society for Testing and Materials.

AWWA: *SEE* American Water Works Association.

B Cu P: A common **B**razing filler metal containing copper **(Cu)** and phosphorous **(P)**.

Bell and spigot pipe: Plastic PVC pipe that has a female (bell) end and a male (spigot) end; similar to cast iron hub and spigot pipe.

Bends: The term that might be used for plastic DWV elbow fittings or cast iron DWV elbow fittings.

Billet: A solid 2-foot-long x 9-inch-diameter copper section used to manufacture copper plumbing tube.

Brass: A copper alloy in which zinc is the main alloying element.

Brass pipe: A type of industrial pipe, also called *Red Brass Pipe,* used for water supply and distribution.

Brazed joint: The connection that is formed by brazing.

Brazing: A process of creating a joint by the use of a non-ferrous filler metal that melts at temperatures above 8400°F but below the melting point of the copper tube and fitting being joined. The molten filler flows into the capillary space between the male end of the copper tube and the female solder cup of the fitting. Brazing is done at a higher temperature (between 11000°F and 15500°F) than soldering and produces a stronger joint than soldering. Brazing filler metals and solder fillers are different and cannot be interchanged or mixed.

Bronze: A copper alloy in which tin is the main alloying element.

Bushing: A fitting that connects pipe or tube to a female fitting with a larger diameter.

Butt fusion: A heat fusion joint. This type of joining is accomplished by heating the two ends of pipe or tubing to the required temperature in special heating devices, and then quickly pushing the ends together with a controlled force.

C: Abbreviation used to indicate the female solder cup on a fitting used with copper tube.

Capillary: Space between the male end of a copper tube and the female cup of a fitting used in a soldered or brazed joint. *SEE ALSO* Capillary action.

Capillary action: The process by which melted filler is drawn into the capillary in a solder or brazed joint. This occurs because the molecules of the filler metal are more strongly attracted to the copper in the pipe than to the other molecules in the filler. The flux reduces the surface tension holding the filler molecules together in spherical form, allowing the molecules to "reach out" along the surface of the pipe and causing the filler to flow along in the capillary. The reaching out and flowing process is called wetting. *SEE ALSO* Capillary.

Cast copper fitting: Fitting made by pouring a molten copper alloy into a mold or cast to form the fitting.

Cleanout adapter: DWV fitting that has one FPT opening that is closed by a plug.

Closet elbow: An "L" shaped soil fitting used directly underneath the water closet to connect the closet to the main soil stack.

Closet flange: DWV fitting that connects the water closet and the sealing gasket to the main DWV line through the closet bend.

Compression molding: One of the plastic manufacturing processes. In this type of process, materials are placed immediately into mold cavities, where the application of heat and pressure first makes them plastic and then hardens them.

Compression fittings: The type of fittings that consist of two or more pipe hubs. They are most often used as conversion fittings under fixtures where they join rigid supply lines to flexible copper supply tubes. Compression fittings are a type of mechanical joining method.

Copper: A reddish metal that is durable, yet soft and easily shaped. Also often used in alloy form as brass or bronze.

Copper pipe: An industrial type of pipe. Copper pipe has a thicker wall than threadless copper pipe, and can be threaded.

Copper press fittings: The type of fittings that are used in the joining method called copper press system. There is a little hump located in the socket of each joint. Pipe is inserted into the socket of the press fitting, and then the press tool is placed over the humped area of the joint to complete the connection. Copper press fittings are a type of mechanical joining method.

Copper push-fit fittings: The type of fittings that are used in the joining method called copper push-fit or push-to-connect systems. The push-connect copper fittings look like adaptations of the normal copper or cast copper alloy fittings. The only difference is the mechanical sealing devices (lock rings and gaskets/o-rings) located in the socket of each joint. These systems are designed to allow joining of the copper tube to the fitting without the use of any tools. Depending on the manufacturer, these joints can be either removable or non-removable. Copper push-fit fittings are a type of a mechanical joining method.

Copper water tube: Term for copper pipe that has thinner walls than pipe called "copper pipe." Copper tube is manufactured using the K, L, M and DWV type designations. Most copper used in plumbing is copper tube.

Coupling with stop: A coupling with a ridge on the inside wall to control the distance the tube fits into the coupling.

Coupling without stop: A coupling without a ridge on the inside wall to control the distance the tube goes in. Couplings without stops are sometimes used to rejoin pipe that's been cut to solve some problem in the system, such as a blockage or frozen pipe, in which case they are referred to as repair couplings. They may also be referred to as slip couplings.

Crimp ring type: A plastic mechanical fitting used with plastic mechanical joining method. A crimp ring surrounding the tube and insert fitting is compressed by a special crimp tool after assembly. The crimp ring version is a one-time assembly, which means that it must be destroyed to disassemble this joint.

Crossover: A fitting with a "U" shaped bend in the middle that allows one run of pipe or tube to pass over another at the approximately the same level.

CPVC (chlorinated polyvinyl chloride) pipe: The type of plastic pipe used for hot and cold potable water distribution, corrosive fluid handling and fire suppression systems. Since CPVC materials do not support combustion, they cannot burn without an external fuel source. This property makes CPVC pipe an alternative to steel and copper pipe for fire sprinkler applications.

Die and stock: Tool used to thread pipe by hand.

Double extra-strong pipe: *SEE* Schedule 120 pipe.

Drain coupling: A cast copper coupling with a drain located between the two pipes being joined; the drain has a threaded cap that can be loosened to allow fluid or air to drain.

Drawing: A process that involves pulling the hollow tube through a series of hardened steel dies of gradually decreasing diameters.

Drawn copper tube: A tube made by heating a cylinder of copper (called a "billet") to a high temperature, piercing a center opening and forcing the billet through a press; the resulting tube is then "drawn" to reduce the diameter and make the walls thinner. Drawn copper tube is very rigid and stiff.

Drop adapter: An adapter fitting with a lug on each side of the run opening. Also called a *sill cock adapter*.

Drop ear ell: A mounting ell with lugs on the heel. May also be called *drop ell.*

Drop ell: *SEE* Drop ear ell.

DWV or copper drainage tube: A type of tube used for sanitary Drainage, Waste & Vent systems and other non-pressure plumbing applications.

Elastomeric o-ring: Also called *seal,* is one of the plastic pipe joining methods. An elastomeric o-ring or seal is held within a hub, with the pipe inserted into the ring. The pipe is cut into a desired length and the end is smoothed, beveled or chamfered (grooved) on the outside. A lubricant is applied to the pipe end, and the pipe is inserted into the hub and gasket with a quick push.

Electric resistance hand tools: Electric resistance soldering hand tools that employ heating electrodes for joining tube and fittings. The tools are lightweight and should be considered when an open flame is a concern.

Electro fusion: A type of heat fusion joint. In this type of joining process, the required temperature and heating time are controlled by passing current through an electrical resistance wire embedded in the socket.

Epoxy bonded joints: A type of joining method used for joining copper tube and fittings. Epoxy bonded joints are a relatively recent development (some are NSF approved and some are not). A two-part, fast-curing, epoxy-based adhesive is used to join copper tube and capillary fittings for water distribution systems. It also may be used in copper fire sprinkler systems (excluding dry systems), or in installations where an open flame may not be appropriate.

Extended bushing: *SEE* Fitting reducer.

Extra-long turn elbow: A copper DWV elbow with an especially long sweep – longer than a "long turn ell."

Extra-strong pipe: *SEE* Schedule 80 pipe.

Extrusion: The process by which the heated billet is forced over the mandrel and through the hole in the die, creating a long hollow tube.

Extrusion molding: One of the plastic manufacturing processes. It is the most common method of plastic pipe manufacture. It employs heating, a screw cylinder, pressure and an extrusion die through which the molten plastic is sent. It then exits in continuous form to be cut in lengths or coiled.

F: Abbreviation used for copper fittings to indicate that a fitting has **f**emale threads.

FIPT: Abbreviation used to indicate a plastic pipe end with female pipe threads on plastic pipe using the IPS system.

FPT: Abbreviation for a female threaded pipe end.

Fitting adapter: An adapter with one plain male fitting end (Ftg) and one threaded end (MPT or FPT). Often used to join soldered copper tube to a threaded pipe or fitting.

Fitting ell: A type of wrot or cast copper street ell with one male fitting end (Ftg) and one female end. Also called *street ell* or *service ell*. *SEE ALSO* Street ell.

Fitting reducer: A copper solder fitting inserted into a female solder cup opening of another fitting (such as a tee) to reduce the diameter of that female opening. This allows a smaller-diameter tube to be connected with the two other lengths of tube. Because it serves the purpose of a bushing and extends beyond the edges of the female cup, the fitting reducer is also called an *extended bushing*. *SEE ALSO* Bushing.

Fixture tee: Plastic DWV tee fitting with very little sweep at the inlet that joins the main run to piping for a fixture.

Flange: A metal ring with FPT around the inside diameter and bolt holes around the rim so it can be bolted to another flange to join two lengths of threaded pipe. Usually a gasket between the two flanges provides a tight seal.

Flange union: Two matching flange fittings joined by bolts.

Flared fittings: The type of fittings made of cast brass or bronze. They are commonly used to join soft temper copper tubing in underground service pipes or where pipes must be cleaned often. Flared fittings are a type of mechanical joining method.

Flexibility: Capability of a pipe to be bent without breaking. Small-diameter flexible plastic tube, for example, is flexible enough to be stored and shipped in coils.

Flush bushing: A bushing that is inserted into a fitting socket so that the bushing is almost even or "flush" with the face of the socket. *SEE ALSO* Bushing.

Flux: A chemical compound applied to ends of pipe to be soldered or brazed that protects the pipe metal from tarnish and rust and promotes wetting. *SEE ALSO* Capillary action; Wetting.

Ftg: Abbreviation used for the plain male end of a pipe or fitting, especially a pipe or fitting to be joined by soldering.

Fusion welding: *SEE* Heat fusion.

Fuel gas tube: A type of copper tube not commonly used or produced in the U.S.; this type of tube is often used in Canada for fuel gas installations of natural gas or liquefied petroleum (LP).

Grooved joint: The connection formed by bolting together the two halves of a coupling especially designed to fit and hold two grooved pipe ends. The seal for the joint is provided by a gasket.

H: Abbreviation used for female pipe end called a "**h**ub" found on plastic DWV pipe.

Heat fusion: Method of pipe joining in which a plastic male pipe end and a socket pipe end are melted and then fused together. Heat fusion is also called *thermal bonding, fusion welding* or *socket fusion.*

Heat fusion joint: The connection formed by heat fusion.

Heat fusion tool: Tool used in heat fusion to melt the pipe ends for joining.

High ear adapter: A cast copper adapter with lugs ("ears") set above the fitting opening. Also called a *high set adapter* or a *hy-set adapter*.

High set adapter: *SEE* High ear adapter.

Hub adapter-cast iron: An adapter used to join a hub end of cast iron pipe to a spigot end of plastic DWV pipe.

Hub and spigot compression joint: *SEE* Compression joint.

Hy-set adapter: *SEE* High ear adapter.

High set elbow: A type of an elbow with a lug or ear on each side by which it can be nailed to a stud. A typical application for a high set elbow would be a shower arm connection.

Injection molding: One of the plastic manufacturing processes. It is the most common method of producing plastic fittings. The plastic powder is melted in a crew-type chamber by the combination of heat and friction. Then a plunger action forces it into cold molds, where the product cools and is ejected in a rigid shape. The operations take place at rigidly controlled temperatures and intervals.

Insert fitting: A plastic mechanical fitting. Insert fittings are fittings that are inserted into the tube. The fitting's barbed outside diameter grabs the inside diameter of the tube. Final sealing is made by compressing a gear-type clamp over the tubing at the point of the barbs. Insert fittings also can transition from tube to a threaded connection by way of barb/thread/spigot combinations.

Intermediate radius ell: A type of an elbow that is produced to the specifications between short- and long-turn elbow. The radius chosen depends on the application,

with a longer radius being preferred when high velocities and turbulence — which can cause erosion corrosion — are a concern.

IPS: *SEE* Iron Pipe Size sizing system.

Iron Pipe Size (IPS) sizing system: An outside-controlled or O.D.-controlled system developed by the steel pipe industry. Pipes are designated by their nominal size, which is approximately the pipe's inside diameter (I.D.). IPS pipe is made in Schedule 40, Schedule 80 and Schedule 120.

Joint: The point in a piping system at which a pipe, fitting or valve is connected to another pipe, fitting or valve.

Liquidus temperature: The higher temperature at which the filler metal is completely melted.

Long radius ell: A copper 90° elbow with a longer turn that makes the change of direction with a more gentle curve. It may also be called a *long turn ell.*

Long turn ell: *SEE* Long radius ell.

M: Abbreviation used with copper pipe and fittings to indicate a **m**ale threaded pipe end.

Manufacturer's Standardization Society (MSS): An organization that sets standards for the manufacture of cast fittings.

Mechanical joints: The type of joints used when the use of heat is impractical, and the type of joints that may have to be disconnected from time to time.

Medical gas tube (Type K or L): A type of tube that is specially cleaned and capped to maintain a clean interior surface acceptable for use with nonflammable medical gases and some other high-purity applications.

MIPT: Abbreviation used with plastic DWV pipe ends to indicate **m**ale **i**ron **p**ipe (size) **t**hreads.

MPT: Abbreviation for **m**ale **p**ipe **t**hreads.

Mounting ell (or elbow): An elbow that has mounting "ears" or lugs attached for anchoring the pipe to the wall or stud. There are several types of mounting ells with different names (such as *"drop ear ell"* or *"high set ell"*), depending upon the location of the ears.

MSS: *SEE* Manufacturer's Standardization Society.

National Sanitation Foundation (NSF): *SEE* NSF International.

NSF International (NSF): An organization that certifies that pipe used to carry potable water meets required standards. Previously called National Sanitation Foundation.

NSF 61: A compliance certification that copper tube and wrot fittings used for potable water systems must meet as a result of the U.S. Safe Drinking Water Act (1996) and the Lead and Copper Rule (1991).

Nut ferrule type: A plastic mechanical fitting used with plastic mechanical joining method. A threaded nut is tightened onto a matching thread that compresses the tube or a ferrule over the insert as it is tightened. The threaded assembly can be taken apart and reassembled as necessary.

Oxygen tube: Type K or Type L drawn copper tube used for oxygen lines that has been cleaned to meet standards set by the National Fire Protection Association. The ends are then capped. This tube is said to be "clean and capped" tube.

PE (polyethylene) pipe: The type of plastic pipe that with properties of light weight, flexibility, chemical resistance, overall toughness and longevity that make it an ideal piping material for a broad variety of applications such as potable water service or distribution lines, natural gas distribution, lawn sprinklers, sewers, waste disposal and drainage lines. PE piping also can be used in low temperatures without the risk of becoming brittle and breaking easily. Major application for certain PE piping formulations is for low-temperature heat transfer applications such as ice rinks and geothermal ground source heat pump piping.

PEX (cross-linked polyethylene) tubing: The type of plastic tubing used in hot and cold water distribution systems and for hydronic radiant heating in Europe for many years. Introduced into the U.S. in the 1980s, PEX has replaced Polybutylene (PB) as the most widely used flexible plumbing tubing.

Piercing mandrel: A pointed rod that is driven through the center of the billet or copper section to create the inside wall of the plumbing tube.

Pipe cutter: Tool that is clamped onto a steel pipe and rotated so that cutter wheels shear the pipe.

Pipe dope: A substance (often a type of plastic compound) used to lubricate threads in a threaded joint and to seal the joint. Also called *thread compound*.

Pipe joining: The connection of pipe, fittings and valves into a piping system.

Pitch: The number of threads per inch of threaded surface. There are industry standards for pitch and other thread characteristics.

Plastic-coated copper tube: A type of copper tube that is plastic coated to provide added corrosion protection for potable water lines in both plumbing and municipal applications.

Plumbing tube: Copper tube used for pressure applications in supply systems, as well as for DWV systems, hydronic heating systems and fire sprinkler systems.

Polymer: A relatively large, heavy molecule. It gives plastic its main characteristics and usually its name, such as ABS, CPVC, PE and others.

Potable water: Water that meets safety standards for use as drinking water.

PP (polypropylene) pipe: A very rigid and strong plastic pipe that is resistant to chemicals.

Pressure rating: The designated working pressure that can be handled continuously by pipe for a designated number of years without failure.

psi: **P**ounds per **s**quare **i**nch. The measurement used for calculating pressure in pipe.

P-trap: A drainage fitting used in a DWV system to prevent sewer gas from leaking back into the system.

P-trap U-bend: A plastic DWV fitting that would be called a "return bend" in other materials.

Pure copper: An unalloyed copper that is relatively soft. It is used for cables and wires, electrical contacts and a wide variety of other parts that are required to pass electrical current.

PVC (polyvinyl chloride) pipe: A hard, strong, rigid plastic pipe with a smooth interior surface that resists chemicals and is not affected by contact with water or soil. PVC pipe is the most widely used plastic material.

Reamer: A tool used to remove burrs from the inside wall of a pipe after it has been cut to length.

Reducer: A fitting that is larger at one end than at the other; is used to join two pieces of pipe of different diameters.

Refrigeration and ACR tube: Type of copper tube used for air conditioning, refrigeration, natural gas and liquefied petroleum (LP) gas.

Repair coupling: *SEE* Slip coupling.

Saddle fusion: A type of heat fusion joint. This type of joining is similar to butt fusion, except that different heating tools are required. *SEE* butt fusion.

Schedule 40 pipe: Pipe that is sized by the IPS system to match the requirements for Schedule 40 listing. Schedule 40 pipe is referred to as *standard pipe* and has the thinnest walls of all the schedules.

Schedule 80 pipe: Pipe that is sized by the IPS system to match the requirements for Schedule 80 listing. Schedule 80 pipe is referred to as *extra-strong pipe* and is the middle-range of pipe by wall thickness.

Schedule 120 pipe: Pipe that is sized by the IPS system to match the requirements for Schedule 120 listing. Schedule 120 pipe is referred to as *double extra-strong pipe* and has the thickest walls of all three schedules.

SDR: *SEE* Standard Dimension Ratio sizing system.

Service ell: *SEE* Street ell.

Short radius ell: A copper 90° ell with a shorter turn, making for a less-gentle curve. May also be called a *short turn ell.*

Short turn ell: *SEE* Short radius ell.

Sill cock adapter: *SEE* Drop adapter.

Sleeving: A process of sliding an outer sleeve or coating over a tube or pipe.

Slip: Term used for an unthreaded female socket end on plastic DWV pipe.

Slip coupling: A coupling without a stop. Also called a repair coupling.
SEE ALSO Coupling without stop.

Slip joint: The connection when one pipe slides into another with a gasket, o- ring, packing or caulking used to made the joint tight.

Slip joint adapter: A fitting that is used to join plastic pipe to a trap.

Socket fusion: A type of heat fusion joint. This type of joining is similar to butt fusion except that different heating tools are required. *SEE* butt fusion.

Soil pipe adapter: A type of adapter that has two hub connectors, one for the soil pipe and the other for the plastic DWV spigot.

Solder: Another name for solder filler, which is generally a wire-like, tin-based alloy sold in spools. Other elements may be added to the tin alloy, but it is against the law to use lead in any solder used in potable water systems.

Solder cup: The female end (socket) of a solder fitting, into which the solder will be fed for a solder joint.

Soldered joint: A connection formed by soldering. Also called *sweat joint* or *sweated joint.*

Soldering: A process of creating a joint by use of a non-ferrous filler metal that melts at temperatures below 8400°F and below the melting point of the copper tube and fitting being joined. The molten filler, called solder, flows into the capillary space between the male end of the copper tube and the female solder cup of the fitting. Soldering is done at a lower temperature than brazing and the soldered joint is not as strong as a brazed joint. Solder filler and brazing fillers are different and cannot be interchanged or mixed. Soldering is sometimes referred to as *sweating,* and a soldered joint is sometimes called a sweat joint or sweated joint.

Solidus temperature: The temperature at which a filler metal starts to melt upon heating.

Solvent cement joint: The connection formed between two plastic pipe ends that have been solvent cemented. Also called a *solvent welded joint.*

Solvent cementing: A pipe joining method in which the ends of plastic pipe are first treated with a solvent that partially dissolves the plastic surfaces, then placed in contact with each other and allowed to reharden, forming a chemical fusion. The process is also called *solvent welding.*

Solvent welded joint: *SEE* Solvent cement joint.

Solvent welding: *SEE* Solvent cementing.

Sp: Abbreviation for an unthreaded male pipe end (a **s**pigot) on a plastic DWV pipe.

Spigot: An unthreaded male pipe end on a plastic DWV pipe.

Spigot adapter-cast iron: A fitting with two hub ends that is used to join the spigot of a plastic pipe to the plain end of a cast iron pipe or fitting.

SR (styrene rubber) pipe: Strong, rigid plastic pipe that resists corrosive soils and sanitary wastes.

Stab type: A plastic mechanical fitting used with the mechanical joining method. A plastic pipe or tubing is cut, the end is chamfered, the stab depth is marked on the pipe or tubing, and then it is stabbed into the fitting.

Standard Dimension Ratio (SDR) sizing system: A method of sizing plastic pipe according to pressure ratings.

Standard pipe: *SEE* Schedule 40 pipe.

Street ell: An elbow with one male end and one female end. May also be called a *service ell*. May be called a *fitting ell*, especially if the male end is an Ftg end.

Strength: Characteristic of plastic pipe dependent on the density of the plastic and thickness of pipe wall.

Sweated joint: *SEE* Soldered joint.

Sweating: *SEE* Soldering.

T-Drill joining method: A type of joining method used for joining copper tube and fittings. It involves a hand tool designed to quickly pull tee connections and outlets from the run of the tube. This reduces the number of tee fittings and brazed joints. The resulting branch outlet joint must be brazed.

Temper: The hardness of a metal or metal alloy.

Temperature correction factor chart glossary: The type of chart provided by many plastic manufacturers' catalogs. It provides a simple way to calculate how much the elevated temperature will reduce the pressure rating.

Thermoplastics: One of the two basic types of plastic materials. Thermoplastics soften when heated and harden when cooled. Thermoplastics can be repeatedly softened/hardened. This is the type of plastic material used in most pipe and fittings.

Thermosets: One of the two basic types of plastic materials. This type of plastic material cannot be re-shaped, even with heating, after the initial forming process.

Thread compound: *SEE* Pipe dope.

Threaded copper pipe: A copper pipe that is threaded by an installer at the job site. Special applications, such as ship building, require copper threaded pipe.

Thread cutting oil: Oil used to lubricate the die and reduce the heat of friction when threading steel pipe.

Threaded joints: Used for joining copper tube and fittings. Threaded joints have both external and internal NPT threads. These joints are used to adapt copper tube to equipment that has threads or to add copper tube to existing iron pipe installations or to other threaded connections.

Threadless copper pipe: A type of industrial threadless copper pipe that has a thinner wall than copper pipe because it is not intended to be threaded. The thinner wall allows for a higher flow rate than the same-sized copper pipe. Threadless copper pipe is often referred to as *TP pipe.*

Transfer molding: One of the plastic manufacturing processes. In this type of process, the compound is plasticized by outside heating and then poured into a mold where it is cooled and allowed to harden. This process is used for designs with complex shapes and great variations in wall thickness.

Transition fitting: *SEE* Adapter.

Tray plug adapter: A fitting that joins the threaded drains on a laundry tray or tub to the solvent weld connectors on the trap or DWV drain line.

TY: A copper fitting that is a combination of a tee and a Y fitting, used in DWV systems to connect three sections of tube. A TY is sometimes thought of as a combination of a tee and a bend because the Y arm is curved to allow for smooth flow of waste. In soil pipe, it would be called a "combination 1/8 bend."

Type K: A copper water tube with the thickest wall used in high-pressure applications for general heating and plumbing.

Type L: A copper water tube with the intermediate wall thickness used for medium-pressure applications in interior hot and cold water lines, steam heating and condensate return lines.

Type M: A copper water tube with the thinnest wall used for hot and cold water lines in residences and low-pressure steam or hot water heat lines.

Union ell: An elbow fitting with a union connection at one end.

Vent elbow: A cast copper elbow that has an opening that allows the installation of a vent to vent air or gas from the line.

Water tube: Copper tube Types K, L and M used to carry water in supply and heating applications.

Welded joint: The connection formed as the result of the welding process.

Welding: The process of heating two ends of pipe to the point at which they melt and blend together, making one continuous pipe. In some cases, the two ends of pipe may be welded together directly, while in other cases a filler metal, called welding rod, is used to fill in between the beveled ends of the pipe.

Welding rod: Filler metal often used in the welding process to fill in between the beveled ends of the pipe.

Wetting: The process by which the flux reduces the surface tension holding the molecules of solder or brazing filler metal together in spherical form and allows the filler molecules to flow freely along the copper pipe and into the capillary of the soldered or brazed joint. *SEE ALSO* Capillary; Capillary action.

Wrot copper fitting: A fitting made from pure copper tube that is formed into the desired shape by applying pressure. Also called *wrought copper*.

Wrought copper fitting: *SEE* Wrot copper fitting.

Wrot DWV fittings: The type of fittings that are made by bending, enlarging or drawing branch openings out of existing copper tube.

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