Process Pipe Drafting

Rip Weaver

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This book is dedicated to my wife Lila. Man's greatest earthly possession is the undemanding love of a wonderful woman. All men seek it, but only the fortunate find it. I happen to be among the fortunate.

PREFACE

Many of the diagrams, drawings and specifications in this book will be somewhat familiar to piping draftsmen all over the world. While companies have some vastly different ways of doing the same job, many items in the text are common to several companies.

Fluor Engineers and Constructors, Inc., a worldwide leader of engineering and constructing industrial complexes, has greatly influenced my thoughts in this book.

However, many items portrayed represent other methods. I have chosen not to represent the methods of any one company but to let the student enter piping drafting with more of a general knowledge.

I do wish to take this opportunity to thank Fluor for its help in getting this book written.

Rip Weaver

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INTRODUCTION

This book acquaints the individual with the basic piping fundamentals as used in refinery and petrochemical plant design. After completing this book, along with the class instruction, the student will have the equivalent of about one year's piping drafting experience. With this background he can enter private business, comprehending something of what is expected of him and generally knowing the terms and equipment that make up the refinery or petrochemical installation.

The need for competent piping draftsmen is very high around the world. You can pick up a newspaper in most major cities and see calls for piping draftsmen in the "help wanted" section. This book will help prepare you to fill one of these high paying jobs.

The draftsman's calling card is his ability to do freehand lettering and good linework. Whether filling out an employment application or making a finished drawing, he is automatically judged by his lettering. To be a professional draftsman, you must do professional lettering; so this book will stress lettering and linework throughout.

After completing the book, you should keep it in your files for constant reference. After doing piping drafting a few weeks, you should read the book again because you will probably retain a lot that slipped by you the first time through.

Most of the book deals with welded type piping and fittings, as process piping most commonly uses them. Welded piping is usually specified for sizes 3" and above. Screwed and socketwelded piping is for sizes 2" and below. Chapter 11 assembles reproductions of pertinent pages from manufacturers' catalogs. Illustrations describe valves, flanges and fittings much better than do hundreds of words. Detailed dimensions are also shown on these reproductions.

This book introduces the reader to these items in various chapters. For full details refer to Chapter 11. By combining this information into one chapter, you will have immediate access to it while you are reading this book and also when you are actually working as a piping draftsman.

Piping drafting will challange you. You must display good draftsmanship, accuracy and speed. Every petrochemical unit you help design will have something new. While drawing on flat paper, you must visualize your work in three dimensions. The supervisor may push you beyond your endurance.

But you will find it a very rewarding occupation–for salary and for job satisfaction. One day you may walk down the operating aisle of a huge petrochemical complex and be able to say, "I designed that unit."

Tools and Supplies

Every professional has his own tools. A professional draftsman is no exception. Below are tools you should have for this course and for your drafting job.

1. Trangular 12" architect's scale
2. 10" 30°-60° triangle
3. 8" adjustable triangle
4. Ames lettering guide
5. Compass
6. 2 Mechanical pencils
7. Mechanical pencil pointer
8. Rapidesign #40 circle template
9. Ellipse template
10. Erasing shield
11. Smoley's Combined Tables

The following supplies are also needed for this course.

1. Sandpaper block
2. H, 2H and 3H lead for mechanical pencil
3. Pink pearl eraser
4. Scratch pad
5. #2½ pencil
6. Red and yellow pencils
7. 6 sheets 18" x 24" tracing vellum paper
8. 24 sheets 8½ x 11" tracing vellum paper
9. 1 tablet Ridgeway #1000H isometric paper

CHAPTER I

EQUIPMENT & TERMS

The student is about to meet a completely new language. The piping draftsman must know the terms of the business. The student has heard some of these; many will be strange. But, even if he has heard the term, does he know what it means? First, the student will investigate some of these new terms. He must learn them well, for a professional knows his business; and this is the language of the professional piping draftsman.

Process Plant Terms

Refinery

A refinery is a plant that takes crude oil as its "feed" or "charge" stock and converts it into the many by-products that people use. Some of these are gasoline, jet fuel, kerosene, butane, propane, fuel oil and asphalt.

Gasoline Plant

The gasoline plant takes natural gas (a vapor) as its charge stock and separates the vapor's heavier products out and reinjects the lighter gas (methane) into a pipeline or perhaps into the gas field it came from. Again gasoline, propane and butane are extracted as products. But, since a gasoline plant starts with a vapor, the heavier hydrocarbons do not exist in its charge stock; so heavier products cannot be made. Asphalt is one of the products that is classified as a heavy hydrocarbon and is not produced in a gasoline plant.

Hydrocarbon

The hydrocarbon compound contains hydrogen and carbon. Hydrocarbon compounds are numerous and form the basis for petroleum products.

They exist mostly as vapors and liquids but may also be solid. In general, piping systems in refineries and gasoline plants transport hydrocarbons or utilities.

Chemical Plant

The chemical plant takes semirefined products from refineries and gasoline plants and—by running them through their units, sometimes blending in other products—converts them into certain chemicals which may be sold as a finished consumer product. One such product widely demanded today is plastic. Chemical plants make many ingredients in modern medicines.

Tank Farm

The tank farm is the area that contains the huge storage tanks of the refinery and gasoline or chemical plants. The tanks are usually isolated from the main processing units in case of fire. They may be 200' or more in diameter and will contain the plant's charge stock for several days. The tanks also will store the plant's products, until the shipment goes to the consumer.

Process Plant Utilities

Utility

The utility is a refinery's service portion. While a home has water, gas and electricity, a refinery or other plant has many more, some of which are below.

Steam. Steam services many plant items. Heat generates steam in fired boilers or heaters, which will make many different steam pressures and temperatures. They apply heat and convert condensate (a pure water) to steam (a vapor). The steam then goes to the different plant units in the piping systems which use the steam.

Many students think they have seen steam, but they haven't. They cannot acutally see steam; it is invisible. What they have seen is the condensate condensing out of the steam. That is where the term "condensate" comes from.

Condensate. As the energy in steam is used, the steam turns to condensate. Another piping system collects this condensate, which is returned under a low pressure to a collection point and is pumped through the boiler tubing and converted to steam again. So the condensate is in a constant cycle from steam to condensate to steam.

Fuel Oil. Fuel oil is another utility that refineries make and partially consume. It is also sold as a product to heat homes and fire furnaces in private business.

Instrument Air. A utility that operates the plant instruments is instrument air. A piping system distributes this air, which has been compressed and dried to remove all its moisture, as the moisture would harm the instruments.

Utility Air. Utility air drives air motors and blows air on objects to clean them, such as some barbers blow cut hair off customers with air hoses.

Cooling Water. Cooling water cools various streams in a plant. The water starts at a cooling tower and is pumped through a piping system to exchangers, which exchange heat. It comes out hotter—much like water from a hot water heater in a home. This water then returns to the cooling tower, which cools the water, and then is ready for more circulation into the unit. Like the steam and condensate system above, this is a constantly circulating system.

Drains. An underground utility collects drains from funnels or catch basins and, in a separate piping system, transports them to a disposal point. Since no pressure is in this drain piping, the pipes must slope to cause flow. This slope is usually 1 foot per 100 feet of line or greater.

It can be very difficult to design drain systems. Since they run underground, they must miss all other underground items. As an example, a $25 million installation will use about 20,000 yards of concrete, most of which will be underground as foundations for the process equipment. The drainage system must twist and turn to miss all the foundations.

Most plants also have more than one drain system. They may have an oily water sewer, a storm water sewer and an acid sewer. The oily water sewer handles the oily drips and drains. The storm water sewer collects surface runoff from rains. The acid sewer collects acid drains and drips. There may be many other types of separate drain systems.

Flare System. The flare system transports vapors (via a piping system) to a flare stack which is very tall and has a flame burning at the top. This system burns waste gases and also collects and burns relief valve discharges. At night the flare stack usually stands out–sending flames high into the air. This is waste gas burning. If it did not burn, it would pollute the air.

These are some basic terms and piping systems you should learn completely. And you will be exposed to many more–beginning with the definition of piping.

Piping and Pipe Sizes

Piping transports a vapor or liquid and some solids. A familiar piping system is the gas and water pipes in a home. These are sized to flow sufficient products into the home. Most are ½" and ¾" and are usually screwed fittings because the pressures and temperatures are very low. Piping systems for refineries usually are 1"-24" with some special systems measuring several feet in diameter. A person could easily walk in some. Pressures and temperatures are very high, so these pipes and fittings are welded and not screwed.

Pipe sizes are calculated to flow a certain product at a set quantity at its pressure and temperature. The higher the pressure, the more pipe thickness required. As the system's temperature rises, it not only affects the thickness, but hot objects expand, and expanding pipe creates a force which must be considered.

Pipes are constructed of many materials–most commonly of carbon steel. They may also be of stainless steel, chrome steel, vitrified clay, cast iron, plastic, glass and many other materials.

Process Plant Equipment

It's important to remember the names and functions of equipment to which the piping draftsman will have to connect.

Vessel

A vessel is only a large diameter pipe which may have internals. Some are installed horizontally, like those at a service station. Most vessels there are underground to store regular and premium gasoline. Many are vertical and vary in size and shape. The tall ones, which have "fractionating trays" inside, are *fractionating towers*. They are 100' or more high.

Reactors are vertical vessels or spheres which contain a catalyst. A chemical reaction occurs in this vessel, changing the molecular structure of the fluid going through it.

No chemical change occurs in fractionating towers which separate the various compounds. The separation results from the different boiling points of the different products. The lighter the product, the lower the boiling point. The desired "cut," or product separation, is drawn off generally as a vapor from the top of the fractionating tower. This vapor is then cooled, usually by cooling water, and condensed to a liquid which the overhead accumulator (see below) then retains. The main point to remember is that the fractionating tower "fractionates," or separates, products. No chemical change occurs just like no chemical change occurs when cream is separated from whole milk. In a "reactor" a chemical change, or reaction, *does* occur.

Overhead accumulator is sometimes called "reflux accumulator." This is a horizontal vessel which collects the overhead product from a fractionating tower. It usually operates one-half full of liquid. These vessels usually have little, if any, internals.

Storage Tanks

Storage tanks still fall under the "vessel" category but are not in the process areas. They usually appear as bunches and are called a "tank farm." The tanks run more than 200' in diameter and are 40 to 60' high. They store the crude oil until the process units are ready for it, store all the various products until they are sold or the plant consumes them and also store "rerun" products, which have come from one unit and are held for further refinement in another.

These tanks have many types. Most are flat bottomed with a conical top. Some have a floating top which floats on top of the stored liquid. These tanks are used when the stored liquid has a high evaporation loss.

Most "light ends" products are stored under pressure so they won't evaporate. Some are propane and butane, which are stored in "bullets" or long horizontal vessels. Some of these lighter products are stored in "spheres," which legs support.

Exchangers

The "heat exchanger" gets its name from exchanging heat from one stream to another. Many methods accomplish this. A common exchanger is the car radiator. This heat exchange comes from water radiating heat through the metal of the radiator. Another common exchanger is the home hot water heater. This exchanges heat from the heating medium to the water. In most applications in process units, this exchange occurs between two process streams so that heat is not wasted. Heat is energy, and wasted energy costs money.

Exchangers also differ in size and shape. Most are the "shell and tube" type installed horizontally. Another is the "fin-fan" or air cooler type, which blows air over exposed tubes to cool the fluid, much like the car radiator works. While the car radiator is vertical, the "fin-fan" is usually horizontal. The "double pipe" exchanger is another type. It has pipe inside a larger pipe, transferring heat from one stream to the other stream. In an exchanger the two streams *never* mix. They exchange their heat through a pipe or "tube" just as the car radiator exchanges heat through the radiator. The water doesn't actually contact the air, or a leak would result, losing the water.

Pumps

Pumps increase the pressure of a *liquid* and cause circulation. The heart, for example, is a pump. The liquid comes to the pump at a low pressure and is discharged at a higher pressure, causing circulation.

Many different pumps exist. The most common is the "centrifugal," which uses a high speed impeller and centrifugal force to increase the pressure. A "reciprocating" pump's parts reciprocate and increase the pressure much like a car's pistons, which go back and forth. This type is often called a "positive displacement" pump.

Compressors

Compressors increase the pressure of a *vapor*. They also come as "reciprocating" and "centrifugal." Familiar compressors are the air compressors in a service station or a simple air pump that inflates a bicycle tire. Unlike liquids, vapors will compress. Car tires have compressed air. An inflated ballon must have compressed air.

Fired Heaters

Fired heaters are huge and are in most refineries, gasoline plants and chemical plants. They may be vertical like a hot water heater, or may be horizontal. They contain pipes, or "tubes."

A "vertical" heater is cylindrical and its diameter may be as much as 20'. The tubes or pipes will run vertically. Burners, firing fuel gas or fuel oil will be on the heater's bottom. Its bottom is usually 6'-7' from the ground.

The "horizontal" heater is shaped like a box and is often called a "box" heater. Its tubes run horizontally. The burners may be on the heater's bottom, ends or sides.

Vertical heaters generally operate for smaller duties, while the larger horizontal heaters carry out heavy duty services.

The heaters have two main sections–radient and convection. The radient section is the large part of the heater, where tubes receive heat radiating from the burners. The convection section of the heater is directly above the radient section and just below the stack. The inlet to heaters is usually in this convection section. The convection section of fired heaters often generates steam.

Boiler

The boiler is another fired heater. It takes a condensate and, by applying intense heat, converts it to steam. Fired heaters–instead of boilers–heat hydrocarbons. Boilers generate steam. Fired heaters may generate comparatively little steam in their convection section, but they mainly heat hydrocarbons.

Boilers and fired heaters have stacks. The stack is the large diameter pipe that carries off hot waste gases. The temperature of these gases in the stack runs from 700° F to 1000° F or more.

Valve Types and Uses

Valves

Valves stop or open and regulate flow. Some valves are huge and some are very small.

Gate valve is the most common type that plants use. It is usually manually operated and is designed for open or shut operation. It's not recommended for throttling.

Globe valve is for throttling. Good examples of globe valves are the faucets on a washbasin which throttle or adjust the flow to suit a person's needs.

Relief valve or *safety valve* is an automatic valve that opens when the pressure reaches "set pressure" on the relief valve. Without relief valves the plants could explode during periods of very high pressure. These valves have a spring that holds them shut. The spring holds until a set pressure is obtained; and, when the pressure is more than the set pressure, the spring "gives" and allows the fluid to escape, thereby relieving the pressure. As the pressure reduces, the spring closes and shuts off the flow.

Control Valve is usually an automatic valve built with a "globe valve" body and controls flow in a piping system. This valve opens, closes or throttles on a signal from an instrument. No manual operation is required, although some manual control valves are available. An example of an automatic control valve is the "Big Joe" type pressure regulating valve that controls a home's gas pressure. The gas line near the meter shows this "control valve." Control valves in a car, for instance, control water flow in the car heater.

Plug valve has a plug that rotates when turned and either lets flow pass through a hole in the plug or turns so that no flow is possible. This valve may be used for on-off service or for throttling. It has a more positive shutoff than the gate valve.

Ball valve uses a ball with a hole in it instead of a wedge-shaped plug, and the rotating ball opens or closes the flow. It also may be used for throttling. Ball valves are comparatively new and are gaining wide acceptance.

Check valve "checks" flow. It lets flow go one way and will not let it reverse. When you have a check valve in a line (or pipe), you have made a one-way street. The flow can only go one way. Many check valves are available. The common ones are *swing check*, in which a flapper lifts up to permit flow; the *piston check*, which has a piston in it that lifts to flow; the *ball check*, which has a ball in it which lifts; and the *butterfly check*, which has two vanes like a butterfly has wings. These "wings" fold back to permit flow but will close to stop backflow.

Plants are now using possibly a hundred other valves, but this book can't cover all of them. The student will be exposed to them as he gains actual experience. He should remember that these valves come in all sizes–from very small to sizes a person could walk through for special applications. The most common valving size is ½" through 24".

Valves are expensive; their total cost is approximately 20-25% of the piping system in most plants. Like pipe, they are manufactured to all material specifications. The most common one is carbon steel.

Piping Terms

Flanges

Flanges make a bolted joint. This book will show later that most valves have flanged ends and must have a companion or matching flange attached. A gasket is then inserted between them, and the bolts are tightened to form a flanged joint.

Fittings

Fittings are many and varied. Some are elbows, tees, reducers, reducing ells and caps.

Instruments

Instruments tell the operator what is happening inside a vessel or pipe. A *pressure gage* tells him the pressure like an oil gage on a car tells the oil pressure in its piping system. A *gage glass* connected to a vessel tells the operator what the vessel's liquid level is. A *level indicator* tells him what the level is from a remote location. A car's gas gage is a level indicator because it is not hooked to the tank but is remotely located on the dashboard. Gage glasses on large coffee urns in restaurants show how much coffee is in the urns by the level in the gage glass itself.

Temperature indicators tell the fluid temperature in the pipe or vessel. They can be remotely located like a car's "temperature indicator." They also can be connected directly to the pipe or vessel.

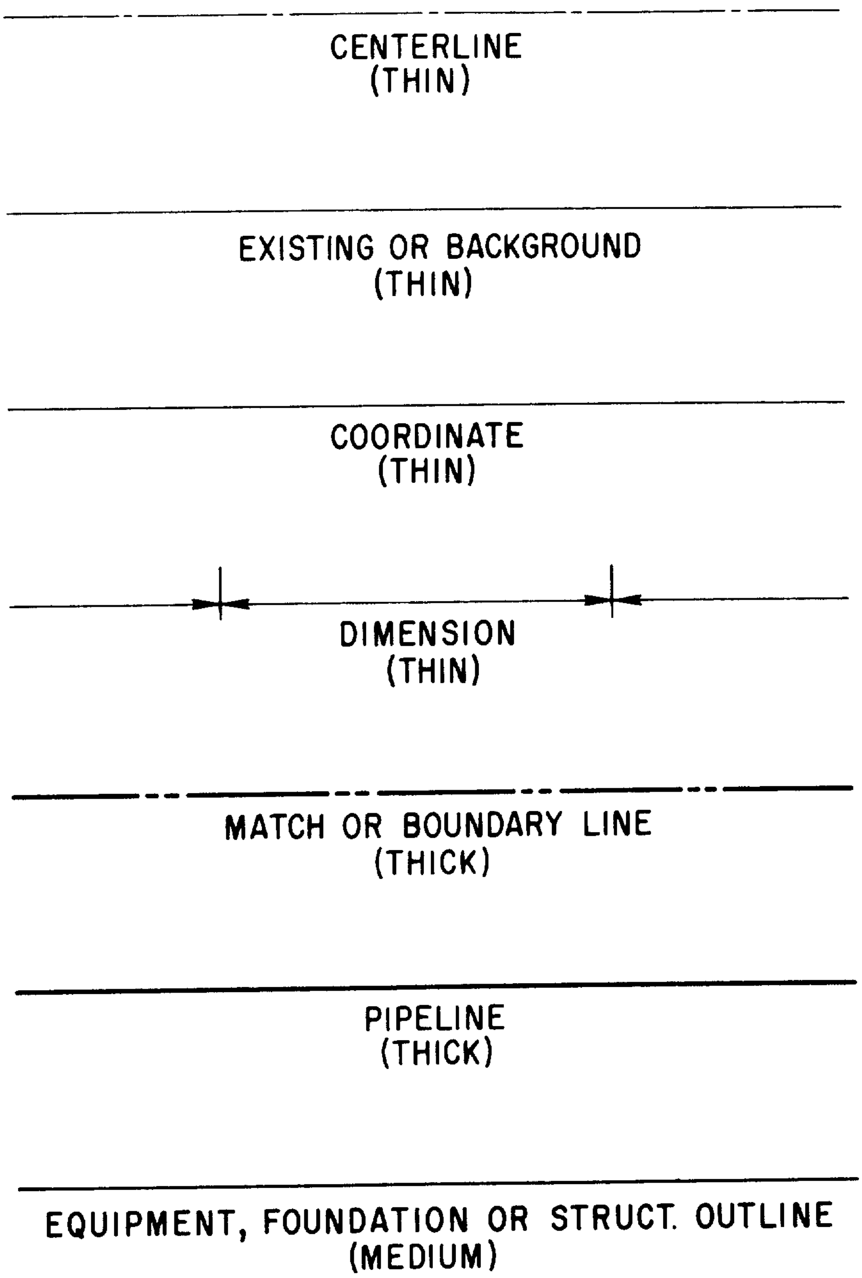
This book will cover other instruments later.

Fluid

Most students may think of fluid as a liquid, but it can also be a vapor. Fluid means something that will flow—something not solid. Piping directs fluid flow.

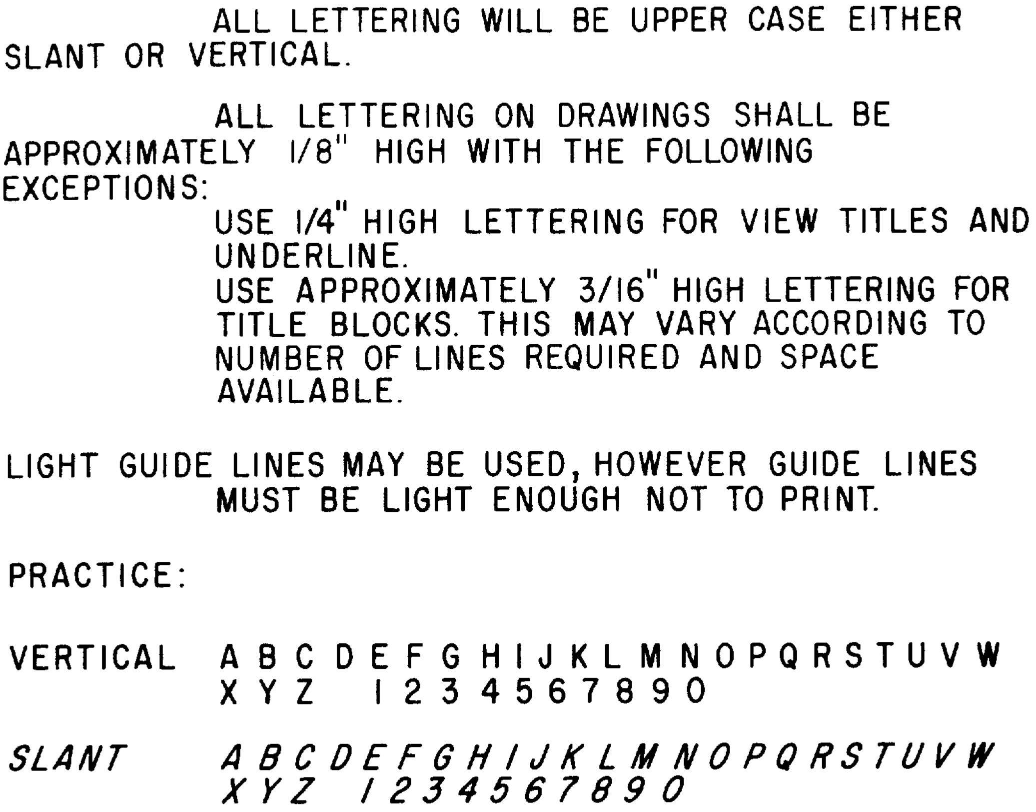
LINEWORK EXERCISE

Linework is important to the professional draftsman—a simple but often overlooked truth. In the piping field, he draws piping as the thick line. If he were doing electrical drafting, he would want electrical to stand out; so he would draw it heavy. All lines must be dark enough to print on a reproduction machine but not so soft as to smear.



LETTERING EXERCISE

The lettering is a professional draftsman's calling card. The student should strive for perfection in his lettering. This requires constant practice. Throughout this course he should practice lettering. At least once a week, turn in a lettering sheet as duplicated below. As soon as his lettering is very good, the instructor will tell him that he may stop turning in the sheet. All lettering must be in capitals. Lower case lettering is not commonly used for piping drawings.



ALL LETTERING WILL BE UPPER CASE EITHER SLANT OR VERTICAL.

ALL LETTERING ON DRAWINGS SHALL BE APPROXIMATELY 1/8" HIGH WITH THE FOLLOWING EXCEPTIONS:

USE 1/4" HIGH LETTERING FOR VIEW TITLES AND UNDERLINE.
USE APPROXIMATELY 3/16" HIGH LETTERING FOR TITLE BLOCKS. THIS MAY VARY ACCORDING TO NUMBER OF LINES REQUIRED AND SPACE AVAILABLE.

LIGHT GUIDE LINES MAY BE USED, HOWEVER GUIDE LINES MUST BE LIGHT ENOUGH NOT TO PRINT.

PRACTICE:

VERTICAL A B C D E F G H I J K L M N O P Q R S T U V W
X Y Z 1 2 3 4 5 6 7 8 9 0

SLANT *A B C D E F G H I J K L M N O P Q R S T U V W*
X Y Z 1 2 3 4 5 6 7 8 9 0

CHAPTER 2

BASIC PIPING DATA

Many students have never seen pipe like the process plants use. The pipe is dimensionally set by the ANSI (American National Standards Institute) code. Wall thickness varies with the "schedule" number, but the *outside* diameter remains constant for the various sizes. As the thickness changes, the inside diameter changes. A schedule number and "standard weight" and "extra strong" list pipe and fittings. Several schedule numbers are available. This book deals with standard weight and extra strong. In table 2-1 the (–) thickness does not match a schedule number.

An example of pipe is in Figure 2-1.

Several methods of manufacturing pipe exist. The most common method makes "seamless," where the pipe is smooth with no seam or joint on the longitudinal axis. "Welded" pipe has a weld lengthwise. This may be "buttwelded" or "ERW" (electric resistance welded) or may be "spiral welded," which has a weld spiraling around the pipe.

Pipe is manufactured in "random length," which is ± 20'-0", and in "double random length," which is ± 40'-0". Unless double random is specified, the draftsmen will get single random lengths.

Pipe is single line and double line on piping drawings. Most companies have converted to single line piping drawings because they take less manhours to draw. Single line piping uses the heavy line for the pipe's center line. Whether single or double line, the OD (outside diameter) is always drawn to scale. For pipe sizes 1½" and below, this would be very difficult; so in both cases these are single line. (See Figures 2-2a and 2-2b.)

Fittings are welded, screwed and socketwelded. The student will find many other types as he learns the business.

The elbow makes turns. It is commonly called an ell and mainly makes 90° and 45° turns. The 90° elbow comes in "long radius" and "short radius." The 45° elbow comes only in long radius. A

Table 2-1

Pipe Diameters, Wall Thickness and Schedule No.

Nominal Size Inches	Outside Diameter Inches	Std Weight Thickness and Schedule Inches		Extra Strong Thickness and Schedule Inches	
1/8	.405	.068	(40)	.095	(80)
1/4	.540	.088	(40)	.119	(80)
3/8	.675	.091	(40)	.126	(80)
1/2	.840	.109	(40)	.147	(80)
3/4	1.050	.113	(40)	.154	(80)
1	1.315	.133	(40)	.179	(80)
1-1/2	1.900	.145	(40)	.200	(80)
2	2.375	.154	(40)	.218	(80)
3	3.500	.216	(40)	.300	(80)
4	4.500	.237	(40)	.337	(80)
6	6.625	.280	(40)	.432	(80)
8	8.625	.322	(40)	.500	(80)
10	10.750	.365	(40)	.500	(60)
12	12.750	.375	(–)	.500	(–)
14	14.000	.375	(30)	.500	(–)
16	16.000	.375	(30)	.500	(40)
18	18.000	.375	(–)	.500	(–)
20	20.000	.375	(20)	.500	(30)
24	24.000	.375	(20)	.500	(–)

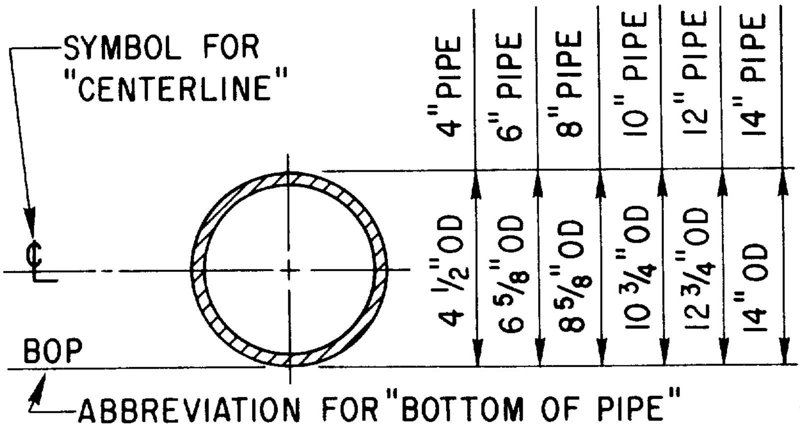


Figure 2-1. Pipe nominal vs. actual outside diameter.

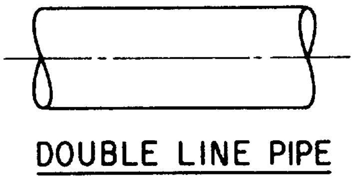


Figure 2-2a. Double line pipe.

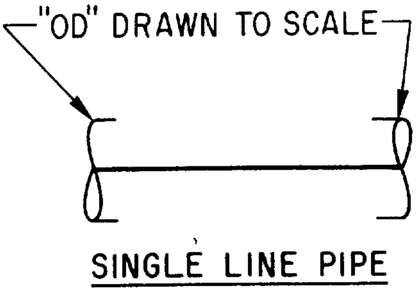
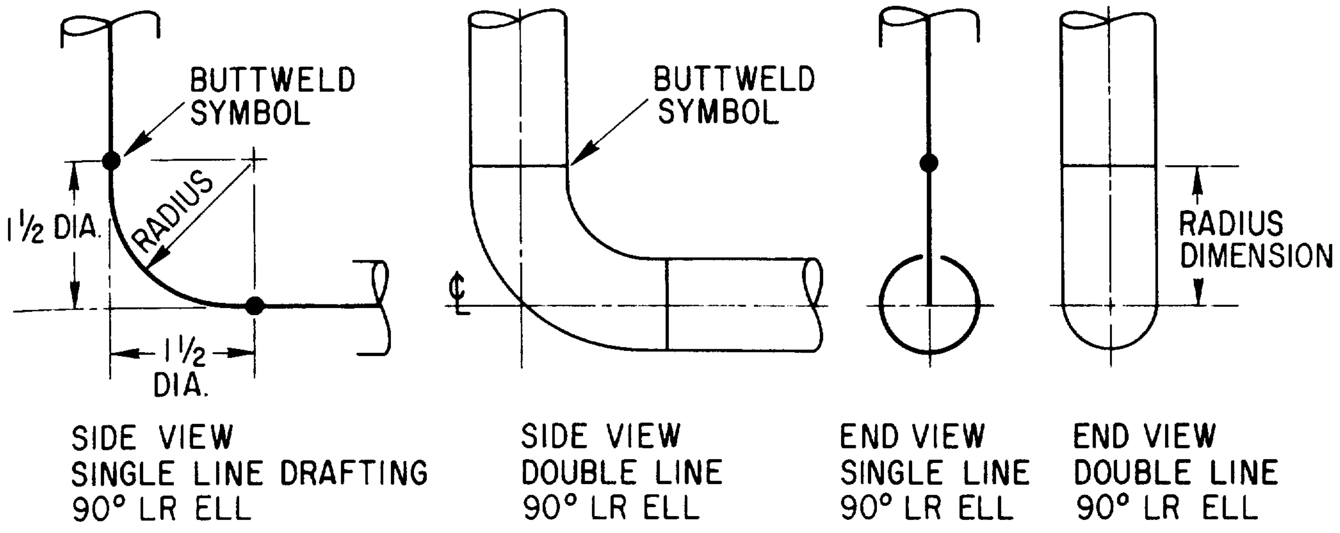


Figure 2-2b. Single line pipe.



SIDE VIEW
SINGLE LINE DRAFTING
90° LR ELL

SIDE VIEW
DOUBLE LINE
90° LR ELL

END VIEW
SINGLE LINE
90° LR ELL

END VIEW
DOUBLE LINE
90° LR ELL

Figure 2-3. 90° elbows.

reducing elbow is also widely used today. One end of it is larger than the other. This is for 90° turns only, and the radius is 1½ times the large-end size. Long radius is "LR" and short radius is "SR." (See Figure 2-3.)

The LR ell's radius is 1½ times the nominal size. A 4" LR ell has a 6" radius on the centerline. (See Figure 2-3.) A 6" LR elbow has a 9" radius. The SR ell's radius is only 1 times the nominal size. A 4" SR ell has a 4" radius. The 6" SR ell has a 6" radius, et cetera. The radius is to be drawn to scale.

The buttweld (Figure 2-4) is a weld that connects pipe or attaches pipe to fittings or fittings to fittings. It is called a buttweld because two beveled ends are butted and welded together. The symbol for a buttweld is a simple dot in single line piping. The symbol for a buttweld in double line piping is a heavy line (Figure 2-3).

The 45° ell is in Figure 2-5. Radius is 1½ x pipe size.

Figure 2-6 shows the reducing ell. Its radius is 1½ x the large end pipe size.

Whether drawing single line or double line, the piping draftsman will *always* draw the pipe size and fittings to scale. On single line drawings, pipe size is drawn to scale for a cut point or for an end view of an elbow or pipe.

The weld tee comes as a *straight tee* and a *reducing outlet tee.* The straight tee applies when the branch and header sizes are the same. The reducing outlet tee applies when the branch size is smaller than the header size. (See Figure 2-7.)

The weld tee is expensive and requires three buttwelds for installation. A substitute for the tee is a *stub-in* where the branch is welded directly to the header. If the pressure is great, the stub-in may have to be reinforced. Many methods can be used to reinforce a stub-in. Some of these are "weld saddle," "reinforcing pad," "weldolet," or other fittings used throughout the industry. (See Figure 2-8.)

Another fitting is the *reducer* which makes a reduction in a pipe. It's either eccentric or concentric. The eccentric reducer costs more than the

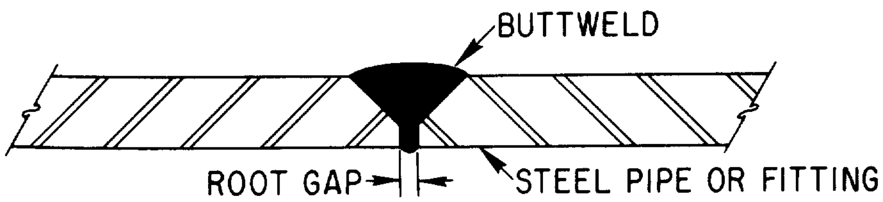


Figure 2-4. Example of a buttweld.

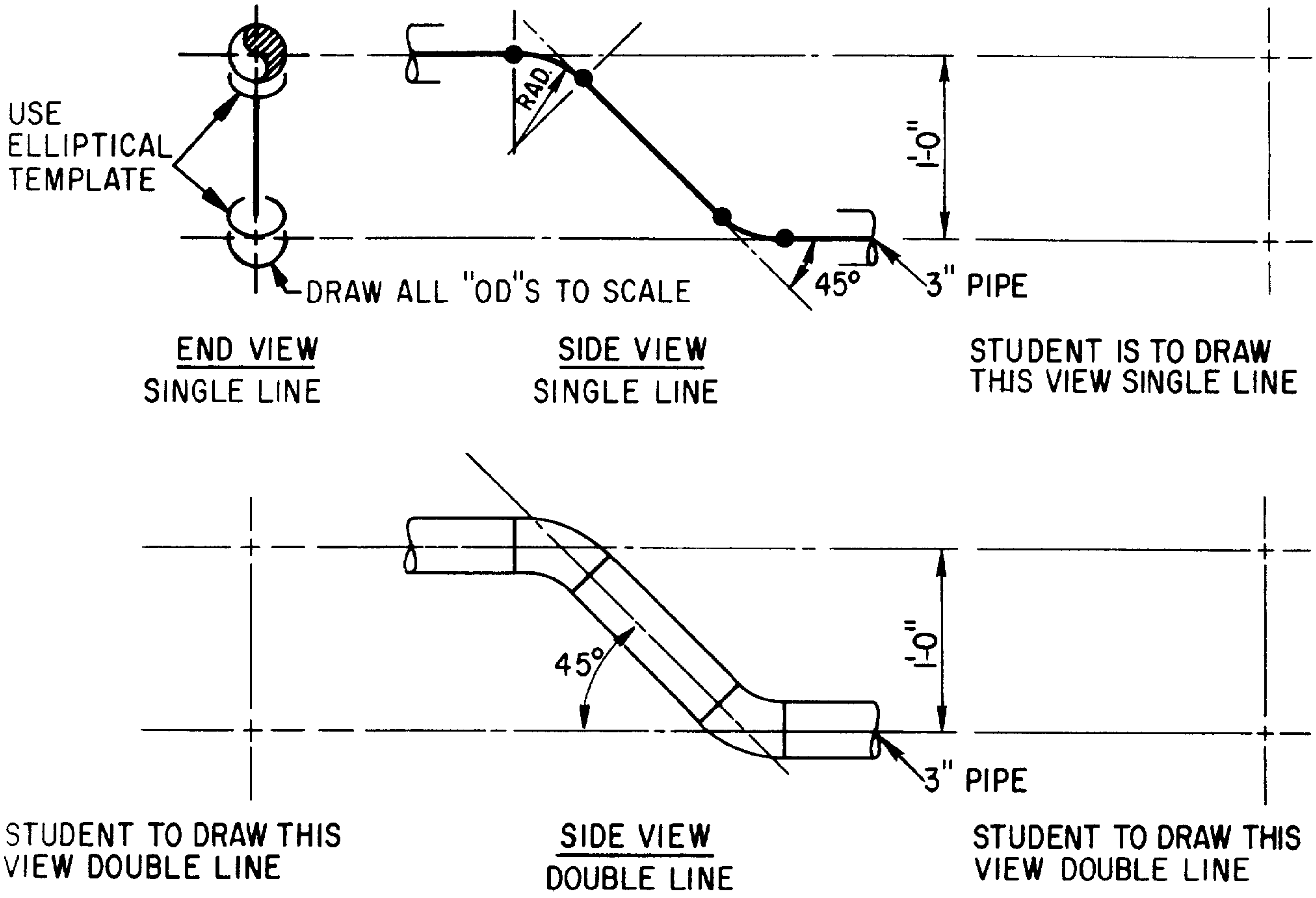


Figure 2-5. 45° elbows.

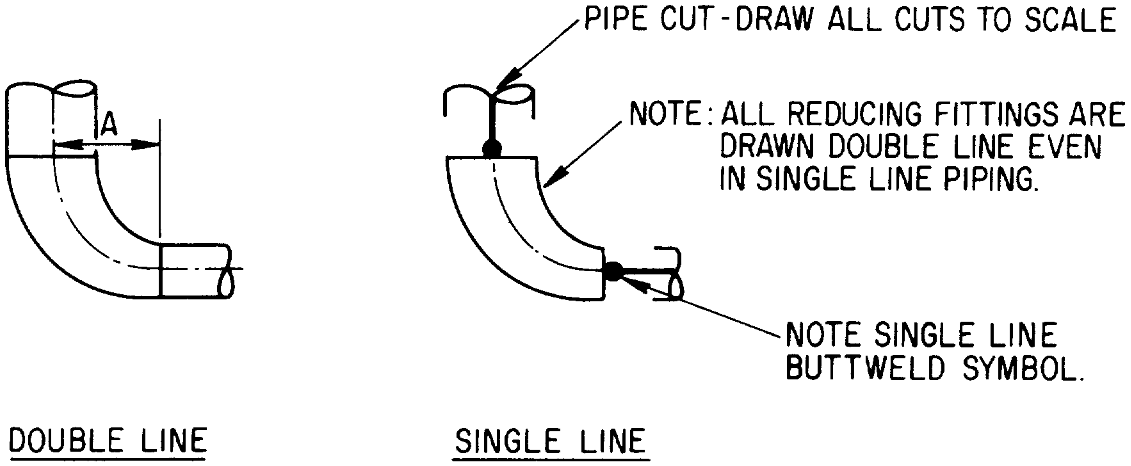
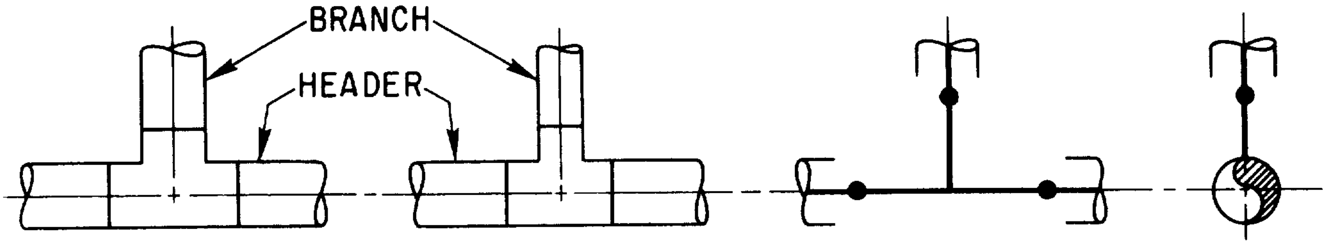


Figure 2-6. Reducing elbows.



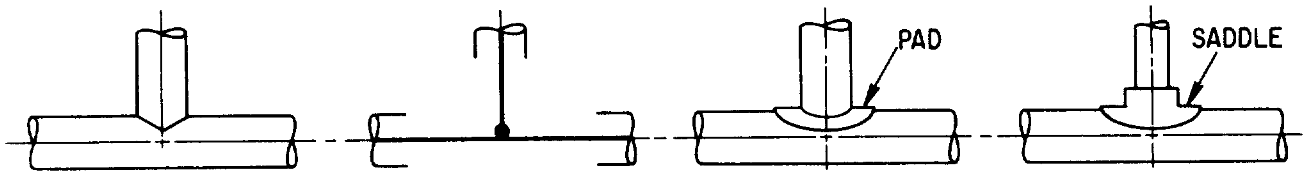
STRAIGHT TEE
DOUBLE LINE

REDUCING TEE
DOUBLE LINE

TEE-STRAIGHT OR REDUCING
SINGLE LINE

END VIEW
SINGLE LINE

Figure 2-7. Weld tee.

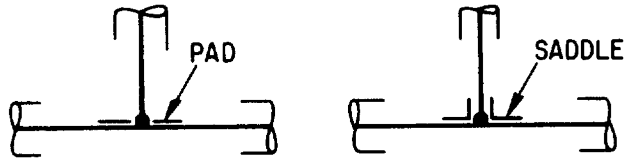


STUB-IN
DOUBLE LINE

STUB-IN
SINGLE LINE

STUB-IN REINFORCED
WITH A"REINFORCING PAD"
DOUBLE LINE

STUB-IN REINFORCED
WITH A WELD SADDLE
DOUBLE LINE

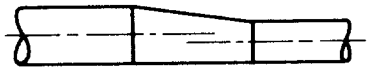


STUB-IN REINFORCED
WITH A"REINFORCING PAD"
SINGLE LINE

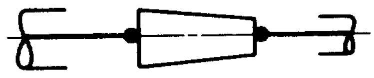
STUB-IN REINFORCED
WITH A WELD SADDLE
SINGLE LINE

NOTE THAT THE SADDLE HAS A VERTICAL NECK ON IT. THIS IS A PURCHASED FITTING. THE REINFORCING PAD IS USUALLY MADE FROM STEEL PIPE AND FORMED TO FIT THE PIPE. IT IS MADE BY HAND AT THE TIME OF FABRICATION OF THE STUB-IN.

Figure 2-8. Stub-in—reinforced and nonreinforced.



ECCENTRIC REDUCER
DOUBLE LINE PIPING



CONCENTRIC REDUCER
SINGLE LINE PIPING

Figure 2-9. Reducer.

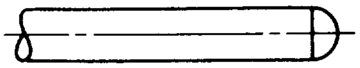
concentric, and where possible the concentric reducer should be used. (See Figure 2-9.)

The *eccentric reducer* is used mostly in pipeways or pipe racks. It keeps the BOP (Bottom of Pipe) constant for self draining or for resting on a constant support. The offset appears in the two centerlines. This offset dimension is ½ the difference of the two *inside* diameters. For a 6" x 4" eccentric reducer, the eccentricity is 1".

The *concentric reducer* has the same centerline as shown.

Whether drawing single or double line piping, reducers are double line and drawn to scale by pipe size and end-to-end length.

WELD CAP
SINGLE LINE PIPING



WELD CAP
DOUBLE LINE PIPING

Figure 2-10. Weld cap.

The weld cap terminates a pipe. This fitting should *always* be drawn double line. (See Figure 2-10.)

Screwed and socketweld fittings are used in sizes 2" and below. Some companies use them for 1½" and below. Figure 2-11 shows them in double line for clarity and single line as they are usually drawn.

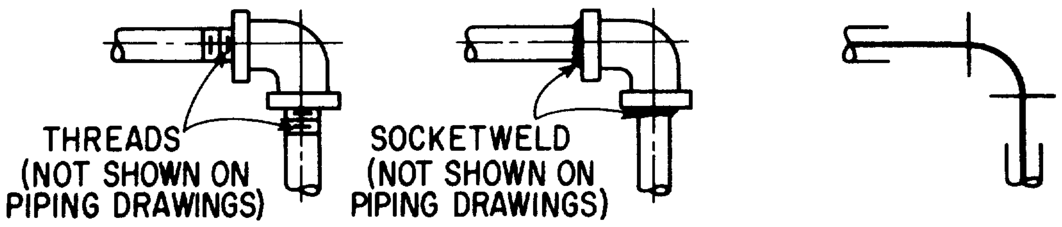
Screwed and socketweld fittings come in the same types as those welded fittings already shown. They have 90° ells, 45° ells, tees, caps, et cetera.

Some different fittings are below.

Swage nipple is a reducer, except it is much longer. It, too, is eccentric or concentric and comes in the welded sizes. It is most commonly used in sizes 2" and smaller instead of using reducers.

Coupling joins two pieces of pipe or male connections. It also stubs-in a small pipe or connection into a large one. (See Figure 2-12.)

Union joins screwed and socketweld pipe and make connections when they may need to be broken apart in the future. The union is a possible leak point and should only be used where the "breakaway" feature is necessary. (See Figure 2-13.)

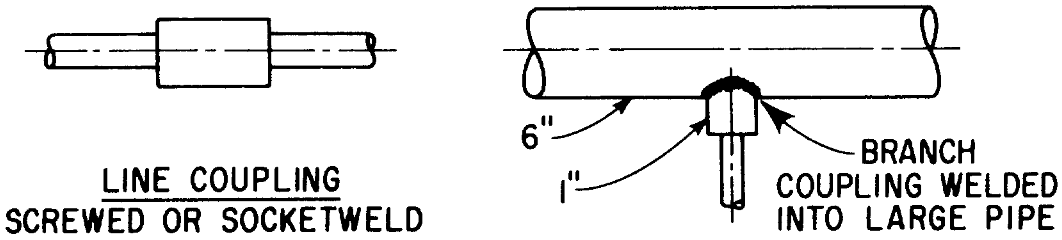


90° ELL
SCREWED ENDS
DOUBLE LINE PIPING

90° ELL
SOCKETWELD ENDS
DOUBLE LINE PIPING

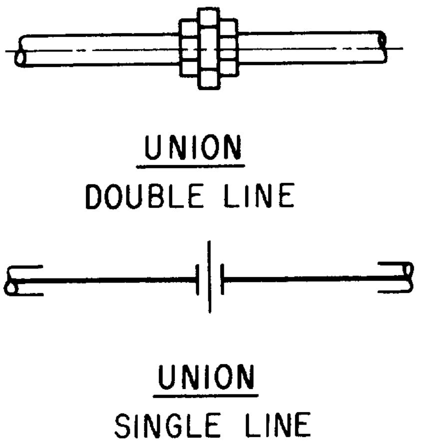
90° ELL
SCREWED OR SOCKETWELD
SINGLE LINE PIPING

Figure 2-11. Screwed and socketweld elbows.



LINE COUPLING
SCREWED OR SOCKETWELD

Figure 2-12. Coupling.


UNION
DOUBLE LINE

UNION
SINGLE LINE

Figure 2-13. Union.

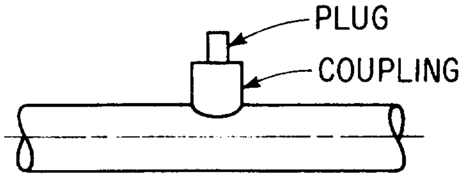
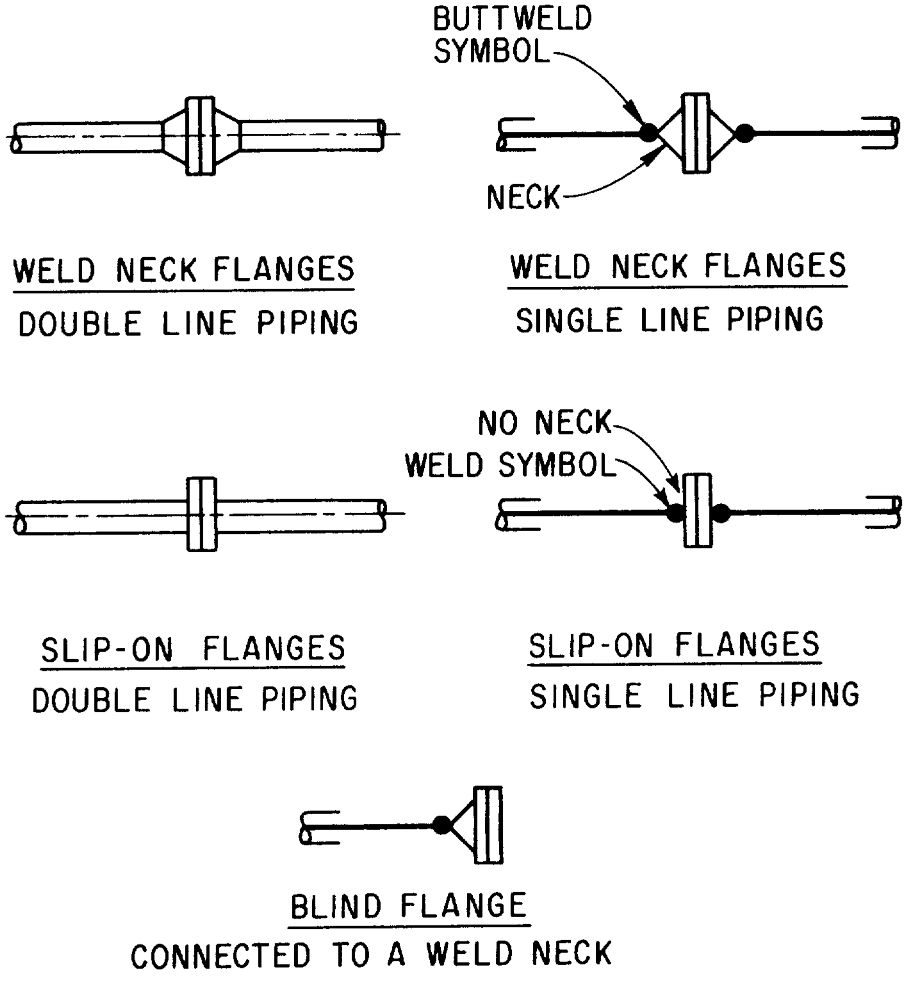


Figure 2-14. Pipe plug.

Plug plugs or stops flow in a screwed fitting at the end. (See Figure 2-14.)

Flanges and Flange Facings

Flanges come in all sizes and materials. The forged steel flange comes in seven basic ratings



WELD NECK FLANGES
DOUBLE LINE PIPING

WELD NECK FLANGES
SINGLE LINE PIPING

SLIP-ON FLANGES
DOUBLE LINE PIPING

SLIP-ON FLANGES
SINGLE LINE PIPING

BLIND FLANGE
CONNECTED TO A WELD NECK

Figure 2-15. Basic flange types.

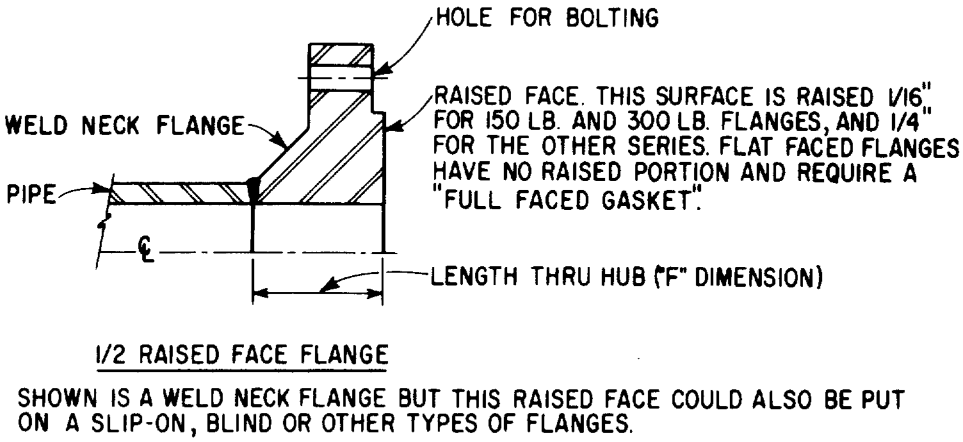


Figure 2-16. Weld neck raised face flange.

which the ANSI set: 150#, 300#, 400#, 600#, 900#, 1500# and 2500#. The student must remember these.

Cast iron flanges come in two ratings. The 125# rating has a flat face, while the 250# rating usually has a raised face.

All flanges make a bolted joint, which can be broken away. Flanges are expensive, and the good "piper" will use them only where necessary. Piping specifications, which the student will see later, will indicate when to use flanges.

The student must also remember the basic flange types. They are in Figure 2-15.

Flange bolting changes with each size and rating. The gasket, placed between flanges, changes with the flange facing. Many flange facings exist. This text will deal with three basic types: raised face, flat face and ring joint. (See Figures 2-16 and 2-17.)

When drawing flanges the length through hub, "F" dimension, is drawn to scale. Flange thickness may be shown double line to scale as depicted in Figure 2-15 or may be shown as a single line as shown in Figure 2-23. For this class, draw flanges with double lines and to scale for OD and thickness.

Flange Bolting

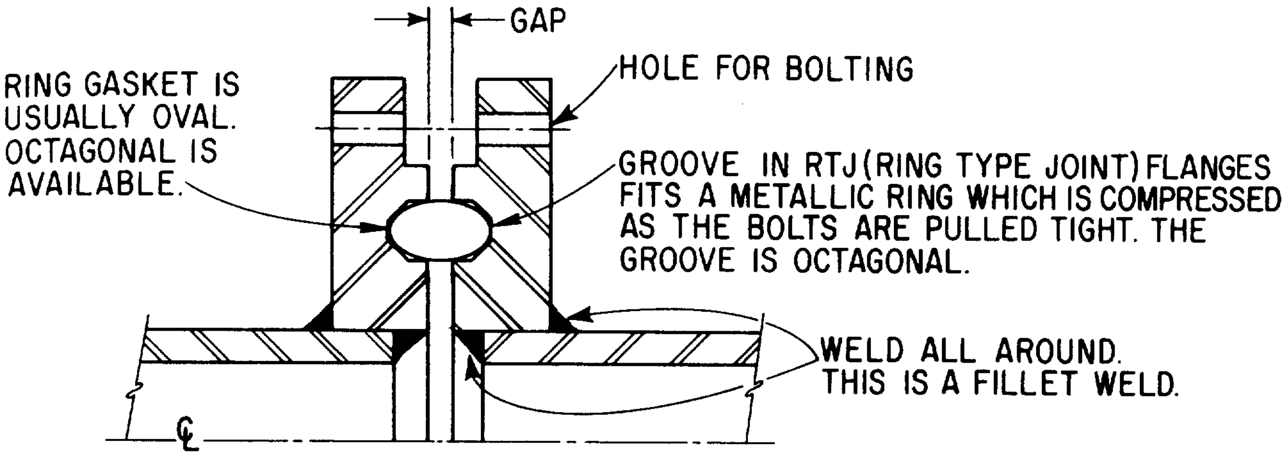
Process pressure piping is under pressure of varying degrees. The more pressure existing, the more bolts required. ANSI has defined bolting requirements. Bolts, regardless of number, will straddle the flange's "normal centerline." Normal centerline is on the North-South, East-West or Up-Down axis. On this basis a flange has four quadrants. Bolt holes are always added in quantities of four: 4, 8, 12, 16, 20, 24, et cetera.

Bolting is always equally spaced on the bolt circle. The 360° circle is divided by the number of bolts to determine their spacing. Twelve bolts have 30° spacing; 16 bolts have 22½° spacing, et cetera. (See Figure 2-18.)

The seven series of ANSI flange ratings (150#, 300#, 400#, 600#, 900#, 1500# and 2500#) are a nominal rating. It does not mean that the rating is the maximum pressure. Pressure-temperature rating determines the flange rating used. For instance, the 150# flange is good for 275# at 100° F. As the temperature rises, allowable pressure goes down. At 500° F the maximum allowable pressure is 150#. At 750° F the 150# flange is good for only 100#. All listed ratings are for carbon steel. Alloy materials will have different ratings. All pressure-temperature ratings are in the ANSI standard on flanges and fittings. (Also see Chapter 11.)

Valves

Valves stop or control flow. The most common refinery-chemical plant valve is the flanged-end



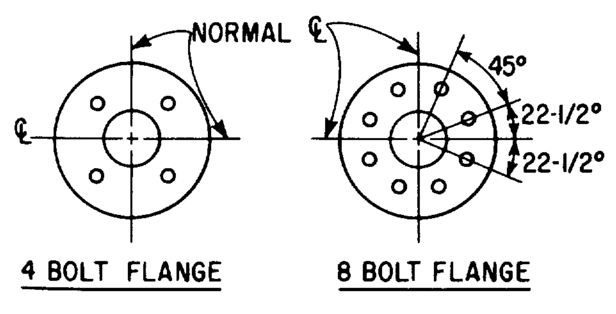
1/2 RING JOINT FLANGES

SHOWN IS A PAIR OF SLIP-ON FLANGES. RING JOINT FACING COULD ALSO BE SPECIFIED FOR WELD NECK AND OTHER TYPES. THE SLIP-ON FLANGE IS SHOWN SO YOU CAN SEE THE INTERNAL AND EXTERNAL WELDS REQUIRED FOR THIS TYPE OF FLANGED JOINT.

Figure 2-17. Slip-on RTJ flange.

valve. They also have screwed ends, socketweld ends, buttwelded ends and other special types.

The most important part of the valve is the body type. The gate body is for on-off service. A gate body is not for throttling service; the globe body is. The student sees globe valves every day. He calls them faucets and controls the water flow in the washbasin or bathtub with them. These are globe body valves. (See Chapter 11 for the difference in body design between gate and globe valves.)



4 BOLT FLANGE

8 BOLT FLANGE

Figure 2-18. Flange bolting.

Valves also have handwheels, which are turned to operate the valve. These handwheels are very long for large valves, and the competent piping draftsman will always think of the proper location of the handwheel when locating a valve. It should be located so that the person operating the valve can get to it easily. The draftsman should always draw it to scale in its open position to insure adequate clearance.

Other valves are check valves, motor operated control valves, angle valves, plug valves, butterfly valves, ball valves, relief valves and diaphragm valves. These all have specific uses and symbols which the piping draftsman will know.

Symbols

Tables 2-2 and 2-3 summarize symbols, which the student *must* memorize before going on. These symbols are the piping draftsman's ABC's. Without completely knowing them, he can't "write" piping.

Tables 2-4 and 2-5 are dimensional tables of the most common flanges, fittings and valves. For

Table 2-2
Symbols of Fittings and Flanges for Piping Drawings
(Courtesy of Fluor Corp.)

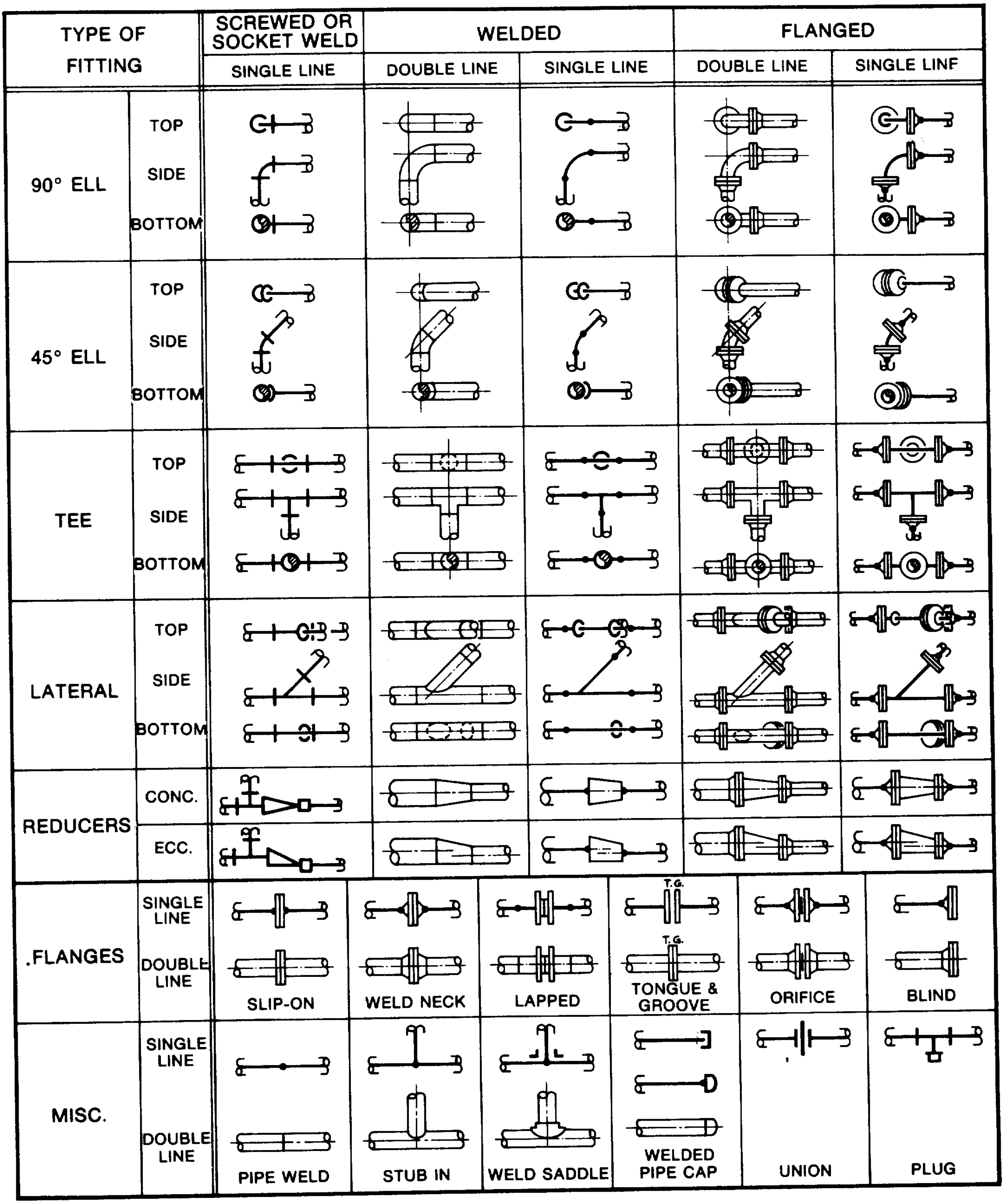


Table 2-3
Symbols of Valves and Fittings for Piping Drawings
(Courtesy of Fluor Corp.)

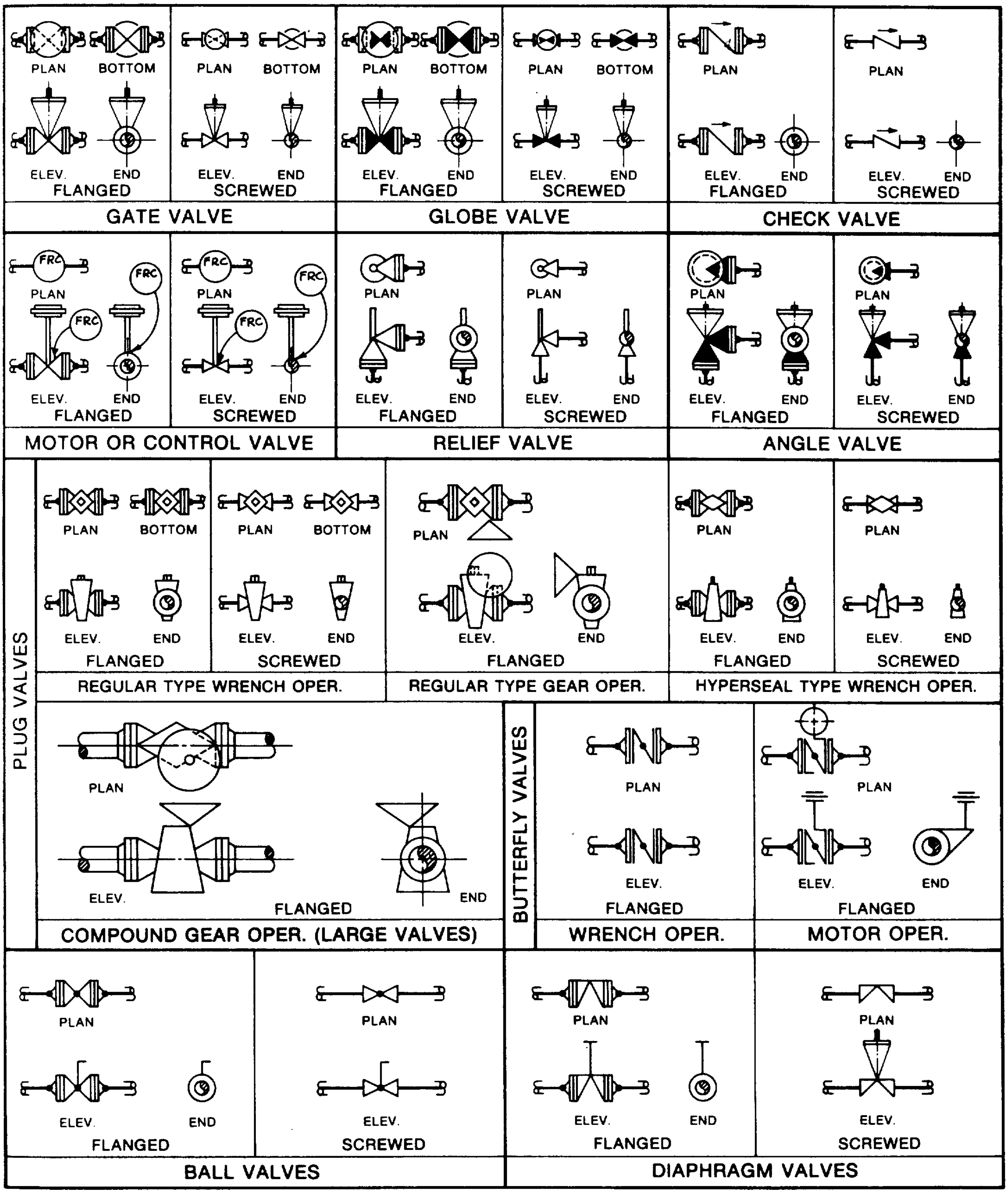
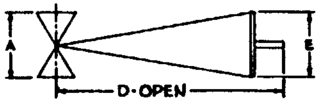
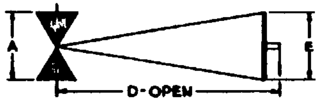


Table 2-4
Flange and Fitting Dimensions
(Courtesy of Fluor Corp.)

NOMINAL PIPE SIZE	WELD FITTING			WELD NECK						WELD NECK AND SLIP-ON									SWAGE NIPPLE		SCREWED FITTING			UNION			COUPLING	
	CENTER TO END		END TO END	TOTAL LENGTH R.F.			TOTAL LENGTH R.T.J.			TOTAL THICKNESS R.F.			TOTAL THICKNESS R.T.J.			OUTSIDE DIAMETER					TEE AND ELL CENTER TO END			END TO END			6000* 1/2", 3/4", 1" 3000* 1 1/2", 2"	
																					M.I.	STL.	STL.	M.I.	F.S.	F.S.		
				150	300	600	150	300	600	150	300	600	150	300	600	150	300	600	REDUCTION	LGTH	150	2000	3000	250	2000 3000	6000	LG.	O.D.
1/2	5/8	1		1 7/8	2 1/16	2 5/16		2 5/16	2 5/16	7/16	9/16	13/16		13/16	13/16	3 1/2	3 3/4	3 3/4	1/4 TO 3/8	2 3/4	1 1/8	1 1/8	1 5/16	1 7/8	1 15/16	2 7/8	1 5/8	1 1/2
3/4	7/16	1 1/8	1 1/2	2 1/16	2 1/4	2 1/2		2 1/2	2 1/2	1/2	5/8	7/8		7/8	7/8	3 7/8	4 5/8	4 5/8	1/4 TO 1/2	3	1 5/16	1 5/16	1 1/2	2 1/8	2 1/4	3 3/8	2	1 3/4
1	7/8	1 1/2	2	2 3/16	2 7/16	2 11/16	2 7/16	2 11/16	2 11/16	9/16	11/16	15/16	13/16	15/16	15/16	4 1/4	4 7/8	4 7/8	1/4 TO 3/4	3 1/2	1 1/2	1 1/2	1 3/4	2 3/8	2 7/16	3 3/4	2 3/8	2 1/4
1 1/2	1 1/8	2 1/4	2 1/2	2 7/16	2 11/16	3	2 11/16	2 15/16	3	11/16	13/16	1 1/8	15/16	1 1/16	1 1/8	5	6 1/8	6 1/8	1/4 TO 1 1/4	4 1/2	1 15/16	2	2 3/8	2 15/16	3	4 1/4	3 1/8	2 1/2
2	1 3/8	2 1/2	3	2 1/2	2 3/4	3 1/8	2 3/4	3 1/16	3 3/16	3/4	7/8	1 1/4	1	1 3/16	1 5/16	6	6 1/2	6 1/2	1/4 TO 1 1/2	6 1/2	2 1/4	2 3/8	2 1/2	3 1/4	3 3/8	4 5/8	3 3/8	3 1/4
3	2	3 3/8	3 1/2	2 3/4	3 1/8	3 1/2	3	3 7/16	3 9/16	15/16	1 1/8	1 1/2	1 3/16	1 7/16	1 9/16	7 1/2	8 1/4	8 1/4	1/4 TO 2 1/2	8								
4	2 1/2	4 1/8	4	3	3 3/8	4 1/4	3 1/4	3 11/16	4 5/16	15/16	1 1/4	1 3/8	1 3/16	1 7/16	1 11/16	9	10	10 3/4	1/4 TO 3 1/2	9								
6	3 3/4	5 5/8	5 1/2	3 1/2	3 7/8	4 5/8	3 3/4	4 3/16	4 13/16	1	1 7/16	2 1/8	1 1/4	1 3/4	2 3/16	11	12 1/2	14	1/2 TO 5	12								
8	5	7	6	4	4 3/8	5 1/2	4 1/4	4 11/16	5 9/16	1 1/8	1 3/8	2 7/16	1 3/8	1 11/16	2 1/2	13 1/2	15	16 1/2	2 TO 6	13								
10	6 1/4	8 1/2	7	4	4 5/8	6 1/4	4 1/4	4 15/16	6 5/16	1 3/16	1 5/8	2 3/4	1 7/16	2 1/16	2 13/16	16	17 1/2	20										
12	7 1/2	10	8	4 1/2	5 1/8	6 3/8	4 3/4	5 7/16	6 7/16	1 1/4	2	2 7/8	1 1/2	2 5/16	2 15/16	19	20 1/2	22										
14	8 3/4	11	13	5	5 5/8	6 3/4	5 1/4	5 15/16	6 13/16	1 3/8	2 1/8	3	1 5/8	2 7/16	3 1/16	21	23	23 3/4										
16	10	12	14	5	5 3/4	7 1/4	5 1/4	6 1/16	7 5/16	1 7/16	2 1/4	3 1/4	1 11/16	2 9/16	3 5/16	23 1/2	25 1/2	27										
18	11 1/4	13 1/2	15	5 1/2	6 1/4	7 1/2	5 3/4	6 5/16	7 9/16	1 9/16	2 3/8	3 1/2	1 13/16	2 11/16	3 9/16	25	28	29 1/4										
20	12 1/2	15	20	5 11/16	6 3/8	7 3/4	5 13/16	6 3/4	7 7/8	1 11/16	2 1/2	3 3/4	1 15/16	2 7/8	3 7/8	27 1/2	30 1/2	32										
24	15	17	20	6	6 5/8	8 1/4	6 1/4	7 1/16	8 7/16	1 7/8	2 3/4	4 1/4	2 1/8	3 3/16	4 7/16	32	36	37										

[illegible]

(Courtesy of Fluor Corp.)

NOMINAL PIPE SIZE	FLANGED GATE VALVE												FLANGED GLOBE VALVE												FLANGED CONTROL VALVE					
	 A E D-OPEN												 A E D-OPEN												FACE TO FACE					
	150				300				600				150				300				600				150		300		600	
	R.F.	R.T.J.			R.F.	R.T.J.			R.F.	R.T.J.			R.F.	R.T.J.			R.F.	R.T.J.			R.F.	R.T.J.			R.F.	R.T.J.	R.F.	R.T.J.	R.F.	R.T.J.
	A	A	D	E	A	A	D	E	A	A	D	E	A	A	D	E	A	A	D	E	A	A	D	E						
½																											7½	7 15/16	8	7 15/16
¾																									7¼		7⅝	8⅛	8⅛	8⅛
1	5	5½	10 11/16	5					8½	8½	10 11/16	5	5⅛	5½	8 5/16	3⅝	8	8½	8¾	4½	8½	8½	9¾	5	7¼	7¾	7¾	8¼	8¼	8¼
1½	6½	7	13 7/16	6	7½	8	13 7/16	6	9½	9½	13 7/16	6	6⅜	7	10	4⅝	9	9½	12	7	9½	9½	12 3/16	7	8¾	9¼	9¼	9¾	9⅞	9⅞
2	7	7½	16½	8	8½	9⅛	18½	8	11½	11⅜	18¼	8	8	8½	13¾	8	10½	11⅛	17¾	9	11½	11⅜	19	10	10	10½	10½	11⅛	11¼	11⅜
3	8	8½	20¾	9	11⅛	11¾	23¼	9	14	14⅛	25¾	10	9½	10	16½	9	12½	13⅛	20½	10	14	14⅛	23½	12	11¾	12¼	12½	13⅛	13¼	13⅜
4	9	9½	25¾	10	12	12⅜	28¼	10	17	17⅛	32	14	11½	12	19¾	10	14	14⅜	24¾	14	17	17⅛	27½	18	13⅞	14⅜	14½	15⅛	15½	15⅜
6	10½	11	35¼	14	15⅞	16½	38½	14	22	22⅛	42¾	20	16	16½	24½	12	17½	18⅛	29¾	18	22	22⅛	35	24	17¾	18¼	18⅝	19¼	20	20⅛
8	11½	12	43	14	16½	17⅛	47	16	26	26⅛	52¼	24	19½	20	26	16	22	22⅜	36½	24					21⅜	21⅞	22⅜	23	24	24⅛
10	13	13½	52½	18	18	18⅜	56½	20	31	31⅛	62¼	27																		
12	14	14½	60½	18	19¾	20⅜	64¼	20	33	33⅛	70	27																		
14	15	15½	70¼	22	30	30⅜	74¾	27	35	35⅛	77¼	30																		
16	16	16½	79¾	24	33	33⅜	80½	27	39	39⅛	83¾	30																		
18	17	17½	89	27	36	36⅜	91	30	43	43⅛	93¾	36																		
20	18	18½	97¼	30	39	39¾	100½	36	47	47¼	104½	36																		
24	20	20½	112¾	30	45	45⅞	120½	36	55	55⅜	126	42																		

special flanges, fittings and valves a draftsman may face on a high pressure job, he will want to refer to manufacturer's dimensional catalogs. What is high pressure? Everything is relative. In process plants 1000 psi (pounds per square inch) is not considered real high. Some plants run several thousand psi. The student should compare this to the 25-30 psi pressure in his automobile tire.

Projection Exercise

Now it is time for the piping drafting student to do some projection exercises. Figures 2-19 through 2-32 show various piping configurations. These are all single line exercises. Refer to Chapter 11 as needed for full dimensional data. Use 3/8"=1'-0" for scale with 10" and 6" pipe sizes.

Figure 2-19 shows a simple 90° ell's side and plan views. The student is to draw the two end views and bottom view.

Figure 2-20 shows a straight tee in elevation and top plan. The student is to complete the end views and bottom view.

Figure 2-21 has an elevation of two 90° ells welded together. The student is to draw all four projections.

Figure 2-22 has a concentric reducer with ells welded to both ends. The student is to draw the top, bottom and both end views.

Figure 2-23 shows a flanged gate valve with flanges bolted to both ends. The student is to project the top, bottom and both end views.

Figure 2-24 shows a flanged check valve, flanges, 90° elbows and some pipe welded to the ells; The student is to draw the other four views.

Figure 2-25 gets a little more complex. It combines fittings in Figures 2-19 through 2-24. The student is to draw the top, bottom and end projections.

Figure 2-26 has two 45° ells. The student must use the ellipse template for these projections, all four of which he is to draw.

The student should note that, on all of the above figures, the piping is buttwelded. He should show every weld in all views as a dot or an ellipitical line for 45° ells.

The next projection exercises will be for screwed or socketweld piping. They do not show the welds, but a short dash across the piping shows the end of the fitting.

Figure 2-27 has a straight tee, two 90° ells and some pipe. The student is to draw the upper plan, the bottom and two end views.

Figure 2-28 has the same fittings as Figure 2-27 but also has a concentric swage and a union. The student is to draw the other four views.

Figure 2-29 has two 45° ells plus a tee and a union. Using the elliptical template, the student is to draw the other four views.

Figure 2-30 has only the end view. The student is to draw the side elevation and the other three views.

Figure 2-31 requires some imagination on the student's part. He doesn't know how long the pipe that he can't see is. He is to assume it's a short piece and is to draw the other four views.

Figure 2-32 shows an elevation and three views of some piping. Here the student sees how he is to use the elliptical template to draw projections. For practice he is to duplicate this study, drawing the full elevation first. Then, he is to extend his own projection lines (lightly) and draw the other three views.

After the student has completed this study, he is to draw the side elevation again. But this time he is to draw the left projection and the bottom view, which Figure 2-32 does not show.

In Figure 2-33 the student is to complete four views of each picture.

Figures 2-19 thru 2-26 (opposite page). Study sheet of single line symbols (courtesy of Fluor Corp.).

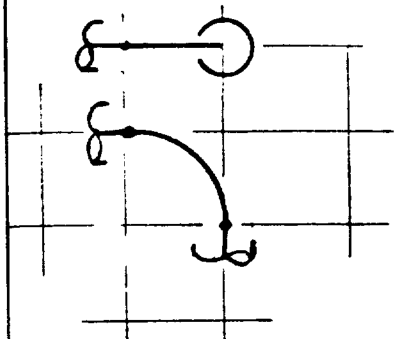


FIGURE 2-19

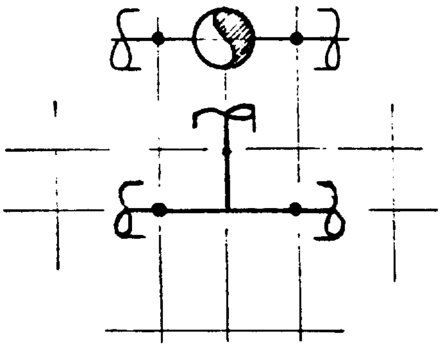


FIGURE 2-20

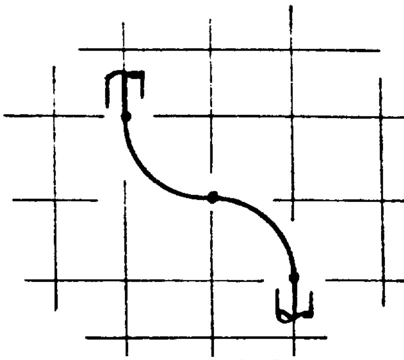


FIGURE 2-21

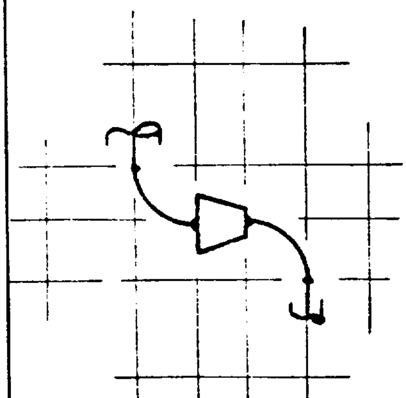


FIGURE 2-22

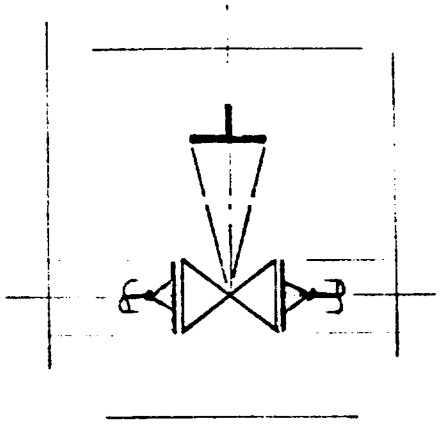


FIGURE 2-23

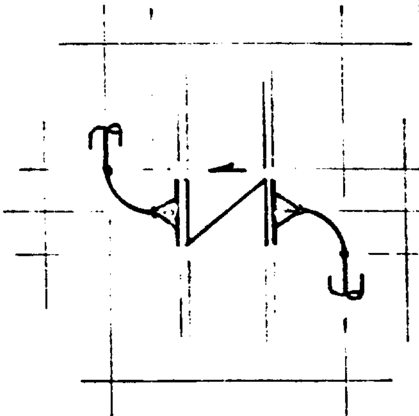


FIGURE 2-24

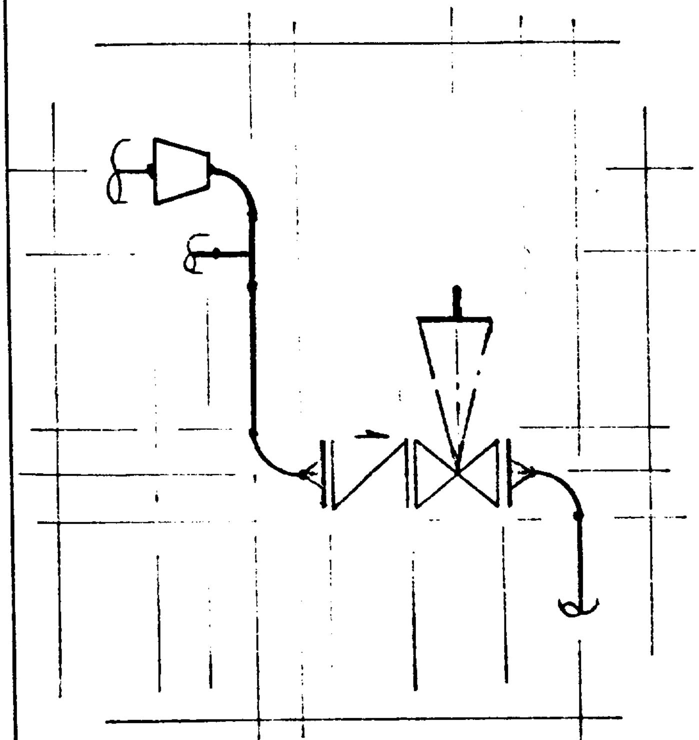


FIGURE 2-25

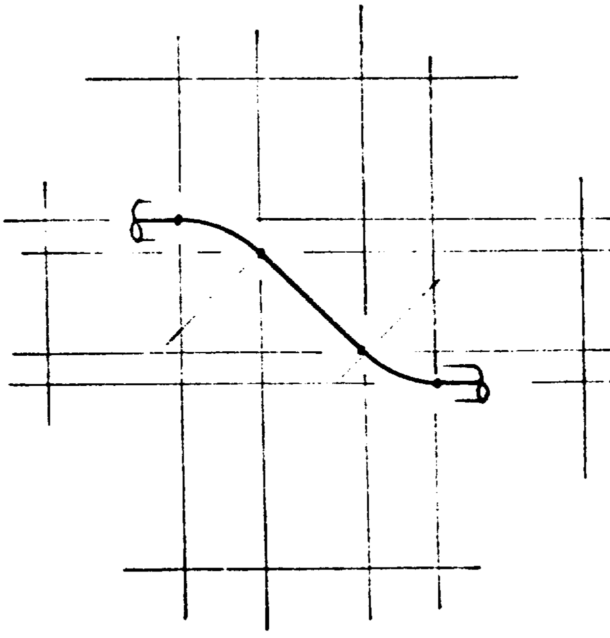


FIGURE 2-26

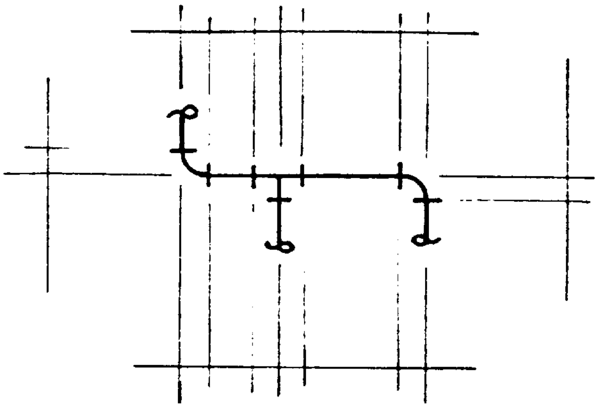


FIGURE 2-27

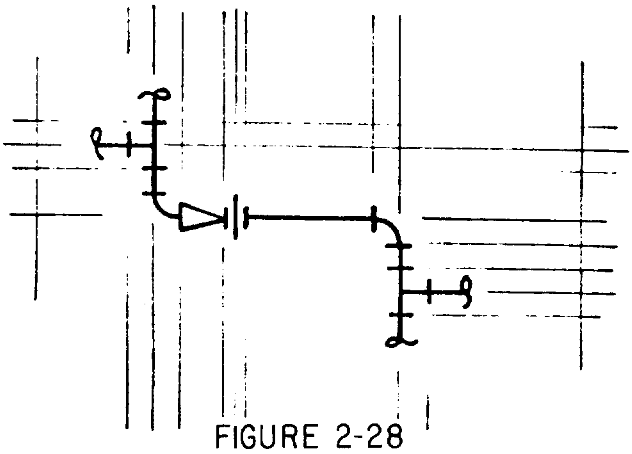


FIGURE 2-28

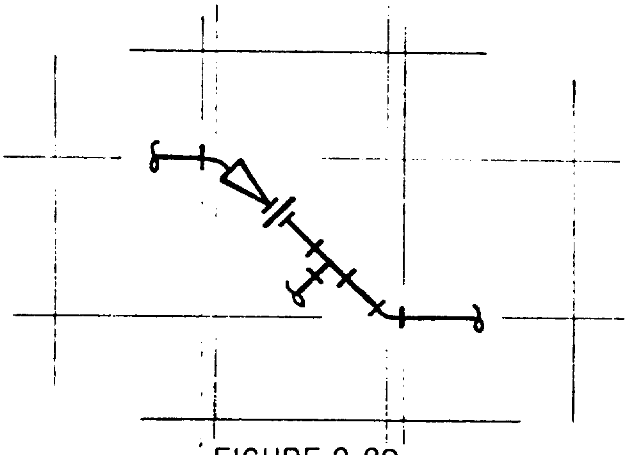


FIGURE 2-29

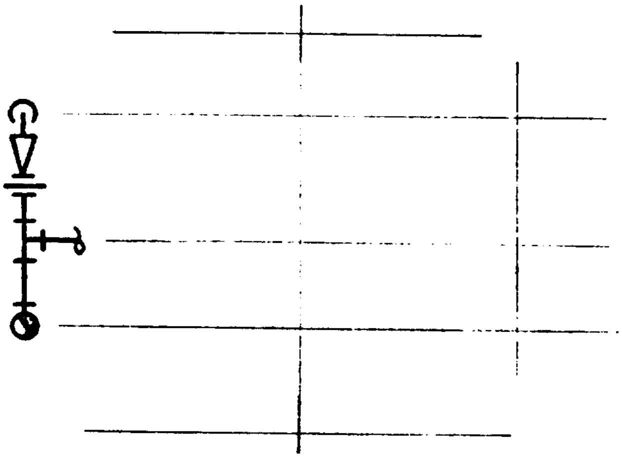


FIGURE 2-30

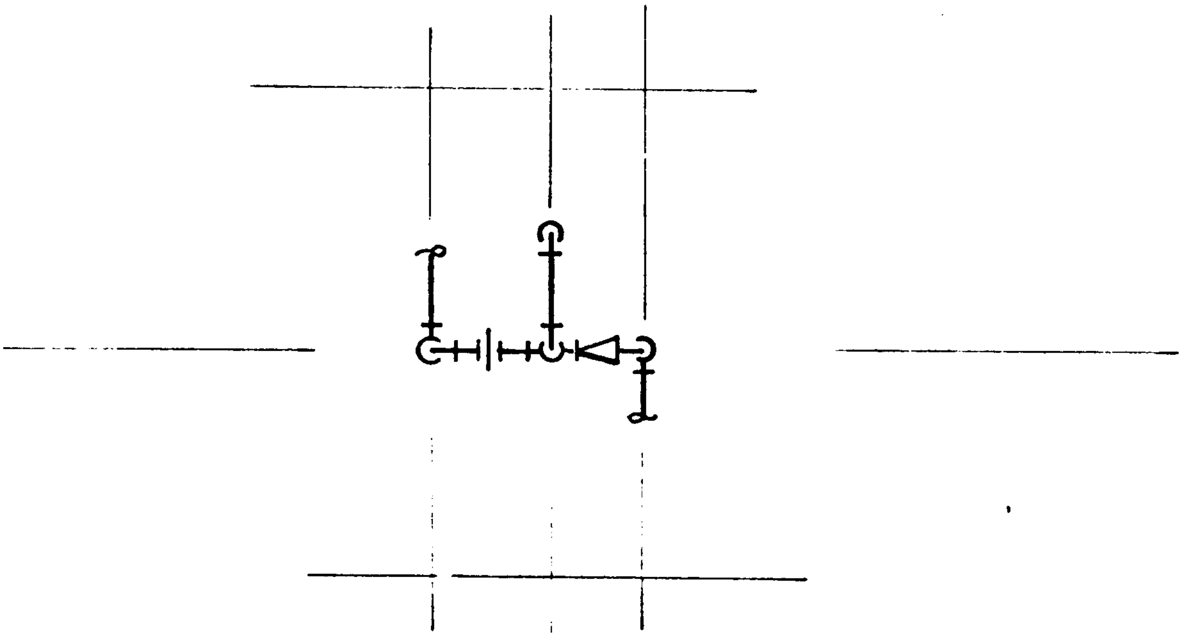


FIGURE 2-31

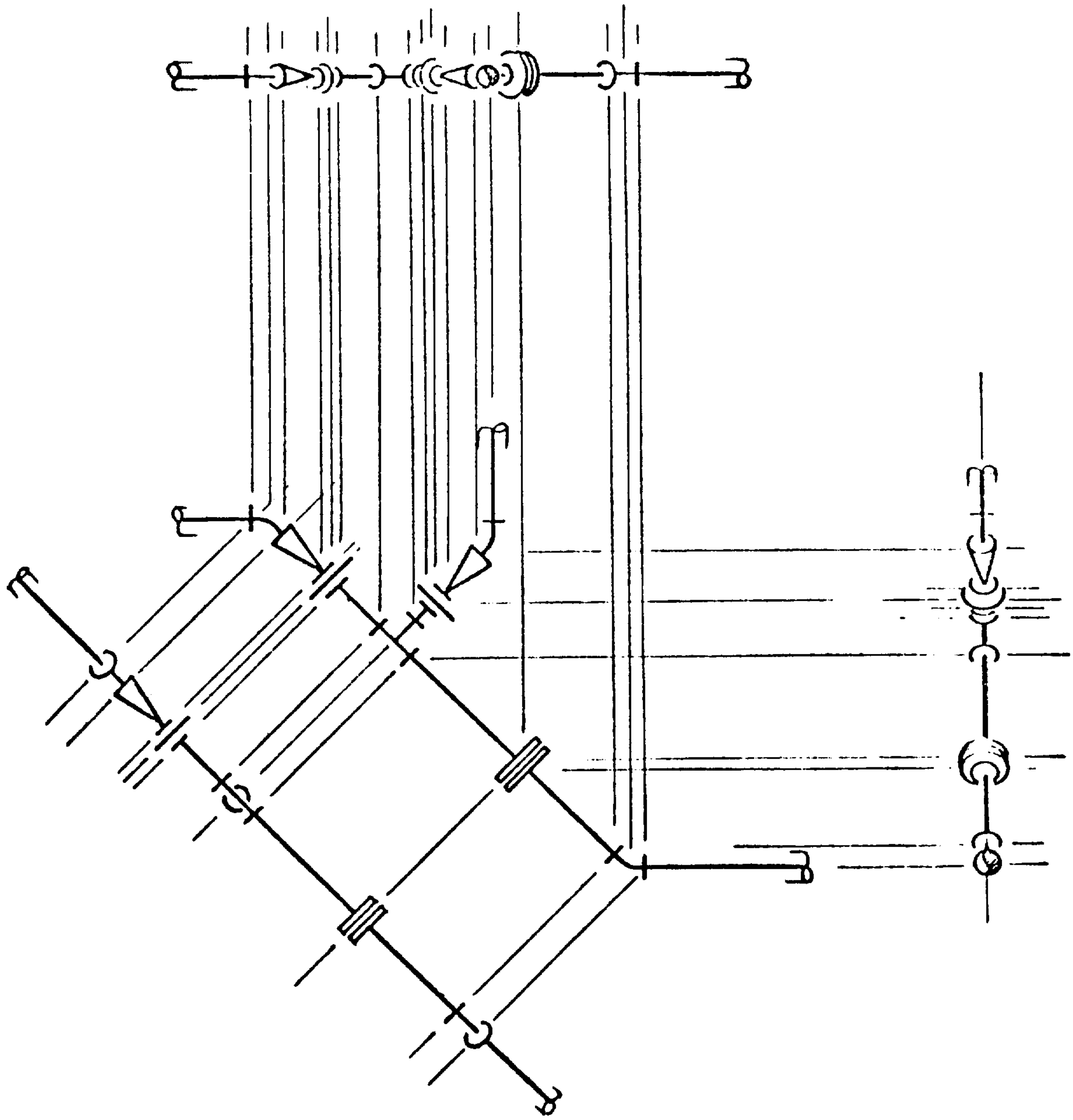


Figure 2-32. Projection Study Sheet (courtesy of Fluor Corp.).

Figures 2-27 thru 2-31 (preceding page). Study sheet of single line symbols (courtesy of Fluor Corp.).

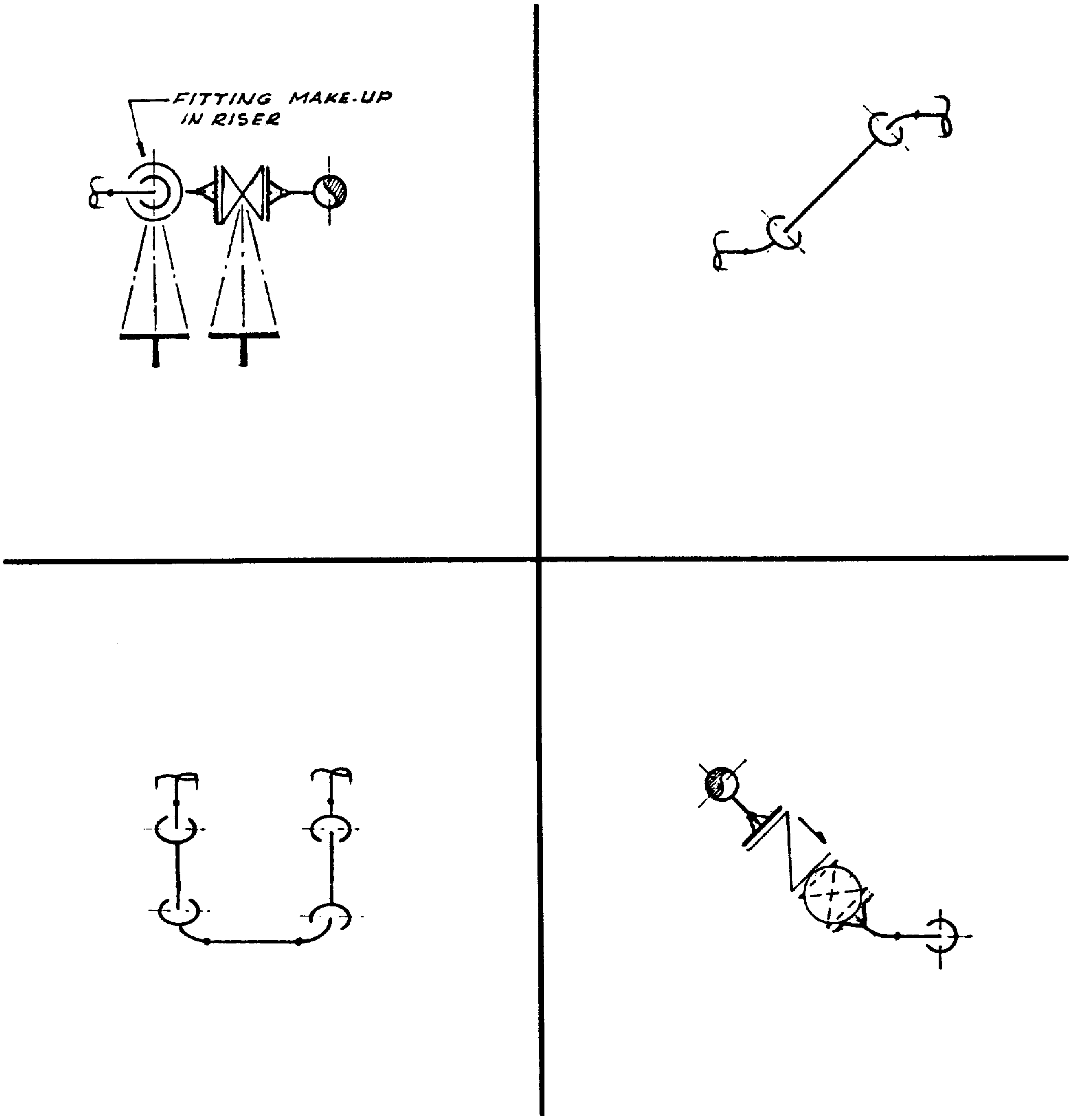


Figure 2-33. Classroom Study Sheet (courtesy of Fluor Corp.).

CHAPTER 3

FLOW DIAGRAMS & INSTRUMENTATION

To learn to read a flow diagram, the student must first learn the language of the flow diagram draftsmen. He has learned some of the draftsmen's signs and symbols in Chapters 1 and 2. Now this text looks at flow diagram language.

Most companies have almost standardized instrument symbols on the flow diagram. They usually publish a flow diagram legend, which defines their symbols. Instrument symbols appear in a circle, or "bubble," as it is quite often called. The ISA, Instrument Society of America, has successfully established instrument flow diagram symbols for the industry. Some symbols are in Table 3-1.

The student must learn the flow diagram piping symbols. The flow diagram depicts many exactly as they appear on the piping drawing. But not all are the same. The plug valve symbol (Table 3-2) illustrates this.

Companies also use flow diagram abbreviations. Many have their own terminology for these notes. Table 3-3 shows some which are quite common.

Flow Diagrams

The process department extensively studies and develops the process flow diagram. The diagram shows all major equipment and main piping and its flow. It also shows operating pressure and temperature of the piping and equipment. Operating pressure and temperature is not to be confused with design conditions for the equipment. Design pressures should be at least 10% above the maximum operating pressure or 25# greater—whichever is larger. Design temperature should be the maximum operating temperature, but should be at least 25° above the normal operating temperature.

From the process flow diagram, the mechanical group develops the mechanical flow diagram. This diagram gives much more detailed data. It shows pipe sizes, specification of the system, all equipment and valving. It also shows instrumentation with all controlling devices. The diagram is the piping draftsman's "road map." It tells him what to pipe, size to run, what and how many valves to use and instruments to install. Some companies call the mechanical flow diagram a "P&I" diagram for piping and instrumentation diagram.

Table 3-1
Flow Diagram Instrument Symbols

○	Locally mounted instrument, like the coffee urn's level glass
⊖	Board mounted instrument. (This is not locally read but is read from the control board, like the student may read his car's gas gage from his instrument panel. Another example might be the oil in his car. The dip stick is a local instrument, which he reads right at the motor. But the oil gage on the dashboard is a remote or board mounted instrument.)
TW	Temperature Well
TA	Temperature Alarm
TI	Temperature Indicator
TR	Temperature Recorder
TRC	Temperature Recording Controller
T	Transmitter (sometimes ⊗)
PC	Pressure Controller
PI	Pressure Indicator or Pressure Gage
PR	Pressure Recorder
PRC	Pressure Recording Controller
PIC	Pressure Indicator Controller
PSV	Relief Valve or Pressure Safety Valve
FE	Flow Element
FI	Flow Indicator
FR	Flow Recorder
FRC	Flow Recording Controller
FA	Flow Alarm
LC	Level Controller
LG	Level Glass or Level Gage
LR	Level Recorder
LI	Level Indicator
LIC	Level Indicating Controller
LA	Level Alarm
HCV	Hand Control Valve
○○	Instrument with two services
-//-//-//-	Instrument Air Line
------	Instrument Electrical Lead
-✱-✱-✱-	Instrument Capillary Tubing
━━━	Pipe Line (as heavy line)
SP ⧄	Piping Specialty Item

Table 3-2
Flow Diagram Piping Symbols

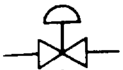
	Control Valve (globe body pattern)		Plug Valve
	Control Valve (butterfly pattern)		Ball Valve
	Gate Valve		Check Valve (arrow indicating flow direction)
	Globe Valve (sometimes )		Spectacle Blind

Table 3-3
Flow Diagram Abbreviations

NV–Needle Valve
CSO–Car Seal Open
CSC–Car Seal Closed
LO–Lock Open
LC–Lock Closed
SC–Sample Connection
PO–Pump Out
SO–Steam Out
F–Furnished by others
DF–Drain Funnel

The utility flow diagram shows utilities, which are a vital part of any unit in the plant. It shows piping, valves and instrumentation for utility piping. Chapter 1 defines utilities.

A mythical process flow diagram is in Figure 3-1.

This simple process flow diagram has a fractionating tower, T-1; an overhead accumulator, V-1; an overhead condenser, E-1; the reflux-product pump, P-1; and a reboiler, E-2. The feed line comes into the tower just above the middle. Then the propane fractionates (or separates on fractionating trays in the vertical vessel) and rises to the top. The heavier hydrocarbons sink to the bottom, and the LC (level controller) control valve draws them off.

The overhead is vapor and must be condensed to a liquid for convenient handling and storage. So E-1 cools and condenses this stream; then it is retained in V-1, the overhead accumulator. The overhead liquid is pumped back to the tower, and the FRC (flow recording controller) controls flow returning to the tower. This flow is called *reflux* and it constantly covers the trays in the tower with liquid.

The accumulator LC valve draws off the propane product. As liquid in the horizontal vessel builds up, the LC sends an air signal to the control valve and opens it to allow more flow through it. As the liquid goes down in V-1, the same air signal tells the control valve to close. While the reflux to the top tray in T-1 is a constant flow, the flow through the LC valve–the product–is intermittent, because the LC valve will open or close as the V-1 level fluctuates.

A mechanical flow diagram appears in Figure 3-2.

Mechanical Flow Diagram

The mechanical flow diagram tells the piping draftsman a much more complete story than the process flow diagram. Each pipe line (commonly called "line") has a line number. The feed line is line 1 from its point of origin to its termination, which–in this case–is from the unit battery limits, or starting point, to the T-1 tower. "C" indicates the piping specification table. Table A will have

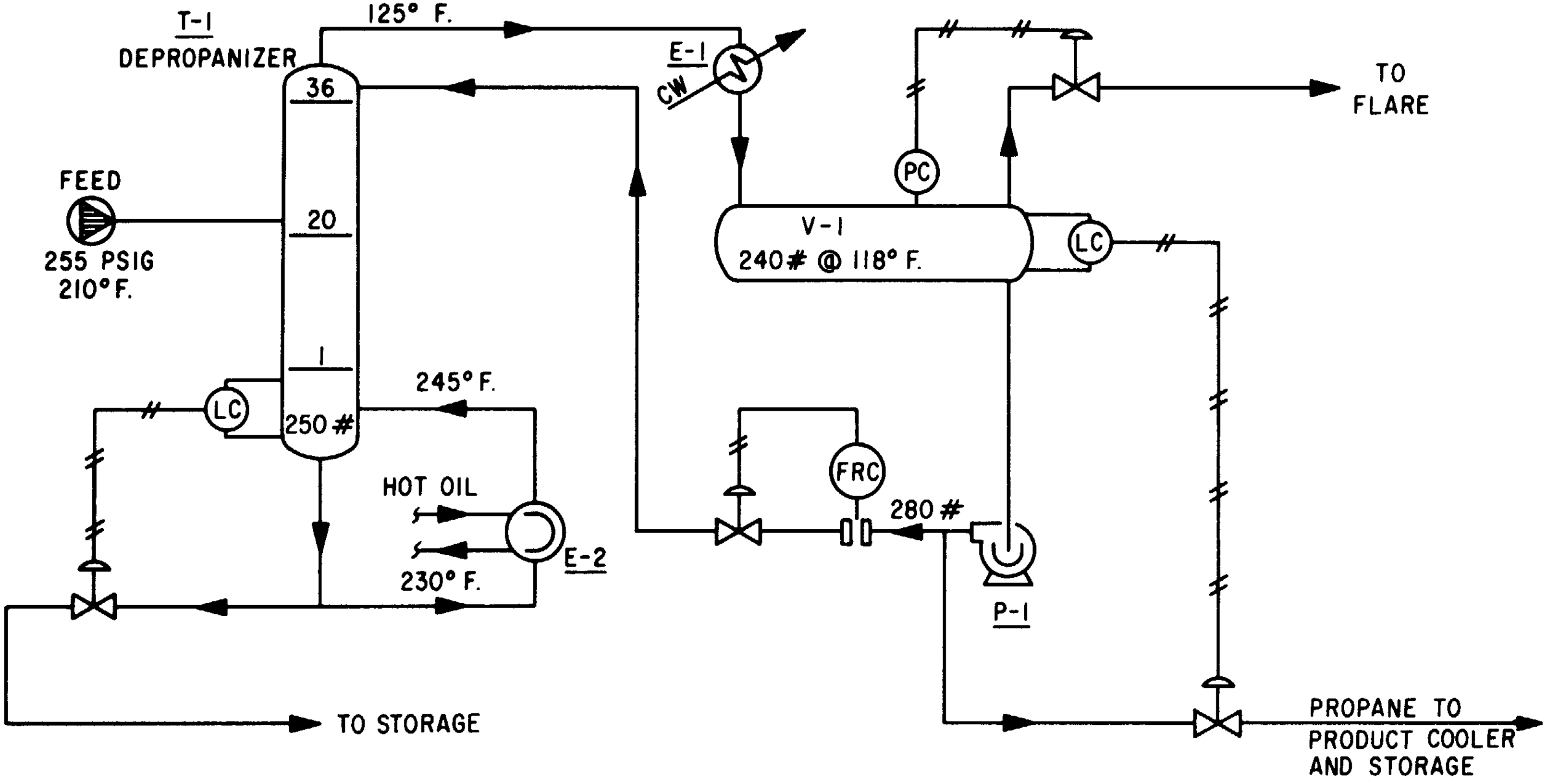
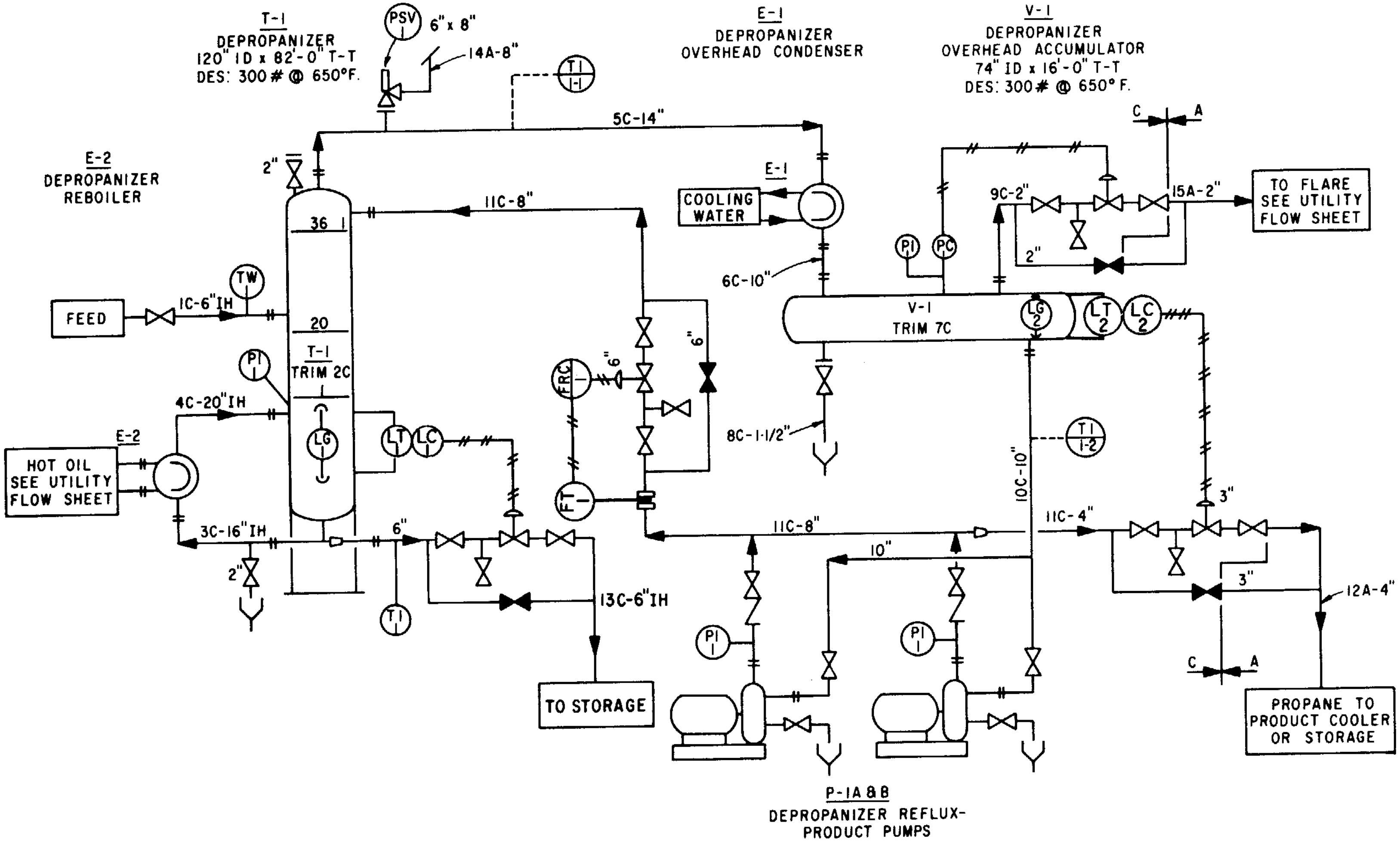


Figure 3-1. Process Flow Diagram



NOTE:
SEE INSTRUMENT SPECIFICATIONS ON PAGES 43-47.
SEE PIPE LINE LIST, PAGES 67 AND 68.

Figure 3-2. Mechanical Flow Diagram

150# flanges; Table C 300# flanges. The next designation is the 6" line size.

Each company will have its own piping specification table. This book uses the letter designation. Some companies use numbers or variances of letters and numbers. However, wherever a draftsman works, he soon memorizes the system there. Again, this road map tells the piping draftsman his duty. He must place a gate valve near the line origin and a TW (thermowell) near the vessel nozzle. From the line list and process flow sheet, he knows that this line operates at 210°; so he must consider expansion as he routes the line. The draftsman is to discharge this feed to tray 20 in T-1. That's quite a story for a small line on paper to tell.

The "trim" for T-1 is line 2. The trim, which is also Table C, is the material required to trim out the vessel. This material is for the 2" vent on the top head, PI (pressure indicator), LG and LC. Piping draftsmen must specify and order all materials necessary to pipe up the unit. Line 3 starts at the bottom of T-1 and goes to the exchanger E-2, a shell and tube exchanger. The symbol says that. It also says that the hot oil stream goes in the "tubeside" and line 3 goes in the "shell side." The piping draftsman must locate a 2" drain on this line, install a gate valve and route it to a drain funnel, which will be connected to the oily sewer system underground. Line 3 is 16" and operates at 230°F. Expansion flexibility is extremely important for these large lines.

Line 4 goes from top of the E-2 shell side to the T-1 tower and is to enter below tray 1. It is C specification and 20". The exchanger has a flanged connection on it as does the tower. Line 5 is C specification and 14". The draftsman has to add a PSV (pressure safety valve), commonly called a relief valve. This valve will have a 300# "set pressure"—the same as the equipment it is protecting. And, should the pressure get above 300#, it will open and discharge to the atmosphere through line 14 A-8".

Dashed lines going to TI-1-1 (top of figure) are "electrical" leads going to a temperature indicator. This indicator has a line through the circle, which means that it is board mounted. The student will read this temperature on the control board in the main control room. Without the line through the middle of the bubble, it would be a local TI (see line 13) and would have a temperature indicator, which the student would read at the pipe.

Line 6 (C specification) is a 10" line from the shell and tube exchanger E-1 to the horizontal accumulator V-1. Line 7 is the vessel trim number.

The student is to thoroughly describe lines 8 through 15 on paper and give it to the instructor. He must describe everything the flow sheet tells him. Later this book refers back to this mechanical flow diagram. The student *must* understand how to "read" all details on it, continually referring to the process flow diagram and giving each line's temperature.

Utility Flow Diagram

The main difference between the two flow diagrams is that, on a utility flow diagram, all lines run plot-planwise. They basically appear as they actually run in the plant. Utilities only partly appear on the mechanical flow diagram, but must all be on the utility flow diagram.

Figure 3-3 is a utility flow diagram that shows utilities for Figure 3-2's mechanical flow diagram.

Line 16A-6" starts at the battery limits and has a battery limit block valve. This appears as a gate valve. Battery limit block valves are at the edge of the unit—as near the battery limit as the student can get them. Usually a ladder and platform give access to these valves, as they are most often in the pipe rack 12' to 20' in the air. These valves are only used when the unit is shut down for normal maintenance or for some emergency. Then most of these valves will be closed.

Located on the unit side of the block valve is the symbol for a "spectacle" or "Figure 8," blind. For added protection this blind is inserted when the unit is down. Should the gate valve leak, this blind will keep the fluid from coming into the unit. Lines 20 through 23 do not have spectacle blinds. These are utilities needed during a shutdown. Why, then, is a gate valve at the battery limit? These lines are connected to a main plant header; and, should a leak develop in the unit, a valve has to shut down the unit header to make repairs without shutting down the entire plant.

Line 16 supplies hot oil to E-2. The pair of flanges are "orifice flanges" and have an impulse line connected to a FRC, flow recording controller. The TI-2 is a local dial thermometer, which enables the operator to check the hot oil's temperature. Line 17A-6" has a TW (thermowell) in it so the operator can insert a TI and check the fluid temperature. He might move the TI from line 16. The "control station" is a flow controller. It consists of a control valve, block valves on either side and a globe valve by-pass. Should it not operate properly, the unit operator can close both gate valves and operate the stream by throttling with the globe valve by-pass. The unit then doesn't shut down while the control valve is being repaired.

Line 17 then returns to the battery limit through a spectacle blind and a battery limit block valve. Line 18ACW-10" is an "A" specification line, and the CW is for cooling water. At exchanger E-1 is a symbol for a butterfly valve. Line 19ACW-10" has the same valve symbol and returns to the battery limit.

Line 15A-2" comes from the mechanical flow diagram; but, since it becomes a flare line, it is considered a utility and appears on the utility flow diagram. Line 20AIA-1½" is A specification. The instrument air (IA) header runs through the unit and supplys air to the pneumatic instruments.

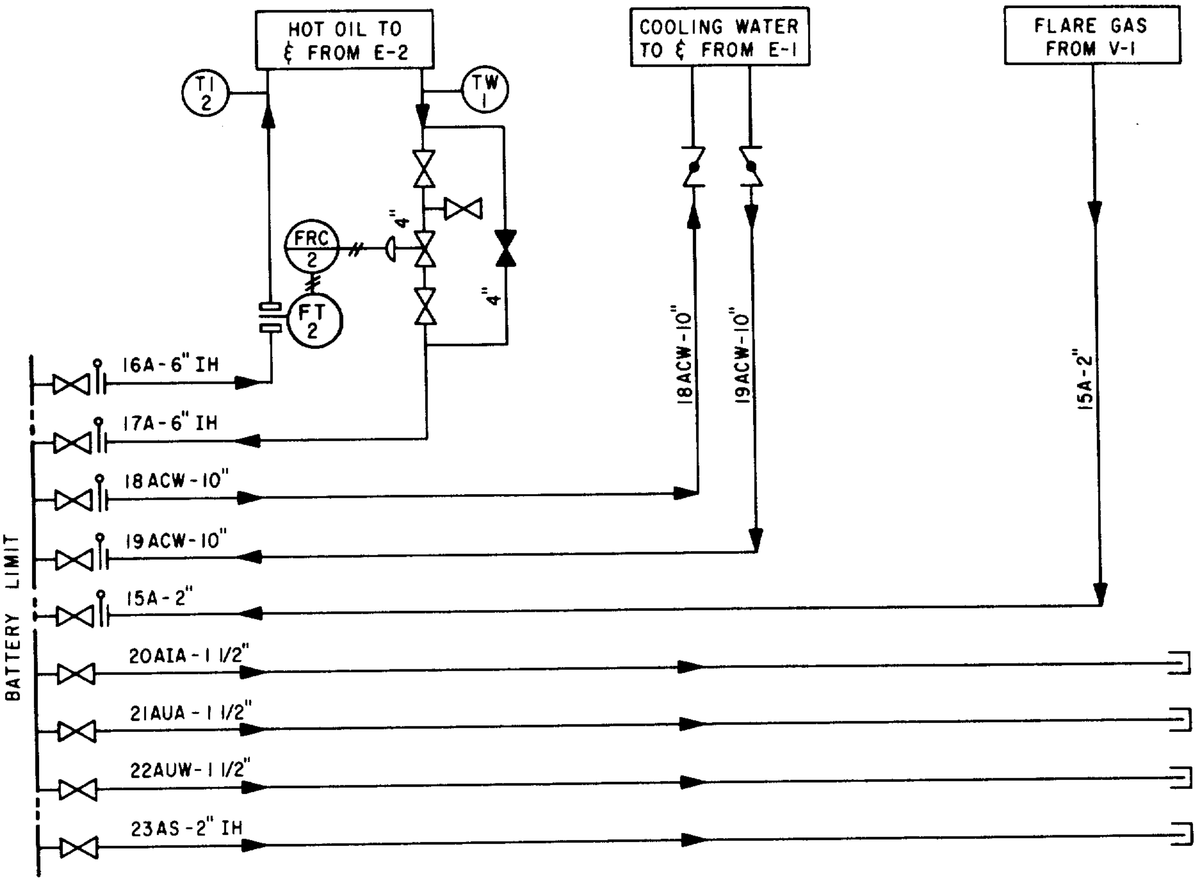


Figure 3-3. Utility Flow Sheet

Line 21 AUA-1½" is A specification. The utility air (UA) runs air drive tools and blows air through hoses to clean unit parts. Line 22 AUW-1½" is A specification. The utility water (UW) washes down the area. Line 23 AS-2" is A specification. The low pressure (50-75#) steam (S) cleans unit parts.

Many other possible utility streams exist. But this course will review only those shown. The student is to closely review line 17 and describe anything that looks different.

Instrumentation

Instrumentation is a vital part of every hydrocarbon plant installation. Automatic instruments perform the function of many plant operators who would be needed if the instruments were unavailable.

Today's plant operators are highly skilled. They must know their instrumentation as well as their plant equipment. The competent piping draftsman, too, must know instrumentation. He doesn't need to know it as thoroughly as the operator, but he must know its function and approximate size. He also should understand how to pipe it up.

By thinking a little, he knows he must install a local instrument where an operator can read it. For instance, he couldn't locate a local temperature indicator 7 feet off grade and point it toward the moon. He must read a local instrument locally, which usually means from the ground. He will probably read a board mounted instrument in a control room. These instruments will have a locally mounted impulse point and a local transmitter which will pneumatically or electronically transmit signals to a remote receiver instrument in a control room.

At first glance a control room looks like a maze of lights, switches and charts. The control panel runs almost the full length of most control rooms. It contains all receiver instruments from the plant. Here the operator can read pressure or temperature of almost any line in the plant. He also can read levels in the vessels and the flow through many of his critical lines. As he notices something performing incorrectly, he must turn a dial or throw a switch for the unit to run normally. Today many control rooms have their instrument leads connected to a computer. When something goes wrong, the computer is programmed to make the necessary correction, and the plant keeps producing product to sell.

The four basic groups of instruments are flow, level, pressure and temperature. Each one branches out into many applications.

Figures 3-4a through 3-4i show how flow instruments appear on flow diagrams, and Figures 3-5a through 3-5f show level instruments. Figures 3-6a through 3-6i show how pressure instruments appear on flow diagrams, and Figure 3-7a through 3-7h show how temperature instruments appear on flow diagrams. Figure 3-8 shows steam traps; Figures 3-9a and 3-9b, miscellaneous instruments.

(Courtesy of Fluor Corp.)

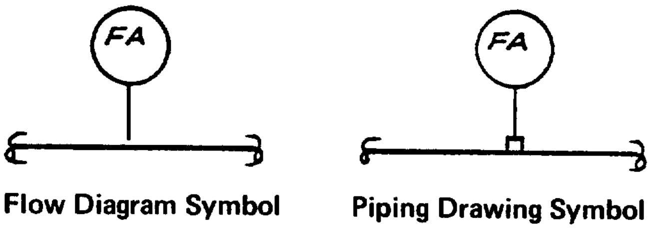


Figure 3-4a. Flow Alarm (FA) indicates excess flow, no-flow or reverse flow by light or horn. Signal is transmitted mechanically from the line media by deflection of paddle or wire transmitting force by a stem assembly to a switch, then electrically to whatever point required.

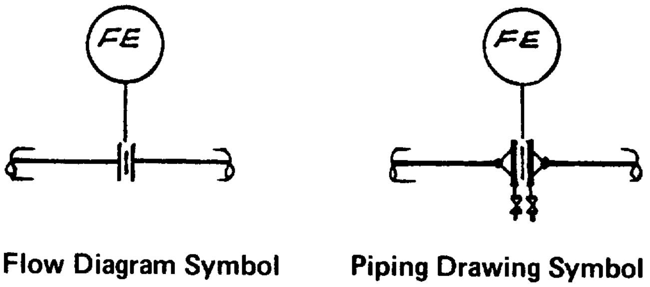
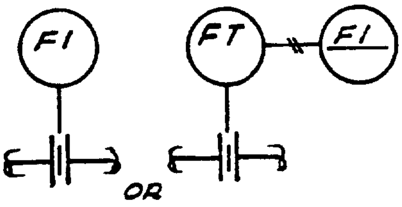
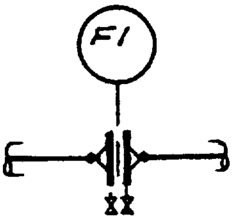


Figure 3-4b. Flow Element (FE) is used for testing flow with portable equipment. Consists of orifice set with plate and plugged tap valves. Up-and-down stream pipe section lengths (see meter runs) are critical and are considered a part of the measuring device.

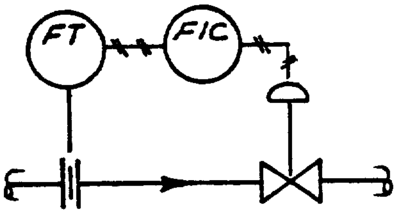


Flow Diagram Symbol

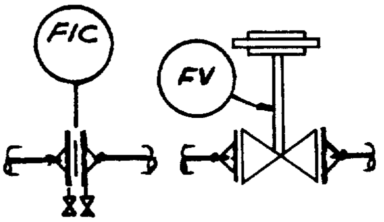


Piping Drawing Symbol

Figure 3-4c. Flow Indicator (FI) is a dial or linear indicator that gives flow rate. Indicator can be (1) direct hook-up or differential type, or (2) board mounted pneumatic type hooked to orifice flanges. An up-and-down stream meter run length is required.

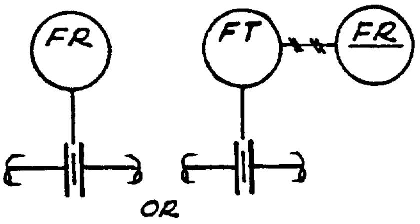


Flow Diagram Symbol

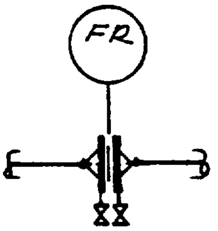


Piping Drawing Symbol

Figure 3-4d. Flow Indicating Controller (FIC) is a flow indicator and a control valve controlling flow connected to an orifice thru a pneumatic transmitter. Orifice must be accompanied by proper length meter runs up-and-downstream.

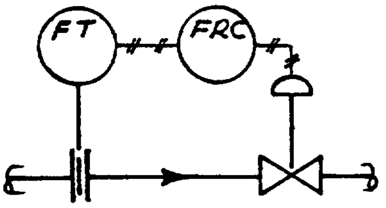


Flow Diagram Symbol



Piping Drawing Symbol

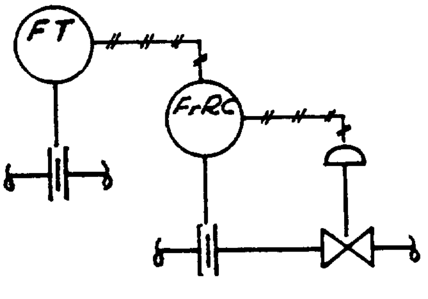
Figure 3-4e. Flow Recorder (FR) makes permanent record of flow measurement. Recorder can be (1) local mounted differential type or (2) board mounted pneumatic type. The orifice must be within a meter run.



Flow Diagram Symbol

Piping Drawing Symbol: See Figure 3-4d

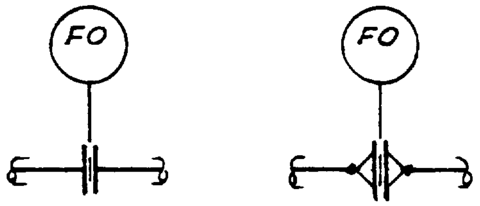
Figure 3-4f. Flow Recording Controller (FRC). (See Flow Indicating Controller.)



Flow Diagram Symbol

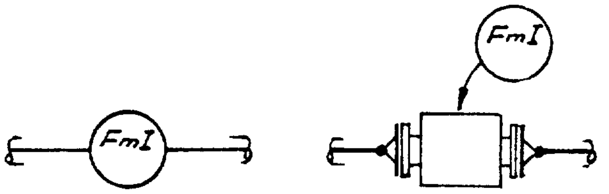
Piping Drawing Symbol: See Figure 3-4d

Figure 3-4g. Flow Ratio Recording Controller (FrRC) is a control valve and a recording instrument that records and controls the flow ratio of the main line. Pneumatic recorder can be either local or board mounted. Orifice must be within a calculated meter run.



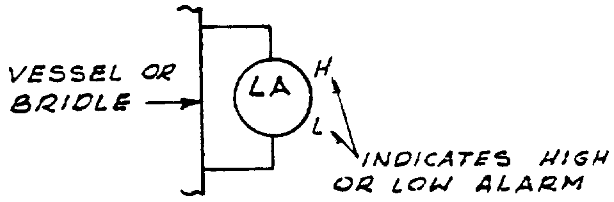
Flow Diagram Symbol **Piping Drawing Symbol**

Figure 3-4h. Restriction Orifice (FO) is standard spec. flanges or special union holding a plate with a small hole to cause constant flow.

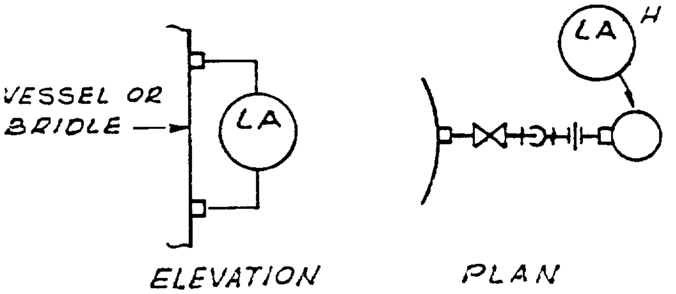


Flow Diagram Symbol **Piping Drawing Symbol**

Figure 3-4i. Displacement Type Flow Meter (FmI) indicates a total amount of flow passing through pipe line; is mounted within line.

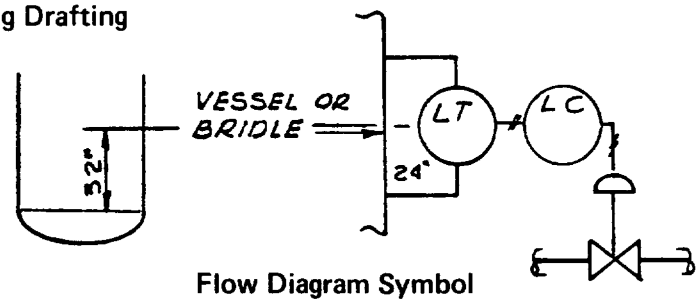


Flow Diagram Symbol

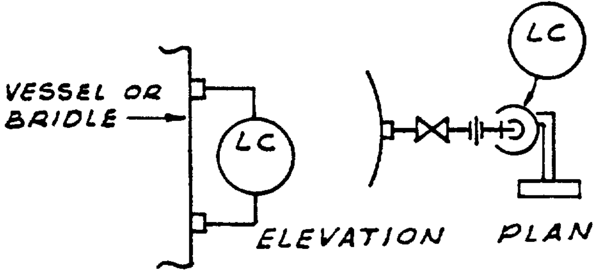


Piping Drawing Symbol

Figure 3-5a. Level Alarm (LA) indicates high or low liquid level by electrical signal to light and/or horn. Switch is operated by a displacer within a chamber hooked to a vessel usually through a bridle.

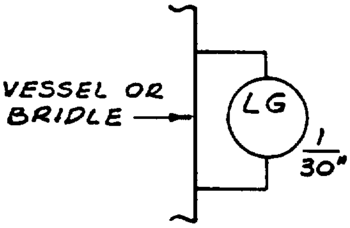


Flow Diagram Symbol

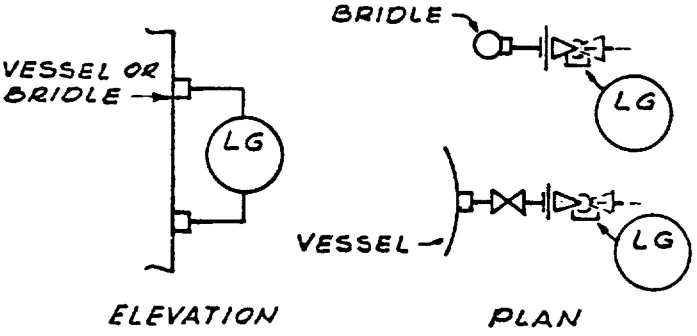


Piping Drawing Symbol

Figure 3-5b. Level Controller (LC) is a blind instrument that regulates vessel liquid level by pneumatic signal to a control valve. Dimension beside instrument balloon is the float length. Dimension on vessel is distance, in inches, from float mid range to vessel seam or tangent line. For horizontal vessels, this dimension would be from the inside bottom.

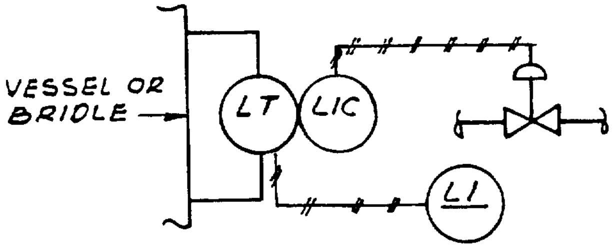


Flow Diagram Symbol



Piping Drawing Symbol

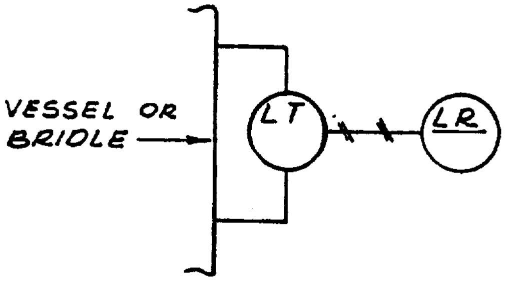
Figure 3-5c. Level Glass (LG) is a direct reading device connected at the low and high points of level variation. The liquid in the tank seeks its own level and may be observed in a transparent glass in the instrument. Upper number beside instrument indicates number of glasses, lower dimension is length between couplings.



Flow Diagram Symbol

Piping Drawing Symbol: See Figure 3-5b

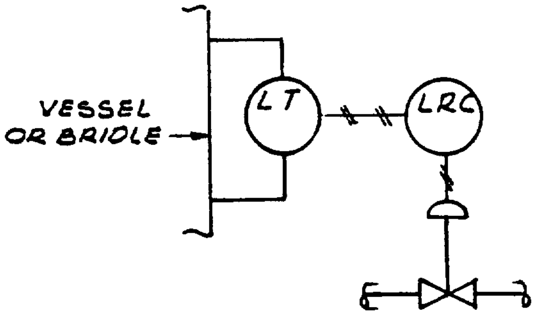
Figure 3-5d. Level Indicating Controller (LIC) is simultaneous control & indication of liquid level by same type transmitter as LC.



Flow Diagram Symbol

Piping Drawing Symbol: See Figure 3-5b

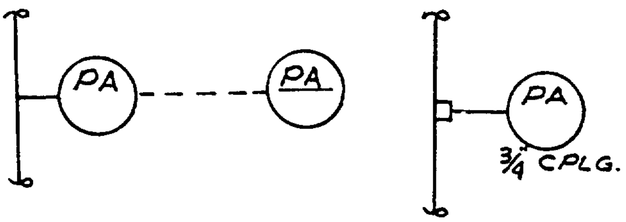
Figure 3-5e. Level Recorder (LR) makes permanent record of liquid level in vessel by pneumatic signal from displacement type transmitter on vessel or bridle.



Flow Diagram Symbol

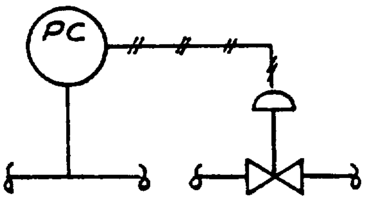
Piping Drawing Symbol: See Figure 3-5b

Figure 3-5f. Level Recorder Controller (LRC) is same transmitter as LR with pneumatic signal to a control valve as well as recorder.

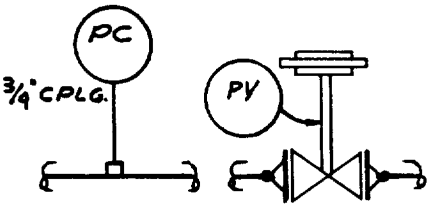


Flow Diagram Symbol **Piping Drawing Symbol**

Figure 3-6a. Pressure Alarm (PA) is pressure switch attached to the pipe or equipment by coupling or flange. When pressure deviates excessively, switch actuates alarm horn or light.

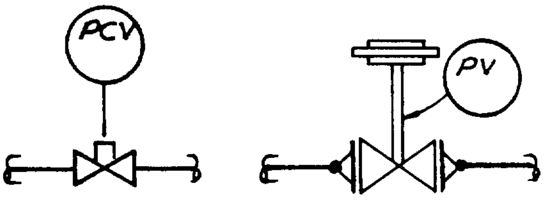


Flow Diagram Symbol



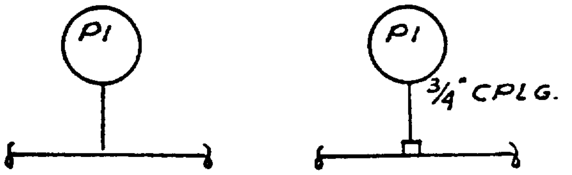
Piping Drawing Symbol

Figure 3-6b. Pressure Controller (PC) is where pipe or vessel pressure is regulated by control valve connected to measurement point thru a pneumatic transmitter.



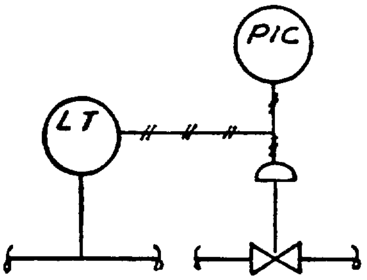
Flow Diagram Symbol **Piping Drawing Symbol**

Figure 3-6c. Pressure Control Valve (PCV) is self contained valve for regulating pressure. Needs no pressure tap on the pipe or equipment.



Flow Diagram Symbol **Piping Drawing Symbol**

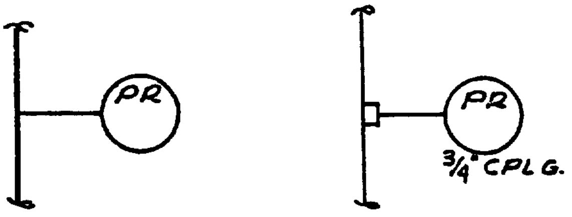
Figure 3-6d. Pressure Indicator (PI) is dial instrument indicating line or equipment pressure.



Flow Diagram Symbol

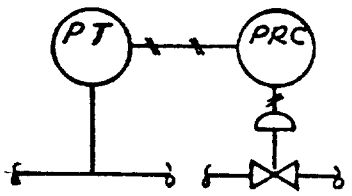
Piping Drawing Symbol: See Figure 3-6b

Figure 3-6e. Pressure Indicating Controller (PIC) is pressure control valve with either an indicating type transmitter or remote mounted pressure indicator.



Flow Diagram Symbol **Piping Drawing Symbol**

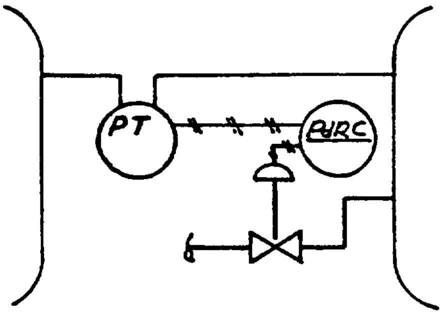
Figure 3-6f. Pressure Recorder (PR) is recording instrument making permanent record of line or equipment pressure. Recorder can be local or board mounted with signal from pneumatic transmitter.



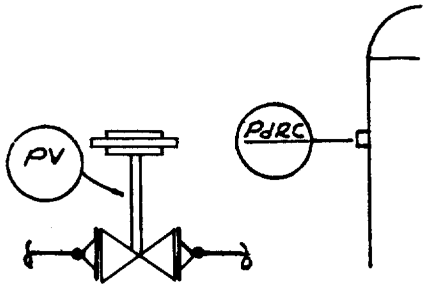
Flow Diagram Symbol

Piping Drawing Symbol: See Figure 3-6b

·Figure 3-6g. Pressure Recording Controller (PRC) instruments are similar to PR with an added pneumatic signal to control valve.

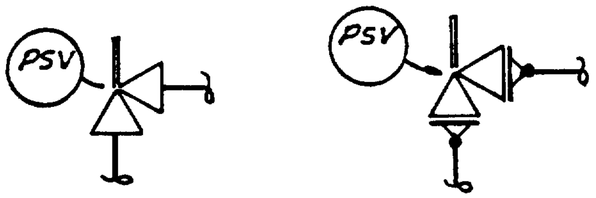


Flow Diagram Symbol



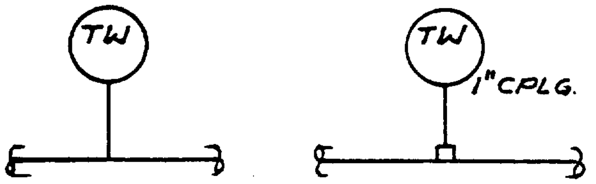
Piping Drawing Symbol

Figure 3-6h. Pressure Differential Recording Controller (PdRC) is control of pressure differential between two vessels or pipe lines by pressure control valve, combined with pressure recording instrument for controlled line or vessel.



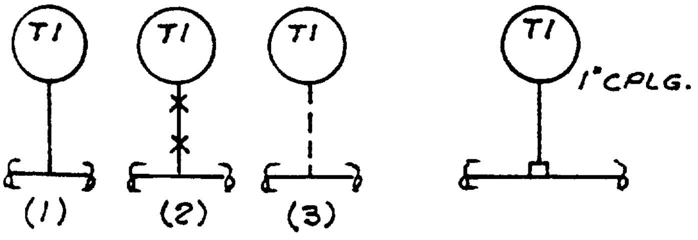
Flow Diagram Symbol **Piping Drawing Symbol**

Figure 3-6i. Pressure Safety Valve (PSV) is an automatic pressure relieving device actuated by pressure up stream of the valve.



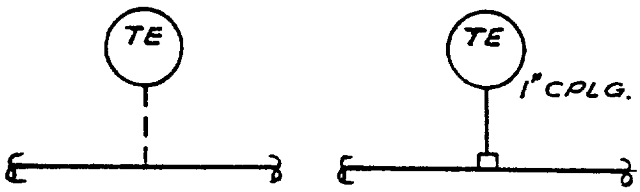
Flow Diagram Symbol **Piping Drawing Symbol**

Figure 3-7a. Temperature Well (TW) is unit for the protection of the temperature instrument bulb. Well is screwed into a coupling or bolted to a flanged connection on the pipe or equipment.



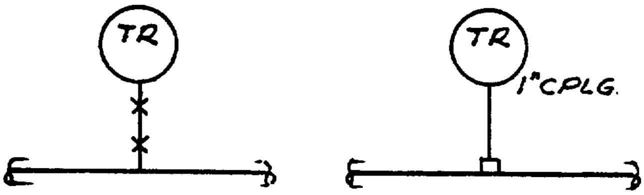
Flow Diagram Symbol **Piping Drawing Symbol**

Figure 3-7b. Temperature Indicator (TI) for temperature measurement can be of three types, (1) Local mounted dial thermometer, (2) Remote mounted dial with capillary tube to measurement point, or (3) Electric thermocouple with remote mounted indicator.



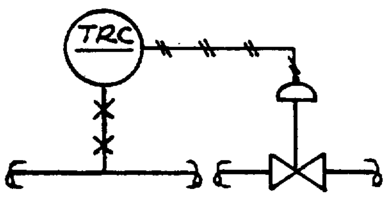
Flow Diagram Symbol **Piping Drawing Symbol**

Figure 3-7c. Temperature Element (TE) is thermocouple without connection to instrument. Used for temperature check with portable test equipment.

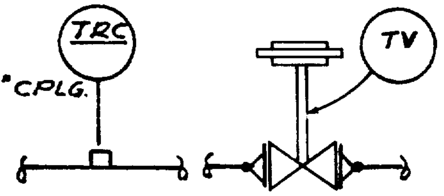


Flow Diagram Symbol **Piping Drawing Symbol**

Figure 3-7d. Temperature Recorder (TR) is recorder for permanent continuous record of equipment or pipe temperature. May be local or board mounted connected by capillary tube or pneumatic.

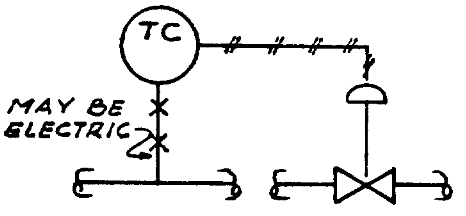


Flow Diagram Symbol



Piping Drawing Symbol

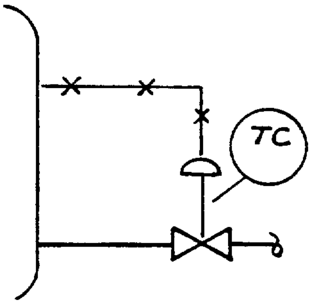
Figure 3-7e. Temperature Recording Controller (TRC) is simultaneous recording and regulation of line or vessel temperature by penumatic signal to recorder and control valve.



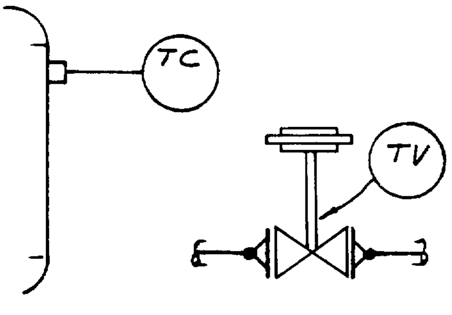
Flow Diagram Symbol

Piping Drawing Symbol: See Figure 3-7e

Figure 3-7f. Temperature Controller (TC) is line or vessel temperature regulated by control valve actuated by pneumatic signal from transmitter connected to measurement point by capillary tube or electric thermocouple.

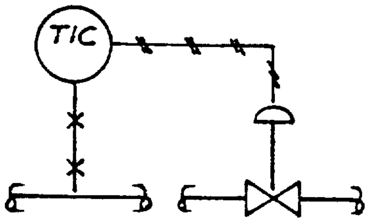


Flow Diagram Symbol



Piping Drawing Symbol

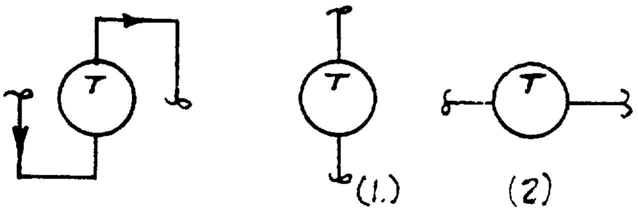
Figure 3-7g. Temperature Controller, self-actuated type (TC) is control valve with direct capillary connection to point of measurement.



Flow Diagram Symbol

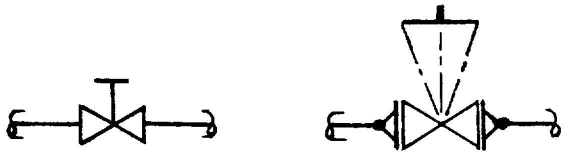
Piping Drawing Symbol: See Figure 3-7e

Figure 3-7h. Temperature Indicating Controller (TIC) is local or board mounted temperature indicator and a control valve to regulate temperature. Pneumatic transmitter can have indicator built into transmitter.



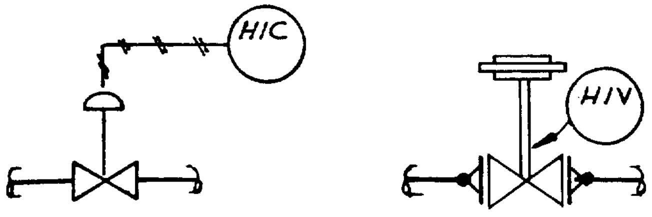
Flow Diagram Symbol **Piping Drawing Symbol**

Figure 3-8a. Steam Trap (T)function is to release condensed steam (condensate), air or gases, from a steam header or steam equipment without the loss of live steam. Of the four types of traps, two are basic. (1) Inverted Bucket is mounted so that condensate enters in bottom of trap and out the top. (2) Thermodynamic Type is mounted in line with condensate piping.



Flow Diagram Symbol **Piping Drawing Symbol**

Figure 3-9a. Hand Control Valve (HCV) is pneumatic control valves that may be equipped with handwheels for manual operation in emergency, for start-ups, or in the event of air failure.



Flow Diagram Symbol **Piping Drawing Symbol**

Figure 3-9b. Hand Indicating Controller (HIC) is pneumatic operated control valve with a remote indicator and control valve operator.

Linework and Lettering Exercise

Figure 3-10 has a sample small drawing of a typical piping plan. It is not drawn to any scale. The student is to copy this drawing to a 3/8" scale. He must particularly concentrate on linework and lettering. He will then turn this drawing in to the instructor for review and grading. Until the student can make an "A" on it, he should redo it every week and continue turning it in for grading.

This drawing has "coordinates." The vertical vessel in the lower left-hand corner has a N.100'-0" coordinate. This means that this vessel centerline is 100'-0" North of a base point commonly called a "bench mark." The exchanger has a N.113'-10" coordinate. Subtracting these two coordinates shows that the exchanger is 13'-10" North of the vessel centerline.

The East-West part of the drawing shows the vessel E-W centerline at W.651'-0". The steel pipe support is at W.642'-0". Subtracting shows the two centerlines are 9'-0" apart. The drawing has one blank dimension line. The student is to calculate and supply this dimension on his finished drawing.

The instructor should demand almost perfection on this project. The student wants to be a professional draftsman. He will be working and competing with professionals. A business won't accept sloppy or poor quality work. The instructor should prepare him for this.

Level Gage Specification Sheet

The level gage specification sheet in Figure 3-11 is a form the Instrument Engineer in most companies fills out. He uses it to tell the vendor, customer, piping draftsman and others what level gage he is specifying for the plant or unit being designed.

In the upper part of the sheet, he transmits much information by blacking in certain squares. The student is to review these terms carefully. The lower part gives detailed information. The LGs are those required on T-1 and V-1 vessels on Figure 3-2's mechanical flow diagram. The student is to review this flow diagram and note the specified level gages.

Level Instruments Specification Sheet

The level instruments specification in Figure 3-12 is a form the Instrument Engineer fills out. Level instruments are LC-1 and LC-2, which are level controllers required for T-1 and V-1 on Figure 3-2's mechanical flow diagram.

The horizontal column "connection style" is filled in with a ULS for LC-1 and LC-2. The specification sheet for level instruments has a supporting sheet (Figure 3-13), which specifies what ULS-type connections are. This sheet has many possible points for locating piping connections. The ULS type is upper and lower side connections. This means that the 1½" screwed connections are on the side of the float cage.

Figure 3-13 doesn't show the float head orientation in relation to the 1½" side connections. It will be filled in later after piping layout is done. The layout usually determines this head orientation.

Relief Valve Specification Sheet

The Instrument Engineer fills out the relief valve specification sheet, (Figure 3-14). It communicates pertinent data about this relief valve to all who read the specification sheet.

text continued on page 48

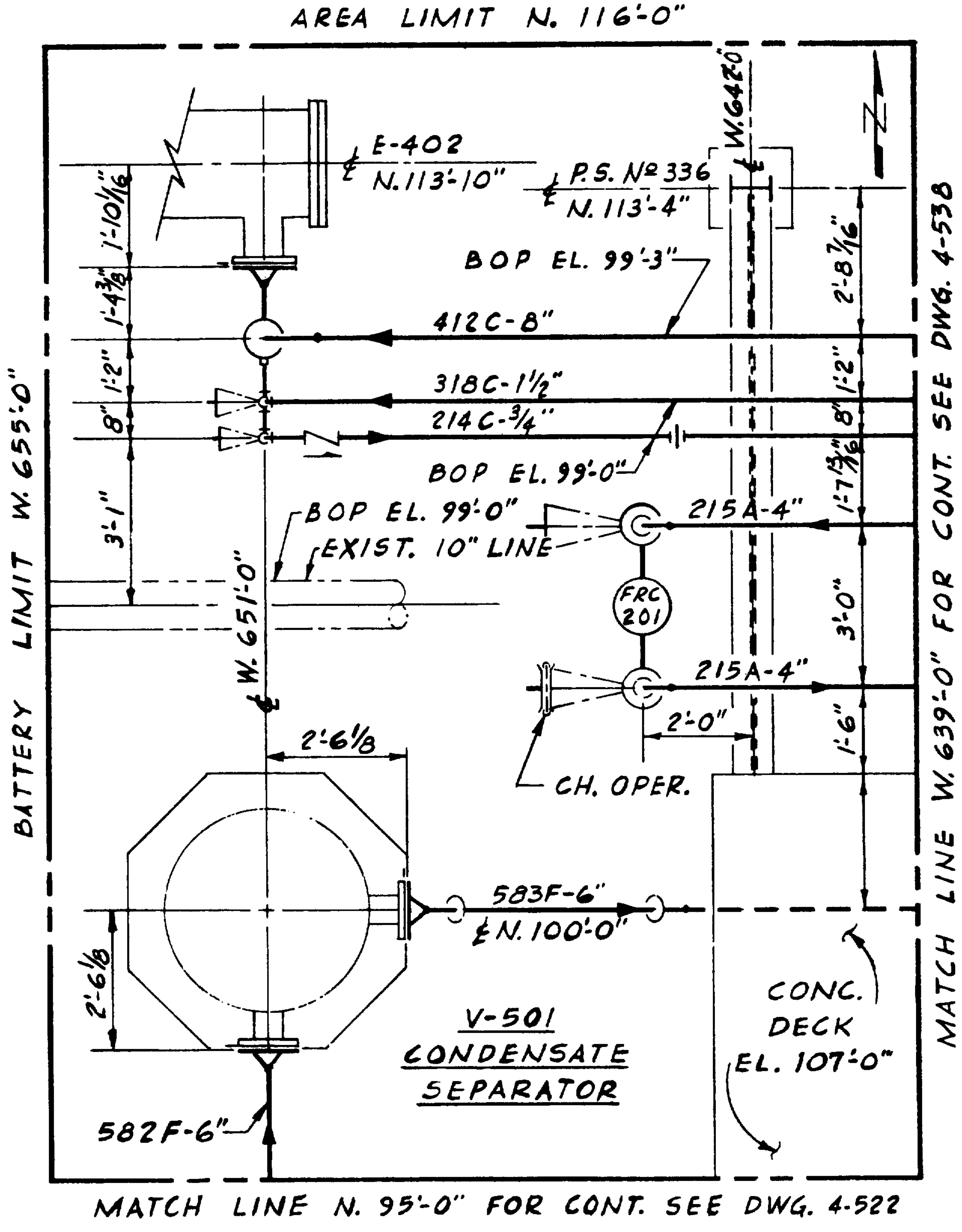
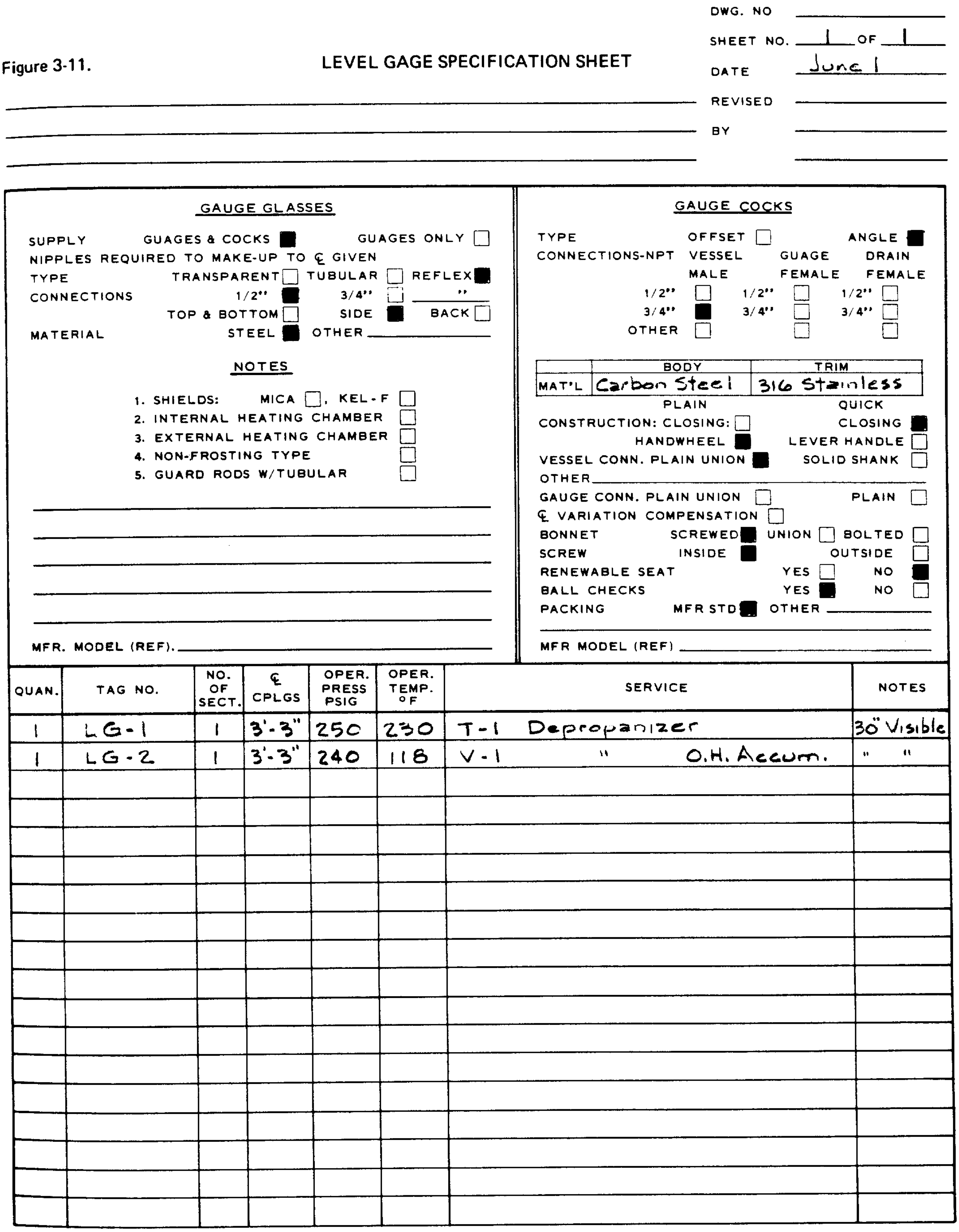


Figure 3-10. Combination Linework and Lettering Exercise. (Courtesy of Fluor Corp.).

Figure 3-11.



LEVEL GAGE SPECIFICATION SHEET

DWG. NO ______
SHEET NO. 1 OF 1
DATE June 1
REVISED ______
BY ______

GAUGE GLASSES

SUPPLY GUAGES & COCKS ☒ GUAGES ONLY ☐
NIPPLES REQUIRED TO MAKE-UP TO ℄ GIVEN
TYPE TRANSPARENT ☐ TUBULAR ☐ REFLEX ☒
CONNECTIONS 1/2" ☒ 3/4" ☐ ______ "
TOP & BOTTOM ☐ SIDE ☒ BACK ☐
MATERIAL STEEL ☒ OTHER ______

NOTES

1. SHIELDS: MICA ☐, KEL-F ☐
2. INTERNAL HEATING CHAMBER ☐
3. EXTERNAL HEATING CHAMBER ☐
4. NON-FROSTING TYPE ☐
5. GUARD RODS W/TUBULAR ☐

MFR. MODEL (REF). ______

GAUGE COCKS

TYPE OFFSET ☐ ANGLE ☒

CONNECTIONS-NPT	VESSEL MALE	GUAGE FEMALE	DRAIN FEMALE
1/2"	☐	☐	☐
3/4"	☒	☐	☐
OTHER	☐	☐	☐

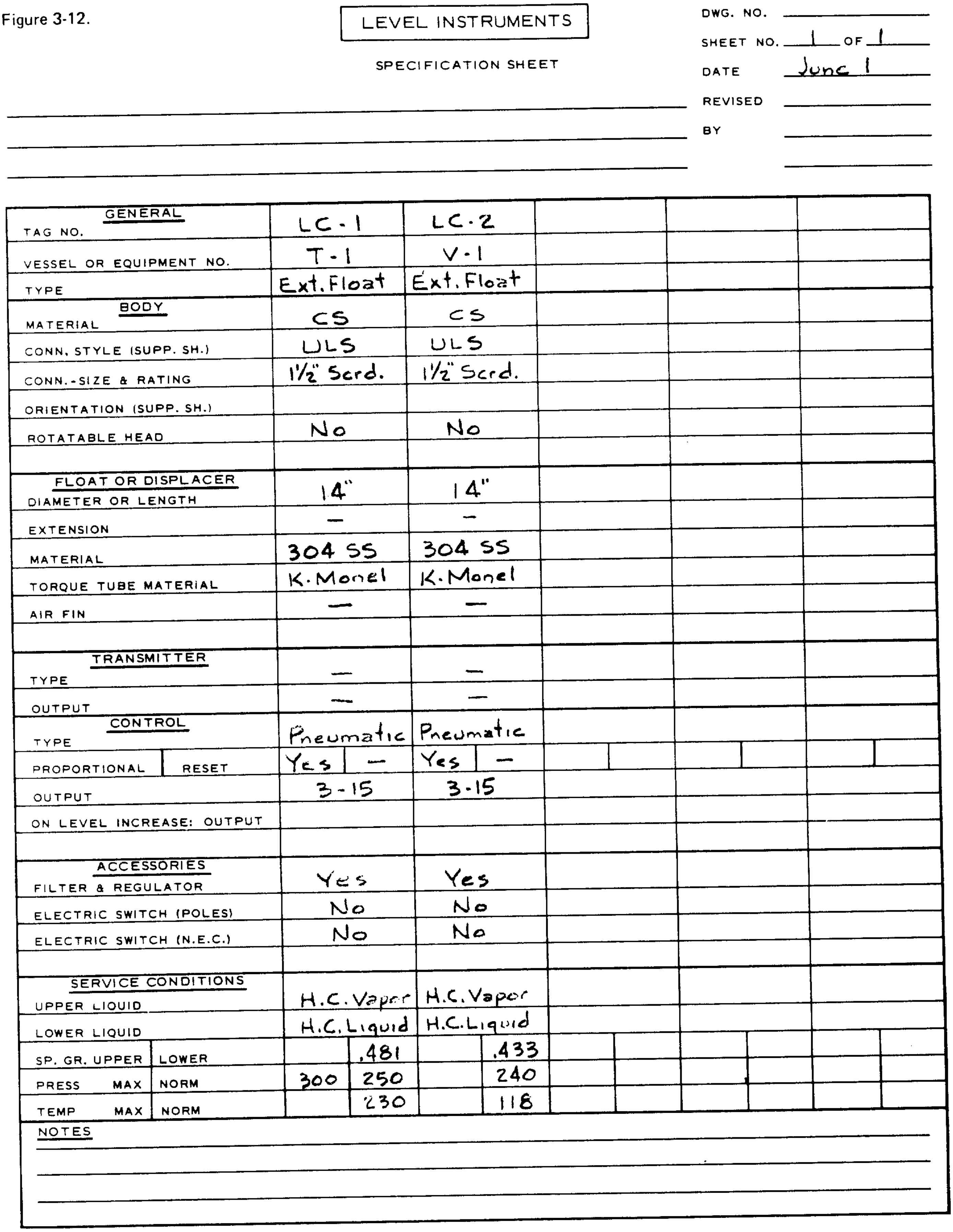
	BODY	TRIM
MAT'L	Carbon Steel	316 Stainless

CONSTRUCTION: PLAIN CLOSING ☐ QUICK CLOSING ☒
HANDWHEEL ☒ LEVER HANDLE ☐
VESSEL CONN. PLAIN UNION ☒ SOLID SHANK ☐
OTHER ______
GAUGE CONN. PLAIN UNION ☐ PLAIN ☐
℄ VARIATION COMPENSATION ☐
BONNET SCREWED ☒ UNION ☐ BOLTED ☐
SCREW INSIDE ☒ OUTSIDE ☐
RENEWABLE SEAT YES ☐ NO ☒
BALL CHECKS YES ☒ NO ☐
PACKING MFR STD ☒ OTHER ______

MFR MODEL (REF) ______

QUAN.	TAG NO.	NO. OF SECT.	℄ CPLGS	OPER. PRESS PSIG	OPER. TEMP. °F	SERVICE	NOTES
1	LG-1	1	3'-3"	250	230	T-1 Depropanizer	30" Visible
1	LG-2	1	3'-3"	240	118	V-1 " O.H. Accum.	" "

Figure 3-12.



LEVEL INSTRUMENTS

SPECIFICATION SHEET

DWG. NO.
SHEET NO. 1 OF 1
DATE June 1
REVISED
BY

GENERAL					
TAG NO.	LC-1	LC-2			
VESSEL OR EQUIPMENT NO.	T-1	V-1			
TYPE	Ext. Float	Ext. Float			
BODY					
MATERIAL	CS	CS			
CONN. STYLE (SUPP. SH.)	ULS	ULS			
CONN.-SIZE & RATING	1½" Scrd.	1½" Scrd.			
ORIENTATION (SUPP. SH.)					
ROTATABLE HEAD	No	No			
FLOAT OR DISPLACER					
DIAMETER OR LENGTH	14"	14"			
EXTENSION	—	—			
MATERIAL	304 SS	304 SS			
TORQUE TUBE MATERIAL	K-Monel	K-Monel			
AIR FIN	—	—			
TRANSMITTER					
TYPE	—	—			
OUTPUT	—	—			
CONTROL					
TYPE	Pneumatic	Pneumatic			
PROPORTIONAL RESET	Yes —	Yes —			
OUTPUT	3-15	3-15			
ON LEVEL INCREASE: OUTPUT					
ACCESSORIES					
FILTER & REGULATOR	Yes	Yes			
ELECTRIC SWITCH (POLES)	No	No			
ELECTRIC SWITCH (N.E.C.)	No	No			
SERVICE CONDITIONS					
UPPER LIQUID	H.C. Vapor	H.C. Vapor			
LOWER LIQUID	H.C. Liquid	H.C. Liquid			
SP. GR. UPPER LOWER	 .481	 .433			
PRESS MAX NORM	300 250	 240			
TEMP MAX NORM	 230	 118			

NOTES

Figure 3-13.

LEVEL INSTRUMENTS

SPECIFICATION SHEET
(SUPPLEMENTAL)

DWG. NO. ____________

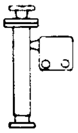
SHEET NO. ______ OF ______

DATE ____________

REVISED ____________

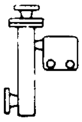
BY ____________

Top and Bottom



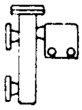
TB

Top and Lower Side



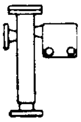
TLS

Upper and Lower Side



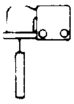
ULS

Upper Side and Bottom



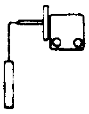
USB

Top Internal Mounted



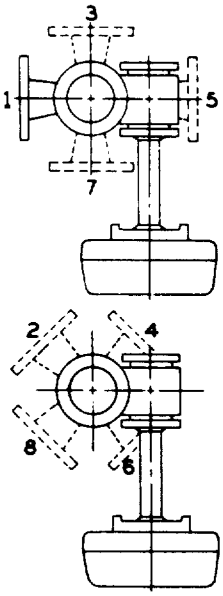
TIM

Side Internal Mounted

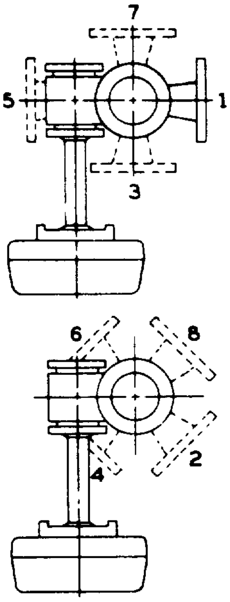


SIM

R



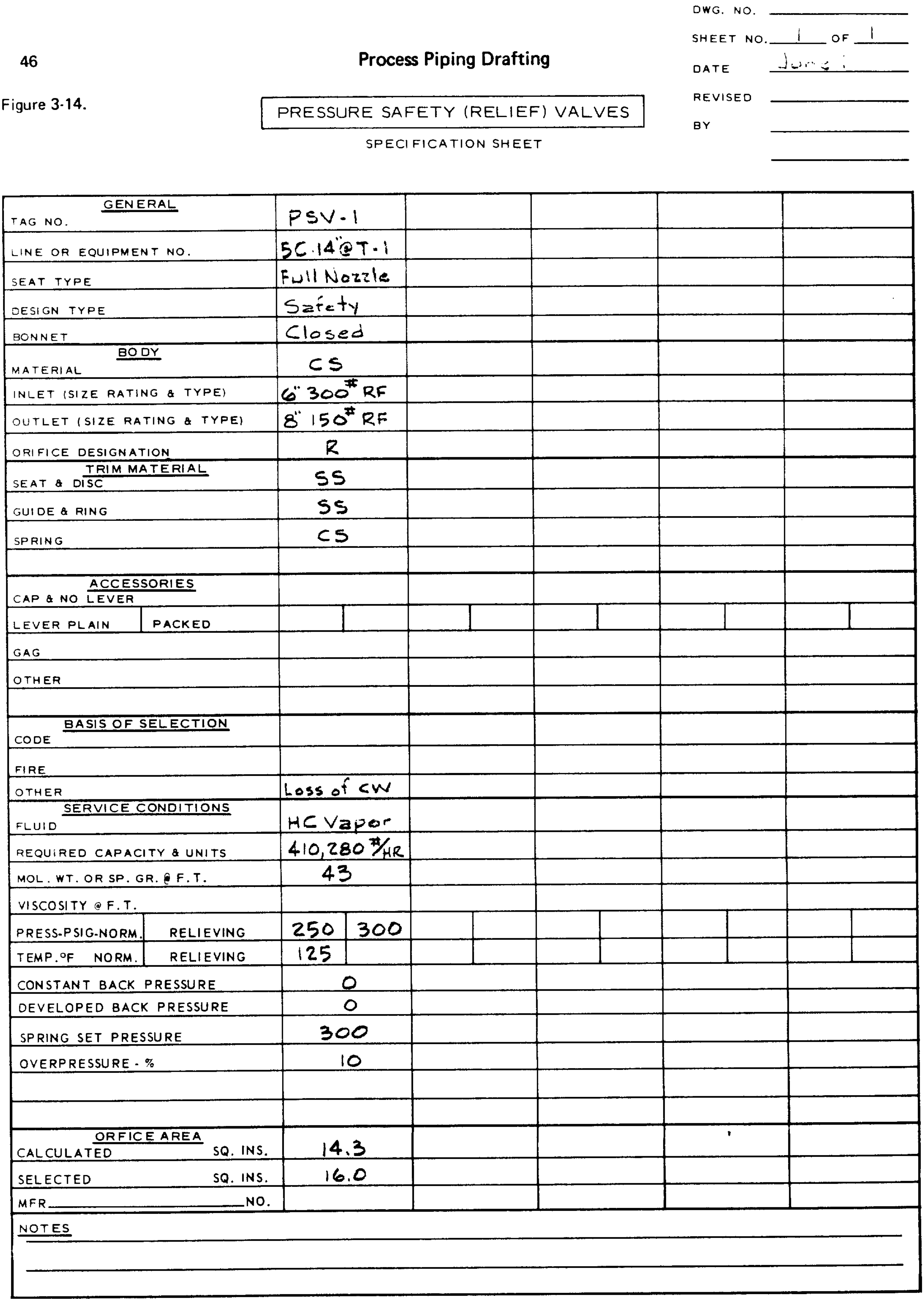
L



CONNECTION STYLE

ORIENTATION
(TOP VIEW)

Figure 3-14.



DWG. NO. ________

SHEET NO. 1 OF 1

DATE June 1

REVISED ________

BY ________

PRESSURE SAFETY (RELIEF) VALVES

SPECIFICATION SHEET

<table>
<tr><td colspan="2">GENERAL
TAG NO.</td><td colspan="2">PSV-1</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">LINE OR EQUIPMENT NO.</td><td colspan="2">5C·14"@T-1</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
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MATERIAL</td><td colspan="2">CS</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">INLET (SIZE RATING & TYPE)</td><td colspan="2">6" 300# RF</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">OUTLET (SIZE RATING & TYPE)</td><td colspan="2">8" 150# RF</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">ORIFICE DESIGNATION</td><td colspan="2">R</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
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SEAT & DISC</td><td colspan="2">SS</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
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FLUID</td><td colspan="2">HC Vapor</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
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<tr><td colspan="2">MOL. WT. OR SP. GR. @ F.T.</td><td colspan="2">43</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
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<tr><td colspan="2">SPRING SET PRESSURE</td><td colspan="2">300</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
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<tr><td colspan="2">ORFICE AREA
CALCULATED SQ. INS.</td><td colspan="2">14.3</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">SELECTED SQ. INS.</td><td colspan="2">16.0</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">MFR ____________ NO.</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
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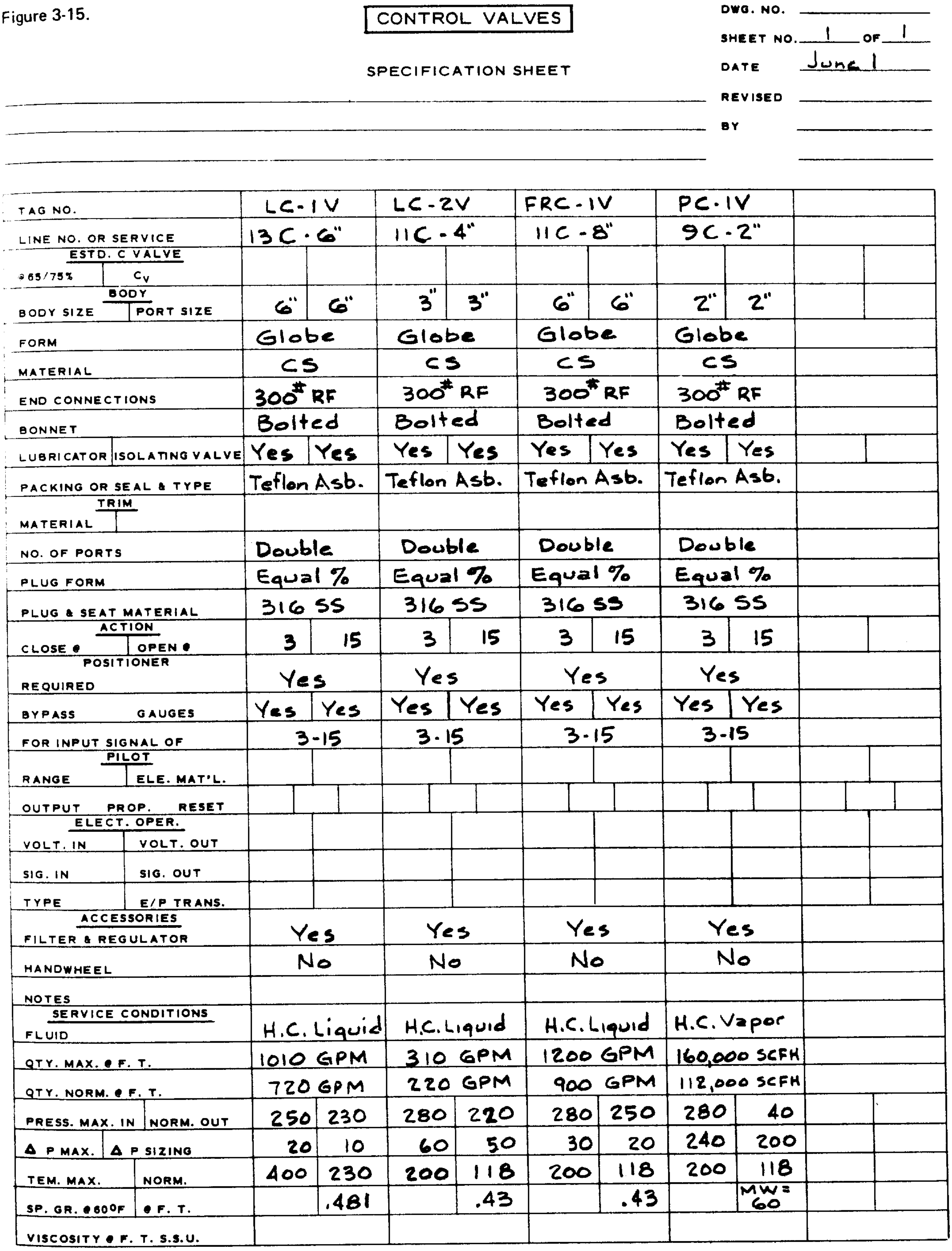
Figure 3-15.



CONTROL VALVES

SPECIFICATION SHEET

DWG. NO.
SHEET NO. 1 OF 1
DATE June 1
REVISED
BY

TAG NO.		LC-1V		LC-2V		FRC-1V		PC-1V			
LINE NO. OR SERVICE		13C-6"		11C-4"		11C-8"		9C-2"			
ESTD. C VALVE @65/75%	CV										
BODY BODY SIZE	PORT SIZE	6"	6"	3"	3"	6"	6"	2"	2"		
FORM		Globe		Globe		Globe		Globe			
MATERIAL		CS		CS		CS		CS			
END CONNECTIONS		300# RF		300# RF		300# RF		300# RF			
BONNET		Bolted		Bolted		Bolted		Bolted			
LUBRICATOR	ISOLATING VALVE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
PACKING OR SEAL & TYPE		Teflon Asb.		Teflon Asb.		Teflon Asb.		Teflon Asb.			
TRIM MATERIAL											
NO. OF PORTS		Double		Double		Double		Double			
PLUG FORM		Equal %		Equal %		Equal %		Equal %			
PLUG & SEAT MATERIAL		316 SS		316 SS		316 SS		316 SS			
ACTION CLOSE @	OPEN @	3	15	3	15	3	15	3	15		
POSITIONER REQUIRED		Yes		Yes		Yes		Yes			
BYPASS	GAUGES	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
FOR INPUT SIGNAL OF		3-15		3-15		3-15		3-15			
PILOT RANGE	ELE. MAT'L.										
OUTPUT PROP.	RESET										
ELECT. OPER. VOLT. IN	VOLT. OUT										
SIG. IN	SIG. OUT										
TYPE	E/P TRANS.										
ACCESSORIES FILTER & REGULATOR		Yes		Yes		Yes		Yes			
HANDWHEEL		No		No		No		No			
NOTES											
SERVICE CONDITIONS FLUID		H.C. Liquid		H.C. Liquid		H.C. Liquid		H.C. Vapor			
QTY. MAX. @ F. T.		1010 GPM		310 GPM		1200 GPM		160,000 SCFH			
QTY. NORM. @ F. T.		720 GPM		220 GPM		900 GPM		112,000 SCFH			
PRESS. MAX. IN	NORM. OUT	250	230	280	220	280	250	280	40		
Δ P MAX.	Δ P SIZING	20	10	60	50	30	20	240	200		
TEM. MAX.	NORM.	400	230	200	118	200	118	200	118		
SP. GR. @60°F	@ F. T.		.481		.43		.43		MW = 60		
VISCOSITY @ F. T. S.S.U.											

This relief valve is the 6" x 8" valve required to protect T-1 on the mechanical flow diagram in Figure 3-2. The specification sheet says it has a 6" 300# RF inlet and an 8" 150# RF outlet. This is basically all the information the piping draftsman needs to know from this sheet. When the relief valve is purchased, he needs to look at the vendor's print to get its exact dimensions. The vendor uses the remaining information so he can furnish the proper relief valve for the specifications.

Control Valve Specification Sheet

The Instrument Engineer also fills out the control valve specification sheet (Figure 3-15). It tells the vendor, piping draftsman and others who refer to it frequently information about a certain control valve.

The control valves are those the mechanical flow diagram depicts in Figure 3-2.

To read this specification sheet, the student should look at LC-1V. It says LC-1V is in line 13C-6". (See mechanical flow diagram to verify this.) The valve is 6", has a globe body and 300# RF flanges for end connections and also gives other information.

The bottom of the sheet gives pressure and temperatures. The ΔP column gives the pressure drop across the valve. The pressure upstream of LC-1V is 250 psig. The pressure downstream is 230 psig. So the pressure drop, appearing as ΔP ("delta" P), is 20 psig. But the sizing ΔP is to be 10 psig (pounds per square inch gage). This means the vendor who designs this control valve is to design it so it takes no more than 10 psig pressure drop. The student is to review the control valve specification carefully.

Review Test

This test reviews the first three chapters. If the student cannot answer all questions correctly, he must *not* go to the next chapter but must reread and learn Chapters 1 through 3.

1. Define PSV. ________________
2. What is its purpose? ________________
3. Define TI. ________________
4. Define PI. ________________
5. Define the difference between a pump and a compressor. ________________
6. Define the difference between a refinery and a gasoline plant. ________________
7. What kind of valve is designed for throttling service? ________________
8. What kind of valve is used for on-off or block valve? ________________
9. What kind of valve prevents backflow? ________________

10. Define fluid. ______________________________

11. Define OD. ______________________________

12. Define BOP. ______________________________

13. What is the OD of 4" pipe? ______________________________

14. What is the OD of 10" pipe? ______________________________

15. What is the OD of 14" pipe? ______________________________

16. Define ANSI. ______________________________

17. Define ℄ . ______________________________

18. What is the radius of a 6" LR ell? ______________________________

19. What is the radius of a 6" SR ell? ______________________________

20. What is the radius of an 8" x 6" reducing ell? ______________________________

21. Give the seven ratings of forged steel flanges. ______________________________

22. Give the two ratings of cast iron flanges. ______________________________

23. List the three basic flange facings. ______________________________

24. Flange bolting is always added in quantities of ______________ bolts per flange.

25. Define condensate. ______________________________

CHAPTER 4

ABBREVIATIONS & SPECIFICATIONS

Many abbreviations, like those below, are common language for the piping draftsman. The memory must be "put in gear" for the first group and the second group need not be memorized. The text has some of the first group but repeats them so the student will always have them together for ready reference.

Group I

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
°F	Degrees Fahrenheit
°C	Degrees Centigrade
LBS	Pounds
∅	Diameter
⅊	Plate
℄	Centerline
BB	Bolted Bonnet
BC	Bolt Circle
BE	Beveled Ends (for welding)
BF	Blind Flange
BM	Bill of Material
BOP	Bottom of Pipe
BW	Buttweld
Ch. Op.	Chain Operated
CI	Cast Iron
CO	Clean Out
CONC.	Concentric
CPLG.	Coupling
CS	Carbon Steel, Cast Steel or Cold Spring
DF	Drain Funnel
DIA.	Diameter
ECC	Eccentric
ELEV.	Elevation
FF	Flat Faced or Full Faced

FLG.	Flange
FOB	Flat on Bottom
FW	Field Weld
GJ	Ground Joint
HC	Hydrocarbon
IBBM	Iron Body Bronze Mounted
ID	Inside Diameter
IDD	Inside Depth of Dish
INS	Insulate
INV	Invert (*inside* bottom of pipe)
IPS	Iron Pipe Size
LR	Long Radius
MI	Malleable Iron
OD	Outside Diameter
OS & Y	Outside Screw and Yoke
PE	Plain End (not beveled)
PR	Pair
PSIA	Pounds Per Square Inch Absolute
PSIG	Pounds Per Square Inch Gage
RED	Reducer
RF	Raised Face
RTJ	Ring Type Joint (sometimes just designated RJ)
SCH	Schedule
SCRD	Screwed
SF	Semi-finished
SMLS	Seamless
SO	Slip-on
SPEC	Specification
SR	Short Radius
SS	Stainless Steel
STD	Standard
STL	Steel
STM	Steam
SW	Socketweld
SWG	Swage
TE	Threaded End
TEMP	Temperature
TOC	Top of Concrete
TOS	Top of Steel
TYP	Typical
VERT	Vertical
WE	Weld End
WN	Weld Neck
WT	Weight
XH	Extra Heavy
XXH	Double Extra Heavy

Group 2

The student should generally know these abbreviations.

AISC	American Institute of Steel Construction
API	American Petroleum Institute
AWS	American Welding Society
AWWA	American Water Works Association
MSS	Manufacturers Standardization Society
W/	With–such as, W/SS trim (with stainless steel trim)
L	Angle (a structural 4" angle shape)
C	Channel (a structural 4" channel shape)
W	W Shape (a structural 8" wide flange shape)
ASSY.	Assembly
AVG	Average
B&B	Bell and Bell
BLDG	Building
B&S	Bell and Spigot
BWG	Birmingham Wire Gage
CAS	Cast Alloy Steel
CO_2	Carbon Dioxide
COND	Condensate
CORR.	Corrosion
DWG	Drawing
EF	Electric Furnace
EFW	Electric Fusion Welded
ERW	Electric Resistance Welded
FIG	Figure or Figure Number
FS	Forged Steel
FSS	Forged Stainless Steel
FT	Feet or Foot
GALV	Galvanized
GR	Grade
H_2	Hydrogen
HDR	Header
LC	Lock Closed
LO	Lock Open
LW	Lap Weld
M	Miscellaneous Shapes, Steel
M&F	Male and Female
MFG	Manufacture
MIN	Minimum
MW	Miter Weld
NI	Nickel
NC	Normally Closed
NO	Normally Open
OH	Open Hearth

REINF	Reinforce
S	Standard Beams, usually called I-Beams
S.O.	Steam Out
SQ	Square
SWP	Standard Working Pressure
S.C.	Sample Connection
T.C.	Test Connection
T&C	Thread and Coupled
T&G	Tongue and Groove
VC	Vitrified Clay
WB	Welded Bonnet

Piping Specifications

Piping specifications are developed by engineers and designers with many years' experience. They define the materials, allowable working pressures and temperatures and all services for which that particular specification is designed. In all piping specification development, the product being handled and its corrosion upon the metal is of prime concern. Consequently, a "corrosion allowance" is specified for each specification table.

These specifications are used by (1) the piping draftsman to find what dimensions he must allow for in his layout and to make a material takeoff so he will order the proper material, (2) the shop fabricator to select his proper material, (3) the field to fabricate the "field fabricate" piping, (4) the instrument group to select the proper material and flange rating for the instruments they will specify, (5) Purchasing and Project departments to specify piping materials to equipment salesmen that have some furnished piping and (6) the stress analysis group.

A contractor develops specifications to utilize the most economical item which will do the job. His specifications should never be "gold plated." An operating company's specifications may have more expensive items in it which vary with the company. A good example is the reducing outlet tee. Most contractors will specify a stub-in, while the operating company might specify a reducing outlet tee, which is more expensive.

Specifications are usually divided into tables or classes. Each table is designed for certain services at a maximum pressure-temperature rating. Pressure range is sometimes limited by the flange rating and in pressures above the 300# class, is usually limited by the pipe wall thickness, as it is usually designed to suit the conditions. The temperature range is usually limited by the type of steel or packing selection for valves. The lubricated plug valve has a temperature limitation due to the lubricant being used.

Piping wall thickness is calculated by a formula in the ANSI Code for Pressure Piping and is governed by pressure, temperature, corrosion allowance and mill tolerance. The mill tolerance is 12½% for seamless pipe and 0.01" for pipe made of plate which is rolled and welded.

For refineries the piping code is ANSI B 31.3 "Code for Petroleum Refinery Piping." The piping draftsman should have a copy of this code, which is at most bookstores, in his reference library. He should know his piping code and will continually read it to refresh himself.

Table 4-1
Contractor's Piping Specifications
Index of Tables

Table	Flg. Rating	Material	Service
A	150# RF	Carbon Steel	Hydrocarbon Process
ACW	125# FF	Carbon Steel	Cooling Water
AIA	125# FF	Galv Carbon Steel	Instrument Air
AS	150# RF	Carbon Steel	Low Pressure Steam
AUA	125# FF	Carbon Steel	Utility Air
AUW	150# RF	Carbon Steel	Utility Water
C	300# RF	Carbon Steel	Hydrocarbon Process

Table 4-2
Piping Specifications

Table	Flg. Rating	Material	Service
CS	300# RF	Carbon Steel	300# Steam
D	400# RF	Carbon Steel	Hydrocarbon Process
F	600# RF	Carbon Steel	Hydrocarbon Process
FR	600# RTJ	Carbon Steel	Hydrogen
G	900# RF	Carbon Steel	Hydrocarbon Process
GR	900# RTJ	Carbon Steel	Hydrogen

The specifications in Table 4-1 are contractor's specifications. They must be modified if the customer submits his own set of specifications.

Specifications not included in Table 4-1, but which are very common in a full set of piping specifications, are noted in Table 4-2. These specifications can continue for all flange ratings and facings and for covering the wide range of utilities.

General Piping Specifications

1.00 Scope

1.01 This specification covers the materials and procedures for all process and utility piping used in the installation of this unit.

2.00 Codes

2.01 All piping in this unit will be designed in accordance with the ANSI B 31.3 code for pressure piping.

2.02 Where stress relieving is required, it will be done in accordance with the piping code. The shop-fabricated piping will be furnace treated and the field welds will be stress relieved with exothermic type stress relieving kits or an equal.

3.00 Drawings

3.01 All piping drawings will clearly indicate all clearances, intersections, anchors, guides, piping supports, spring and rod hangers and connections to associated equipment.

3.02 Piping drawings will show dimensions in feet and inches. Inches will be used when the dimension is less than 1'-0". Piping will be dimensioned to the closest 1/16".

3.03 A coordinate will locate all equipment such as vessels, towers, exchangers, pumps, fired heaters, air coolers, pipe racks and buildings. Piping will be dimensioned from these coordinates where possible.

3.04 Pipe 12" and under will be drawn single line. Double line piping will be used for lines 14" and larger and for congested areas where double line might be clearer. Standard symbols will be used throughout. Process area piping drawings will be drawn to a 3/8"=1'-0" scale. Yard piping and underground piping will be drawn to a smaller scale.

3.05 Each line on the piping arrangement drawings will be marked to show flow direction and the line number, specification table, line size and insulation requirements if insulation is needed.

An example is 12A-4"IH.

12 is the line number
A is the specification table
4" is the pipe size
I is insulate
H is heat conservation (type of insulation)

4.00 Clearances

4.01 Headroom beneath main process pipeways will be a minimum of 12'-0". This is *clearances* and will not be infringed on by lines droping out of the bottom of the rack, electrical lighting features or instrument raceways.

4.02 Minimum 7'-6" clearance will be maintained for all lines inside buildings, miscellaneous lines in the process units and lines running over aisles and platforms.

4.03 Minimum clearance over main roadways will be 17'-6" to the lowest projection and 15'-0" over secondary roadways.

4.04 Minimum clearance between equipment and/or piping for maintenance will be 2'-6". Horizontal clearance between exchanger shell flanges will be 1'-6" minimum.

4.05 Pipe rack supports will be spaced at 25'-0" maximum with pickup supports required for lines 4" and smaller. Main pipe racks preferably will be one level. If two levels are required, all "bents" will be strutted with a steel member at a level midway between the two rack levels.

5.00 Insulation

5.01 All hot insulated lines 3" and larger will be supported on minimum 3" high insulation shoes. For thicker insulation the shoes will be at least ½" higher than the insulation thickness. Insulation shoes will be made from 6" W cut in two pieces.

5.02 Insulation requirements are in the Pipe Line List. The required thickness appears in the insulation specifications. To determine the thickness, insulate according to the operating temperature shown. All insulation materials will be installed and purchased according to the insulation specifications.

6.00 Piping

6.01 IPS pipe sizes 1¼", 2½", 3½", 5" and 7" will be used only for equipment connections.

6.02 All piping, as far as practical, will be routed overhead on pipe racks, or pipe sleepers, and will be routed as short as possible, using the minimum number of fittings. Special consideration will be given to keeping alloy piping as short as possible. All piping will have suitable expansion provisions for hot lines.

6.03 Unless noted on the specific piping drawings, all material will be according to the piping specifications.

6.04 All operating valves 7'-6" above grade or platform will be equipped with a chain operator and chain within 4'-6" of grade or platform. Valves *not* considered as operating valves are branch line block valves from a main header, blocks and bypasses on control valves, level control valves, level gage valves, battery limit block valves and block valves on exchangers and coolers.

6.05 Expansion and contraction will be considered for each line. Cold spring of 3/4 or more inches will be used where it benefits the piping system. Cold spring less than 3/4" won't be used except in special close-connected piping or for positioning. All cold spring or cut long will be calculated according to the ANSI Code for Pressure Piping and will be noted on all piping plans and elevations and isometric drawings.

6.06 In 150$^{\#}$ and 300$^{\#}$ ratings, slip-on flanges may be substituted for weld necks as shown in the individual specifications where required for space limitations. The supervisor must approve using any slip-on flanges.

6.07 Pipe joint compound is to be omitted for backwelding in screwed piping. Backwelding is required for screwed fittings on lines operating at 300# or greater, or on lines operating at 700°F or hotter.

6.08 Flat type start-up strainers are used for pump start-up and are to be removed after start-up. They will not show on piping drawings but will show on the piping isometric.

7.00 Instrumentation

7.01 Liquid level controllers will be located where the gage glass is visible from them. The level control valve will be located where the operator can see the gage glass while operating the control valve by-pass.

7.02 Level gages and level controllers are to be accessible.

7.03 Control valves are to be located at grade.

7.04 Pressure gage connections to piping and equipment will be ¾" thredolet or sockolet.

7.05 Temperature instruments to piping and equipment will be 1" thredolets. When the flow sheet calls for a flanged connection, it will be a 1½" *Long Welding Neck.* The instrument group will buy the companion flange with the thermowell welded in. The piping group will buy bolts and gaskets.

7.06 The minimum requirement for meter runs for orifice flanges will be computed according to AGA (American Gas Association) standards. A .75 diameter ratio will be used for determining the upstream and downstream straight pipe requirements.

7.07 Orifice flange taps will be vertical for vapor service and horizontal for liquid service. Taps can be 45° to the vertical. Piping will furnish the two valves and nipples connected to the orifice flange. These valves will not show on the piping plans and elevations but will on the isometric.

8.00 Vents and Drains

8.01 All lines will have high point vents and low point drains for testing in the field. These will be ½" coupling and plug. Valves will not be provided for these hydrotesting connections.

Piping Specification
Table A
Hydrocarbon Process

Nominal Flange Rating: 150# RF
Design Conditions: 275 psig @ 100° F (Full Flange Rating)
Corrosion Allowance: 0.06"

Pipe		
½"-2"	Sch 80 Smls Stl OH or EF	ASTM A-106 Gr B (PE)
3"-10"	Sch 40 Smls Stl OH or EF	ASTM A-53 Gr B (BE)
12"-24"	0.375" Wall Smls Stl OH or EF	ASTM A-53 Gr B (BE)
Fittings		
½"-2"	3000# FS Socketweld	ASTM A-105 Gr II
3"-24"	Std Wt Buttwelding Smls	ASTM A-234 Gr WPB
Valves		
Gate Valves		
½"-2"	150-800# FS Socketweld	Vogt #SW-12113 through #SW-12118
3"-24"	150# CS Flanged RF	Crane # 47X
Bevel gear operate for 16" and larger.		
Globe Valves		
½"-2	150-800# FS Socketweld	Vogt #SW-12143 through #SW-12148
3"-8"	150# CS Flanged RF	Crane # 143X

Check Valves		
½"-2"	150-800# FS Socketweld	Vogt #SW-702 through #SW-708
(For horizontal installation only)		
3"-24"	150# CS Flanged RF	Crane #147X
Flanges		
2" and below	150# RF FS Socketweld	ASTM A-181 Gr I or II
3"-24"	150# RF FS Welding Neck	ASTM A-181 Gr I or II
Orifice Flanges		
2"-24"	300# RF, FS Welding Neck Bore to match pipe	ASTM A-181 Gr I or II or ASTM A-105 Gr II
Unions		
2" and smaller	3000# FS GJ Integral Seat Socketweld	ASTM A-105 Gr II
Thredolets and Sockolets		
1½" and smaller	3000# FS	ASTM A-105 Gr II
Plugs		
1½" and smaller	Solid FS Square Head	ASTM A-105 Gr II

Branch Connections

Branches 3"-8" use tee for line size branches. Stub-in all other sizes. Reinforce if required per ANSI piping code. For branches 2" and below, use socketweld tee for line size branches. Stub-in all other sizes.

Bolts

ASTM A-193 Gr B-7 Alloy Stl Stud Bolts w/2 ASTM A-194 Gr 2H SF Hvy Hex Nuts each

Gaskets

150# Spiral wound, 1/8" thk type 304SS, asbestos filled
Flexitallic style CG or equal

Note: Specified manufacturer or equal may be purchased.

Piping Specification
Table ACW
Cooling Water

Nominal Flange Rating: 125# FF
Design Conditions: 12" and smaller-200 psig @ 100° F
14"-24"-150 psig @ 100° F
Corrosion Allowance: 0.05"

Pipe		
½"-1½"	Sch 80 Smls Stl OH or EF	ASTM A-106 Gr B (TE)
2"	Sch 40 Smls Stl OH or EF	ASTM A-53 Gr B (TE)
3"-10"	Sch 40 Smls Stl OH or EF	ASTM A-53 Gr B (BE)
12"-24"	0.375" Wall Smls Stl OH or EF	ASTM A-53 Gr B (BE)
Fittings		
½"-2"	3000# FS Scrd	ASTM A-105 Gr II
3"-24"	Std Wt Smls Buttwelding	ASTM A-234 Gr WPB
Valves		
Gate Valves		
½"-2"	125# SWP Bronze Scrd	Crane #440
3"-24"	125# IBBM Flgd FF	Crane #465½
Globe Valves		
½"-2"	125# SWP Bronze Scrd	Crane #1
3"-8"	125# IBBM Flgd FF	Crane #351
Check Valves		
½"-2"	125# SWP Bronze Scrd	Crane #34
3"-24"	125# IBBM Flgd FF	Crane #373
Flanges		
½"-2"	150# FF, FS Scrd	ASTM A-181 Gr I or II
3"-24"	150# FF, FS Wldg Neck	ASTM A-181 Gr I or II
Orifice Flanges		
2"-24"	300# RF, FS Wldg Neck Bore to Match Pipe	ASTM A-181 Gr I or II or ASTM A-105 Gr II
Unions		
½"-2"	3000# FS GJ Scrd Integral Seat	ASTM A-105 Gr II
Thredolets		
2" and Smaller	3000# FS Scrd	ASTM A-105 Gr II

Plugs		
2" and Smaller	Solid FS Square Head	ASTM A-105 Gr II
Bolts		
Square head Machine Bolts w/1 SF Hvy Hex Nut each		ASTM A-307 Gr A

Branch Connections

3" through 8" use tee for line size branches. Stub-in all other sizes. For branches 2" and below, use screwed tee for line size branches. Stub-in all other sizes.

Gaskets

150# Asbestos full face, 1/16" thk JM-60 or equal

Note:

1. Specified manufacturer or equal may be purchased.
2. Use flat faced flanges with full faced gaskets against CI flat faced equipment and valves. Use raised face flanges for all other joints.
3. All underground screwed joints are to be seal welded.

Piping Specification
Table AIA
Instrument Air
Drinking Water

Nominal Flange Rating: 125$^{\#}$ FF
Design Conditions: 150 psig @ 200° F
Corrosion Allowance: 0.05"

Pipe		
½"-4"	Sch 40 Buttweld Steel Galv (T & C)	ASTM A-120 OH or EF
Fittings		
½"-4"	3000$^{\#}$ FS Scrd Galv	ASTM A-105 Gr II
Valves		
Gate Valves		
½"-2"	125$^{\#}$ SWP Bronze Scrd	Crane $^{\#}$440
3"and 4"	125$^{\#}$ Bronze Flgd	Crane $^{\#}$4437
Globe Valves		
½"-2"	125$^{\#}$ SWP Bronze Scrd	Crane $^{\#}$1
3" and 4"	150$^{\#}$ Bronze Flgd	Crane $^{\#}$4197
Check Valves		
½"-2"	125$^{\#}$ SWP Bronze Scrd	Crane $^{\#}$34
3" and 4"	150$^{\#}$ Bronze Flgd	Crane $^{\#}$4033
Flanges		
½"-4"	150$^{\#}$ FF, FS Scrd Galv	ASTM A-181 Gr I or II
Gaskets		
150$^{\#}$ Asbestos Full Face 1/16" thk JM-60 or equal		
Bolts		
Sq. Head Machine Bolt w/1 SF Hvy Hex Nut each		ASTM A-307
Swage Nipples		
Sch 80 Smls Stl Galv Threaded both ends		ASTM A-106 Gr B

Branch Connections
Use scrd tee for line size branches. Use scrd reducing tee for branch connections smaller than line size.

Note: Specified manufacturer or equal may be purchased.

Piping Specification
Table AS
Low Pressure Steam
Condensate

Nominal Flange Rating: 150# RF
Design Conditions: 275 psig @ 100° F (Full Flange Rating)
Corrosion Allowance: 0.125"

Pipe		
½"-1½"	Sch 80 Smls Stl OH or EF	ASTM A-106 Gr B (PE)
2"	Sch 40 Smls Stl OH or EF	ASTM A-53 Gr B (PE)
3"-10"	Sch 40 Smls Stl OH or EF	ASTM A-53 Gr B (BE)
12"-24"	0.375" Wall Smls Stl OH or EF	ASTM A-53 Gr B (BE)
Fittings		
½"-2"	3000# FS Socketweld	ASTM A-105 Gr II
3"-24"	Std Wt Smls Buttwelding	ASTM A-234 Gr WPB
Valves		
Gate Valves		
½"-2"	150-800# FS Socketweld	Vogt #SW-12113 through SW-12118
3"-24"	150# CS Flgd RF	Crane #47XR
Globe Valves		
½"-2"	150-800# FS Socketweld	Vogt #SW-12143 through SW-12148
3"-8"	150# CS Flgd RF	Crane #143XR
Check Valves		
½"-2"	150-800# FS Socketweld	Vogt #SW-703 through SW-708
(Horizontal installation only)		
3"-24"	150# CS Flgd RF	Crane #147X
Flanges		
2" and below	150# RF FS Socketweld	ASTM A-181 Gr I or II
3"-24"	150# RF FS Wldg Neck	ASTM A-181 Gr I or II
Orifice Flanges		
2"-24"	300# RF, FS Wldg Neck Bore to match pipe	ASTM A-181 Gr I or II or ASTM A-105 Gr II
Unions		
2" and smaller	3000# FS GJ Integral Seat Socketweld	ASTM A-105 Gr II

Thredolets and Sockolets

2" and smaller	$3000^{\#}$ FS Scrd or Socketweld instruments, vents and drains are to use scrd.	ASTM A-105 Gr II

Plugs

2" and smaller	Solid FS Square Head	ASTM A-105 Gr II

Branch Connections

Branches 3"-8" use tee for line size branches. Stub-in all other sizes. Reinforce if required per ANSI piping code. For branches 2" and below, use socketweld tee for line size branches. Stub-in all other sizes.

Bolts

ASTM A-193 Gr B7 Alloy Stl Stud Bolts w/2 ASTM A-194 Gr 2H Semi-finished Hvy Hex Nuts each

Gaskets

$150^{\#}$ Spiral Wound, 1/8" thk, type 304SS, asbestos filled
Flexitallic style CG or equal

Note: Specified manufacturer or equal may be purchased.

Piping Specification
Table AUA, AUW
Utility Air and Water

Nominal Flange Rating: 125# FF
Design Conditions: 12" and smaller - 200 psig @ 100°F
Corrosion Allowance: 0.05"

Pipe		
½"-1½"	Sch 80 Smls Stl OH or EF	ASTM A-106 Gr B (PE)
2"	Sch 40 Smls Stl OH or EF	ASTM A-53 Gr B (PE)
3"-10"	Sch 40 Smls Stl OH or EF	ASTM A-53 Gr B (BE)
Fittings		
½"-2"	3000# FS Socketweld	ASTM A-105 Gr II
3"-10"	Std Wt Smls Wldg	ASTM A-234 Gr WPB
Valves		
Gate Valves		
½"-2"	125# SWP Bronze Scrd	Crane #440
3"-10"	125# SWP IBBM Flgd FF	Crane #465½
Globe Valves		
½"-2"	125# SWP Bronze Scrd	Crane #1
3"-8"	125# IBBM Flgd FF	Crane #351
Check Valves		
½"-2"	125# SWP Bronze Scrd	Crane #34
3"-10"	125# IBBM Flgd FF	Crane #373
Flanges		
½"-2"	150# RF FS Socketweld	ASTM A-181 Gr I or II
3"-10"	150# FF FS Wldg Neck	ASTM A-181 Gr I or II
Orifice Flanges		
2"-10"	300# RF FS Wldg Neck Bore to Match Pipe	ASTM A-181 Gr I or II or ASTM A-105 Gr II
Unions		
½"-2"	3000# FS GJ Socketweld Integral Seat	ASTM A-105 Gr II
Thredolets		
2" and smaller	3000# Scrd	ASTM A-105 Gr II
Plugs		
2" and smaller	Solid FS Sq. Head	ASTM A-105 Gr II

Branch Connections

3"-8" use tee for line size branches. Stub-in all other sizes. For branches 2" and below, use socketweld tee for line size branches. Stub-in all other sizes.

Bolts

Square head Machine Bolts w/1 Semi-finished Hvy Hex Nut each	ASTM A-307 Gr A

Gaskets

150# Asbestos full face, 1/16" thk JM-60 or equal

Note: 1. Specified manufacturer or equal may be purchased.

2. Use flat faced flanges with full faced gaskets against flat faced equipment and valves. All other joints will have raised face flanges.

Piping Specification
Table C
Hydrocarbon Process

Nominal Flange Rating: 300$^{\#}$ RF
Design Conditions: 430 psig @ 600°F
Corrosion Allowance: 0.06"

Pipe		
½"-2"	Sch 80 Smls Stl OH or EF	ASTM A-106 Gr B (PE)
3"-10"	Sch 40 Smls Stl OH or EF	ASTM A-53 Gr B (BE)
12"-20"	0.375" Wall Smls Stl OH or EF	ASTM A-53 Gr B (BE)
24"	0.500" Wall Smls Stl OH or EF	ASTM A-53 Gr B (BE)
Fittings		
½"-2"	3000$^{\#}$ FS Socketweld	ASTM A-105 Gr II
3"-20"	Std Wt Buttwelding Smls	ASTM A-234 Gr WPB
24"	Ex Hvy Buttwelding Smls	ASTM A-234 Gr WPB
Valves		
Gate Valves		
½"-2"	150-800$^{\#}$ FS Socketweld	Vogt $^{\#}$SW-12113 through $^{\#}$SW-12118
3"-24"	300$^{\#}$ CS Flgd RF	Crane $^{\#}$33X
Bevel gear operate for 16" and larger.		
Globe Valves		
½"-2"	150-800$^{\#}$ FS Socketweld	Vogt $^{\#}$SW-12143 through $^{\#}$SW-12148
3"-8"	300$^{\#}$ CS Flgd RF	Crane $^{\#}$151X
Check Valves		
½"-2"	150-800$^{\#}$ FS Socketweld	Vogt $^{\#}$SW-703 through $^{\#}$SW-708
3"-24"	300$^{\#}$ CS Flgd RF	Crane $^{\#}$159X
Flanges		
2" and below	300$^{\#}$ RF FS Socketweld	ASTM A-181 Gr I or II
3"-24"	300$^{\#}$ RF FS Wldg Neck	ASTM A-181 Gr I or II
Orifice Flanges		
2"-24"	300$^{\#}$ RF, FS Wldg Neck Bore to match pipe	ASTM A-181 Gr I or II or ASTM A-105 Gr II
Unions		
2" and smaller	3000$^{\#}$ FS GJ Integral Seat Socketweld	ASTM A-105 Gr II

Thredolets

1½" and smaller	3000$^{\#}$ FS Scrd	ASTM A-105 Gr II

Plugs

1½" and smaller	Solid FS Sq. Head	ASTM A-105 Gr II

Branch Connections

Branches 3"-8" use tee for line size branches. Stub-in all other sizes. Reinforce if required per ANSI piping code. For branches 2" and below, use socket weld tee for line size branches. Stub-in all other sizes.

Bolts

ASTM A-193 Gr. B7 Alloy Steel Stud Bolts w/2 ASTM A-194 Gr. 2H SF Hvy Hex Nuts each

Gaskets

300$^{\#}$ Spiral wound, 1/8" thk, type 304SS, asbestos filled
Flexitallic style CG or equal

Note: Specified manufacturer or equal may be purchased.

Thread Engagement

When male and female threaded ends are coupled together the male end is inserted into the female threads until the joint is tight. This overlap is called *thread engagement.* Table 4-3 provides thread engagement dimensions in inches.

Table 4-3
American Standard and API Thread Engagement

Dimensions, in Inches			
Size	Thread Engagement	Size	Thread Engagement
⅛	¼	1	11/16
¼	⅜	1¼	11/16
⅜	⅜	1½	11/16
½	½	2	¾
¾	9/16	2½	15/16

Insulation

When insulation conserves heat, it is called heat conservation insulation. Cold insulation is for temperatures 40° and below.

Insulation also is used for "safety" or personnel protection. A pipe operating at 150°F or more may not require insulation for heat conservation. But, in areas around walkways or platforms, an operator could be burned badly if he touches this hot line. So "safety" insulation is added to the pipe at points where operators might come in contact with it.

Hot insulation is applied to pipe, fittings and valves in steam service. Valves in process service usually are not insulated unless required for "saftey." Heat lost at these valves is so minor it does not pay to insulate the valves. Also, these valves are left uninsulated for easy maintenance access.

Aluminum covering is applied to piping, fittings and equipment insulation as a weather protection. This may be smooth aluminum or may be corrugated. Generally the smooth covering is for piping and equipment insulated with block-type insulation. Corrugated aluminum is for equipment insulated with blanket-type insulation.

Insulated piping 3" and above is elevated above the pipe rack with 3" "shoes," which protects the insulation so that it will not rub against the support and tear. The actual bottom of pipe is 3" above the support. This shoe is made by cutting a 6" W in two parts and making two shoes. This W section is about 14" long.

Fluid operating temperature governs insulation thickness for mineral wool-type insulation by pipe size. Table 4-4 gives the preferred thickness.

Table 4-4
Hot Insulation Thickness (Inches) for Piping

Pipe Size	To 225°F	226°F–275°F	276°F–325°F	326°F–375°F	376°F–425°F	426°F–475°F	476°F–525°F	526°F–575°F	576°F–625°F
½	1	1	1	1	1	1	1	1	1½
¾	1	1	1	1	1	1	1	1	1½
1	1	1	1	1	1	1½	1½	1½	1½
1½	1	1	1	1	1½	1½	1½	1½	1½
2	1	1	1	1	1½	1½	1½	1½	1½
3	1	1	1	1½	1½	1½	1½	1½	1½
4	1	1	1½	1½	1½	1½	2	2	2
6	1	1½	1½	1½	1½	2	2	2	2
8	1½	1½	1½	2	2	2	2	2½	2½
10	1½	1½	1½	2	2	2	2½	2½	2½
12	1½	1½	2	2	2	2	2½	2½	2½
14	1½	2	2	2	2	2½	2½	2½	2½

Pipe Line List

The line list with the flow diagrams serve as the piping draftsman's road map. It lists the line numbers, in numerical order, shows the class or specification of the line and size, whether it is insulated, what the line is transporting, whether this commodity is liquid or vapor, the line's starting and termination points, design pressure and temperature and operating pressure and temperature. The piping supervisor usually fills out the line list and selects the piping specification which will handle the system's particular conditions. The piping draftsman gets a copy of the line list and flow diagrams to use while making his piping drawings.

Figure 4-1a and 4-1b is the line list for flow diagrams in Figures 3-2 and 3-3. While this line list is small, a normal one for a $10-million job will be 40-50 pages.

Piping Specialty List

The piping specialty list covers items that piping specifications do not. These might be line blinds, or spectacle blinds; pump and compressor start-up strainers; special line strainers; special valves such as a twin-seated valve or heater fuel oil firing valves; or the many other special piping items not covered by a general specification.

All piping materials must be listed on paper so purchasing agents can buy them. The information must be exact as the purchasers will buy by those specifications.

The piping supervisor will usually fill out the piping specialty list and keep the original on file to add any new items. The piping draftsman will receive a copy of this list.

A blank form, "piping specialty list," is in Figure 4-2.

Figure 4-1a.

PIPE LINE LIST

JOB NO. ____________
SHEET NO. 1 REV. ______
DATE ________ BY ________

REV	FLOW DIAG. NO	LINE NO.	LINE CLASS	LINE SIZE	INSU.	COMMODITY	VAP. LIQ.	DESCRIPTION ORIGIN FROM	DESCRIPTION TERMINUS TO	Des PSIG Oper. PSIG	Des °F Oper °F	Reinf. Pad Post Heat Treat	
△		1	C	6"	IH	Hydrocarb. Feed	V L	Battery Limits	T-1	300 255	250 210	No No	
△		2	C	–	IH	Hydro-carbon	V L	T-1 Trim Material		300 250	275 245	No No	
△		3	C	16"	IH	Hydro-carbon	L	T-1	E-2	300 250	275 230	No No	
△		4	C	20"	IH	Hydro-carbon	V	E-2	T-1	300 250	275 245	No No	
△		5	C	14"	No	Hydro-carbon	V	T-1	E-1	300 245	150 125	No No	
△		6	C	10"	No	Hydro-carbon	L	E-1	V-1	300 240	150 118	No No	
△		7	C	–	No	Hydro-carbon	L V	V-1 Trim Material		300 240	150 118	No No	
△		8	C	1½"	No	Hydro-carbon	L	V-1	Oily Water Sewer	300 240	150 118	No No	
△		9	C	2"	No	HC Flare	V	V-1	PC-1 at line 15A-2"	300 240	150 118	No No	
△		10	C	10"	No	Propane	L	V-1	P-1A & B	300 240	150 118	No No	
△		11	C	8"	No	Propane	L	P-1A & B	T-1 Reflux & to LC-2 @ line 12A-4"	310 280	150 118	No No	
△		12	A	4"	No	Propane	L	Line 11C-4"	Battery Limits (To Storage)	245 220	140 118	No No	
△		13	C	6"	IH	Hydro-carbon	L	Line 3C-16"	Battery Limits (To Storage)	300 250	275 230	No No	
△		14	A	8"	No	Hydro-carbon	V	PSV-1	Atmosphere	– Atm.	– Amb	No No	
△		15	A	2"	No	HC Flare	V	PC-1 at line 9C-2"	Battery Limits (Flare)	100 40	150 118	No No	

△ △ △ △ △ △ △ △

Figure 4-1b.

PIPE LINE LIST

JOB NO. ____________

SHEET NO. 2 REV. ______

DATE ________ BY ______

REV	FLOW DIAG. NO	LINE NO.	LINE CLASS	LINE SIZE	INSU.	COMMODITY	VAR. / LIQ.	DESCRIPTION ORIGIN FROM	DESCRIPTION TERMINUS TO	Des PSIG / Oper. PSIG	Des °F / Oper °F	Reinf. Pad / Post Heat Treat	
△		16	A	6"	IH	Hot Oil	L	Battery Limits	E-2	150	500	No	
										100	400	No	
△		17	A	6"	IH	Hot Oil	L	E-2	Battery Limits	150	500	No	
										80	130	No	
△		18	ACW	10"	No	Cooling Water Supply	L	Battery Limits	E-1	100	100	No	
										60	75	No	
△		19	ACW	10"	No	Cooling Water Return	L	E-1	Battery Limits	100	125	No	
										40	95	No	
△		20	AIA	½"	No	Instrum. Air	V	Battery Limits	Unit Supply Hdr.	100	125	No	
										90	100	No	
△		21	AUA	½"	No	Utility Air	V	Battery Limits	Unit Supply Hdr.	150	125	No	
										100	100	No	
△		22	AUW	½"	No	Utility Water	L	Battery Limits	Unit Supply Hdr.	90	125	No	
										50	100	No	
△		23	AS	2"	IH	50# Steam	V	Battery Limits	Unit Supply Hdr.	75	320	No	
										50	298	No	
△													
△													
△													
△													
△													
△													
△													

△ △ △ △ △ △ △ △

Figure 4-2.

PIPING SPECIALTY LIST

= This symbol on flow diagrams or drawings denotes a piping specialty item not otherwise covered by piping specifications

SHEET NO. ______ OF _____ REV. ________
CONTRACT NO. ____________________
BY ____________ DATE ____________

SP NO.	P.O. NO.	QUAN.	SIZE	DESCRIPTION	LINE NO.	FLOWSH. NO.

△	△	△	△	△	△	△	△

Test

This is a test on Chapter 4. If you miss more than two questions, you should reread the chapter. If you miss more than five, you should be in another field of endeavor.

1. Define BOP. ________________________________
2. Define ECC. ________________________________
3. What is WN RF? ________________________________
4. What piping code (ANSI) would you use for refineries? ________________
5. What is the difference between 125# and 150# flanges? ________________
6. What type of carbon steel is used for instrument air? ________________
7. Piping table "C" has a flange rating of ________________________
8. List the seven basic flange ratings. ________________________
9. Define TOS. ________________________________
10. Piping drawings are usually drawn to a ____________ =1'-0" scale.
11. Define the parts of line 16A-12"IH:
    16 is ________________________________
    A is ________________________________
    12" is ________________________________
    I is ________________________________
    H is ________________________________
12. Pipe racks are spaced at ________ feet and have a clearance of ________ feet.
13. Insulated lines ____________ and larger have "shoes."
14. Operating valves ____________ or more above grade shall be chain operated.
15. A level control valve is located so that the operator can see ________________ when operating the by-pass valve.

16. Backwelding is required for screwed fittings if the lines are operating at ________________ or more pounds.

17. Temperature instruments shall be ________________ size thredolets.

18. Pressure gage connections shall be ________________ size thredolets.

19. For liquid service, orifice taps shall be (a) horizontal or (b) vertical? ____________________________

20. Hydrostatic vents and drains shall be ________________ size.

CHAPTER 5

NOMENCLATURE, PLANS & DETAILS

This book has defined some terms the student will hear in the piping drafting room. Other terms he must become familiar with are below.

Vessel Nomenclature

Head is the end closure of the vessel–usually a 2:1 semi-elliptical head with major to minor axes of 2:1. It may be a flanged and dished head or other shape.

Shell is the wall of the vessel, like the sides of a tin can.

Skirt, a cylindrical supporting structure, is welded to the bottom head of a vertical vessel and extends to the base support. Anchor bolt holes are located in the base plate which is welded to the skirt.

Skirt vents are usually 3" or 4" holes at the top of the skirt to keep dangerous gases from accumulating in it. Usually four of them are equally spaced around the top of the skirt.

Base plate is flat plate welded to vessel supports (skirt) that bears on concrete foundation and contains holes for anchor bolts.

Saddles are steel supports supporting horizontal vessels or exchangers, which have holes for anchor bolts.

Skirt access opening is a hole near the bottom of the skirt which allows entrance inside for inspection. It is usually 18" ID and 2'-6" above bottom of base plate.

Nozzle is a short piece of pipe welded in the shell with a flange welded to the other end. The piping flange bolts to the vessel nozzle. Nozzles may also be the long weld neck type.

Reinforcing pad is plate formed to fit the vessel shell and used around nozzles to replace metal taken out of the shell when the hole is cut for the nozzle. It reinforces the shell opening.

Manhole is like a nozzle, except it is usually 18" IPS or 18" ID and has a hinged blind flange bolted to it. This is used for taking vessel internals in or out of the vessel and is for the workmen to enter the vessel. It should have a platform if it is 15' or more above grade.

Manhole hinge is a hinge connected to the manhole nozzle flange and the blind flange. It allows the blind flange to be swung aside for access to the vessel.

Tray is in a vertical fractionating tower, the flat plate spaced at ± 2'-6" and is bolted or welded to the shell. It supports process liquids and allows the vapors from below to flow through the liquid, causing fractionation.

Seal pan is below the bottom tray and seals the liquid so that incoming vapors cannot by-pass the tray.

Insulation rings are continuous steel rings welded to the outside of the vertical vessels on ± 12'-0" centers for the length of the vessel. They support the vessels insulation. A ring can be cut to miss nozzles.

Skirt fireproofing is where brick or gunite is applied to the outside and sometimes the inside of vertical vessel skirts to prevent damage to the skirt from fire.

Ladders and cages are rung-type ladders with cages built of structural shapes to prevent a man climbing the ladder from falling. They provide access up and down the vessel to the various platforms. Ladder offsets are spaced at ± 30'-0" with an offset platform.

Platforms are bolted to and supported by clips on the outside of the vessel. They're usually 3'-0" wide with toe plates and handrails. Platforms provide access to manholes, instruments, valves and relief valves. Platform walking surface may be ¼" floor plate or grating. Grating is always used in areas of heavy snow.

Section VIII Code refers to the ASME Unfired Pressure Vessel Code, Section VIII. This code is for designing pressure vessels, heat exchangers and fired heater tubes.

Structural Nomenclature

Column is a vertical steel or concrete member that supports structures, pipe racks, buildings, et cetera.

Strut is a structural member which carries load-axially only in tension or compression.

Truss is a fabricated load-bearing structure used mainly for long spans, such as a roof truss in a building or a truss made for an elevated road crossing.

Slide plate is plate placed on concrete to allow a vessel or exchanger saddle to slide on to take care of expansion and contraction.

Floor plate is sometimes called checkered plate because it has a raised pattern in a checked pattern to form a non-slip surface. It is used for platforms and floors in compressor buildings.

Gage line is the line through the center of holes punched in a structural member for bolting.

Kip is 1,000 pounds.

Concrete Nomenclature

Anchor bolts are made from round steel rod with one end in a "J" or "L" shape, which is embedded in concrete. Sometimes machine bolts are used.

Cinch anchors provide an anchor bolt in concrete after the concrete is formed.

Rebar is short for reinforcing bar, a round steel rod with a raised pattern that gives structural strength to concrete. Some rebar terms follow.

> *Main bar* is the main stress-bearing steel rebar in the concrete.
>
> *Ties* is the rebar that holds the main bar in place until the concrete is poured.
>
> *Stirrup* is rebar shaped like a U or stirrup.

Rebar is called by a number which gives its diameter in eighths of an inch. A #4 bar is 4/8", or ½" diameter. A #8 bar is 8/8" or 1", in diameter. Anchor bolts follow this same pattern. A #12 anchor bolt is 1½" diameter.

Grout is a rich mixture of cement, sand and water used on top of a foundation to give the final leveling and elevation to the item being supported.

Octagon is an eight-sided foundation usually used for a spread footing for vertical vessels to distribute the load over a wide area.

Pedestal is concrete on top of the spread footing and rising above grade or paving to form the exposed direct contact surface for the equipment being supported.

Electrical Nomenclature

Volt is similar to pressure in piping.

Ampere is similar to flow rate or gpm in fluids.

Watt is energy or power. 746 watts equal 1 horsepower.

Kilowatt is 1000 watts.

Conduit is aluminum, steel, plastic or fiber compound pipe in which electrical wires are routed for their mechanical strength and protection. Conduits may be routed overhead or underground. When run underground they are encased in concrete for added protection. This concrete is covered with a layer of red colored concrete to identify it as an electrical bank.

AWG is American Wire Gage.

NEC is National Electrical Code.

NEMA is National Electrical Manufacturers Association.

Explosion-proof is Electrical equipment which can stand an internal explosion and prevent any flame from escaping.

Hazardous area is an area susceptible to fire or explosion because of electrical arcs.

Division 1 area is a hazardous area under normal operation.

Division 2 area is an area which is hazardous only under abnormal conditions, such as a pipe leak.

Non-hazardous area is an area which is non-hazardous and requires no special electrical precautions.

Plot Plan

The plot plan is a plan view of the plant or unit being built. It shows the equipment, main pipe rack, control buildings, access roadways, other buildings plus other pertinent information. This drawing is drawn to as large a scale as possible–usually 1" to 10'-0". It shows the equipment item numbers but does not dimension the equipment's location. (Some companies do dimension the plot plan.)

The customer wanting the unit built may supply the plot plan, or the contractor may develop it. The plot plan is laid out on the "flow of systems" principle. The feed line, or charge line, enters the unit battery limits (confines of the unit) and goes to a piece of equipment, a pump or vessel. To keep this line as short as possible, this equipment will be located close to the battery limits, where the charge line enters. This line then flows into another piece of equipment next to the first piece. This same pattern generally follows equipment location for the entire unit. Exceptions are special equipment, such as fired heaters, which should be at least 50' from any process equipment.

Alloy lines, such as chrome-moly and stainless steel, take presidence over all carbon steel lines, as they are the most expensive and must be routed the shortest possible distance–considering flexibility, of course.

Many ways for laying out a plot plan of process type equipment exist. Methods will vary with the customer's preferences.

Equipment Arrangement

Pumps

Pumps will normally be under the pipeway with the centerline of discharge 2'-0" from the centerline of the rack column. The top of grout elevation is 1'-0" above the "high point of grade." For pumps in a row, the front concrete is evened up so they are all a set distance from the centerline of the discharge. This enables all drain funnels to line up and saves underground piping costs.

For pumps which have a 12" or larger carbon steel or 8" and larger alloy suction line operating at 400°F or higher, investigate locating the pump right at the vessel base and spring mounting the pump. This can make considerable savings over having to loosen up the hot pipe with ells and pipe, all of which must be insulated.

Pump suction lines should never have a vapor pocket in them. A few cases permit this, but they should be avoided. Liquid pockets are also to be avoided. Pump suction lines are to be as short as possible. In general, pumps should be on the same side of the rack as the vessel they are taking suction from. Since it is desirable to have all these pumps on one side of the rack, it would be best to locate the vessels having pump suctions on the same side as the pumps.

Exchangers

Location of exchangers should allow for adequate tube removal space. In most cases, exchangers will pull away from the rack. Back head of exchangers should be on a line 8'0" from the pipe rack column centerline. The top of the foundation's grout elevation will be 2'-6" above the high point of grade or paving. This applies to double pipe exchangers as well as shell and tube. The process engineer assigned to the job will set kettle-type reboilers in elevation. In the case of shell and tube exchangers having large nozzles on the bottom, the top of grout may have to go 3'-0" or more above grade. It then figures that the line coming out is to have 1'-0" clearance between the insulation and grade. The top of grout shouldn't be raised for all exchangers because one requires it.

Another item that should line up is the back concrete footing of exchangers. As a rule, the back saddle centerline of bolt holes can be 5'-6" from the back head line, which is 8'-0" from the column. This would make all back concrete piers 13'-6" from the rack column centerline. Front saddles can be lined up in some cases; but, due to varying tube lengths, this is not always possible.

Control Valves

Locating control valves varies with the job, but they are generally on a line 2'-0" from the pipe rack column with all handwheels turned in toward the operating aisle under the pipeway. Some control valves may be located at the equipment, but in general this is to be avoided. If they are alongside an exchanger, equipment may have to be spread, which costs money. If stations are located at the base of a vertical tower, the tower—which is hotter than the line—will grow more than the line and lift the station off its support. This also could cause stress at the flanges and cause leaking.

Pipe Racks

The original layout should provide 20% excess space in the total run. For most cases, a two level rack with the levels 4'-0" apart should be considered. The main pipeway will always be strutted, and this strut will run midway between the two levels and support lines entering and leaving the pipeway.

Rack bents should be spaced at 25'-0" maximum centers. This means that lines 4" and smaller will have to have supplementary support. Strapping an angle to larger lines and supporting the smaller lines achieves this. These "pickup" supports will appear on the final piping drawings. These bents should not be located with different spacings on the same pipeway. All should be kept 20', 18', et cetera.

If the customer requires all racks to be fireproofed, the draftsman should investigate using cast-in-place concrete supports. Depending on the area, they might mean less money. In most areas this is the case. Precast supports should be investigated also.

It is preferred to keep cooling water lines out of the rack, as they take up much space and cause the rack to be larger. As a rule, if water headers are 10" or larger, they should be underground. In freezing climates locate all water underground.

If the pipe rack requirement is 24' or less (including the 20% excess), a single level rack should be used. This type is easier to work in the field, and a savings here is very important. To keep the beam smaller, the draftsman can have a 2'-0" overhang past the columns. For a 24' requirement, columns would be spaced 20' apart.

Horizontal Vessels

Here again the concrete support nearest the rack should be 13'-6" from the column centerline to line up with the exchanger footing. The top of grout will vary but should be no less than 2'-6". NPSH requirements on the pump specs should always be checked for setting an accumulator elevation. The NPSH shown is the dimension from the bottom of the vessel to the pump centerline. Generally, 2'-0" should be added for line loss; and, since the pump's centerline is 2'-0" above grade, 4'-0" would be added to the NPSH requirement. For example, a 10' NPSH requirement shown on the pump spec, adding the (above) 4'-0" would be 14'-0". Since the top of grout of concrete footings is 6" lower than the bottom inside of the vessel, this 6" is subtracted. Results show grout elevation of 13'-6" above grade for 10' NPSH requirements. So, actually a factor of 3'-6" now is to be added to NPSH requirements.

Saddles should be about 15% of vessel length in from the tangent. The next highest 3" increment is considered if this turns out to be a fraction.

Ladders should have cages if the platform is 20'-0" or higher above grade.

Vertical Vessels

The largest vessel determines these vessels' location. A 10'-0" dimension should be the dimension from the rack column centerline to the edge of the largest tower. If the largest vessel were 6'-0" diameter, then the centerline of all vertical vessels would be 13'-0" from the rack column centerline. Some companies prefer to line up all vertical vessel centerlines with the largest vessel centerline.

The operating aisle is usually under the rack, so the first ladder up from grade should be on the rack side. All instrumentation on the vessel's bottom portion should be visible from this side.

Ladder runs should be broken to have a maximum run of 30'-0".

Column davits should be furnished for vertical vessels with removable internals if the top of the vessel is over 50'-0" from grade. This davit should be on the side of the vessel away from the rack. This area at grade should be kept clear for a drop area. Manholes are to be located so they are accessible from this davit. Vessels larger than 10'-0" diameter require special care when orienting manholes, or two davits will have to be furnished.

Fired Heaters

Fired heaters should be 50' from a piece of equipment containing hydrocarbon. (Reactors may be much closer to reduce pipe costs.) As a minimum, keep it at least 25' from other equipment. 50' is preferred. *Heaters should have road access.* They also should have tube pulling area free and clear for the tube length plus 5'-0".

A snuffing steam manifold should be at least 50' from the heater. Heater control valves can be at the base of the heater or near the rack. Manual fuel shut-off valves should be 50' from the heater.

Vertical heaters must not be set too high. Only headroom under the base is needed. Headroom under the lowest pipe makes the heater floor too high, cutting off access to the burners. In general, the floor of the vertical heater should be about 7'-0" from grade.

Fin-fans or Air Coolers

The draftsman should use the suspended driver-type fin-fan as much as possible. Using this type involves an extra charge, but it is more than made up by not having to pour concrete foundations for the drivers. Also, this gives draftsmen the design possibility of installing fin-fans over the main pipeway. This should always be considered.

To install fin-fans over a pipeway, the draftsman should know the rack width and get the fin-fan tube lengths to suit the rack. The fin-fan design should eliminate a midway column.

Control Buildings

The draftsman can make great savings if he locates the control building in a general area, non-hazardous classification. However, most operating companies want the control building in the center of the unit so the operators have easy access to all parts of the unit. Sometimes draftsmen can pressurize this building to accomplish a less expensive classification.

Control buildings generally should be constructed of concrete block. Some items often overlooked in "estimating" sizes of control buildings are toilet facilities, locker rooms and kitchen facilities. The draftsman must check the customer specs for these and other requirements.

Flare Headers

Flare headers quite often cause problems if they aren't given full consideration at the early layout stage. It is desirable to locate them on one side of the lower rack. This lets PSV discharge lines run across at the strut level and drop down into the header, keeping all these lines self-draining. By keeping the header(s) to the side of the rack, expansion loops can be flat-turned out, thereby keeping the header self-draining.

If the draftsman has to rise up with a flare header to meet customer's elevation, he is putting a big pocket that can build up liquid condensate. Then he has to install a small liquids drop-out pot to catch the liquids. This will at least require a level gauge and manual drain valve. Process determines the size of this pot. If small, it could be located on a pipe column. A drain funnel must be provided to collect these liquids. *Any liquid pockets in any flare line must be valved and should be insulated and traced in cold climates.*

Plot Plan

The plot plan in Figure 5-1 is a typical installation of new equipment in an existing unit. The pipe rack and the rack's east side were existing. The control building was existing, and the old unit controls went into the control building. New unit controls must be integrated into the existing control board.

When adding new equipment into an existing unit, the draftsman must have drawings of the existing installation. Pipe is existing in the pipe rack. The draftsman will have to route the new pipe in the rack to miss the old pipe. New underground sewer lines will tie into the existing sewer system. All utility headers are in the rack, and the new lateral lines will connect to the existing headers.

The battery limits shown is the extent of the responsibility of the job. This is indicated by heavy dashed (solid) lines and will have a coordinate to define this line by dimension. All work to be done outside this unit will be by others. Some of this work is bringing in feed lines, utility lines and running product lines from the unit. This is called "OBL" (outside battery limits) work, or sometimes "off-plot" work.

The new equipment shown is V-1, 3 and 5, vertical vessels; V-2 and 4, horizontal vessels; E-1, 2, 3 and 5, shell and tube exchangers; E-4, a double pipe set of exchangers (set of 8); and P-1, 2 and 3 pumps, with a spare pump for each one. In most plants the "A" pump is the operating pump and is an electric motor-driven pump. The "B" pump is the spare and may be steam turbine driven or electric motor driven. Steam turbine-driven spares are used in areas where electric power failure may occur more frequently. Electric motors would shut down, but the steam-driven turbines would "kick in" and keep the unit flowing.

Foundation Location Plan

The plot plan had no dimensions. The field must have some way of locating this equipment. This location is shown on the foundation location plan. It is a plan of all foundations in the unit or plant. The concrete that is underground and covered by earth or paving is shown with dashed lines. The portion that will project above grade is shown with a solid line.

The concrete drawing, showing full installation details, will show a coordinate line. No coordinates need to be shown here but will be on the foundation location plan. They are shown for the "crosshair" lines, locating the foundation exactly from the unit "bench mark". Also shown at each piece of concrete is the equipment item number and the drawing number on which the field can find all details necessary for pouring the concrete foundation.

The foundation location serves many useful functions. By showing the extremeties of the underground concrete (the spread footing), any interferences will appear. When spread footings do interfere, there are two possible courses of action. The spread footings can be combined, or the equipment can be spread further apart so that the spread footings do not touch. If the piping designer cannot spread the equipment apart, it then must be a

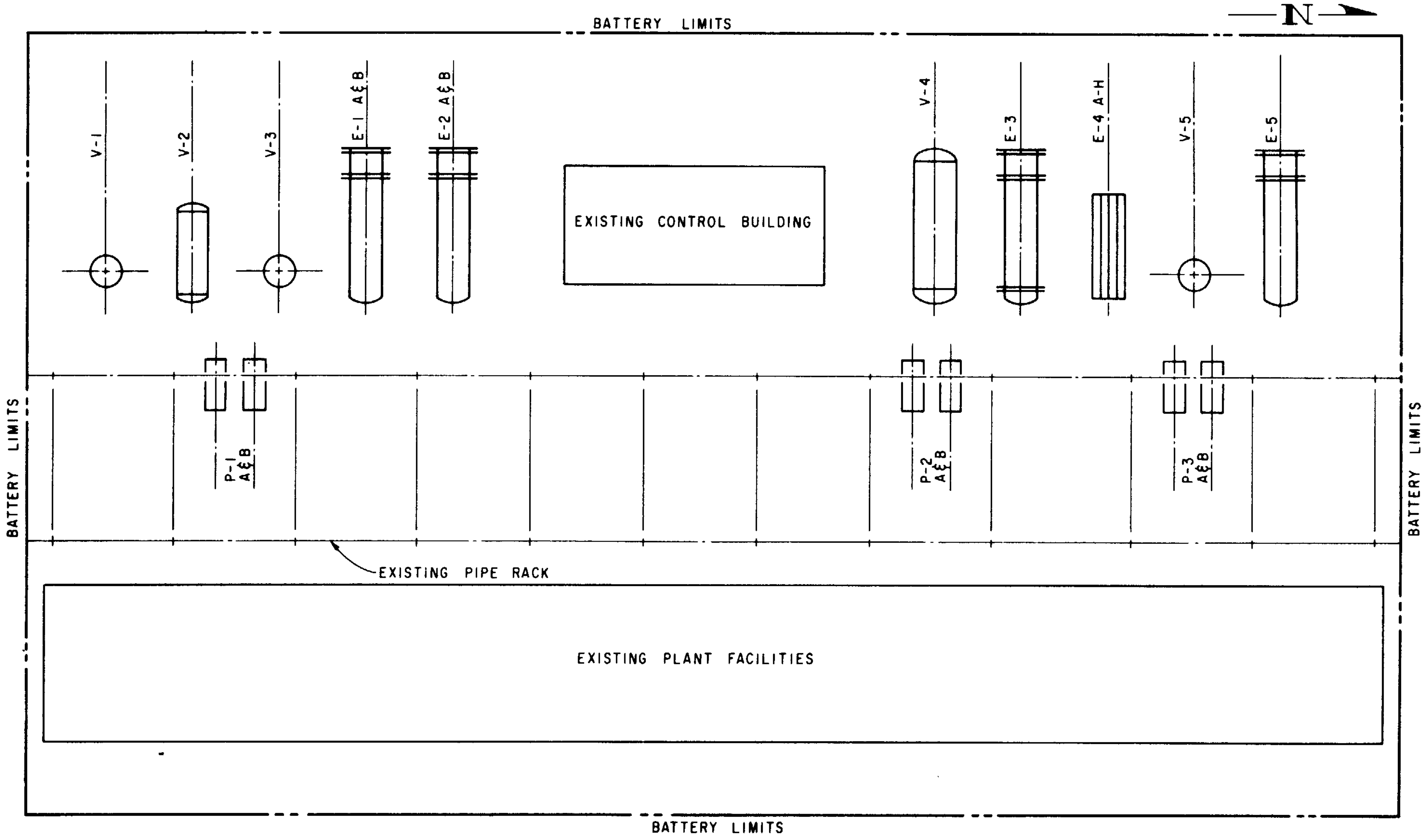


Figure 5-1. Plot Plan.

combined footing. Numerous cases of combined footings are due to so many pieces of equipment being located in a small plot area. The author recalls one unit where a $2 million-unit went on a 50' x 150' plot, or roughly a house-lot size. On this congested plot, almost all spread footings were combined.

One may wonder why all equipment is not spread so that foundations do not touch. First, the more spread out equipment is, the more the unit will cost. Secondly, real estate for these plants is very expensive. A good designer will try to use as little ground as possible. Then, why isn't everything crowded together to reduce the cost and amount of real estate?

Another cost to be considered is maintenance. Maintenance is done on a scheduled "turnaround" basis. This is when the unit or plant is shut down and men are put into the unit for a maintenance "overhaul." This may be done yearly for some units and every several years for others. When turnaround time comes, the owners have all possible men working in the unit to complete the scheduled work so that the plant will be down a minimum number of days. These turnarounds run 24 hours a day with shift crews. If the plant is too congested, this "down time" will be much longer. And, when the plant is down, it isn't making any profits.

Adequate maintenance clearance is given in the piping specifications–general section. The piping designer should follow it in locating any equipment.

Normal daily maintenance is done while the plant is operating. Equipment spacing is adequate for this maintenance.

A typical foundation location plan is in Figure 5-2. Existing foundations are not shown except for the pipe rack spread footings, which are shown so that new equipment foundations can be drawn in and clearances checked. Also, showing the coordinates and PS (pipe support) numbers gives an existing bench mark in the unit.

Piping Drawing Index

The piping drawing index is made from the plot plan. A sepia of the plot plan is marked with the individual piping plans' match line coordinates. These piping plans are usually drawn on "4" size, which is 22" x 34" or 24" x 36". They are drawn to a 3/8" = 1'-0" scale.

A piping plan could take in an area 50' x 80', but more commonly an area is about 40' x 70'. By keeping the drawing areas smaller, more draftsmen can be assigned to a particular unit. Therefore, the job can be finished earlier. In any event, match lines should be located so that pipe racks are separate areas and apart from the process equipment. It is best to keep a fractionating tower and its related exchangers, accumulators and pumps within one drawing area if possible.

This drawing then shows the detail drawing number for each area and the area's limits covered by the drawing. Also, the drawing number is shown for the matching drawing on all sides of the assigned drawing. If one line goes out of one area to a match line, the draftsman can check the matching drawing to see that his routing of the line matches on the matching drawing. He is *not* to route pipe to the match line without considering the matching drawing.

The plot plan shown earlier in the book has been marked to make a piping drawing index, which is in Figure 5-3.

Standard Piping Details

Many piping details are standard installations and are used many times in a plant installation. By producing a drawing of all these details (see Figures 5-4 thru 5-11), the draftsman doesn't have to draw them in detail each time they are used. He simply depicts them in a simple manner and refers to the standard detail sheet for fabrication details. The student should become well acquainted with them.

Type A Supports

The type A support (see Figure 5-4) supports lines close to grade or platforms and is usually 2'-0" plus or minus in length. The most common use is for supporting control stations (the control valve, blocks and by-pass, which is commonly

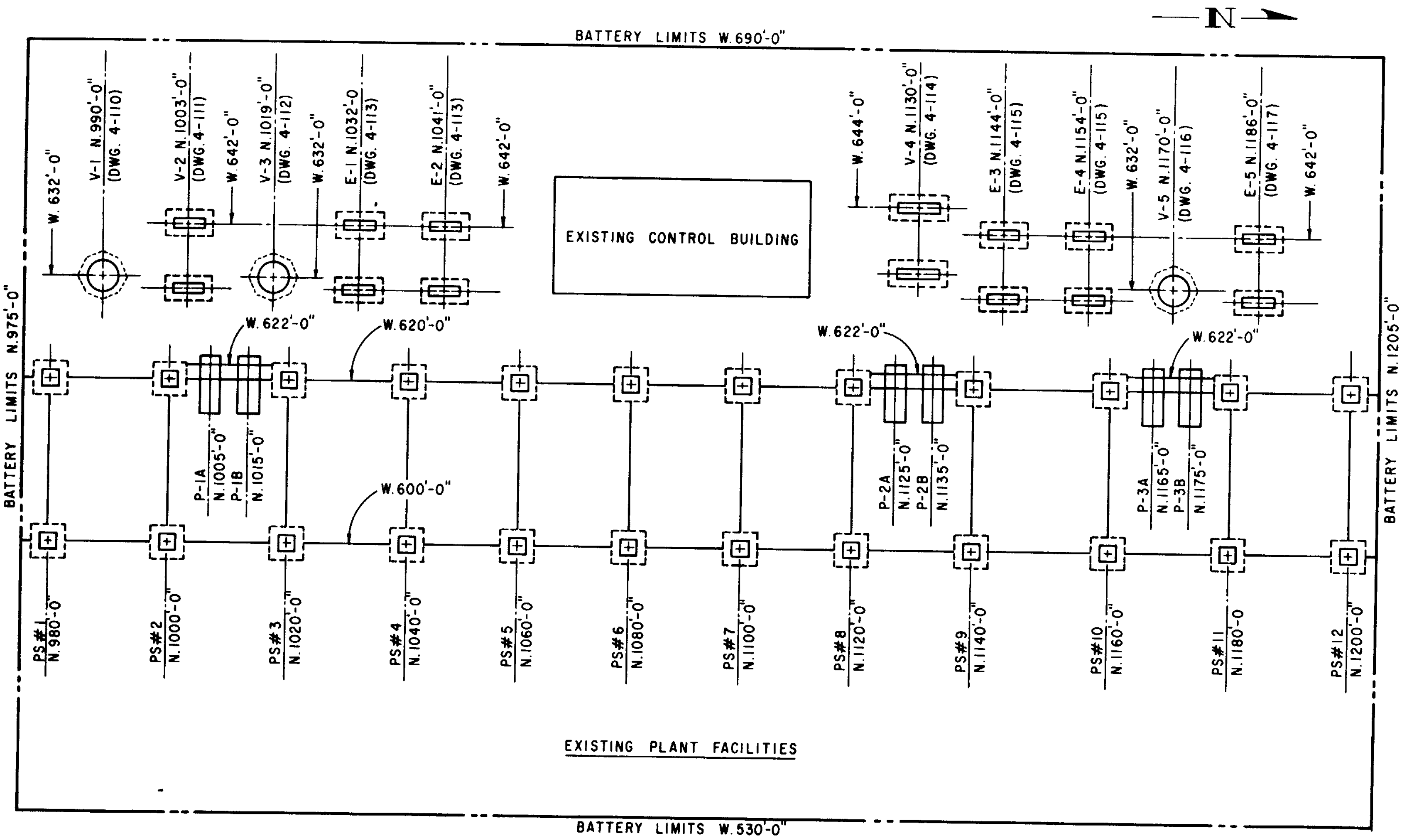


Figure 5-2. Foundation Location Plan.

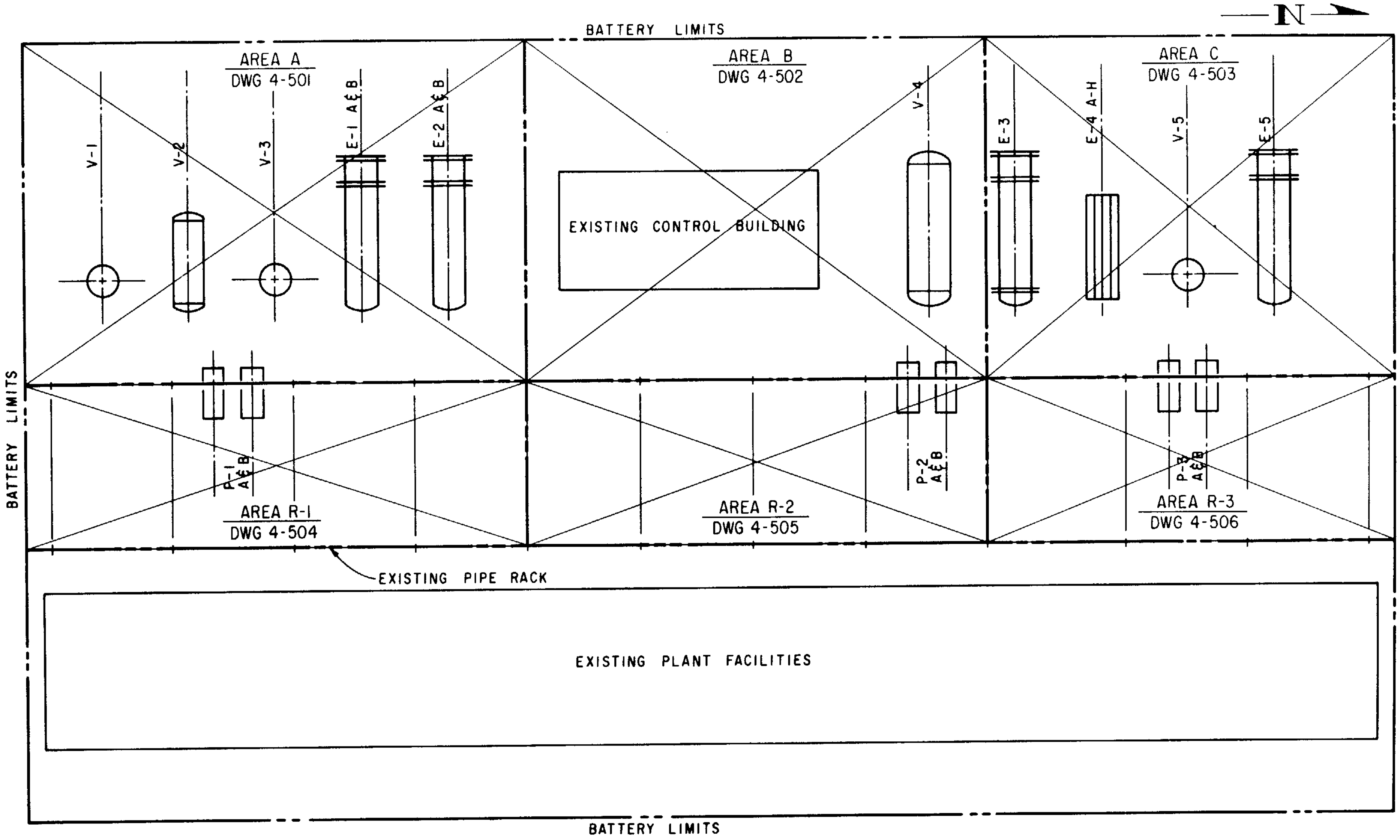
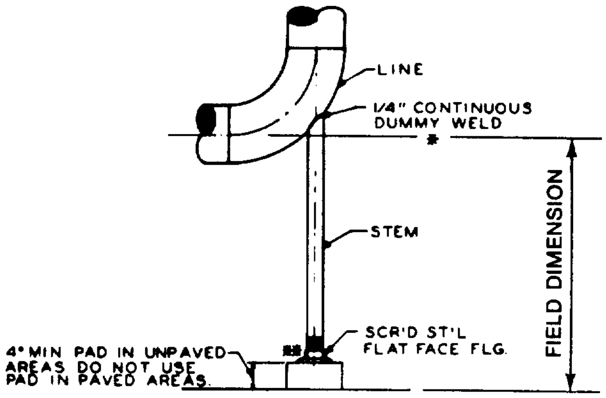


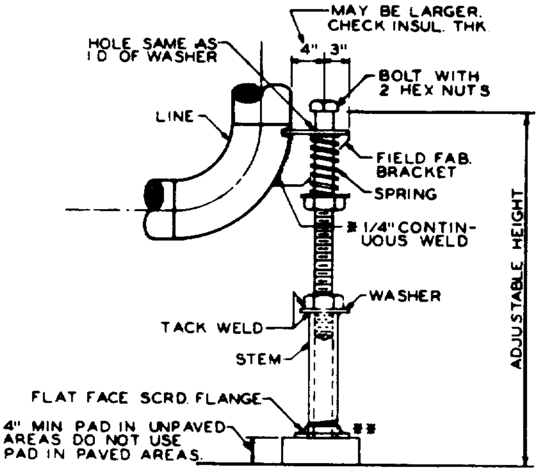
Figure 5-3. Piping Drawing Index.



LINE SIZE	STEM
2" & UNDER	1" PIPE
3" & 4"	2" PIPE
6" & OVER	3" PIPE

* FIELD WELD ** FIELD THREAD

Figure 5-4. Type A Adjustable Base Support. (Courtesy of Fluor Corp.)



* FIELD WELD ** FIELD THREAD

INE SIZE	STEM	BOLT	BRACKET SIZE	WASHER	SPRING
& UNDER	1" PIPE	3/4"X10"	2"X2"X1/4"∠	2" O.D. X 13/16" I.D. X 0148 THK	1 1/4" P.D., 5" LG. 9/32" DIA. WIRE 10 COILS ACTIVE.
& 4"	2" PIPE	1 1/8"X12"	3"X3"X 5/16∠	2 3/4" O.D. X 1 1/4" I.D. X 0.164" THK.	2" P.D., 6 1/2" LG. 1/2" DIA WIRE 6 COILS ACTIVE.
THRU 12"	3" PIPE	1 1/2"X12"	4"X3"X3/8"∠	3 3/4" O.D. X 1 3/4" I.D. X 0.179" THK	1 5/8" I.D. X 2 3/4" O.D. 9/16" DIA WIRE 4 ACTIVE COILS, 2 IN-ACTIVE COILS, OPEN HEIGHT 4 1/2" SOLID HEIGHT 3 9/16" - SPRING LOAD @ 15/16" COMPRESSION 3000#
& OVER	3" PIPE	1 1/2"X12"	6"X3 1/2"X 1/2"∠	3 3/4" O.D. X 1 3/4" I.D. X 0.179" THK.	

Figure 5-5. Type B Adjustable Base Support. (Courtesy of Fluor Corp.)

called a control station or control loop). Another common use is for supporting low lines entering or leaving exchanger nozzles on the bottom of the exchanger.

Type B Supports

Type B support (Figure 5-5) differs from A (Figure 5-4) in that it has a spring in it. It is much more expensive than A, and its use should be limited to lines that have considerable movement from cold to hot positions.

Both A and B have a small amount of adjustment available by turning the screwed flange at the bottom. After the plant is on stream and the piping and equipment are up to operating temperature, the expansion of equipment may raise the control station up. This will be a fraction of an inch, but even 1/16" will lift it up off the support. The operators will review each control station or support and twist the base screwed flange to make contact with paving.

Dummy Supports

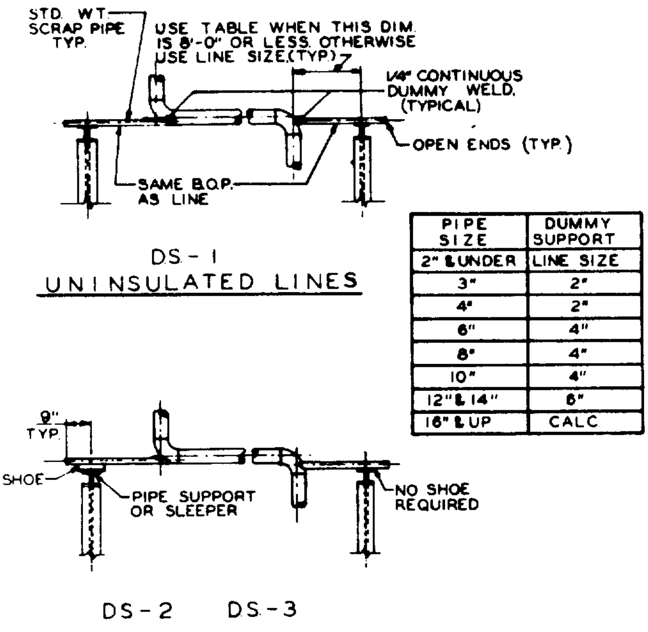
Figure 5-6 shows dummy supports. "Dummy" means the weld attaching the support leg to the main pipe does not penetrate the main pipe. No hole is cut in the main pipe. The type A support detail shows a "dummy weld" where the supporting pipe meets the elbow.

Dummy Support #1 is used at pipe racks for lines that are *not* insulated. Since the BOP (bottom of pipe) is the same for the small pipe and the larger main pipe, the centerlines are not the same. This becomes the piping draftsman's job—to calculate and show this offset of centerlines.

The student is to practice by calculating the offset for all sizes shown through 14" and turn in his answers for grading.

Vent and Drain Details

Figure 5-7 shows typical vent and drain details. Type A vents and drains are valved and are operating vents and drains. Where required, they will be shown on the flow sheet and may be larger than ½". If so, the size will be shown on the flow sheet.



PIPE SIZE	DUMMY SUPPORT
2" & UNDER	LINE SIZE
3"	2"
4"	2"
6"	4"
8"	4"
10"	4"
12" & 14"	6"
16" & UP	CALC

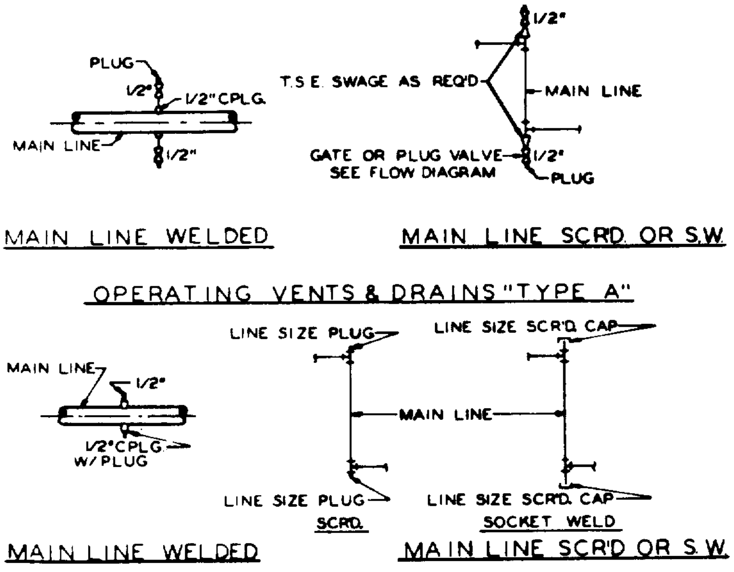
Figure 5-6. Dummy Supports
(Courtesy of Fluor Corp.)

Type B vents and drains are not valved. These are hydrostatic vents and drains and are required at all high or low-point pockets in the pipe line. After the line is in place, it is filled with water and pressure tested in accordance with the ANSI B31.3 piping code. This test is about 1½ times the design pressure. It is designed to test the quality of the welding and the flanged joint makeup.

Vents are needed to let all air out of the system so it can fill with water and also to let air in to displace the water when draining. Drains are needed to drain all testing water out of the line.

Level Gage Installation

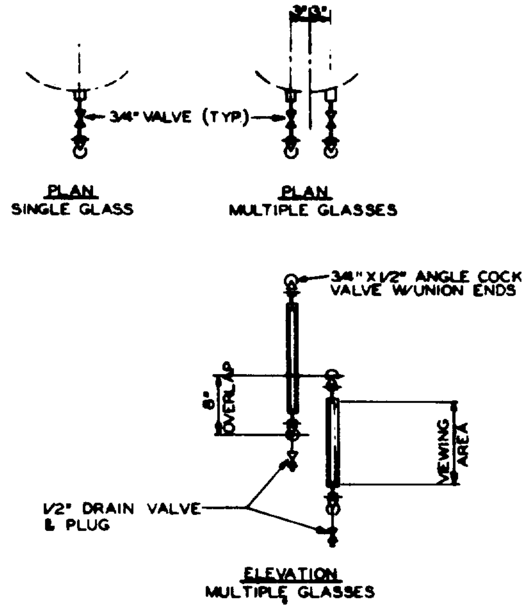
Figure 5-8 is a typical level gage installation. They attach to a vessel to show the level of liquid in that vessel. The vessel will have ¾" couplings welded into it to meet the LG piping. The instrument department will supply the LG, and the piping draftsman will supply the piping and valves for



NOTES:
NIPPLES, VALVES & FITTINGS, TO CONFORM TO GOVERNING PIPE SPECS.
FOR VALVES, GATE OR PLUG, SEE FLOW DIAGRAM.

TYPICAL VENT AND DRAIN DETAILS
1 ALL HIGH & LOW POINTS TO HAVE VENT OR DRAIN.
2 TYPE "A" WILL BE SHOWN ON FLOW DIAGRAM WHERE REQ'D.

Figure 5-7. Typical Vent and Drain Details.
(Courtesy of Fluor Corp.)



NOTES:
AS A MINIMUM THE VIEWING AREA WILL COVER THE FLOAT RANGE OF LEVEL CONTROLLERS.
NIPPLES, VALVES, & FITTINGS TO CONFORM TO GOVERNING PIPE SPECS
FOR VALVES, GATE OR PLUG, SEE FLOW DIAGRAM FOR ADJOINING VALVES.

Figure 5-8. Typical Level Gage Installation.
(Courtesy of Fluor Corp.)

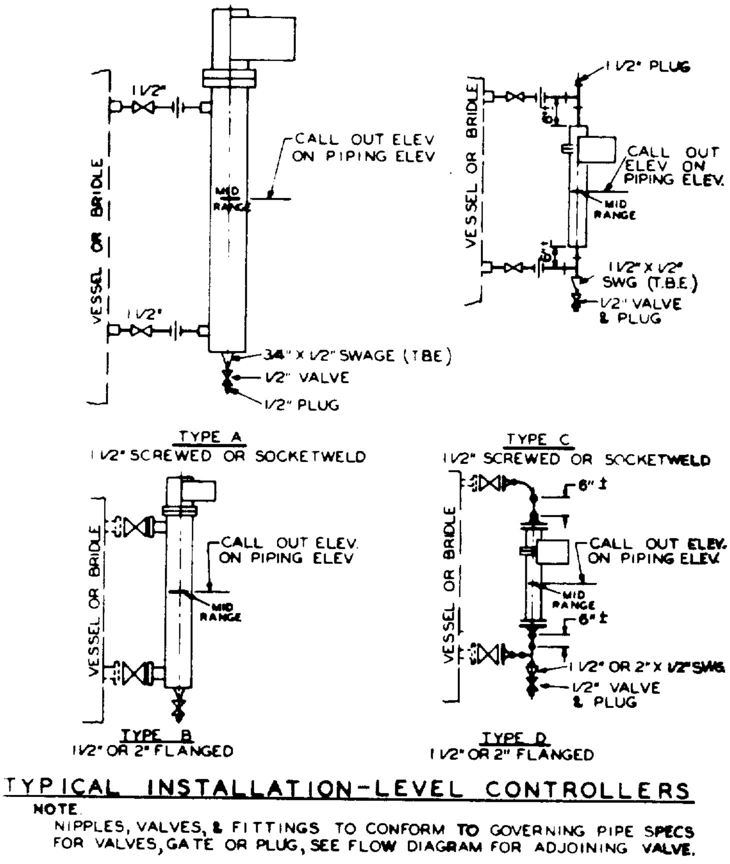


Figure 5-9. Typical Installation-Level Controllers.
(Courtesy of Fluor Corp.)

installation. The angle cock valve is furnished with the gage glasses.

Usually, the center-to-center of connections on an LG is limited to 5'-0". This means that a viewing range of 5'-0" or greater requires more than one LG. Due to the design of the LG and the piping, a "viewing area" of about 3½" is lost on each end of an LG. So, a 5'-0" glass gives a 4'-5" viewing area. To not lose the level in the vessel, multiple LGs are overlapped 8". This really gives 1" overlap of viewing area.

Level Controller Installation

Figure 5-9 shows typical level controller installations.

The level controller does just what its name says—it controls the level in a vessel. It does this by having its instrument air impulse line connected to a level control valve in a pipe. As the level builds up in the vessel, the impulse line opens the control valve more to let more liquid through. As the level drops in the vessel, the impulse line shuts the control valve some and reduces liquid coming through so the level will build back up in the vessel.

The level controller has a mid-range point shown on the cage. This is usually the liquid level point in the vessel. The float in the level controller cage can go up or down from the point. Adjustment can change this mid-range point, or liquid level.

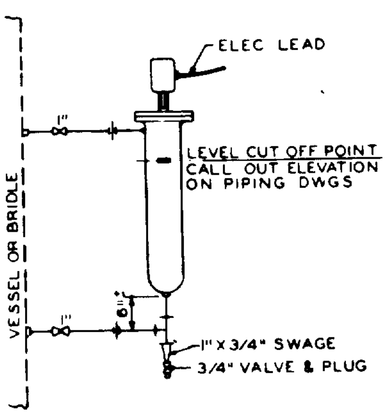
Level controllers come in varied "float ranges." The float range is the length up or down that the float can travel. A 14" float range controller can travel 7" up or down from the mid-range point, or a total of 14". A 32" float range will travel 16" each way from the mid-range point. A 60" float range will travel 30" each way from this point. The longer the float range is, the wider the level range you can control in the vessel.

Since one cannot actually see the level in a level controller cage, he should have a level gage installed wherever a level controller is. The "viewing area" of the gage glass should at least equal the level controller's float range. *The center-to-center of taps on the level gage is greater than the viewing area.* For 30" viewing area, the center-to-center of taps will be about 37"—"about" because this length will vary with the different manufacturers and LG types.

Many companies want "full coverage" level controllers and level gages on horizontal drums. This means they want to be able to cover the level anyplace in the vessel.

As a problem, a 120" diameter horizontal vessel will be used. A 72" float range LC is specified. The mid-range of the LC is to be set on the vessel centerline. With a maximum 5'-0" c-c taps LG (4'-5" viewing area), how many LGs are needed to have coverage of the LC float range? The student is to draw a sketch to 3/8" scale to prove it and show by dimension how he would locate the LGs.

Next he is to draw the same sketch, but now the LGs are to cover the top float range and *all* of the bottom half of the vessel. How many LGs are needed and how would the student locate them? *He must cover all of the bottom half of the vessel. And the bottom LG viewing area's lowest point*



NOTES:
NIPPLES, VALVES, & FITTINGS TO CONFORM TO GOVERNING PIPE SPECS
FOR VALVES, GATE OR PLUG, SEE FLOW DIAGRAM AND MATCH ADJOINING VALVES.

Figure 5-10. Typical Installation-Level Alarms.
(Courtesy of Fluor Corp.)

must be set on the bottom inside diameter point of the vessel.

Level controllers come in 1½" or 2" connections. These connections may be screwed or flanged. Of course, screwed connections will be the least expensive. The actual level controller specifications will identify the types. The instrument department writes these specifications.

These level controller connections also come in varied positions. The type A controller shows that the top connection is on the side and the bottom connection is on the side. This is a "top-side, bottom-side" controller. Types C and D are "top-top" and "bottom-bottom" controllers. Here both top and bottom connections are on the top and bottom. There can be "top-top" and bottom-side" or any other types of controllers. The specifications will tell the piping draftsman which type to install.

Level Alarm Installation

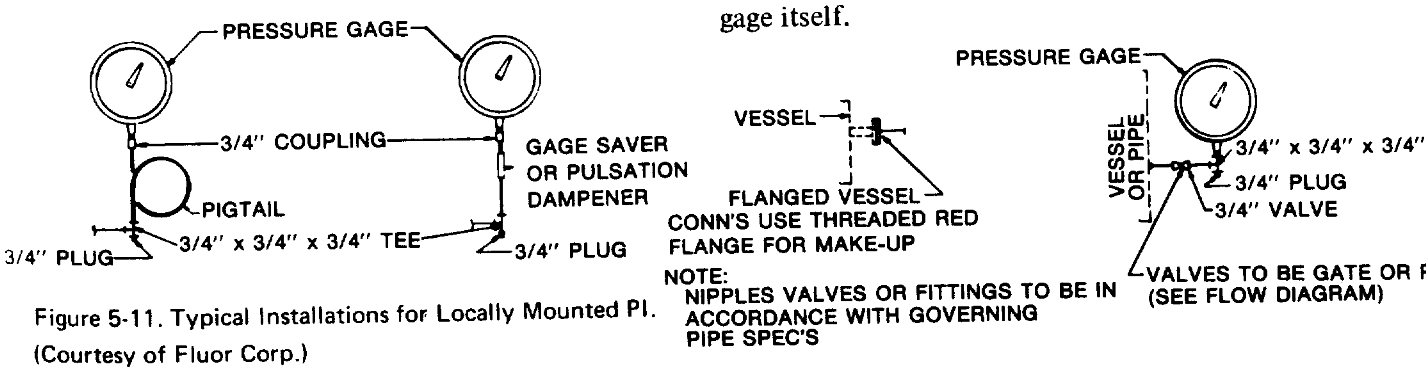
A level alarm (see Figure 5-10) works similarly to a level controller. However, it does not control any level. But it does have a float cage and has an internal float that can travel. It has 1" connections that connect to a vessel or bridle. The alarm is usually on the vessel in the vapor space, so there is no liquid in the cage. As the level rises in the cage, the float will rise, causing electrical contact. This then will sound an alarm or turn on a warning light on the main control board. When the level alarm is actuated, it is considered an abnormal condition; and immediate correction is required. The unit operator will go to the vessel and operate the controls by hand to lower the level and then will locate the malfunction.

Level alarms are also installed in liquid portions of vessels to sound when the liquid level gets too low. The flow diagram will tell the piping draftsman where the alarm is to be installed.

Level alarm instruments can be wired to serve as a high or a low liquid level shut-down instrument.

Pressure Gage Installation

A pressure gage measures the pressure in a pipe or vessel. Figure 5-11 shows a locally-mounted PI (pressure indicator). A board-mounted PI is where the pressure would not be seen at the pipe or vessel. It would be read in the main control room. A board-mounted PI or PRC would have a valve and a transmitter locally. For pressure connections, the piping group will furnish piping through the first valve for board-mounted installations. For local mounted PI's, the piping group will furnish all piping. The instrument group will furnish the pressure gage itself.



NOTE:
NIPPLES VALVES OR FITTINGS TO BE IN ACCORDANCE WITH GOVERNING PIPE SPEC'S

Figure 5-11. Typical Installations for Locally Mounted PI.
(Courtesy of Fluor Corp.)

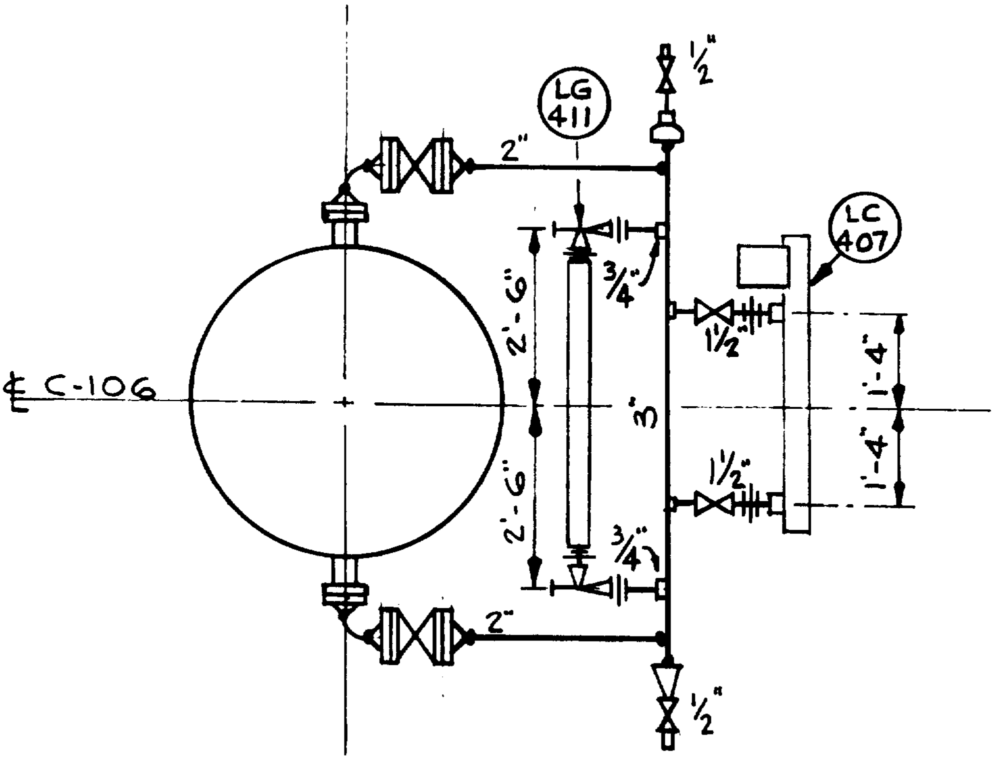


Figure 5-12. Bridle hookup.

The Bridle

Bridles are expensive and should be avoided. But because many companies use them, every piping draftsman must be aware of bridles. Figure 5-12 shows a typical bridle hookup. The vessel has 2" top and bottom flanged connections for a bridle. Actually this is a bad bridle because a pocket is built-in where waste may accumulate and plug the lower bridle arm. A better connection would have the lower vessel bridle nozzle coming out of C-106 horizontally about 6" above the bottom. This would allow the lower bridle arm to be self-draining and eliminate the pocket.

The 3" vertical piece is called a *standpipe.* Here the level gage and level controller are connected and a pressure gage could also be connected. This level controller has a 32" float range and is set with the mid-range on the vessel centerline. The 5' level gage is located where it covers the LC float range plus an equal amount of excess viewing area on either side of the float range.

Note that the 2" arms have bridle block valves. The LC has 1½" block valves. The LG does not have block valves but does have angle cock valves supplied with the level gage.

The 3" standpipe is vented and drained. The vent is shown as a coupling welded onto a 3" weld cap and the drain is shown as a 3" x ½" swage. Actually the vent and drain could be done either way depending on which was cheaper. Usually the swage is cheaper and would be used for both the vent and drain but both types are shown here for the students.

It is very simple to avoid bridles. Just direct-connect both the LG and LC to the vessel. This is almost always the preferred method.

Traced Lines

Sometimes fluids will solidify if not kept hot. This is certainly true in very cold climates where the fluid inside the pipe or equipment may freeze. To keep the fluid hot the line or equipment is *traced.* This tracing may be accomplished by using electricity, steam or some other hot flowing fluid. In the case of steam tracing, a ¼" tube is attached to the traced pipe and both are insulated. The steam flowing in the ¼" tubing will keep the pipe warm and prevent freezing. If greater heating is necessary sometimes 3/8" or ½" tubes are used and in severe cases multiple tubing is run for steam tracing.

REVIEW TEST

This test is to be an open book test. Answers are to be written on a separate piece of paper and are to be in the students' own words.

1. What are the main uses for ladders and platforms on vessels? ________________

2. Define electrical conduit. ________________

3. What is the purpose of a plot plan? ________________

4. What is the main thing to consider when locating exchangers? ________________

5. What is a pipe "bent"? ________________

6. What is the main thing to consider in piping flare headers? ________________

7. Define battery limits. ________________

8. Define a plant coordinate system. ________________

9. What is the purpose of a foundation location plan? ________________

10. What is a spread footing? ________________

11. What is a "turnaround"? ________________

12. What is the purpose of the piping drawing index? ________________

13. What is a dummy weld? ________________

14. What is "hydrostatic testing"? Why is it done? ________________

15. On a LG, define viewing area. ________________

16. On a LC, define "top-top, bottom-side." ________________

17. What is the float cage on an LC? ________________

18. What is the purpose of an LA (level alarm)? ________________

19. Define "combined footing." ____

20. Piping plans and elevations are usually drawn to what scale? Single line piping is used to what size?

____

CHAPTER 6

PIPING DESIGN NOTES & PLANS

A piping plan of a process unit will show all major equipment in the drawing area. It will locate this equipment in the North-South and East-West directions and will also show all piping to and from this equipment. All instrumentation; access ladders and platforms; and line numbers, sizes and the piping specification will be shown. Flow will be noted for all lines. The piping will be dimensioned so that, with the sections and elevations and standard piping details, the draftsman drawing the piping isometric will not have to refer to vendor's prints. Data required by him should be on the piping drawings.

Since it is a piping drawing, piping should be drawn with the heaviest line so that it stands out. Equipment, dimensions, ladders and platforms and centerlines should all be drawn with a lighter line. Scale is very important; and all equipment, valve lengths, flange diameters and line locations should be drawn to scale. Concrete supports too, should be drawn to scale. This will let the piping draftsman know that an obstacle exists that the pipe must miss. Valve handwheels are to be drawn to scale. The student is to draw the stem in the open position so he can see it clears all obstructions. It would do no good to install a valve that couldn't be operated.

General piping drafting notes guide the piping draftsman. These notes may vary by company. The following ones are generally used in one form or another.

1.0 PIPING DRAWINGS

1.1 All piping drawings shall be single line for sizes 12" and under and double line for sizes 14" and larger.

1.2 Most reducing fittings shall be double line. This includes reducers and reducing elbows, but does *not* include reducing outlet tees.

1.3 All other fittings will be single line.

1.4 All piping drawings will be drawn to 3/8"=1'-0" scale. Exception: Tank farms, offsites, underground, etc. will be reviewed to see if a smaller scale would be more practical.

1.5 In general, all piping drawings will be on a 24"x36" or 22"x34" drawing.

1.6 Equipment shall be drawn in lighter than piping.

1.7 Structural steel shall be shown *single line* (light) on all plan drawings. Show only enough to present the picture. Some elevations may require double line on steel.

1.8 Avoid duplication of dimensions. Give only enough dimensions and coordinates to enable the isometric spool to be drawn.

1.9 Do *not* dimension valves, fitting makeup, etc., as these will be shown on the isometric.

1.10 Coordinates will locate all major equipment. Piping will be dimensioned from these coordinates or from other pipes. Do *not* tie equipment together by dimensions. This duplicates the dimension, since the coordinates locate the equipment.

1.11 In general, plans and elevations will be drawn of all piping process areas. For some special cases, only plans will be made—such as a contract where a scale model is required.

1.12 Show valve handwheel orientation on all isometric spool sheets.

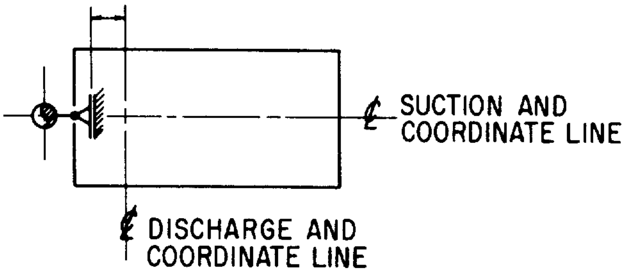
1.13 Isometric spool sheets are preferably to have the North arrow pointed up and to the right. As a second choice, the North arrow may be pointed up and to the left. Do *not* point any North arrows down.

1.14 For piping plans, point the North arrow up or to the right.

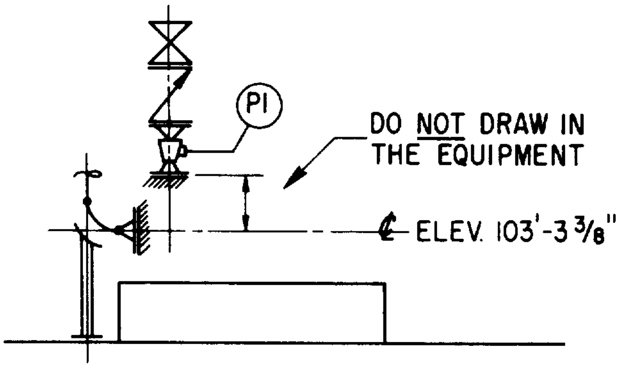
1.15 Locate North arrow in the drawing's upper right corner.

1.16 Show dimensions in feet and inches for 1'-0" and over.

1.17 Do not try to draw pumps, compressors, heaters, et cetera as they actually look. We are interested in our piping connection points and should show our points with the least possible drafting. (See Figure 6-1.)



PUMP OR COMPRESSOR IN PLAN



ELEVATION

Figure 6-1. How To Show Pumps on Piping Drawings.

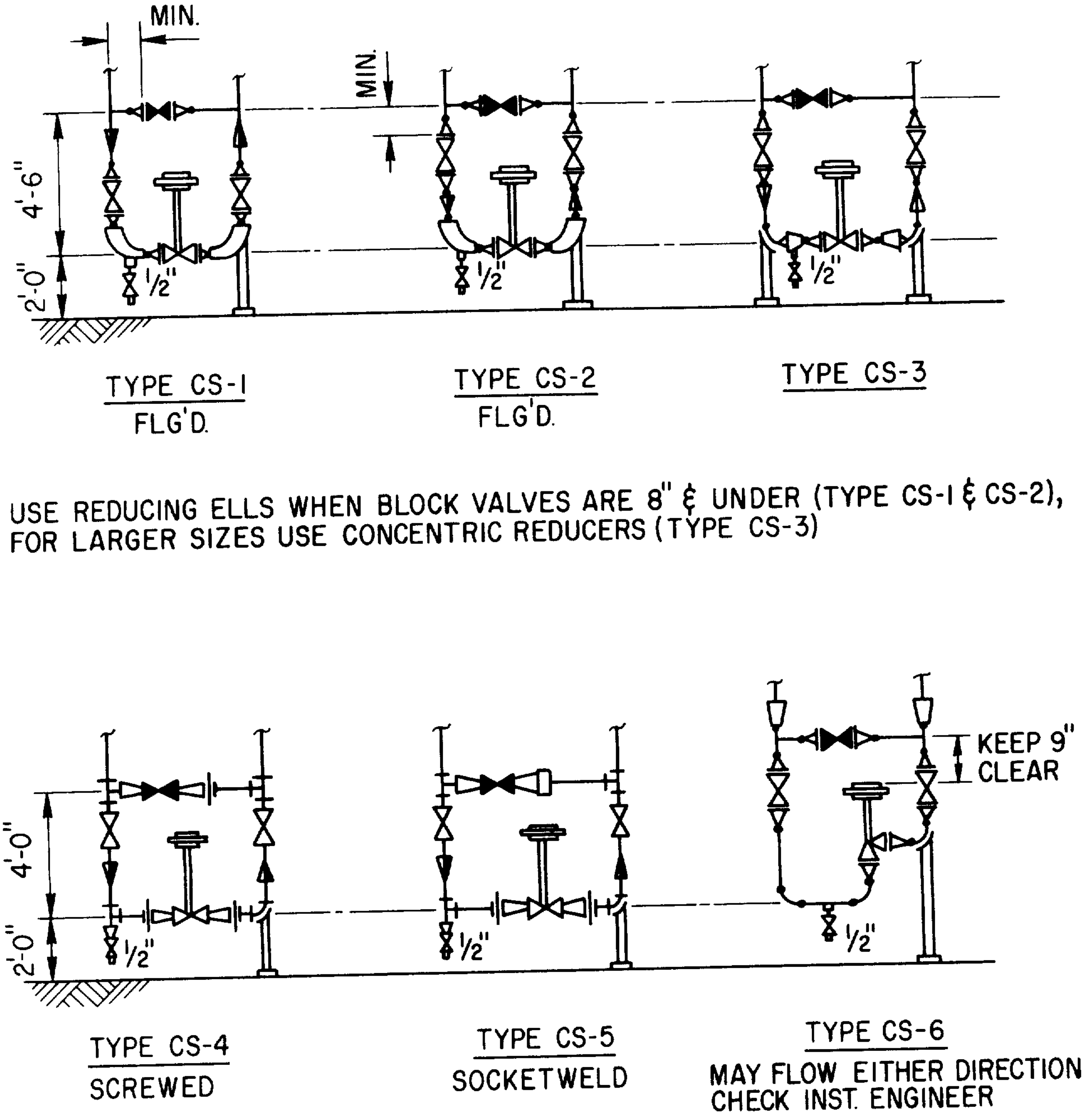
1.18 Typical control valve arrangements are in Figure 6-2.

1.19 Pump suctions are in Figure 6-3.

1.20 Orifice flanges meter the flow through a pipe. These 2 flanges are bolted together with an orifice plate between them. This plate has a small diameter hole, which is calculated for each service.

Each orifice flange has a tapped hole, which has a pressure sensing device attached to it. The orifice hole restricts the flow in the pipe, causing a pressure difference on each side of the orifice plate. Pressure sensing devices in the two orifice flange taps record or indicate the difference in pressure, which can then be converted into the flow going through the pipe.

The fluid being measured must be flowing without much turbulence. To accomplish this, a certain amount of "straight run" pipe is required—

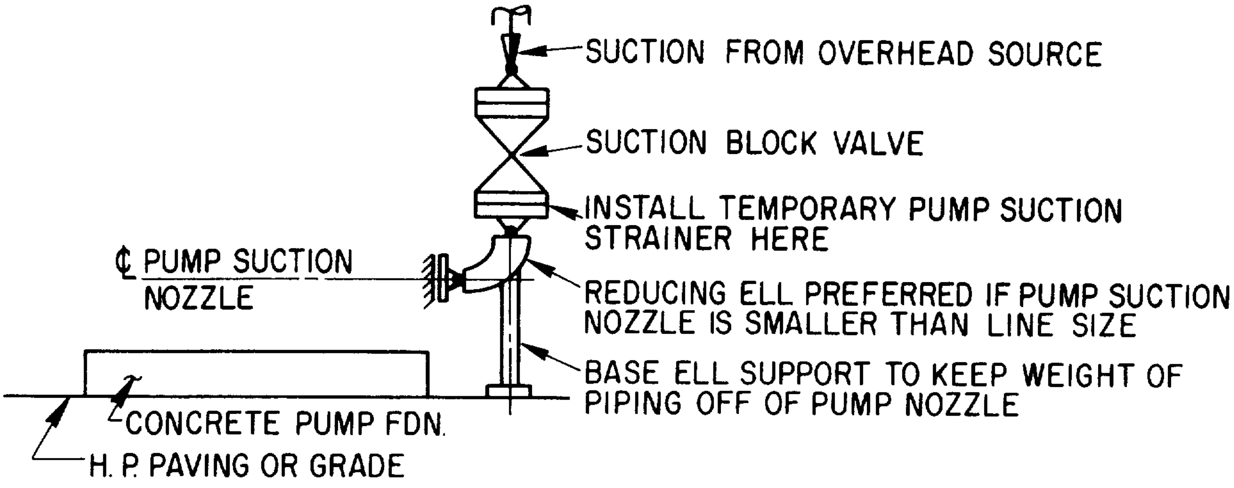


USE REDUCING ELLS WHEN BLOCK VALVES ARE 8" ₵ UNDER (TYPE CS-1 ₵ CS-2), FOR LARGER SIZES USE CONCENTRIC REDUCERS (TYPE CS-3)

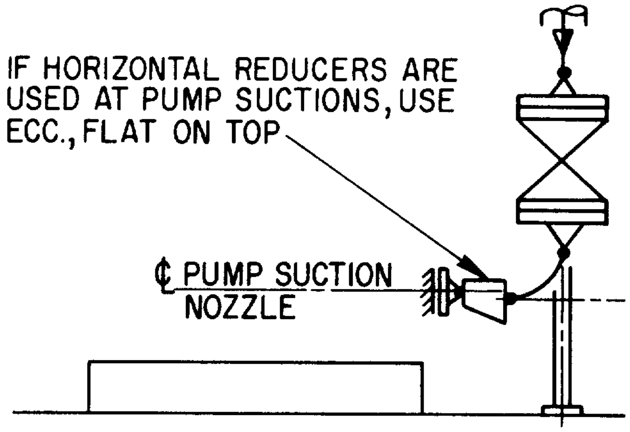
NOTES:

1. CHECK HEIGHTS ₵ WIDTHS OF CONTROL VALVE OPERATORS FOR CLEARANCE.
2. CONTROL VALVE COOLING FINS REQUIRED AT 450°F ₵ ABOVE.
3. ON PULSATING PIPING LOWER BY-PASS AS MUCH AS POSSIBLE. MAKE THE INSTALLATION COMPACT TO REDUCE VIBRATION.
4. DIMENSION 2'-0" IS FROM HIGH POINT OF GRADE OR PAVING.

Figure 6-2. Typical Control Stations.



END SUCTION PUMP



END SUCTION PUMP

NOTE:

A. PUMPS TO BE LOCATED CLOSE TO THE VESSEL FROM WHICH THEY ARE TAKING SUCTION. KEEP SUCTION LINE SHORT AS POSSIBLE.

B. SUCTION LINE TO FLOW CONTINUOUSLY DOWN FROM VESSEL SUCTION NOZZLE TO PUMP SUCTION NOZZLE. DO NOT LET THE LINE GO UP. THIS WOULD FORM AN AIR POCKET WHICH WOULD ACCUMULATE AN AIR BUBBLE WHICH COULD BE FORCED IN THE PUMP. AIR IN PUMPS CAUSE "CAVITATION" WHICH DAMAGES THE PUMPS.

C. LINE REDUCTIONS ARE TO BE MADE DIRECTLY ON PUMP NOZZLES. DO NOT "CHOKE" ANY PUMP SUCTION.

Figure 6-3. Piping at End Suction Pumps.

upstream and downstream—of the orifice flanges. Many curves are published to establish the exact amount of straight run required, but, to keep it simple, only one will be discussed. This one is the worse condition. If one designs to this, he will be safe.

The upstream straight run is figured as 30 x pipe nominal size, and the downstream straight run as 6 x pipe nominal size. For a 4" line, this would be 30 x 4", = 120" or 10'-0" upstream and 6 x 4", = 24" or 2'-0" downstream straight run.

This straight run is to be straight pipe with no connections. (See Figure 6-4.)

1.21 An example of piping, at vertical vessels or towers, is in Figure 6-5.

1.22 Standard pipe spacing is in Figure 6-6.

1.23 Standard bolting for flanges is in Figures 6-7 and 6-8.

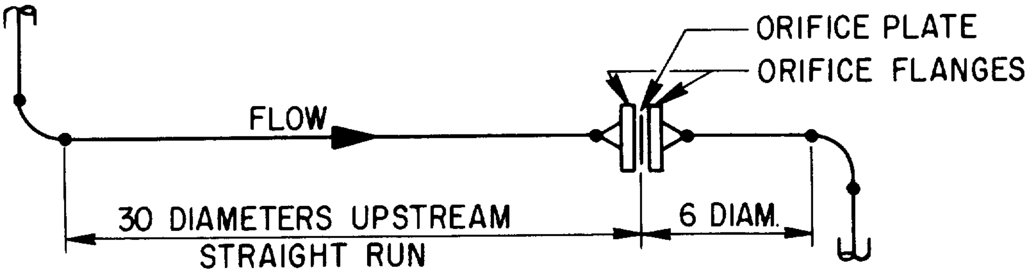


Figure 6-4. Meter Run Dimensions.

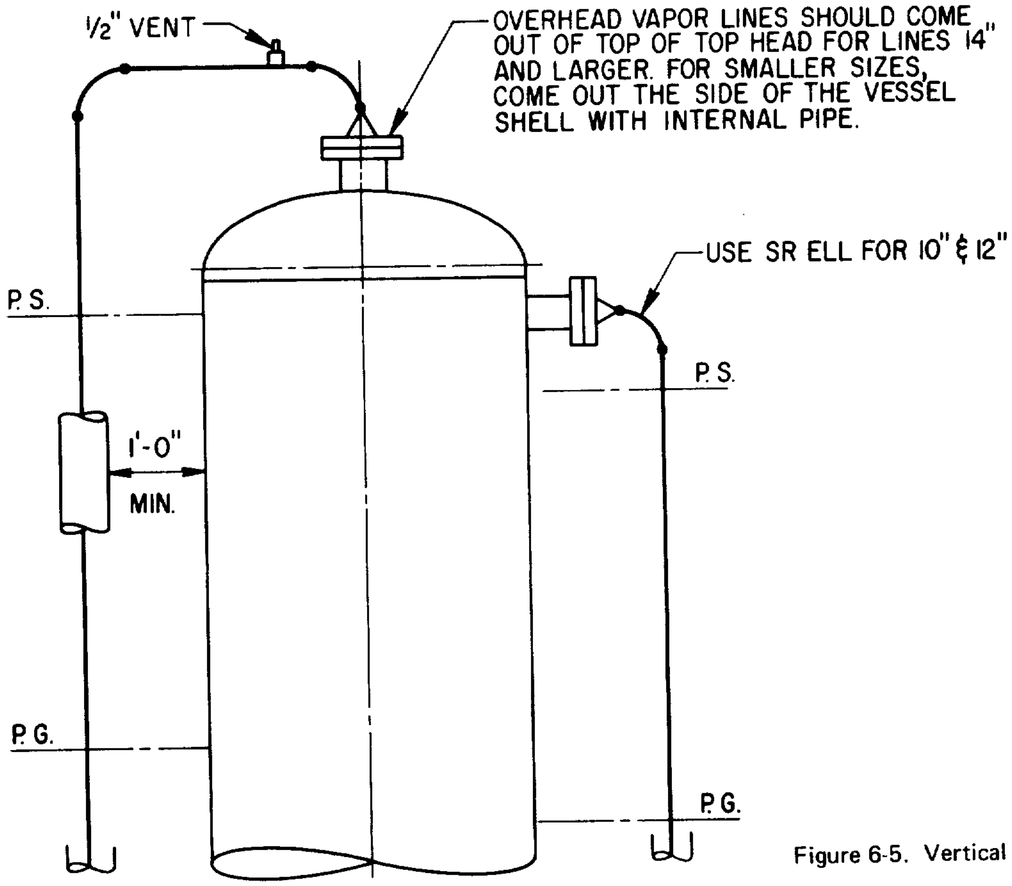
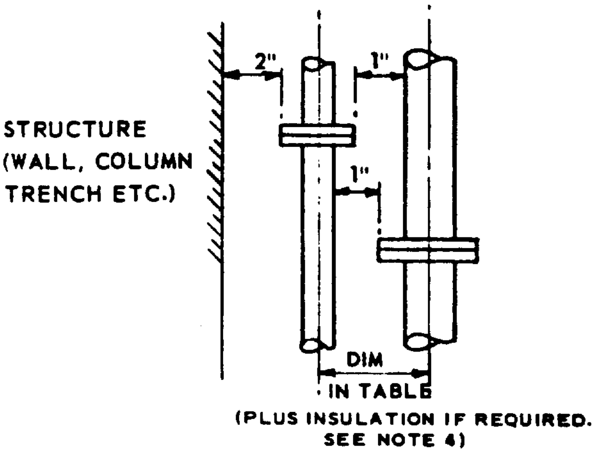


Figure 6-5. Vertical Vessel Piping.

RATING		600#											300#–400#											150#										
	SIZE	16	14	12	10	8	6	4	3	2	1½	1	16	14	12	10	8	6	4	3	2	1½	1	16	14	12	10	8	6	4	3	2	1½	1
150#	1	15½	14	13	12	10	9	7½	6	5	5	4½	14½	13½	12	10½	9½	8	7	6	5	5	4½	13½	12½	11½	10	8½	7½	6½	5½	5	4½	4
	1½	15½	14	13	12	10½	9	7½	6½	5½	5	4½	15	13½	12½	11	9½	8½	7	6½	5½	5	4½	14	12½	11½	10	9	7½	6½	6	5	4½	
	2	16	14½	13½	12½	10½	9½	8	6½	5½	5½	5	15	14	12½	11	10	8½	7½	6½	5½	5½	5	14	13	12	10½	9	8	7	6	5½		
	3	16½	15	14	13	11	10	8½	7	6	6	5½	15½	14½	13	11½	10½	9	8	7	6	6	5½	14½	13½	12½	11	9½	8½	7½	6½			
	4	17	15½	14½	13½	11½	10½	9	7½	7	6½	6½	16	15	13½	12	11	9½	8½	7½	7	6½	6½	15	14	13	11½	10	9	8				
	6	18	16½	15½	14½	13	11½	10	8½	8	7½	7½	17½	16	15	13½	12	11	9½	8½	8	7½	7½	16½	15	14	12½	11½	10					
	8	19	17½	16½	15½	14	12½	11	9½	9	9	8½	16½	17	16	14½	13	12	10½	9½	9	9	8½	17½	16	15	13½	12½						
	10	20	18½	17½	16½	15	13½	12	11	10½	10	10	19½	18	17	15½	14	13	11½	11	10½	10	10	18½	17	16	14½							
	12	21	19½	18½	17½	16	14½	13	12½	12	11½	11½	20½	19	18	15½	15	14	13	12½	12	11½	11½	19½	18	17								
	14	21½	20	19	18	16½	15	14	13½	13	12½	12½	21	19½	18½	17	16	15	14	13½	13	12½	12½	20	18½									
	16	22½	21	20	19	17½	16½	15	14½	14	14	13½	22	20½	19½	18½	17½	16½	15	14½	14	14	13½	21										
300# – 400#	1	15½	14	13	12	10	9	7½	6	5	5	4½	14½	13½	12	10½	9½	8	7	6	5	5	4½											
	1½	15½	14	13	12	10½	9	7½	6½	5½	5	5	15	13½	12½	11	9½	8½	7	6½	5½	5												
	2	16	14½	13½	12½	10½	9½	8	6½	5½	5½	5	15	14	12½	11	10	8½	7½	6½	5½													
	3	16½	15	14	13	11	10	8½	7	6½	6½	6	15½	14½	13	11½	10½	9	8	7														
	4	17	15½	14½	13½	11½	10½	9	8	7½	7	7	16	15	13½	12	11	9½	8½															
	6	18	16½	15½	14½	13	11½	10	9	8½	8½	8	17½	16	15	13½	12	11																
	8	19	17½	16½	15½	14	12½	11	10½	10	9½	9½	18½	17	16	14½	13																	
	10	20	18½	17½	16½	15	13½	12	11½	11	11	10½	19½	18	17	15½																		
	12	21	19½	18½	17½	16	15	13½	13	12½	12½	12	20½	19	18																			
	14	21½	20	19	18	17	16	15	14½	14	13½	13½	21	19½																				
	16	22½	21	20½	19½	18½	17½	16	15½	15	15	14½	22																					
600#	1	15½	14	13	12	10	9	7½	6	5	5	4½																						
	1½	15½	14	13	12	10½	9	7½	6½	5½	5																							
	2	16	14½	13½	12½	10½	9½	8	6½	5½																								
	3	16½	15	14	13	11	10	8½	7																									
	4	17	15½	14½	13½	11½	10½	9																										
	6	18	16½	15½	14½	13	11½																											
	8	19	17½	16½	15½	14																												
	10	20	18½	17½	16½																													
	12	21	19½	18½																														
	14	21½	20																															
	16	22½																																



GENERAL NOTES

1. LINE SPACING DIMENSIONS ARE BASED ON A CLEARANCE OF 1" BETWEEN THE OUTSIDE DIAMETER OF FLANGE AND THE OUTSIDE DIAMETER OF PIPE, WITH A MINIMUM SPACING BETWEEN ANY TWO LINES OF 4".
2. SIDE MOVEMENT DUE TO EXPANSION OF HOT LINES MUST BE ALLOWED FOR AND SPACING INCREASED ACCORDINGLY.
3. WHEN THE PIPE AND/OR FLANGES ARE INSULATED, THE INSULATION THICKNESS IS ADDED TO THE SPACING DIMENSION.
4. INCREASED SPACING MAY BE REQUIRED WHERE ORIFICE FLANGES ARE INVOLVED.

Figure 6-6. Line Spacing Pipe (courtesy of Fluor Corp.).

Pipe Size	150#				300#					400#			
	Quan.	Dia.	Mach	Stud	Quan.	Dia.	Mach	Stud		Quan.	Dia.	Stud	
			R.F.	R.F.			R.F.	R.F.	R.T.J.			R.F.	R.T.J.
1/2"	4	1/2"	1 3/4"	2 1/4"	4	1/2"	2"	2 1/2"	3"	4	1/2"	3"	3"
3/4"	4	1/2"	2"	2 1/4"	4	5/8"	2 1/2"	2 3/4"	3 1/4"	4	5/8"	3 1/4"	3 1/4"
1"	4	1/2"	2"	2 1/2"	4	5/8"	2 1/2"	3"	3 1/2"	4	5/8"	3 1/2"	3 1/2"
1 1/2"	4	1/2"	2 1/4"	2 3/4"	4	3/4"	3"	3 1/2"	4"	4	3/4"	4"	4"
2"	4	5/8"	2 3/4"	3"	8	5/8"	3"	3 1/2"	4"	8	5/8"	4"	4 1/4"
2 1/2"	4	5/8"	3"	3 1/4"	8	3/4"	3 1/4"	3 3/4"	4 1/2"	8	3/4"	4 1/2"	4 3/4"
3"	4	5/8"	3"	3 1/2"	8	3/4"	3 1/2"	4"	4 3/4"	8	3/4"	4 3/4"	5"
4"	8	5/8"	3"	3 1/2"	8	3/4"	3 3/4"	4 1/4"	5"	8	7/8"	5 1/4"	5 1/2"
6"	8	3/4"	3 1/4"	3 3/4"	12	3/4"	4 1/4"	4 3/4"	5 1/2"	12	7/8"	5 3/4"	6"
8"	8	3/4"	3 1/2"	4"	12	7/8"	4 3/4"	5 1/4"	6"	12	1"	6 1/2"	6 3/4"
10"	12	7/8"	3 3/4"	4 1/2"	16	1"	5 1/4"	6"	6 3/4"	16	1 1/8"	7 1/4"	7 1/2"
12"	12	7/8"	4"	4 1/2"	16	1 1/8"	5 3/4"	6 1/2"	7 1/4"	16	1 1/4"	7 3/4"	8"
14"	12	1"	4 1/4"	5"	20	1 1/8"	6"	6 3/4"	7 1/2"	20	1 1/4"	8"	8 1/4"
16"	16	1"	4 1/2"	5 1/4"	20	1 1/4"	6 1/2"	7 1/4"	8"	20	1 3/8"	8 1/2"	8 3/4"
18"	16	1 1/8"	4 3/4"	5 3/4"	24	1 1/4"	6 3/4"	7 1/2"	8 1/4"	24	1 3/8"	8 3/4"	9"
20"	20	1 1/8"	5 1/4"	6"	24	1 1/4"	7"	8"	8 3/4"	24	1 1/2"	9 1/2"	9 3/4"
24"	20	1 1/4"	5 3/4"	6 3/4"	24	1 1/2"	7 3/4"	9"	10"	24	1 3/4"	10 1/2"	11"
*30"	28	1 1/4"	6"	8"	28	1 3/4"	---	12"	13 1/4"	28	2"	14"	14 1/2"
*36"	32	1 1/2"	6 3/4"	9"	32	2"	---	13 3/4"	15"	32	2"	15"	15 3/4"
*42"	36	1 1/2"	7 1/4"	9 1/2"	36	2"	---	14 3/4"	16"	32	2 1/2"	17 1/4"	18 1/4"

* Use only for ANSI flanges

Figure 6-7. Bolting for Flanges.

Pipe Size	600#				900#				1500#			
	Quan.	Dia.	Stud		Quan.	Dia.	Stud		Quan.	Dia.	Stud	
			R.F.	R.T.J.			R.F.	R.T.J.			R.F.	R.T.J.
1/2"	4	1/2"	3"	3"	4	3/4"	4"	4"	4	3/4"	4"	4"
3/4"	4	5/8"	3 1/4"	3 1/4"	4	3/4"	4 1/4"	4 1/4"	4	3/4"	4 1/4"	4 1/4"
1"	4	5/8"	3 1/2"	3 1/2"	4	7/8"	4 3/4"	4 3/4"	4	7/8"	4 3/4"	4 3/4"
1 1/2"	4	3/4"	4"	4"	4	1"	5 1/4"	5 1/4"	4	1"	5 1/4"	5 1/4"
2"	8	5/8"	4"	4 1/4"	8	7/8"	5 1/2"	5 3/4"	8	7/8"	5 1/2"	5 3/4"
2 1/2"	8	3/4"	4 1/2"	4 3/4"	8	1"	6"	6 1/4"	8	1"	6"	6 1/4"
3"	8	3/4"	4 3/4"	5"	8	7/8"	5 1/2"	5 3/4"	8	1 1/8"	6 3/4"	7"
4"	8	7/8"	5 1/2"	5 3/4"	8	1 1/8"	6 1/2"	6 3/4"	8	1 1/4"	7 1/2"	7 3/4"
6"	12	1"	6 1/2"	6 3/4"	12	1 1/8"	7 1/2"	7 3/4"	12	1 3/8"	10"	10 1/4"
8"	12	1 1/8"	7 1/2"	7 3/4"	12	1 3/8"	8 1/2"	8 3/4"	12	1 5/8"	11 1/4"	11 3/4"
10"	16	1 1/4"	8 1/4"	8 1/2"	16	1 3/8"	9"	9 1/4"	12	1 7/8"	13 1/4"	13 1/2"
12"	20	1 1/4"	8 1/2"	8 3/4"	20	1 3/8"	9 3/4"	10"	16	2"	14 3/4"	15 1/4"
14"	20	1 3/8"	9"	9 1/4"	20	1 1/2"	10 1/2"	11"	16	2 1/4"	16	16 3/4"
16"	20	1 1/2"	9 3/4"	10"	20	1 5/8"	11"	11 1/2"	16	2 1/2"	17 1/2"	18 1/2"
18"	20	1 5/8"	10 1/2"	10 3/4"	20	1 7/8"	12 3/4"	13 1/4"	16	2 3/4"	19 1/4"	20 1/4"
20"	24	1 5/8"	11 1/4"	11 1/2"	20	2"	13 1/2"	14"	16	3"	21	22 1/4"
24"	24	1 7/8"	12 3/4"	13 1/4"	20	2 1/2"	17"	17 3/4"	16	3 1/2"	24	25 1/2"

Note: for inlet flange of relief valves 1" and smaller, add 1/2" to length; 1 1/2" through 4", add 3/4" to length; 6" through 10", add 1" to length.

Figure 6-8. Bolting for Flanges.

1.24 Figure 6-9 shows pipe wall thickness and flange bores.

1.25 Ring numbers for RTJ flange gaskets are in Figure 6-10.

General Comments to the Student

You have now finished Chapter 6. This is one-half of the course. Now is the time to stop and take stock of what you have learned and make sure you have learned enough to enable you to go to the last half of this book. The author suggests that each of you reread Chapters 1 through 6 and make sure you have learned them.

Pipe Size		1"	1 1/2"	2"	2 1/2"	3"	4"	6"	8"
SCH. 40	Wall	.133"	.145"	.154"	.203"	.216"	.237"	.280"	.322"
	Bore	1.049"	1.610"	2.067"	2.469"	3.068"	4.026"	6.065"	7.981"
SCH. 80	Wall	.179"	.200"	.218"	.276"	.300"	.337"	.432"	.500"
	Bore	0.957"	1.500"	1.939"	2.323"	2.900"	3.826"	5.761"	7.625"
		10"	12"	14"	16"	18"	20"	24"	30"
SCH. 30	Wall	.307"	.330"	.375"	.375"	.438"	.500"	.562"	.625"
	Bore	10.136"	12.090"	13.250"	15.250"	17.124"	19.000"	22.876"	28.750"
STANDARD	Wall	.365"	.375"	.375"	.375	.375"	.375"	.375"	.375"
	Bore	10.020"	12.000"	12.250"	15.250"	17.250"	19.250"	23.250"	29.250"
SCH. 40	Wall	.365"	.406"	.438"	.500"	.562"	.593"	.687"	-----
	Bore	10.020"	11.938"	13.124"	15.00	16.876"	18.814"	22.626"	-----
X STG.	Wall	.500"	.500"	.500"	.500"	.500"	.500"	.500"	-----
	Bore	9.750"	11.750"	13.000"	15.000"	17.000"	19.000"	23.000"	29.000"
SCH. 80	Wall	.593"	.687"	.750"	.843"	.937"	1.031"	1.218"	-----
	Bore	9.564"	11.376"	12.500"	14.314"	16.126"	17.938"	21.564"	-----

Figure 6-9. Pipe Wall Thickness and Flange Bores.

Pipe Size	1"	1 1/2"	2"	21/2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"	36"	42"
150#	R-15	R-19	R-22	R-25	R-29	R-36	R-43	R-48	R-52	R-56	R-59	R-64	R-68	R-72	R-76	--	--	--
300#, 400#, & 600#	R-16	R-20	R-23	R-26	R-31	R-37	R-45	R-49	R-53	R-57	R-61	R-65	R-69	R-73	R-77	R-95	R-98	--
900#	R-16	R-20	R-24	R-27	R-31	R-37	R-45	R-49	R-53	R-57	R-62	R-66	R-70	R-74	R-78	--	--	--
1500#	R-16	R-20	R-24	R-27	R-35	R-39	R-46	R-50	R-54	R-58	R-63	R-67	R-71	R-75	R-79	--	--	--
2500#	R-18	R-23	R-26	R-28	R-32	R-38	R-47	R-51	R-55	R-60	--	--	--	--	--	--	--	--

Figure 6-10. Ring Numbers for Ring Joint Flanges.

You should be able to answer the following questions without referring to the book.

Review Test

1. Define the basic difference between a refinery and a gasoline plant. ______________________________
2. What is a hydrocarbon? ______________________________
3. What is a utility line? Name five. ______________________________
4. What is condensate? ______________________________
5. What is the function of a cooling tower? ______________________________
6. Pipe is made from many materials. The most common material is ______________________________.
7. Where is the normal liquid level on most overhead accumulators? ______________________________
8. What instrument keeps the liquid at this point? ______________________________
9. Light ends products, such as propane and butane, are usually stored in long horizontal vessels. These are called ______________________________.
10. Define "fin-fan." ______________________________
11. The most commonly used pump in process units is the ______________________________.
12. Give the seven basic forged steel flange ratings. ______________________________
13. What is a companion flange? ______________________________
14. As pipe thicknesses increase, the ______________ diameter changes. The ______________ diameter remains constant.
15. Approximately how long is a single random length of pipe? ______________________________
16. What is a stub-in? ______________________________
17. Fittings 2" and below in line size are usually ______________ or ______________ types. Fittings 3" and above are usually buttwelding type.
18. Cast iron flanges have two basic ratings: ______________ and ______________.

19. The 150# RF and 300#RF have a 1/16" RF. The 400# RF and higher ratings have a ________________RF.

20. When two flanges are bolted together, they will have the same rating. This means they will have the same number of bolts, the same OD, the same BC and the same RF dimension. Define OD, BC and RF. ____

21. Which flow diagram is the piping draftsman's "road map"? ____________________________

22. What is a TW? How does it differ from a TI? __________________________________

23. Define a coordinate system of dimensioning. __________________________________

24. Define RTJ. ____

25. The mill tolerance for seamless steel pipe is________________%.

26. Hot insulated lines 3" and larger are supported on ______________________ high shoes.

27. Pumps are usually located under the pipe rack with the centerline of discharge located _______________________ out from the centerline of the rack column.

28. The top of grout for pump foundations is usually_______________________ above the high point of grade or paving.

29. What is a "dummy" support? ____

30. What is "hydrostatic" testing and why do we do it? _______________________________________

CHAPTER 7

PIPING PLANS & PROCESS EQUIPMENT

Piping Plans and Elevations or Sections

Figure 7-1 is an actual piping plan. It was initially drawn on 24"x36" tracing paper and has been reduced. Many construction companies use a camera to microfilm all their drawings. A copy of this microfilm is then sent to the field construction office. They have a machine that takes the microfilm and produces them a large working print.

Any light lines on the original tracing, small lettering or generally poor draftsmanship will not reproduce on the microfilm and therefore will not reproduce on the field print. So again, *linework and lettering must be good and sharp.* And, if one works for a company that uses microfilm, his lettering should be a minimum of 1/8" high.

Now, in reading this piping plan, students will read it in the general order that the good piping draftsman might draw it. Also, they'll consider where he would have to go to get his information to make the finished piping plan. The draftsman's supervisor might give him a copy of the piping drawing index (Chapter 5), which would show him his drawing area, or his match lines. It also would show him what equipment, vessels, exchangers, reboilers, pumps, et cetera were in his area.

To learn the coordinates of his equipment, he must refer to the foundation location plan (Chapter 5). There he also can learn the coordinates and spacing of his pipe rack. If he is given this project to do before the foundation location plan is drawn–which sometimes happens–then the piping layout, done by an experienced piping designer, will establish the coordinates. Should this occur, the piping draftsman is to check and agree with the layout coordinates.

The piping draftsman will need the mechanical flow diagram and the utility flow diagram. If a sewer flow diagram is made, he will need a copy of it to know where to locate funnels. If the underground piping drawings have been made, this will also tell him this data. He also needs a copy of the line list (Chapter 4).

Then, to draw the piping sections (Figures 7-2 and 7-3) he must refer to the foundation drawings for the equipment elevation and the structural steel drawings for the pipe rack elevations.

He also must review the underground electrical drawings to determine if there are underground electrical trenches, electrical conduit or electrical manholes. In general, the piping draftsman should review all possible information about his drawing area. He should know more about what is in the area than anyone else. And he should know this *before* he makes his *first* line on his drawing.

The author has picked a very easy piping plan and sections for the student to study. Many actual areas are so full of piping that not much white is on the drawing. The author is telling the student this to impress on him the need for accuracy in this business. There's only one way to pipe up an area–the accurate way. The area he is looking at will cost about $250,000. If the draftsman is thinking of something else while doing piping, a small error could cost $5,000 to fix in the field. He must learn to concentrate on what he is doing and do it right.

The first thing to do in starting the piping drawing is to lightly draw in the four drawing limit lines. Three are "match lines," matching another drawing area. The fourth is the "area limits," where the point or coordinate is the extent of the unit being drawn. Coordinates are given for each line.

Next, the student is to locate the crosshair centerlines of the equipment, starting with the Depropanizer. Then, he is to draw in the centerlines of the exchangers; locate the reboiler; draw in the foundations of all this equipment. After he pencils in lightly the coordinates of all these lines, he is ready to draw the equipment.

The Depropanizer is his main piece of equipment in this drawing area. So, he is to draw it in first. The vessel drawing indicates the size and what nozzles are required. The vessel drawing will also give the "nozzle orientation," where nozzles are located around the circumference of the tower. The vessel ladder and platform drawings show the location of these items. One must always orient himself in relation to the North arrow.

The mechanical flow diagram will show all connections to the tower. It may even differ from the vessel drawing as to location in relation to a tray number for some connections. In that event, the student should ask his supervisor which is correct.

The Depropanizer is now drawn in to scale. The student is to draw in the Depropanizer Reboiler, E-119, referring to the vendor's print and drawing it in lightly. He then draws in E-104A and B, two shell and tube exchangers to be piped in parallel. Had they been piped in series, the flow would have gone through E-104A and then B for the shell or tube side. The other side flow would have been E-104B first; then, E-104A.

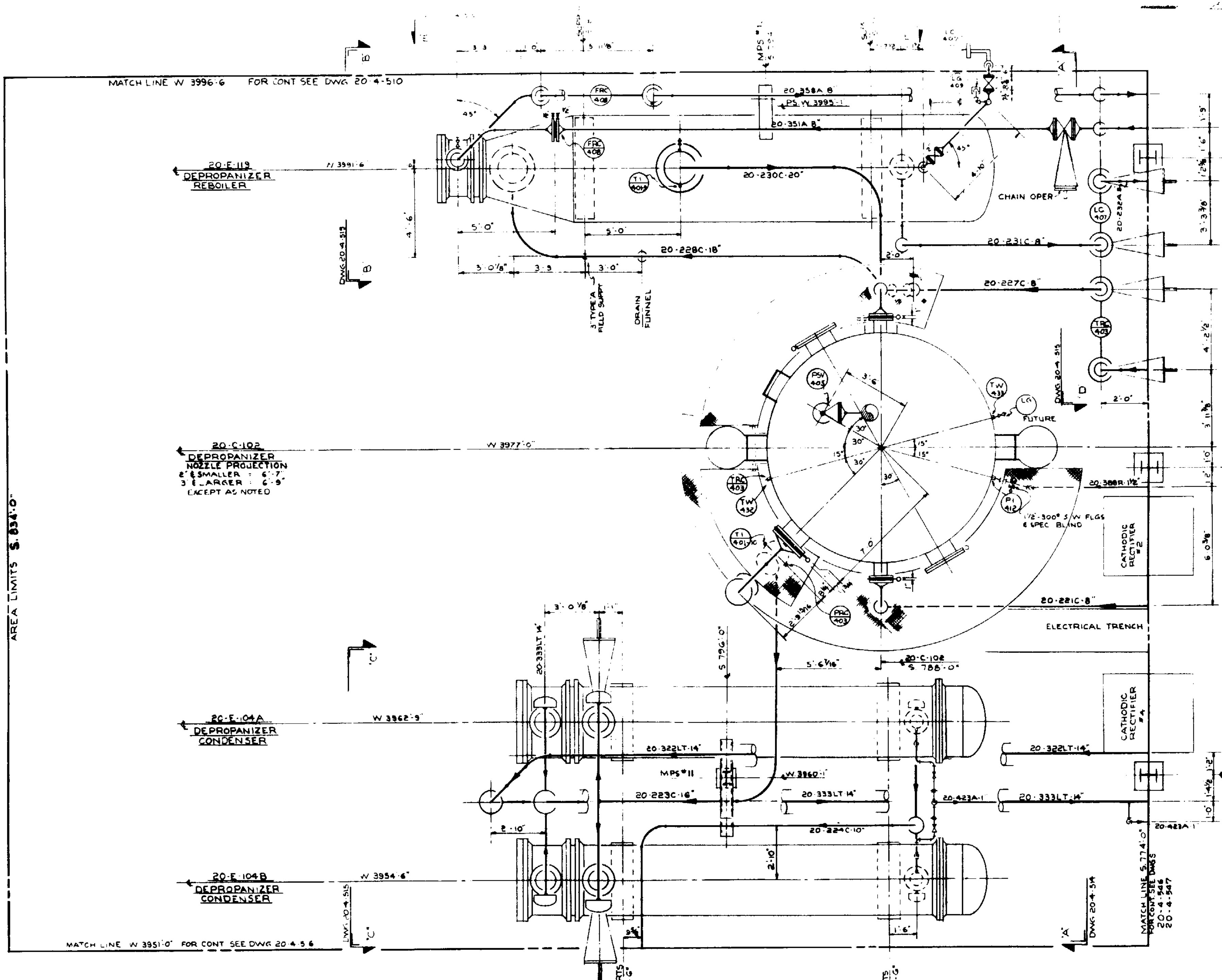
Exchangers are piped up with the fluid being cooled flowing down and the fluid being heated flowing up. One must always remember to reverse flow exchangers.

Now all the equipment is drawn in lightly and the coordinates are shown lightly. It's time to draw the piping in. The student must always start at the top of the tower and draw down. The instrument specification sheet determines the relief valve size. The student draws it in to scale and shows the tailpipe discharging up. He then draws in the overhead vapor line, number 223C-16" going to E-104A and B shellside.

The next nozzle is the reflux. The student connects line 227C-8" to the reflux nozzle and goes right on down the tower, showing each connection on the vessel and piping it up or showing the proper instrument bubble.

Now he is ready to pipe up E-104A and B tubeside, drawing in the 14" cooling water lines, number 322LT-14" going in the bottom of the exchanger and number 333LT-14" leaving the top of the tubeside.

As the student probably has some problems trying to visualize how that pipe twists around, now is the time for him to start drawing his sections. His supervisor may tell him where he wants sections cut. If not, the student should cut eleva-


MATCH LINE W 3996-6 FOR CONT SEE DWG 20-4-510
20-E-119
DEPROPANIZER REBOILER
W 3991-6
20-C-102
DEPROPANIZER
NOZZLE PROJECTION
2" & SMALLER : 6'-7"
3" & LARGER : 6'-9"
EXCEPT AS NOTED
W 3977'-0"
20-E-104A
DEPROPANIZER CONDENSER
W 3962'-9"
20-E-104B
DEPROPANIZER CONDENSER
W 3954'-6"
MATCH LINE W 3951'-0" FOR CONT SEE DWG 20-4-516
AREA LIMITS S 834'-0"
FRC 408
TI 404
TI 401
TRC 403
TW 432
TW 433
PSV 405
PI 412
PRC 403
LC 407
LG 409
LG
FUTURE
20-358A 8"
PS W 3995'-1
20-351A 8"
20-230C-20"
20-228C-18"
20-231C-8"
20-227C-8"
20-232A-8"
20-388R-1½"
20-221C-8"
1½"-300# S/W FLGS & SPEC BLIND
CHAIN OPER
3" TYPE A FIELD SUPPT
DRAIN FUNNEL
MPS #1
PS #12 W 3992'-0"
PS #11 W 3976'-0"
PS #10 W 3960'-0"
CATHODIC RECTIFIER #2
CATHODIC RECTIFIER #4
ELECTRICAL TRENCH
20-C-102 S 788'-0"
S 796'-0"
20-333LT-14"
20-322LT-14"
MPS #11
W 3960'-1"
20-223C-16"
20-224C-10"
20-423A-1
MATCH LINE S 774'-0" FOR CONT SEE DWGS 20-4-546 20-4-547
DWG 20-4-515
DWG 20-4-514
B
C
A
D
5'-0"
3'-0⅞"
3'-3"
3'-0"
4'-6"
2'-0"
2'-10"
3'-0⅛"
5'-6¹⁄₁₆"
1'-6"
45°
30°
15°
7'-0"
3'-6"

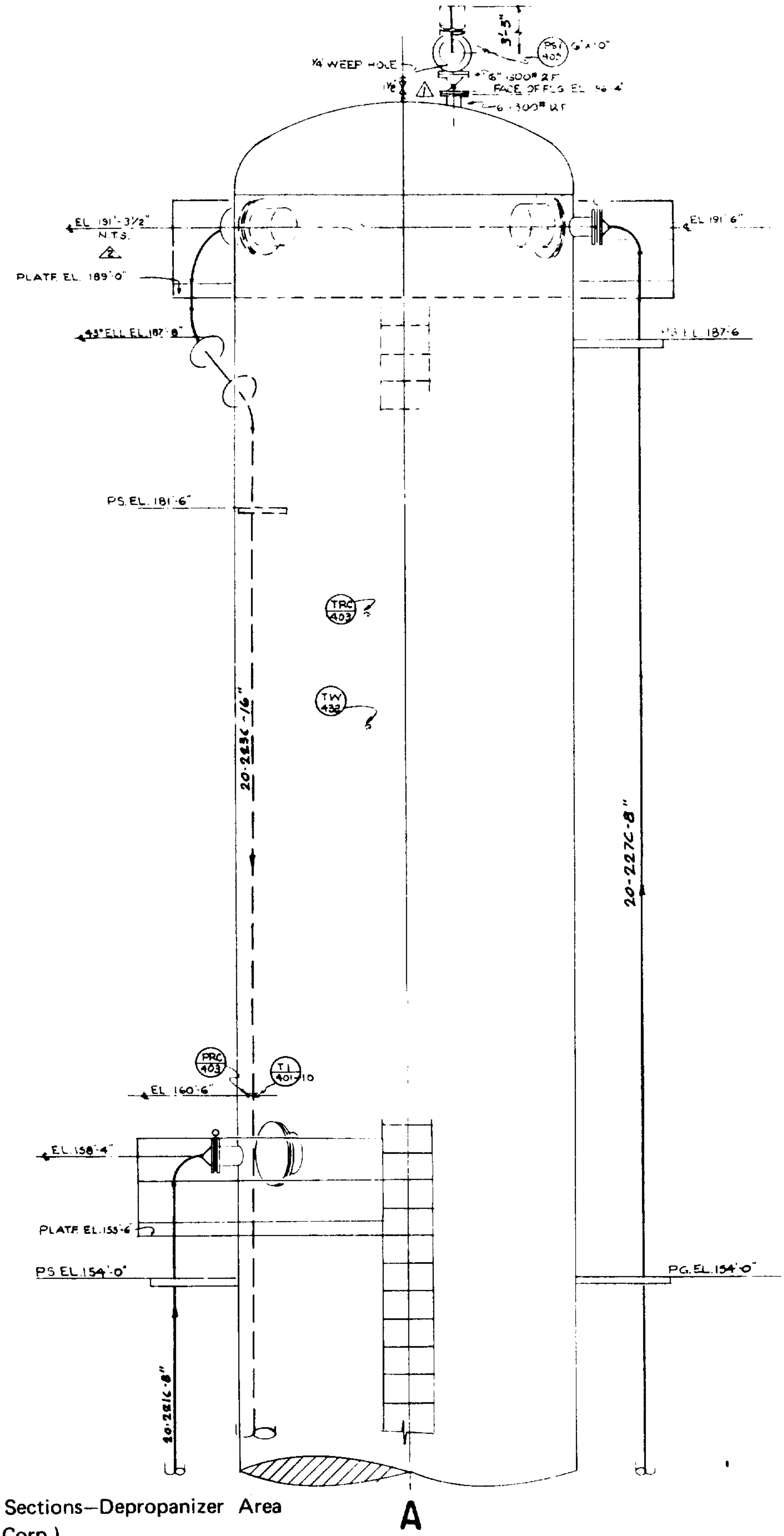


Figure 7-2. Piping Sections—Depropanizer Area (courtesy of Fluor Corp.).

THIS PORTION TURNS 90° AND CONNECTS TO A ON NEXT PAGE.

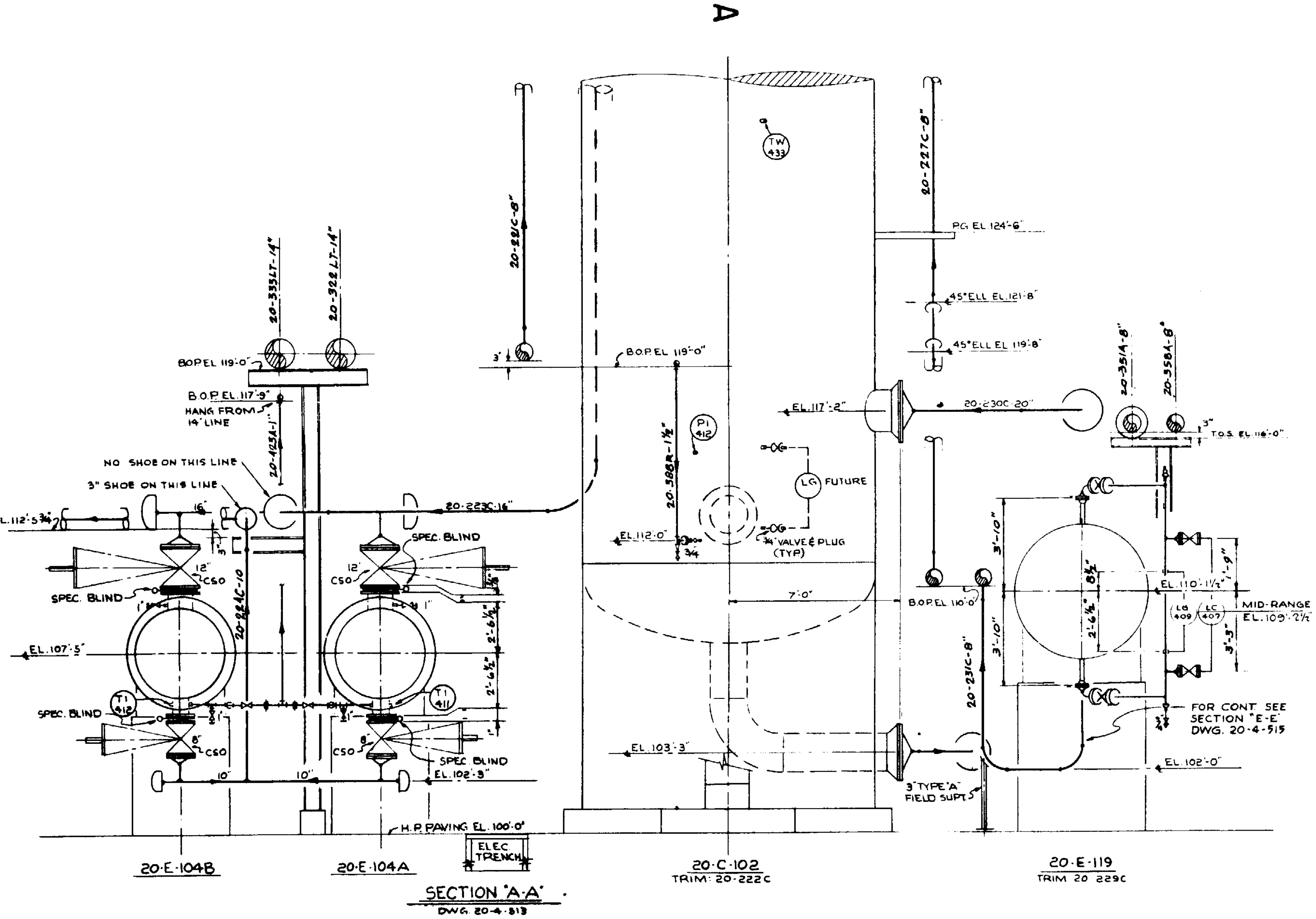


Figure 7-2. (continued)

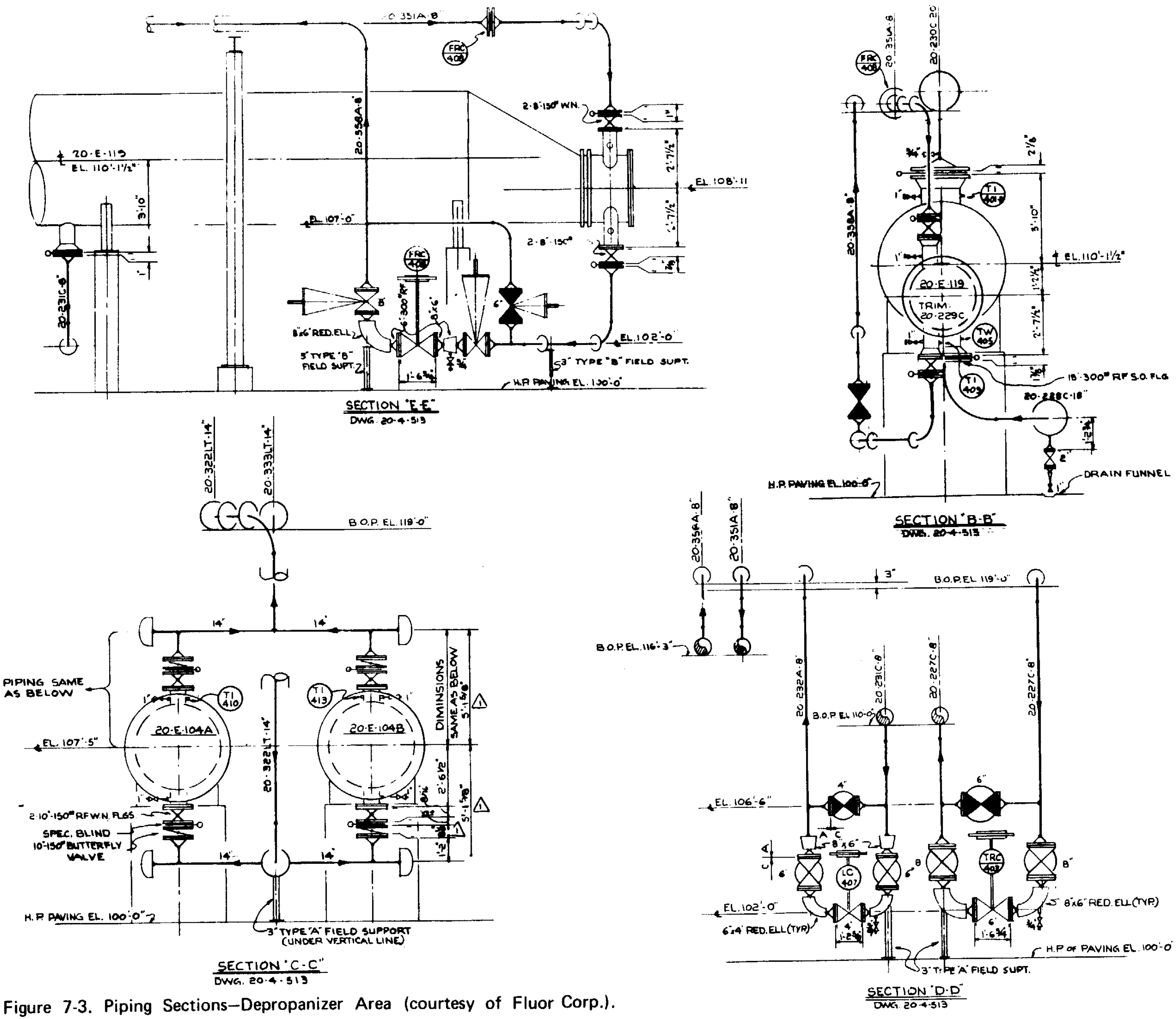


Figure 7-3. Piping Sections—Depropanizer Area (courtesy of Fluor Corp.).

tion A-A for all process units, showing the tower in elevation and all nozzles on the shellside for exchangers. Then, section B-B and C-C can be cut, showing the tubeside nozzles and their piping.

On a horizontal vessel or reboiler like E-119, the student will want to cut a partial section, E-E, to show details he cannot show in the two end elevations. But he is not to draw side views of simple exchangers like E-104A and B.

As he is piping up his plans and sections, he must check the flow sheet for control valve assemblies and meter runs and follow the line back to whoever is drawing the other part of that line. If the flow sheet calls for a meter run and/or control station, the student must not assume the other person is showing it in his area. One of the two draftsmen must make sure he is. The author once saw one line going through two areas, *both* having the control valve station.

A good spot at which to locate control valve stations is 2'-0" out from the centerline of the rack columns. In Figure 7-1 the stations LC-407 and TRC-403 are examples. The latter is board mounted. The student notes the control valve-temperature recorder. He also notes that the by-pass valve, it's flanges and the related piping in the plan aren't shown. Section D-D will show all of this. But, the control valve block's handwheels do appear. They are oriented North, so the operator walking under the pipe rack can reach them.

In Figure 7-2, section A-A, the student notices the fractionating tower is cut in elevation. When he does this, he also must cut the piping in the same relative area as done here. The tower is cut when it is very tall, and a long section has no nozzles. Basically, there's nothing to show. If one did have some connections, he could not cut the tower.

Also, at the top of the vessel, the 6"x10" PSV has a 6"-600# RF flange on it. The nozzle on C-102 is a 6" 300# RF. Since the draftsman cannot put a 600# flange against a 300# flange, a pair of flanges has to be welded hub to hub to make this fitup.

All elevations of nozzles are shown. Line 227C-8" shows the reflux liquid going up to the top tray. At elevation 191'-6" is the vessel nozzle. Platform elevation is 189'-0". But what is the PS at elevation 187'-6"? That is a pipe support needed to support the weight of the line to keep this "dead weight" off the nozzle. It also supports "live weight," which would be the weight of the liquid in the line.

Down the tower on the same line is a P.G. at elevation 154'-0" and 124'-6". These are pipe guides. They do not actually connect to the pipe, as a pipe support does, but encircle the pipe to keep it from swaying, putting forces on the nozzle.

Pipe supports and guides are drawn on the vessel ladder and platform detail drawing. The piping designer establishes them as he orients the tower and lays out the piping area.

The lines are all single line. Many companies draw all piping as single line. It is quicker. But, for line sizes 14" and up, double line should be used. It is easier to notice any interference.

Figure 7-3 shows sections B-B, C-C, D-D and E-E of the Depropanizer area. As subtracting coordinates on plans gives the distances between two or more points, subtracting elevations gives the distance between those two elevation points.

In section C-C, the centerline elevation of E-104 A and B is 107'-5". Adding 5'-1 5/8" to this gets to the 14" header at elevation 112'-6 5/8". The 90° ell is at BOP El. 119'-0". A BOP elevation appears only where supports are located. Dimensioning pipe always use centerlines. One-half the OD, or 7", must be added to the BOP to get centerline elevation 119'-7". Then, by subtracting 112'-6 5/8", the dimension between the centerline of the 90° ell and that of the centerline of the 14" header is 7'-0 3/8".

Figures 7-4 and 7-5 are plans of the upper and lower levels in the pipe rack. These are typical of pipe racks–i.e., utilities are in the top level and the process piping is in the bottom level.

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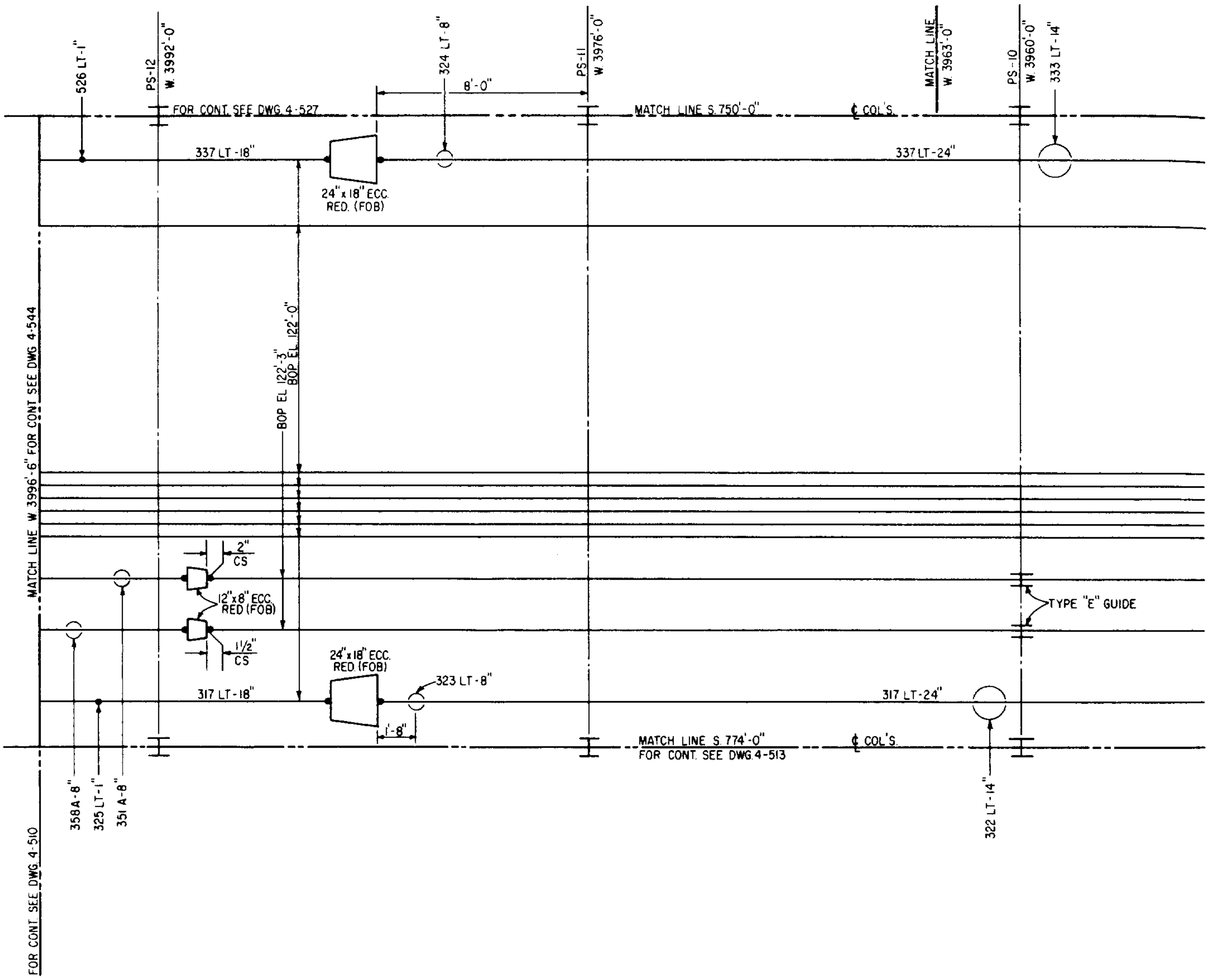


Figure 7-4. Piping Plan—Upper Pipe Rack—Fractionation Unit (courtesy of Fluor Corp.).

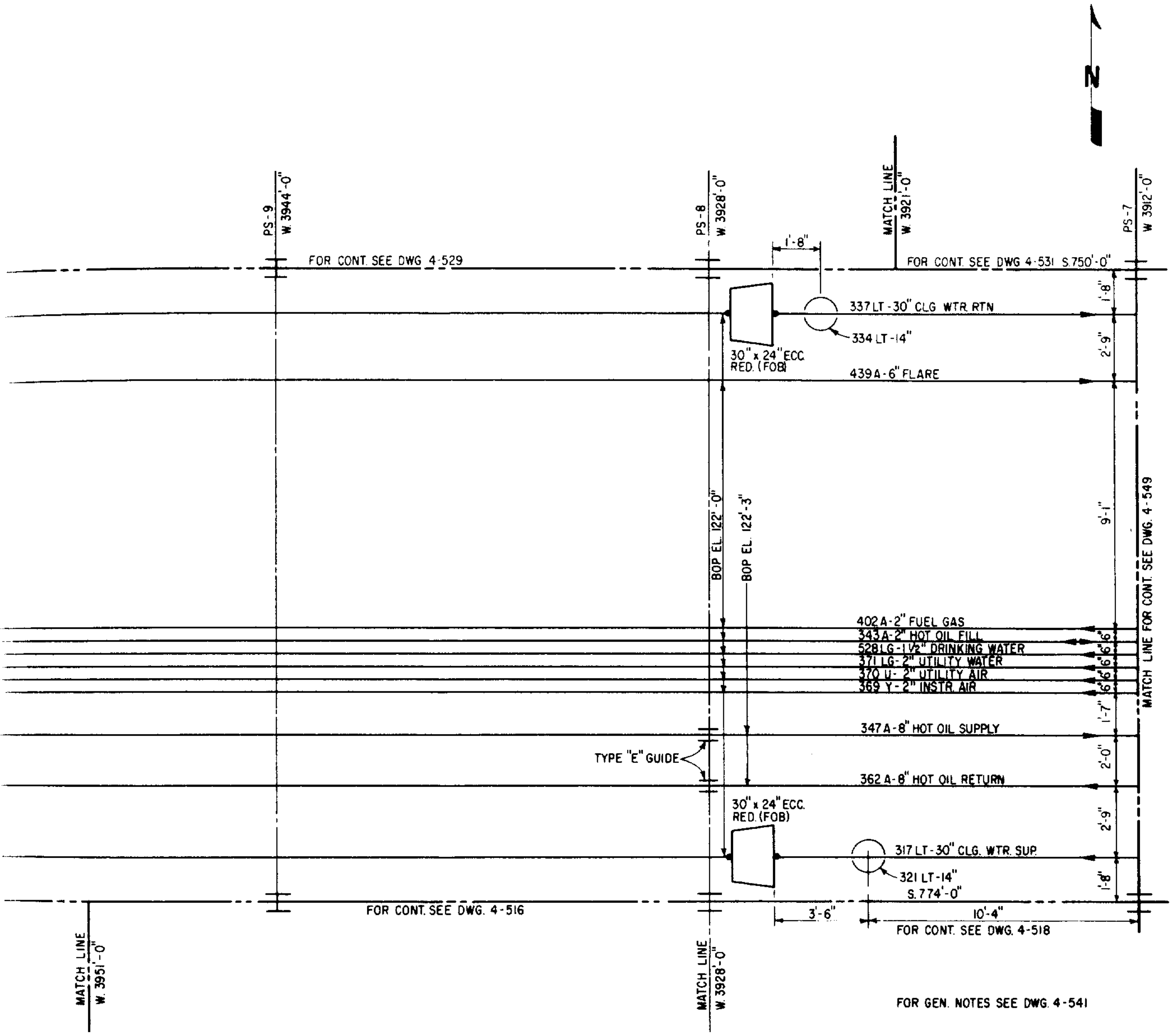


Figure 7-4. (continued)

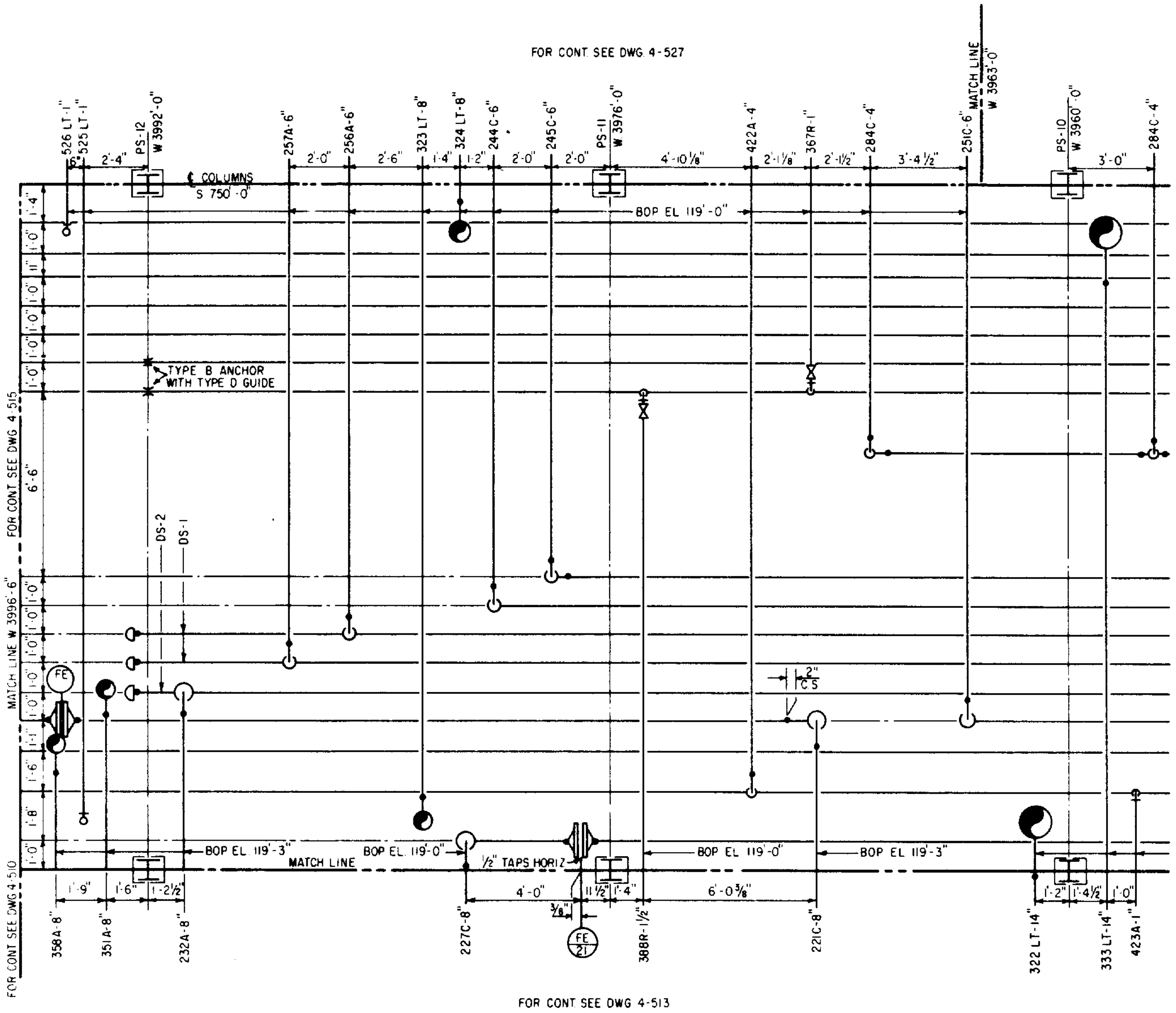


Figure 7-5. Piping Plan—Lower Pipe Rack—Fractionation Unit (courtesy of Fluor Corp.).

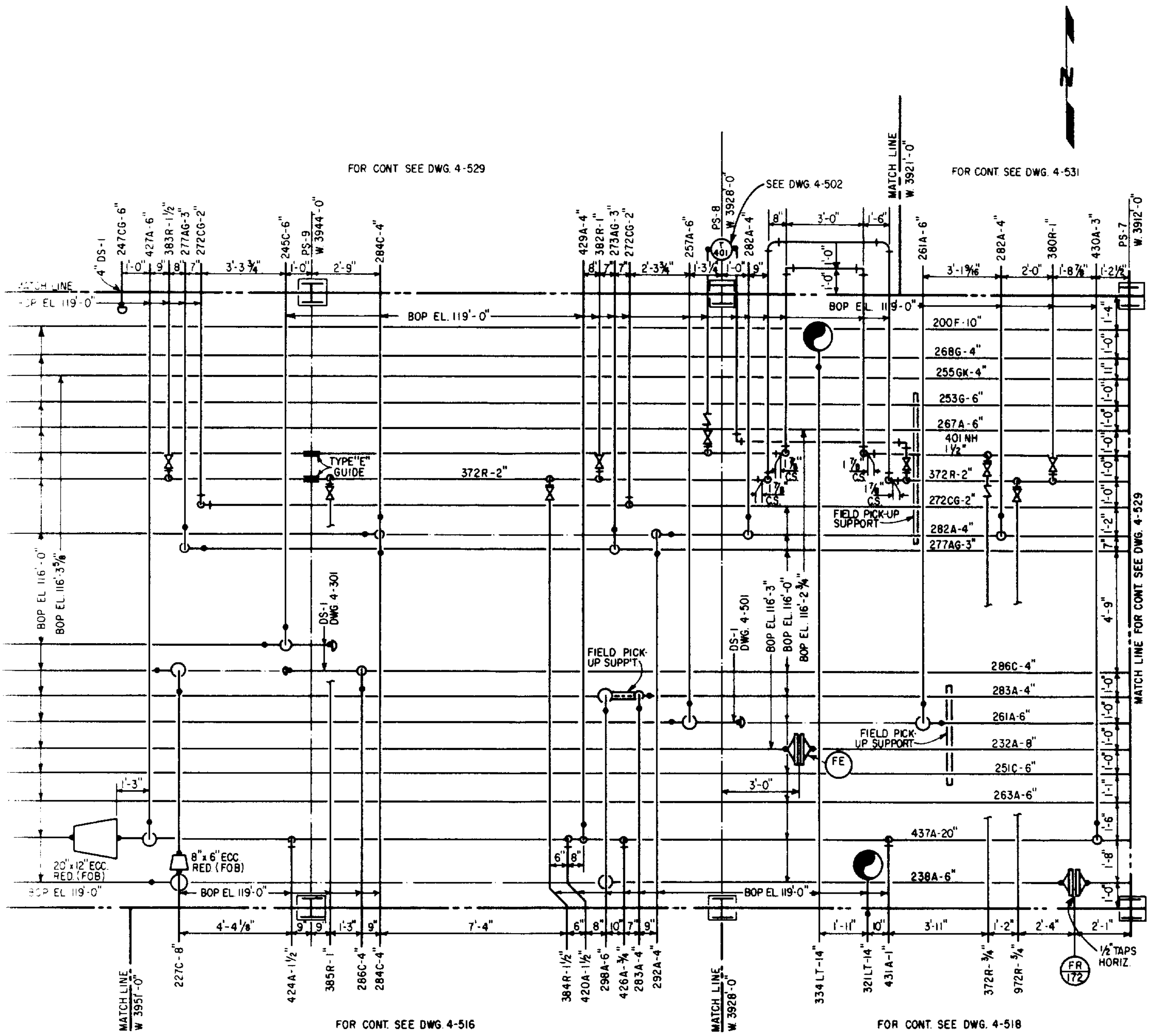


Figure 7-5. (continued)

Figures 7-6 and 7-7 show the piping plan and sections for Depropanizer Reflux Drums and their related pumps. Piping here gets a little more congested. Pumps G-104A and G-105 are the normally operating pumps. Piping at G-104B can take suction from either Reflux Drum. It is called a "common spare." The student is to study this piping carefully, for common spares are used quite often.

One can order pumps with a top suction instead of an end suction, like those here. The discharge remains on the top in either case. Piping for common spares is usually simpler if all three pumps have top suctions.

Piping Isometrics (Spools)

Piping isometrics are the end product of all those expended manhours. Figure 7-8 is an isometric of line 226C, the 12" suction line to G-104A and B. An isometric is drawn for *each line* and is sent to a fabricator or to the field if they are field fabricating.

The author likes to think of these process units as erector sets. Each unit is custom designed. Isometric detail sheets of each piece of piping are made. The isometric shows all flanges, valves, instrumentation connecting to it and every weld as well as the equipment to which it connects. It also shows all dimensions needed to fabricate the pipe. Dimensions are to the closest 1/16". After fabrication, field forces will erect the pieces, which must fit.

Assembly material—such as valves, bolts, gaskets, spectacle blinds and start-up strainers—are bought and sent directly to the job site. The pipe fabricator will only furnish pieces that require welding.

This line would be made and shipped in three pieces. Piece 1 would be from the weld neck flange at C-106 nozzle and down to the two 12" block valves. Piece 2 might be the small piece at G-104A suction which would be two 12" weld necks, one 90° ell, a short piece of 12" pipe and a ¾" coupling for a PI. Piece 3 would be the suction piece at G-104B.

Supports under the ells at the pump suction are called out as 3" Type "A" FS (field support), and no dimension is shown. The field makes these. After the 12" line is in place, the field will measure the support length needed and then fabricate and install this support.

Vessel Drawings

Vessels are the main part of the process unit in that this is "where things happen." Piping transports the fluid from one item to another. The vessel is just one of these items.

Figure 7-9 is a vessel drawing. This one is a fractionating tower, a Depropanizer, item C-102. A Depropanizer does just that. It depropanizes, or fractionates out propane. The propane will come

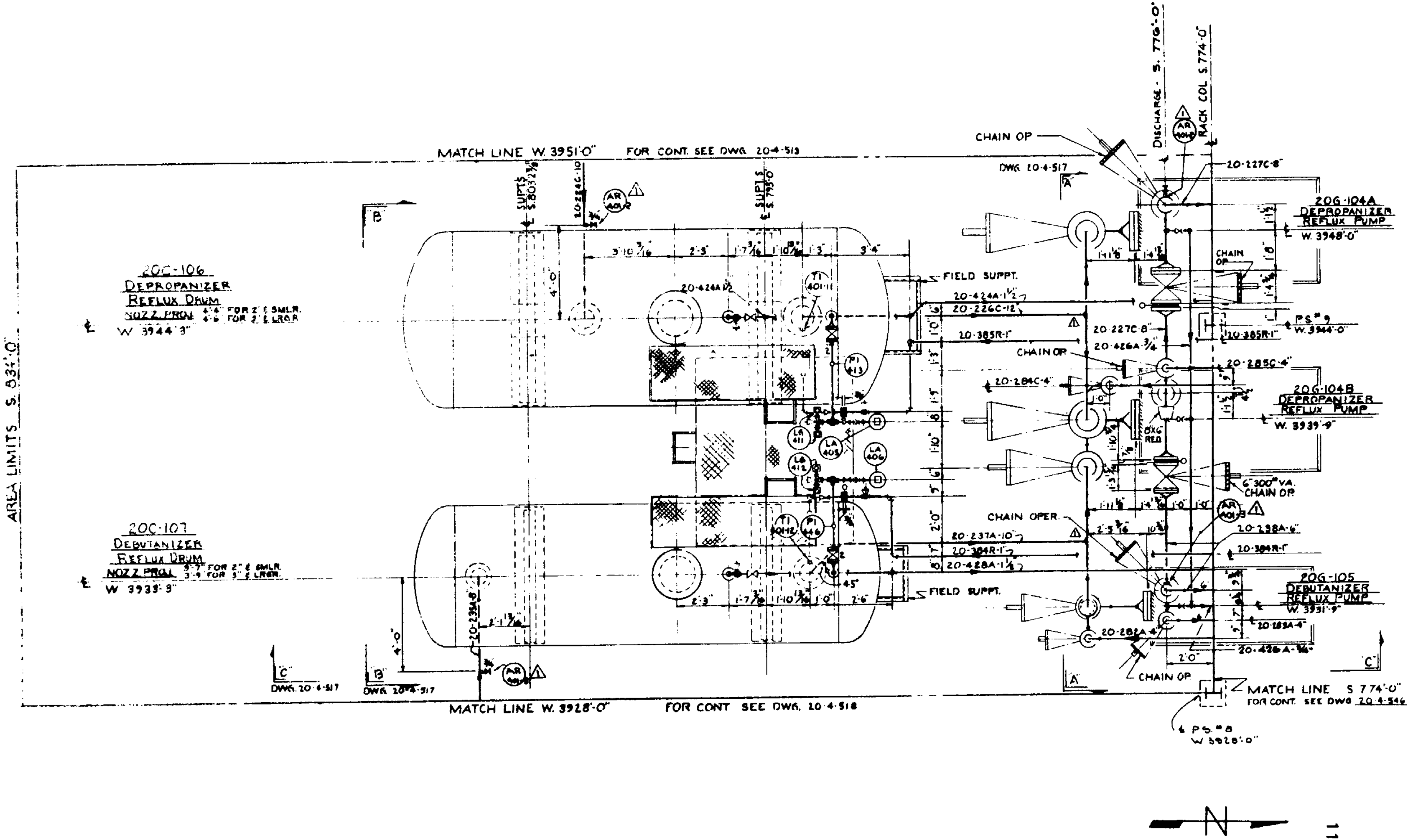


Figure 7-6. Piping Plan—Accumulator Area (courtesy of Fluor Corp.).

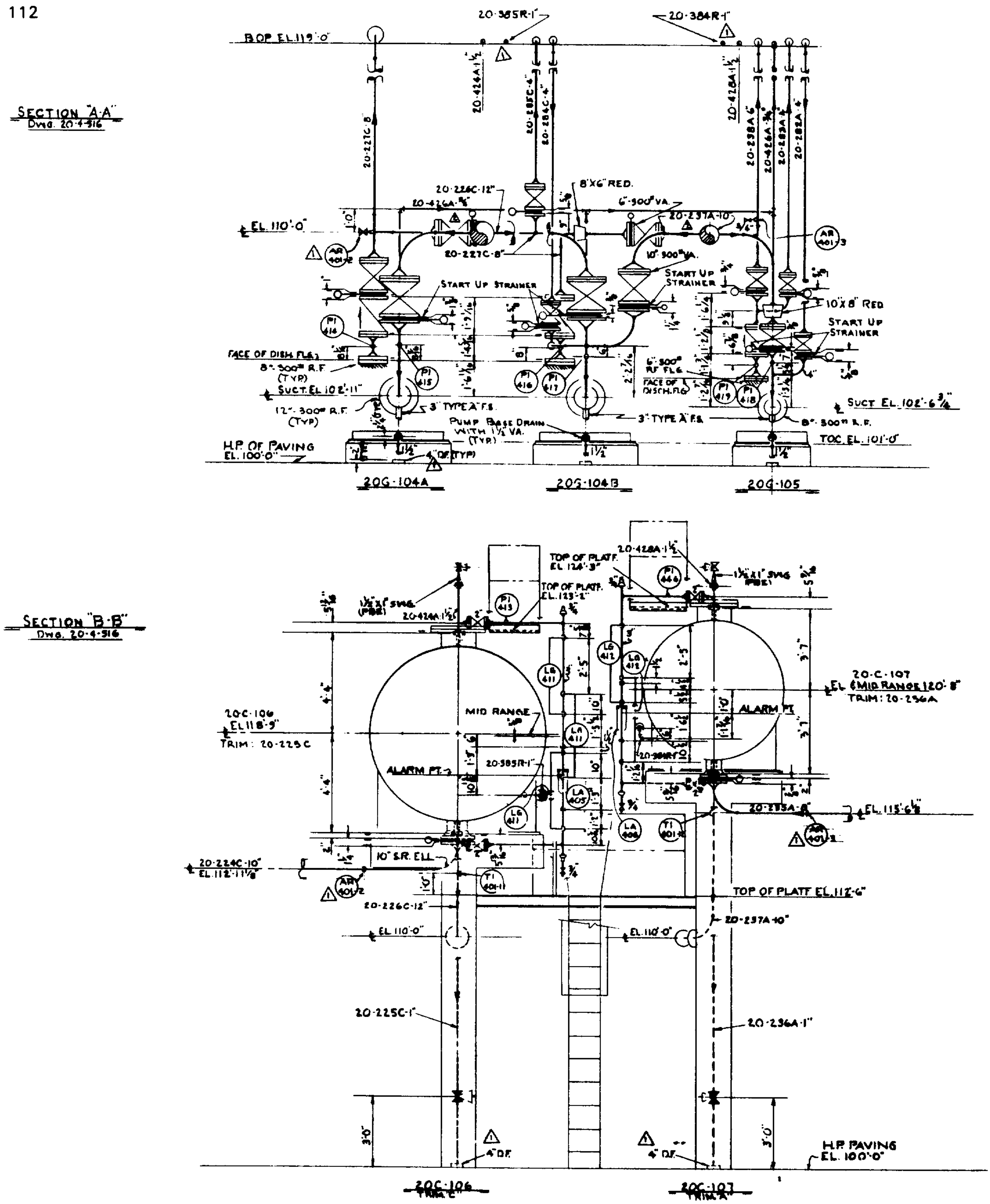


Figure 7-7. Piping Sections—Accumulator Area (courtesy of Fluor Corp.).

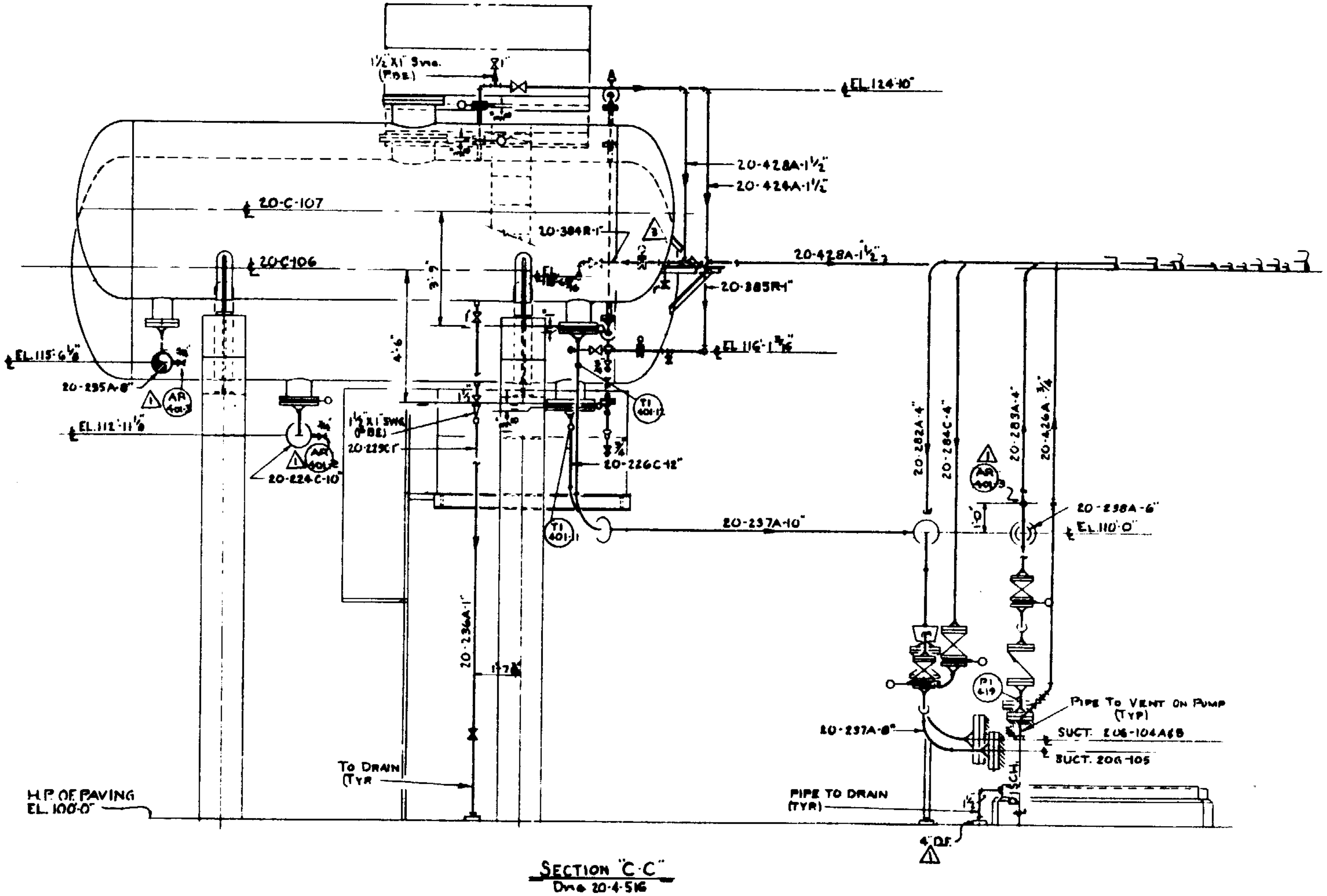


Figure 7-7. (continued)

out as a vapor through nozzle N-2. It will then be cooled and condensed in an exchanger and will go to a Reflux Drum or Accumulator, where it will be a liquid.

Here is a new form of dimensioning. Fractionating towers are normally dimensioned with "tail dimensions." Tail dimensions are shown here to be from the bottom of the base plate. They could be from any other selected point. Tail dimensions are another form of elevations. M-2 has a tail dimension of 57'-6"; M-3 has one of 90'-4". Subtracting the two tail dimensions shows they are 32'-10" apart.

The flow diagram will show the Depropanizer trays only where a nozzle or instrument connection is there to help orient the draftsman. But the actual vessel drawing will show all the trays in complete detail. Trays are usually purchased from a tray vendor, shipped to the shop building the tower and installed there. This tower has 36 trays of the 2-pass type. "Two pass" means it has two downcomers. The "downcomer" is the vertical piece that carries the tray liquid down to the next tray. Tray #7, for instance, has side downcomers on its outside. Tray #6 has center downcomers in its center. The downcomers alternate from center to outside throughout the tower.

The connection schedule lists nozzles. They are shown in the elevation, *not* in their actual orientation. They are shown in a spot that is easy to show. The "true orientation plan" gives the actual orientation of the nozzle. Again, one orients himself with the North arrow.

Figure 7-10 is a drawing of ladders, platforms, pipe supports and guides and column davit. The elevation shows these items again in untrue orientation. One must go to actual plans, orienting himself by the North arrow, to find the true orientation. Here again tail dimensions are used.

In the holes in platform #1 is a 20" ID opening for N-2. Figure 7-9 shows that N-2 is a 16" nozzle. So, 2" are clear all around the 16" pipe. Some companies require the hole to be large enough to clear the OD of a flange.

Figure 7-11 is the Depropanizer Reflux Drum, a simple horizontal vessel with no internals. It stores liquid propane product and reflux. Usually the level controller keeps the liquid level on the vessel centerline.

Vessels and exchangers in this book are shown with a 2:1 semi-elliptical head. (Figure 7-22 describes how to draw this head.) Many types of heads are used, but the 2:1 semi-elliptical is the most commonly specified one.

Heat Exchangers

Heat exchangers exchange heat from one fluid to another. The fluid may be liquid or vapor. Exchangers have two parts which have piping connections. They are the tubes, or tubeside, and the shell, or shellside.

In Figure 7-12 the 10" 150#RF nozzles are the tubeside connections. Fluid going in the bottom will be diverted into the tubes. Tubes are fixed to the tubesheet and may be ¾" to 1" in diameter. Hundreds of these tubes will run the length of the shell and come back to the tubeside outlet nozzle. The tubeside baffle then forces the fluid out the 10" 150#RF outlet just like it forces the incoming fluid to go into the tubes. The one tube shown is a sample of the many tubes that make up the "tube bundle."

The tube bundle includes all tubes which are permanently fixed to the tubesheet. The tube bundle is removable in most exchangers. By unbolting and dropping off the channel piece (tubeside), the tubesheet can be pulled out of the shell, pulling with it all the tubes. They can be cleaned or replaced, if required. The tube bundle diameter is about 1" less than the shell diameter. Tubes are about as close together as they can be installed. Tube bundles are very heavy. This one would weigh more than 10 tons.

The shell is very simple. It is like a vessel covering the tube bundle. Fluid going in the shellside in this case is a vapor. It is being cooled and condensed. Condensing means that while cooling, the vapor–or at least some of it– is being changed to a liquid. So, the outlet nozzle doesn't have to be as large as the inlet nozzle. Flow goes in the 12" 300#RF nozzle, flows around the tubes and goes out the 8" 300#RF nozzle.

One "reverse flows" exchangers. If the shell inlet is on the top, the tube inlet will be on the bottom. Also, the fluid being heated should always flow up and the fluid being cooled should always flow down.

The shell cover here is a 2:1 semi-elliptical head. Some exchangers have flanged removable shell covers. The flanged shell cover is very expensive and is specified only where periodic inspection is required. Maintenance men remove the shell cover and can inspect the tubes to see if they are still fairly clean. If a growth or tube fouling is noted, the heat transfer rate is reduced and a full cleaning is required.

Pump Drawing

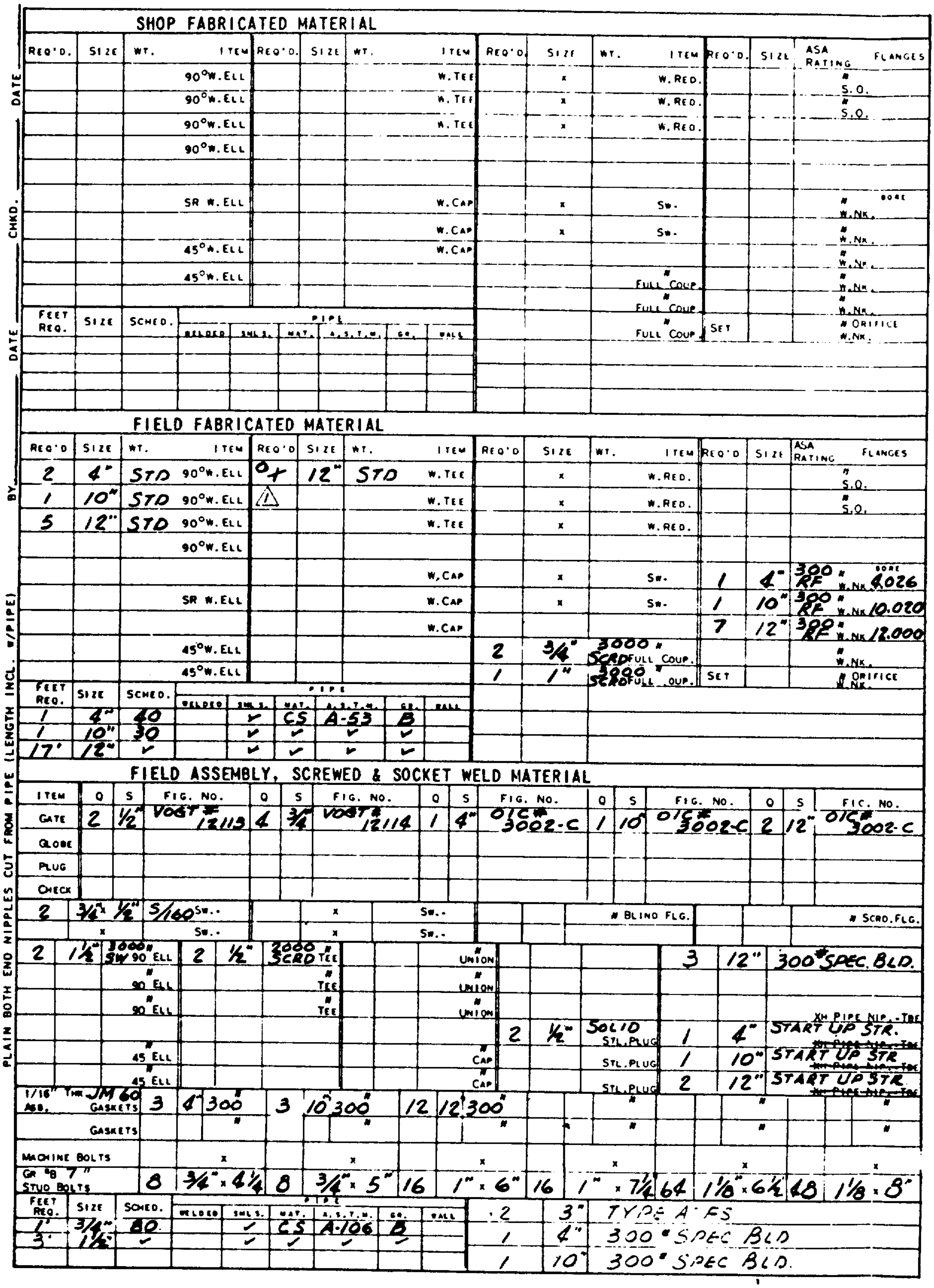
The vendor who furnishes the pump furnishes the pump outline drawing. Figure 7-13 is a simulated pump outline drawing. The base details and various small connections have been omitted for clarity, showing the basic pump information needed for doing piping.

A pump of this size would sit on 1'-0" of concrete. This would make the centerline of the suction nozzle 3'-0" above grade.

Most pumps have the suction and discharge flange at the same rating. This is due to hydrotesting–testing under pressure with water. A 150# rating line may go to the pump suction. But the discharge line rating might be 600#. The suction nozzle will be 600#. And the 150# line would have to have a 600# flange on it to match the 600# pump nozzle.

The manufacturer tests pumps to 1½ times the design pressure. This pressure is usually about 10% greater than the discharge pressure. Since the dis-

text continued on page 122



DATE ____ CHKD. ____ DATE ____ BY ____

PLAIN BOTH END NIPPLES CUT FROM PIPE (LENGTH INCL. W/PIPE)
"SW" DENOTES "SOCKET WELD"
"S" DENOTES "SCREWED"

SHOP FABRICATED MATERIAL

REQ'D.	SIZE	WT.	ITEM	REQ'D.	SIZE	WT.	ITEM	REQ'D.	SIZE	WT.	ITEM	REQ'D.	SIZE	ASA RATING	FLANGES
			90°W.ELL				W.TEE		x		W.RED.				# S.O.
			90°W.ELL				W.TEE		x		W.RED.				# S.O.
			90°W.ELL				W.TEE		x		W.RED.				
			90°W.ELL												
			SR W.ELL				W.CAP		x		SW.				# W.NK. BORE
							W.CAP		x		SW.				# W.NK.
			45°W.ELL				W.CAP								# W.NK.
			45°W.ELL								# FULL COUP.				# W.NK.
											# FULL COUP.				# W.NK.
											# FULL COUP.	SET			# ORIFICE W.NK.

FEET REQ.	SIZE	SCHED.	PIPE WELDED	SMLS.	MAT.	A.S.T.M.	GR.	WALL

FIELD FABRICATED MATERIAL

REQ'D	SIZE	WT.	ITEM	REQ'D	SIZE	WT.	ITEM	REQ'D	SIZE	WT.	ITEM	REQ'D	SIZE	ASA RATING	FLANGES
2	4"	STD	90°W.ELL	0+	12"	STD	W.TEE		x		W.RED.				# S.O.
1	10"	STD	90°W.ELL	△1			W.TEE		x		W.RED.				# S.O.
5	12"	STD	90°W.ELL				W.TEE		x		W.RED.				
			90°W.ELL												
							W.CAP		x		SW.	1	4"	300 RF	# W.NK. BORE 4.026
			SR W.ELL				W.CAP		x		SW.	1	10"	300 RF	# W.NK. 10.020
							W.CAP					7	12"	300 RF	# W.NK. 12.000
			45°W.ELL					2	3/4"	3000# SCRD	FULL COUP.				# W.NK.
			45°W.ELL					1	1"	3000# SCRD	FULL COUP.	SET			# ORIFICE W.NK.

FEET REQ.	SIZE	SCHED.	PIPE WELDED	SMLS.	MAT.	A.S.T.M.	GR.	WALL
1	4"	40		✓	CS	A-53	B	
1	10"	30		✓	✓	✓	✓	
17'	12"	✓		✓	✓	✓	✓	

FIELD ASSEMBLY, SCREWED & SOCKET WELD MATERIAL

ITEM	Q	S	FIG. NO.	Q	S	FIG. NO.	Q	S	FIG. NO.	Q	S	FIG. NO.	Q	S	FIG. NO.
GATE	2	1/2"	VOGT # 12113	4	3/4"	VOGT # 12114	1	4"	OIC # 3002-C	1	10"	OIC # 3002-C	2	12"	OIC # 3002-C
GLOBE															
PLUG															
CHECK															

2	3/4" x 1/2"	5/160 SW..		x	SW..			# BLIND FLG.			# SCRD.FLG.
	x	SW..		x	SW..						

2	1½"	3000# SW 90 ELL	2	½"	2000# SCRD TEE			# UNION				3	12"	300# SPEC. BLD.
		# 90 ELL			# TEE			# UNION						
		# 90 ELL			# TEE			# UNION						XH PIPE NIP.-TBE
									2	½"	SOLID STL.PLUG	1	4"	START UP STR. ~~XH PIPE NIP.-TBE~~
		# 45 ELL						# CAP			STL.PLUG	1	10"	START UP STR ~~XH PIPE NIP.-TBE~~
		# 45 ELL						# CAP			STL.PLUG	2	12"	START UP STR. ~~XH PIPE NIP.-TBE~~

1/16" THK JM 60 ASB. GASKETS	3	4" 300#	3	10" 300#	12	12" 300#		#		#		#
GASKETS		#		#		#		#		#		#
MACHINE BOLTS		x		x		x		x		x		x
GR "B 7" STUD BOLTS	8	3/4" x 4¼	8	3/4" x 5"	16	1" x 6"	16	1" x 7¼	64	1⅛" x 6½	48	1⅛ x 8"

FEET REQ.	SIZE	SCHED.	PIPE WELDED	SMLS.	MAT.	A.S.T.M.	GR.	WALL			
1'	3/4"	80		✓	CS	A-106	B		2	3"	TYPE A FS
3'	1½"	✓		✓	✓	✓	✓		1	4"	300# SPEC BLD
									1	10"	300# SPEC BLD.

Figure 7-8. Piping Isometric (courtesy of Fluor Corp.).

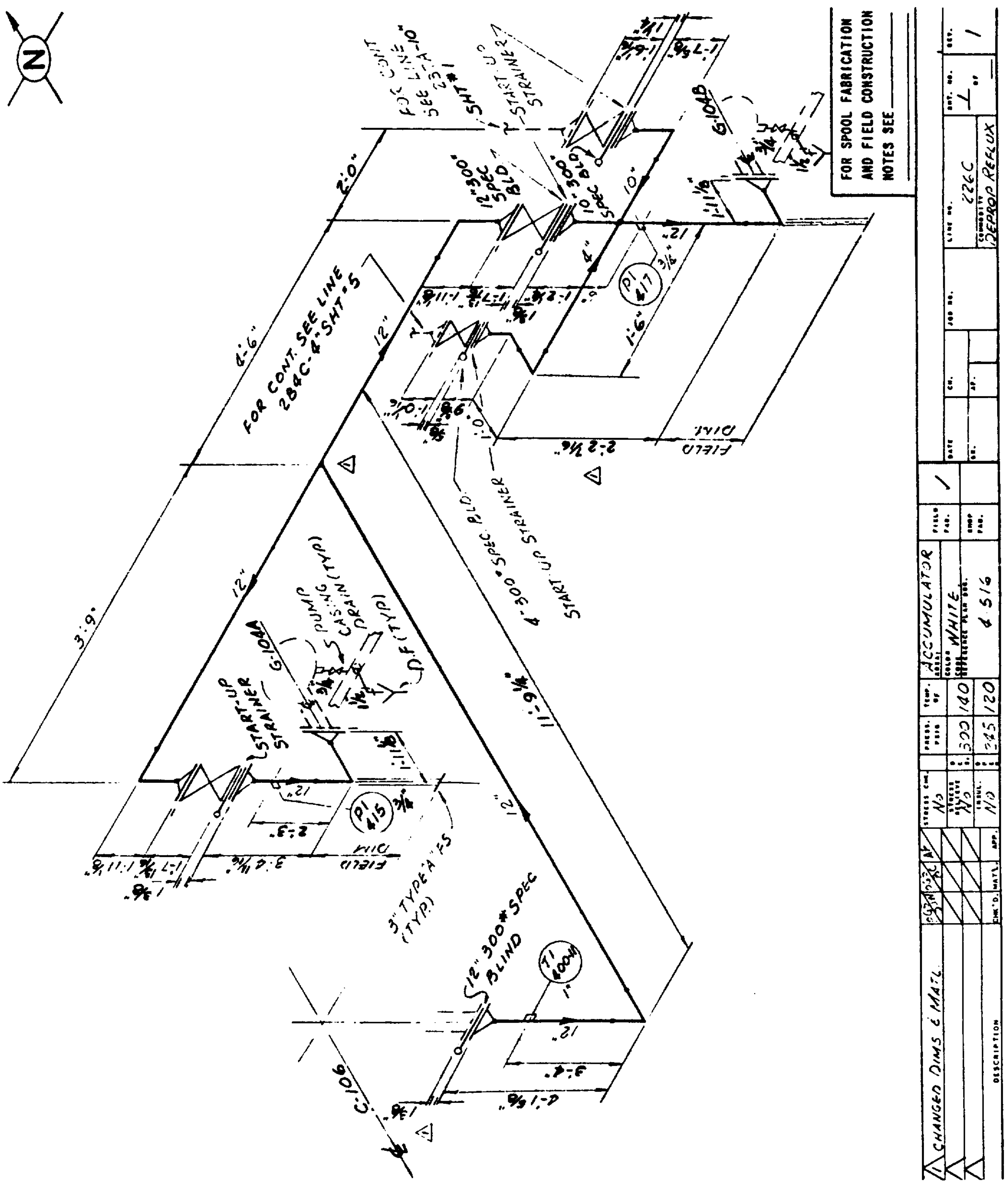
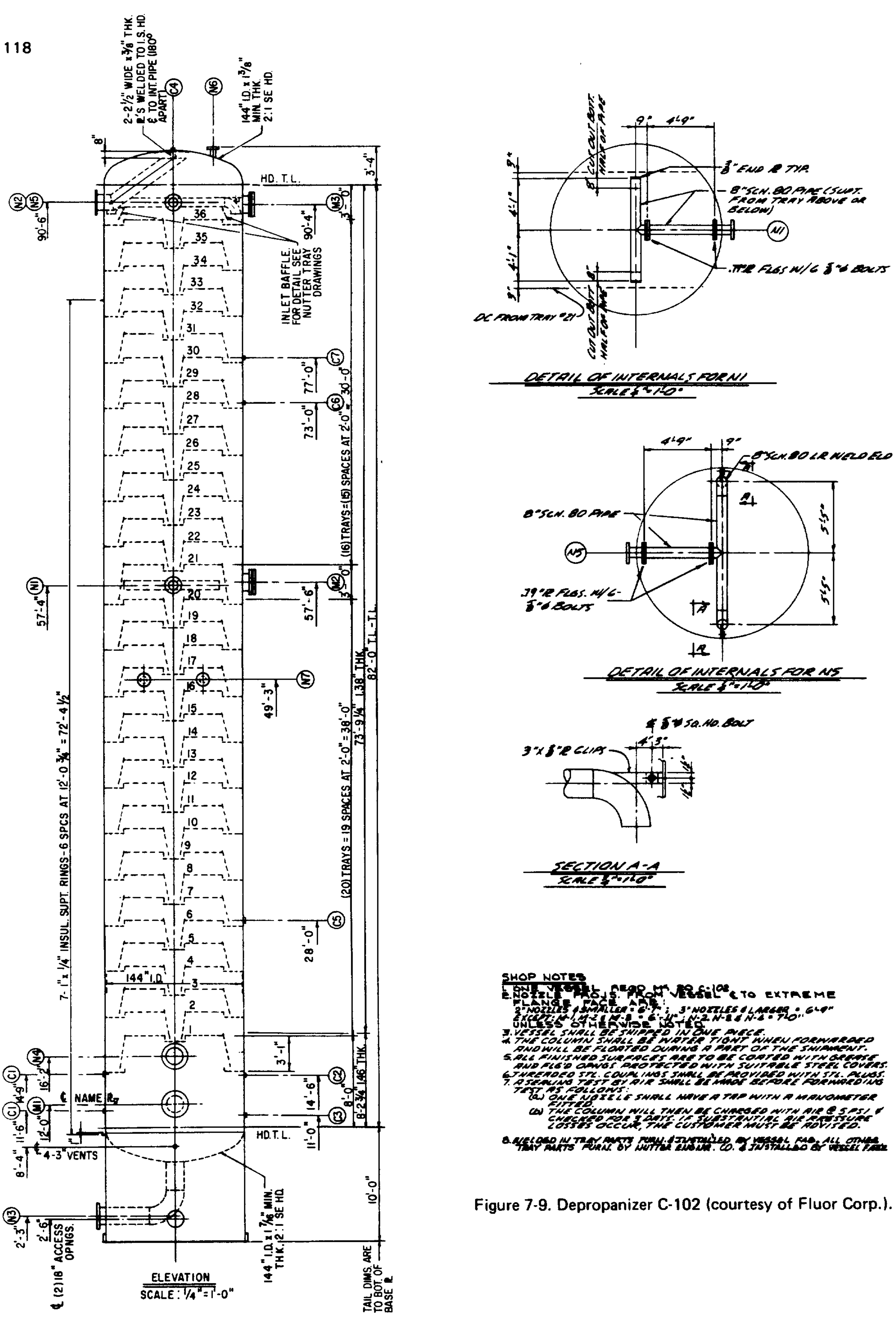
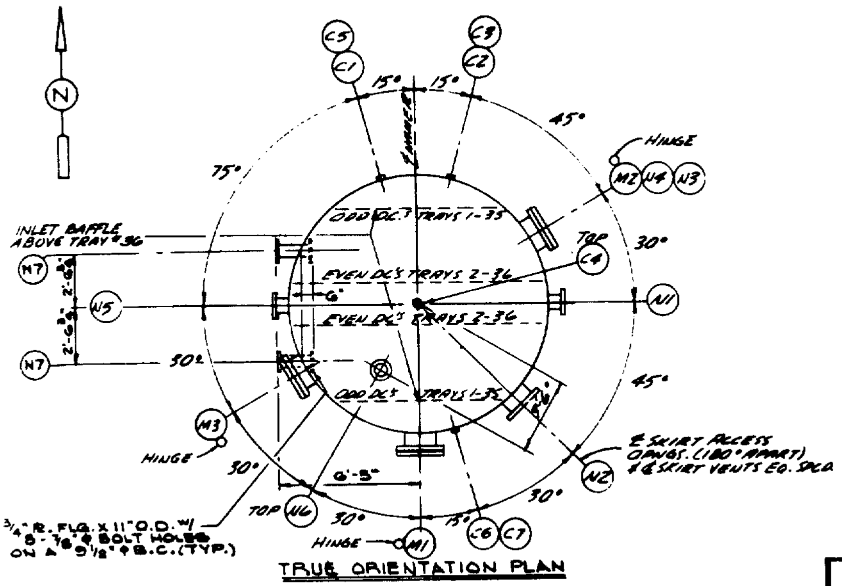


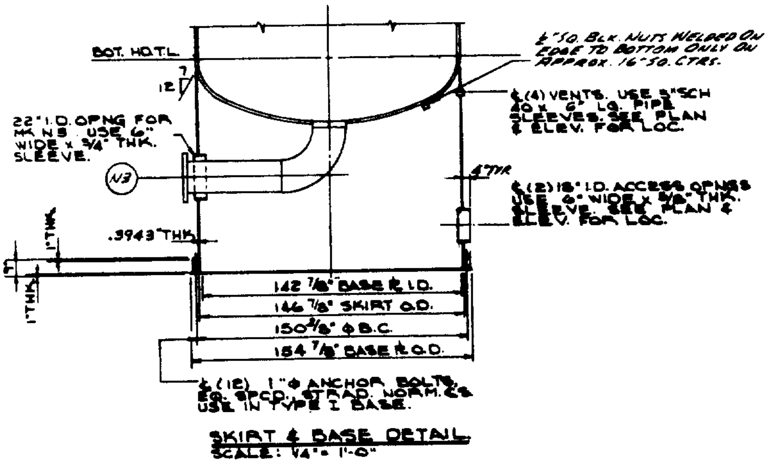
Figure 7-8. (continued)



SHOP NOTES
1. ONE VESSEL REQD MK. NO. C-102
2. NOZZLE PROJS. FROM VESSEL ℄ TO EXTREME FLANGE FACE ARE:
2" NOZZLES & SMALLER = 6'-7"; 3" NOZZLES & LARGER = 6'-9"
EXCEPT: M-1, M-2 & M-3 = 6'-11"; N-2, N-5 & N-6 = 7'-0"
UNLESS OTHERWISE NOTED.
3. VESSEL SHALL BE SHIPPED IN ONE PIECE.
4. THE COLUMN SHALL BE WATER TIGHT WHEN FORWARDED AND WILL BE FLOATED DURING A PART OF THE SHIPMENT.
5. ALL FINISHED SURFACES ARE TO BE COATED WITH GREASE AND FLG'D OPNGS. PROTECTED WITH SUITABLE STEEL COVERS.
6. THREADED STL. COUPLINGS SHALL BE PROVIDED WITH STL. PLUGS.
7. A SEALING TEST BY AIR SHALL BE MADE BEFORE FORWARDING TEST AS FOLLOWS:
(a) ONE NOZZLE SHALL HAVE A TAP WITH A MANOMETER FITTED.
(b) THE COLUMN WILL THEN BE CHARGED WITH AIR @ 5 PSI & CHECKED FOR 3 DAYS. IF SUBSTANTIAL AIR PRESSURE LOSSES OCCUR, THE CUSTOMER MUST BE ADVISED.
8. WELDED IN TRAY PARTS FURN. & INSTALLED BY VESSEL FAB. ALL OTHER TRAY PARTS FURN. BY NUTTER ENGRG. CO. & INSTALLED BY VESSEL FABR.

Figure 7-9. Depropanizer C-102 (courtesy of Fluor Corp.).





DESIGN DATA

1. CODE STAMP SECT. VIII 1962 ASME
2. OTHER SPECS. SP 4.1.1
3. DESIGN PRESS. @ TEMP. 300 PSIG @ 650 °F
4. OPER. PRESS. @ TEMP. 255 PSIG @ 225 °F
5. NAME PLATE STAMPING NONE [redacted]
6. STRESS RELIEVING YES
7. RADIOGRAPHING FULL
8. JOINT EFFICIENCY | SHELL 100 % | HEADS 100 %
9. NOM. CORROSION ALLOWANCE | SHELL 1/8" | HEADS 1/8"
FLG'D. OPNGS - 1/8"
10. MAX. ALLOW. PRESS. (NEW & COLD) PSIG
(a) MAX. ALLOW. PRESS. LIMITED BY
11. HYDROSTATIC TEST PRESSURE 495.62 PSIG
12. MATERIAL SPECIFICATIONS
(a) SHELL A-212-B FBQ
(b) HEADS A-212-B FBQ
(c) LINING NONE
(d) SKIRT 715 6AIO1 - 6641
(e) BASE PLATE & CHAIRS 715 6AIO1 - 6641
(f) NOZZLE NECKS & PIPE A-106-A SMLS.
(g) FLANGES ASA B16.5
(h) COUPLINGS [redacted] FORGED STEEL
(j) GASKETS 1/16" THK. JM 60 OR EQ.
(k) BOLTS (EXTERNAL) A-193-B7 / A-194-2H
(l) BOLTS (INTERNAL) C. STL.
(m) INTERNALS (EXCEPT AS NOTED) C. STL.
(n) TRAYS
(p) CAPS

13. M.H. & H.H. FURN. W/ BLIND FLG. STUDS & GSKT.
14. INSUL. OR FIREPROOFED SKIRTS TO HAVE SLEEVED OPNG.

15. FIREPROOFING (BY OTHERS)	INSIDE SKIRT	THK.	MATERIAL	SQ. FT.
	OUTSIDE SKIRT	THK. 4"	BRICK	420

16. INSULATION (BY OTHERS) 1 1/2" THK. 3721 SQ. FT.
17. PAINT ONE S/C PRIMER
18. INSPECTED BY CUSTOMER
19. WEIGHTS

(a) TRAYS	FURN. BY		60,600 LBS.
	INSTALLED BY		
(b) CAPS	FURN. BY		LBS.
	INSTALLED BY		

(c) EST. VESSEL FABR. (LESS TRAYS & CAPS) 230,050 LBS.
(d) EST. VESSEL EMPTY (LESS OPER. LIQUID) 336,200 LBS.
(e) EST. VESSEL OPERATING [redacted] 457,800 LBS.
(f) EST. VESSEL FULL OF WATER 959,710 LBS.

DEPROPANIZER 20-C-102
20-4-405

MARK	NO. REQ'D	SIZE	RATING	FACING	DESCRIPTION
C7	1	1"	6000#	CPLG	TRC
C6	1	1"	6000#	CPLG	TRC (WELL ONLY)
C5	1	1"	6000#		TRC (WELL ONLY)
C4	1	1 1/2"	3000#		VENT
C3	1	1 1/2"	3000#		STEAM OUT
C2	1	3/4"	6000#		PI
C1	2	3/4"	6000#	CPLG	LG
N7	2	6"	300#	R.F	FUTURE INLET W/ BLIND FLG. BOLTS / GSKT
N6	1	6"	300#	RF	PSV
N5	1	8"			REFLUX INLET
N4	1	20"			REBOILER RETURN INLET
N3	1	18"			BOTTOMS OUTLET
N2	1	16"			OVERHEAD VAPOR OUTLET
N1	1	8"	300#	RF	FEED INLET
M3	1	18"	300#	RF	MANWAY (FURNISH HINGE)
M2	1	18"	300#	RF	MANWAY (FURNISH HINGE)
M1	1	18"	300#	RF	MANWAY (FURNISH HINGE)

CONNECTION SCHEDULE

PROCESS ENG. APP. ____________ DATE ____________
INST. ENG. APP. ____________ DATE ____________
INSTRUMENT APPROVAL CONSISTS OF CHECKING SIZE AND ELEVATION OF INSTRUMENT CONNECTIONS.

Figure 7-9. (continued)

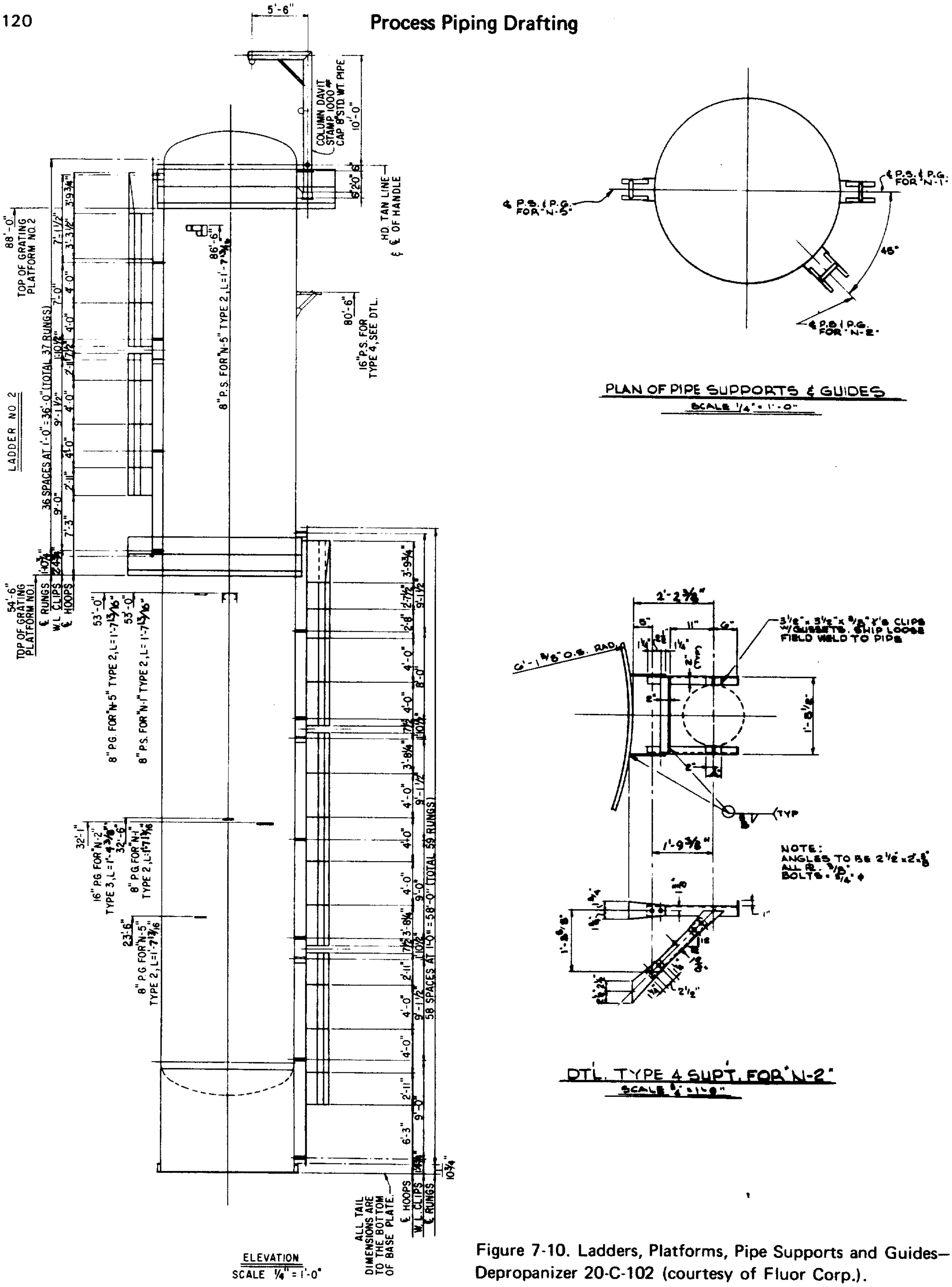
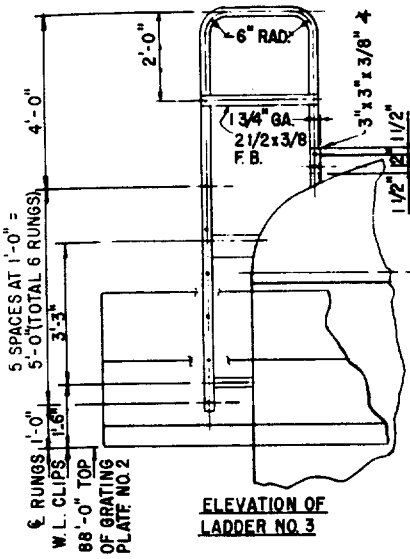
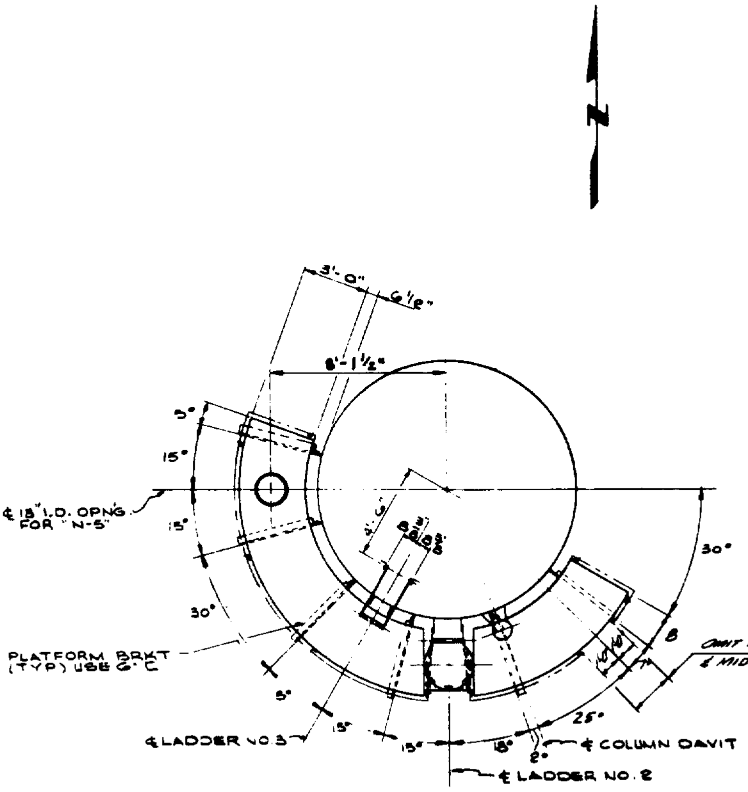


Figure 7-10. Ladders, Platforms, Pipe Supports and Guides—Depropanizer 20-C-102 (courtesy of Fluor Corp.).

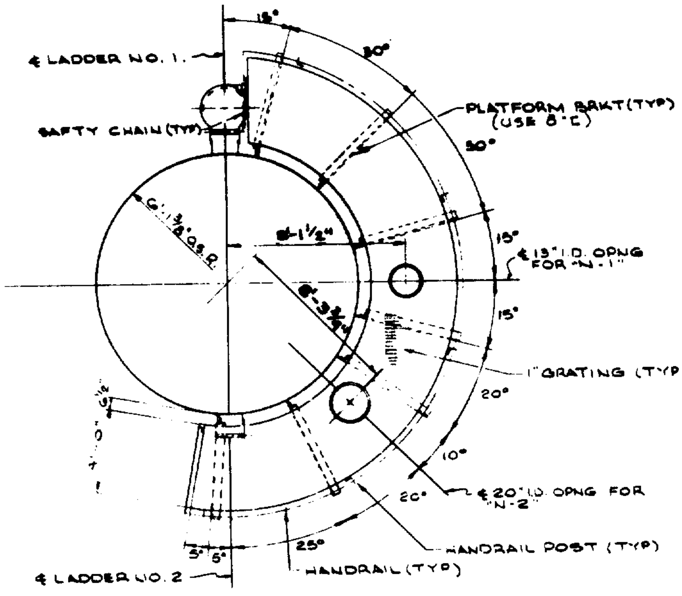


ELEVATION OF LADDER NO. 3



PLAN OF PLATFORM NO. 2

SCALE 1/4" = 1'-0"

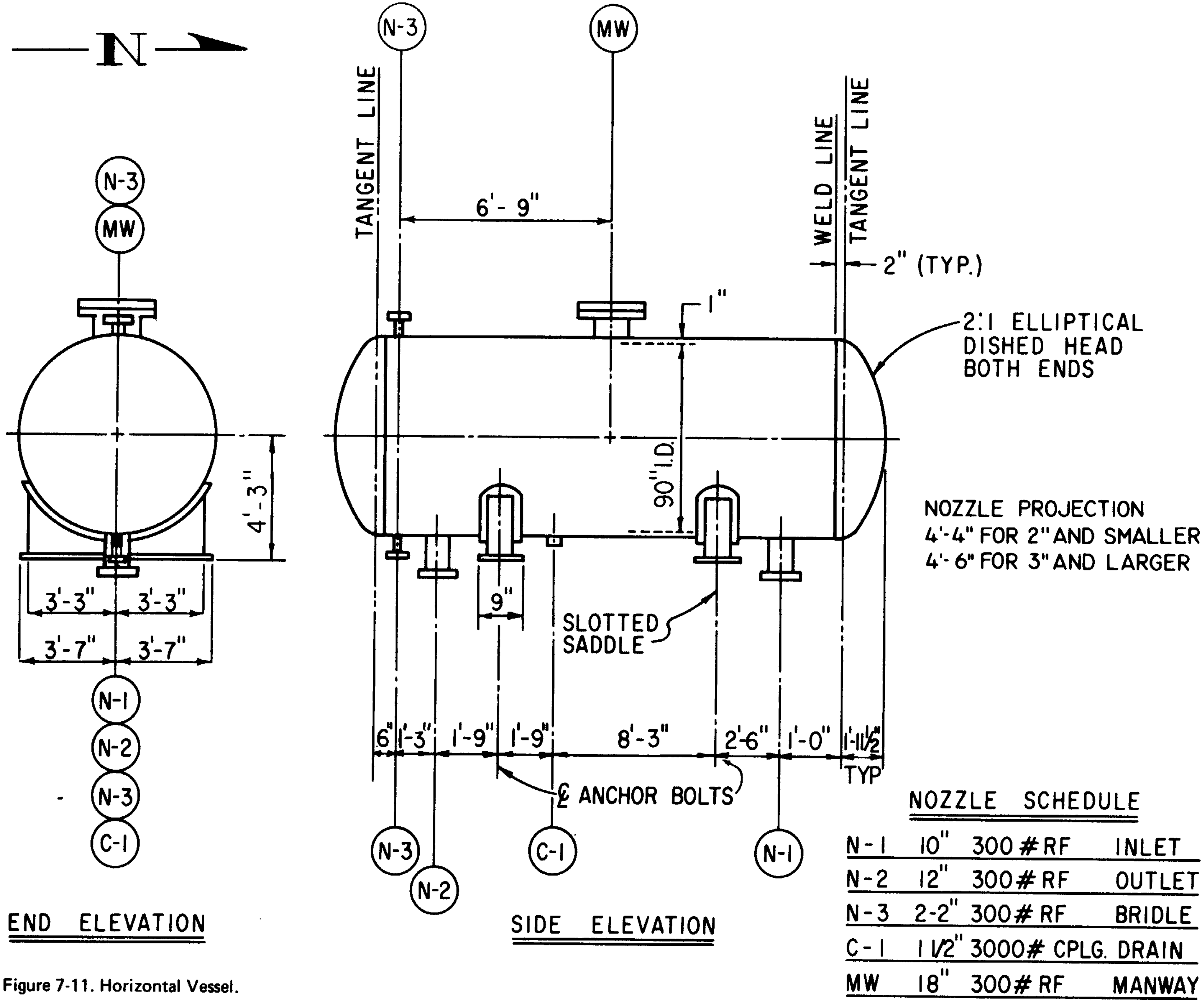


PAINT NOTE: ALL PARTS ONE S/C PRIMER

PLAN OF PLATFORM NO. 1

SCALE 1/4" = 1'-0"

Figure 7-10. (continued)

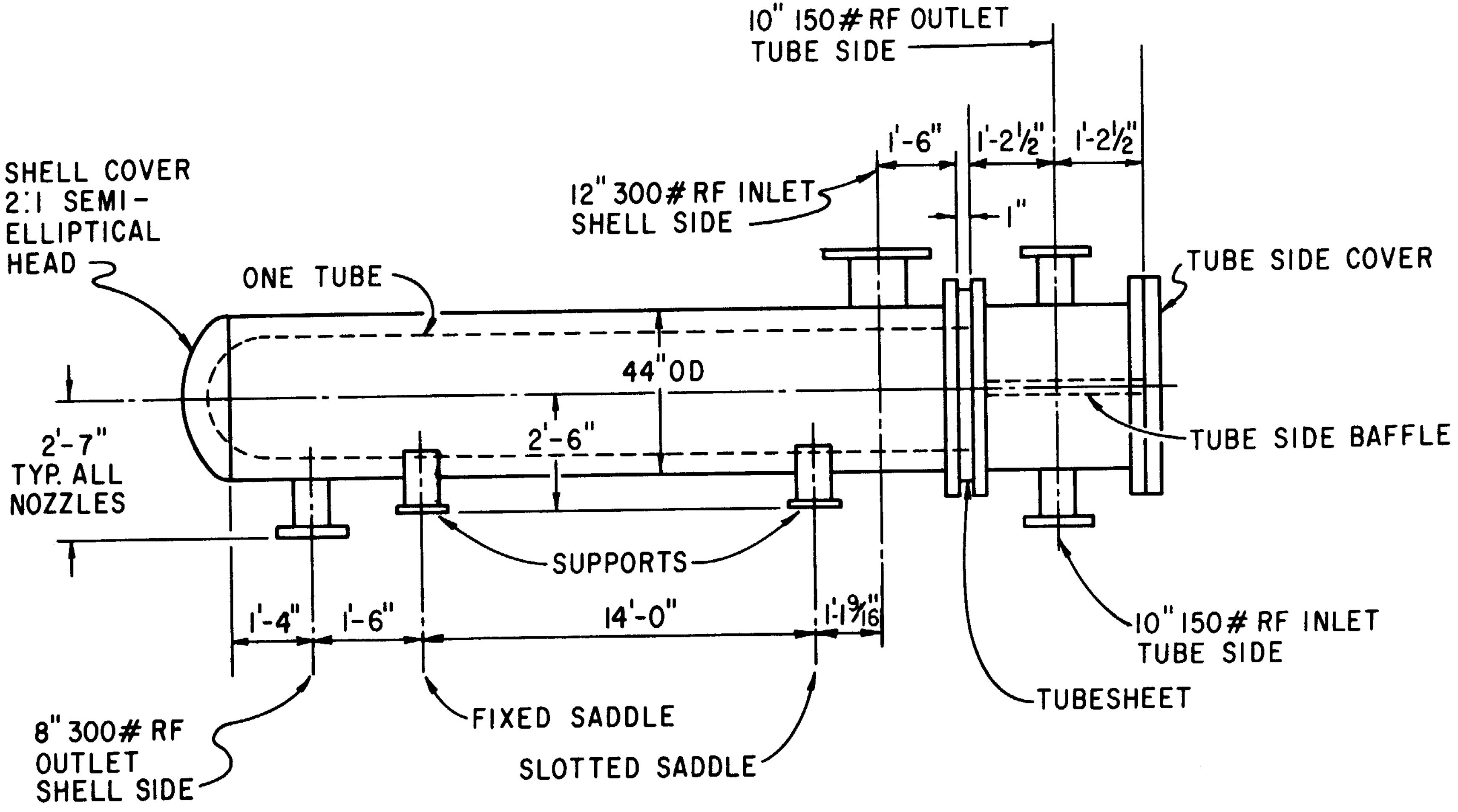


NOZZLE PROJECTION
4'-4" FOR 2" AND SMALLER
4'-6" FOR 3" AND LARGER

NOZZLE SCHEDULE

N-1	10"	300# RF	INLET
N-2	12"	300# RF	OUTLET
N-3	2-2"	300# RF	BRIDLE
C-1	1 1/2"	3000# CPLG.	DRAIN
MW	18"	300# RF	MANWAY

Figure 7-11. Horizontal Vessel.



SIDE ELEVATION

Figure 7-12. Heat Exchanger.

charge pressure is always greater than the suction pressure, the discharge's flange rating is usually the governing rating.

Figure 7-13 shows a centrifugal pump. (The other kinds won't be discussed.) This particular pump has an "end suction." The suction nozzle is on the front end of the pump. Top suction is also available. In end and top suction, centrifugal pumps have the discharge on the top—offset from the centerline as shown.

Concrete Drawings

Many small organizations call on their piping draftsmen to draw the concrete foundation drawings. A structural engineer will design the foundation and present the draftsman with a rough sketch and the outline dimensions.

Figure 7-14 shows the foundation for a C-102 vertical vessel. The reinforcing bar, which goes in the concrete, has been left off this drawing for clarity.

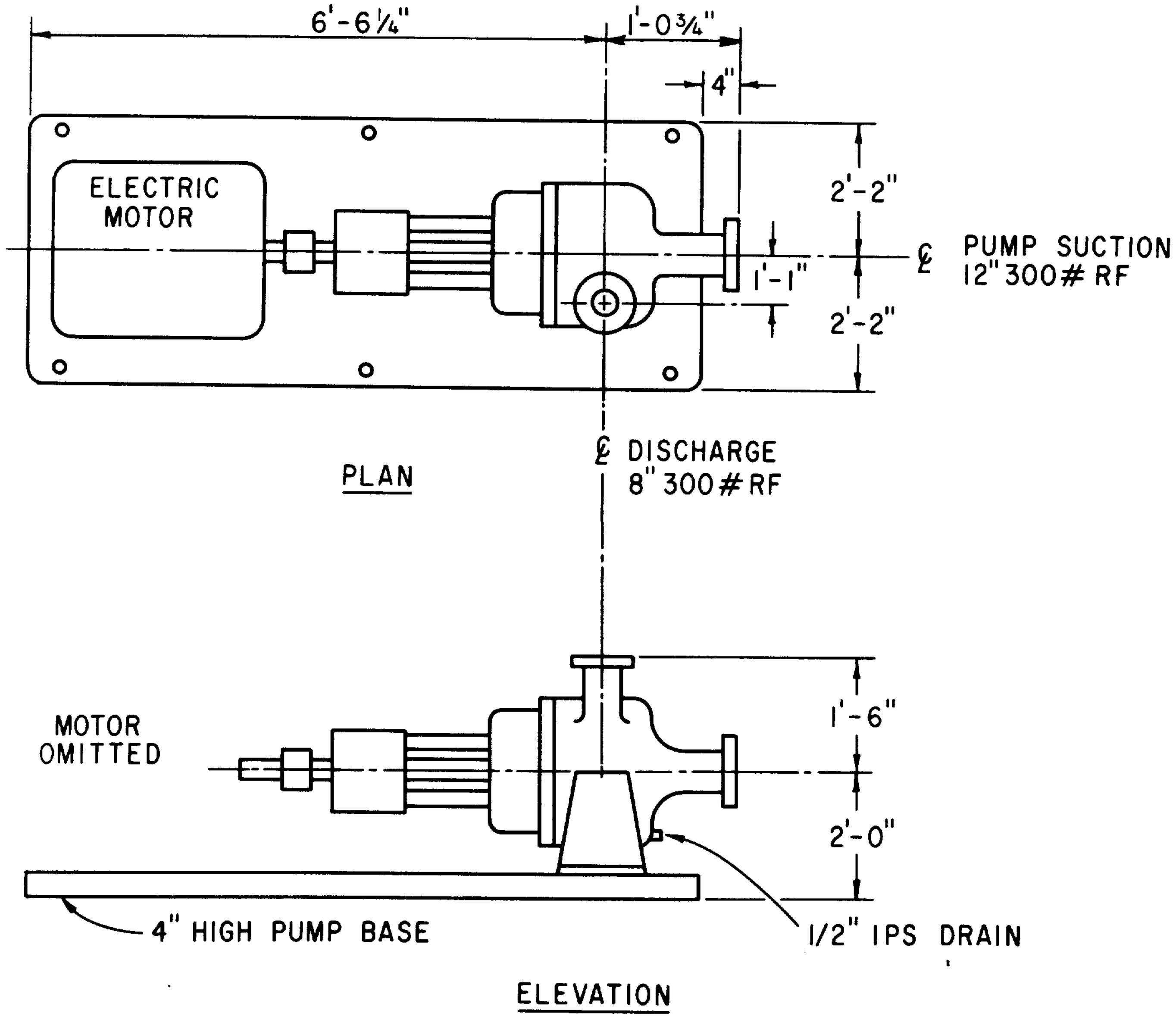


Figure 7-13. Pump Outline Dimensions.

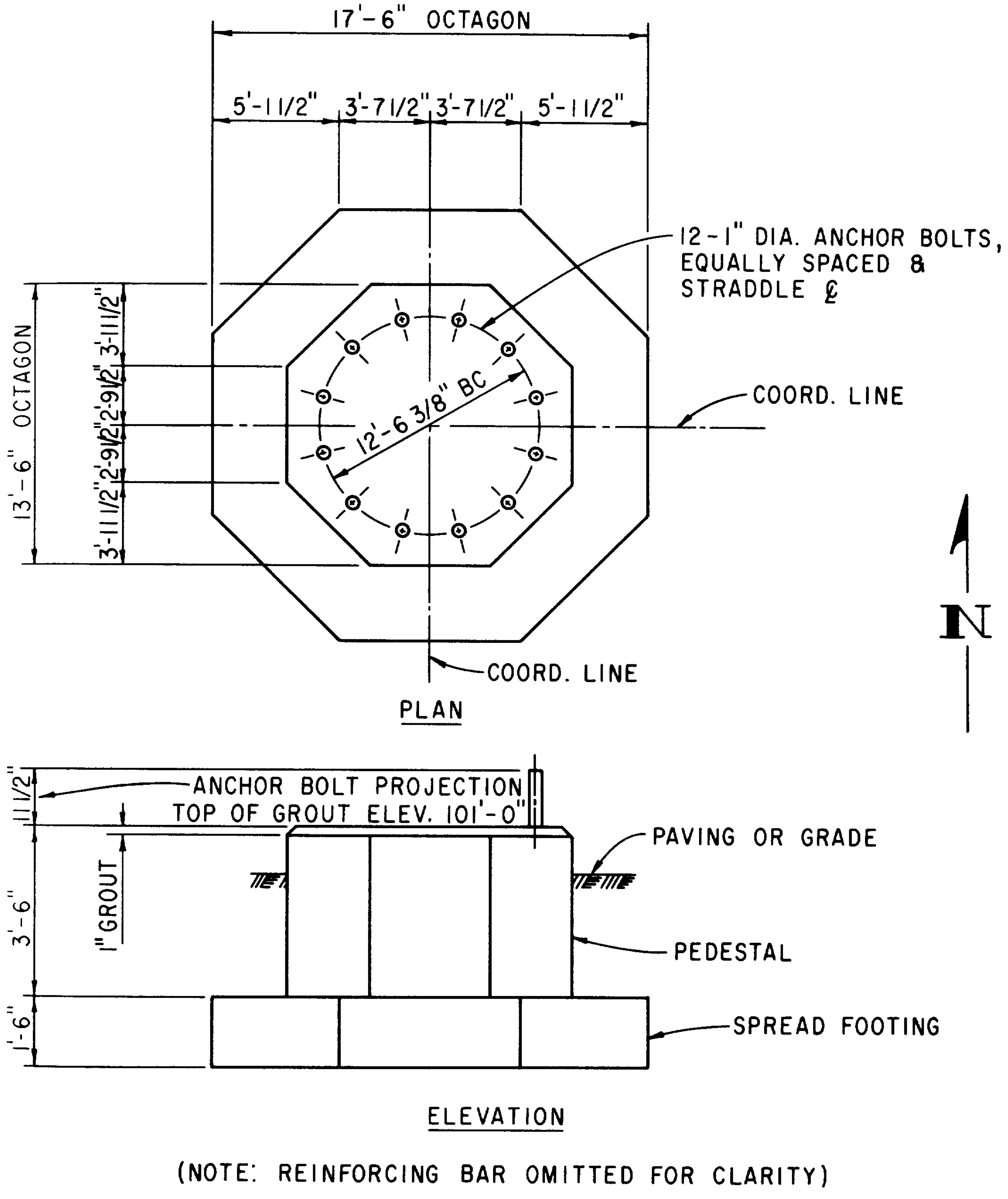


Figure 7-14. Vertical Vessel Foundation. Item C-102

Besides anchor bolts, the vertical vessel foundation has two major parts. They are the pedestal, which rises above the ground about 1'-0", and the spread footing, which has an octagon larger than the pedestal. The concrete for this foundation will be calculated by figuring the volume of the two octagons which in this case, is 34 cubic yards. While that may not sound like much, concrete weighs about 4,000 pounds per cubic yard. This foundation would weigh 136,000#.

The piping draftsman will draw the pedestal to scale on his piping plan as he draws the vertical vessel.

The 1" grout is common on most foundations. The elevation of top of grout is 101'-0". If grade is 100'-0" elevation, the field will excavate 4 feet to start setting their forms. They will pour their concrete to elevation 100'-11", leaving 1" for grout. Grout is a very rich concrete.

After the equipment is set and shims are in place to make sure the equipment is in the correct spot, the grout is then put in place.

Figure 7-15 is the foundation for the C-106 horizontal vessel in Figure 7-11. This foundation has two vertical members, piers, reaching to elevation 114'-6". The two saddles will rest on these elevated piers. The center-to-center of the two pieces is 10'-0", matching the anchor bolts in vessel C-106. Can the student calculate the cubic yards of concrete required?

Figure 7-16 shows the foundation for reboiler E-119. This foundation resembles the C-106 one except it is only 6'-4" from grade to top of grout, and a "slide plate" has been added to the south pier only.

A slide plate is added and embedded in the grout when the equipment is hot in operation and is expected to grow. One end of this exchanger is anchored and the nuts are left loose on the anchor bolts on the other end. The slide plate, a piece of steel plate, is–in this case–6" x 3/8" x 5'-0". That allows the exchanger support saddle to slide on it. If the slide plate were not inserted, the exchanger support would slide directly on the foundation and would harm the concrete.

Figure 7-17 is the foundation for exchanger E-104 in figure 7-12. This foundation also has a slide plate on the south end. The top of grout is elevation 104'-11". This foundation has 6.3 cubic yards of concrete.

Figure 7-18 is the pump foundation for G-104 A and B. The top of grout for pumps is 1'-0" above grade or paving. Two pumps are required. How many cubic yards of concrete are required for these two foundations?

All these pump drawings show a coordinate line but no actual coordinate. The field engineer will refer to the foundation location plan (Chapter 5) for the actual coordinates.

text continued on page 129

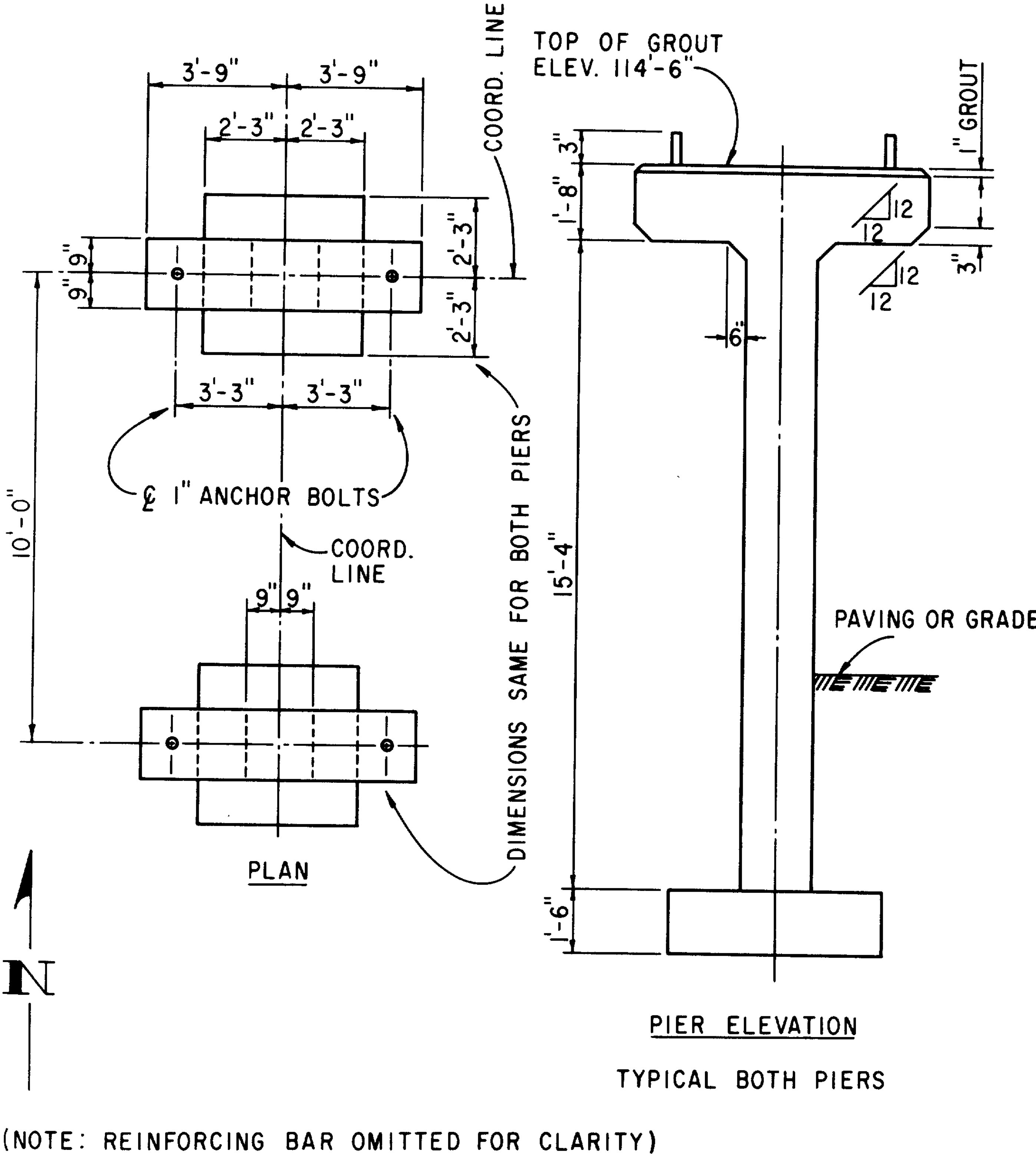


Figure 7-15. Horizontal Vessel Foundation.

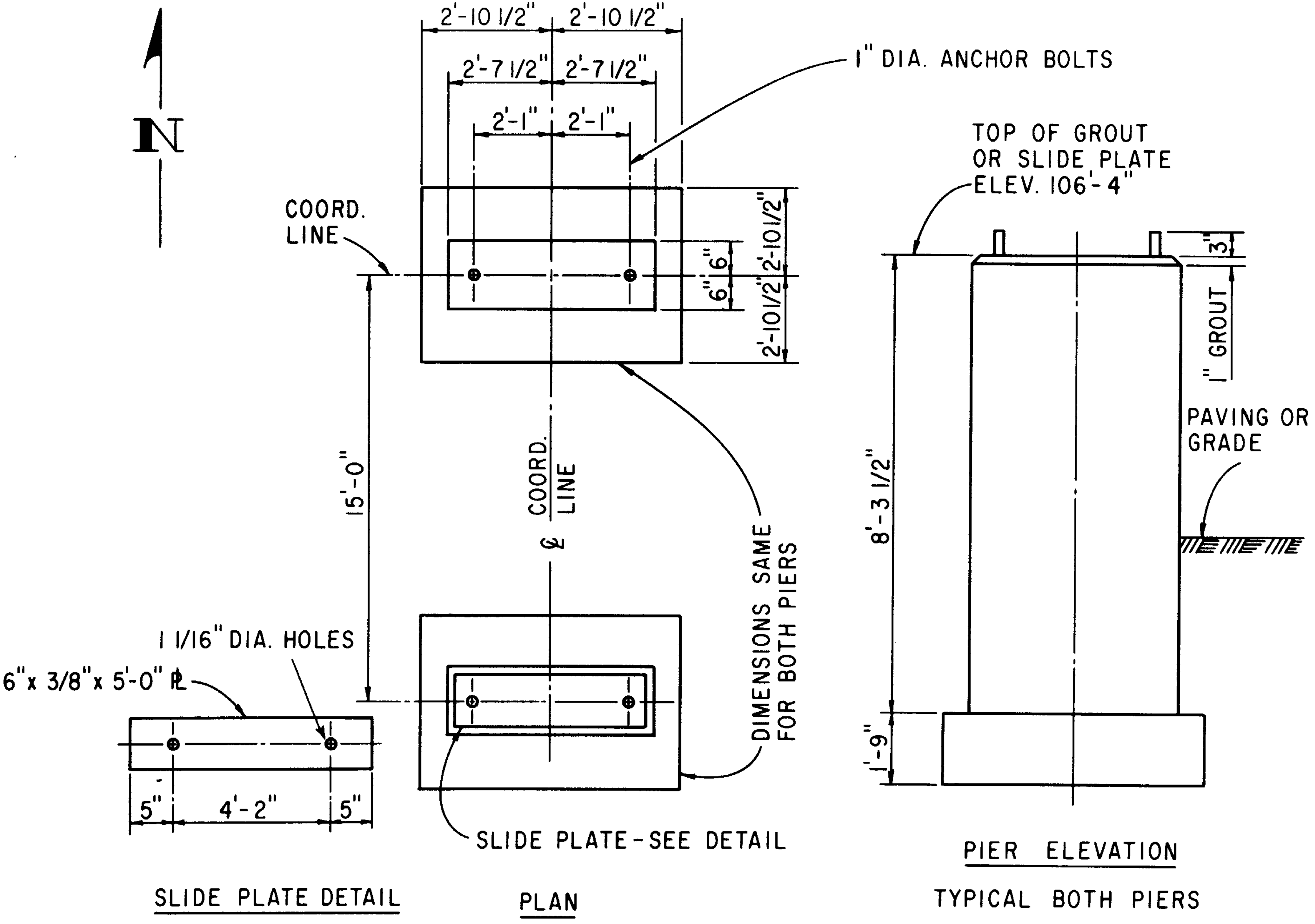
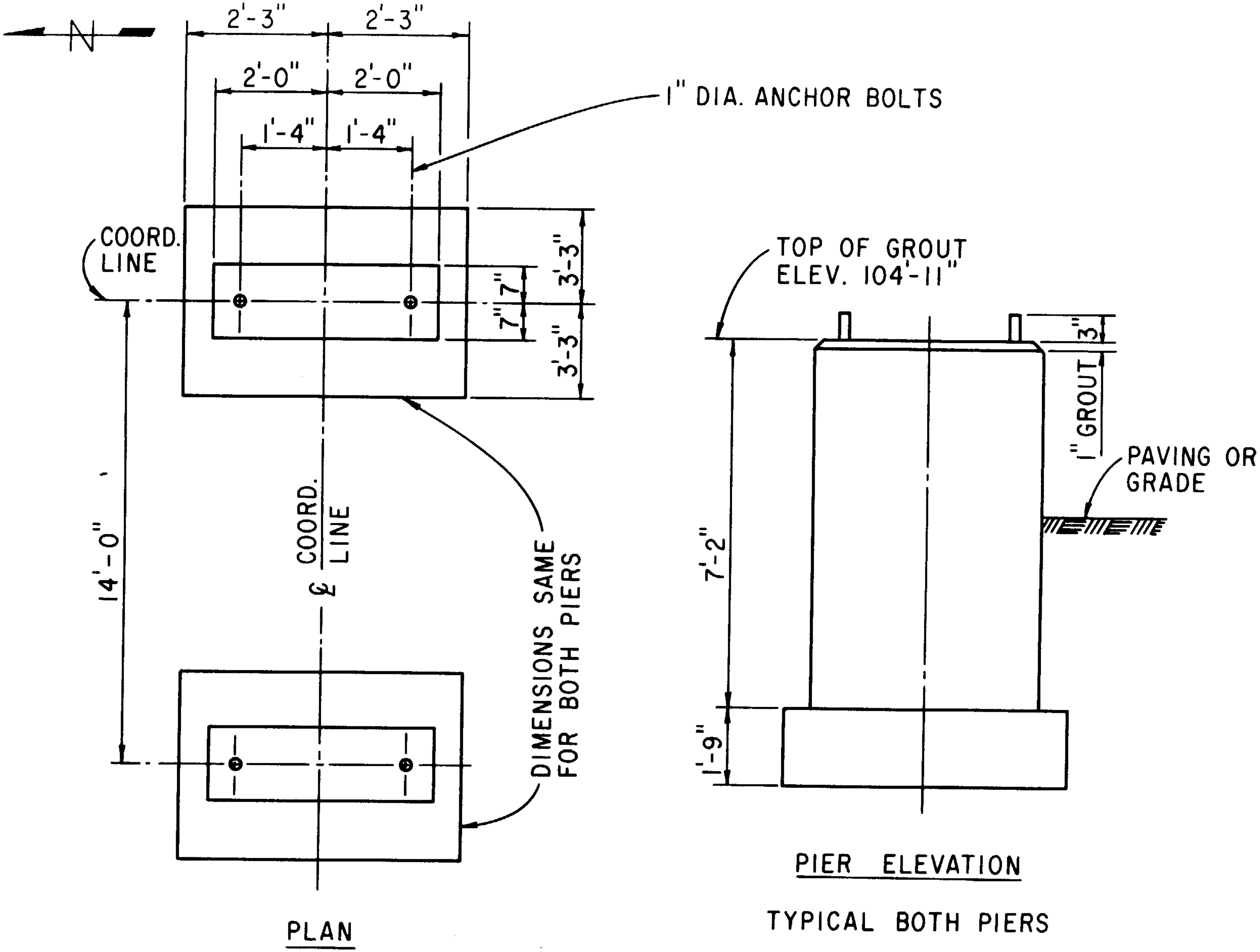


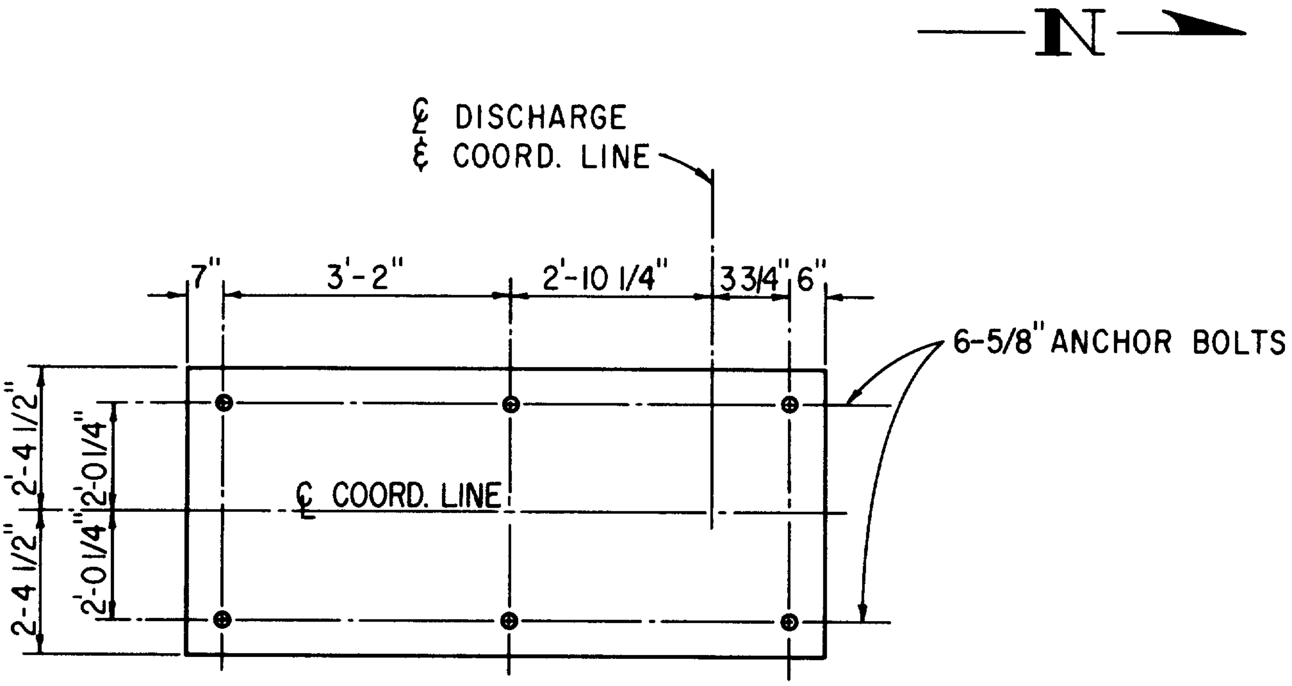
Figure 7-16. Reboiler Foundation.

(NOTE: REINFORCING BAR OMITTED FOR CLARITY)

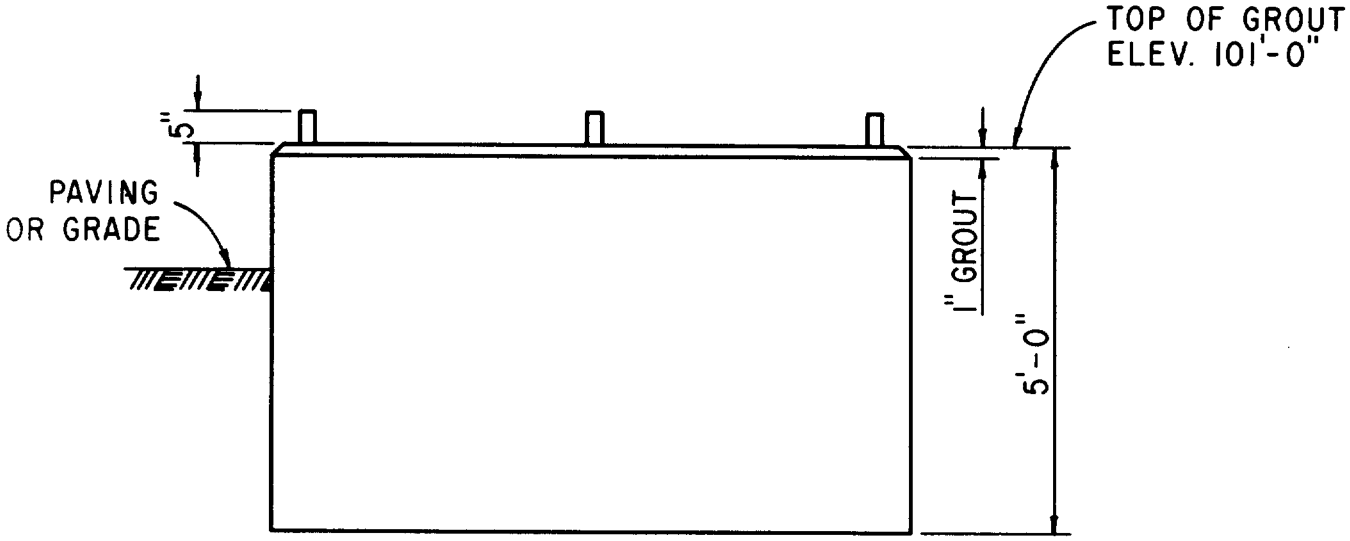


(NOTE: REINFORCING BAR OMITTED FOR CLARITY)

Figure 7-17. Exchanger Foundation.



PLAN



ELEVATION

Figure 7-18. Pump Foundation. Item G-104A & B

Structural Steel

The competent structural steel draftsman will make his steel drawings single line, with only enough drawn double line as needed for clarity. He also will not show a lot of details, such as a certain type of connection. These will be typical connection details and will be drawn on a connection detail sheet. Figures 7-19 and 7-20 show connection details within a circle.

To read this steel drawing, he must look at the top plan on Figure 7-19. A 12" member is at elevation 122'-0" and another one at elevation 116'-0". This says that it is a two-level pipe rack, 6'-0" between levels. The "strut," or member connecting the columns, is an 8" member at elevation 119'-0" or midway between the two levels. Some bents have a double strut, the second one being at elevation 124'-0".

A pipe rack "bent" is two columns, and the horizontal member(s) which connect them support pipe in the rack. The "strut" connects two bents.

The plan also says that the bents are spaced at 16'-0" centers.

Elevations for this pipe rack are in Figure 7-20.

Figure 7-21 shows typical ladder and platform details that a horizontal vessel or an elevated structure would have.

Fluor actually used this pipe rack steel drawing on a foreign job. Members shown are specified in a foreign abbreviation–such as 8UB17, 12UB31 or 10UB21. For a domestic contract, U.S. abbreviations would be used.

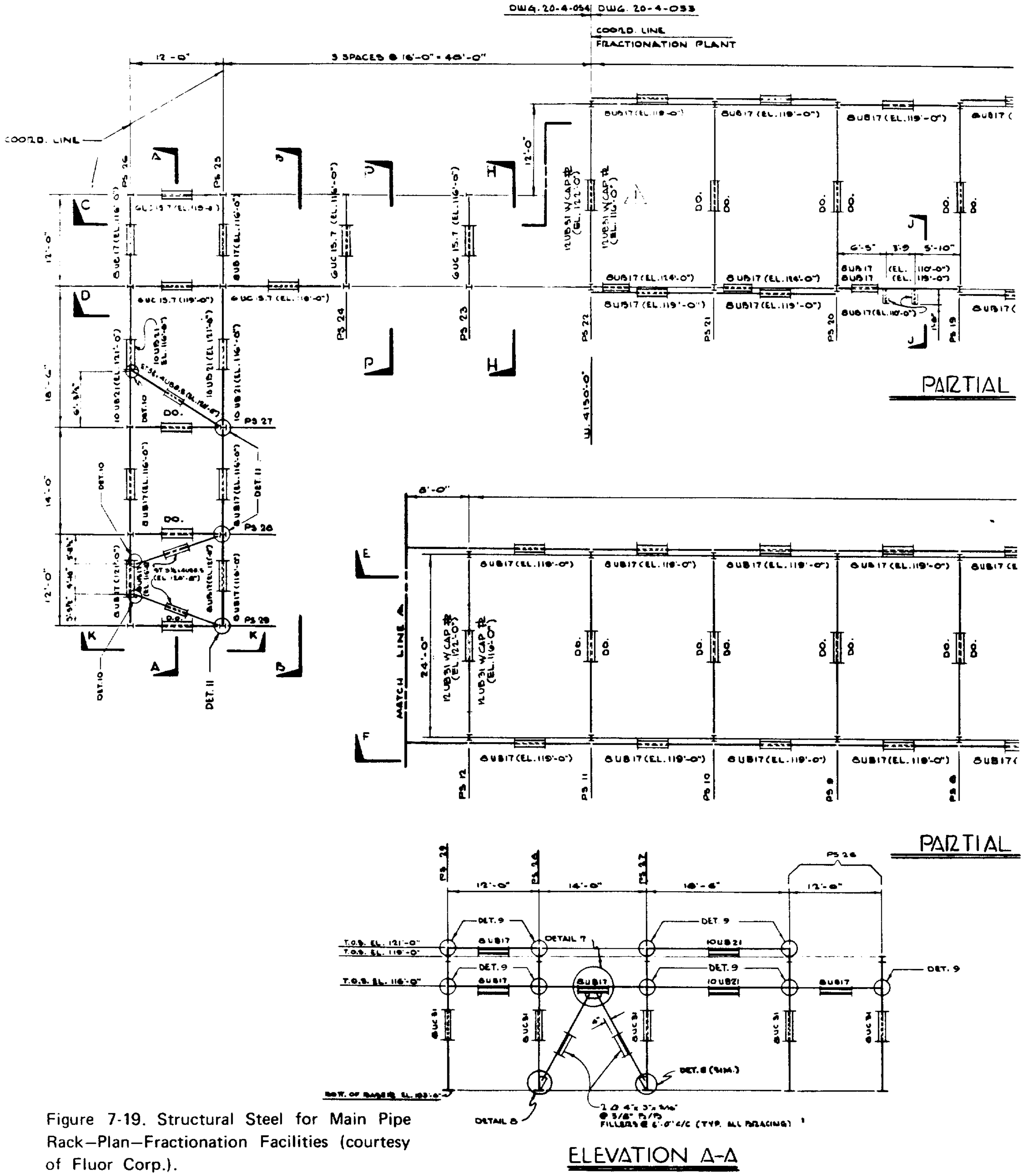
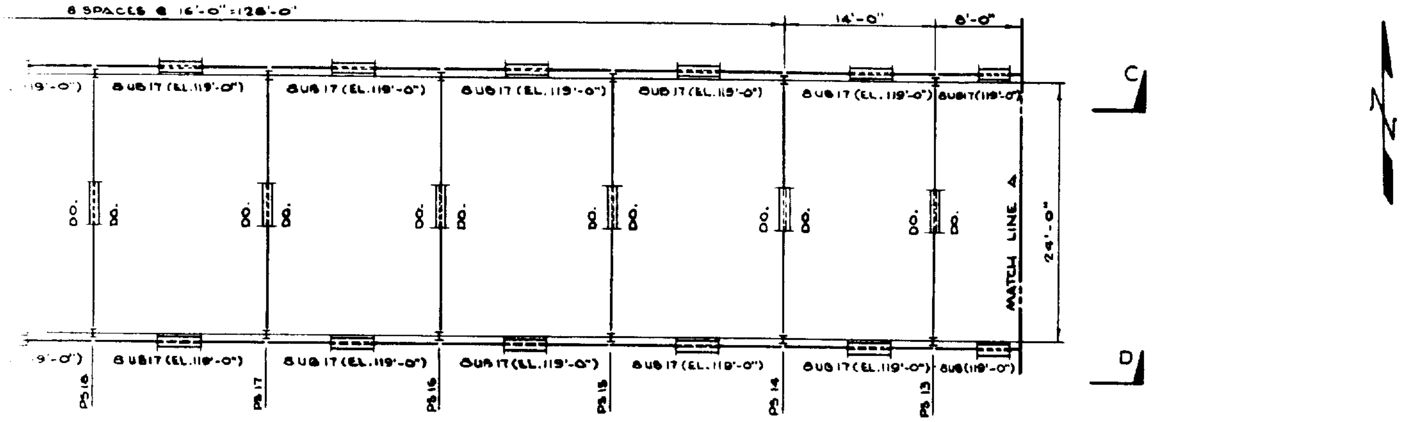
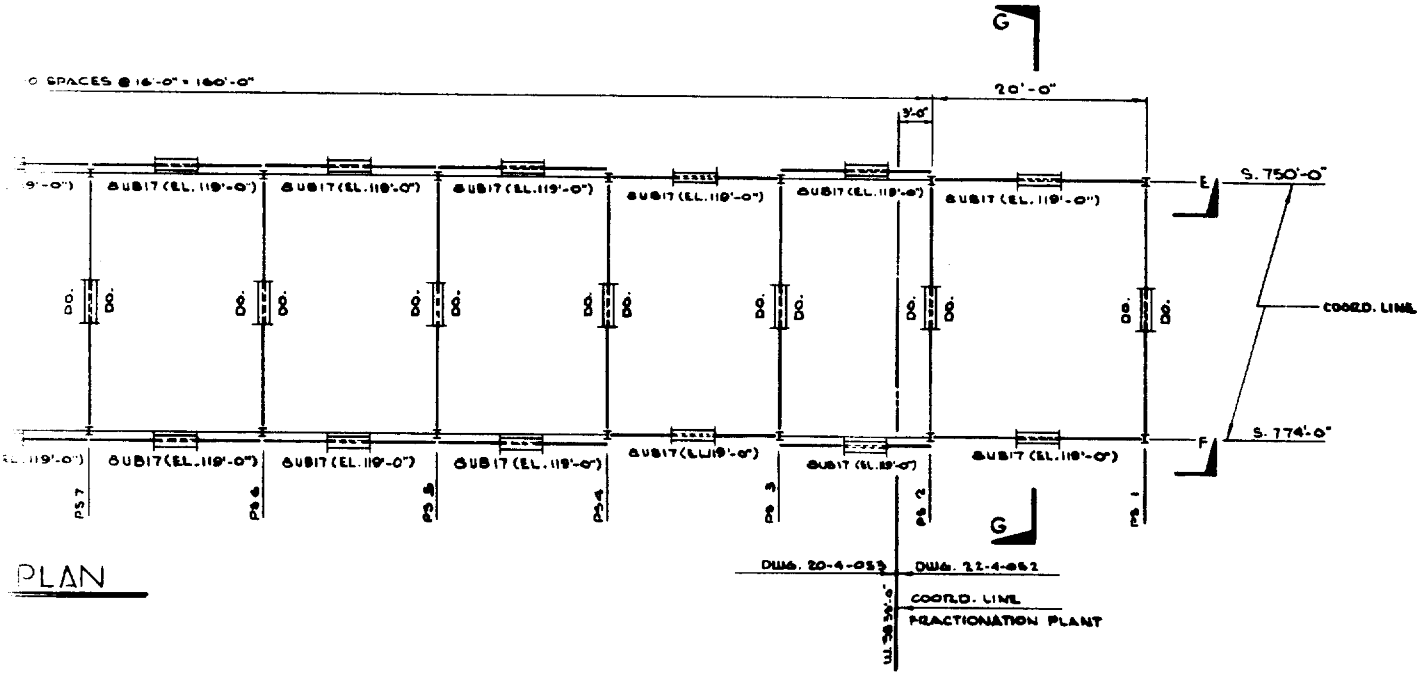


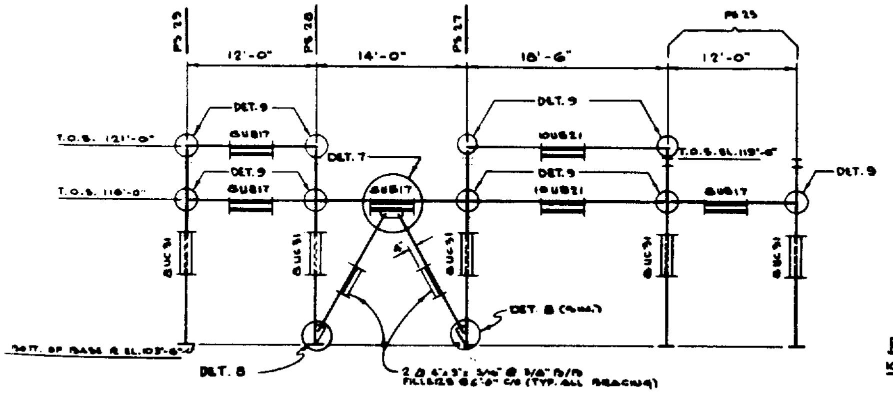
Figure 7-19. Structural Steel for Main Pipe Rack—Plan—Fractionation Facilities (courtesy of Fluor Corp.).



PLAN



PLAN



NOTES:

FOR STEEL SPECIFICATIONS SEE SP 6326-2000.2.
ALL STEEL THIS DWG TO BE BS-15.
ALL STEEL THIS DWG TO RECEIVE ONE SHOP COAT RED LEAD PRIMER WITH LINSEED OIL ALKLYD VEHICLE MEETING FEDERAL SPECS TT-866, TYPE II.
ALL BOLTS TO BE 3/4"ø BLACK BOLTS WITH 13/16"ø ROUND HOLES.

BILL OF MATERIALS:

105,000 LBS. STRUCTURAL STEEL (APPROX. WEIGHT)

Figure 7-19. (continued)

ELEVATION B-B

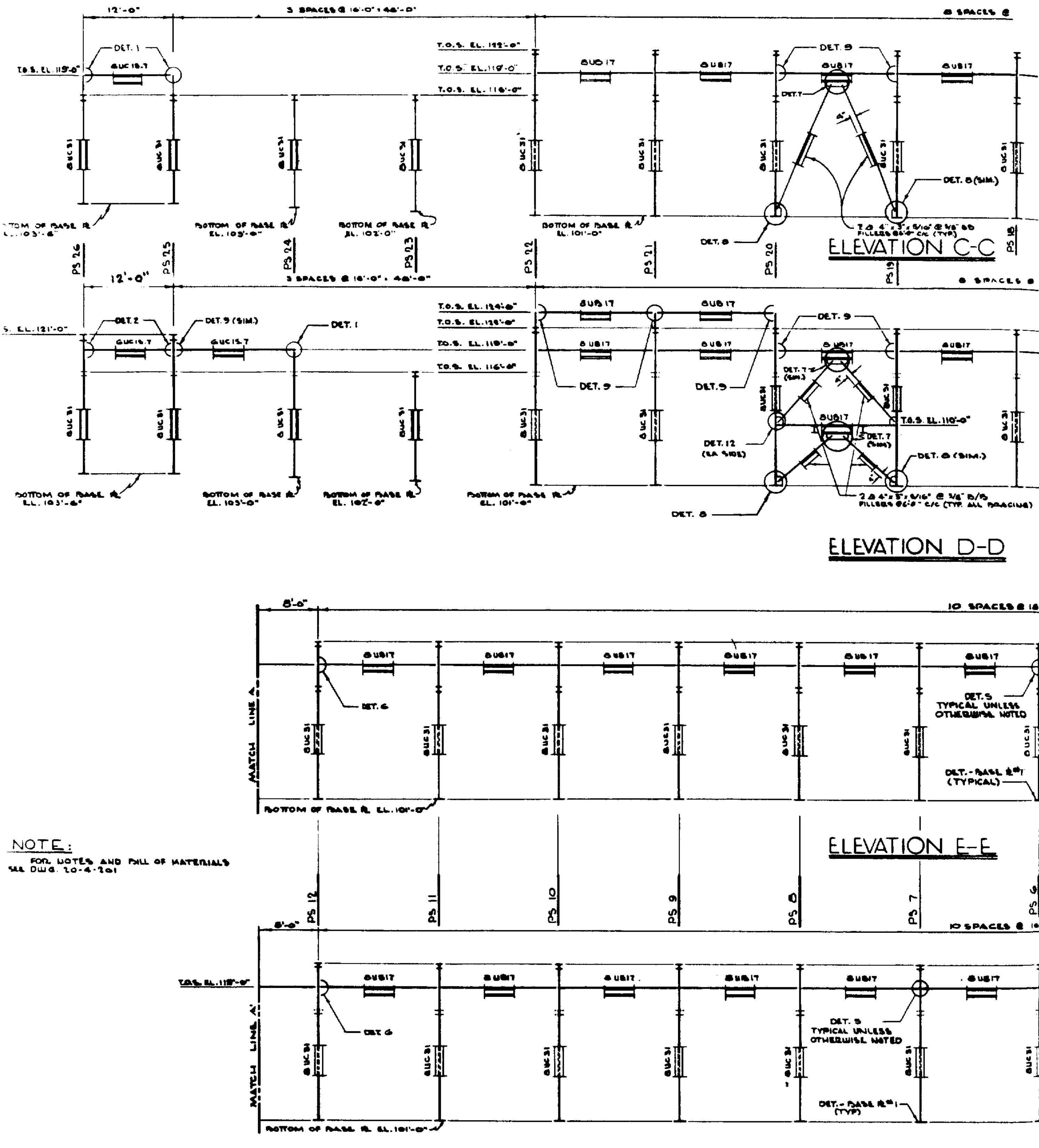
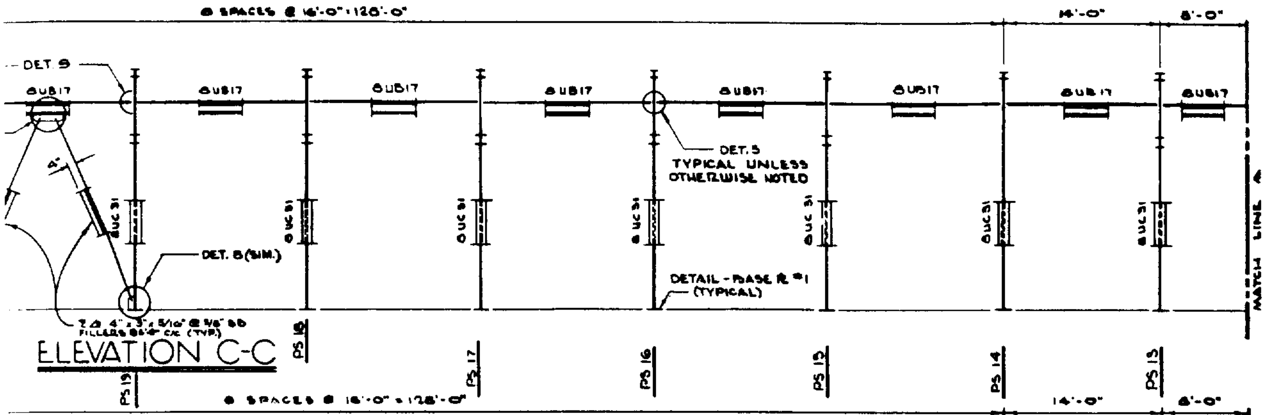
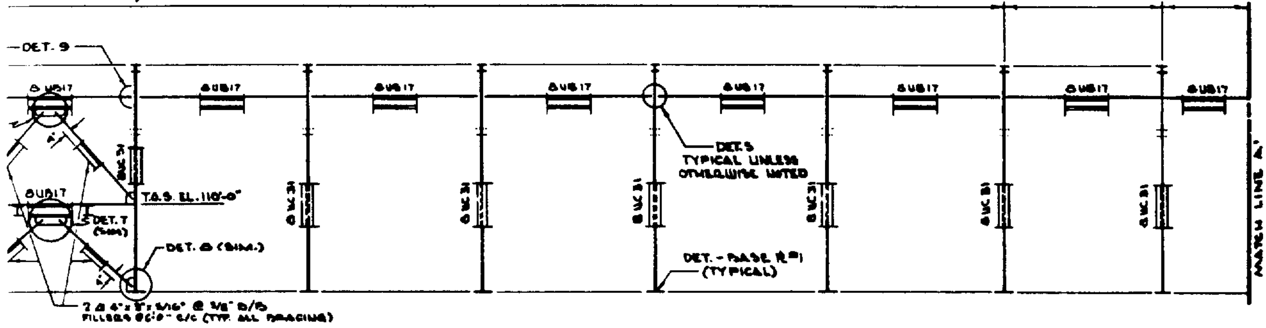


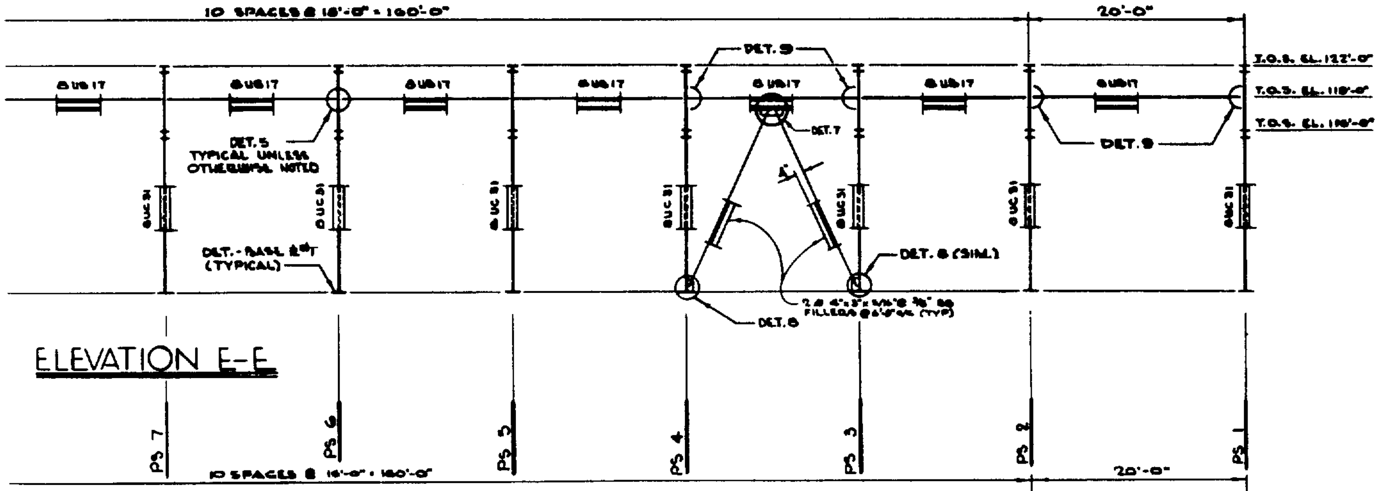
Figure 7-20. Structural Steel for Main Pipe Rack—Elev.—Fractionation Facilities (courtesy of Fluor Corp.).



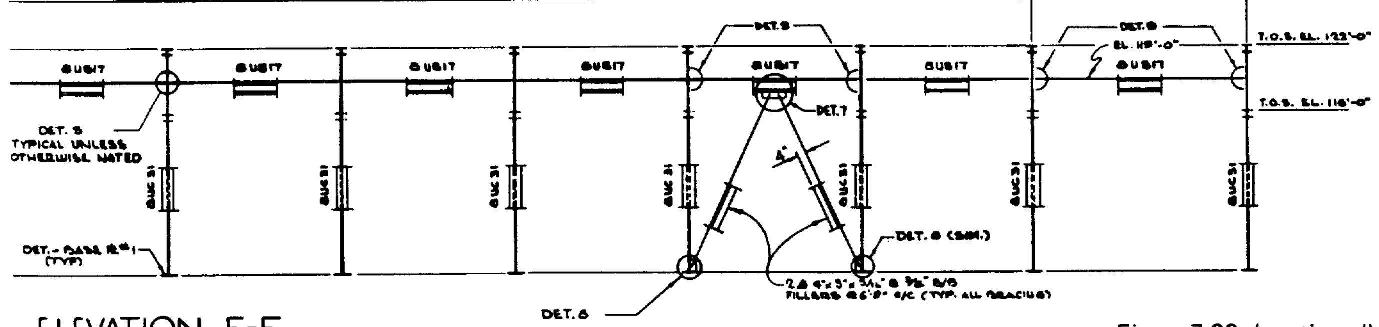
ELEVATION C-C



ELEVATION D-D

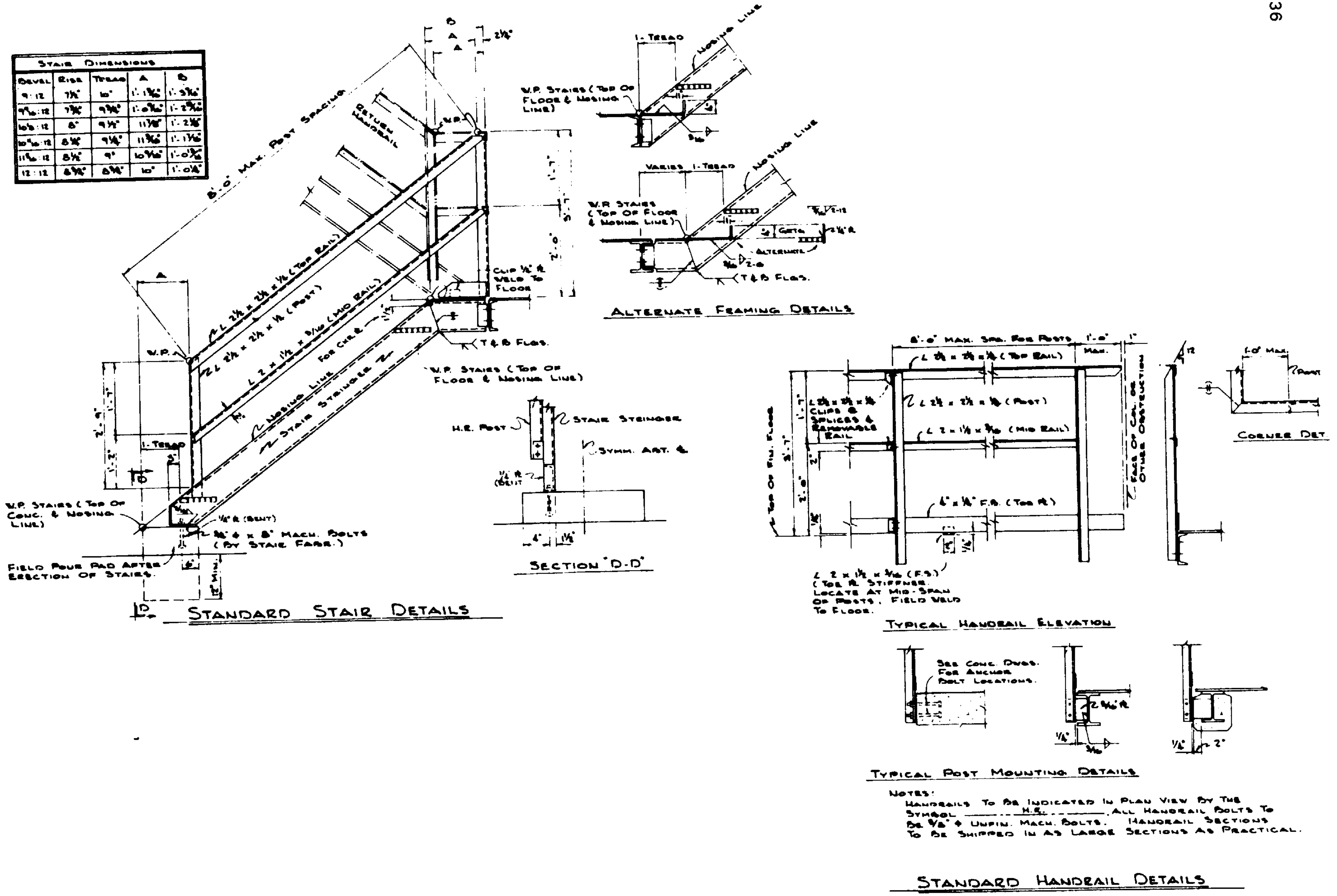


ELEVATION E-E



ELEVATION F-F

Figure 7-20. (continued)



STAIR DIMENSIONS

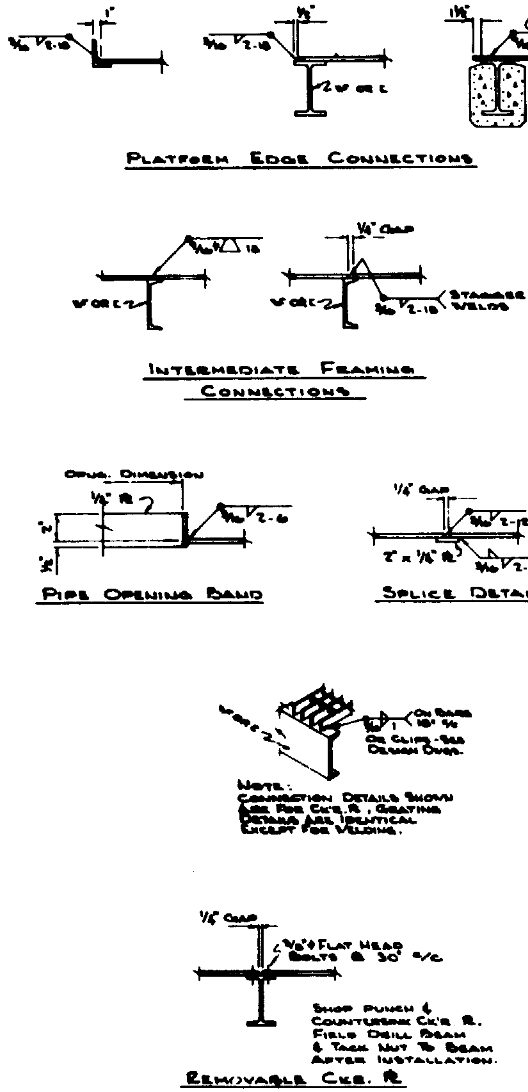
BEVEL	RISE	TREAD	A	B
9 : 12	7½"	10"	1'-1[illegible]"	1'-3[illegible]"
[illegible] : 12	7[illegible]"	9[illegible]"	1'-0[illegible]"	1'-2[illegible]"
10⅝ : 12	8"	9½"	11[illegible]"	1'-2[illegible]"
[illegible] : 12	8¼"	9¼"	11[illegible]"	1'-1[illegible]"
11[illegible] : 12	8½"	9"	10[illegible]"	1'-0[illegible]"
12 : 12	8¾"	8¾"	10"	1'-0¼"

NOTES:
HANDRAILS TO BE INDICATED IN PLAN VIEW BY THE SYMBOL ——— – – H.R. – – ———. ALL HANDRAIL BOLTS TO BE ⅝" ϕ UNFIN. MACH. BOLTS. HANDRAIL SECTIONS TO BE SHIPPED IN AS LARGE SECTIONS AS PRACTICAL.

STANDARD HANDRAIL DETAILS

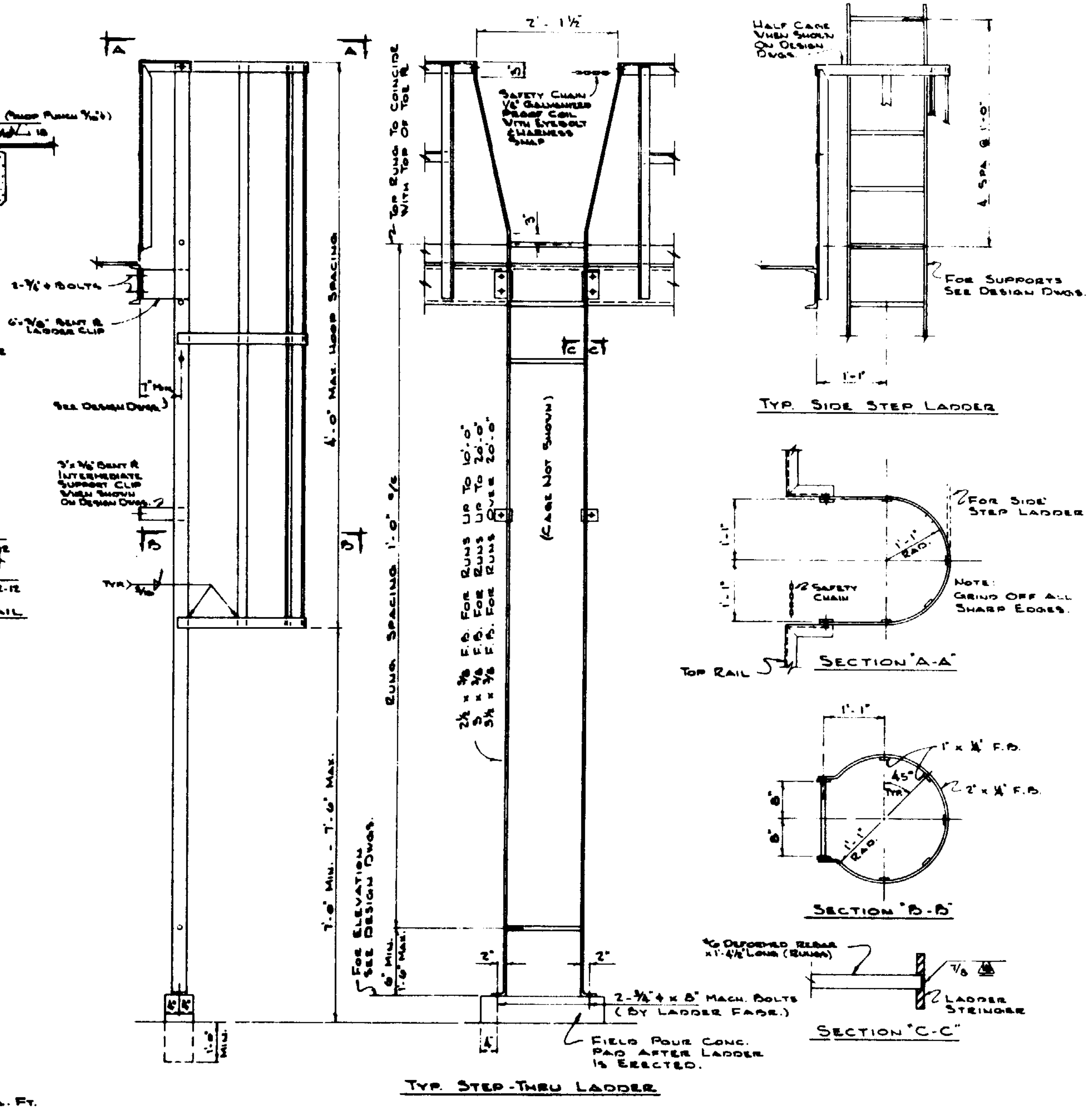
Figure 7-21. Standard stair and handrail details (courtesy of Fluor Corp.)

Figure 7-21. (continued)



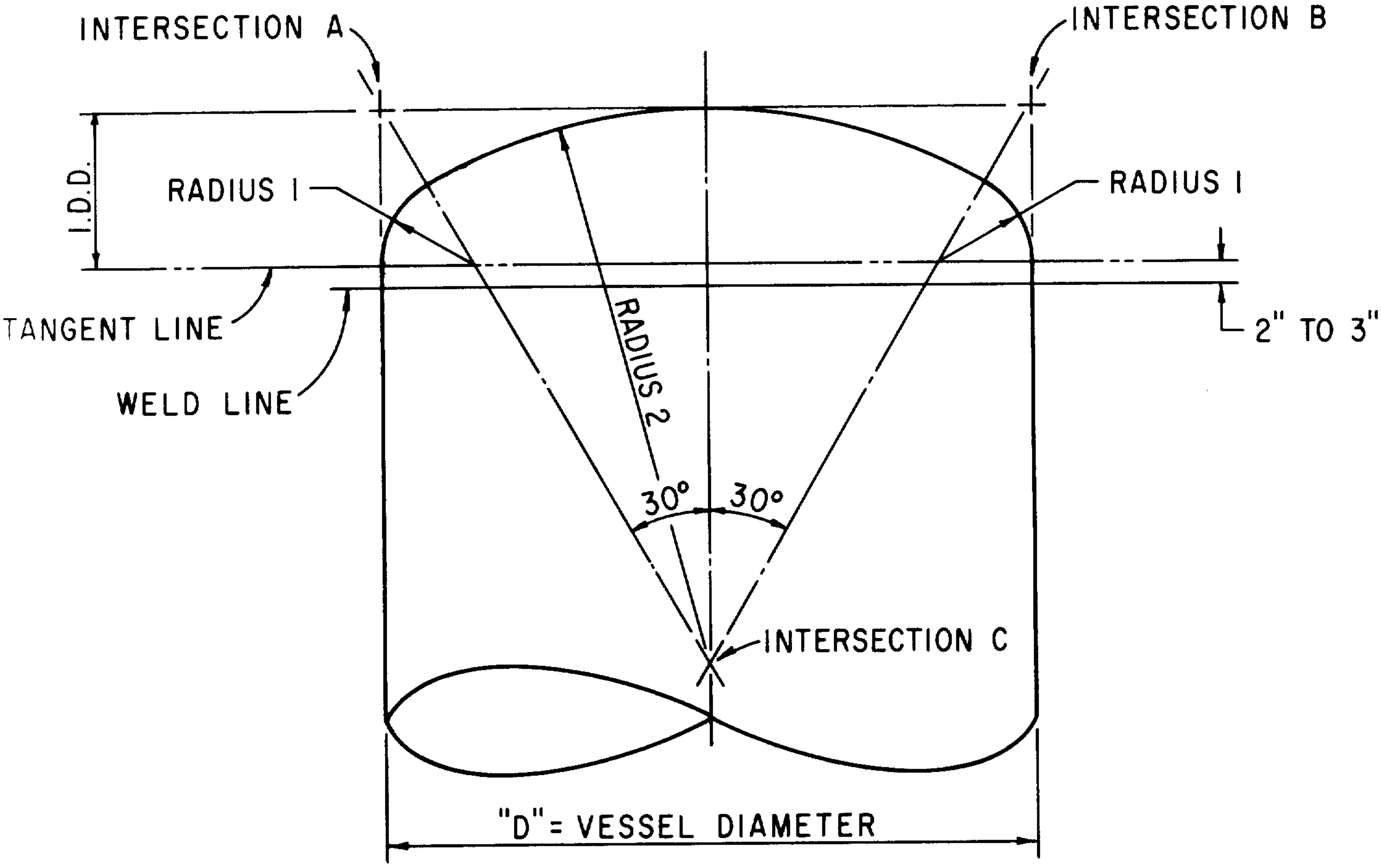
NOTES:
MAXIMUM SIZE OF CK'R. R PCS. TO BE 25 SQ. FT.
PROVIDE ONE 9/16"φ DRAIN HOLE EA. PIECE.

STANDARD CHECKER PLATE & GRATING DETAILS



STANDARD LADDER DETAILS

NOTE:
CAGES REQ'D. AS NOTED ON DWGS.



STEP 1 - DRAW VESSEL DIAMETER AND CENTERLINE ESTABLISHING WELD AND TANGENT LINES.

" 2 LOCATE I.D.D. LENGTH AS 1/4 OF "D" FROM TANGENT LINE.

" 3 LOCATE INTERSECTIONS "A" AND "B" AND DRAW A 30° LINE FROM THESE POINTS TO THE VESSEL CENTERLINE.

" 4 DRAW ARCS FORMED BY RADIUS 1.

" 5 WITH COMPASS POINT AT INTERSECTION "C" DRAW ARC FORMED BY RADIUS 2.

Figure 7-22. How to draw a 2:1 Semi-elliptical head.

CHAPTER 8

ISOMETRIC DEFINITIONS, DIMENSIONING & CALL-OUTS

Isometric Definition

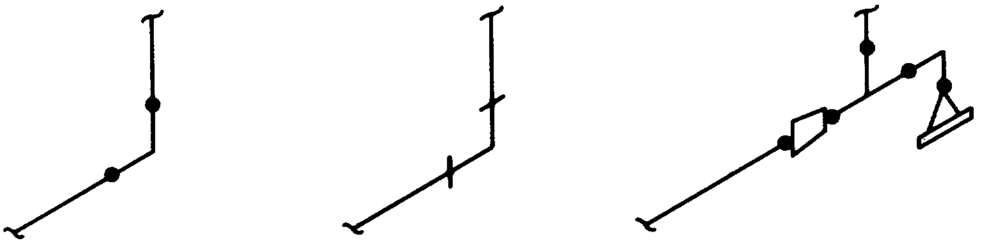
Most companies want their piping arrangements drawn in plans and elevations. Many modern contractors, such as Fluor, have utilized a 3/8"=1'-0" scale model as a design tool, showing the petrochemical complex to scale, including each and every pipe. When models are used, the piping draftsman will be put to work showing his piping on the model. When models are utilized, piping elevations are not drawn.

In both cases a drawing is needed to transmit, to the pipe fabricator, the detail dimensions of each line. Most contractors draw the pipe line from origin to terminus as an isometric. This isometric is also called a "spool drawing."

The isometric spool drawing shows the piece in three dimensions–length, width and depth. As the student has learned in previous drafting courses, isometrics are drawn on a 30° angle. To simplify piping isometrics, all ells are drawn square cornered. (See Figure 8-1 for examples.)

On all piping isometrics, the North arrow should point up and to the right. If the draftsman cannot show the pipe properly with the North arrow to the right, the alternate is to point it up and to the left. In no case will the North arrow point down. (See Figure 8-2.)

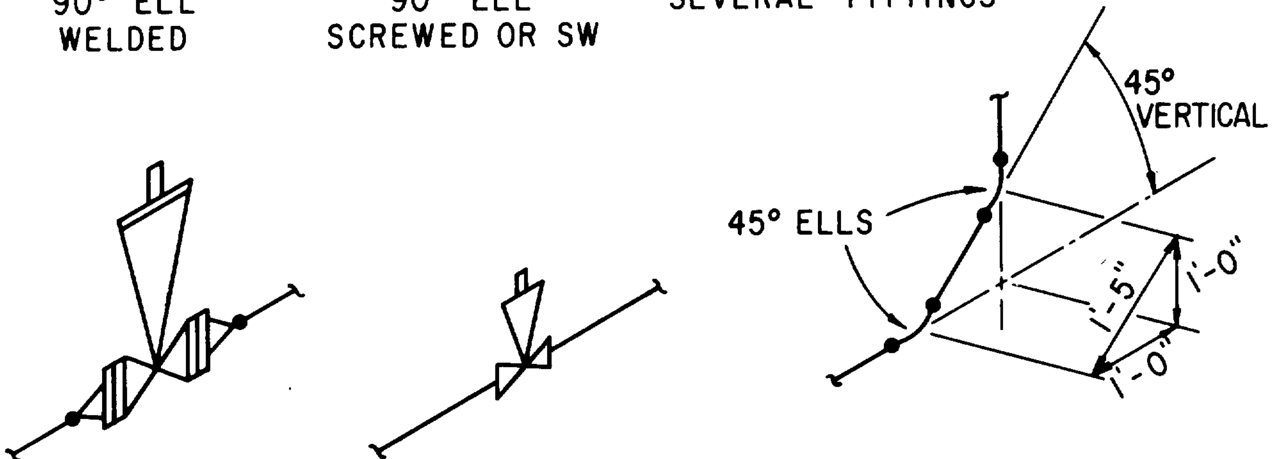
To draw an isometric (or spool) of a line, the student must be able to visualize it in three dimensions. The author suggests that he buy some pipe cleaners–little pieces of wire covered with a white cottony substance. These are excellent to bend to the configuration of a pipe. After he has the configuration analyzed, the pipe cleaners can be straightened out, ready for new bending. (The author admits to having bent many pipe cleaners as he was learning this business.)



90° ELL
WELDED

90° ELL
SCREWED OR SW

SEVERAL FITTINGS



FLANGED
GATE VALVE

SCREWED OR SW
GATE VALVE

45° ELLS
W/PROJECTED DIMENSIONAL LINES

Figure 8-1. Typical Isometric Views.

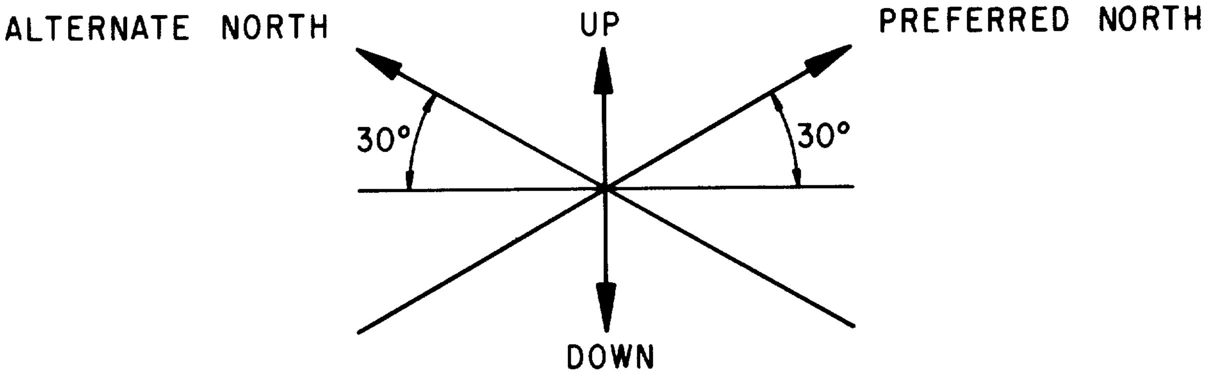


Figure 8-2. Isometric North Arrow.

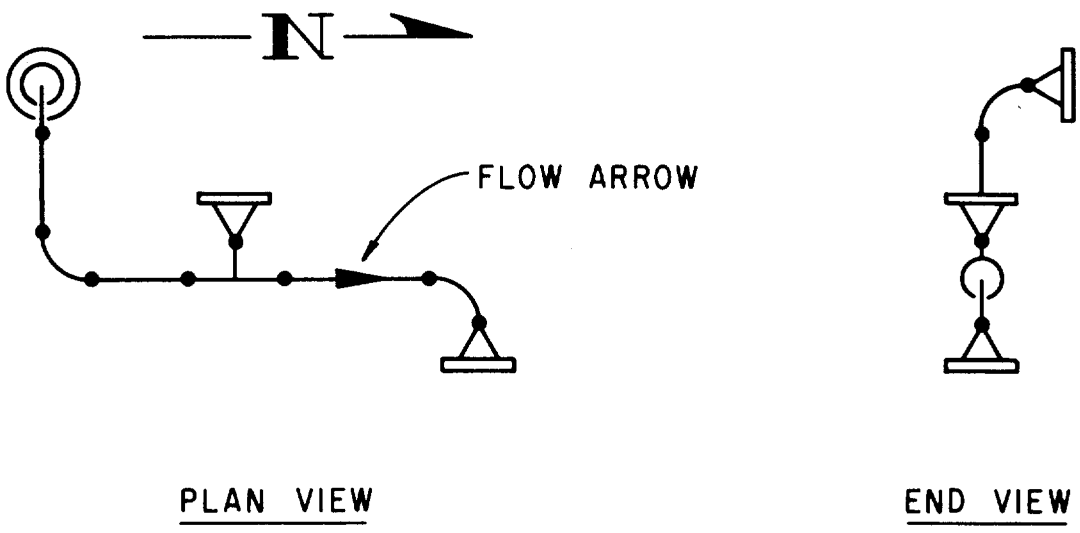


Figure 8-3. Orthographic #1.

The student will now look at a few lines drawn orthographically and then will draw the same lines as isometrics. He must remember to *always orient himself with the North arrow.* (See Figures 8-3 and 8-5 for the orthographic presentations and Figures 8-4 and 8-6 for the isometric.)

When trying to draw an isometric one must always figure which way the line is going from the point of intersection. (See Figure 8-6.) If point one is the point of intersection, then line A goes North and line B goes South from that point. Line C goes up and line D goes West.

A point of intersection is where two lines cross. While constructing an isometric, the student may have many points of intersection. If he is ever undecided on how to draw from a certain point, he should just figure he is at the point of intersection and decide which way to go–Up, Down, East, West, North, South.

Now that he understands isometrics, he will have no trouble converting the following orthographics to isometrics. To let the student use his imagination, only the plan view will be shown. The student is to dream up his own end view and draw the isometric, using good linework and lettering. He is not to dimension–just draw the configuration as shown in Figures 8-4 and 8-6. He is to draw one isometric per 8½ x 11 sheet of Figures 8-7 through 8-12.

To be fabricated, isometrics must have dimensions. As stated, piping draftsmen dimension to the closest 1/16". Dimensioning of isometrics requires practice. Dimension lines are to be drawn to parallel the pipe, valves and fittings symbols. They are to be drawn to the centerlines of fittings and to face of flanges. (See Figure 8-13 for an example of dimensioning. Also see Figure 7-8.)

Dimension lines are located where they are easily read. The student is to make the dimensions, especially the fractions, large enough to be read without mistake. These prints are used in shops and in the field in all kinds of weather. They will get dirty. They still must be read without error.

This isometric is the finished product of the piping draftsman. The student is to draw it so there is no doubt in the reader's mind.

He must *not* break dimension lines to insert dimensions. This is a machine shop practice and is *not* done in process piping drafting.

The student is to draw the isometric and add dimension lines for Figures 8-14 and 8-15. He is not to fill in any dimensions.

Angles seem to give the isometric draftsmen the most trouble. 45° ells form angles and must be dimensioned properly. The best way to do this is with a projected box showing the dimension lines at the box. (See Figure 8-1.) When elbows roll and

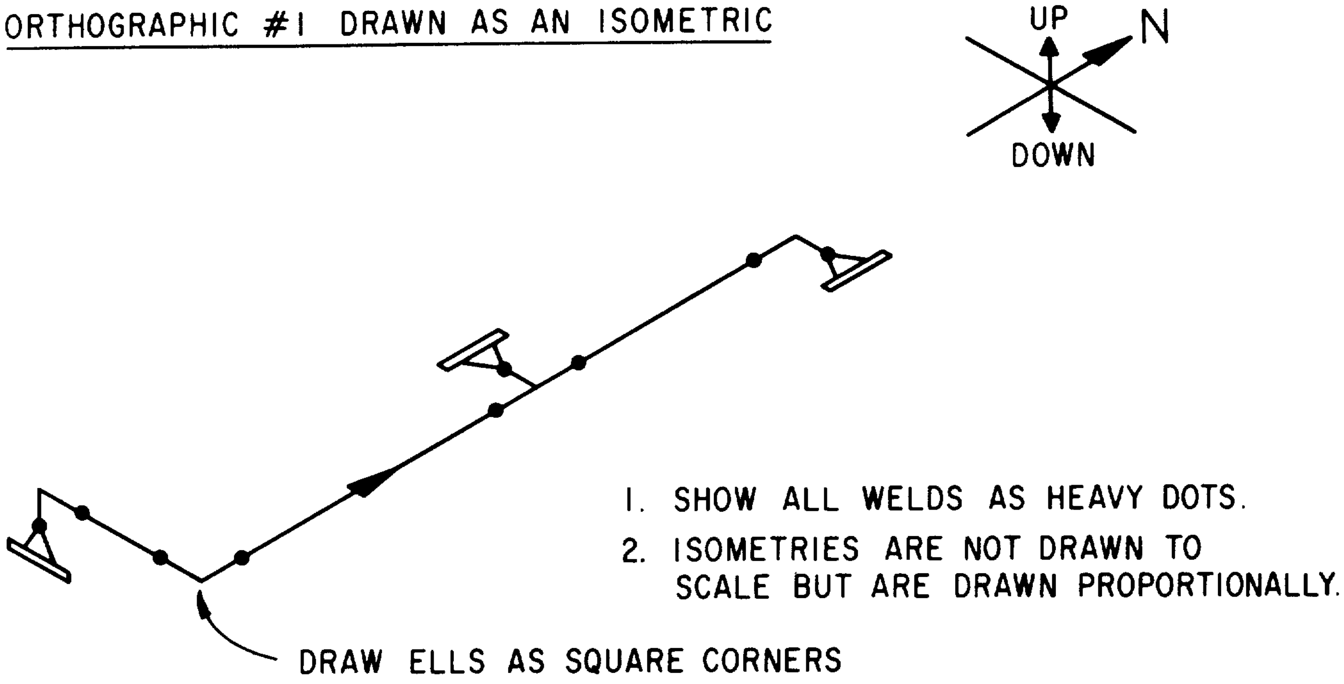


Figure 8-4. Isometric of Figure 8-3.

form a compound angle, the full three-dimension box must be shown very clearly. The student is to work the problems in Figure 8-16.

Detail Dimensioning

Detail dimensions of all pipe and fittings are required by the piping draftsman and the piping fabricator. When dimensioning an isometric, the student has learned to give the control dimensions, which are center-to-center of fittings and to face of flanges. To arrive at many of these dimensions, the piping draftsman must know and figure the detail dimensions.

For most detail dimensions the student is to refer to the chart in Chapter 2. Looking under weld neck flanges he sees "Total Length R.F." The total length of a 4" 300# RF weld neck flange is 3 3/8". This the length "F" Figure 8-17 shows. It includes the 1/16" raised face for 150# and 300# series flanges. But catalog dimensions of flanges with ratings of 400# and larger do *not* include the RF in their "F" dimension. The RF for these ratings is 1/4"—not 1/16". For convenience the chart in Chapter 2 has included the 1/4" raised face for the 600# flanges.

Chapter 11 has reproductions from manufacturer's catalogs. The student is to refer to them for complete detail dimensions of flanges and fittings.

The RTJ (Ring Type Joint) flange has an octagonal groove machined in its face to fit the metal ring gasket. (See detail in Chapter 2.) The "B" dimension (see page 194) of RTJ flanges is to the bottom of this groove for all ratings. Flanges are to be dimensioned to the extreme face. So, to figure this dimension, the piping draftsman must add the depth of groove to the length through hub the "F" dimension. The chart in Chapter 2 has done this for 150#, 300# and 600# RTJ flanges. (See Figure 8-19 and pages 194-196.)

When looking in catalogs for RTJ valve dimensions, the depth of groove must be added to both ends of a valve dimension and to flange lengths.

The RTJ gasket causes the mating flanges *not* to make contact. This space between the flanges is the "RTJ gap." (See Figure 2-17 on page 17). This gap is different for each flange, so one must look it up when dimensioning. A valve

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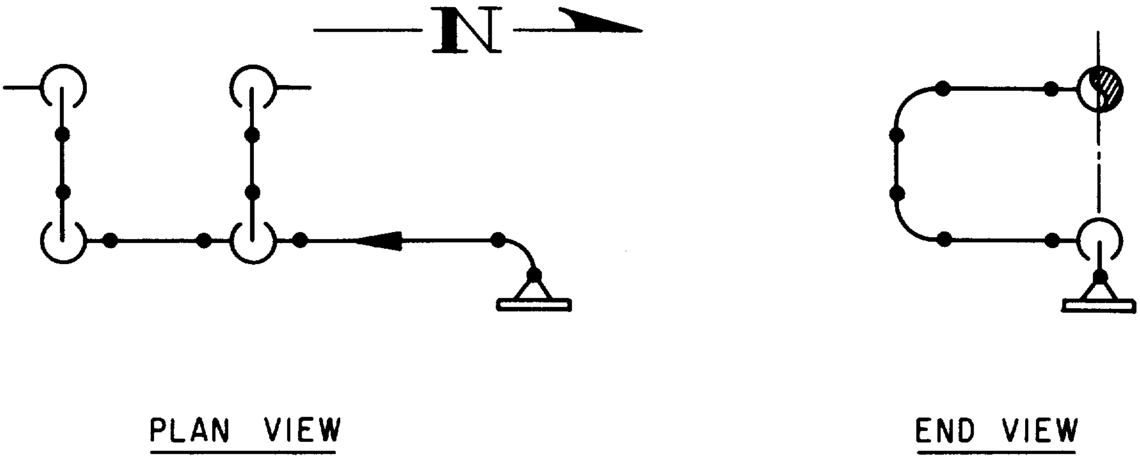


Figure 8-5. Orthographic #2.

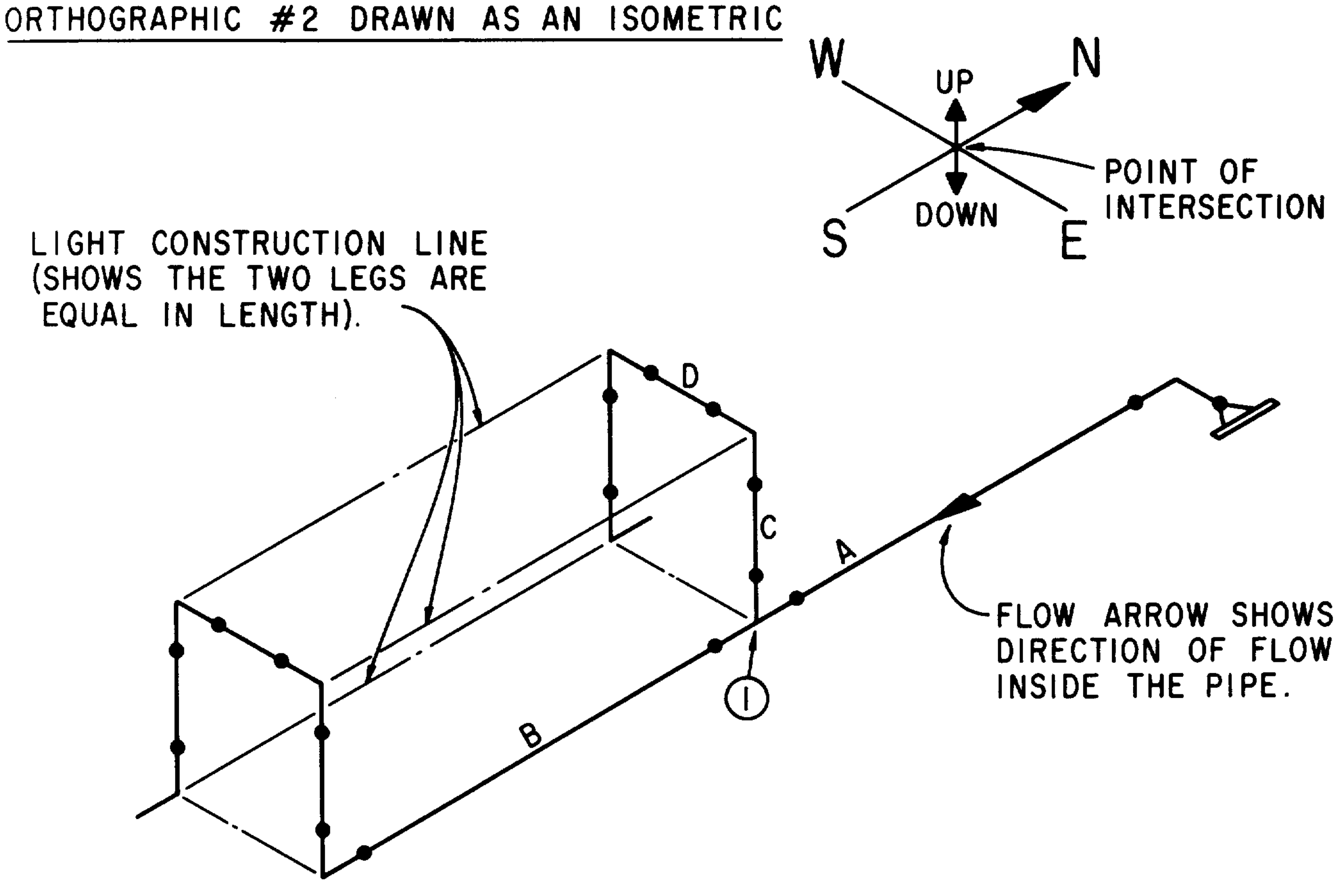


Figure 8-6. Isometric of Figure 8-5.

Figure 8-7

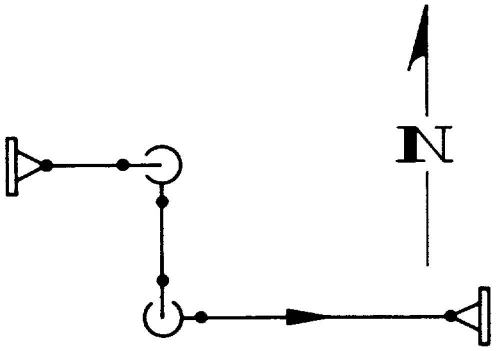


Figure 8-10

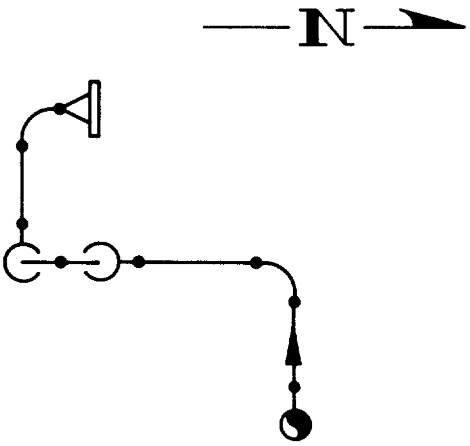


Figure 8-8

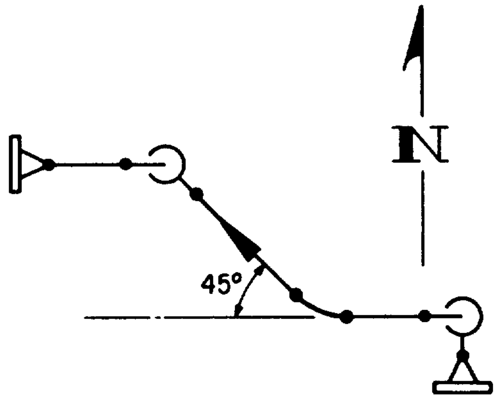


Figure 8-11

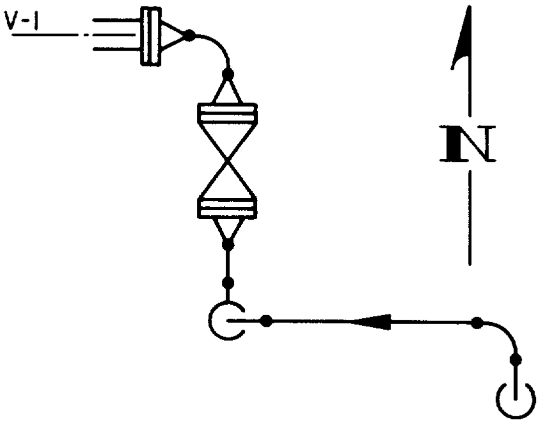


Figure 8-9

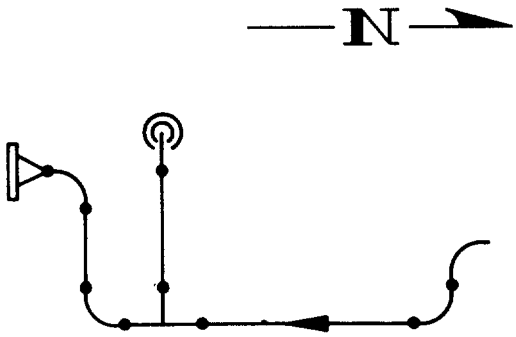
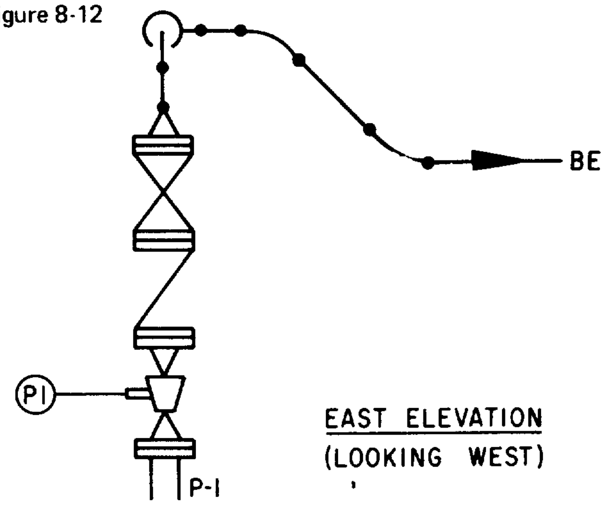
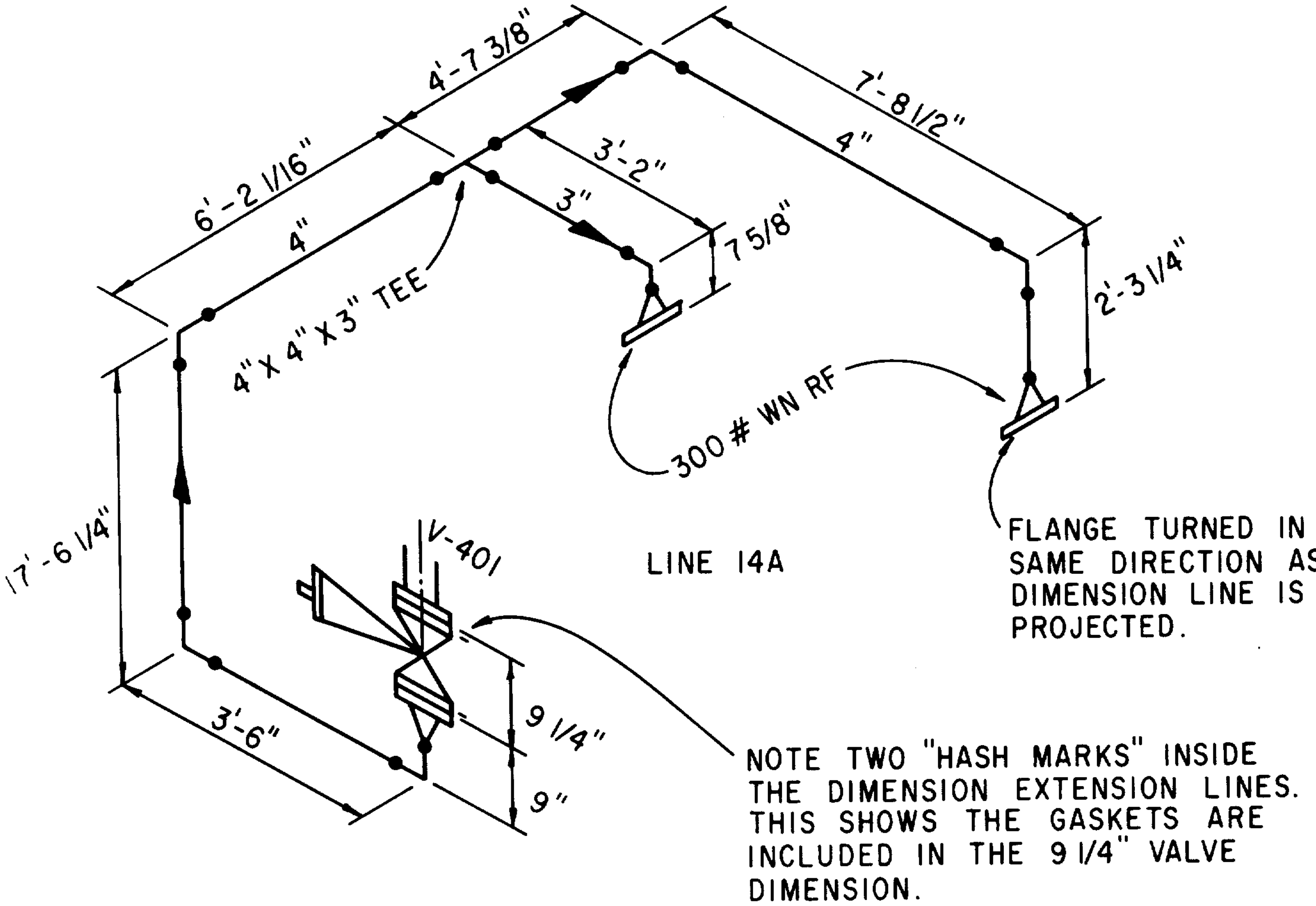


Figure 8-12



Figures 8-7—8-12. Orthographic to Isometric Problems.



FLANGE TURNED IN SAME DIRECTION AS DIMENSION LINE IS PROJECTED.

NOTE TWO "HASH MARKS" INSIDE THE DIMENSION EXTENSION LINES. THIS SHOWS THE GASKETS ARE INCLUDED IN THE 9 1/4" VALVE DIMENSION.

Figure 8-13. Dimentioning of Isometrics.

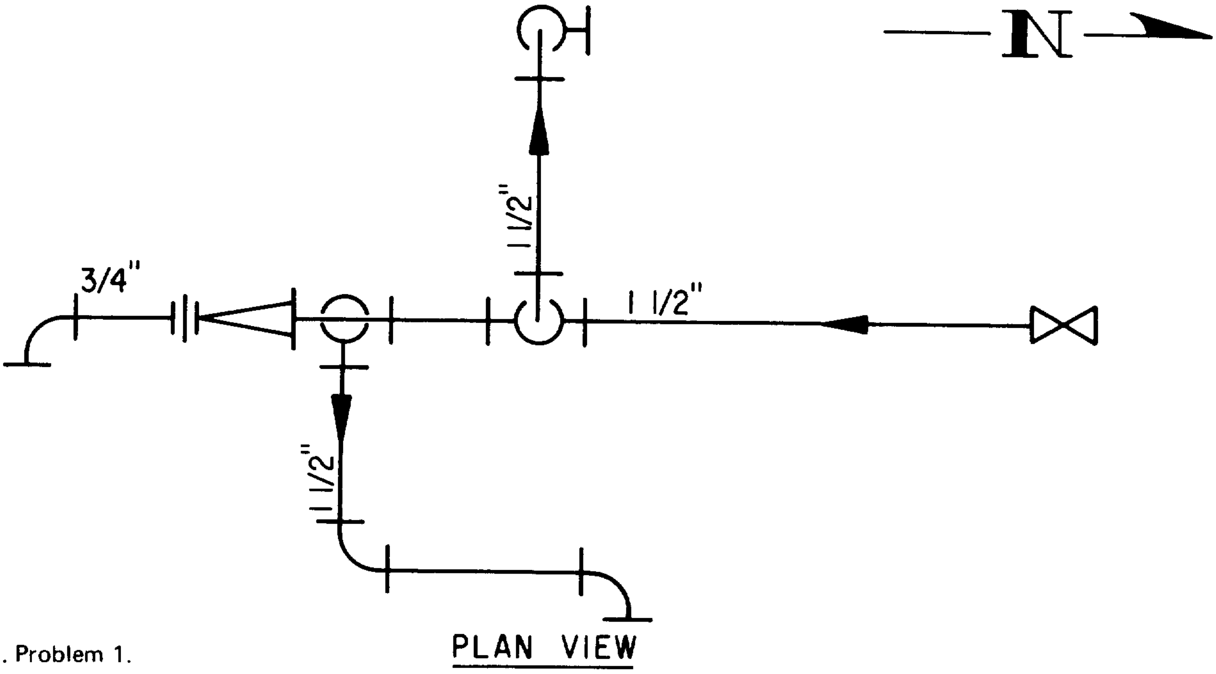


Figure 8-14. Problem 1.

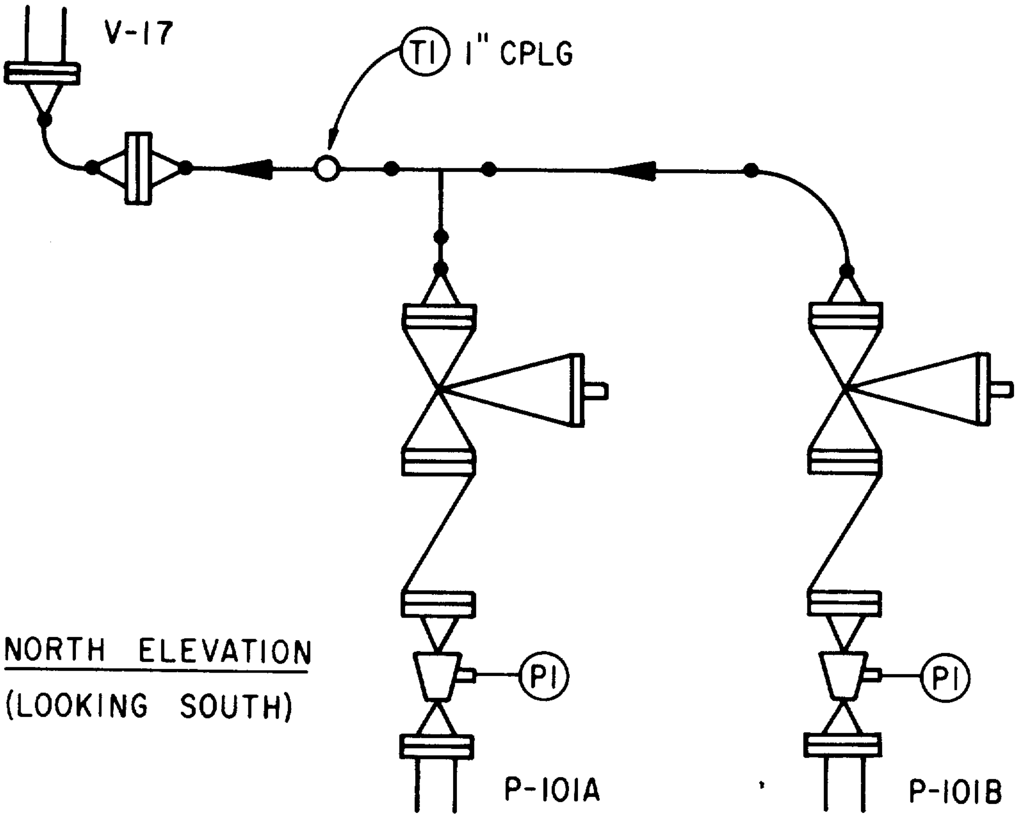
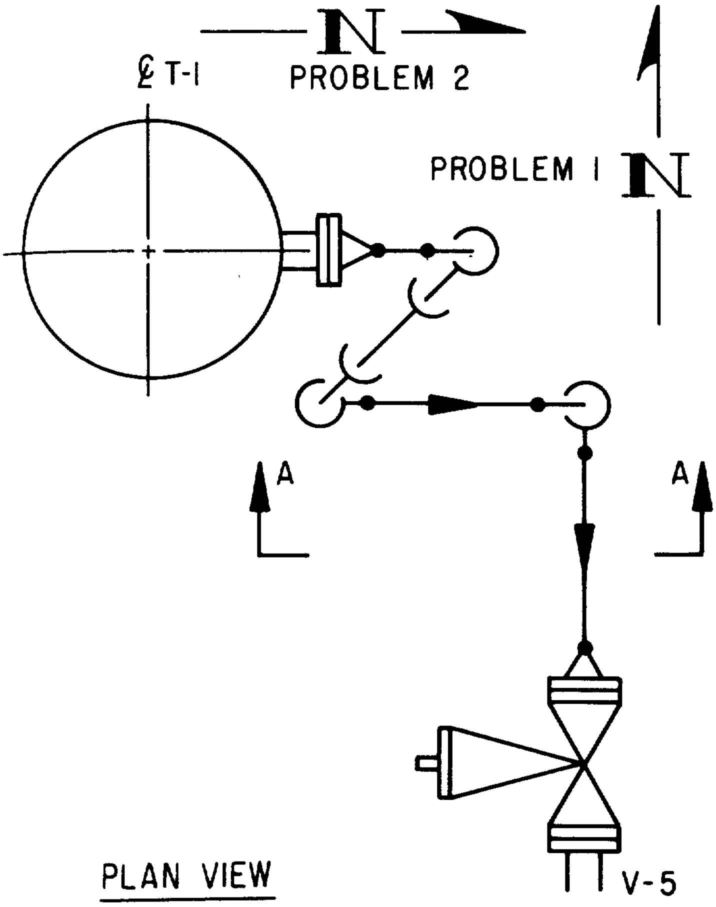
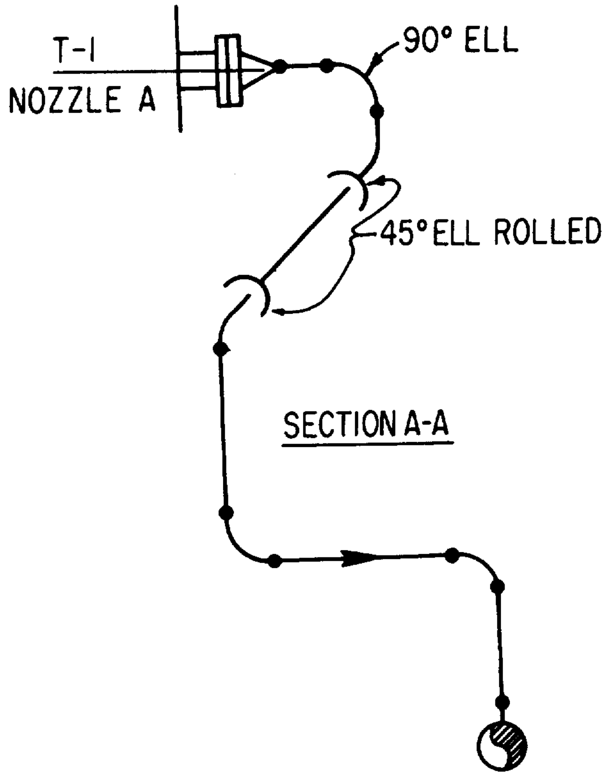


Figure 8-15. Problem 2.



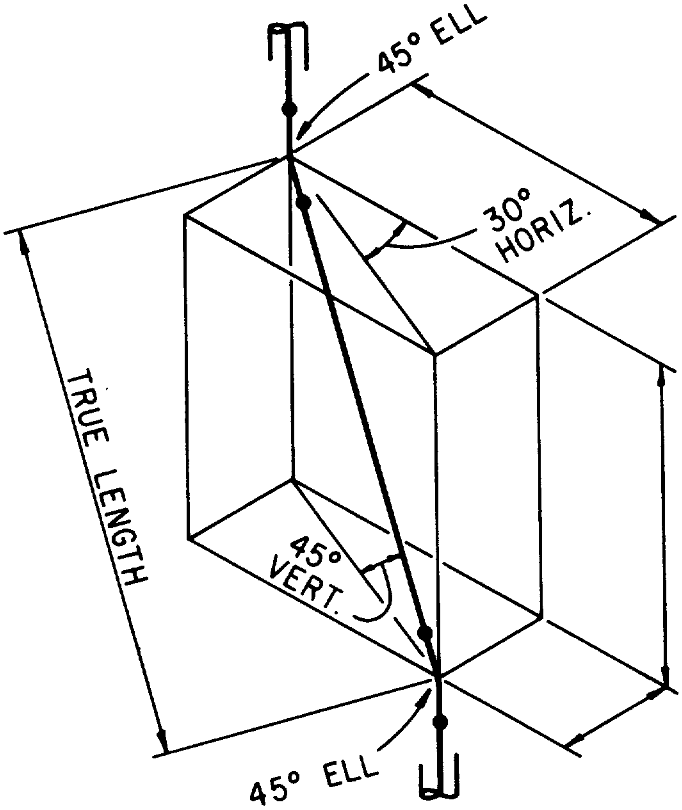
PLAN VIEW

THE STUDENT IS TO DRAW THE ISOMETRIC OF THIS PLAN AND SECTION TWICE. FIRST WITH THE NORTH ARROW POINTING UP. THEN WITH NORTH ARROW TO THE RIGHT IN BOTH PROBLEMS SHOW THE NORTH ARROW UP AND TO THE RIGHT ON THE ISOMETRIC. SHOW ALL NECCESSARY DIMENSION LINES IMAGINE THAT YOU ARE THE FABRICATOR. WHAT OVERALL CONTROL DIMENSIONS DO YOU NEED ?



SECTION A-A

AN EXAMPLE OF A ROLLING ANGL BOX IS SHOWN BELOW TO GIVE YOU A HINT.



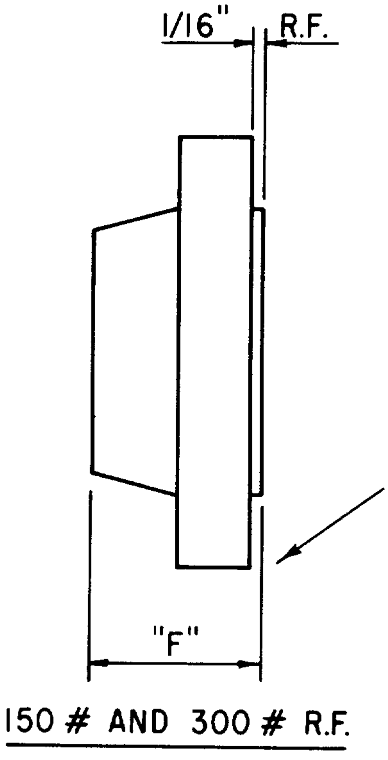


Figure 8-17. Flange Dimensions.

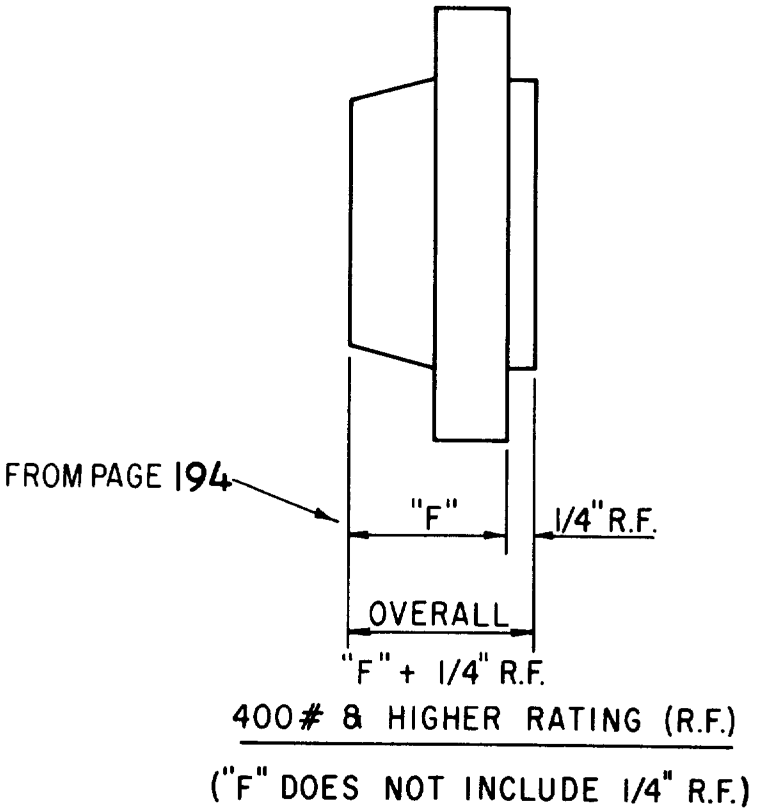


Figure 8-18. Flange Dimensions.

dimension is to include the gaskets usually. Gaskets are shown by the "hash" mark. A RTJ gasket dimension is the gap dimension. (See page 196 for gap dimensions.)

Using the piping specifications in Chapter 4, the student is to draw an isometric of the six problems in Figure 8-20. In number 1 he is to note line 16C. By referring to Table C in the specifications (Chapter 4), he learns that the flanges are 300# RF. He is to give all fitting and all control dimensions for total welded piping.

Now this book gets a little harder. Figure 8-21 has 12 piping configurations. Using the specifications in Chapter 4, the student is to supply dimensions for each blank dimension line. For practice he is to duplicate each of the 12 problems, using his best linework and lettering.

Problem 8 has socketwelded fittings. The student will need to refer to the manufacturer's catalog data on socketwelded fittings in Chapter 11.

He must remember to consider all gasketing, including the RTJ gap in Problem 10.

Figures 8-22a and 8-22b show two ways to dimension the same piece of pipe. Figure 8-22b is the preferred method. It shows the control dimension, 39'-9 3/16". For checking fabrication accuracy, the student is to show the control dimensions. To find this dimension in Figure 8-22a, each center-to-center dimension would have to be added. While this could be done, an error could result in the addition.

Isometric or Spool Call-outs

Spool call-outs are items on the isometric that are not covered in the general piping specifications. It may be something that is "off-spec" or something special required for that line. In any event, the piping draftsman must become aquainted with spool call-outs.

Figures 8-23 through 8-27 show many items that are commonly called out on spools. Item 1 shows a FRC-2 in a C spec line. The control valve rating is always to be called out. If it is "in spec," just the control valve is called out. If it is "out of spec," the control valve and companion flanges must be called out.

Item 2 is a 1" screwed control valve. This also must be called out.

Item 3 shows eccentric and concentric reducers. When they are concentric, only the sizes need to be called out. When the reducer is eccentric, one must give the sizes, say ecc. red, and note which side has the flat side. In this case, it is FOB (flat on bottom). He also must give the eccentricity or the offset dimension. To calculate this offset, he subtracts the smaller from the larger I.D. and divides the result by 2. Then he rounds off his answer to the closest 1/16".

Item 4 shows orifice flanges. One calls out the FR or FRC number, orientation of the taps and a note to "grind welds smooth inside." This means the weld at the weld neck orifice flange is to be ground smooth on the inside of the flange. This keeps meter run flow as non-turbulent as possible. Orifice flanges are drawn vertically if the taps are vertical and horizontally if the taps are to be horizontal. The first dimension line away from the line is to dimension the pipe. The second line is to dimension the orifice plate and gaskets. Two "hash marks" are inside the gap dimension. Also, there are two gaskets—one on each side of the orifice plate. Orifice plates for RF flanges are usually 1/8" thick. If one has 1/8" gaskets (2), then the gap dimension would be 3/8".

Item 5 shows how field supports are to be called out. One must always give the pipe size of these field supports. He gets the proper size from the typical piping detail on field supports (Chapter 5).

Item 6 lists fittings that must be called out. All reducing fittings, including reducing tees if used, must be called out. Elbows are assumed to be

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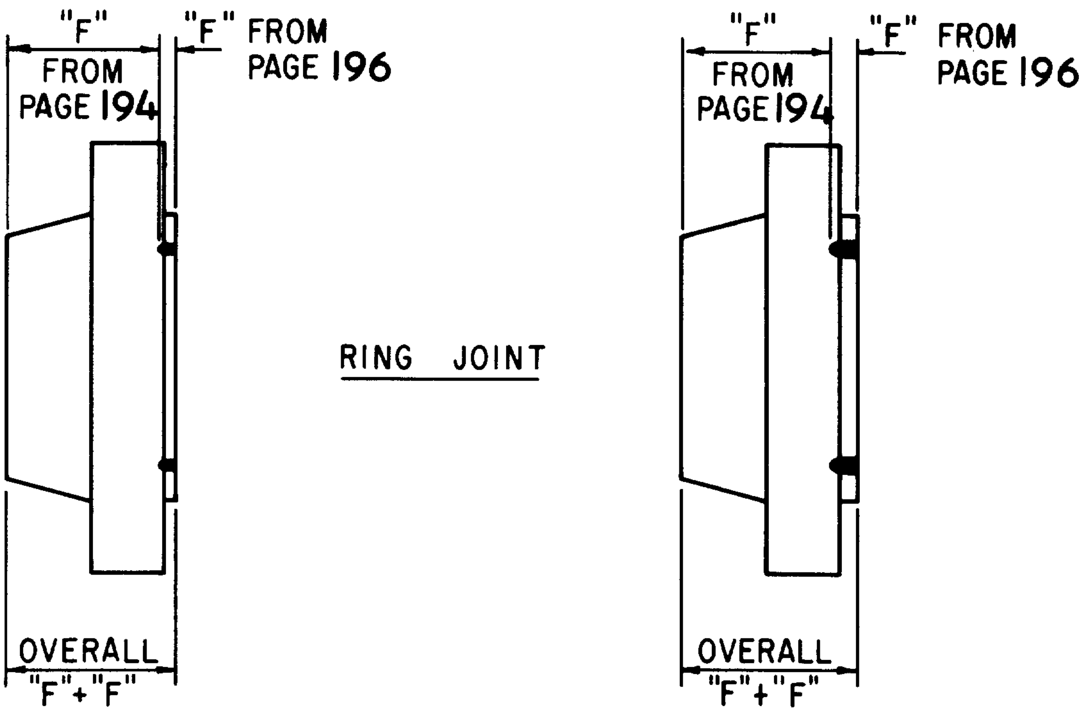


150# AND 300# (R.T.J.)
("F" INCLUDES 1/16" R.F.)

400# ¢ HIGHER RATING (R.T.J.)
("F" DOES NOT INCLUDE 1/4" R.F. DIM.)

Flange 8-19. RTJ Flange Dimensions.

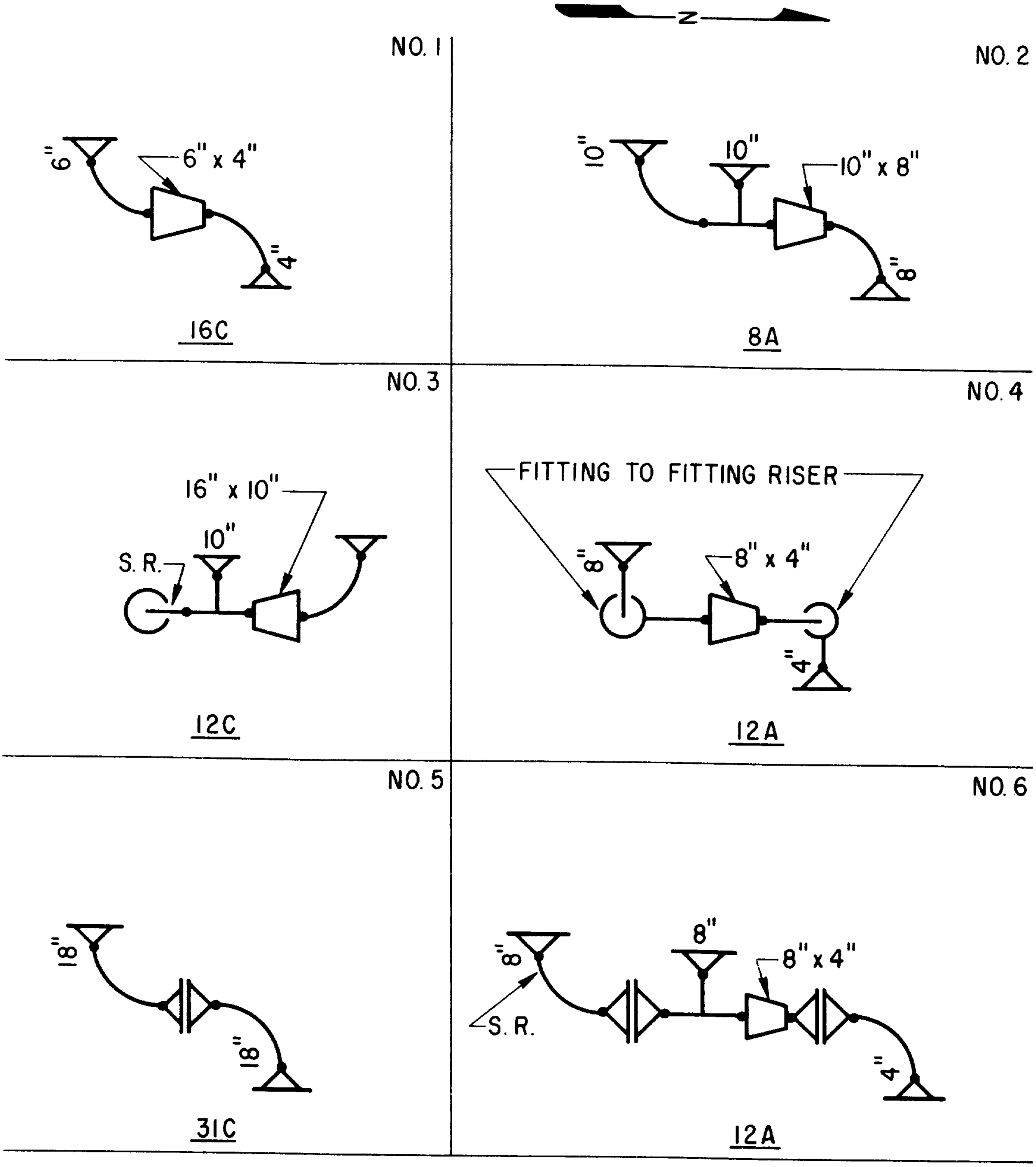


Figure 8-20. Dimensional Problems.

FILL IN EACH OF THE 16 DIMENSIONS
(TEMP. 300°F.)

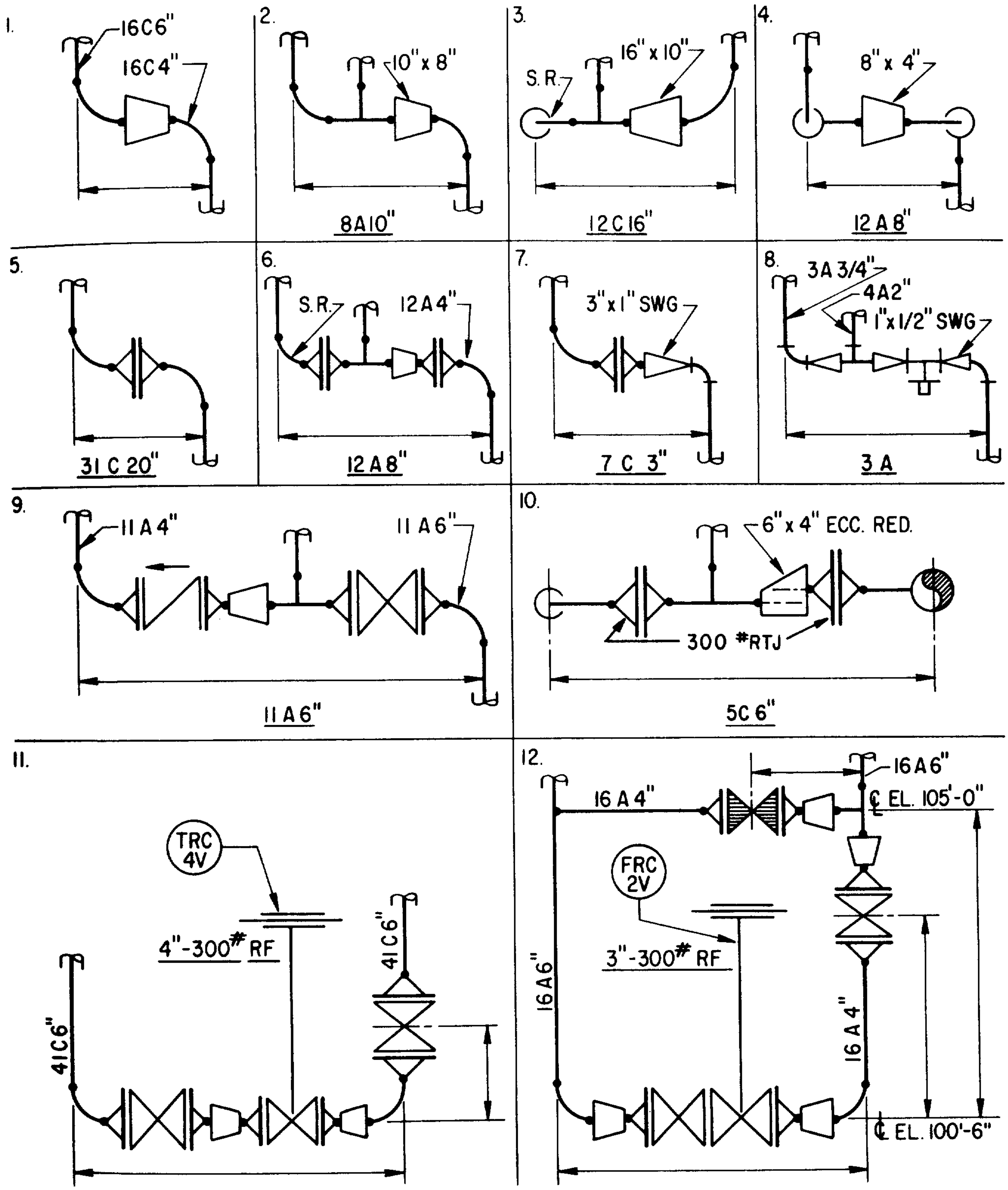


Figure 8-21. Dimensional Problems.

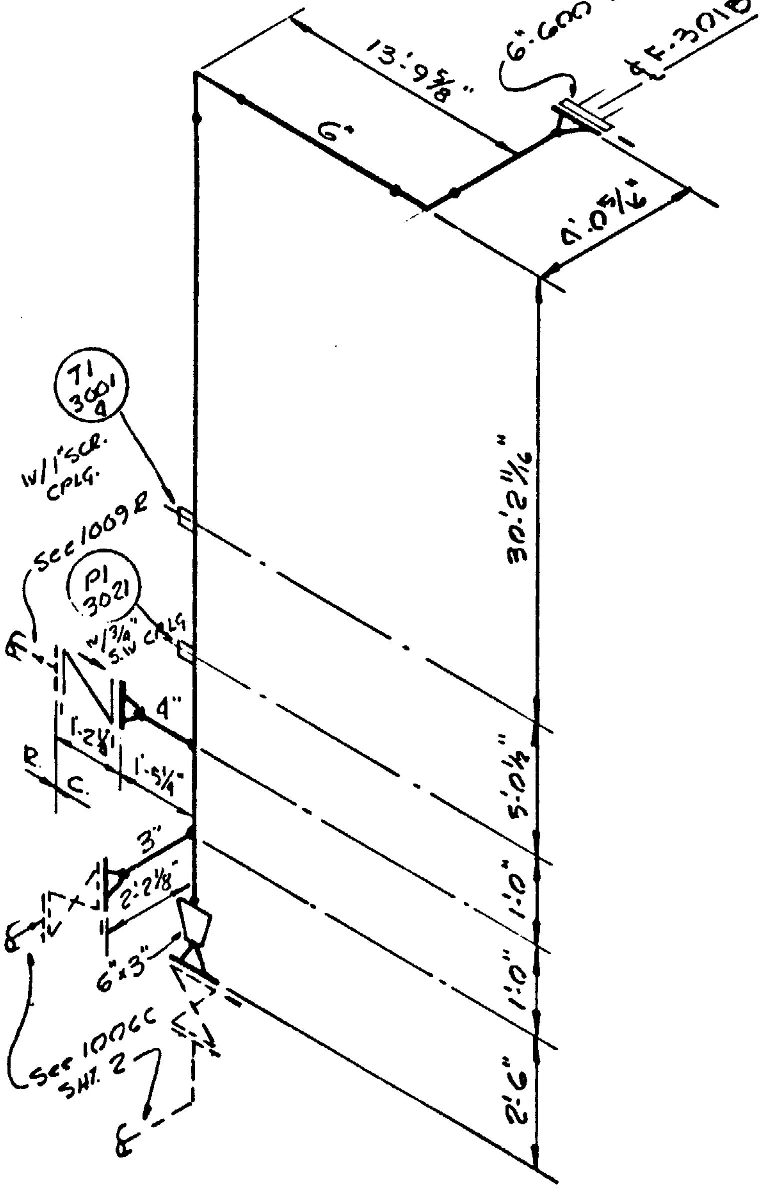


Figure 8-22a. Dimension Methods (courtesy of Fluor Corp.).

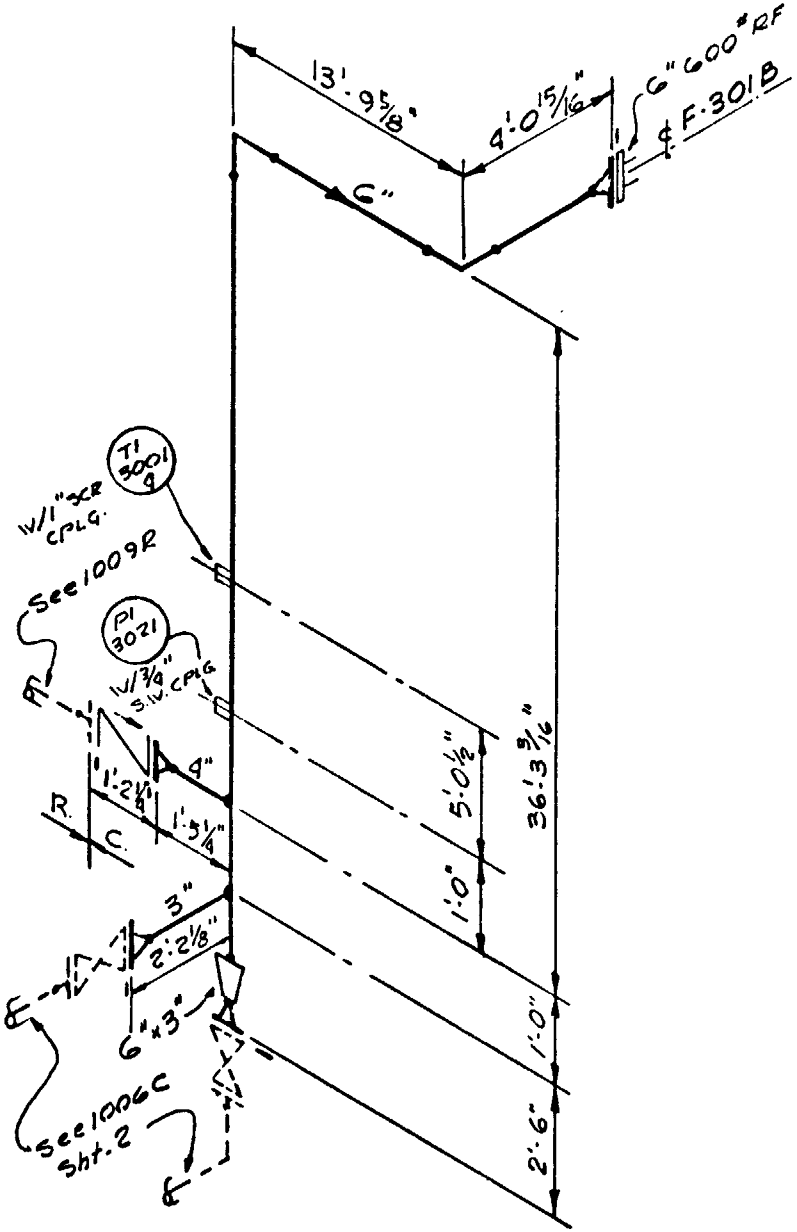


Figure 8-22b. Preferred Dimension Methods (courtesy of Fluor Corp.).

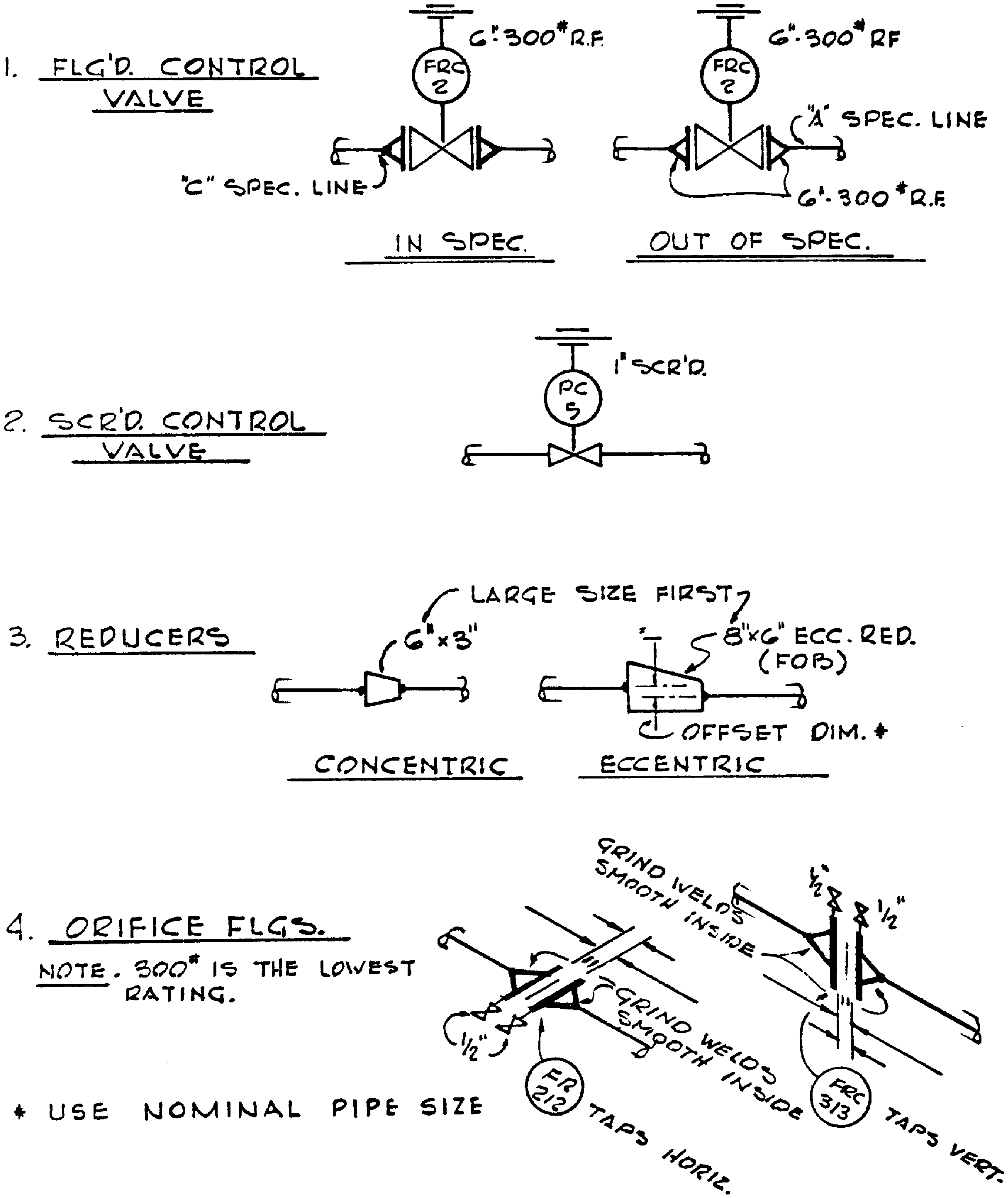


Figure 8-23. Spool Call-outs (courtesy of Fluor Corp.)

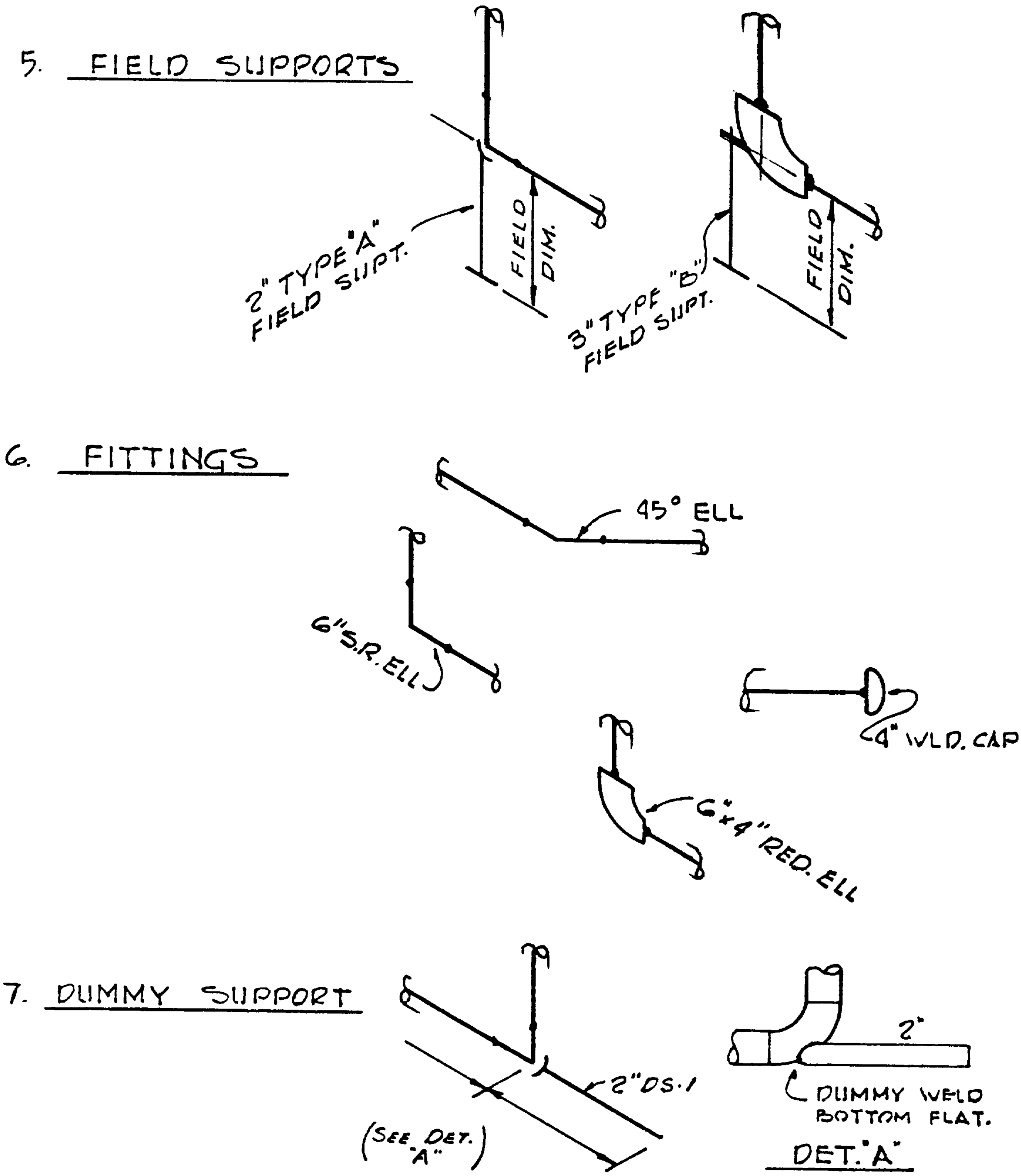
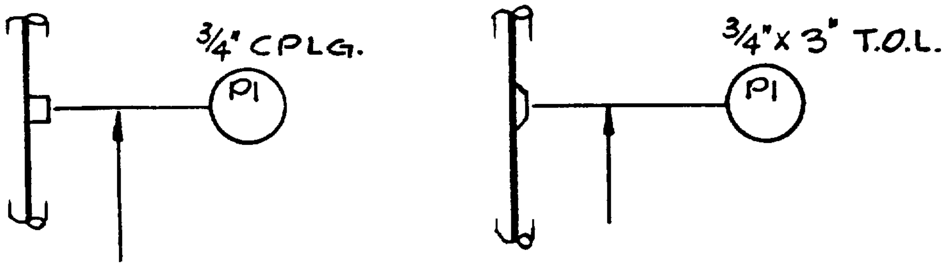
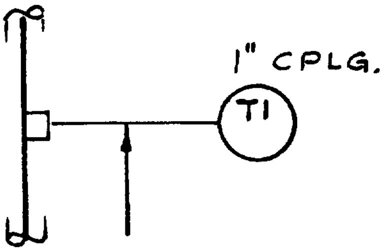


Figure 8-24. Spool Call-outs (courtesy of Fluor Corp.).

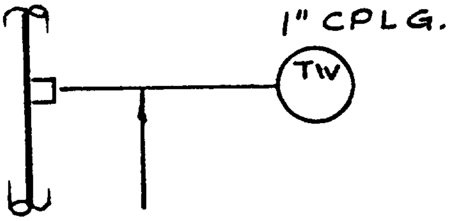
8. PRESSURE INDICATOR



9. TEMPERATURE INDICATOR



10. TEMPERATURE WELL



11. LINE SIZE & FLOW

12. NOZZLES

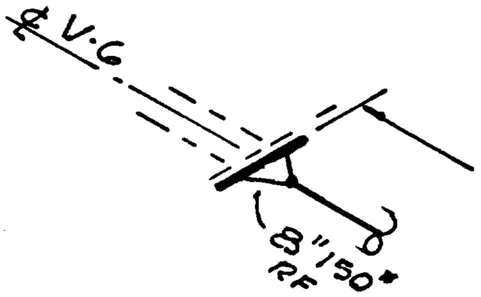


Figure 8-25. Spool Call-outs (courtesy of Fluor Corp.).

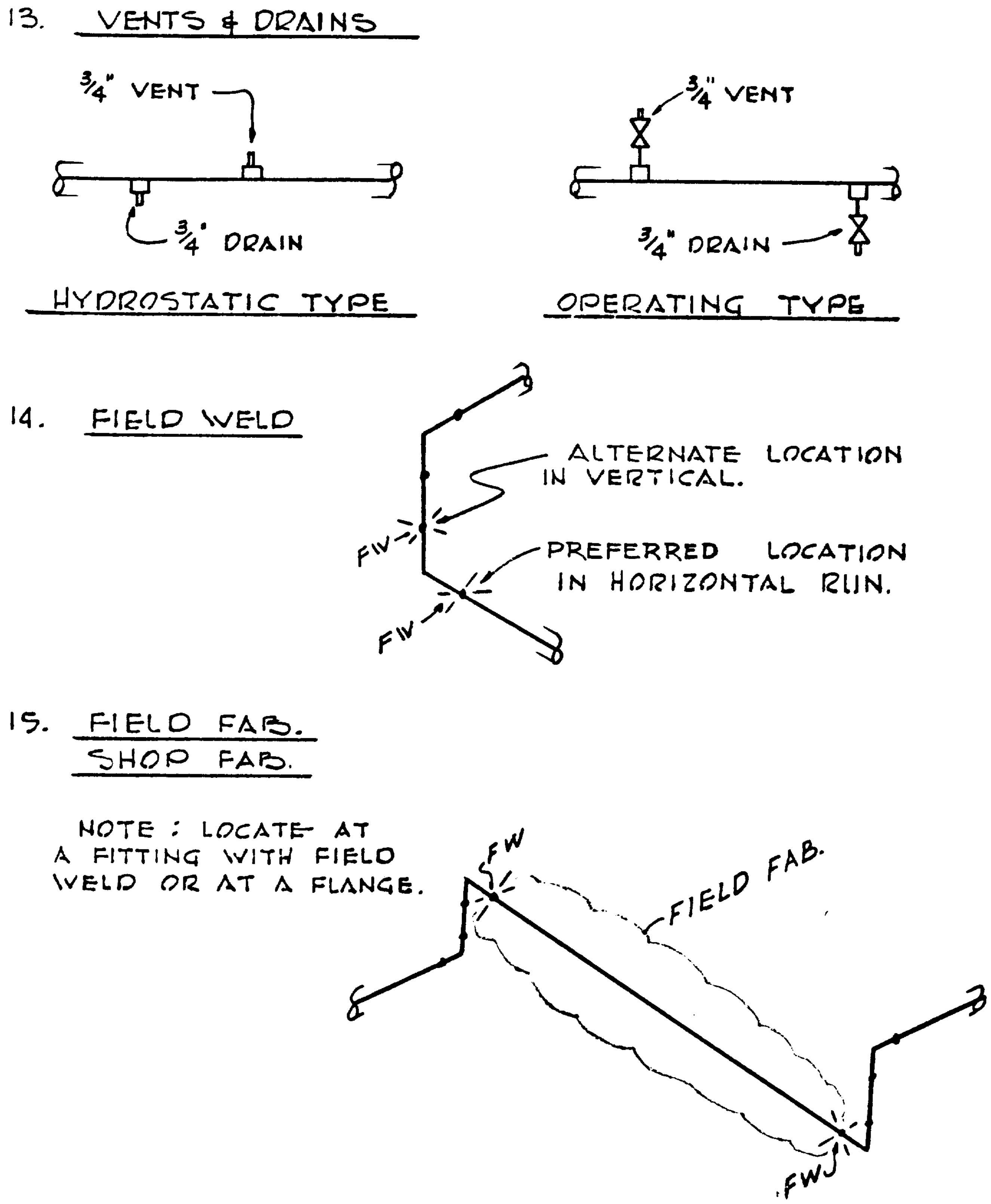
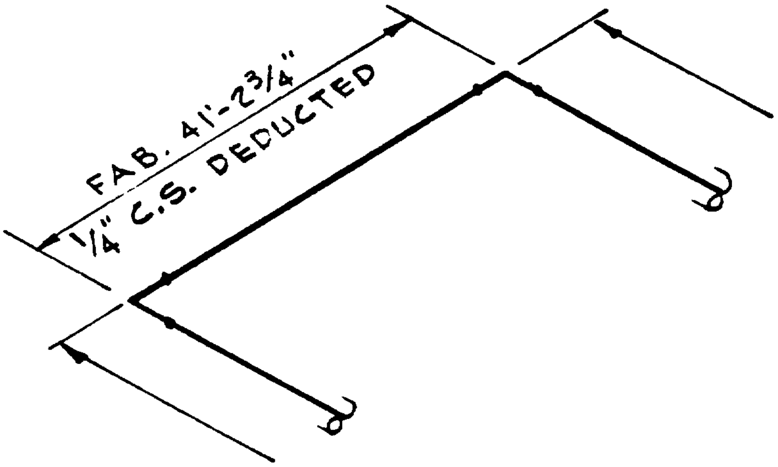


Figure 8-26. Spool Call-outs (courtesy of Fluor Corp.).

16. COLD SPRING



17. SPECIALTIES

ALWAYS CALL OUT ANYTHING THAT DEVIATES FROM THE PIPING SPEC., & ALL SPECIAL CONDITIONS SUCH AS MITRES, SPECIALTY ITEMS, ETC.

18. MISC.

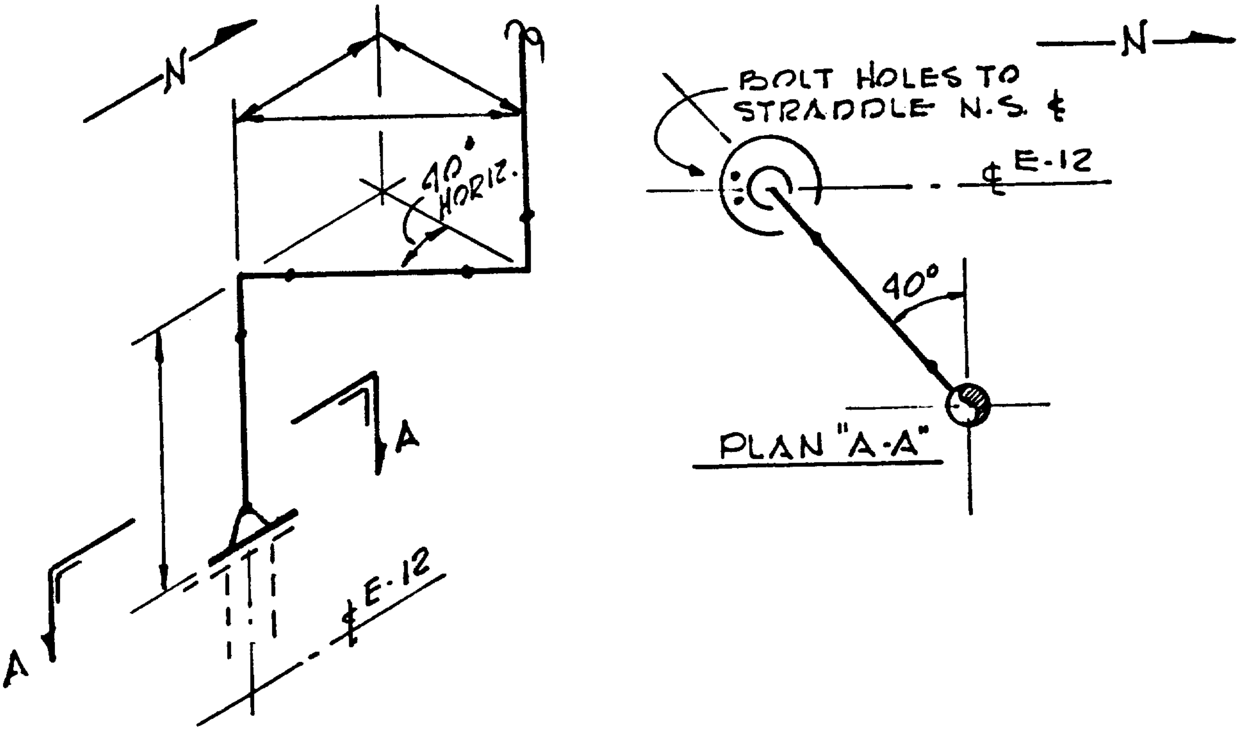


Figure 8-27. Spool Call-outs (courtesy of Fluor Corp.).

LR (long radius) unless called out as SR (short radius).

Item 7 shows how to call out a horizontal dummy support.

Items 8, 9 and 10 depict various coupling call-outs. The student is to note the 3/4" x 3" T.O.L. in item 8. This is a thredolet, 3/4" size, fitting on a 3" header.

Item 11 shows how to call out line size and flow. This flow arrow should appear at least once on every spool. Preferably, it will show on every change of direction. The line size should be located at the flow arrow.

Item 12 shows how to call out equipment nozzle companion flanges. These companion flanges are called out only if they are "off-spec."

Item 13 shows call-outs for hydrostatic and operating vents and drains. The hydrostatic connections are not valved. One must always call out the drain size. This tells the fabricator what size coupling or thredolet to install.

Item 14 shows how to call out a field weld. On shop fabricated piping, many times one will want a field weld at a certain spot. He may be running a line through a platform or a sleeve in a concrete wall. If it came to the field all welded, he couldn't install it. These special field welds must be called out.

Item 15 shows how to define a spool when one wants part of it fabricated in a shop and part fabricated in the field.

Item 16 shows how to call out cold spring. One gives the fabricating dimension on the dimension line and the cold spring under the dimension line.

Item 17 notes some of the many special items that must be called out.

Item 18 shows how to project a triangle and its dimension lines. The 40° angle is shown as horizontal and must be called out as horizontal or vertical. A plan view is cut to show the pipe fabricator the proper bolt hole orientation. Bolt holes in the flange, on the piping, must fit the bolt holes in the equipment flange. Any time there is any doubt on bolt hole orientation, they are called out. This is better than having a piece of pipe in the field that will not fit.

Figure 8-28 is a typical isometric of a pump discharge line with a meter run and control station. The student is to duplicate this isometric, add dimension lines, dimensions and give the proper spool call-outs. He is to use the standard piping details in Chapter 5. The pump discharge nozzle has a coupling for a PI. What size is it? Downstream of the control valve is a coupling for a TI. What size is it?

Figure 8-29 has three problems which will test the student's knowledge. He is to draw an isometric of each line, show dimensions needed and give the proper call-outs.

Figure 8-30 has four problems. He is to draw the isometric for each line and properly dimension and call-out.

Figure 8-31 through 8-34 show typical piping at equipment. The student is to draw an isometric for each line shown, giving all dimensions and call-outs.

While not drawn to scale, piping isometrics are drawn somewhat proportionally. A dimension of 15'-0" would be shown as longer than one of 2'-6". However, it is common to exaggerate small dimensions when needed for clarity.

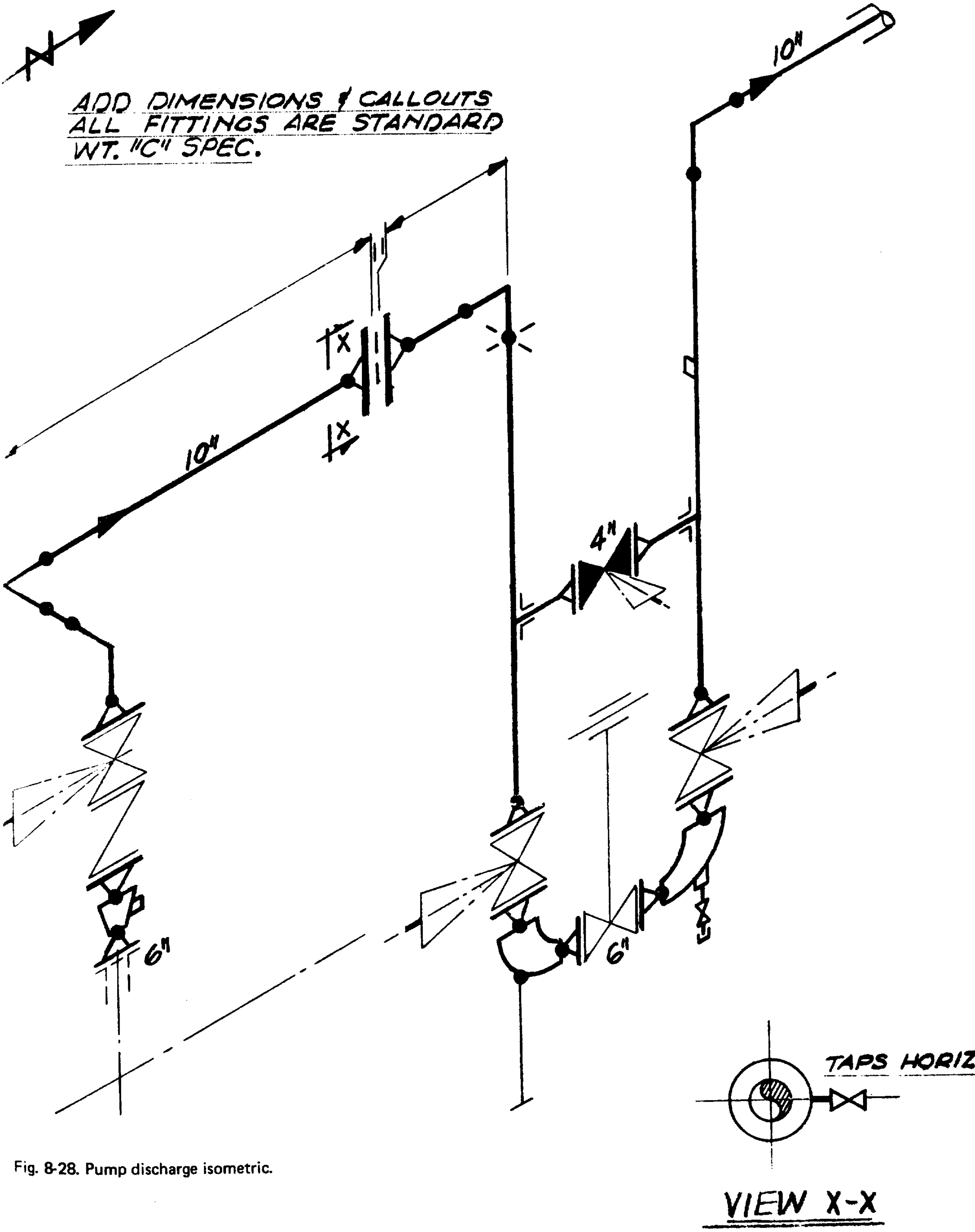
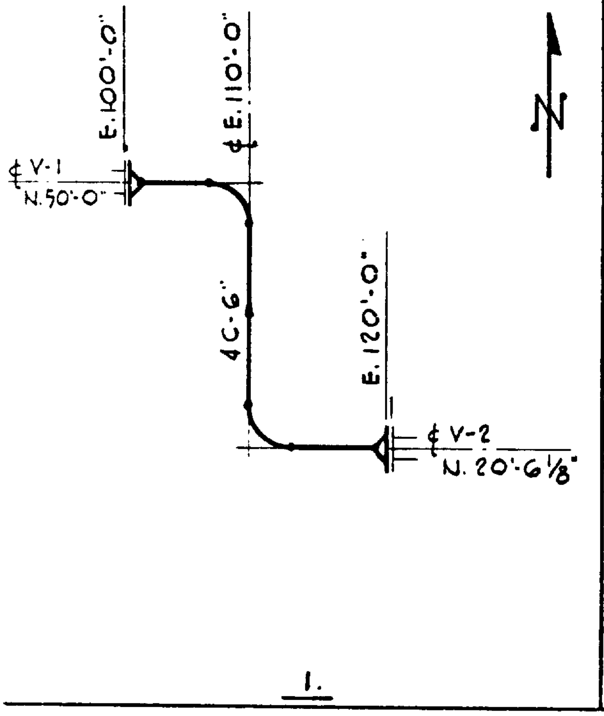
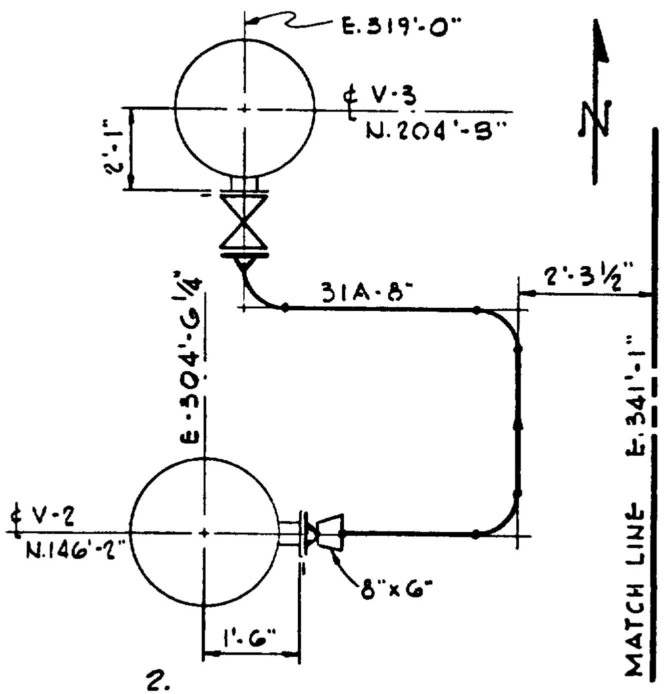


Fig. 8-28. Pump discharge isometric.

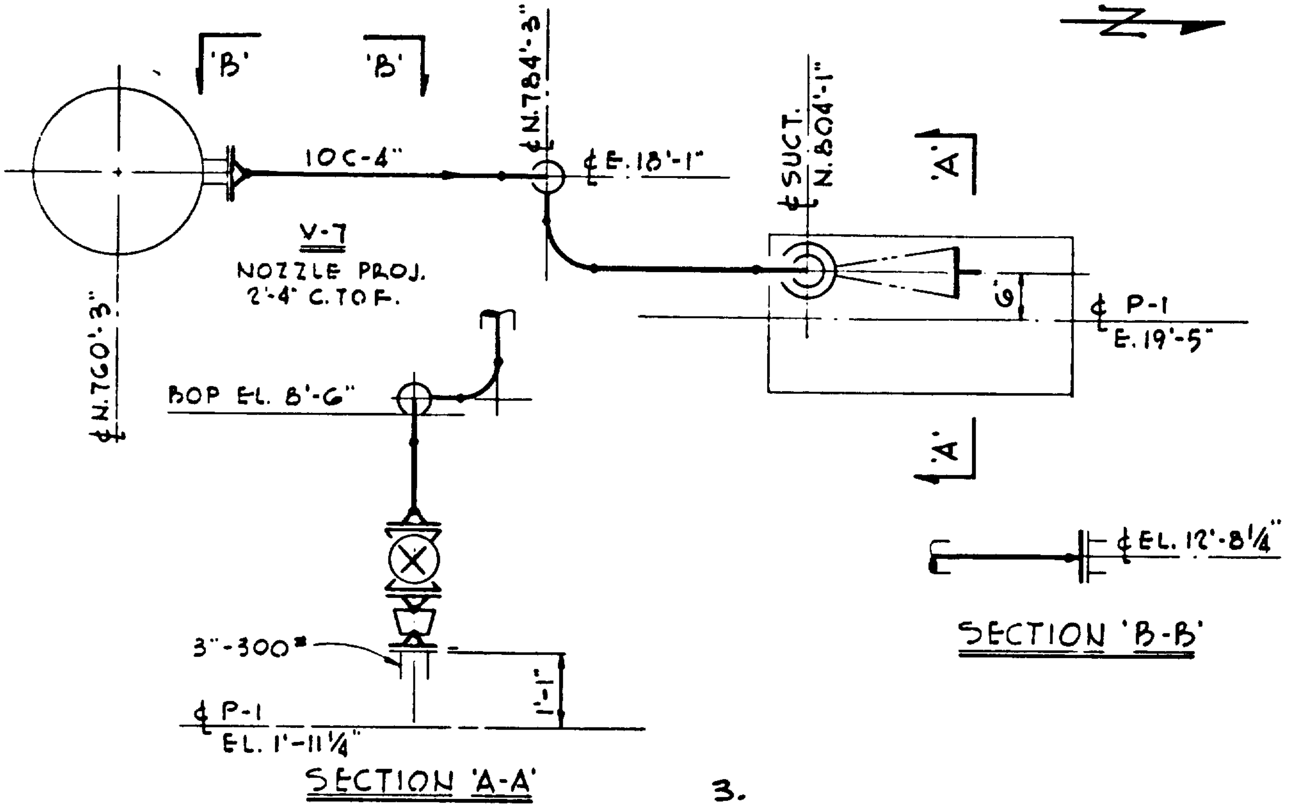
DRAW AN ISOMETRIC OF EACH LINE.
SHOW DIMENSIONS AND SPOOL
CALLOUTS.



1.



2.



3.

Figure 8-29. Isometric Problems (courtesy of Fluor Corp.).

DRAW AN ISOMETRIC OF EACH LINE. SHOW DIMENSIONS & SPOOL CALLOUTS REQUIRED FOR FABRICATION AND ERECTION.

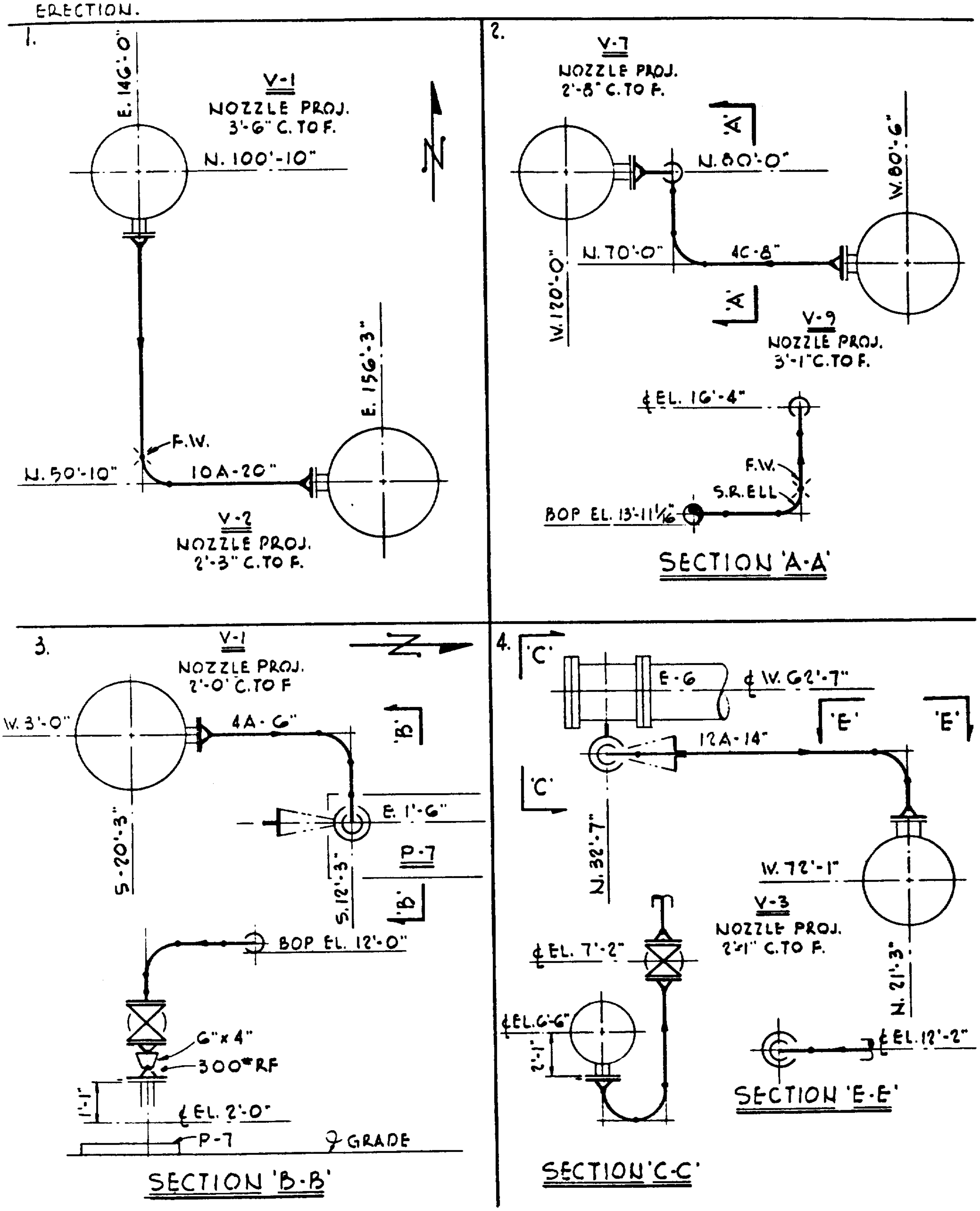


Figure 8-30. Isometric Problems (courtesy of Fluor Corp.).

HOMEWORK

DRAW AN ISOMETRIC OF
EACH LINE & DIMENSION
FOR FABRICATION.

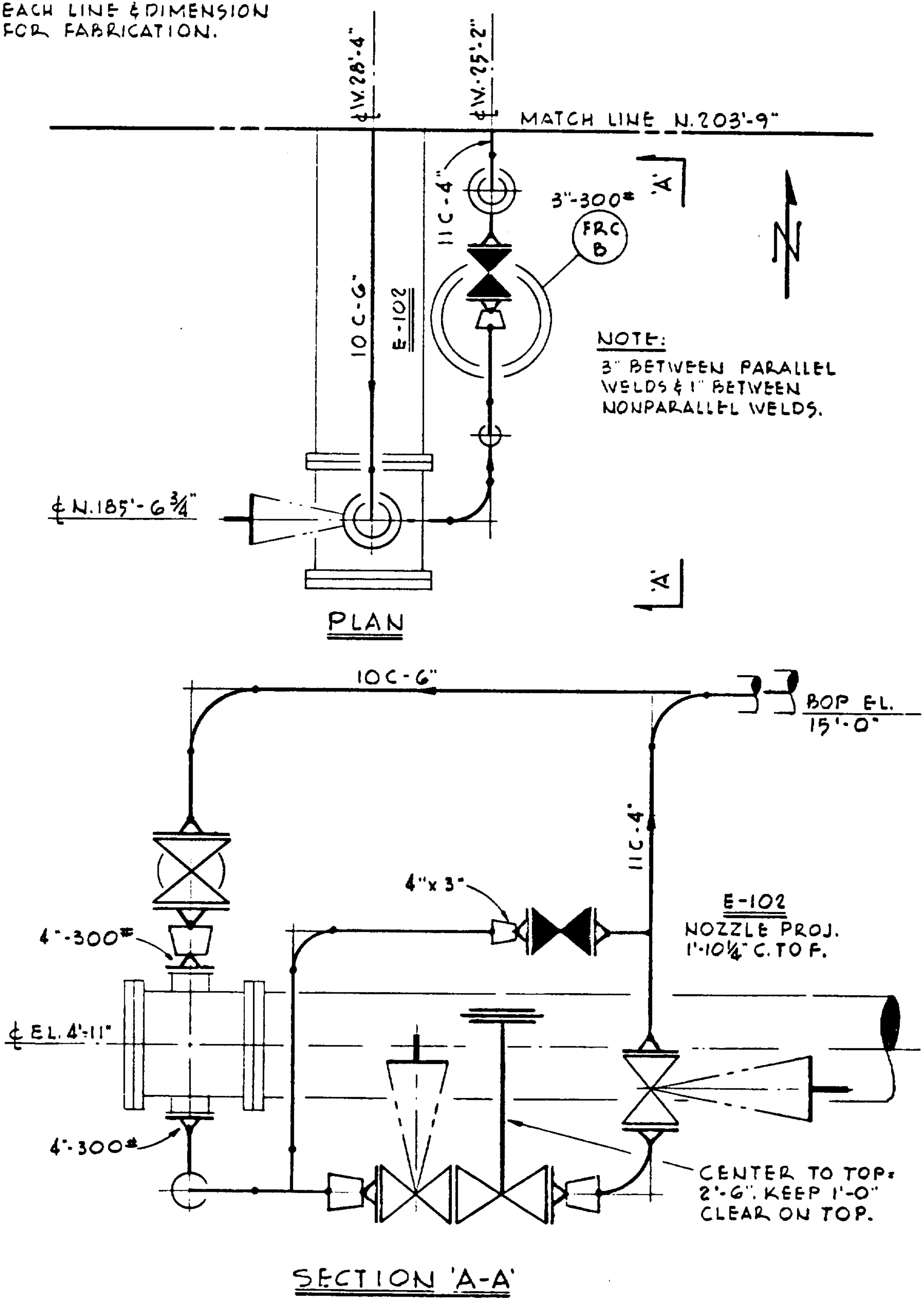


Figure 8-31. Isometric Problems (courtesy of Fluor Corp.).

HOMEWORK

DRAW AN ISOMETRIC OF
EACH LINE & DIMENSION
FOR FABRICATION

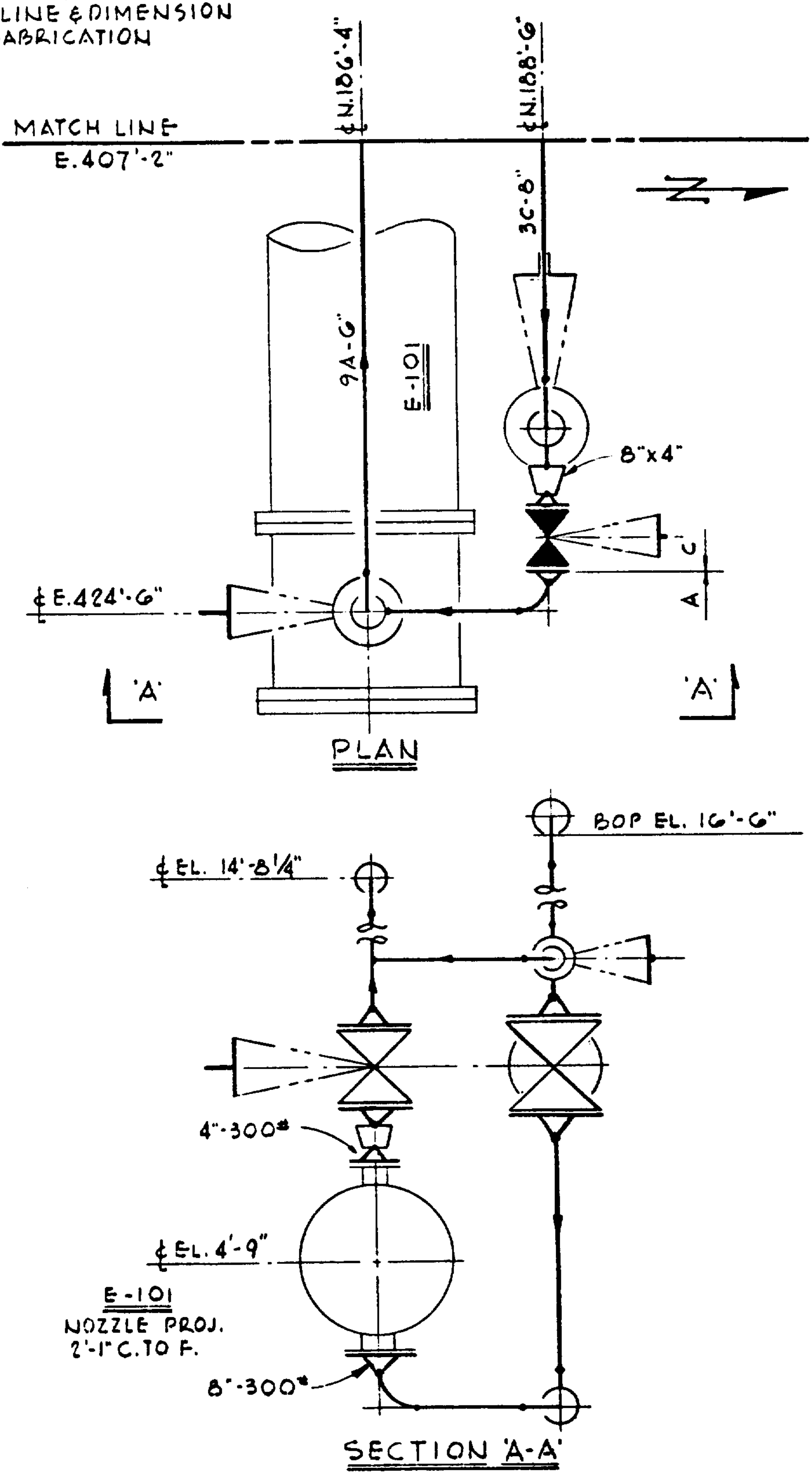


Figure 8-32. Isometric Problems (courtesy of Fluor Corp.).

HOMEWORK

DRAW AN ISOMETRIC OF EACH LINE. SHOW DIMENSIONS, NOTES REQUIRED FOR FABRICATION & ERECTION.

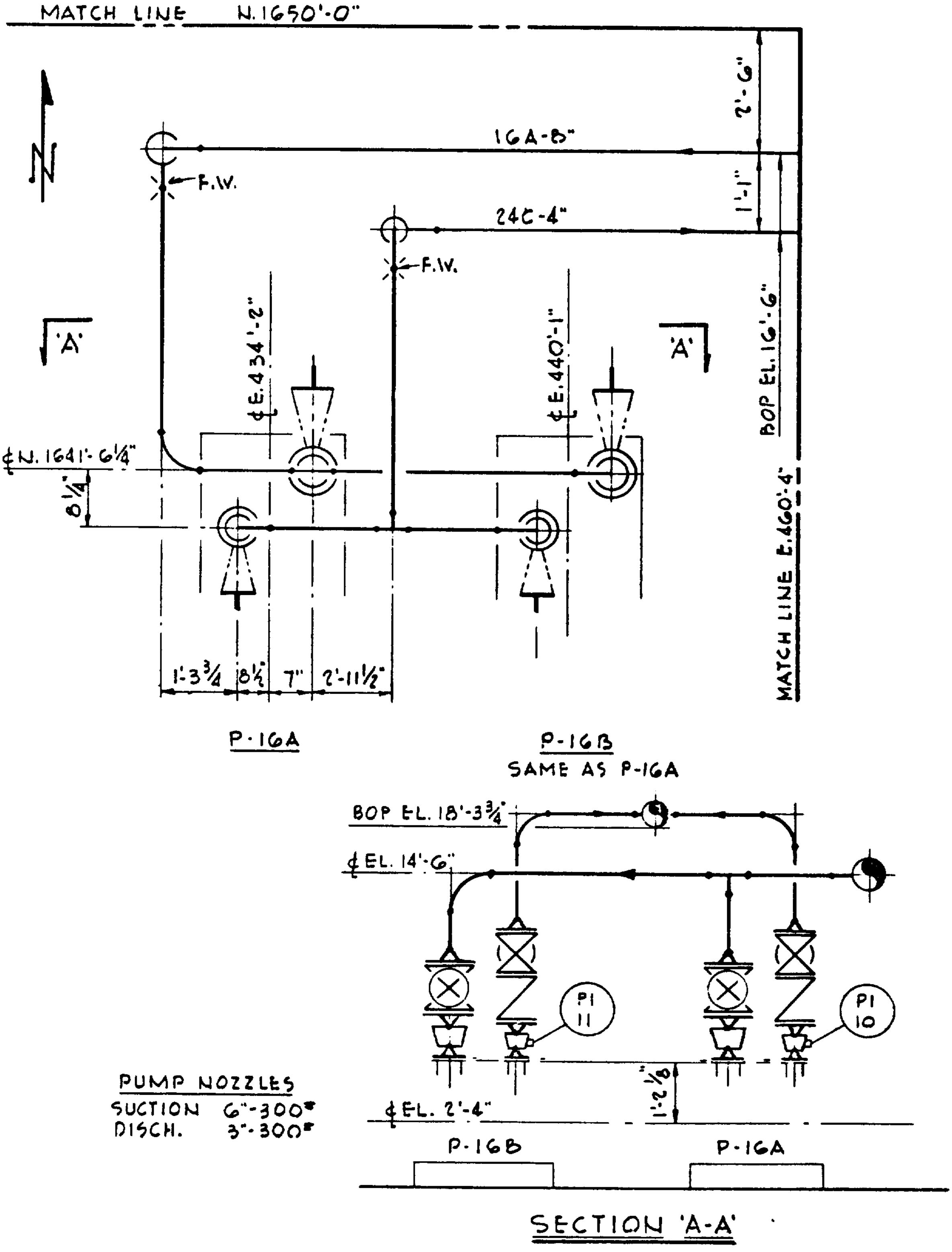


Figure 8-33. Isometric Problems (courtesy of Fluor Corp.).

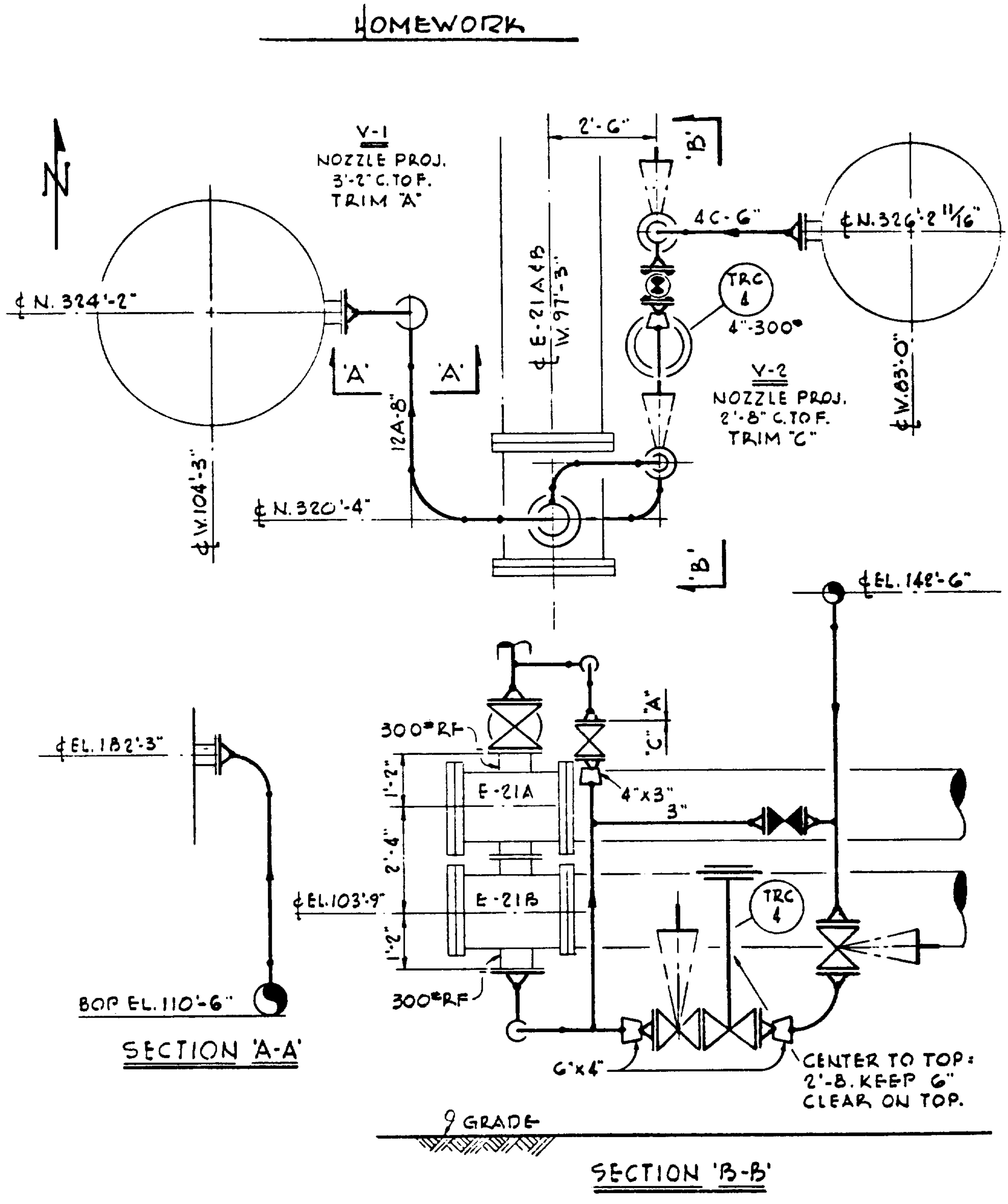


Figure 8-34. Isometric Problems (courtesy of Fluor Corp.).

CHAPTER 9

PROBLEMS

Trigonometric Problems

Every piping draftsman is confronted with triangles. Pipe just will not run straight. Most of these triangles are right triangles and are easily solved with Smoley's combined Tables.

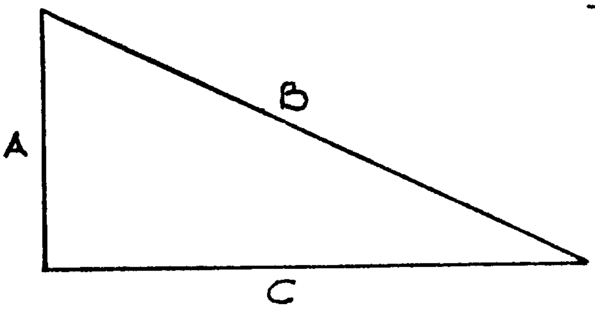
To acquaint the student with Smoley's Tables and to refresh his trig, he is to answer the following problems, using his Smoley's handbook.

1. The square of 22'-4¾" is ____________.
2. The square of 1'-2 1/8" is ____________.
3. The log of 7'-4 1/16" is ____________.
4. The log cos. of 48°-17' is ____________.
5. The log tan. of 38°-18' is ____________.
6. The log sin. of 10°-04' is ____________.
7. The sq. root of 5625 is ____________.
8. The log cotan. of 24°-12' is ____________.
9. π = ____________.
10. The three sides of a right triangle are (1) base, (2) rise, (3) ____________.

Figures 9-1 and 9-2 have formulas, problems and some solutions for right triangles. The student must understand them thoroughly before going on.

Figure 9-3 is a classroom study sheet. He is to solve for "x" in problems 1 through 6. He is not to continue this chapter until he completely understands how to solve these problems.

Figure 9-4 shows how pipe can turn and form triangles. This example forms several triangles. The piping draftsman must be able to take the picture of the piping and mentally form the triangles before he can solve them. Figures 9-4 and 9-5 show steps taken to solve this problem. Figure 9-5 shows the answers and how they appear on the isometric.



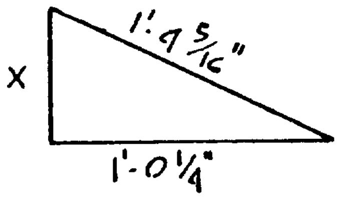
FORMULAS:

$$A = \sqrt{B^2 - C^2}$$

$$B = \sqrt{C^2 + A^2}$$

$$C = \sqrt{B^2 - A^2}$$

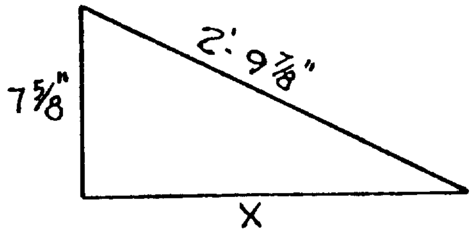
EXAMPLES.



$$(1'\text{-}4\tfrac{5}{16}'')^2 = 1.8479$$

$$(1'\text{-}0\tfrac{1}{4}'')^2 = -1.0421$$

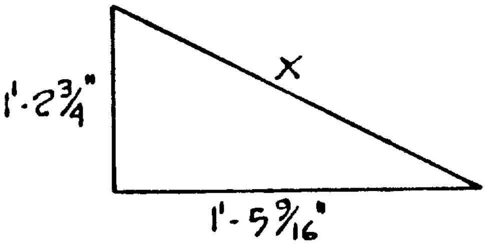
$$X = .8058 = 10\tfrac{3}{4}''$$



$$(2'\text{-}9\tfrac{7}{8}'')^2 = 7.968900$$

$$(0'\text{-}7\tfrac{5}{8}'')^2 = -0.403754$$

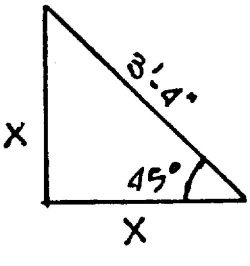
$$X = 7.565146 = 2'\text{-}9''$$



$$(1'\text{-}2\tfrac{3}{4}'')^2 = 1.5109$$

$$(1'\text{-}5\tfrac{9}{16}'')^2 = +2.1420$$

$$X = 3.6529 = 1'\text{-}10\tfrac{15}{16}''$$



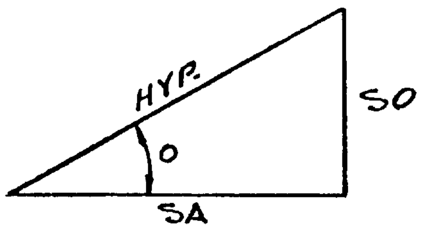
GIVEN: TRAVEL FOR OFFSET ON 45°

FIND: SIDES BY FORMULA — $\sqrt{\dfrac{\text{TRAVEL}^2}{2}}$

$$\text{TRAVEL}^2 = (3'\text{-}4'')^2$$

$$\frac{(3'\text{-}4'')^2}{2} = \frac{11.1111}{2} = 5.55555 = 2'\text{-}4\tfrac{5}{16}''$$

Figure 9-1. Solving Right Triangles with Squares.



$$\frac{SO}{SA} = TAN$$

$$SO = TAN \times SA$$

$$SA = \frac{SO}{TAN}$$

$$\frac{SO}{HYP} = SIN$$

$$SO = SIN \times HYP.$$

$$HYP = \frac{SO}{SIN}$$

$$\frac{HYP}{SO} = CSC$$

$$HYP = CSC \times SO$$

$$SO = \frac{HYP}{CSC}$$

$$\frac{SA}{SO} = COT$$

$$SA = COT \times SO$$

$$SO = \frac{SA}{COT}$$

$$\frac{SA}{HYP} = COS$$

$$SA = COS \times HYP$$

$$HYP = \frac{SA}{COS}$$

$$\frac{HYP}{SA} = SEC$$

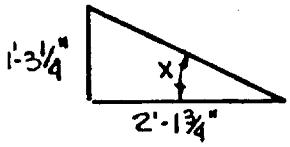
$$HYP = SEC \times SA$$

$$SA = \frac{HYP}{SEC}$$

Figure 9-2. Trigonometric Functions and Formulas.

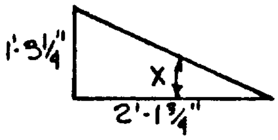
USING LOGARITHMS SOLVE THE FOLLOWING RIGHT TRIANGLES FOR "X" ONLY.

1.



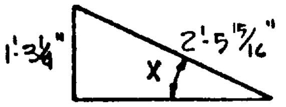
$\frac{SO}{SA} = \text{TAN } X$

2.



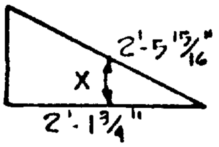
$\frac{SA}{SO} = \text{COT } X$

3.



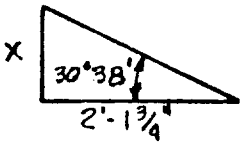
$\frac{SO}{HYP} = \text{SIN } X$

4.



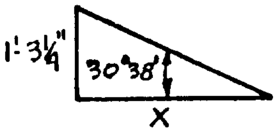
$\frac{SA}{HYP} = \text{COS } X$

5.



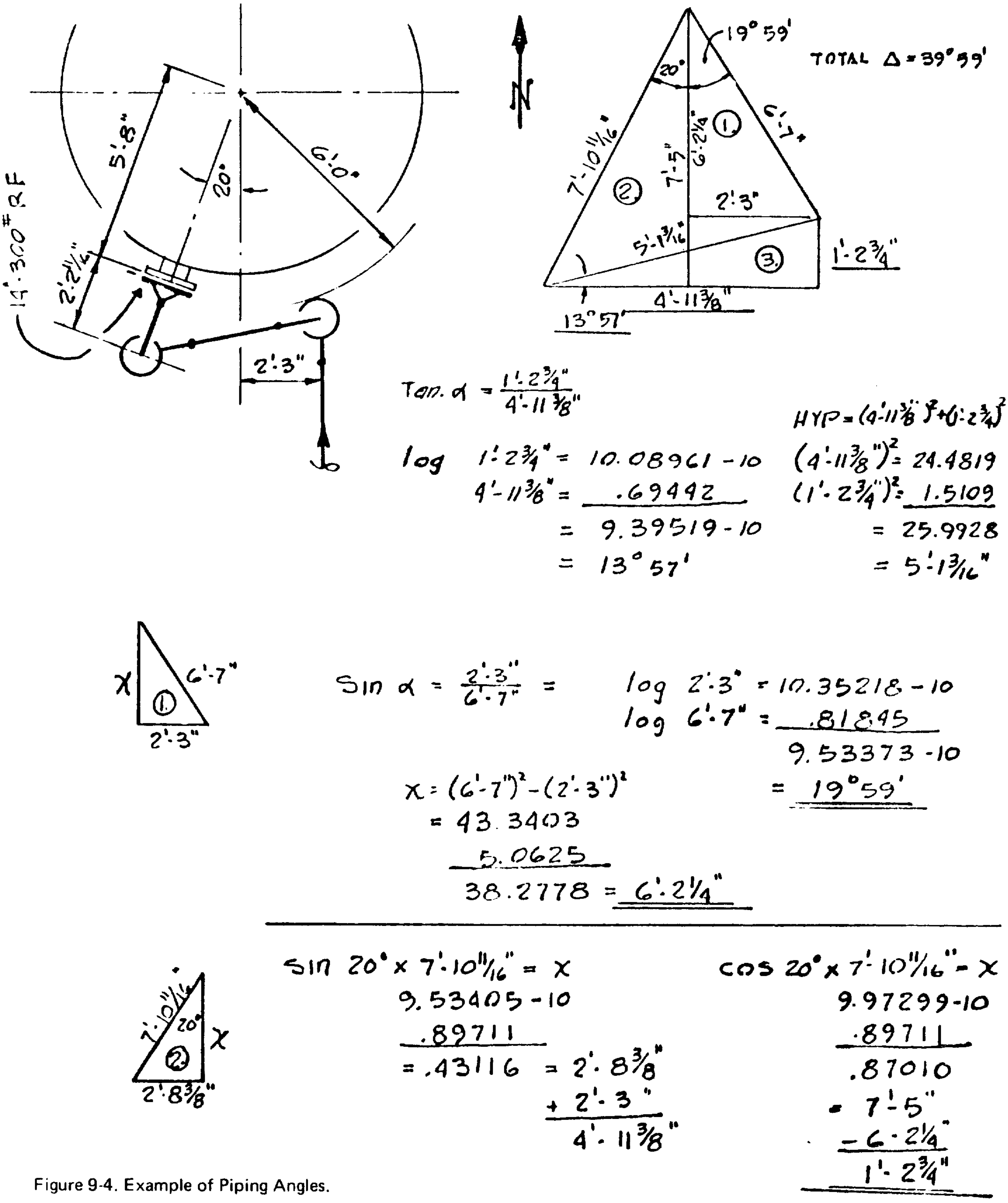
$SO = SA \times TAN$

6.



$SA = COT. \times SO$

Figure 9-3. Triangle Problems.



Tan. α = 1'-2¾" / 4'-11⅜"

log 1'-2¾" = 10.08961 - 10
4'-11⅜" = .69442
= 9.39519 - 10
= 13° 57'

HYP = $(4'\text{-}11\frac{3}{8}")^2 + (1'\text{-}2\frac{3}{4}")^2$
$(4'\text{-}11\frac{3}{8}")^2$ = 24.4819
$(1'\text{-}2\frac{3}{4}")^2$ = 1.5109
= 25.9928
= 5'-1 3/16"

Sin α = 2'-3" / 6'-7" =

log 2'-3" = 10.35218 - 10
log 6'-7" = .81845
9.53373 - 10
= 19°59'

X = $(6'\text{-}7")^2 - (2'\text{-}3")^2$
= 43.3403
5.0625
38.2778 = 6'-2¼"

sin 20° × 7'-10 11/16" = X
9.53405 - 10
.89711
= .43116 = 2'-8⅜"
+ 2'-3"
4'-11⅜"

cos 20° × 7'-10 11/16" = X
9.97299 - 10
.89711
.87010
= 7'-5"
- 6'-2¼"
1'-2¾"

Figure 9-4. Example of Piping Angles.

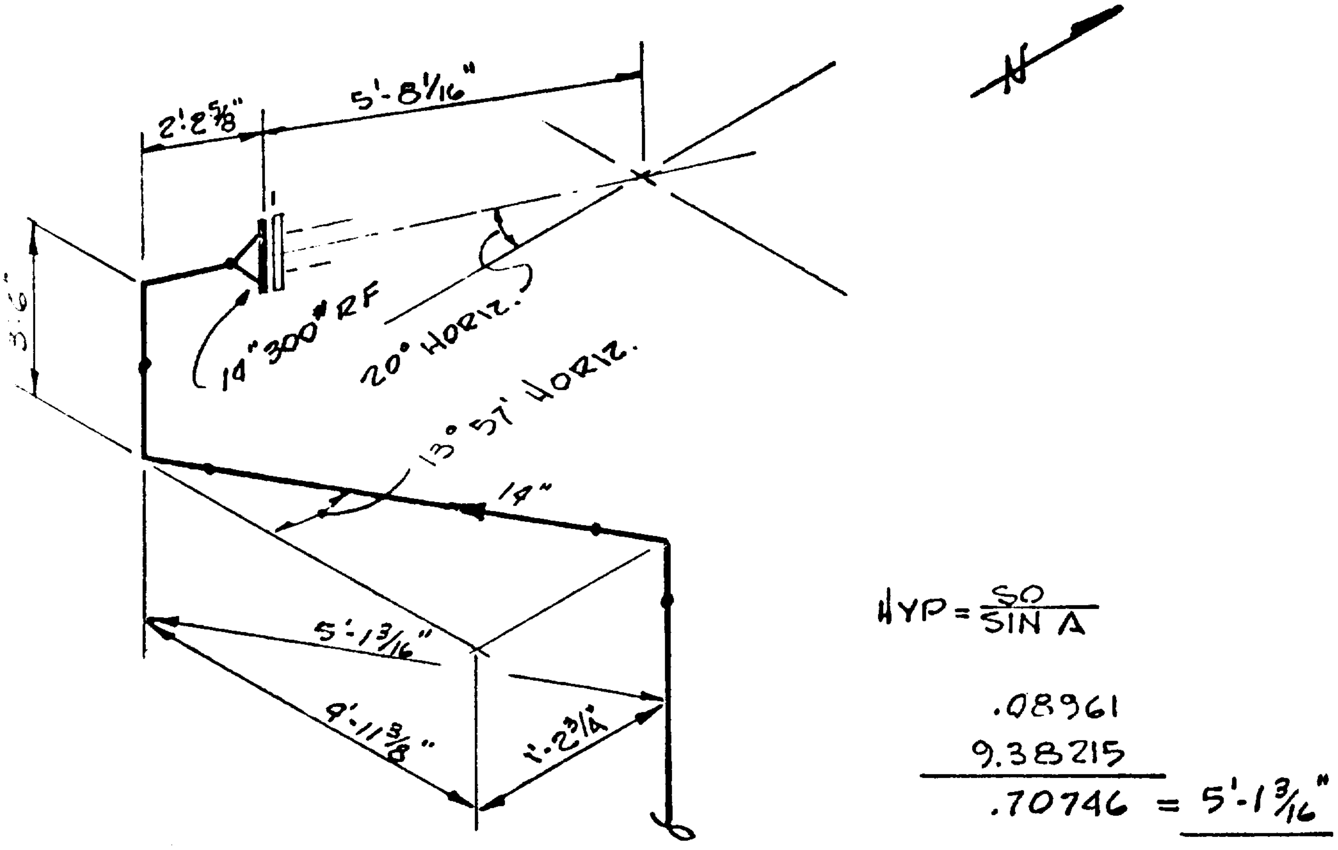


Figure 9-5. Answer Sheet for Figure 9-4.

Figure 9-6 shows how piping not only forms angles in one plane but can roll at the same time into another plane. This is a "rolling offset" or "compound angle." The student is to follow the steps through, one by one, to see how this problem is solved.

Figure 9-7 shows a rolling offset. For homework, the instructor will give some dimensions for A, B and C. The student is to solve for dimension x and angle y.

Figures 9-8 and 9-9 have four problems to be solved.

Figure 9-10 shows a piece of pipe as one might have on a job. Example 1 shows it in plan. Example 2 is a rolling offset problem using 45° ells. Calculate the angle left out using example 2a as a guide. In example 3, calculate a, b and c. The student is to work the problem and supply the missing information in example 2a.

Natural Functions

Since many students use electronic desk calculators, natural functions are commonly used when solving right triangles. The use of natural functions requires that all numbers be converted to whole numbers and decimals so any feet and inches number must be converted to feet and decimals of a foot. Table 9-1 provides these conversions.

To convert 9'-5¼" to feet and decimals of a foot, Table 9-1 shows 5¼" equals .4375' so 9'-5¼" becomes 9.4375'.

Using the functions and formulas shown in Figure 9-2, triangles may be solved using the natural functions located in the Smoleys handbook. Problem #1, Figure 9-3 is solved:

Table 9-1 Decimal Equivalents

	Decimals of a Foot												Decimals of an inch	
	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"		
-	.0000	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167	-	
1/16"	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	.9219	1/16"	.0625
1/8"	.0104	.0937	.1771	.2604	.3437	.4271	.5104	.5937	.6771	.7604	.8437	.9271	1/8"	.1250
3/16"	.0156	.0990	.1823	.2656	.3490	.4323	.5156	.5990	.6823	.7656	.8490	.9323	3/16"	.1875
1/4"	.0209	.1042	.1875	.2708	.3542	.4375	.5208	.6042	.6875	.7708	.8542	.9375	1/4"	.2500
5/16"	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6094	.6927	.7760	.8594	.9427	5/16"	.3125
3/8"	.0312	.1146	.1979	.2812	.3646	.4479	.5312	.6146	.6979	.7812	.8646	.9479	3/8"	.3750
7/16"	.0365	.1198	.2031	.2865	.3698	.4531	.5365	.6198	.7031	.7865	.8698	.9531	7/16"	.4375
1/2"	.0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	.9583	1/2"	.5000
9/16"	.0469	.1302	.2135	.2969	.3802	.4635	.5469	.6302	.7135	.7969	.8802	.9635	9/16"	.5625
5/8"	.0521	.1354	.2188	.3021	.3854	.4688	.5521	.6354	.7188	.8021	.8854	.9688	5/8"	.6250
11/16"	.0573	.1406	.2240	.3073	.3906	.4740	.5573	.6406	.7240	.8073	.8906	.9740	11/16"	.6875
3/4"	.0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792	3/4"	.7500
13/16"	.0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844	13/16"	.8125
7/8"	.0729	.1562	.2396	.3229	.4062	.4896	.5729	.6562	.7396	.8229	.9062	.9896	7/8"	.8750
15/16"	.0781	.1615	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9948	15/16"	.9375

SO ÷ SA = TAN X so 1'-3¼" ÷ 2'-1¾" = TAN X

converting, 1'-3¼" becomes 1.2708' and 2'-1¾" becomes 2.1458'.

then:

1.2708÷2.1458 = TAN X
0.5922 = TAN X
30°-38' = X

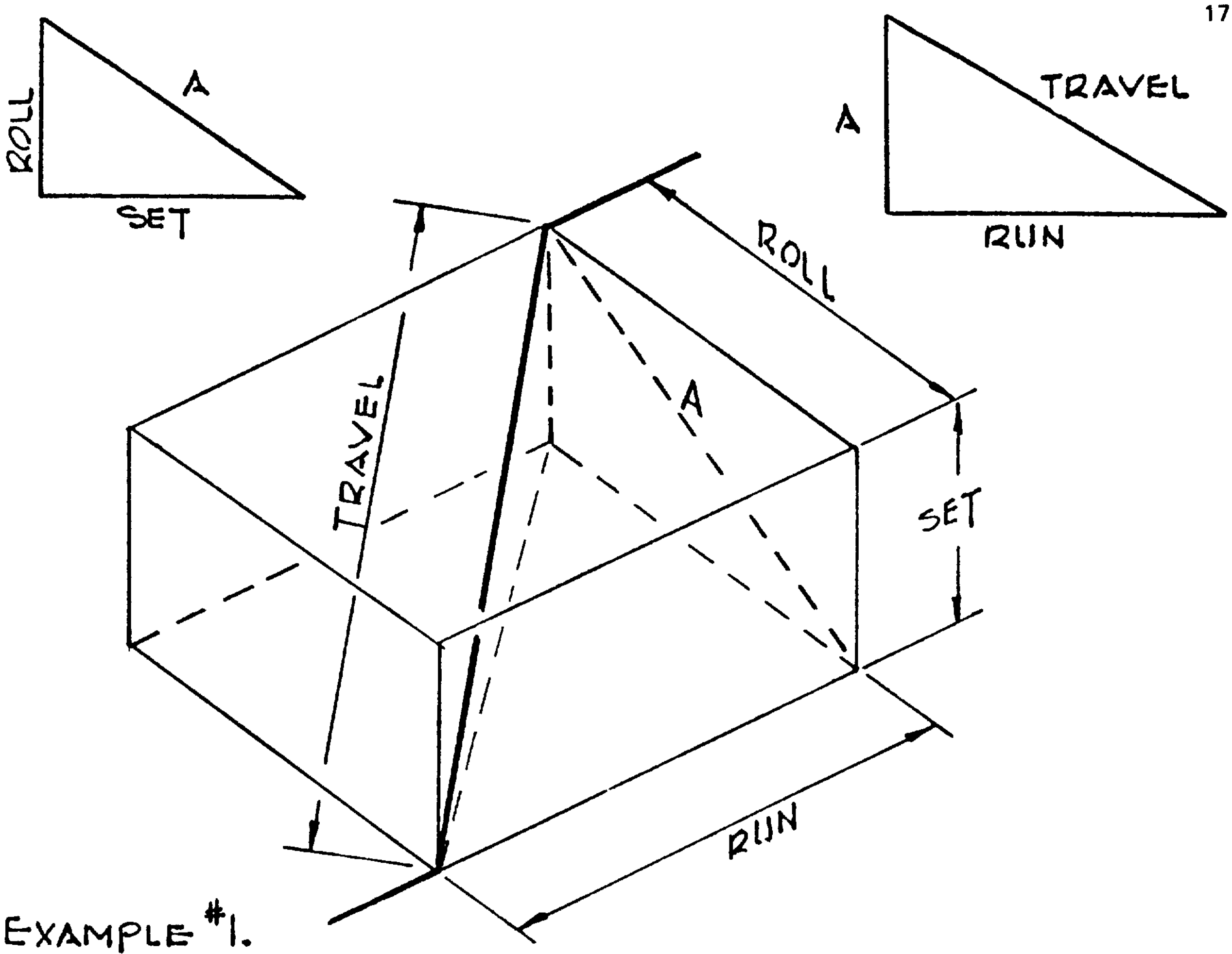
For practice, solve all triangles shown in Figure 9-3 using natural functions.

Orthographic Projections

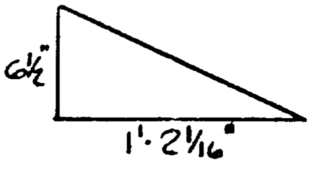
The student has drawn isometrics from orthographics. The reverse of this is to draw orthographics from isometrics. The following problems utilize a lot of what he has learned concerning the plant coordinate system, the elevations shown and the dimensioning methods.

Using a 3/8" = 1'-0" scale, he is to draw the plan view and section A-A for the isometric in Figures 9-11 and 9-12. Also, he is to give all valve dimensions, gasket hash marks where required and other control dimensions. He must be thorough.

Figure 9-11 gives the isometric of line 6A; Figure 9-12, the isometric of line 12C.



EXAMPLE #1.



1'-2 1/16" SET ON 6½" ROLL USING 45° FITTINGS.

6½"^{2} = 0.293403

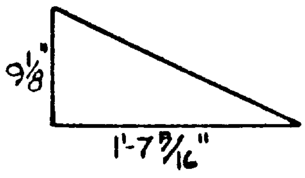
1'-2 1/16"^{2} = 1.373300

1.666703 = 1'-3½"

1.666703

3.333406 = 1'-9 15/16" TRAVEL.

EXAMPLE #2.

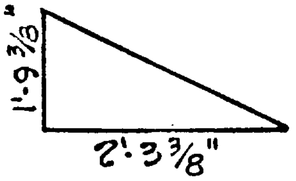


9⅛" ROLL, 1'-7 5/16" SET & 2'-3⅜" RUN

9⅛"^{2} = 0.578234

1'-7 5/16"^{2} = 2.590100

3.168334 = 1'-9⅜"



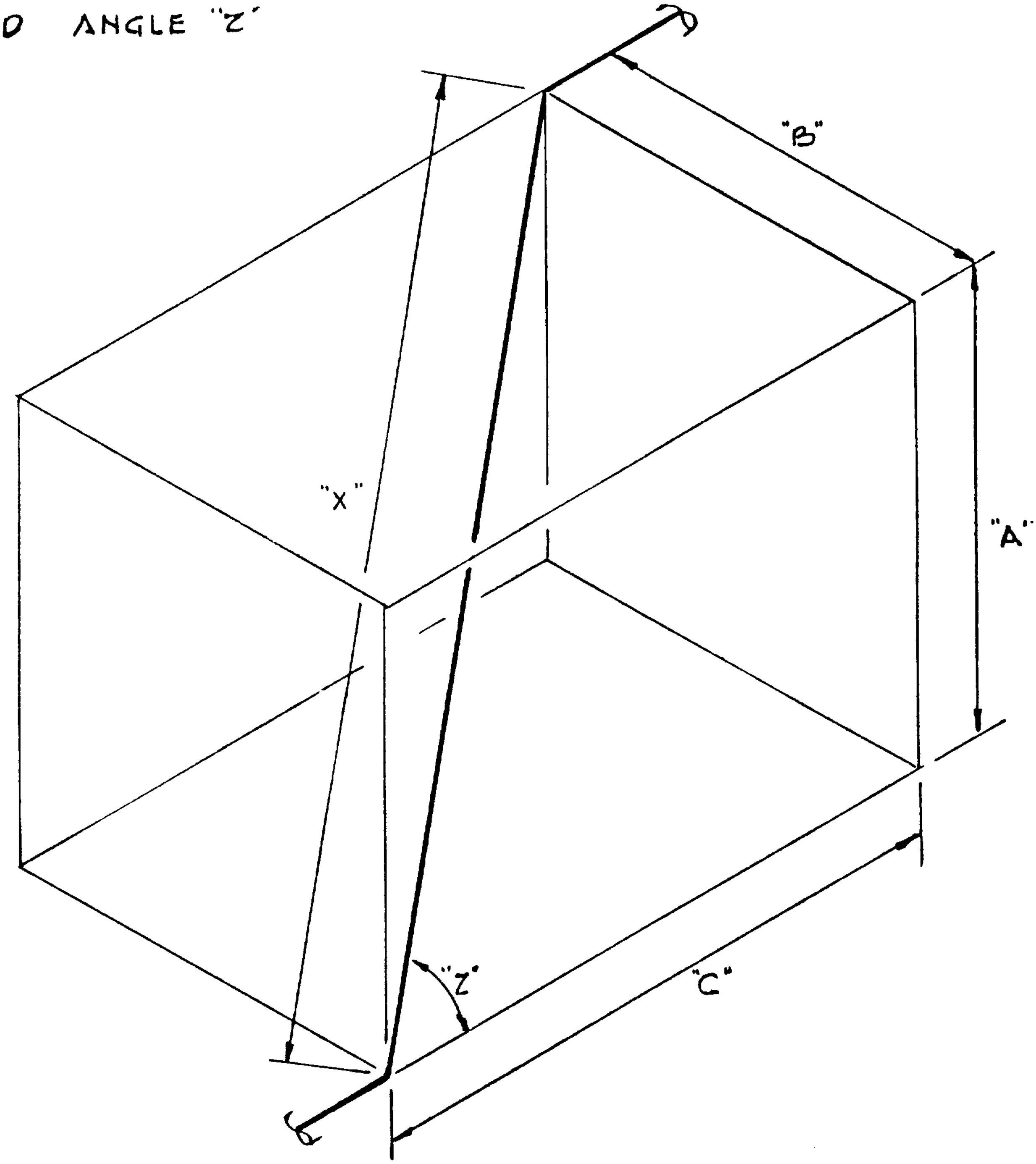
1'-9⅜"^{2} = 3.1729 ; FROM ABOVE

2'-3⅜"^{2} = 5.204

8.3760 = 2'-10¾" TRAVEL.

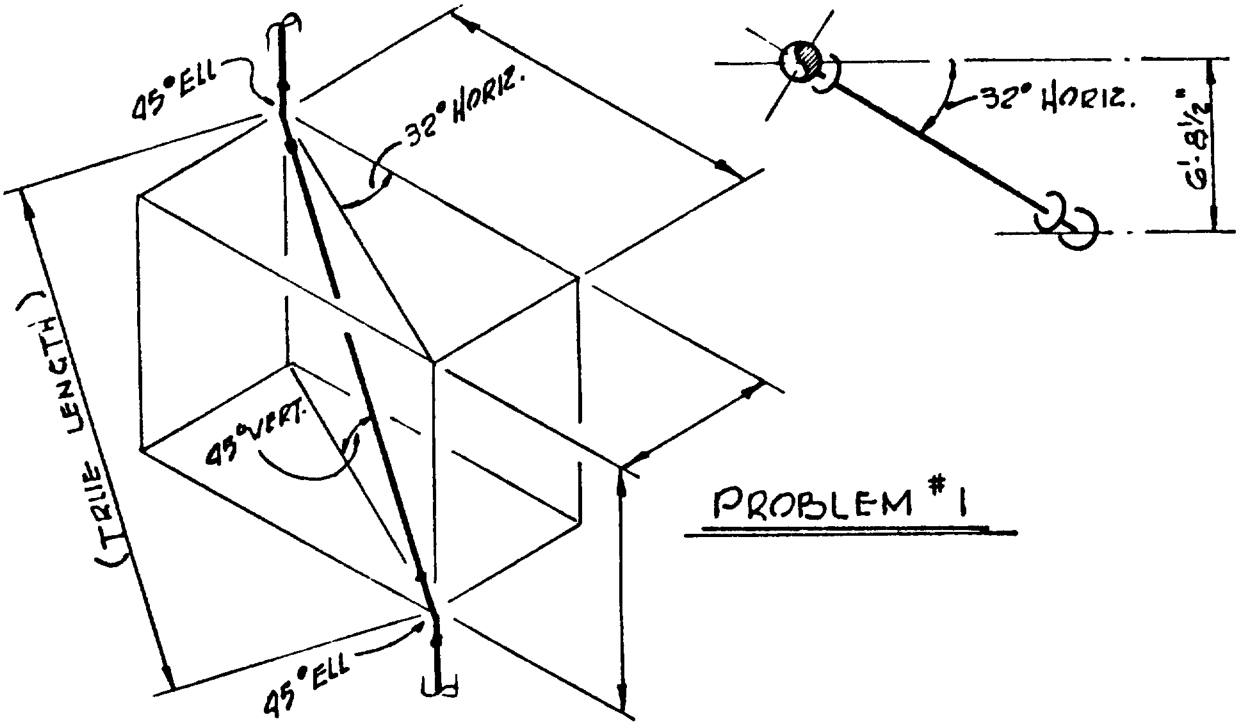
Figure 9-6. Rolling Offsets Containing Two Right Triangles.

ASSIGN VARIOUS PROBLEMS WITH DIFFERENT DIMENSIONS.

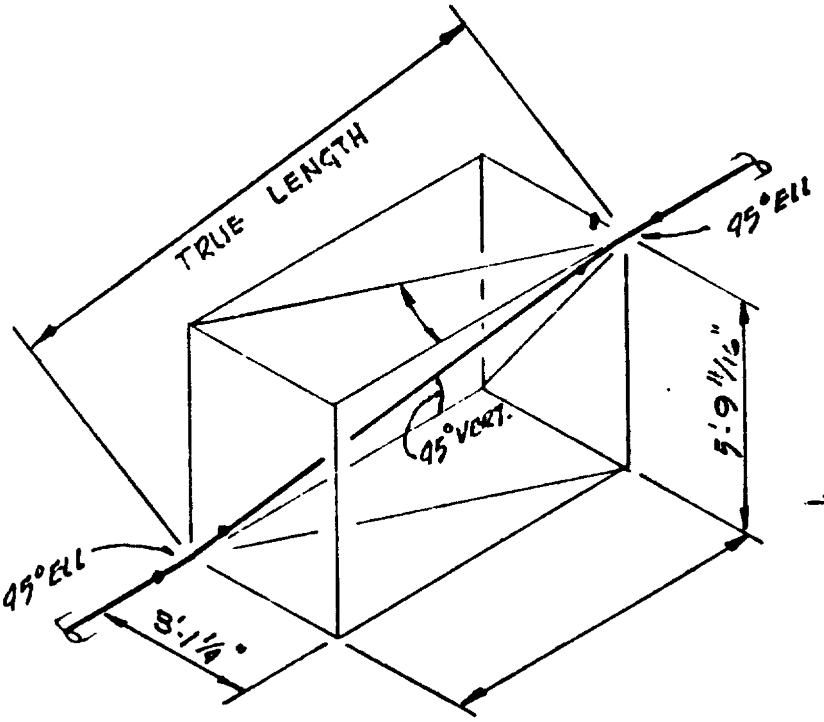


FIND DIMENSION "X"
FIND ANGLE "Z"
"A" =
"B" =
"C" =

Figure 9-7. Rolling Offset Problems.

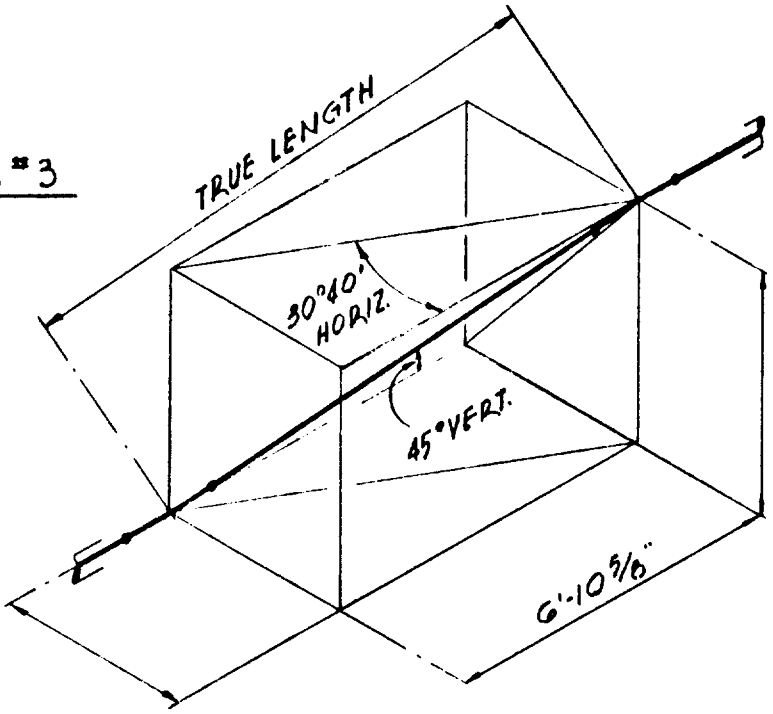


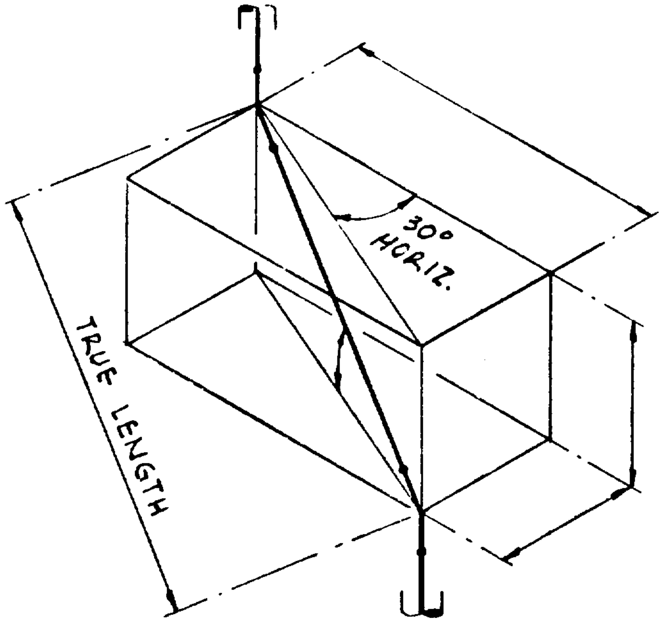
PROBLEM #1



PROBLEM #2

Figure 9-8. Rolling Offset Problems.





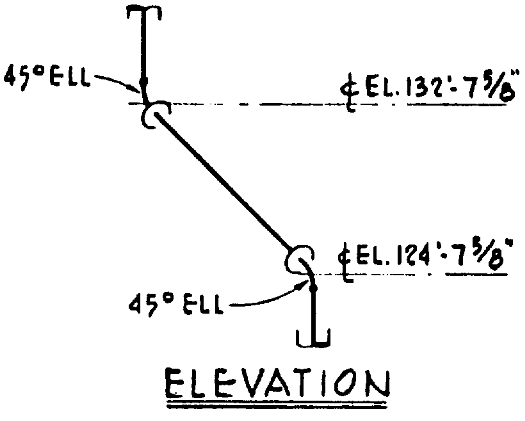


Figure 9-9. Rolling Offset Problems.

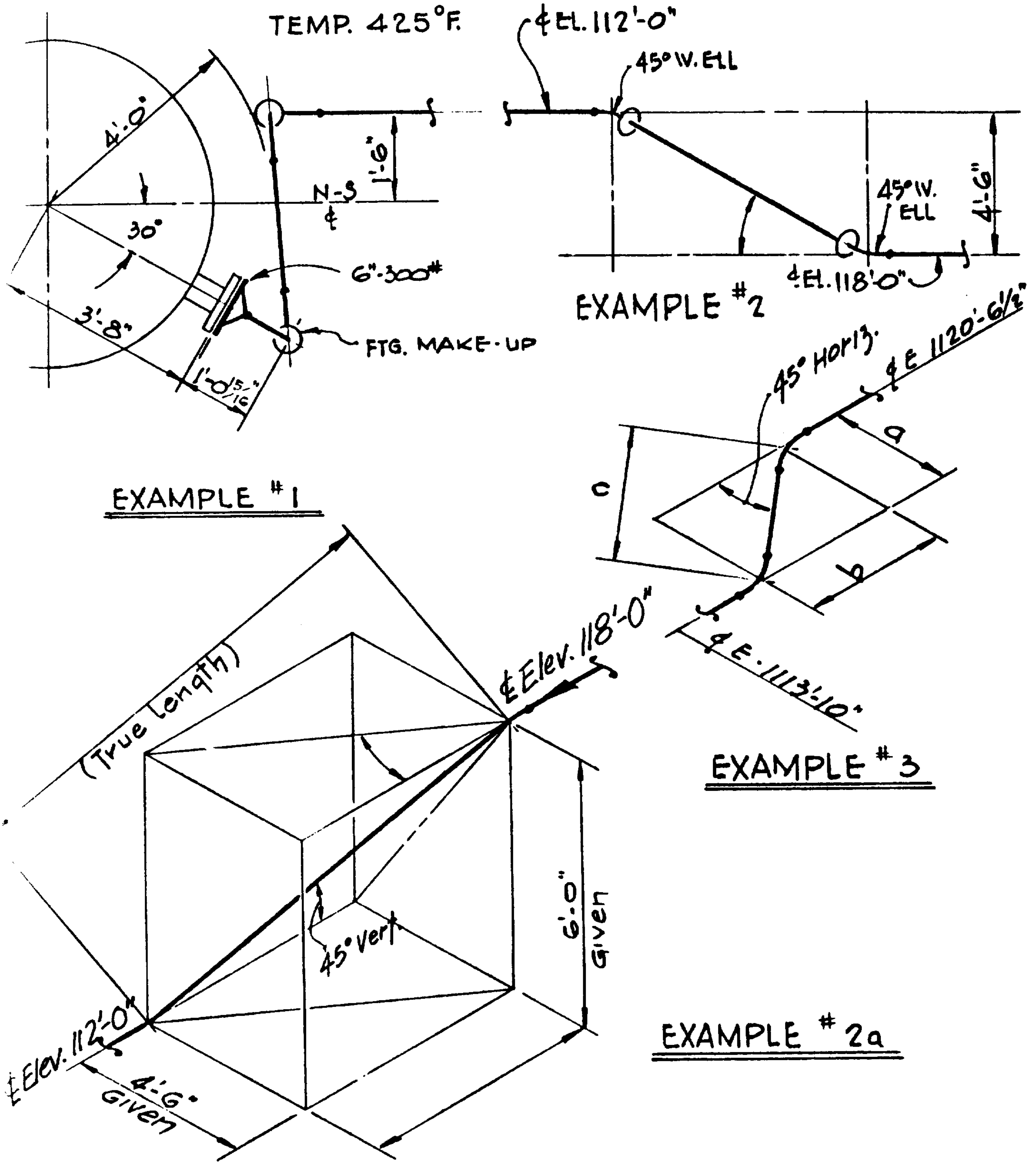


Figure 9-10. Rolling Offset Problems.

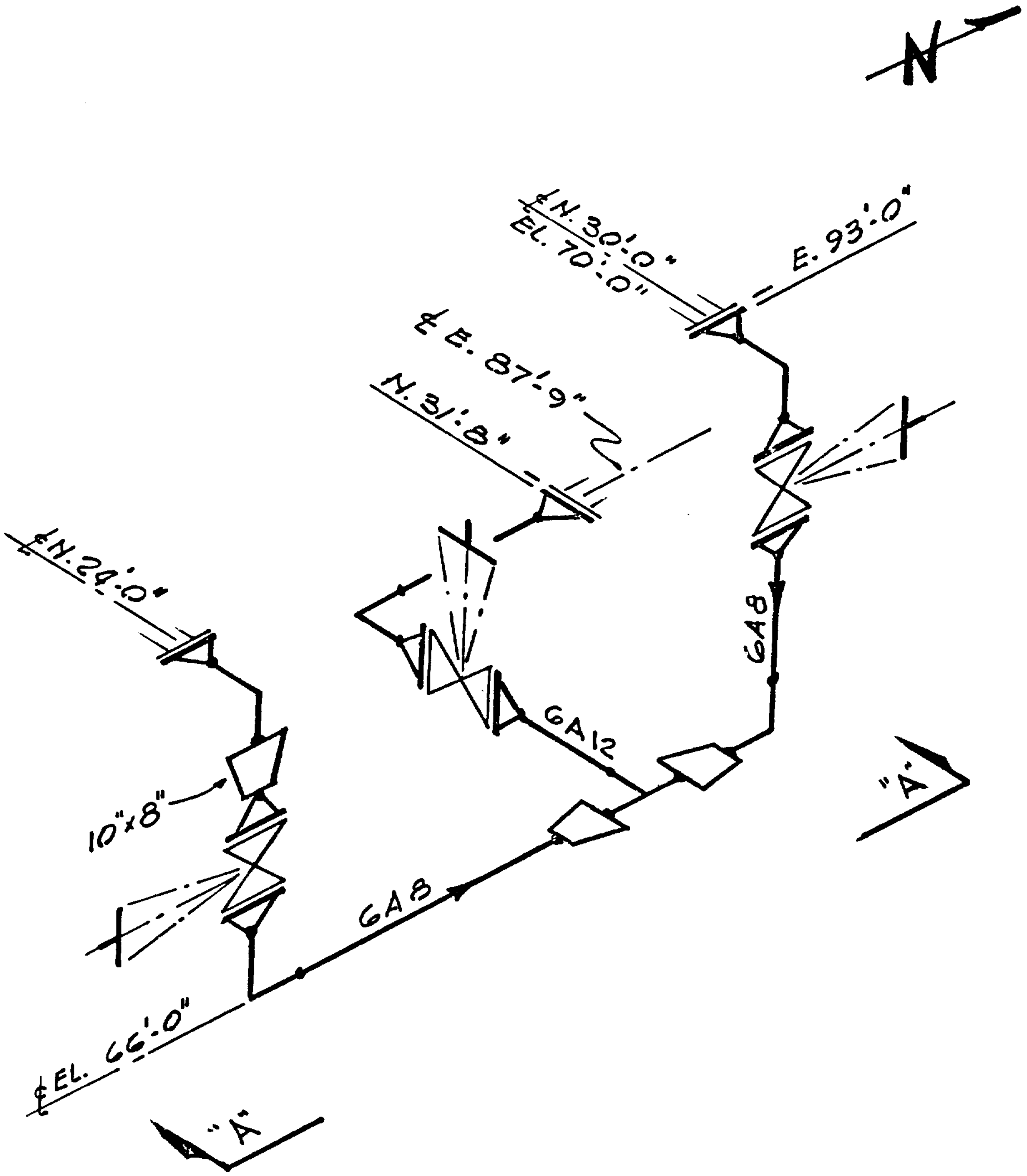
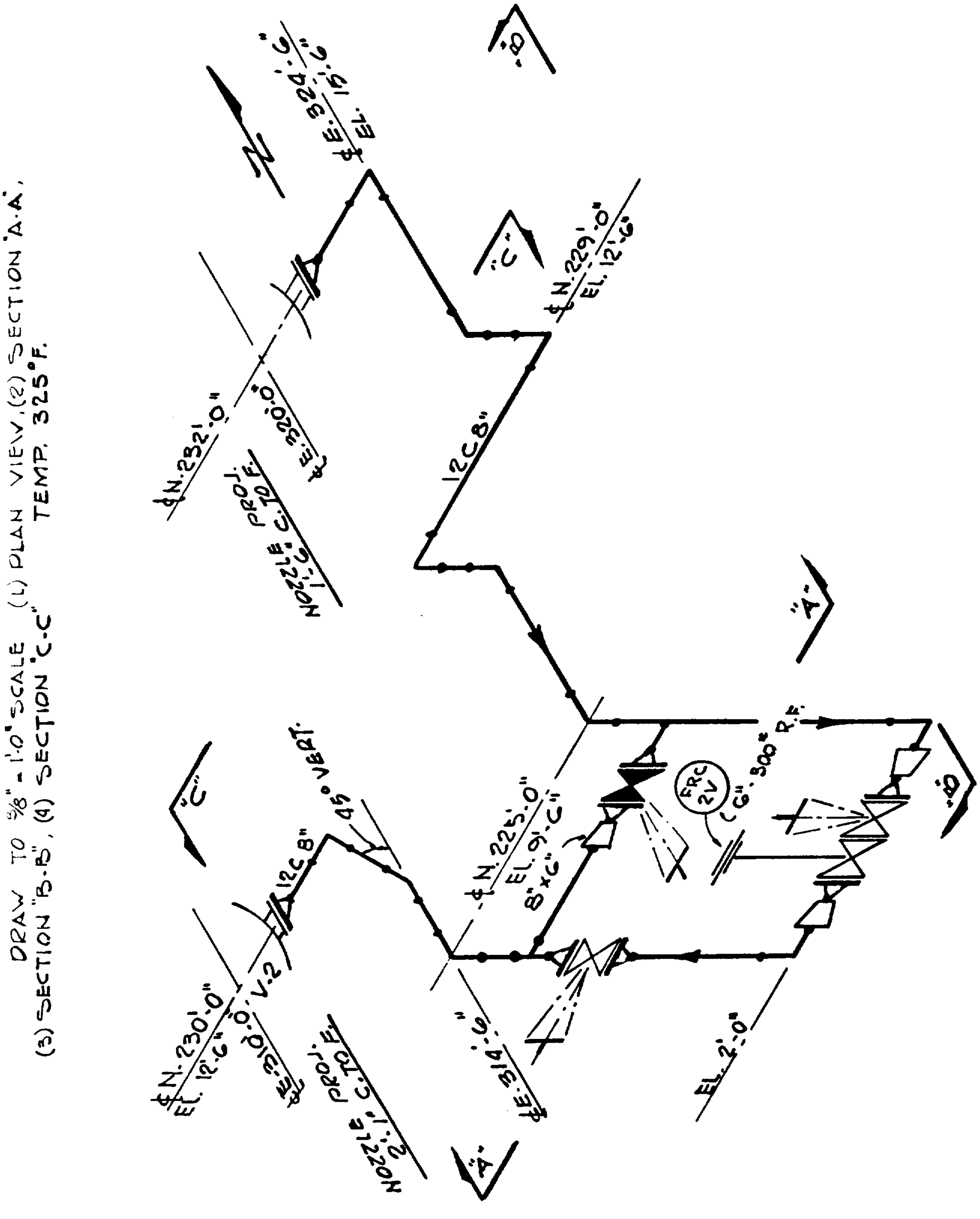


Figure 9-11. Isometric of Line 6A.



DRAW TO 3/8" = 1'-0" SCALE (1) PLAN VIEW, (2) SECTION 'A-A', (3) SECTION 'B-B', (4) SECTION 'C-C' TEMP. 325°F.

Figure 9-12. Isometric of Line 12C (courtesy of Fluor Corp.).

CHAPTER 10

FINAL TEST

Now the student will put his new learning to a test. The following project should take about 30 hours. This should be *his* project, and he is to look only at his paper. He's to do his best linework and lettering. And after completing his drawings, he is to give them to the instructor. At the end of the 30 hours, he may check another student's work. Good luck. Here is the project.

A piping designer has made a rough layout of a process area. He has made some errors because he was rushed. He gives you the flow diagram, layout and equipment drawings and says, "Draw this up in finished form. Use three sheets of 18" x 24" paper. Draw the plan and sections A-A, B-B and C-C. Draw the isometrics for lines 223C, 224C and 227C. Draw them on isometric paper."

You can use the book for this project. Use the piping specifications, insulation specifications and piping standard details. Use the foundation and equipment drawings, pages 118-130.

Assume that the high point of paving is elevation 100'-0", that all pipe rack members are 8" x 8" wide flange shapes, that TOS elevation is 114'-0" for the main rack member and elevation 116'-0" for the connecting strut.

If you have any questions, direct them to your instructor.

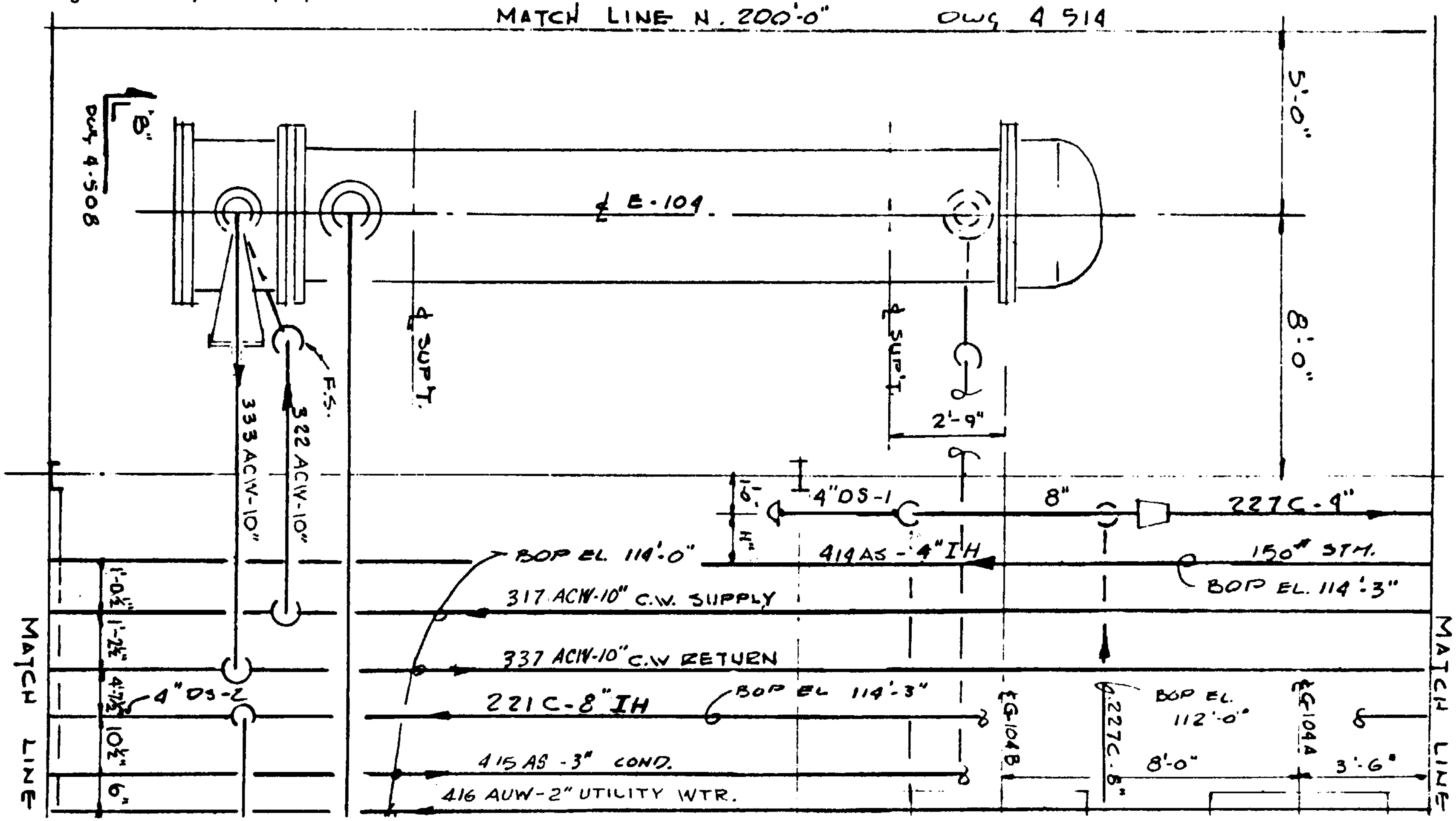
Draw all items to scale.

The flow diagram states that LG-411 is 3 sections put together to total 39" center-to-center of taps. LC-407 has a 32" float range and will be type #12809W per page 255. The 6" control valve, TRC-405, is shown on page 244. Use the single port steel body, port guided with extension bonnet with Type 657 diaphram actuator as shown on page 243, upper left-hand corner. The 3" control valve, LC-407, does not appear on this area layout. Refer to Chapter 5 for bridle details.

PSV-405 is shown on pages 230 and 231.

The student is referred to Figures 10-1 and 10-2, which show the rough layout of a depropanizer area and the mechanical flow sheet for this depropanizer area, respectively.

Figure 10-1. Layout—Depropanizer Area.



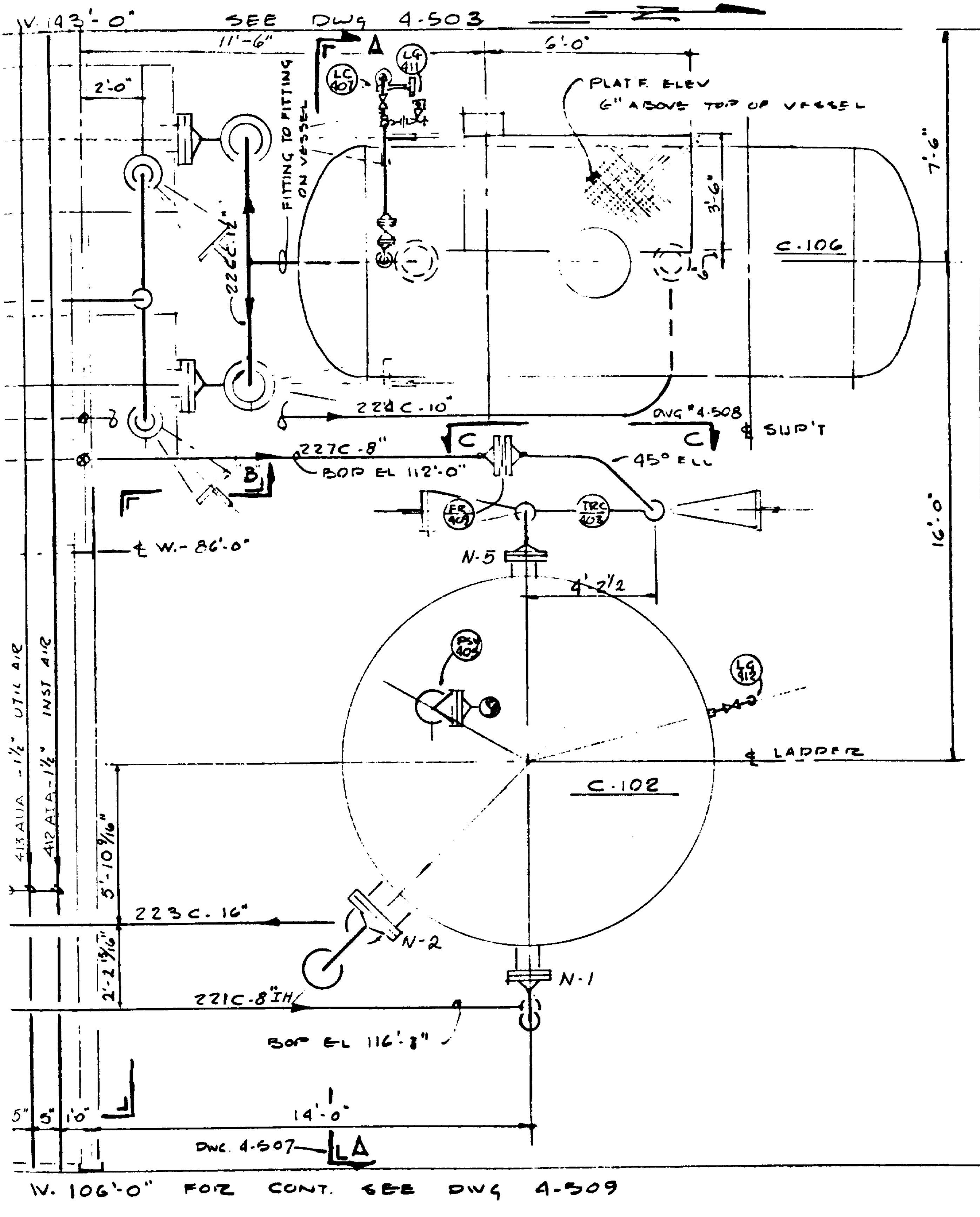


Figure 10-1. (continued).

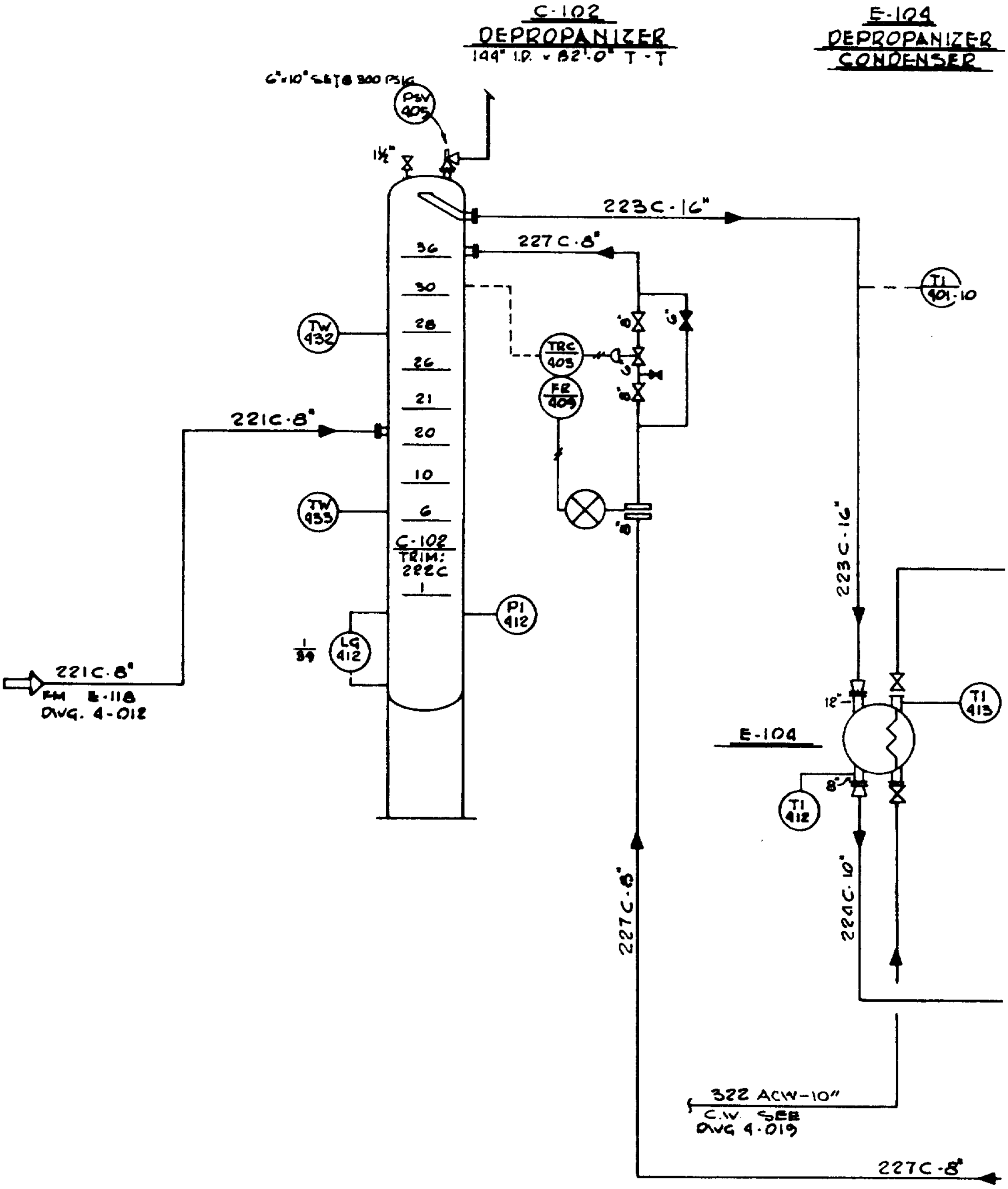


Figure 10-2. Mechanical Flow Diagram—Depropanizer.

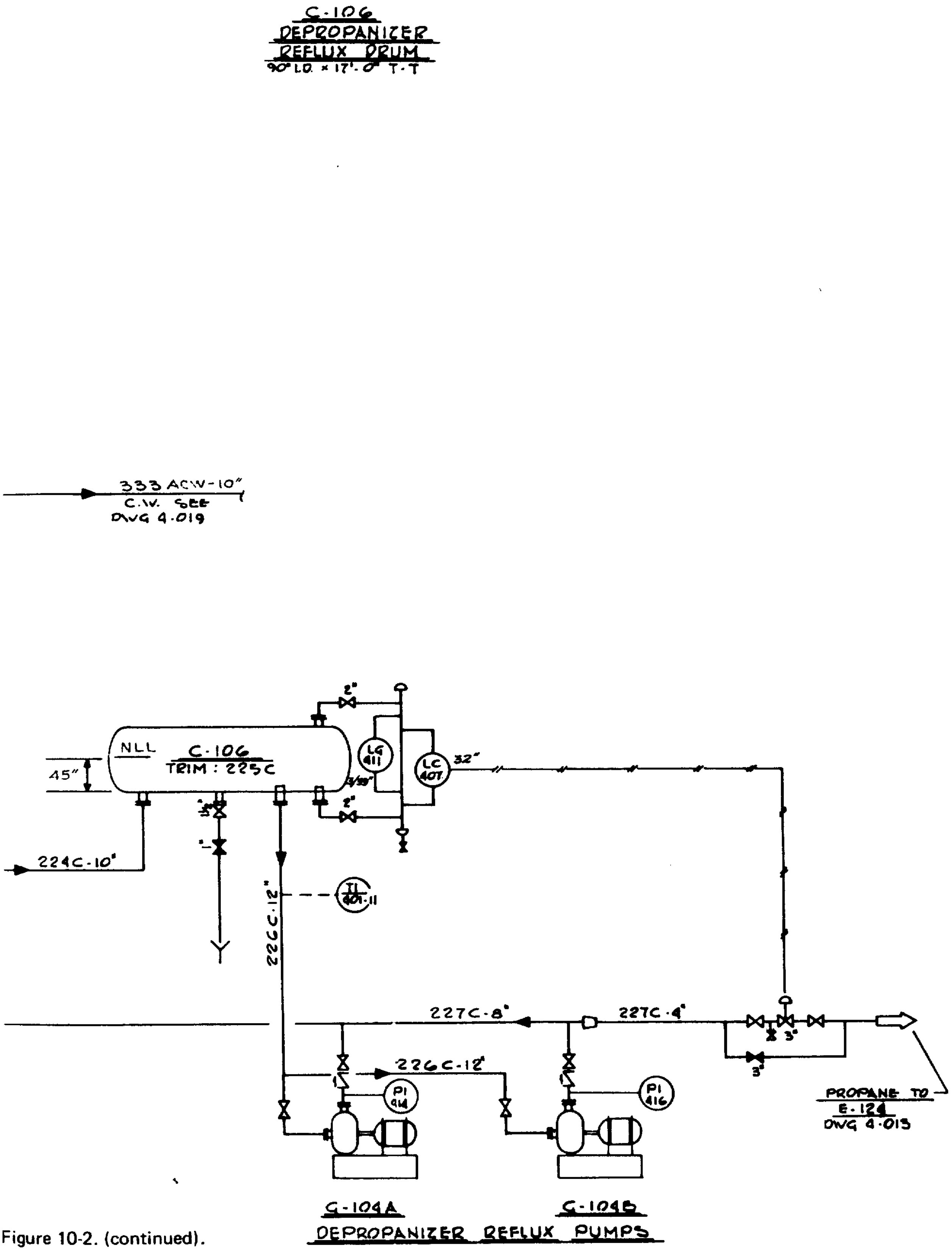


Figure 10-2. (continued).

CHAPTER 11

MANUFACTURERS' CATALOG REPRODUCTIONS

Manufacturers are very helpful in furnishing catalog data to the professional piping draftsman. Their goal, of course, is to get the draftsman to specify their valves, fittings, et cetera for the unit being designed.

There are many manufacturers of a similar item. For gate valves one might have Crane, Walworth, Powell, Edwards or numerous others furnishing almost identical items. The face-to-face dimensions of standard valves are the same regardless who makes them. Manufacturers adopted this standard several years ago. It is now an ANSI standard, B16.10.

Manufacturers have allowed the reproduction of some pages out of their catalogs which appear here for reference.

Table 11-1
Catalog Reproductions

Items	Page
Dimensions and Weights of Welded and Seamless Pipe	188
Commercial Wrought Steel Pipe Data	189, 190
Flanging Processes–Welded Flanged Joints	191
Forged Steel Flanges–Types	192
Forged Steel Flanges–Working Pressures	193
Forged Steel Flanges–Dimensions in Inches	194, 195
Ring Joint Facing and Rings	196
Bolting–Definitions	197
Forged Steel Screwed Fittings	198, 199
Advantages of Steel Socket Welding Fittings	200
Forged Steel Socket Welding Fittings	201, 202
Steel Buttwelding Fittings	203
Steel Buttwelding Fittings–Dimensions in Inches	204
Bronze Gate Valves–Names of Parts	205
Bronze Globe Valves–Names of Parts	206
125# Ferrosteel Wedge Gate Valves–Names of Parts	207
Cast Steel Wedge Gate Valves–150 and 300 pound	208
Cast Steel Wedge Gate Valves–150 to 1500 pound dimensions	209
Cast Steel Globe and Angle Valves	210, 211
Cast Steel Swing Check Valves	212, 213
Length of Pipe in Bends	214
Calculation of Pipe Bends	215, 216
Spacing of Pipe Supports	217, 218
Liquid Level Gages–Flat Glass (Reflex)	219, 220
Liquid Level Gages–Flat Glass (Transparent)	221
Liquid Level Gages–General Picture	222
Liquid Level Gages–Dimensions	223
Safety-Relief Valves–General Information	224, 225
Safety-Relief Valves–Definitions	226
Safety-Relief Valves–Screwed Connections	227, 228
Safety-Relief Valves–Flanged Connections	229, 230
Safety-Relief Valves–Dimensions for "R" Orifice	231
Hydro-Relief Valves (for relieving liquids)	232
Safety-Relief Valves–Standard Flange Facings	233
Control Valves–Diaphram Actuators	234, 235
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Control Valves–Body Type A	238, 239
Control Valves–Dimensions for Design "A" Bodies	240
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Liquid Level Controllers–Principles of Level Control	247 to 249
Liquid Level Controllers–Type of Connections	250
Liquid Level Controllers–Applications	251, 252
Liquid Level Controllers–Specifications	253 to 256
Liquid Level Controllers–Orientation (all models)	257

Courtesy of Crane Co.

Dimensions and Weights of WELDED AND SEAMLESS STEEL PIPE

Listed by ASA Schedule Numbers . . . . with Standard, Extra Strong, and Double Extra Strong pipe included for comparison purposes.

Nominal Wall Thicknesses, in Inches

Nominal Size Inches	Outside Dia. Inches	Sched. 10	Sched. 20	Sched. 30	Standard	Sched. 40	Sched. 60	Extra Strong	Sched. 80	Sched. 100	Sched. 120	Sched. 140	Sched. 160	Double Extra Strong
⅛	.405	...	...	...	.068	.068	...	.095	.095	...	...	...	...	...
¼	.540	...	...	...	.088	.088	...	.119	.119	...	...	...	...	...
⅜	.675	...	...	...	.091	.091	...	.126	.126	...	...	...	...	...
½	.840	...	...	...	.109	.109	...	.147	.147	...	...	...	.187	.294
¾	1.050	...	...	...	.113	.113	...	.154	.154	...	...	...	.218	.308
1	1.315	...	...	...	.133	.133	...	.179	.179	...	...	...	.250	.358
1¼	1.660	...	...	...	.140	.140	...	.191	.191	...	...	...	.250	.382
1½	1.900	...	...	...	.145	.145	...	.200	.200	...	...	...	.281	.400
2	2.375	...	...	...	.154	.154	...	.218	.218	...	...	...	.343	.436
2½	2.875	...	...	...	.203	.203	...	.276	.276	...	...	...	.375	.552
3	3.500	...	...	...	.216	.216	...	.300	.300	...	...	...	.438	.600
3½	4.000	...	...	...	.226	.226	...	.318	.318	...	...	...	...	.636
4	4.500	...	...	...	.237	.237	...	.337	.337	...	.438	...	.531	.674
5	5.563	...	...	...	.258	.258	...	.375	.375	...	.500	...	.625	.750
6	6.625	...	...	...	.280	.280	...	.432	.432	...	.562	...	.718	864
8	8.625	...	.250	.277	.322	.322	.406	.500	.500	.593	.718	.812	.906	.875
10	10.750	...	.250	.307	.365	.365	.500	.500	.593	.718	.843	1.000	1.125	...
12	12.750	...	.250	.330	.375	.406	.562	.500	.687	.843	1.000	1.125	1.312	...
14 OD	14.00	.250	.312	.375	.375	.438	.593	.500	.750	.937	1.093	1.250	1.406	...
16 OD	16.00	.250	.312	.375	.375	.500	.656	.500	.843	1.031	1.218	1.438	1.593	...
18 OD	18.00	.250	.312	.438	.375	.562	.750	.500	.937	1.156	1.375	1.562	1.781	...
20 OD	20.00	.250	.375	.500	.375	.593	.812	.500	1.031	1.281	1.500	1.750	1.968	...
24 OD	24.00	.250	.375	.562	.375	.687	.968	.500	1.218	1.531	1.812	2.062	2.343	...
30 OD	30.00	.316	.500	.625	.375	...	...	.500	...	...	...	...	...	...

Calculated Weights for Plain Ends, in Pounds per Foot

Nominal Size Inches	Outside Dia. Inches	Sched. 10	Sched. 20	Sched. 30	Standard	Sched. 40	Sched. 60	Extra Strong	Sched. 80	Sched. 100	Sched. 120	Sched. 140	Sched. 160	Double Extra Strong
⅛	.405	...	...	...	.24	.24	...	.31	.31	...	...	...	...	...
¼	.540	...	...	...	.42	.42	..	.54	.54	...	...	...	...	...
⅜	.675	...	...	...	.57	.57	...	.74	.74	...	...	...	...	...
½	.840	...	...	...	.85	.85	...	1.09	1.09	...	...	...	1.30	1.71
¾	1.050	...	...	...	1.13	1.13	...	1.47	1.47	...	...	...	1.94	2.44
1	1.315	...	...	...	1.68	1.68	...	2.17	2.17	...	...	...	2.84	3.66
1¼	1.660	...	...	...	2.27	2.27	...	3.00	3.00	...	...	...	3.77	5.21
1½	1.900	...	...	...	2.72	2.72	...	3.63	3.63	...	...	...	4.86	6.41
2	2.375	...	...	...	3.65	3.65	...	5.02	5.02	...	...	...	7.44	9.03
2½	2.875	...	...	...	5.79	5.79	...	7.66	7.66	...	...	...	10.01	13.70
3	3.500	...	...	...	7.58	7.58	...	10.25	10.25	...	...	...	14.32	18.58
3½	4.000	...	...	...	9.11	9.11	...	12.51	12.51	...	...	...	...	22.85
4	4.500	...	...	...	10.79	10.79	...	14.98	14.98	...	19.01	...	22.51	27.54
5	5.563	...	...	...	14.62	14.62	...	20.78	20.78	...	27.04	...	32.96	38.55
6	6.625	...	...	...	18.97	18.97	...	28.57	28.57	...	36.39	...	45.30	53.16
8	8.625	...	22.36	24.70	28.55	28.55	35.64	43.39	43.39	50.87	60.63	67.76	74.69	72.42
10	10.750	...	28.04	34.24	40.48	40.48	54.74	54.74	64.33	76.93	89.20	104.13	115.65	...
12	12.750	...	33.38	43.77	49.56	53.56	73.16	65.42	88.51	107.20	125.49	139.68	160.27	...
14 OD	14.00	36.71	45.68	54.57	54.57	63.37	84.91	63.37	106.13	130.73	150.67	170.22	189.12	...
16 OD	16.00	42.05	52.36	62.58	62.58	82.77	107.50	82.77	136.46	164.83	192.29	223.50	245.11	...
18 OD	18.00	47.39	59.03	82.06	70.59	104.75	138.17	93.45	170.75	207.96	244.14	274.23	308.51	...
20 OD	20.00	52.73	78.60	104.13	78.60	122.91	166.40	104.13	208.87	256.10	296.37	341.10	379.01	...
24 OD	24.00	63.41	94.62	140.80	94.62	171.17	230.91	125.49	296.36	367.40	429.39	483.13	541.94	...
30 OD	30.00	79.43	157.53	196.08	118.65	...	...	157.53	...	...	...	...	...	...

COMMERCIAL WROUGHT STEEL PIPE DATA

Courtesy of Crane Co.

Note 1: The letters "s", "x", and "xx" in the column of Schedule Numbers indicate Standard, Extra Strong, and Double Extra Strong Pipe, respectively.

Note 2: The values shown in square feet for the Transverse Internal Area also represent the volume in cubic feet per foot of pipe length.

Nominal Pipe Size Inches	Outside Diameter (D) Inches	Schedule No. *See Note 1*	Wall Thickness (t) Inches	Inside Diameter (d) Inches	Area of Metal (a) Square Inches	Transverse Internal Area		Moment of Inertia (I) Inches to 4th Power	Weight of Pipe Pounds per foot	Weight of Water Pounds per foot of pipe	External Surface Sq. Ft. per foot of pipe	Section Modulus $(2\frac{I}{D})$
						Square Inches	*See Note 2* Square Feet					
⅛	0.405	40s	.068	.269	.0720	.0568	.00040	.00106	.244	.025	.106	.00523
		80x	.095	.215	.0925	.0364	.00025	.00122	.314	.016	.106	.00602
¼	0.540	40s	.088	.364	.1250	.1041	.00072	.00331	.424	.045	.141	.01227
		80x	.119	.302	.1574	.0716	.00050	.00377	.535	.031	.141	.01395
⅜	0.675	40s	.091	.493	.1670	.1910	.00133	.00729	.567	.083	.178	.02160
		80x	.126	.423	.2173	.1405	.00098	.00862	.738	.061	.178	.02554
½	0.840	40s	.109	.622	.2503	.3040	.00211	.01709	.850	.132	.220	.04069
		80x	.147	.546	.3200	.2340	.00163	.02008	1.087	.102	.220	.04780
		160	.187	.466	.3836	.1706	.00118	.02212	1.300	.074	.220	.05267
		...xx	.294	.252	.5043	.050	.00035	.02424	1.714	.022	.220	.05772
¾	1.050	40s	.113	.824	.3326	.5330	.00371	.03704	1.130	.231	.275	.07055
		80x	.154	.742	.4335	.4330	.00300	.04479	1.473	.188	.275	.08531
		160	.218	.614	.5698	.2961	.00206	.05269	1.940	.128	.275	.10036
		...xx	.308	.434	.7180	.148	.00103	.05792	2.440	.064	.275	.11032
1	1.315	40s	.133	1.049	.4939	.8640	.00600	.08734	1.678	.375	.344	.1328
		80x	.179	.957	.6388	.7190	.00499	.1056	2.171	.312	.344	.1606
		160	.250	.815	.8365	.5217	.00362	.1251	2.840	.230	.344	.1903
		...xx	.358	.599	1.0760	.282	.00196	.1405	3.659	.122	.344	.2136
1¼	1.660	40s	.140	1.380	.6685	1.495	.01040	.1947	2.272	.649	.435	.2346
		80x	.191	1.278	.8815	1.283	.00891	.2418	2.996	.555	.435	.2913
		160	.250	1.160	1.1070	1.057	.00734	.2839	3.764	.458	.435	.3421
		...xx	.382	.896	1.534	.630	.00438	.3411	5.214	.273	.435	.4110
1½	1.900	40s	.145	1.610	.7995	2.036	.01414	.3099	2.717	.882	.497	.3262
		80x	.200	1.500	1.068	1.767	.01225	.3912	3.631	.765	.497	.4118
		160	.281	1.338	1.429	1.406	.00976	.4824	4.862	.608	.497	.5078
		...xx	.400	1.100	1.885	.950	.00660	.5678	6.408	.42	.497	.5977
2	2.375	40s	.154	2.067	1.075	3.355	.02330	.6657	3.652	1.45	.622	.5606
		80x	.218	1.939	1.477	2.953	.02050	.8679	5.022	1.28	.622	.7309
		160	.343	1.689	2.190	2.241	.01556	1.162	7.440	.97	.622	.979
		...xx	.436	1.503	2.656	1.774	.01232	1.311	9.029	.77	.622	1.104
2½	2.875	40s	.203	2.469	1.704	4.788	.03322	1.530	5.79	2.07	.753	1.064
		80x	.276	2.323	2.254	4.238	.02942	1.924	7.66	1.87	.753	1.339
		160	.375	2.125	2.945	3.546	.02463	2.353	10.01	1.54	.753	1.638
		...xx	.552	1.771	4.028	2.464	.01710	2.871	13.70	1.07	.753	1.997
3	3.500	40s	.216	3.068	2.228	7.393	.05130	3.017	7.58	3.20	.916	1.724
		80x	.300	2.900	3.016	6.605	.04587	3.894	10.25	2.86	.916	2.225
		160	.438	2.624	4.205	5.408	.03755	5.032	14.32	2.35	.916	2.876
		...xx	.600	2.300	5.466	4.155	.02885	5.993	18.58	1.80	.916	3.424
3½	4.000	40s	.226	3.548	2.680	9.886	.06870	4.788	9.11	4.29	1.047	2.394
		80x	.318	3.364	3.678	8.888	.06170	6.280	12.51	3.84	1.047	3.140
4	4.500	40s	.237	4.026	3.174	12.73	.08840	7.233	10.79	5.50	1.178	3.214
		80x	.337	3.826	4.407	11.50	.07986	9.610	14.98	4.98	1.178	4.271
		120	.438	3.624	5.595	10.31	.0716	11.65	19.00	4.47	1.178	5.178
		160	.531	3.438	6.621	9.28	.0645	13.27	22.51	4.02	1.178	5.898
		...xx	.674	3.152	8.101	7.80	.0542	15.28	27.54	3.38	1.178	6.791
5	5.563	40s	.258	5.047	4.300	20.01	.1390	15.16	14.62	8.67	1.456	5.451
		80x	.375	4.813	6.112	18.19	.1263	20.67	20.78	7.88	1.456	7.431
		120	.500	4.563	7.953	16.35	.1136	25.73	27.10	7.09	1.456	9.250
		160	.625	4.313	9.696	14.61	.1015	30.03	32.96	6.33	1.456	10.796
		...xx	.750	4.063	11.340	12.97	.0901	33.63	38.55	5.61	1.456	12.090
6	6.625	40s	.280	6.065	5.581	28.89	.2006	28.14	18.97	12.51	1.734	8.50
		80x	.432	5.761	8.405	26.07	.1810	40.49	28.57	11.29	1.734	12.22
		120	.562	5.501	10.70	23.77	.1650	49.61	36.40	10.30	1.734	14.98
		160	.718	5.189	13.32	21.15	.1469	58.97	45.30	9.16	1.734	17.81
		...xx	.864	4.897	15.64	18.84	.1308	66.33	53.16	8.16	1.734	20.02
8	8.625	20	.250	8.125	6.57	51.85	.3601	57.72	22.36	22.47	2.258	13.39
		30	.277	8.071	7.26	51.16	.3553	63.35	24.70	22.17	2.258	14.69
		40s	.322	7.981	8.40	50.03	.3474	72.49	28.55	21.70	2.258	16.81
		60	.406	7.813	10.48	47.94	.3329	88.73	35.64	20.77	2.258	20.58
		80x	.500	7.625	12.76	45.66	.3171	105.7	43.39	19.78	2.258	24.51
		100	.593	7.439	14.96	43.46	.3018	121.3	50.87	18.83	2.258	28.14
		120	.718	7.189	17.84	40.59	.2819	140.5	60.63	17.59	2.258	32.58
		140	.812	7.001	19.93	38.50	.2673	153.7	67.76	16.68	2.258	35.65
		...xx	.875	6.875	21.30	37.12	.2578	162.0	72.42	16.10	2.258	37.56
		160	.906	6.813	21.97	36.46	.2532	165.9	74.69	15.80	2.258	38.48

Nominal Pipe Size Inches	Outside Diameter (D) Inches	Schedule No. ***See Note 1***	Wall Thickness (t) Inches	Inside Diameter (d) Inches	Area of Metal (a) Square Inches	Transverse Internal Area		Moment of Inertia (I) Inches to 4th Power	Weight of Pipe Pounds per foot	Weight of Water Pounds per foot of pipe	External Surface Sq. Ft. per foot of pipe	Section Modulus $\left(2\frac{I}{D}\right)$
						Square Inches	***See Note 2*** Square Feet					
10	10.750	20	.250	10.250	8.24	82.52	.5731	113.7	28.04	35.76	2.814	21.15
		30	.307	10.136	10.07	80.69	.5603	137.4	34.24	34.96	2.814	25.57
		40s	.365	10.020	11.90	78.86	.5475	160.7	40.48	34.20	2.814	29.90
		60x	.500	9.750	16.10	74.66	.5185	212.0	54.74	32.35	2.814	39.43
		80	.593	9.564	18.92	71.84	.4989	244.8	64.33	31.13	2.814	45.54
		100	.718	9.314	22.63	68.13	.4732	286.1	76.93	29.53	2.814	53.22
		120	.843	9.064	26.24	64.53	.4481	324.2	89.20	27.96	2.814	60.32
		140	1.000	8.750	30.63	60.13	.4176	367.8	104.13	26.06	2.814	68.43
		160	1.125	8.500	34.02	56.75	.3941	399.3	115.65	24.59	2.814	74.29
12	12.75	20	.250	12.250	9.82	117.86	.8185	191.8	33.38	51.07	3.338	30.2
		30	.330	12.090	12.87	114.80	.7972	248.4	43.77	49.74	3.338	39.0
		..s	.375	12.000	14.58	113.10	.7854	279.3	49.56	49.00	3.338	43.8
		40	.406	11.938	15.77	111.93	.7773	300.3	53.53	48.50	3.338	47.1
		..x	.500	11.750	19.24	108.43	.7528	361.5	65.42	46.92	3.338	56.7
		60	.562	11.626	21.52	106.16	.7372	400.4	73.16	46.00	3.338	62.8
		80	.687	11.376	26.03	101.64	.7058	475.1	88.51	44.04	3.338	74.6
		100	.843	11.064	31.53	96.14	.6677	561.6	107.20	41.66	3.338	88.1
		120	1.000	10.750	36.91	90.76	.6303	641.6	125.49	39.33	3.338	100.7
		140	1.125	10.500	41.08	86.59	.6013	700.5	133.68	37.52	3.338	109.9
		160	1.312	10.126	47.14	80.53	.5592	781.1	160.27	34.89	3.338	122.6
14	14.00	10	.250	13.500	10.80	143.14	.9940	255.3	36.71	62.03	3.665	36.6
		20	.312	13.376	13.42	140.52	.9758	314.4	45.68	60.89	3.665	45.0
		30s	.375	13.250	16.05	137.88	.9575	372.8	54.57	59.75	3.665	53.2
		40	.438	13.124	18.66	135.28	.9394	429.1	63.37	58.64	3.665	61.3
		..x	.500	13.000	21.21	132.73	.9217	483.8	72.09	57.46	3.665	69.1
		60	.593	12.814	24.98	128.96	.8956	562.3	84.91	55.86	3.665	80.3
		80	.750	12.500	31.22	122.72	.8522	687.3	106.13	53.18	3.665	98.2
		100	.937	12.126	38.45	115.49	.8020	824.4	130.73	50.04	3.665	117.8
		120	1.093	11.814	44.32	109.62	.7612	929.6	150.67	47.45	3.665	132.8
		140	1.250	11.500	50.07	103.87	.7213	1027.0	170.22	45.01	3.665	146.8
		160	1.406	11.188	55.63	98.31	.6827	1117.0	189.12	42.60	3.665	159.6
16	16.00	10	.250	15.500	12.37	188.69	1.3103	383.7	42.05	81.74	4.189	48.0
		20	.312	15.376	15.38	185.69	1.2895	473.2	52.36	80.50	4.189	59.2
		30s	.375	15.250	18.41	182.65	1.2684	562.1	62.58	79.12	4.189	70.3
		40x	.500	15.000	24.35	176.72	1.2272	731.9	82.77	76.58	4.189	91.5
		60	.656	14.688	31.62	169.44	1.1766	932.4	107.50	73.42	4.189	116.6
		80	.843	14.314	40.14	160.92	1.1175	1155.8	136.46	69.73	4.189	144.5
		100	1.031	13.938	48.48	152.58	1.0596	1364.5	164.83	66.12	4.189	170.5
		120	1.218	13.564	56.56	144.50	1.0035	1555.8	192.29	62.62	4.189	194.5
		140	1.438	13.124	65.78	135.28	.9394	1760.3	223.64	58.64	4.189	220.0
		160	1.593	12.814	72.10	128.96	.8956	1893.5	245.11	55.83	4.189	236.7
18	18.00	10	.250	17.500	13.94	240.53	1.6703	549.1	47.39	104.21	4.712	61.1
		20	.312	17.376	17.34	237.13	1.6467	678.2	59.03	102.77	4.712	75.5
		..s	.375	17.250	20.76	233.71	1.6230	806.7	70.59	101.18	4.712	89.6
		30	.438	17.124	24.17	230.30	1.5990	930.3	82.06	99.84	4.712	103.4
		..x	.500	17.000	27.49	226.98	1.5763	1053.2	92.45	98.27	4.712	117.0
		40	.562	16.876	30.79	223.68	1.5533	1171.5	104.75	96.93	4.712	130.1
		60	.750	16.500	40.64	213.83	1.4849	1514.7	138.17	92.57	4.712	168.3
		80	.937	16.126	50.23	204.24	1.4183	1833.0	170.75	88.50	4.712	203.8
		100	1.156	15.688	61.17	193.30	1.3423	2180.0	207.96	83.76	4.712	242.3
		120	1.375	15.250	71.81	182.66	1.2684	2498.1	244.14	79.07	4.712	277.6
		140	1.562	14.876	80.66	173.80	1.2070	2749.0	274.23	75.32	4.712	305.5
		160	1.781	14.438	90.75	163.72	1.1369	3020.0	308.51	70.88	4.712	335.6
20	20.00	10	.250	19.500	15.51	298.65	2.0740	756.4	52.73	129.42	5.236	75.6
		20s	.375	19.250	23.12	290.04	2.0142	1113.0	78.60	125.67	5.236	111.3
		30x	.500	19.000	30.63	283.53	1.9690	1457.0	104.13	122.87	5.236	145.7
		40	.593	18.814	36.15	278.00	1.9305	1703.0	122.91	120.46	5.236	170.4
		60	.812	18.376	48.95	265.21	1.8417	2257.0	166.40	114.92	5.236	225.7
		80	1.031	17.938	61.44	252.72	1.7550	2772.0	208.87	109.51	5.236	277.1
		100	1.281	17.438	75.33	238.83	1.6585	3315.2	256.10	103.39	5.236	331.5
		120	1.500	17.000	87.18	226.98	1.5762	3754.0	296.37	98.35	5.236	375.5
		140	1.750	16.500	100.33	213.82	1.4849	4216.0	341.10	92.66	5.236	421.7
		160	1.968	16.064	111.49	202.67	1.4074	4585.5	379.01	87.74	5.236	458.5
24	24.00	10	.250	23.500	18.65	433.74	3.0121	1315.4	63.41	187.95	6.283	109.6
		20s	.375	23.250	27.83	424.56	2.9483	1942.0	94.62	183.95	6.283	161.9
		..x	.500	23.000	36.91	415.48	2.8853	2549.5	125.49	179.87	6.283	212.5
		30	.562	22.876	41.39	411.00	2.8542	2843.0	140.80	178.09	6.283	237.0
		40	.687	22.626	50.31	402.07	2.7921	3421.3	171.17	174.23	6.283	285.1
		60	.968	22.064	70.04	382.35	2.6552	4652.8	238.11	165.52	6.283	387.7
		80	1.218	21.564	87.17	365.22	2.5362	5672.0	296.36	158.26	6.283	472.8
		100	1.531	20.938	108.07	344.32	2.3911	6849.9	367.40	149.06	6.283	570.8
		120	1.812	20.376	126.31	326.08	2.2645	7825.0	429.39	141.17	6.283	652.1
		140	2.062	19.876	142.11	310.28	2.1547	8625.0	483.13	134.45	6.283	718.9
		160	2.343	19.314	159.41	292.98	2.0346	9455.9	541.94	126.84	6.283	787.9

Welded Flanged Joints

Welded flanged joints can be furnished in the types illustrated here. The Cranelap stub ends with Cranelap flange, also illustrated, afford an auxiliary flanged connection for welding.

Application: Any of the welded flanged joints shown at the right can be applied to straight pipe, pipe bends, the ends and nozzles of welded headers, and the flanged ends of welded assemblies. Special shop equipment assures the perfect alignment of flange faces on all Crane Welded Flanged Joints.

Welding: The shop welding of these flanged joints is performed by Crane welders working under approved procedure control.

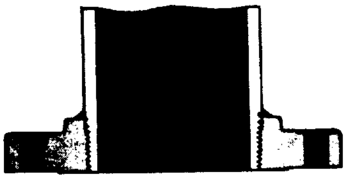
Special piping materials: These types of welded flanged joints can be furnished on many special piping materials, including numerous alloy steels, with facilities for heat-treating after fabrication.

Complete information and prices will be furnished on application.

Forged Steel Screwed Flange, Seal-Welded

A Crane Forged Steel Screwed Flange is used in this joint. The pipe and the flange are accurately threaded; the flange is made up tight on the pipe, seal-welded, and then refaced. The joint is sealed by fillet-welding the back of the flange to the pipe, thus assuring no leakage through the threads.

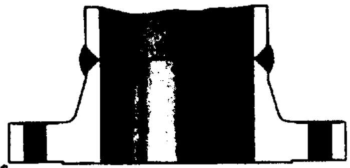
The refacing assures perfect alignment of the flange faces, and that the end of the pipe is flush with the face of the flange. The threads retain the function of holding the flange securely on the pipe, hence there is no shearing action.



Screwed Flange
Seal-Welded and Refaced

Forged Steel Welding Neck Flange

Crane Welding Neck Flanges are of forged steel. They are machined with a beveled end and bored to match the inside diameter of the pipe to which they are applied. A butt-weld is used to attach the welding neck flange to the pipe, which is also machine beveled.



Welding Neck Flange
Butt-Welded to Pipe

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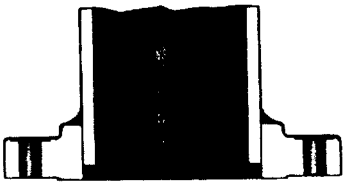
Forged Steel Slip-On Welding Flange

Crane Forged Steel Slip-On Welding Flanges are bored for a snug fit on the pipe and, when applied to fabricated piping, are welded at the front and back through the two methods defined below and illustrated at the right.

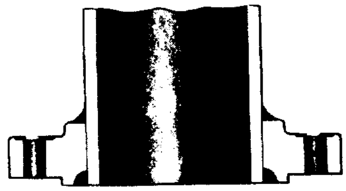
Type No. 1: Type No. 1 is Crane standard for welded flanged joints using Forged Steel Slip-On Welding Flanges. Regular flanges are utilized with the end of the pipe set back from the face of the flange and the flange welded to the pipe both in front and back.

Type No. 2: Type No. 2 is furnished on special order only; slip-on flanges with a special front groove for welding are used. The pipe is flush with the flange face; this is accomplished by refacing, after both the front and back of the flange are welded to the pipe.

Code limitation: When piping must comply with the American Standard Code for Pressure Piping or the ASME Boiler and Pressure Vessel Code, the use of the slip-on flanged joint is permissible on all sizes of flanges listed under primary service pressure ratings up to and including the 900-pound class, and in sizes 2½-inch and smaller of the 1500-pound class, of the American Steel Flange Standard (ASA B16.5-1957).



Type No. 1
Slip-On Welding Flange
Welded Front and Back

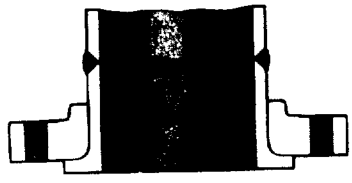


Type No. 2
Slip-On Welding Flange
Welded Front and Back and Refaced

Cranelap Stub Ends and Cranelap Flange

The Cranelap stub end with Cranelap flange can be applied to fabricated piping. Both the stub end and the pipe are machine beveled. A butt-weld is used to complete the joint.

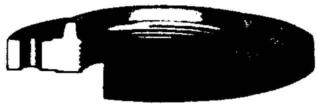
This type of joint has all of the advantages of the regular Cranelap joint as described on pages 363 to 365. In most cases, piping can be fabricated with Cranelap joints applied directly, which eliminates the weld necessary for the application of the Cranelap stub end with Cranelap flange.



Cranelap Flange with
Cranelap Stub End
Butt-Welded to Pipe

A variety of types in seven different pressure classes . . . 150 to 2500-Pound

Description of materials...........page 8
Working pressures..............page 309
Sizes and weights.....pages 310 and 311
Dimensions...........pages 312 and 313
Prices.......................on request

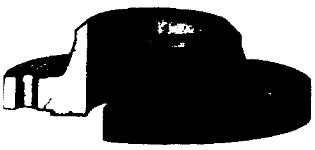


Screwed Flange

No. 556,	**150-Pound**
No. 291 E,	**300-Pound**
No. 651 E,	**400-Pound**
No. 856 E,	**600-Pound**
No. 1266 E,	**900-Pound**
No. 1556 E,	**1500-Pound**

Slip-On Welding Flange

No. 554,	**150-Pound**
No. 294 E,	**300-Pound**
No. 694 E,	**400-Pound**
No. 854 E,	**600-Pound**
No. 1294 E,	**900-Pound**
No. 1594 E,	**1500-Pound**



Welding Neck Flange
(For boring, see page 314.)

No. 568,	**150-Pound**
No. 296 E,	**300-Pound**
No. 656 E,	**400-Pound**
No. 855 E,	**600-Pound**
No. 1265 E,	**900-Pound**
No. 1565 E,	**1500-Pound**

Cranelap Flange

No. 572,	**150-Pound**
No. 496 E,	**300-Pound**
No. 664 E,	**400-Pound**
No. 862 E,	**600-Pound**
No. 1262 E,	**900-Pound**
No. 1562 E,	**1500-Pound**

Blind Flange

No. 556½,	**150-Pound**
No. 297 E,	**300-Pound**
No. 657 E,	**400-Pound**
No. 858 E,	**600-Pound**
No. 1267 E,	**900-Pound**
No. 1557 E,	**1500-Pound**

Reducing Screwed Flange

No. 558½,	**150-Pound**
No. 292 E,	**300-Pound**
No. 658 E,	**400-Pound**
No. 857 E,	**600-Pound**
No. 1263 E,	**900-Pound**
No. 1558 E,	**1500-Pound**

Reducing Slip-On Welding Flange

No. 554½,	**150-Pound**
No. 290 E,	**300-Pound**
No. 693 E,	**400-Pound**
No. 853 E,	**600-Pound**
No. 1295 E,	**900-Pound**
No. 1595 E,	**1500-Pound**

For correct method of ordering reducing flanges, see page 311.

The Crane line of Forged Steel Flanges comprises the complete assortment of straight and reducing types illustrated on this page. Made in seven different pressure classes . . . . 150, 300, 400, 600, 900, 1500, and 2500-Pound . . . . they are available in a variety of materials and with various flange facings, providing a correct type for any service requirement.

Materials: Crane flanges are made of carbon steel forgings having a highly refined grain structure and generally excellent physical properties well in excess of recognized minimum requirements.

In the 150 and 300-pound pressure classes, the flanges are regularly made of carbon steel conforming to ASTM Specification A 181, Grade II; on special order, they can be furnished heat-treated (normalized or annealed) to conform to ASTM Specification A 105, Grade II.

In the 400-pound and higher pressure classes, the flanges are regularly made of carbon steel conforming to ASTM Specification A 105, Grade II.

In addition, flanges in 300-pound and higher pressure classes can be made to order of Crane No. 5 Chrome-Molybdenum Forged Steel (ASTM A 182, Grade F5a).

American Standard: The dimensions and drilling of all flanges conform to the American Steel Flange Standard B16.5-1957, for their respective pressure class.

This Standard does not include slip-on welding flanges of the 2500-pound class nor sizes 3-inch and larger of the 1500-pound class; in such classes and sizes, Crane slip-on welding flanges have the same dimensions as American Standard Steel Screwed Flanges, being bored instead of threaded.

Flange facings: The 150 and 300-Pound Screwed, Slip-On Welding, Welding Neck, and Blind Flanges are regularly furnished with an American Standard 1/16-inch raised face.

The aforementioned flanges, in 400-pound and higher pressure classes, are regularly furnished with an American Standard 1/4-inch male face (large male).

Other types of facings such as ring joint, female, tongue, groove, etc., can be furnished; see pages 332 to 335 for complete information.

In addition, flanges of any pressure class are available with a flat face (raised or male face removed); the flat face will have a spiral serrated finish.

Finish of flange faces: The 1/16-inch raised faces and the 1/4-inch large male faces are regularly furnished with a serrated finish. A smooth finish can be furnished when specified.

Drilling: The flanges are regularly furnished faced, drilled, and spot faced to the corresponding pressure class of the American Standard. They can be furnished faced only, when specified.

Reducing flanges: The Reducing Screwed and Reducing Slip-On Welding Flanges, illustrated above, are available in any size reduction; prices are based on the outside diameter of the flange. For ordering information, see page 311.

Reducing Welding Neck Flanges and Eccentric Reducing Screwed or Slip-On Welding Flanges can be made to order; information on request.

Reducing Cranelap Flanges are not recommended and, consequently, are not manufactured. Another type of flanged joint or connection should be used.

Working Pressures

ASA and API Standards: Crane pressure-temperature ratings conform to those listed in the American Steel Flange Standard, ASA B16.5-1957, and in the American Petroleum Institute (API) Standard No. 600, Fourth Edition, 1958.

Cold service: For temperatures between minus 20 F and plus 100 F, the ratings shown in the table for 100 F will apply.

For temperatures below minus 20 F, steels with suitable impact strength must be used; pressure ratings for such steels will be the same as shown in the table for 100 F.

Gaskets: The use of these ratings requires gaskets conforming to requirements set forth in American Standard B16.5-1957.

The user is responsible for selecting gaskets of dimensions and materials capable of withstanding the required bolt loading without injurious crushing, as well as being suitable for the service conditions in all other respects.

Flange facings: Unless otherwise ordered, Crane screwed, slip-on welding, welding neck, and blind flanges of the 150 and 300-pound classes are furnished with a 1/16-inch raised face. In the 400-pound and higher pressure classes, these flanges are furnished with a 1/4-inch large male face.

Cranelap flanges and joints: These ratings also apply to Cranelap flanges, the rating being dependent upon the type of facing applied to the lapped pipe end. Ratings for Cranelap joints are contingent upon the use of pipe of proper material having an equal or higher rating.

Steam, Water, Oil, Oil Vapor, Gas, or Air

Metal	Temp.	Pounds per Square Inch, Non-Shock						
	Deg. Fahr.	150 Lb.	300 Lb.	400 Lb.	600 Lb.	900 Lb.	1500 Lb.	2500 Lb.
[1]Carbon Steel Flanges	100°	275	720	960	1440	2160	3600	6000
	150	255	710	945	1420	2130	3550	5915
	200	240	700	930	1400	2100	3500	5830
	250	225	690	920	1380	2070	3450	5750
	300	210	680	910	1365	2050	3415	5690
	350	195	675	900	1350	2025	3375	5625
	400	180	665	890	1330	2000	3330	5550
	450	165	650	870	1305	1955	3255	5430
260°C	500	**150**	625	835	1250	1875	3125	5210
	550	140	590	790	1180	1775	2955	4925
	600	130	555	740	1110	1660	2770	4620
	650	120	515	690	1030	1550	2580	4300
	700	110	470	635	940	1410	2350	3920
	750	100	425	575	850	1275	2125	3550
	800	92	365	490	730	1100	1830	3050
450°C	850	[2]82	[2]**300**	[2]**400**	[2]**600**	[2]**900**	[2]**1500**	[2]**2500**
	875	[2]75	[2]260	[2]350	[2]525	[2]785	[2]1305	[2]2180
	900	[2]70	[2]225	[2]295	[2]445	[2]670	[2]1115	[2]1855
	925	[2]60[3]	[2]190[3]	[2]250[3]	[2]375[3]	[2]565[3]	[2]945[3]	[2]1570[3]
	950	[2]55[3]	[2]155[3]	[2]205[3]	[2]310[3]	[2]465[3]	[2]770[3]	[2]1285[3]
	975	[2]50[3]	[2]120[3]	[2]160[3]	[2]240[3]	[2]360[3]	[2]600[3]	[2]1000[3]
	1000	[2]40[3]	[3]85[3]	[2]115[3]	[2]170[3]	[2]255[3]	[2]430[3]	[2]715[3]
No. 5 Chromium-Molybdenum Alloy Steel Flanges (made to order)	At temperatures lower than 700 F, ratings are the same as those for Carbon Steel Flanges.							
	700°	. . .	485	645	965	1450	2415	4025
	750	. . .	450	600	900	1350	2250	3745
	800	. . .	415	555	835	1250	2080	3470
	850	. . .	385	510	765	1150	1915	3190
	875	. . .	365	490	735	1100	1830	3055
	900	. . .	350	465	700	1050	1750	2915
	925	. . .	335	445	665	1000	1665	2775
	950	. . .	315	420	635	950	1585	2640
	975	. . .	**300**	**400**	**600**	**900**	**1500**	**2500**
	1000	. . .	250	335	500	750	1250	2085
	1025	. . .	215	285	430	645	1070	1785
	1050	. . .	180	240	355	535	890	1485
	1075	. . .	145	195	290	435	730	1215
	1100	. . .	115	150	225	340	565	945
	1125[4]	. . .	95	125	190	285	470	785
	1150[4]	. . .	75	100	150	225	375	630
	1175[4]	. . .	65	85	125	190	315	530
	1200[4]	. . .	50	70	105	155	255	430

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[1] Where welded construction is used, consideration should be given to the possibility of graphite formation on carbon steel at temperatures above 775 F.

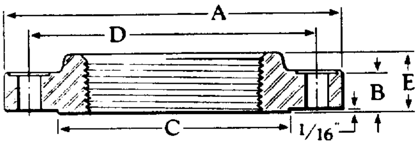
[2] Product used within the jurisdiction of Section 1, Power Boilers, of the ASME Boiler and Pressure Vessel Code, is subject to the same maximum temperature limitations placed upon the material in Table P7, 1959 edition thereof.

[3] Product used within the jurisdiction of Section 1, Power Piping, of the ASA Code for Pressure Piping, B31.1, is subject to the same maximum temperature limitations placed upon piping of the same general composition in Table 2a, 1955 edition thereof.

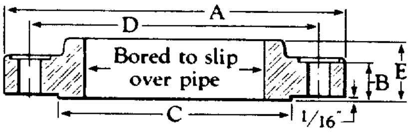
[4] Consideration should be given to the possibility of excessive oxidation (scaling) when No. 5 Chromium-Molybdenum Steel is used at temperatures above 1100 F.

Courtesy of Crane Co.

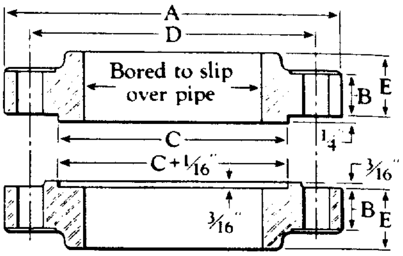
FORGED STEEL FLANGES
Dimensions, in Inches



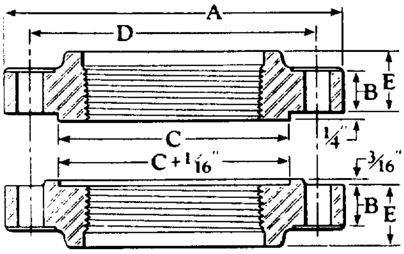
Screwed Flange
150 and 300-Pound



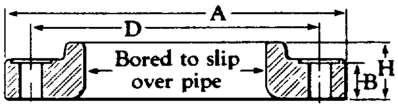
Slip-On Welding Flange
150 and 300-Pound



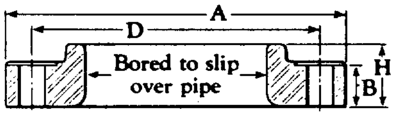
Slip-On Welding Flange
400, 600, 900, and 1500-Pound



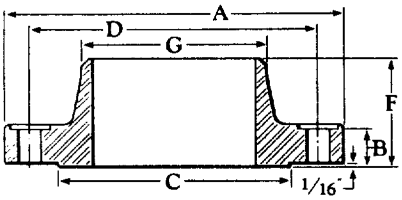
Screwed Flange
400, 600, 900, 1500, and 2500-Pound



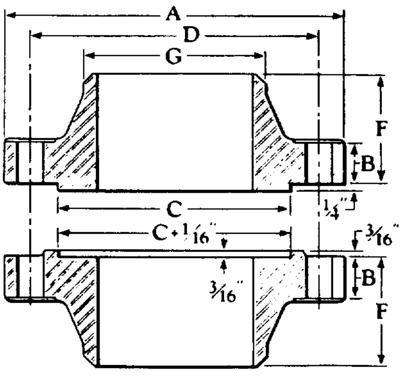
Cranelap Flange
150 and 300-Pound



Cranelap Flange
400, 600, 900, 1500, and 2500-Pound



Welding Neck Flange
150 and 300-Pound



Welding Neck Flange
400, 600, 900, 1500, and 2500-Pound

Class	Pipe Size	A	B	C	D	Bolts No.	Bolts Dia.	E	F	G	H
150 Pound	1/2	3 1/2	7/16	1 3/8	2 3/8	4	1/2	5/8	1 7/8	0.84	5/8
	3/4	3 7/8	1/2	1 11/16	2 3/4	4	1/2	5/8	2 1/16	1.05	5/8
	1	4 1/4	9/16	2	3 1/8	4	1/2	11/16	2 3/16	1.32	11/16
	1 1/4	4 5/8	5/8	2 1/2	3 1/2	4	1/2	13/16	2 1/4	1.66	13/16
	1 1/2	5	11/16	2 7/8	3 7/8	4	1/2	7/8	2 7/16	1.90	7/8
	2	6	3/4	3 5/8	4 3/4	4	5/8	1	2 1/2	2.38	1
	2 1/2	7	7/8	4 1/8	5 1/2	4	5/8	1 1/8	2 3/4	2.88	1 1/8
	3	7 1/2	15/16	5	6	4	5/8	1 3/16	2 3/4	3.50	1 3/16
	3 1/2	8 1/2	15/16	5 1/2	7	8	5/8	1 1/4	2 13/16	4.00	1 1/4
	4	9	15/16	6 3/16	7 1/2	8	5/8	1 5/16	3	4.50	1 5/16
	5	10	15/16	7 5/16	8 1/2	8	3/4	1 7/16	3 1/2	5.56	1 7/16
	6	11	1	8 1/2	9 1/2	8	3/4	1 9/16	3 1/2	6.63	1 9/16
	8	13 1/2	1 1/8	10 5/8	11 3/4	8	3/4	1 3/4	4	8.63	1 3/4
	10	16	1 3/16	12 3/4	14 1/4	12	7/8	1 15/16	4	10.75	1 15/16
	12	19	1 1/4	15	17	12	7/8	2 3/16	4 1/2	12.75	2 3/16
	14	21	1 3/8	16 1/4	18 3/4	12	1	2 1/4	5	14.00	3 1/8
	16	23 1/2	1 7/16	18 1/2	21 1/4	16	1	2 1/2	5	16.00	3 7/16
	18	25	1 9/16	21	22 3/4	16	1 1/8	2 11/16	5 1/2	18.00	3 13/16
	20	27 1/2	1 11/16	23	25	20	1 1/8	2 7/8	5 11/16	20.00	4 1/16
	24	32	1 7/8	27 1/4	29 1/2	20	1 1/4	3 1/4	6	24.00	4 3/8
300 Pound	1/2	3 3/4	9/16	1 3/8	2 5/8	4	1/2	7/8	2 1/16	0.84	. . .
	3/4	4 5/8	5/8	1 11/16	3 1/4	4	5/8	1	2 1/4	1.05	1
	1	4 7/8	11/16	2	3 1/2	4	5/8	1 1/16	2 7/16	1.32	1 1/16
	1 1/4	5 1/4	3/4	2 1/2	3 7/8	4	5/8	1 1/16	2 9/16	1.66	1 1/16
	1 1/2	6 1/8	13/16	2 7/8	4 1/2	4	3/4	1 3/16	2 11/16	1.90	1 3/16
	2	6 1/2	7/8	3 5/8	5	8	5/8	1 5/16	2 3/4	2.38	1 5/16
	2 1/2	7 1/2	1	4 1/8	5 7/8	8	3/4	1 1/2	3	2.88	1 1/2
	3	8 1/4	1 1/8	5	6 5/8	8	3/4	1 11/16	3 1/8	3.50	1 11/16
	3 1/2	9	1 3/16	5 1/2	7 1/4	8	3/4	1 3/4	3 3/16	4.00	. . .
	4	10	1 1/4	6 3/16	7 7/8	8	3/4	1 7/8	3 3/8	4.50	1 7/8
	5	11	1 3/8	7 5/16	9 1/4	8	3/4	2	3 7/8	5.56	2
	6	12 1/2	1 7/16	8 1/2	10 5/8	12	3/4	2 1/16	3 7/8	6.63	2 1/16
	8	15	1 5/8	10 5/8	13	12	7/8	2 7/16	4 3/8	8.63	2 7/16
	10	17 1/2	1 7/8	12 3/4	15 1/4	16	1	2 5/8	4 5/8	10.75	3 3/4
	12	20 1/2	2	15	17 3/4	16	1 1/8	2 7/8	5 1/8	12.75	4
	14	23	2 1/8	16 1/4	20 1/4	20	1 1/8	3	5 5/8	14.00	4 3/8
	16	25 1/2	2 1/4	18 1/2	22 1/2	20	1 1/4	3 1/4	5 3/4	16.00	4 3/4
	18	28	2 3/8	21	24 3/4	24	1 1/4	3 1/2	6 1/4	18.00	5 1/8
	20	30 1/2	2 1/2	23	27	24	1 1/4	3 3/4	6 3/8	20.00	5 1/2
	24	36	2 3/4	27 1/4	32	24	1 1/2	4 3/16	6 5/8	24.00	6
400 Pound For smaller sizes, use 600-Pound	4	10	1 3/8	6 3/16	7 7/8	8	7/8	2	3 1/2	4.50	2
	5	11	1 1/2	7 5/16	9 1/4	8	7/8	2 1/8	4	5.56	2 1/8
	6	12 1/2	1 5/8	8 1/2	10 5/8	12	7/8	2 1/4	4 1/16	6.63	2 1/4
	8	15	1 7/8	10 5/8	13	12	1	2 11/16	4 5/8	8.63	2 11/16
	10	17 1/2	2 1/8	12 3/4	15 1/4	16	1 1/8	2 7/8	4 7/8	10.75	4
	12	20 1/2	2 1/4	15	17 3/4	16	1 1/4	3 1/8	5 3/8	12.75	4 1/4
	14	23	2 3/8	16 1/4	20 1/4	20	1 1/4	3 5/16	5 7/8	14.00	4 5/8
	16	25 1/2	2 1/2	18 1/2	22 1/2	20	1 3/8	3 11/16	6	16.00	5
	18	28	2 5/8	21	24 3/4	24	1 3/8	3 7/8	6 1/2	18.00	5 3/8
	20	30 1/2	2 3/4	23	27	24	1 1/2	4	6 5/8	20.00	5 3/4
	24	36	3	27 1/4	32	24	1 3/4	4 1/2	6 7/8	24.00	6 1/4

Dimensions, in Inches — continued

Class	Pipe Size	A	B	C	D	Bolts		E	F	G	H
						No.	Dia.				
600 Pound	½	3¾	9/16	1⅜	2⅝	4	½	⅞	2 1/16	0.84	⅞
	¾	4⅝	⅝	1 11/16	3¼	4	⅝	1	2¼	1.05	1
	1	4⅞	11/16	2	3½	4	⅝	1 1/16	2 7/16	1.32	1 1/16
	1¼	5¼	13/16	2½	3⅞	4	⅝	1⅛	2⅝	1.66	1⅛
	1½	6⅛	⅞	2⅞	4½	4	¾	1¼	2¾	1.90	1¼
	2	6½	1	3⅝	5	8	⅝	1 7/16	2⅞	2.38	1 7/16
	2½	7½	1⅛	4⅛	5⅞	8	¾	1⅝	3⅛	2.88	1⅝
	3	8¼	1¼	5	6⅝	8	¾	1 13/16	3¼	3.50	1 13/16
	4	10¾	1½	6 3/16	8½	8	⅞	2⅛	4	4.50	2⅛
	5	13	1¾	7 5/16	10½	8	1	2⅜	4½	5.56	2⅜
	6	14	1⅞	8½	11½	12	1	2⅝	4⅝	6.63	2⅝
	8	16½	2 3/16	10⅝	13¾	12	1⅛	3	5¼	8.63	3
	10	20	2½	12¾	17	16	1¼	3⅜	6	10.75	4⅜
	12	22	2⅝	15	19¼	20	1¼	3⅝	6⅛	12.75	4⅝
	14	23¾	2¾	16¼	20¾	20	1⅜	3 11/16	6½	14.00	5
	16	27	3	18½	23¾	20	1½	4 3/16	7	16.00	5½
	18	29¼	3¼	21	25¾	20	1⅝	4⅝	7¼	18.00	6
	20	32	3½	23	28½	24	1⅝	5	7½	20.00	6½
	24	37	4	27¼	33	24	1⅞	5½	8	24.00	7¼
900 Pound For smaller sizes, use 1500 Pound	3	9½	1½	5	7½	8	⅞	2⅛	4	3.50	2⅛
	4	11½	1¾	6 3/16	9¼	8	1⅛	2¾	4½	4.50	2¾
	5	13¾	2	7 5/16	11	8	1¼	3⅛	5	5.56	3⅛
	6	15	2 3/16	8½	12½	12	1⅛	3⅜	5½	6.63	3⅜
	8	18½	2½	10⅝	15½	12	1⅜	4	6⅜	8.63	4½
	10	21½	2¾	12¾	18½	16	1⅜	4¼	7¼	10.75	5
	12	24	3⅛	15	21	20	1⅜	4⅝	7⅞	12.75	5⅝
	14	25¼	3⅜	16¼	22	20	1½	5⅛	8⅜	14.00	6⅛
	16	27¾	3½	18½	24¼	20	1⅝	5¼	8½	16.00	6½
	18	31	4	21	27	20	1⅞	6	9	18.00	7½
	20	33¾	4¼	23	29½	20	2	6¼	9¾	20.00	8¼
	24	41	5½	27¼	35½	20	2½	8	11½	24.00	10½
1500 Pound	½	4¾	⅞	1⅜	3¼	4	¾	1¼	2⅜	0.84	1¼
	¾	5⅛	1	1 11/16	3½	4	¾	1⅜	2¾	1.05	1⅜
	1	5⅞	1⅛	2	4	4	⅞	1⅝	2⅞	1.32	1⅝
	1¼	6¼	1⅛	2½	4⅜	4	⅞	1⅝	2⅞	1.66	1⅝
	1½	7	1¼	2⅞	4⅞	4	1	1¾	3¼	1.90	1¾
	2	8½	1½	3⅝	6½	8	⅞	2¼	4	2.38	2¼
	2½	9⅝	1⅝	4⅛	7½	8	1	2½	4⅛	2.88	2½
	3	10½	1⅞	5	8	8	1⅛	2⅞	4⅝	3.50	2⅞
	4	12¼	2⅛	6 3/16	9½	8	1¼	3 9/16	4⅞	4.50	3 9/16
	5	14¾	2⅞	7 5/16	11½	8	1½	4⅛	6⅛	5.56	4⅛
	6	15½	3¼	8½	12½	12	1⅜	4 11/16	6¾	6.63	4 11/16
	8	19	3⅝	10⅝	15½	12	1⅝	5⅝	8⅜	8.63	5⅝
	10	23	4¼	12¾	19	12	1⅞	6¼	10	10.75	7
	12	26½	4⅞	15	22½	16	2	7⅛	11⅛	12.75	8⅝
	14	29½	5¼	16¼	25	16	2¼	. . .	11¾	14.00	9½
2500 Pound	½	5¼	1 3/16	1⅜	3½	4	¾	1 9/16	2⅞	0.84	1 9/16
	¾	5½	1¼	1 11/16	3¾	4	¾	1 11/16	3⅛	1.05	1 11/16
	1	6¼	1⅜	2	4¼	4	⅞	1⅞	3½	1.32	1⅞
	1¼	7¼	1½	2½	5⅛	4	1	2 1/16	3¾	1.66	2 1/16
	1½	8	1¾	2⅞	5¾	4	1⅛	2⅜	4⅜	1.90	2⅜
	2	9¼	2	3⅝	6¾	8	1	2¾	5	2.38	2¾
	2½	10½	2¼	4⅛	7¾	8	1⅛	3⅛	5⅝	2.88	3⅛
	3	12	2⅝	5	9	8	1¼	3⅝	6⅝	3.50	3⅝
	4	14	3	6 3/16	10¾	8	1½	4¼	7½	4.50	4¼
	5	16½	3⅝	7 5/16	12¾	8	1¾	5⅛	9	5.56	5⅛
	6	19	4¼	8½	14½	8	2	6	10¾	6.63	6
	8	21¾	5	10⅝	17¼	12	2	7	12½	8.63	7
	10	26½	6½	12¾	21¼	12	2½	9	16½	10.75	9
	12	30	7¼	15	24⅜	12	2¾	10	18¼	12.75	10

Regular Facings

In 150 and 300-pound pressure classes, the screwed, slip-on welding, welding neck, and blind flanges are furnished with a 1/16-inch raised face.

In 400-pound and higher pressure classes, the aforementioned flanges have a ¼-inch male face (large male).

American Standard

The dimensions and drilling of flanges conform to the American Steel Flange Standard, B16.5-1957, for their respective pressure class. This Standard does not include slip-on welding flanges in the 2500-pound class nor sizes 3-inch and larger of the 1500-pound class. Crane flanges of this type have the same dimensions as American Standard Steel Screwed Flanges, being bored instead of threaded.

Cranelap Flanges

For sizes, see pages 310 and 311. For information on complete Cranelap Joints, see page 363. Cranelap flanges also are recommended for use in combination with Cranelap stub ends; see pages 298 to 301.

3-inch Cranelap Joints

(300 and 600-Pound)

When 3-inch 300 or 600-pound flanges with ring joint facing are to be bolted to Cranelap joints, orders must so specify; they require a groove of special pitch diameter. See page 334 for dimensions.

Galvanizing

Galvanized flanges can be furnished to order.

Order by Catalog Number

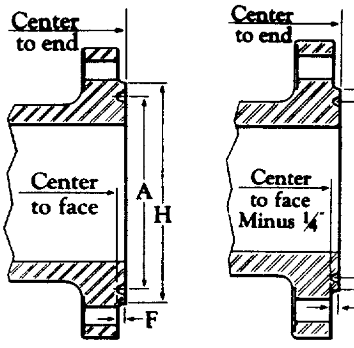
When ordering 150 to 1500-pound flanges, specify the catalog number; see pages 310 and 311.

Ordering Reducing Flanges

For correct method of specifying reducing flange sizes, see note at bottom of page 311.

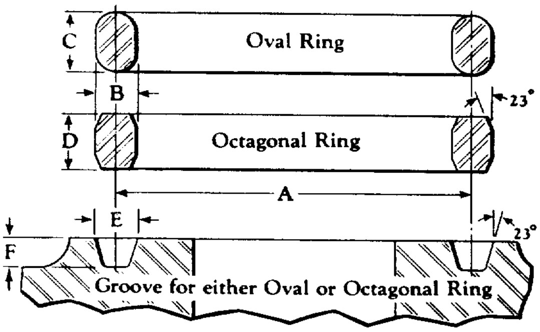
RING JOINT FACING AND RINGS

American Standard—Dimensions, In Inches

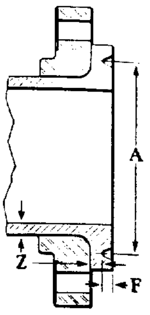


150 and 300-Pound 400, 600, 900, 1500, and 2500-Pound

For Valves, Fittings, and Flanges

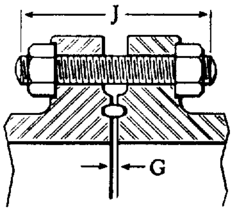


Oval rings fit grooves having either a flat or round bottom; octagonal rings only fit grooves having a flat bottom.



("Z" represents pipe thickness.)

Cranelap Joints



"G" is approximate clearance with stud bolts tight.

Assembled Ring Joint

*Dimension "J" does not apply to Cranelap Joints; see "Stud bolt lengths" on next page.

†Caution: 3-inch 300 and 600-Pound Cranelap Ring Joints use Ring No. R 30, having a pitch diameter of 4⅜ inches. When 3-inch 300 or 600-Pound ring joint valves, fittings, or flanges are to be bolted to Cranelap joints, orders must specify; they will be machined special.

Class	Size	Ring No.	A	B	C	D	E	F	G	H	*J	Stud Bolts No.	Stud Bolts Dia.
150 Pound	1	R 15	1 7/8	5/16	9/16	1/2	11/32	1/4	5/32	2 1/2	3	4	1/2
	1 1/4	R 17	2 1/4	5/16	9/16	1/2	11/32	1/4	5/32	2 7/8	3	4	1/2
	1 1/2	R 19	2 9/16	5/16	9/16	1/2	11/32	1/4	5/32	3 1/4	3 1/4	4	1/2
	2	R 22	3 1/4	5/16	9/16	1/2	11/32	1/4	5/32	4	3 1/2	4	5/8
	2 1/2	R 25	4	5/16	9/16	1/2	11/32	1/4	5/32	4 3/4	3 3/4	4	5/8
	3	R 29	4 1/2	5/16	9/16	1/2	11/32	1/4	5/32	5 1/4	4	4	5/8
	3 1/2	R 33	5 3/16	5/16	9/16	1/2	11/32	1/4	5/32	6 1/16	4	8	5/8
	4	R 36	5 7/8	5/16	9/16	1/2	11/32	1/4	5/32	6 3/4	4	8	5/8
	5	R 40	6 3/4	5/16	9/16	1/2	11/32	1/4	5/32	7 5/8	4 1/4	8	3/4
	6	R 43	7 5/8	5/16	9/16	1/2	11/32	1/4	5/32	8 5/8	4 1/4	8	3/4
	8	R 48	9 3/4	5/16	9/16	1/2	11/32	1/4	5/32	10 3/4	4 1/2	8	3/4
	10	R 52	12	5/16	9/16	1/2	11/32	1/4	5/32	13	5	12	7/8
	12	R 56	15	5/16	9/16	1/2	11/32	1/4	5/32	16	5	12	7/8
	14	R 59	15 5/8	5/16	9/16	1/2	11/32	1/4	1/8	16 3/4	5 1/2	12	1
	16	R 64	17 7/8	5/16	9/16	1/2	11/32	1/4	1/8	19	5 3/4	16	1
	18	R 68	20 3/8	5/16	9/16	1/2	11/32	1/4	1/8	21 1/2	6 1/4	16	1 1/8
	20	R 72	22	5/16	9/16	1/2	11/32	1/4	1/8	23 1/2	6 1/2	20	1 1/8
	24	R 76	26 1/2	5/16	9/16	1/2	11/32	1/4	1/8	28	7 1/4	20	1 1/4

Class	Size	Ring No.	A	B	C	D	E	F	G			H	*J			No. of Stud Bolts			Dia. of Stud Bolts		
									300 Lb.	400 Lb.	600 Lb.		300 Lb.	400 Lb.	600 Lb.	300 Lb.	400 Lb.	600 Lb.	300 Lb.	400 Lb.	600 Lb.
†300, 400, and †600 Pound	1/2	R 11	1 11/32	1/4	7/16	3/8	9/32	7/32	1/8	...	1/8	2	3	...	3	4	...	4	1/2	...	1/2
	3/4	R 13	1 11/16	5/16	9/16	1/2	11/32	1/4	5/32	...	5/32	2 1/2	3 1/4	...	3 1/4	4	...	4	5/8	...	5/8
	1	R 16	2	5/16	9/16	1/2	11/32	1/4	5/32	...	5/32	2 3/4	3 1/2	...	3 1/2	4	...	4	5/8	...	5/8
	1 1/4	R 18	2 3/8	5/16	9/16	1/2	11/32	1/4	5/32	...	5/32	3 1/8	3 1/2	...	3 3/4	4	...	4	5/8	...	5/8
	1 1/2	R 20	2 11/16	5/16	9/16	1/2	11/32	1/4	5/32	...	5/32	3 9/16	4	...	4	4	...	4	3/4	...	3/4
	2	R 23	3 1/4	7/16	11/16	5/8	15/32	5/16	7/32	...	3/16	4 1/4	4	...	4 1/4	8	...	8	5/8	...	5/8
	2 1/2	R 26	4	7/16	11/16	5/8	15/32	5/16	7/32	...	3/16	5	4 1/2	...	4 3/4	8	...	8	3/4	...	3/4
	†3	†R 31	†4 7/8	7/16	11/16	5/8	15/32	5/16	7/32	...	3/16	5 3/4	4 3/4	...	5	8	...	8	3/4	...	3/4
	3 1/2	R 34	5 3/16	7/16	11/16	5/8	15/32	5/16	7/32	...	3/16	6 1/4	5	...	5 1/2	8	...	8	3/4	...	7/8
	4	R 37	5 7/8	7/16	11/16	5/8	15/32	5/16	7/32	7/32	3/16	6 7/8	5	5 1/2	5 3/4	8	8	8	3/4	7/8	7/8
	5	R 41	7 1/8	7/16	11/16	5/8	15/32	5/16	7/32	7/32	3/16	8 1/4	5 1/4	5 3/4	6 1/2	8	8	8	3/4	7/8	1
	6	R 45	8 5/16	7/16	11/16	5/8	15/32	5/16	7/32	7/32	3/16	9 1/2	5 1/2	6	6 3/4	12	12	12	3/4	7/8	1
	8	R 49	10 5/8	7/16	11/16	5/8	15/32	5/16	7/32	7/32	3/16	11 7/8	6	6 3/4	7 3/4	12	12	12	7/8	1	1 1/8
	10	R 53	12 3/4	7/16	11/16	5/8	15/32	5/16	7/32	7/32	3/16	14	6 3/4	7 1/2	8 1/2	16	16	16	1	1 1/8	1 1/4
	12	R 57	15	7/16	11/16	5/8	15/32	5/16	7/32	7/32	3/16	16 1/4	7 1/4	8	8 3/4	16	16	20	1 1/8	1 1/4	1 1/4
	14	R 61	16 1/2	7/16	11/16	5/8	15/32	5/16	7/32	7/32	3/16	18	7 1/2	8 1/4	9 1/4	20	20	20	1 1/8	1 1/4	1 3/8
	16	R 65	18 1/2	7/16	11/16	5/8	15/32	5/16	7/32	7/32	3/16	20	8	8 3/4	10	20	20	20	1 1/4	1 3/8	1 1/2
	18	R 69	21	7/16	11/16	5/8	15/32	5/16	7/32	7/32	3/16	22 5/8	8 1/4	9	10 3/4	24	24	20	1 1/4	1 3/8	1 5/8
	20	R 73	23	1/2	3/4	11/16	17/32	3/8	7/32	7/32	3/16	25	8 3/4	9 3/4	11 1/2	24	24	24	1 1/4	1 1/2	1 5/8
	24	R 77	27 1/4	5/8	7/8	13/16	21/32	7/16	1/4	1/4	7/32	29 1/2	10	11	13 1/4	24	24	24	1 1/2	1 3/4	1 7/8

Machine Bolt
Square Head
With Hexagon Nut

Stud
Threaded Oversize on One End
Other End Threaded for Nut

Definitions

A bolt is threaded on one end only, the other end being upset into the form of a head.

A stud is threaded on both ends, one end being oversize in diameter to fit tightly (wrench fit) in a tapped hole, the other being to the standard diameter for a nut assembly.

A stud bolt is threaded to the standard diameter, either on both ends or full length, for nut assembly on each end.

Stud Bolt
Threaded on Both Ends
With Two Hexagon Nuts

Stud Bolt
Threaded Entire Length
With Two Hexagon Nuts

Materials and Specifications

Crane furnishes machine bolts, studs, stud bolts, and nuts as follows:

Machine Bolts for use at temperatures up to 500 F are made from steel complying with ASTM Specification A 307, Grade B. This steel has a minimum tensile strength of 55,000 pounds per square inch.

The bolts have Regular Square heads in accordance with American Standard ASA B18.2.

All machine bolts are threaded in accordance with American Standard ASA B1.1 Coarse Thread Series, Class 2A fit.

Nuts regularly furnished with machine bolts are steel conforming to ASTM Specification A 307.

Nuts are made to American Standard ASA B18.2 Heavy Hexagon dimensions.

All nuts are tapped in accordance with American Standard ASA B1.1 Coarse Thread Series, Class 2B fit.

Studs and Stud Bolts for use at temperatures up to 500 F are made from cold rolled steel complying with ASTM Specification A 108, Open Hearth free-cutting grade.

Cold rolled steel studs (nut ends only) and stud bolts are threaded in accordance with American Standard ASA B1.1 Coarse Thread Series, Class 2A fit.

Nuts regularly furnished with cold rolled steel studs and stud bolts are cold formed steel conforming to ASTM Specification A 307.

Nuts are made to American Standard ASA B18.2 Heavy Semi-Finished Hexagon dimensions.

All nuts are tapped in accordance with American Standard ASA B1.1 Coarse Thread Series, Class 2B fit.

Alloy Steel Studs and Stud Bolts are made of Crane Triplex or Templex Steel. Crane Triplex Steel complies with the requirements of ASTM Specification A 193, Grade B7 bolting. Crane Templex Steel complies with the requirements of ASTM Specification A 193, Grade B14 bolting.

Crane Triplex Steel has been used with uniformly satisfactory results in thousands of steel valve and fitting installations, many of which—particularly in oil refineries—have been operating under extreme pressures and temperatures. Templex Steel, another Crane development in bolting materials, is superior to Triplex Steel in creep resistance; on temperatures over 850 F, especially where joints are made up for permanent, long-time service, as in steam power plants, Crane Templex Steel will be found ideal.

Physical Properties	Minimum	Crane Triplex average	Crane Templex average
Tensile strength.............psi	125,000	134,000	145,000
Yield point...................psi	105,000	116,000	118,000
Elongation in 2 inches...per cent	16	20	20
Reduction of area......per cent	50	57	57
Brinell hardness number..(range)	260–320	270–300	285–320

Crane Alloy Steel Studs (nut ends only) and Stud Bolts (entire length) are threaded in accordance with American Standard ASA B1.1 . . . . Coarse Thread Series on sizes 1-inch and smaller and 8-Pitch Thread Series on sizes 1⅛-inch and larger, Class 2A fit.

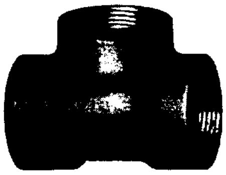
Nuts regularly furnished with alloy steel studs and stud bolts are hot forged, medium carbon steel, oil quenched, conforming to ASTM Specification A 194, Grade 2H.

Nuts are made to American Standard ASA B18.2 Heavy Semi-Finished Hexagon dimensions.

All nuts are tapped in accordance with American Standard ASA B1.1 . . . .Coarse Thread Series on sizes 1-inch and smaller and 8-Pitch Thread Series on sizes 1⅛-inch and larger, Class 2B fit.

FORGED STEEL SCREWED FITTINGS
2000, 3000, and 6000-pound W.O.G.

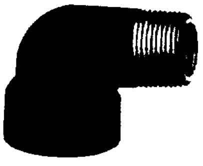
90° Elbow
No. 240, 2000-Pound
No. 380, 3000-Pound
No. 660, 6000-Pound



Tee
No. 241, 2000-Pound
No. 381, 3000-Pound
No. 661, 6000-Pound

45° Elbow
No. 242, 2000-Pound
No. 382, 3000-Pound
No. 662, 6000-Pound

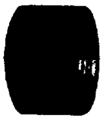
Cross
No. 243, 2000-Pound
No. 383, 3000-Pound
No. 663, 6000-Pound



90° Street Elbow
No. 384, 3000-Pound
No. 664, 6000-Pound

Coupling
No. 386, 3000-Pound
No. 666, 6000-Pound

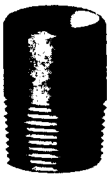
Reducer
No. 387, 3000-Pound
No. 667, 6000-Pound



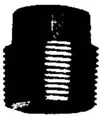
Half Coupling
No. 388, 3000-Pound
No. 668, 6000-Pound

Cap
No. 389, 3000-Pound

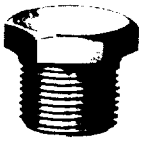
45° Y-Bend
No. 245, 2000-Pound
No. 665, 6000-Pound



Round Head Plug
No. 308, 3000-Pound



Square Head Plug
No. 309, 3000-Pound



Hexagon Head Plug
No. 602, 6000-Pound

Hexagon Bushing
No. 600, 6000-Pound

Recommendations: These are unusually strong, rugged fittings. They are ideally suited for high pressure hydraulic lines and for high pressure-temperature service in oil refineries, oil and gas fields, central power stations, and industrial and chemical plants.

The 2000-Pound W.O.G. Fittings, exceptionally compact and light in weight, are intended for services beyond the temperature range of malleable iron fittings and for many relatively low pressure installations where the extra strength and safety afforded by steel fittings are desired.

Materials and design: Elbows, tees, crosses, and Y-bends are forged solid; the caps, couplings, reducers, plugs, and bushings are machined from solid steel. Carbon steel billets or bar stock used in the manufacturing process are subject to rigid specifications for strength, toughness, and resistance to temperature and shock.

The fittings feature liberal metal sections throughout and have an ample factor of safety over the recommended working pressures. All openings are drilled; on forged fittings, each opening is reinforced with a wide band which completely surrounds the thread chamber, extending beyond the last thread. The design provides the requisite strength, adds to the compact, neat appearance, and permits a sure wrench grip.

Threads: Threads are long and are accurately cut to gauge. All openings are in true alignment and chamfered to permit easy entrance of pipe.

Face Bushing
No. 601, 6000-Pound

MSS ratings: Working pressures agree with those in the MSS Standard for Forged Steel Screwed Fittings, No. SP-49-1956.

Working Pressures

Steam, Water, Oil, Oil Vapor, Gas, or Air

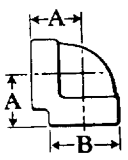
Temp.	Psi, Non-Shock Carbon Steel ASTM A105, Grade II		
Deg. Fahr.	2000 Pound W.O.G.	3000 Pound W.O.G.	6000 Pound W.O.G.
100°	2000	3000	6000
150	1970	2955	5915
200	1940	2915	5830
250	1915	2875	5750
300	1895	2845	5690
350	1875	2810	5625
400	1850	2775	5550
450	1810	2715	5430
500	1735	2605	5210
550	1640	2460	4925
600	1540	2310	4620
650	1430	2150	4300
700	1305	1960	3920
750	1180	1775	3550
800	1015	1525	3050
850[1]	830	1250	2500
875[1]	725	1090	2180
900[1]	615	925	1855
925[1,2]	520	785	1570
950[1,2]	425	640	1285
975[1,2]	330	500	1000
1000[1,2]	235	355	715

[1] Product used within the jurisdiction of Section 1, Power Boilers, of the ASME Boiler and Pressure Vessel Code is subject to the same maximum temperature limitations placed upon the material in Table P7, 1959 edition thereof.

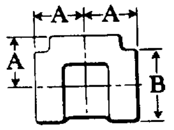
[2] Product used within the jurisdiction of Section 1, Power Piping, of the ASA Code for Pressure Piping B31.1 is subject to the same maximum temperature limitations placed upon piping of the same general composition in Table 2a, 1955 edition thereof.

FORGED STEEL SCREWED FITTINGS

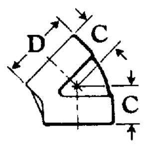
Dimensions, in Inches



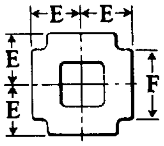
90° Elbow



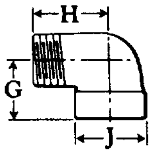
Tee



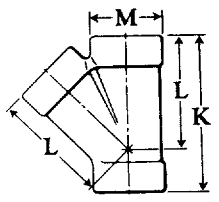
45° Elbow



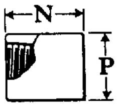
Cross



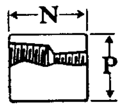
90° Street Elbow



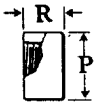
45° Y-Bend



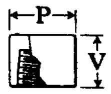
Coupling



Reducer



Half Coupling



Cap

Couplings, reducers, and caps are machined from solid steel.

Dimensions of reducing sizes are the same as those of the straight size corresponding to the largest opening

Size	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	V
								2000-Pound W.O.G. Fittings								
1/4	13/16	29/32	3/4	1 1/32	31/32	1	..	..	..	..	..	..	..	..	..	..
3/8	31/32	1 1/32	3/4	1 1/32	31/32	1	..	..	..	..	..	..	..	..	..	..
1/2	1 1/8	1 5/16	7/8	1 5/16	1 1/8	1 5/16	..	..	..	3	2 1/8	1 5/16	..	..	..	..
3/4	1 5/16	1 1/2	1	1 1/2	1 5/16	1 1/2	..	..	..	3 9/16	2 9/16	1 1/2	..	..	..	..
1	1 1/2	1 13/16	1 1/8	1 13/16	1 1/2	1 13/16	..	..	..	4 1/8	3	1 13/16	..	..	..	..
1 1/4	1 3/4	2 7/32	1 5/16	2 7/32	1 3/4	2 3/16	..	..	..	4 13/16	3 1/2	2 3/16	..	..	..	..
1 1/2	2	2 15/32	1 7/16	2 15/32	2	2 7/16	..	..	..	5 3/8	3 15/16	2 7/16	..	..	..	..
2	2 3/8	3	1 11/16	3	2 3/8	2 31/32	..	..	..	6 7/16	4 3/4	2 31/32	..	..	..	..
2 1/2	3	3 5/8	2	3 21/32	..		..	..	..	..	..	..	..	..	..	..
3	3 3/8	4 5/16	2 1/2	4 5/8	..	..	..	..	..	..	..	..	..	..	..	..
4	4 3/16	5 3/4	3 1/8	5 3/4	4 3/16	5 3/4	..	..	..	..	..	..	..	..	..	..
								3000-Pound W.O.G. Fittings								
1/8	13/16	29/32	3/4	1 1/32	..	..	..	..	..	..	..	..	1 1/4	5/8	..	3/4
1/4	31/32	1 1/32	3/4	1 1/32	31/32	1	7/8	1 1/4	1	..	..	..	1 3/8	3/4	11/16	1
3/8	1 1/8	1 5/16	7/8	1 5/16	1 1/8	1 5/16	1	1 1/2	1 1/4	..	..	..	1 1/2	7/8	3/4	1
1/2	1 5/16	1 1/2	1	1 1/2	1 5/16	1 1/2	1 1/4	1 5/8	1 1/2	..	..	..	1 7/8	1 1/8	15/16	1 1/4
3/4	1 1/2	1 13/16	1 1/8	1 13/16	1 1/2	1 13/16	1 3/8	1 7/8	1 3/4	..	..	..	2	1 3/8	1	1 1/4
1	1 3/4	2 7/32	1 5/16	2 7/32	1 3/4	2 3/16	1 3/4	2 1/4	2	..	..	..	2 3/8	1 3/4	1 3/16	1 1/2
1 1/4	2	2 15/32	1 7/16	2 15/32	2	2 7/16	2	2 5/8	2 7/16	..	..	..	2 5/8	2 1/4	1 5/16	1 5/8
1 1/2	2 3/8	3	1 11/16	3	2 3/8	2 31/32	2 1/8	2 13/16	2 3/4	..	..	..	3 1/8	2 1/2	1 9/16	1 5/8
2	2 1/2	3 9/16	2	3 21/32	2 1/2	3 5/16	2 1/2	3 5/16	3 5/16	..	..	..	3 3/8	3	1 11/16	2
2 1/2	3 3/8	4 3/8	2 1/16	4	..	..	..	..	..	..	..	..	3 5/8	3 5/8	1 13/16	2 3/8
3	3 3/4	4 3/4	2 1/2	4 5/8	..	..	..	..	..	..	..	..	4 1/4	4 1/4	2 1/8	2 9/16
4	4 1/2	6	..	..	..	..	..	..	..	..	..	..	4 3/4	5 1/2	..	2 11/16
								6000-Pound W.O.G. Fittings								
1/8	31/32	1 1/32	3/4	1 1/16	31/32	1	..	..	..	..	..	..	1 1/4	7/8	5/8	..
1/4	1 1/8	1 5/16	7/8	1 5/16	1 1/8	1 5/16	1	1 1/2	1 1/4	..	..	..	1 3/8	1	11/16	..
3/8	1 5/16	1 1/2	1	1 1/2	1 5/16	1 1/2	1 1/8	1 5/8	1 1/2	3 9/16	2 9/16	1 1/2	1 1/2	1 1/4	3/4	..
1/2	1 1/2	1 13/16	1 1/8	1 13/16	1 1/2	1 13/16	1 3/8	1 7/8	1 3/4	4 1/8	3	1 13/16	1 7/8	1 1/2	15/16	..
3/4	1 3/4	2 7/32	1 5/16	2 3/16	1 3/4	2 3/16	1 3/4	2 1/4	2	4 13/16	3 1/2	2 3/16	2	1 3/4	1	..
1	2	2 15/32	1 11/32	2 7/16	2	2 7/16	2	2 5/8	2 7/16	5 3/8	3 15/16	2 7/16	2 3/8	2 1/4	1 3/16	..
1 1/4	2 3/8	3	1 11/16	2 31/32	2 3/8	2 31/32	2 1/8	2 13/16	2 3/4	6 7/16	4 3/4	2 31/32	2 5/8	2 1/2	1 5/16	..
1 1/2	2 1/2	3 9/16	1 23/32	3 5/16	2 1/2	3 5/16	2 1/2	3 5/16	3 5/16	..	..	..	3 1/8	3	1 9/16	..
2	3 3/8	4 3/8	2 1/16	4	3 1/4	4	..	..	..	..	..	..	3 3/8	3 5/8	1 11/16	..
2 1/2	3 3/4	4 3/4	2 1/2	4 5/8	3 3/8	4 5/8	..	..	..	..	..	..	3 5/8	4 1/4	1 13/16	..
3	4 3/16	5 3/4	3 1/8	5 3/4	4 3/16	5 3/4	..	..	..	..	..	..	4 1/4	5	2 1/8	..

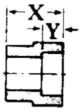
STEEL SOCKET-WELDING REDUCER INSERTS

Advantages of Steel Socket-Welding Fittings

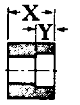
Reducer Insert

No. 1250
For use with Standard or Schedule 40 Pipe

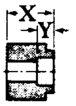
No. 1390
For use with Extra Strong or Schedule 80 Pipe



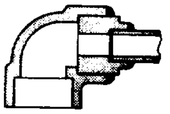
Type No. 1



Type No. 2



Type No. 3



Socket-welding reducer insert applied to a socket - welding elbow.

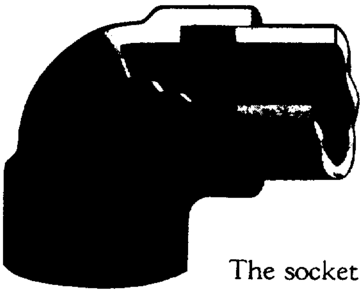
Socket-Welding Reducer Inserts serve the same purpose as threaded bushings used with screwed fittings. The Inserts simplify the problem of making reductions in the sizes of pipe in socket-welded lines and avoid the delays and extra costs involved in procuring reducing fittings. By carrying an assorted stock of Reducer Inserts, the user can make up many combinations of reducing sizes in any type of fitting in the least amount of time and at low cost.

The illustration at the right shows one of these fittings inserted in a straight size 90° elbow to make a reducing size. The Insert is placed in the end of the fitting and fillet welded; the smaller size pipe is then inserted in the smaller pipe end of the Reducer Insert and welded.

Reducer Inserts are available in 1, 1¼, 1½, and 2-inch sizes, the No. 1250 being made for use with Standard or Schedule 40 Pipe and the No. 1390 being made for use with Extra Strong or Schedule 80 Pipe. The fittings are made in three types, depending on the size, as illustrated above. They are made of carbon steel conforming to requirements of ASTM Specification A105, Grade II. Prices are furnished on request.

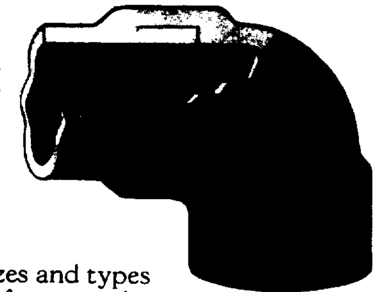
Weights and Dimensions

Size	Pounds, Each Carbon Steel		Dimensions, in Inches		
Inches	No. 1250	No. 1390	Type	X	Y
1 × ¾	.40	.44	No. 1	1½	9/16
× ½	.36	.44	No. 2	1 5/16	½
1¼ × 1	.6	.7	No. 1	1 11/16	⅝
× ¾	.6	.7	No. 2	1⅜	9/16
× ½	.6	.9	No. 3	1⅜	½
1½ × 1¼	.6	.9	No. 1	1⅞	11/16
× 1	.6	.9	No. 2	1 7/16	⅝
× ¾	.9	.9	No. 3	1 7/16	9/16
× ½	.9	.9	No. 3	1 7/16	½
2 × 1½	.9	1.2	No. 2	1 9/16	¾
× 1¼	1.1	1.2	No. 3	1 9/16	11/16
× 1	1.2	1.0	No. 3	1 9/16	⅝
× ¾	1.2	1.0	No. 3	1 9/16	9/16
× ½	1.2	1.0	No. 3	1 9/16	½



On installations where the pipe need not butt against the shoulder, the socket compensates for inaccuracies in measuring and cutting the pipe.

On installations where the pipe must butt against the shoulder, free, uninterrupted flow is assured. Fitting and pipe have the same inside diameter.



The socket type weld has advantages over the butt-weld that recommend it strongly for fittings for small size pipe lines. The pipe used with it does not require beveling.

Since the pipe end slips into, and is supported by the socket, the joint is self-aligning; tack welding and special clamps to line up and hold the joint are unnecessary Because the weld metal is deposited on the outer surface of the pipe, there is no danger of forming welding icicles which would clog the line and restrict flow.

These fittings have the same inside diameter as Standard or Schedule 40, Extra Strong or Schedule 80, Schedule 160, or Double Extra Strong Pipe, depending upon the weight of fitting ordered. On installations where the pipe is butted against the shoulder at the back of the socket, the fittings permit free, uninterrupted flow of the fluid in the line.

The fittings, in the sizes and types covered therein, conform to the American Standard, ASA B16.11–1946, as explained on page 294. The bore diameter of the socket is the same for all fittings regardless of the pressure class.

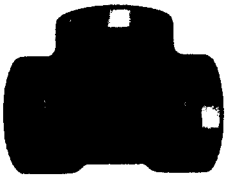
Forged Steel Socket-Welding Fittings have ample metal sections throughout; the long, low band forming the socket wall extends beyond the shoulder at the back of the bore, leaving no weak corner. Exhaustive tests show conclusively that the fittings are as strong as, or stronger than, pipe.

Being only slightly larger than pipe, the fittings, when welded in place, make an exceptionally neat appearing, workmanlike installation.

Size of fitting	Bore diameter of socket (Minimum)
⅛"	0.420"
¼	0.555
⅜	0.690
½	0.855
¾	1.065
1	1.330
1¼	1.675
1½	1.915
2	2.406
2½	2.906
3	3.535
4	4.545

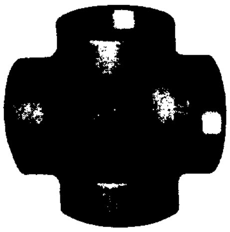
FORGED STEEL SOCKET-WELDING FITTINGS
2000, 3000, 4000, and 6000-Pound W.O.G.

90° Elbow
No. 1240, 2000-Pound WOG
No. 1380, 3000-Pound WOG
No. 1460, 4000-Pound WOG
No. 1660, 6000-Pound WOG

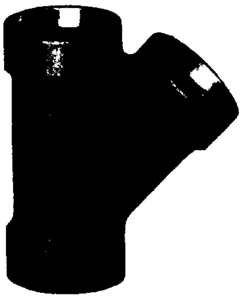


Tee
No. 1241, 2000-Pound WOG
No. 1381, 3000-Pound WOG
No. 1461, 4000-Pound WOG
No. 1661, 6000-Pound WOG

45° Elbow
No. 1242, 2000-Pound WOG
No. 1382, 3000-Pound WOG
No. 1462, 4000-Pound WOG
No. 1662, 6000-Pound WOG



Cross
No. 1243, 2000-Pound WOG
No. 1383, 3000-Pound WOG
No. 1463, 4000-Pound WOG
No. 1663, 6000-Pound WOG



45° Y-Bend
No. 1245, 2000-Pound WOG
No. 1385, 3000-Pound WOG
No. 1465, 4000-Pound WOG
No. 1665, 6000-Pound WOG

Coupling
No. 1246, 2000-Pound WOG
No. 1386, 3000-Pound WOG
No. 1466, 4000-Pound WOG
No. 1666, 6000-Pound WOG

Reducer
No. 1247, 2000-Pound WOG
No. 1387, 3000-Pound WOG
No. 1467, 4000-Pound WOG
No. 1667, 6000-Pound WOG

Cap
No. 1249, 2000-Pound WOG
No. 1389, 3000-Pound WOG
No. 1469, 4000-Pound WOG
No. 1669, 6000-Pound WOG

2000-Pound WOG Fittings are for use with Schedule 40 or Standard pipe
3000-Pound WOG Fittings are for use with Schedule 80 or Extra Strong pipe
4000-Pound WOG Fittings are for use with Schedule 160 pipe
6000-Pound WOG Fittings are for use with Double Extra Strong pipe

Working Pressures*
Steam, Water, Oil, Oil Vapor, Gas, or Air

Material	Temp.	Pounds, Non-Shock			
	Deg. Fahr.	2000 Pound WOG	3000 Pound WOG	4000 Pound WOG	6000 Pound WOG
Carbon Steel ASTM A 105 Grade II	100°	2000	3000	4000	6000
	150	1970	2955	3940	5915
	200	1940	2915	3885	5830
	250	1915	2875	3830	5750
	300	1895	2845	3790	5690
	350	1875	2810	3750	5625
	400	1850	2775	3700	5550
	450	1810	2715	3620	5430
	500	1735	2605	3470	5210
	550	1640	2460	3280	4925
	600	1540	2310	3080	4620
	650	1430	2150	2865	4300
	700	1305	1960	2610	3920
	750	1180	1775	2365	3550
	800	1015	1525	2030	3050
	850	830	1250	1665	2500
	875	725	1090	1450	2180
	900	615	925	1235	1855
	925	520	785	1045	1570
	950	425	640	855	1285
	975	330	500	665	1000
	1000	235	355	475	715

Recommendations: These unusually rugged, durable fittings are ideal for small (up to and including 4") welded lines on relatively low pressure service, for high pressure hydraulic lines, or for high pressure-temperature service.

The 2000-Pound WOG Fittings are for use with Schedule 40 or Standard pipe . . . the 3000-Pound, with Schedule 80 or Extra Strong pipe . . . the 4000-Pound, with Schedule 160 pipe . . . and the 6000-Pound, with Double Extra Strong pipe.

Design: Elbows, tees, crosses, and Y-bends are forged solid; their openings are reinforced with a wide band which completely surrounds the socket chamber, extends well beyond the back of the socket, and meets recognized requirements for socket-weld dimensions. Reducer inserts (see page 296), couplings, reducers, and caps are machined from solid steel. Openings of all fittings are drilled and the ends are bored to slip over pipe.

Materials: The fittings are made from high grade carbon steel (ASTM A 105, Grade II) of unusual strength and toughness. It is particularly suitable for fusion welding.

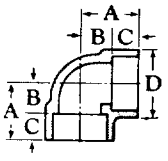
American Standard: These fittings conform to the American Standard for Steel Socket-Welding Fittings (B16.11-1946). This Standard includes elbows, tees, crosses, and couplings in sizes 3-inch and smaller for use with Schedule 40, Schedule 80, and Schedule 160 pipe.

***Note:** When pipe is rated in accordance with the Code for Pressure Piping or any other Code, these fittings may be used for the same pressures and temperatures as the pipe even though such ratings exceed those in the table above.

The fittings, of course, must be made of a material having chemical and physical properties comparable to the pipe, and must be of suitable weight, as indicated by the schedule numbers.

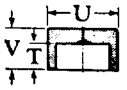
FORGED STEEL SOCKET-WELDING FITTINGS

Dimensions, in Inches

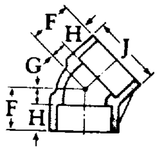


90° Elbow

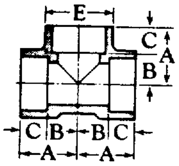
Dimensions of reducing sizes are the same as those of the straight size corresponding to the largest opening.



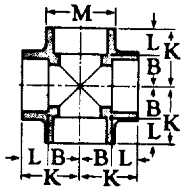
Cap



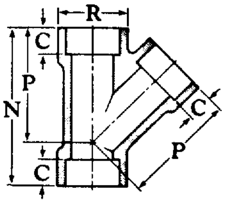
45° Elbow



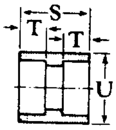
Tee



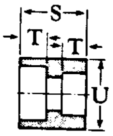
Cross



45° Y-Bend



Coupling

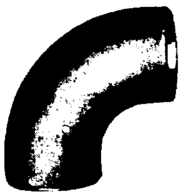


Reducer

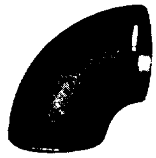
Size	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V
2000-Pound WOG Fittings, for use with Schedule 40 or Standard Pipe																			
1/4	13/16	7/16	3/8	29/32	29/32	3/4	5/16	7/16	1 1/32	31/32	17/32	1	2 5/16	1 5/8	13/16	1	3/8	3/4	5/8
3/8	31/32	17/32	7/16	1 1/32	1 1/32	3/4	5/16	7/16	1 1/32	31/32	7/16	1	2 11/16	1 7/8	1	1 1/8	7/16	1	11/16
1/2	1 1/8	5/8	1/2	1 5/16	1 5/16	7/8	7/16	7/16	1 5/16	1 1/8	1/2	1 5/16	3	2 1/8	1 1/4	1 3/8	1/2	1 1/4	3/4
3/4	1 5/16	3/4	9/16	1 1/2	1 1/2	1	1/2	1/2	1 1/2	1 5/16	9/16	1 1/2	3 9/16	2 9/16	1 1/2	1 1/2	9/16	1 1/2	1 3/16
1	1 1/2	7/8	5/8	1 13/16	1 13/16	1 1/8	9/16	9/16	1 13/16	1 1/2	5/8	1 13/16	4 1/8	3	1 13/16	1 3/4	5/8	1 3/4	1
1 1/4	1 3/4	1 1/16	11/16	2 7/32	2 7/32	1 5/16	11/16	5/8	2 7/32	1 3/4	11/16	2 3/16	4 13/16	3 1/2	2 3/16	1 7/8	11/16	2 1/4	1 1/16
1 1/2	2	1 1/4	3/4	2 15/32	2 15/32	1 7/16	13/16	5/8	2 15/32	2	3/4	2 7/16	5 3/8	3 15/16	2 7/16	2	3/4	2 1/2	1 3/16
2	2 3/8	1 1/2	7/8	3	3	1 11/16	1	11/16	3	2 3/8	7/8	2 31/32	6 7/16	4 3/4	2 31/32	2 1/2	7/8	3	1 3/8
2 1/2	3	1 5/8	1 3/8	3 5/8	3 5/8	2 1/16	1 1/8	15/16	4	3 1/4	1 5/8	4	...	...	...	2 1/2	7/8	3 5/8	1 1/2
3	3 3/8	2 1/4	1 1/8	4 5/16	4 5/16	2 1/2	1 1/4	1 1/4	4 5/8	3 3/8	1 1/8	4 5/8	...	...	...	2 3/4	1	4 1/8	1 5/8
4	4 3/16	2 5/8	1 9/16	5 3/4	5 3/4	3 1/8	1 5/8	1 1/2	5 3/4	4 3/16	1 9/16	5 3/4	...	...	...	3	1 1/8	5 1/4	1 7/8
3000-Pound WOG Fittings, for use with Schedule 80 or Extra Strong Pipe																			
1/4	13/16	7/16	3/8	29/32	29/32	3/4	5/16	7/16	1 1/32	31/32	17/32	1	2 5/16	1 5/8	13/16	1	3/8	7/8	11/16
3/8	31/32	17/32	7/16	1 1/32	1 1/32	3/4	5/16	7/16	1 1/32	31/32	7/16	1	2 11/16	1 7/8	1	1 1/8	7/16	1	3/4
1/2	1 1/8	5/8	1/2	1 5/16	1 5/16	7/8	7/16	7/16	1 5/16	1 1/8	1/2	1 5/16	3	2 1/8	1 1/4	1 3/8	1/2	1 1/4	7/8
3/4	1 5/16	3/4	9/16	1 1/2	1 1/2	1	1/2	1/2	1 1/2	1 5/16	9/16	1 1/2	3 9/16	2 9/16	1 1/2	1 1/2	9/16	1 1/2	1
1	1 1/2	7/8	5/8	1 13/16	1 13/16	1 1/8	9/16	9/16	1 13/16	1 1/2	5/8	1 13/16	4 1/8	3	1 13/16	1 3/4	5/8	1 3/4	1 1/16
1 1/4	1 3/4	1 1/16	11/16	2 7/32	2 7/32	1 5/16	11/16	5/8	2 7/32	1 3/4	11/16	2 3/16	4 13/16	3 1/2	2 3/16	1 7/8	11/16	2 1/4	1 3/16
1 1/2	2	1 1/4	3/4	2 15/32	2 15/32	1 7/16	13/16	5/8	2 15/32	2	3/4	2 7/16	5 3/8	3 15/16	2 7/16	2	3/4	2 1/2	1 1/4
2	2 3/8	1 1/2	7/8	3	3	1 11/16	1	11/16	3	2 3/8	7/8	2 31/32	6 7/16	4 3/4	2 31/32	2 1/2	7/8	3	1 1/2
2 1/2	3	1 5/8	1 3/8	3 5/8	3 5/8	2 1/16	1 1/8	15/16	4	3 1/4	1 5/8	4	...	...	...	2 1/2	7/8	3 5/8	1 1/2
3	3 3/8	2 1/4	1 1/8	4 5/16	4 5/16	2 1/2	1 1/4	1 1/4	4 5/8	3 3/8	1 1/8	4 5/8	...	...	...	2 3/4	1	4 1/4	1 3/4
4	4 3/16	2 5/8	1 9/16	5 3/4	5 3/4	3 1/8	1 5/8	1 1/2	5 3/4	4 3/16	1 9/16	5 3/4	...	...	...	3	1 1/8	5 1/2	1 7/8
4000-Pound WOG Fittings, for use with Schedule 160 Pipe																			
1/2	1 5/16	3/4	9/16	1 1/2	1 1/2	1	1/2	1/2	1 1/2	1 5/16	9/16	1 1/2	3 9/16	2 9/16	1 1/2	1 3/8	1/2	1 1/2	7/8
3/4	1 1/2	7/8	5/8	1 13/16	1 13/16	1 1/8	9/16	9/16	1 13/16	1 1/2	5/8	1 13/16	4 1/8	3	1 13/16	1 1/2	9/16	1 3/4	15/16
1	1 3/4	1 1/16	11/16	2 3/16	2 3/16	1 5/16	11/16	5/8	2 3/16	1 3/4	11/16	2 3/16	4 13/16	3 1/2	2 3/16	1 3/4	5/8	2 1/4	1 1/8
1 1/4	2	1 1/4	3/4	2 7/16	2 7/16	1 11/32	13/16	17/32	2 7/16	2	3/4	2 7/16	5 3/8	3 15/16	2 7/16	1 7/8	11/16	2 1/2	1 3/16
1 1/2	2 3/8	1 1/2	7/8	2 31/32	2 31/32	1 11/16	1	11/16	2 31/32	2 3/8	7/8	2 31/32	6 7/16	4 3/4	2 31/32	2	3/4	3	1 3/8
2	2 1/2	1 5/8	7/8	3 5/16	3 5/16	1 23/32	1 1/8	19/32	3 5/16	2 1/2	7/8	3 5/16	...	...	...	2 1/2	7/8	3 5/8	1 1/2
2 1/2	3 1/4	2 1/4	1	4	4	2 1/16	1 1/4	13/16	4	3 1/4	1	4	...	...	...	2 1/2	7/8	4 1/8	1 5/8
3	3 3/4	2 1/2	1 1/4	4 3/4	4 3/4	2 1/2	1 3/8	1 1/8	4 5/8	3 3/8	7/8	4 5/8	...	...	...	2 3/4	1	4 5/8	1 3/4
6000-Pound WOG Fittings, for use with Double Extra Strong Pipe																			
3/8	1 1/8	17/32	19/32	1 5/16	1 5/16	7/8	3/8	1/2	1 5/16	1 1/8	19/32	1 5/16	3	2 1/8	1 1/4	1 1/8	7/16	1 5/16	15/16
1/2	1 5/16	5/8	11/16	1 1/2	1 1/2	1	3/8	5/8	1 1/2	1 5/16	11/16	1 1/2	3 9/16	2 9/16	1 1/2	1 3/8	1/2	1 1/2	1
3/4	1 1/2	3/4	3/4	1 13/16	1 13/16	1 1/8	7/16	11/16	1 13/16	1 1/2	3/4	1 13/16	4 1/8	3	1 13/16	1 1/2	9/16	1 3/4	1 1/16
1	1 3/4	7/8	7/8	2 3/16	2 3/16	1 5/16	1/2	13/16	2 3/16	1 3/4	7/8	2 3/16	4 13/16	3 1/2	2 3/16	1 3/4	5/8	2 1/4	1 1/4
1 1/4	2	1 1/16	15/16	2 7/16	2 7/16	1 11/32	5/8	23/32	2 7/16	2	15/16	2 7/16	5 3/8	3 15/16	2 7/16	1 7/8	11/16	2 1/2	1 5/16
1 1/2	2 3/8	1 1/4	1 1/8	2 31/32	2 31/32	1 11/16	19/32	1 3/32	2 31/32	2 3/8	1 1/8	2 31/32	6 7/16	4 3/4	2 31/32	2	3/4	3	1 3/8
2	2 1/2	1 1/2	1	3 5/16	3 5/16	1 23/32	7/8	27/32	3 5/16	2 1/2	1	3 5/16	...	...	...	2 1/2	7/8	3 5/8	1 5/8
2 1/2	3 1/4	1 3/4	1 1/2	4	4	2 1/16	1	1 1/16	4	3 1/4	1 1/2	4	...	...	...	2 1/2	7/8	4 1/4	1 5/8
3	3 3/4	2 1/8	1 5/8	4 3/4	4 3/4	2 1/2	1 1/4	1 1/4	4 5/8	3 3/8	1 1/4	4 5/8	...	...	...	2 3/4	1	5	1 7/8

STEEL BUTT-WELDING FITTINGS
For Use With Standard Pipe

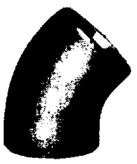
Courtesy of Crane Co.



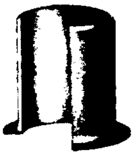
No. 352 E
90° Long Radius Elbow
Straight and Reducing



No. 331 E
90° Short Radius Elbow

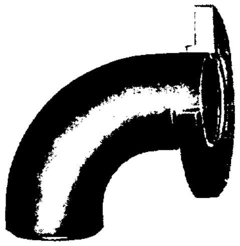


No. 354 E
45° Long Radius Elbow

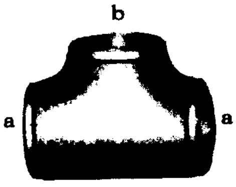


No. 574
Cranelap Stub End

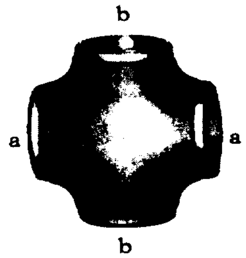
For sizes and weights, see the facing page.
For pressure-temperature ratings, see page 305.



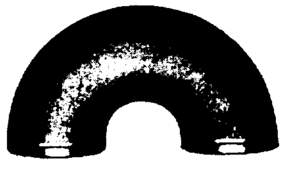
No. 335 E
90° Long Radius Elbow
Long Tangent on One End
(flange is not included)



No. 353 E
Tee
Straight and Reducing



No. 336 E
Cross
Straight and Reducing



Return Bend
No. 372 E, Short Radius
No. 373 E, Long Radius

Thickness: Standard fittings in sizes 12-inch and smaller are made for use with Standard pipe (the heaviest weight on 8, 10, and 12-inch sizes). In sizes 14-inch and larger, Standard fittings are made for use with O.D. pipe ⅜-inch thick.

Materials: Unless otherwise specified, the fittings are made of carbon steel conforming to requirements of ASTM Specification A 234, Grade B.

Fittings made of Grade A carbon steel, genuine wrought iron, stainless steel, or other materials can be furnished when specified; information on request.

American Standard: These fittings conform, in types and sizes included therein, to the American Standard for Steel Butt-Welding Fittings, B16.9-1958.

The Standard does not include sizes smaller than 1-inch, nor does it include 90° elbows with a long tangent on one end, short radius 90° elbows, crosses, short radius return bends, or shaped nipples.

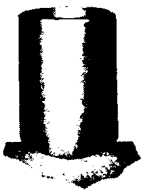
90° elbow with long tangent: The No. 335 E are 90° long radius elbows having a long tangent on one end to permit welding on a slip-on welding flange. The tangent end is not beveled; the other end is beveled.

Cranelap stub ends: Cranelap stub ends, made of Grade B seamless steel pipe lapped to the full thickness of the pipe wall, and Cranelap flanges (see page 308) afford an ideal method of installing flanged equipment in a welded line. The swivel flange eliminates the difficulty of aligning bolt holes and permits installing the equipment at any angle.

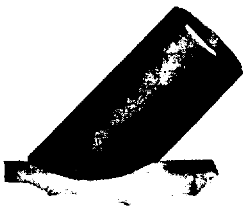
Shaped nipples: Shaped nipples eliminate the use of templates when saddling one pipe upon another; they save erection time and assure an accurate fit. Both ends are beveled for welding. When ordering, be sure to specify both the pipe size and the nominal size of the header on which the nipple will be used; header sizes which the nipples are shaped to fit are included in the upper table on the facing page.

Prices: Prices are furnished on request.

Ordering reducing tees and crosses: When ordering reducing tees and crosses, specify the size of openings in the sequence of the lower case letters (a and b) shown on their illustrations at the left.



No. 350 E
90° Shaped Nipple



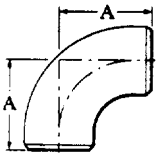
No. 351 E
45° Shaped Nipple

No. 357 E
Cap

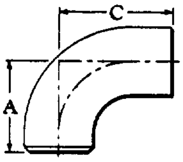
Concentric Reducer

Eccentric Reducer

STEEL BUTT-WELDING FITTINGS
Dimensions, in Inches



90° Long Radius Elbow
Straight or Reducing



90° Long Radius Elbow with Long Tangent on One End

Standard, Extra Strong, Schedule 160, and Double Extra Strong Fittings have the same outside dimensions.

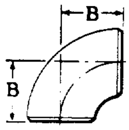
American Standard: These fittings conform, in sizes and types included therein, to the American Standard, B16.9-1958; see page 293.

Thickness: Standard Fittings 12-inch and smaller are made for use with Standard pipe (heaviest weight on 8, 10, and 12-inch sizes); sizes 14-inch and larger are made for use with O.D. pipe ⅜-inch thick.

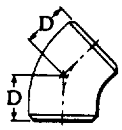
Extra Strong Fittings 12-inch and smaller are made for use with Extra Strong pipe; larger sizes are made for use with O.D. pipe ½-inch thick.

Schedule 160 Fittings are made for use with Schedule 160 pipe.

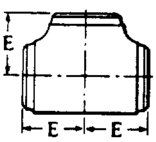
Double Extra Strong Fittings are made for use with Double Extra Strong pipe.



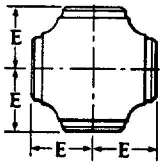
90° Short Radius Elbow



45° Long Radius Elbow

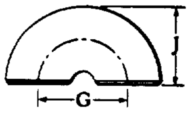


Straight Tee

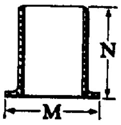


Straight Cross

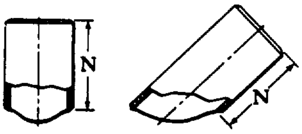
Cap



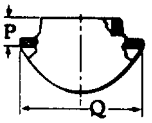
Short Radius Return Bend



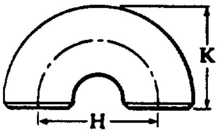
Cranelap Stub End



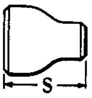
90° Type 45° Type Shaped Nipples



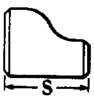
Reinforcing Welding Saddle



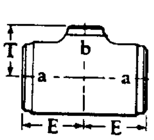
Long Radius Return Bend



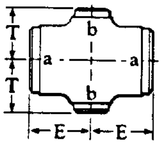
Concentric Reducer



Eccentric Reducer



Reducing Tee



Reducing Cross

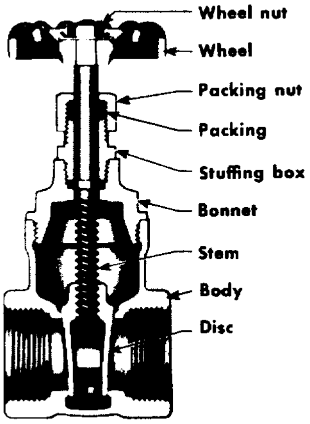
Dimension "T" is shown in table below; refer to large table for dimension "E".

Size a b	T	Size a b	T
1 ×¾ *	1½	6×3½	5
1¼×1 *	1⅞	×3	4⅞
×¾ *	1⅞	×2½	4¾
1½×1¼*	2¼	8×6	6⅝
×1 *	2¼	×5	6⅜
×¾ *	2¼	×4	6⅛
2 ×1½	2⅜	×3½	6
×1¼	2¼	10×8	8
×1	2	×6	7⅝
×¾	1¾	×5	7½
2½×2	2¾	×4	7¼
×1½	2⅝	12×10	9½
×1¼	2½	×8	9
×1	2¼	×6	8⅝
3 ×2½	3¼	×5	8½
×2	3	14×12*	10⅝
×1½	2⅞	×10*	10⅛
×1¼	2¾	×8 *	9⅝
3½×3	3⅝	×6 *	9¼
×2½	3½	16×14*	12
×2	3¼	×12*	11⅝
×1½	3⅛	×10*	11⅛
4 ×3½	4	×8 *	10⅝
×3	3⅞	18×16*	13
×2½	3¾	×14*	13
×2	3½	×12*	12⅝
×1½	3⅜	×10*	12⅛
5 ×4	4⅝	20×18*	14½
×3½	4½	×16*	14
×3	4⅜	×14*	14
×2½	4¼	×12*	13⅝
×2	4⅛	24×20*	17
6 ×5	5⅜	×18*	16½
×4	5⅛	×16*	16

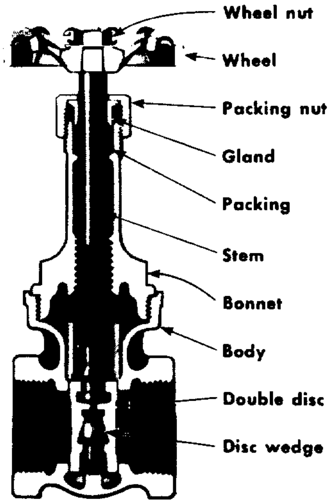
Size	A	B	C	D	E	F	G	H	J	K	M	N	P	Q	S	Pipe Schedule Numbers for:	
																Std. Ftgs.	Extra Strong
½	1½	. .	. .	⅝	. .	. .	. .	3	. .	1¹⁵⁄₁₆	. .	. .	. .	. .	. .	40	80
¾	1⅛	. .	. .	⁷⁄₁₆	1⅛*	. .	. .	2¼	. .	1¹¹⁄₁₆	1¹¹⁄₁₆	4	. .	. .	2	40	80
1	1½	1	. .	⅞	1½*	1½	2	3	1⅝	2³⁄₁₆	2	4	1	4⅛	2	40	80
1¼	1⅞	1¼	. .	1	1⅞*	1½	2½	3¾	2¹⁄₁₆	2¾	2½	4	1⅛	4¾	2	40	80
1½	2¼	1½	3¼	1⅛	2¼*	1½	3	4½	2⁷⁄₁₆	3¼	2⅞	4	1⅛	5¼	2½	40	80
2	3	2	4¼	1⅜	2½	1½	4	6	3³⁄₁₆	4³⁄₁₆	3⅝	6	1⅛	5¹⁵⁄₁₆	3	40	80
2½	3¾	2½	5	1¾	3	1½	5	7½	3¹⁵⁄₁₆	5³⁄₁₆	4⅛	6	1⅛	6⁷⁄₁₆	3½	40	80
3	4½	3	5¾	2	3⅜	2	6	9	4¾	6¼	5	6	1⅛	7⁹⁄₁₆	3½	40	80
3½	5¼	3½	6¾	2¼	3¾	2½	. .	. .	. .	. .	5½	6	1¼	8¹⁄₁₆	4	40	80
4	6	4	7½	2½	4⅛	2½	8	12	6¼	8¼	6³⁄₁₆	6	1⅜	8⁹⁄₁₆	4	40	80
5	7½	5	9	3⅛	4⅞	3	10	15	7¾	10⁵⁄₁₆	7⁵⁄₁₆	8	1⅜	9⅝	5	40	80
6	9	6	10¾	3¾	5⅝	3½	12	18	9⁵⁄₁₆	12⁵⁄₁₆	8½	8	1½	11¾	5½	40	80
8	12	8	13¾	5	7	4	16	24	12⁵⁄₁₆	16⁵⁄₁₆	10⅝	8	2	14¾	6	40	80
10	15	10	17	6¼	8½	5	20	30	15⅜	20⅜	12¾	10	2½	17⅞	7	40	60
12	18	12	20½	7½	10	6	24	36	18⅜	24⅜	15	10	2¾	20⅞	8	. .	. .
14	21	14	. .	8¾	11*	6½	28	42	21	28	16¼	12	3¼	22⅛	13	30	. .
16	24	16	. .	10	12*	7	32	48	24	32	18½	12	3½	24⅛	14	30	40
18	27	18	. .	11¼	13½*	8	36	54	27	36	21	12	4	26⅛	15	. .	. .
20	30	20	. .	12½	15*	9	40	60	30	40	23	12	4	30⅛	20	20	30
24	36	24	. .	15	17*	10½	48	72	36	48	27¼	12	4	34⅛	20	20	. .

BRONZE GATE VALVES
Names of Parts

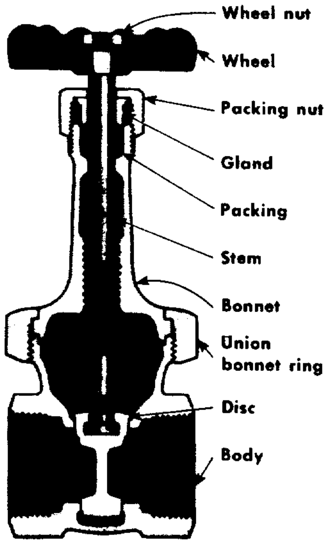
Courtesy of Crane Co.



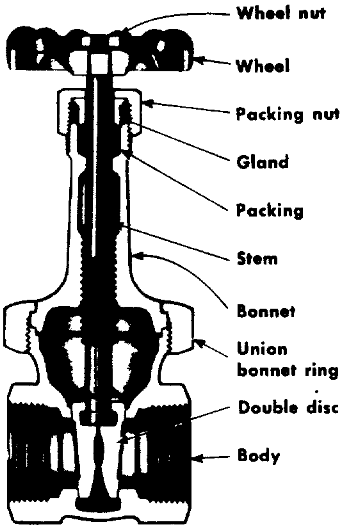
No. 410
Non-Rising Stem
Screwed Bonnet
Wedge Disc



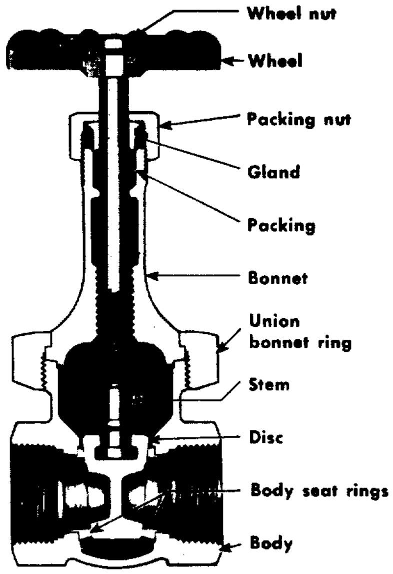
No. 440
Rising Stem
Screwed Bonnet
Double Disc



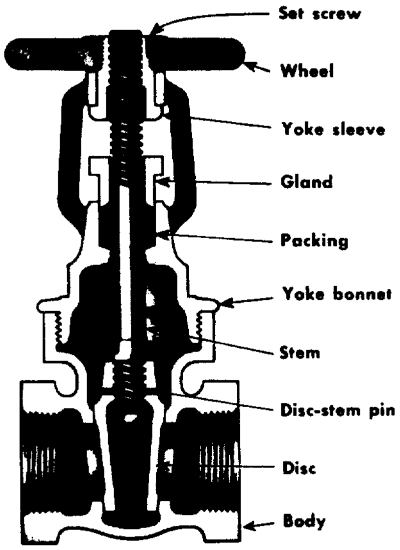
No. 428-UB
Rising Stem
Union Bonnet
Wedge Disc



No. 435-UB
Rising Stem
Union Bonnet
Double Disc



No. 424
Rising Stem
Union Bonnet, Wedge Disc
Expanded Seats



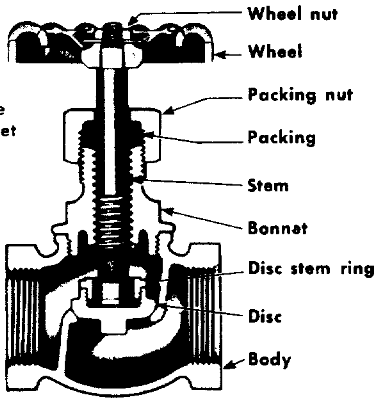
No. 459
Underwriters' Pattern
Outside Screw & Yoke
Wedge Disc

Courtesy of Crane Co.

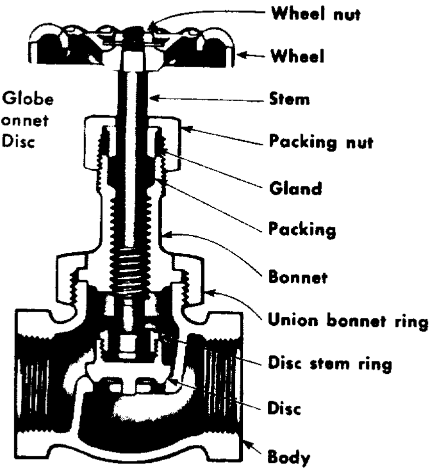
BRONZE GLOBE AND ANGLE VALVES

Names of Parts

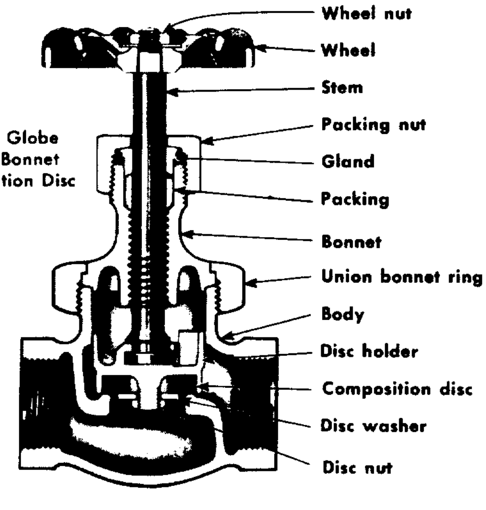
No. 1, Globe
Screwed Bonnet
Metal Disc



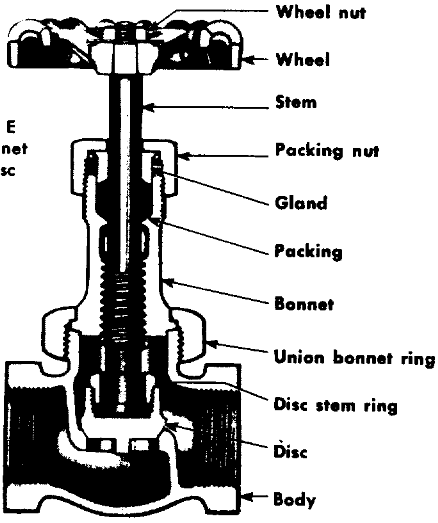
No. 70, Globe
Union Bonnet
Metal Disc



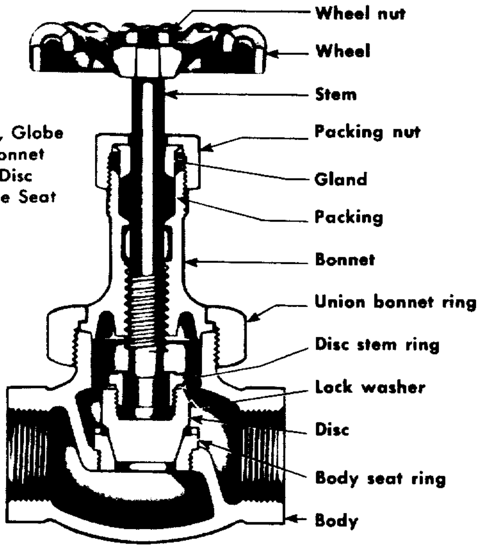
No. 7, Globe
Union Bonnet
Composition Disc



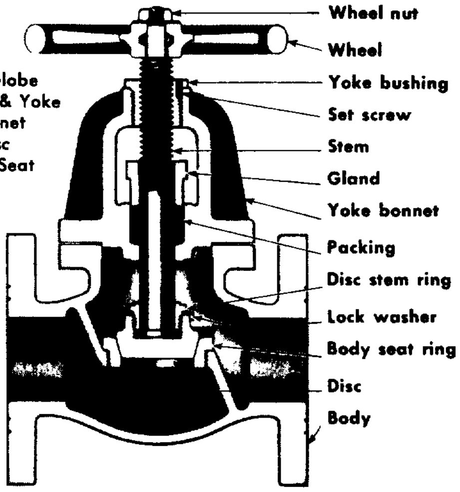
No. 362 E
Union Bonnet
Metal Disc



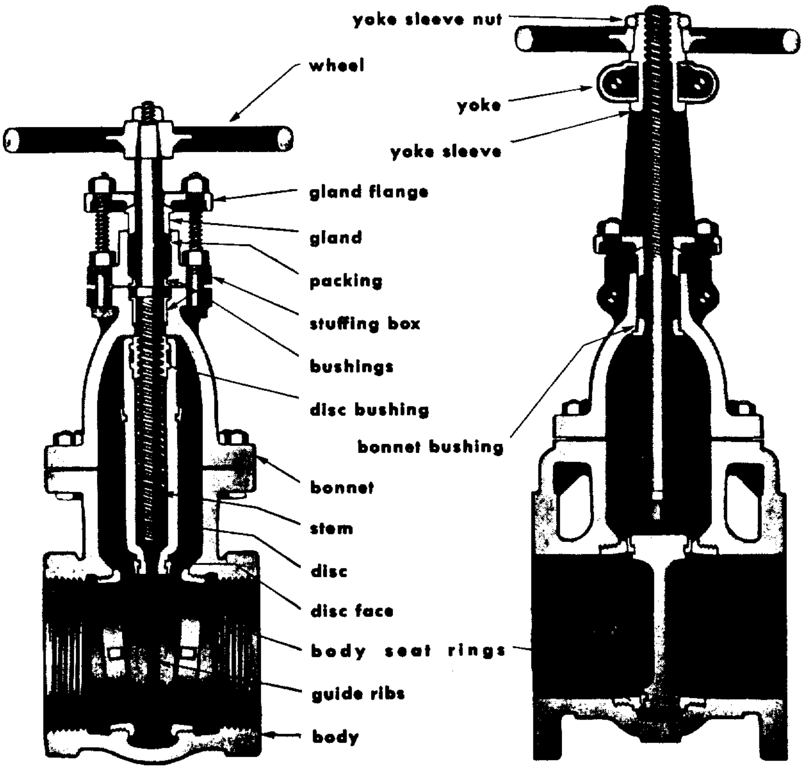
No. 382 P, Globe
Union Bonnet
Metal Disc
Renewable Seat



No. 87 P, Globe
Outside Screw & Yoke
Bolted Bonnet
Metal Disc
Renewable Seat

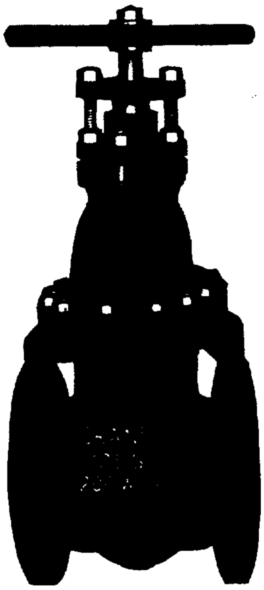


125-POUND FERROSTEEL WEDGE GATE VALVES
Names of Parts



Non-Rising Stem Valve
Bronze Trimmed — Open

Outside Screw and Yoke Valve
Bronze Trimmed — Closed



Non-Rising Stem Flanged
Bronze trimmed and all-iron valves with screwed, flanged, or hub ends are available.

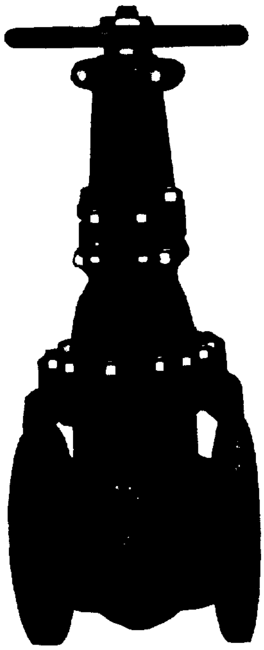
Crane 125-Pound Ferrosteel Wedge Gate Valves are described in detail on this and the seven pages that follow.

The valves have proved their versatility and dependability in practically every industry. Sizes 16-inch and smaller, particularly, with many features of unusual merit, set a new peak for quality in iron body wedge gate valves; unusual strength, long service life, and fine all-around adaptability in all types of installations are a few of the advantages of the Crane line.

Bronze trimmed and all-iron non-rising stem and outside screw and yoke valves are available; refer to the listings below:

General Description	page 73
Non-Rising Stem Valves	pages 74 and 75
Outside Screw and Yoke Valves	pages 76 and 77
Quick-Opening Valves	page 78
Underwriters Pattern Valves	page 79

The following alloy iron valves, made to the same high standard of quality and exacting design as the 125-pound valves, are also included in this section:



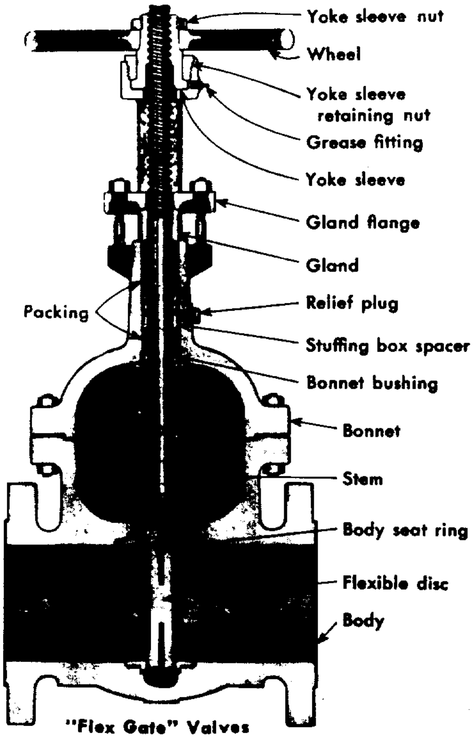
Outside Screw and Yoke Flanged
Bronze trimmed screwed and flanged, or all-iron flanged valves, are available.

Courtesy of Crane Co.

CAST STEEL WEDGE GATE VALVES
150 and 300-Pound

"Flex Gate" Valves

(Sizes 2 to 12-inch regular; sizes 14 to 36-inch on order)



"Flex Gate" Valves
(300-Pound Valve illustrated)

Regularly furnished in sizes 2 to 12-inch; available on order in sizes 14-inch to 36-inch.

Crane's patented one-piece flexible disc . . . solid through the center only . . . permits each disc face to move independently of the other.

Crane "Flex Gate" Valves offer a host of benefits. The design effects easy operation; less torque is required to seat and unseat . . . . the disc will not stick in the closed position, even if closed while hot and allowed to cool . . . . the resiliency of the construction compensates for minor misalignment of seats due to pipeline deflection . . . . and the valves are tight over a wide range of pressures on both the inlet seat and the outlet seat.

A complete line . . . featuring Crane's patented "Flex Gate" design in sizes 2 to 12-inch

The term "Flex Gate" is a Crane Co. trademark; registration pending in the U.S. Patent Office.

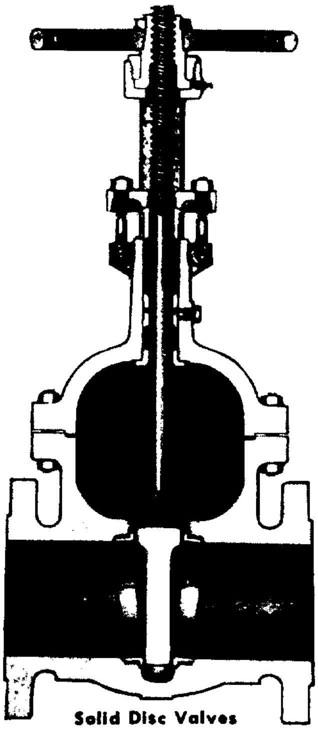
Crane 150 and 300-Pound Cast Steel Wedge Gate Valves offer dependable service in steam, water, oil, and oil vapor lines. Quality materials and fine workmanship combined with tested designs assure high utility in severe service. A variety of trim materials are furnished.

The line, in the popular 2 to 12-inch size range, introduces Crane's "Flex Gate" Valves . . . . with patented one-piece flexible wedge disc . . . . a major step forward in fine valve construction.

"Flex Gate" Valves: Crane "Flex Gate" Valves feature a new concept in valve design . . . . a flexible wedge disc. Instead of being made solid with both seating faces maintained in the same rigid position, flexibility . . . . or resiliency . . . is attained by having the two faces separated from each other except fo a small section at the center. See the two illustrations at the left.

Solid Disc Valves

(Sizes 1½ to 24-inch regular; sizes 30 and 36-inch on order)



Solid Disc Valves
(300-Pound Valve illustrated)

Solid wedge disc valves, except for the disc, are the same design as the "Flex Gate" Valves.

The shape of the flexible disc can be likened to two wheels on a very short axle. The "axle" or spud at the center of the disc is amply strong to carry the two halves of the disc together at all times . . . . and yet, it permits a degree of action between them. It is this "flexibility" that makes the disc tight on both faces over a wide range of pressures . . . . prevents sticking during temperature changes, and assures minimum operating torque.

Although each disc face can move independently of the other . . . . up to two full degrees . . . . the construction is one-piece. There are no loose parts to cause harmful vibration.

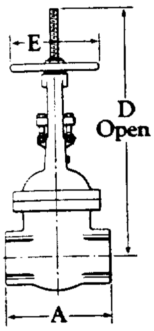
Solid Disc Valves: Crane Solid Wedge Disc Valves, illustrated at the upper right, are regularly furnished in the 1½-inch size and in sizes 14 to 24-inch; they are optional in sizes 2 to 12-inch. As in the "Flex Gate" design, careful engineering and workmanship are combined to produce a quality product highly dependable in severe service.

The disc is the solid web type. The facings are smoothly and accurately machined, and are then ground to a mirror-like finish. The disc is carefully fitted into the valve so that an even, wide, and true contact is made with the corresponding faces of the body seat rings.

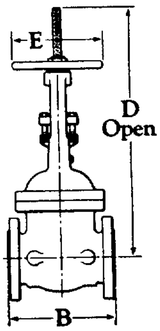
Disc guides; stem connection: Both the flexible disc and the solid disc have long, machined guide slots which engage the guide ribs in the body to maintain true alignment of the disc throughout its travel. The seating faces do not contact each other until the valve is virtually closed. A tee-head disc-stem connection prevents lateral strains on the stem.

CAST STEEL WEDGE GATE VALVES
150 to 1500-Pound Dimensions

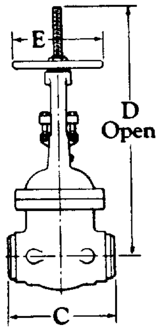
Courtesy of Crane Co.



Screwed



Flanged



Butt-Welding

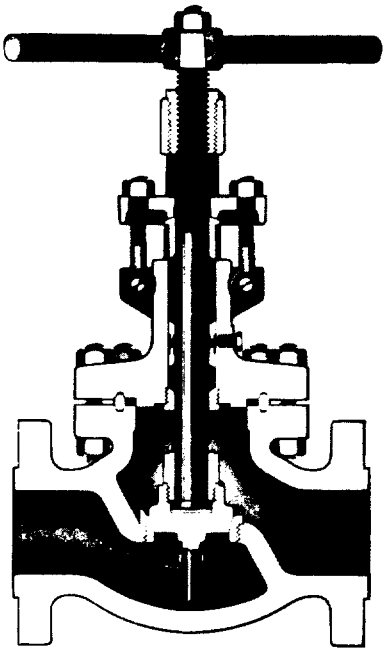
Face to face: Flanged valves of the 150 and 300-pound pressure classes are regularly furnished with a 1/16-inch raised face; those of the 400, 600, 900, 1500, and 2500-pound classes are regularly furnished with 1/4-inch high large male facing; face to face dimensions include these facings.

All flanged and butt-welding valves conform to the American Standard for Face-to-Face Dimensions of Ferrous Flanged and Welding End Valves, B16.10-1957, for their respective pressure class. This Standard does not include 3½-inch steel valves.

Dimensions, in Inches

Class	Size of Valve	A	B	C	D	E
150-Pound	2	6¼	7	8½	15¾	8
	2½	7	7½	9½	16½	8
	3	7⅜	8	11⅛	20¾	9
	3½	...	8½	...	23	9
	4	8	9	12	25¾	10
	5	...	10	15	30½	12
	6	...	10½	15⅞	35¼	14
	8	...	11½	16½	44	16
	10	...	13	18	52½	18
	12	...	14	19¾	60½	18
	14	...	15	22½	70¼	22
	16	...	16	24	79¾	24
	18	...	17	26	89	27
	20	...	18	28	97¼	30
	24	...	20	32	112¾	30
300-Pound	1½	...	7½	...	16¾	8
	2	7	8½	8½	18	8
	2½	8	9½	9½	19	8
	3	9	11⅛	11⅛	23¼	9
	4	11	12	12	28¼	10
	5	...	15	15	33½	12
	6	...	15⅞	15⅞	38½	14
	8	...	16½	16½	47	16
	10	...	18	18	56½	20
	12	...	19¾	19¾	64¼	20
	14	...	30	30	75¼	27
	16	...	33	33	81	27
	18	...	36	36	91½	30
	20	...	39	39	99¾	36
	24	...	45	45	120½	36
400-Pound	4	...	16	16	30¾	12
	5	...	18	18	35	14
	6	...	19½	19½	40¼	16
	8	...	23½	23½	50½	20
	10	...	26½	26½	59¾	24
	12	...	30	30	67¾	24
	14	...	32½	32½	74¾	27
	16	...	35½	35½	80¾	27

Class	Size of Valve	B	C	D	E
600-Pound	2	11½	11½	18¼	8
	2½	13	13	22¼	9
	3	14	14	25¾	10
	3½	15	...	32	14
	4	17	17	31½	14
	5	20	20	36¾	16
	6	22	22	42¾	20
	8	26	26	52¼	24
	10	31	31	62¼	27
	12	33	33	70	27
	14	35	35	77¼	30
	16	39	39	83¾	30
	18	43	43	93¾	36
	20	47	47	104½	36
	24	55	55	126	42
900-Pound	3	15	15	27¼	12
	4	18	18	31½	14
	5	22	22	36¾	16
	6	24	24	42¾	20
	8	29	29	52½	24
	10	33	33	62¼	27
	12	38	38	73½	30
	14	40½	40½	77¼	30
	16	44½	44½	85¾	36
1500-Pound	1	10	10	16	8
	1¼	11	11	16½	8
	1½	12	12	20	9
	2	14½	14½	22⅛	10
	2½	16½	16½	26⅜	12
	3	18½	18½	28	14
	4	21½	21½	33	16
	5	26½	26½	38¾	20
	6	27¾	27¾	47	24
	8	32¾	32¾	55	27
2500-Pound	Dimensions of 2500-Pound Valves are furnished on application.				



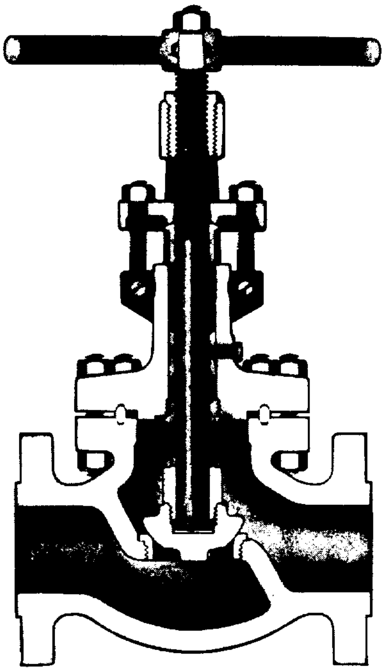
Plug Type Disc

Crane Steel Globe and Angle Valves embody many refinements in design and materials.

Disc and seat: The "XR" trimmed valves (for steam, water, or general service) and "U" trimmed valves (for steam, water, oil, or oil vapor service) in sizes 6-inch and smaller have a plug type disc and seat (illustrated at left); the 8-inch size has a flat disc and seat (not illustrated). The 2-inch valves do not have a disc stem guide.

All sizes of "X" trimmed valves (for oil or oil vapor service) are furnished with a 35° taper seat and a ball shaped seating face on the disc (illustrated at right).

Body seat ring: All valves have the shoulder-type screwed-in body seat ring for utmost tightness and security; in "U" trimmed valves, the rings are also seal brazed or seal welded.



Ball Type Disc

Body and bonnet: The body and bonnet have heavy metal sections with liberal reinforcement at points subjected to greatest stress. The bonnet is fitted with a stem hole bushing.

Bonnet joint: A ring-type bonnet joint holds pressure easily on the 400, 600, 900, 1500, and 2500-pound valves, assuring tightness and maximum strength. On 150 and 300-pound valves, a close-fitting male and female bonnet joint retains the gasket and accurately centers the working parts.

The 300-pound and higher pressure valves have through stud bolts in the bonnet joint. The 150-pound valves employ studs, threaded into the bonnet flange on the body.

Stuffing box: The stuffing box on all valves is deep, assuring tightness and long packing life. The stuffing box is the lantern-type on all except the 150-pound valves. When wide open, the valves can be repacked while under pressure.

Gland: A two-piece ball-type gland and gland flange assure even pressure on the packing without binding on the stem. The gland flange is held in place by swinging eye bolts; the bolts will not loosen in service.

Stem: The stem is of liberal diameter and has unusual strength. Threads are clean and accurately cut and have long engagement with the yoke bushing. The stem and disc are held together by a disc stem ring, which permits the disc to swivel.

Drilling: Flanged valves of each pressure class are furnished with the end flanges faced, drilled, and spot faced (FD & SF) unless otherwise ordered. When orders so specify, flanged valves can be furnished faced only.

Flange facings: The 150 and 300-pound flanged valves are regularly furnished with an American Standard $\frac{1}{16}$-inch raised face on the end flanges; the 400, 600, 900, 1500, and 2500-pound flanged valves regularly have a $\frac{1}{4}$-inch male face (large male).

When so ordered, valves can be furnished with other types of facings, such as ring joint, female, tongue, groove, etc.; see pages 332 to 335.

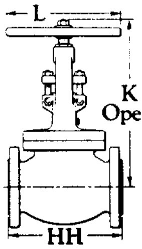
Finish of flange faces: The $\frac{1}{16}$-inch raised faces of the 150 and 300-pound valves and the $\frac{1}{4}$-inch male faces of the 400-pound and higher pressure class valves are regularly furnished with a serrated finish.

A smooth finish can be furnished on the raised or male faces, when specified.

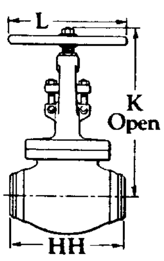
American Standard: In design and materials, Crane Cast Steel Globe and Angle Valves exceed the requirements of Standards issued by the American Standards Association.

The butt-welding valve ends and the dimensions and drilling of end flanges on flanged valves conform to the American Steel Flange Standard, B16.5-1957, for their respective pressure class.

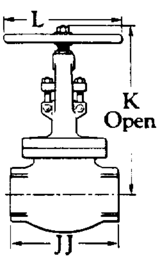
Flanged and butt-welding valves conform to the American Standard for Face-to-Face and End-to-End Dimensions of Ferrous Flanged and Welding End Valves, B16.10-1957, for their respective pressure class. This Standard does not include $3\frac{1}{2}$-inch steel valves.



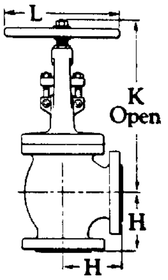
Globe Flanged



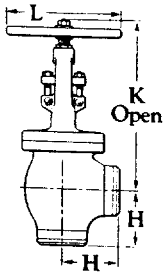
Globe Butt-Welding



Globe Screwed



Angle Flanged



Angle Butt-Welding

Dimensions, in Inches

All dimensions shown below apply to valves without gears; dimensions "HH" and "H" apply also to valves with gears. For sizes regularly furnished with gears, see asterisked (*) note at right.

Class	Size	Globe Valves						Angle Valves		All Valves
		Flanged		Butt-Welding		Screwed		Flanged or Butt-Welding†		
		HH	K	HH	K	JJ	K	H	K	L
150 Pound	2	8	13¾	8	13¾	8	13¾	4	12½	8
	2½	8½	14½	8½	14½	...	...	4¼	13	8
	3	9½	16½	9½	16½	...	...	4¾	15	9
	3½	10½	17¼	...	...	...	...	...	...	9
	4	11½	19¾	11½	19¾	...	...	5¾	17¾	10
	5	14	23	14	23	...	...	7	20¾	10
	6	16	24½	16	24½	...	...	8	21¾	12
	8	19½	26	19½	26	...	...	9¾	23½	16
300 Pound	2	10½	17¾	10½	17¾	...	...	5¼	17¾	9
	2½	11½	19	11½	19	...	...	5¾	19	10
	‡3	12½	20½	12½	20½	...	...	6¼	20½	10
	3½	13¼	22½	...	...	...	...	6⅝	22½	12
	4	14	24¾	14	24¾	...	...	7	24¾	14
	5	15¾	26½	...	...	...	...	7⅞	26½	16
	6	17½	29¾	17½	29¾	...	...	8¾	29¾	18
	8	22	36½	22	36½	...	...	11	36½	24
400 Pound	4	16	25¼	16	25¼	...	...	8	25¼	14
	5	18	28½	18	28½	...	...	9	28½	18
	6	19½	31¼	19½	31¼	...	...	9¾	31¼	20
	8	23½	38¼	23½	38¼	...	...	11¾	38¼	27
600 Pound	2	11½	19	11½	19	...	...	...	...	10
	2½	13	21¼	13	21¼	...	...	6½	21¼	12
	‡3	14	23½	14	23½	...	...	7	23½	12
	3½	15	25	...	...	...	...	7½	25	14
	4	17	27½	17	27½	...	...	8½	27½	18
	5	20	30¾	20	30¾	...	...	10	30¾	20
	6	22	35	22	35	...	...	11	35	24
900 Pound	3	15	24	15	24	...	...	7½	24	12
	4	18	29½	18	29½	...	...	9	29½	20
	6	24	37¾	24	37¾	...	...	12	37¾	27
1500 Pound	2	14½	25⅛	14½	25⅛	...	...	...	...	14
	2½	16½	28⅛	16½	28⅛	...	...	...	...	18
	3	18½	33½	18½	33½	...	...	...	...	24

†Angle butt-welding valves are made only in the 600-pound class in sizes 2½, 3, 4, 5, and 6-inch.

‡When 3-inch 300 and 600-pound flanged valves with ring joint facing are to be bolted to Cranelap Joints, orders must so specify; a groove of special pitch diameter is required; see page 334 for dimensions.

***Ball-bearing yoke; gearing:** Crane Cast Steel Globe and Angle Valves, in the larger sizes of the 300-pound and higher pressure classes, are regularly furnished with a ball-bearing yoke and spur or bevel gears, as follows:

300-Pound	8-inch
400-Pound	6 and 8-inch
600-Pound	5 and 6-inch
900-Pound	4 and 6-inch
1500-Pound	3-inch

Orders must state whether spur or bevel gears are wanted; see page 149 for description.

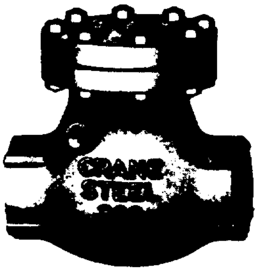
When specified, the above valves can be furnished without gears (plain bearing yoke).

Note: All dimensions apply to valves without gears. Face to face (HH) and center to face (H) dimensions also apply to valves with gears; for additional dimensions of geared valves; see page 149.

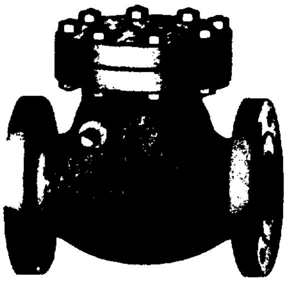
Face to face: The 150 and 300-pound flanged valves are regularly furnished with a 1/16-inch raised face; valves of the 400-pound and higher pressure classes have a ¼-inch high large male face. The face to face (HH) and center to face (H) dimensions include this facing.

Flanged and butt-welding valves conform to the American Standard for Face-to-Face Dimensions of Ferrous Flanged and Welding End Valves, B16.10-1957. This Standard does not include steel valves in the 3½-inch size.

Ordering: When ordering, specify catalog number and suffix; see preceding page.



Screwed
For Oil, Oil Vapor,
Steam, or Water
No. 148 X, 150-Pound
No. 158 X, 300-Pound



Flanged
For Oil, Oil Vapor,
Steam, or Water
No. 147 X, 150-Pound
No. 159 X, 300-Pound
No. 169 X, 400-Pound
No. 175 X, 600-Pound
No. 187 X, 900-Pound
No. 199 X, 1500-Pound

Butt-Welding
For Oil, Oil Vapor,
Steam, or Water
No. 147½ X, 150-Pound
No. 159½ X, 300-Pound
No. 169½ X, 400-Pound
No. 175½ X, 600-Pound
No. 187½ X, 900-Pound
No. 199½ X, 1500-Pound

A rugged line . . . designed for severe service on oil, oil vapor, steam, and water lines.

Crane Cast Steel Swing Check Valves, described on these facing pages, embody the many refinements in design and materials necessary to withstand severe service.

For working pressures, test pressures, service recommendations, and specification of materials, see pages 156 and 157. For weights and dimensions, see the facing page.

Materials: These valves, in all pressure classes, are regularly furnished with a body and cap made of Crane Carbon Steel conforming to requirements of ASTM A 216, Grade WCB.

Seating materials are Exelloy to Exelloy (Class "X" trim), suitable for steam, water, oil, oil vapor, air, or gas.

Design: On flanged and butt-welding valves the full port area is maintained without pockets, from the inlet port to the valve seat, to avoid turbulence. On the outlet side of the valve seat, the body is of generous proportions, allowing full swing of the disc and minimizing erosion and flow resistance.

Body seat ring: A shoulder-type screwed-in body seat ring provides maximum tightness and security.

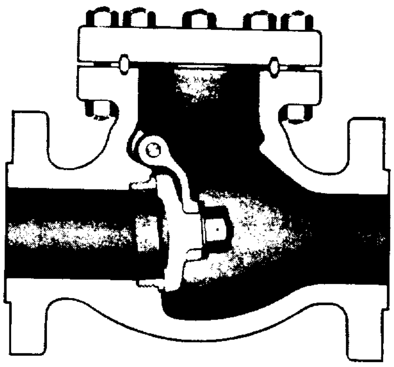
Cap joint: Valves of the 150 and 300-pound pressure classes have a male and female type cap joint.

Valves of the 400, 600, 900, 1500, and 2500-pound pressure classes have a ring type cap joint.

Crane Triplex Steel studs and stud bolts assure an unusually strong and tight joint. The 150-pound valves are equipped with studs; all other valves have through stud bolts.

Flange facings: The 150 and 300-pound flanged valves are regularly furnished with an American Standard 1/16-inch raised face on the end flanges.

The 400, 600, 900, 1500, and 2500-pound flanged valves are regularly furnished with a ¼-inch male face (large male).



Cross Section of
Cast Steel Swing Check Valve

***Note:** The 150-pound valves in sizes 14 and 16-inch (not Illustrated) have a bottom seated body seat ring . . . . and the complete disc, hinge, and hinge pin assembly is suspended from a hinge bracket; the bracket is securely fastened to a pad which is cast integral with the body.*

When so ordered, flanged valves can be furnished with other types of facings, such as ring joint, female, tongue, groove, etc.

Finish of flange faces: The 1/16-inch raised faces and the ¼-inch male faces are regularly furnished with a serrated finish.

A smooth finish can be furnished on raised or male faces, when specified.

Standards: In design and materials, Crane Cast Steel Swing Check Valves exceed the requirements of Standards issued by the American Standards Association and the American Petroleum Institute.

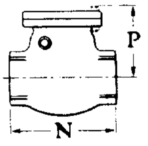
The end flanges on flanged valves as well as the dimensions of butt-welding valve ends conform to the American Steel Standard, B16.5-1957, for their respective pressure class.

Flanged and butt-welding valves of all classes, in sizes 12-inch and smaller, conform to the American Standard for Face-to-Face and End-to-End Dimensions of Ferrous Flanged and Welding End Valves, B16.10-1957, for their respective pressure class. This Standard does not include 3½-inch steel valves.

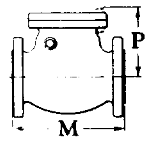
Flanged and butt-welding valves of all classes conform also to the API Standard for Pipe Line Valves, No, 6-D, Ninth Edition, April, 1960. This Standard does not include a 3½ or 5-inch size.

Prices: Prices of all valves are furnished on request.

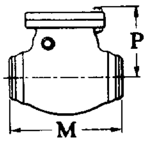
For additional description, weights, and dimensions, see the facing page.



Screwed



Flanged



Butt-Welding

When ordering, specify catalog number and suffix; see the preceding page.

Drilling: Flanged valves are regularly furnished with end flanges faced, drilled and spot faced (FD & SF); they are drilled to the corresponding pressure class of the American Standard; they can be furnished faced only, when specified.

Face to face: Face to face dimensions (M) of flanged valves include the 1/16-inch raised face on the 150 and 300-pound pressure classes and the 1/4-inch high large male face on the 400-pound and higher pressure classes.

Butt-welding valves: Unless otherwise ordered, 150 and 300-pound butt-welding valves are bored to match the inside diameter of standard pipe (heaviest weight on the 8, 10, and 12-inch sizes). For all other pressure classes, orders must specify the diameter of the bore (I.D. of pipe).

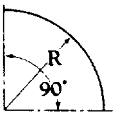
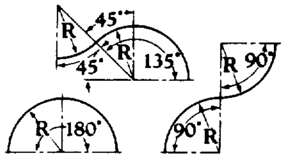
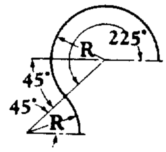
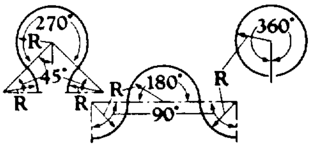
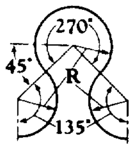
Smaller size 400 and 900-pound valves: For smaller size 400-pound valves, use the 600-pound valves. For smaller size 900-pound valves, use the 1500-pound valves.

2500-pound valves: Prices, weights, and dimensions of 2500-pound valves are furnished on request. For sizes and general description, see page 160.

Weights and Dimensions — Prices on Request

Pressure Class	Size	Pounds, Each			Dimensions, in Inches			
		Screwed Valves	Flanged Valves	Butt-Welding Valves	Screwed		Flanged or Butt-Welding	
	Inches		FD & SF		N	P	M	P
150 Pound	2	27	34	25	8	5	8	5
	2½	40	50	30	8½	5½	8½	5½
	3	50	65	50	9½	6	9½	6
	3½	...	94	...	...	...	10½	6½
	4	96	100	100	11½	7	11½	7
	5	...	140	120	...	...	13	8
	6	...	200	160	...	...	14	9
	8	...	390	360	...	...	19½	10¼
	10	...	510	...	...	...	24½	12⅛
	12	...	775	...	...	...	27½	13¾
	14	...	1200	...	...	...	35	on
	16	...	1450	...	...	...	39	request
300 Pound	2	40	62	47	9½	6¾	10½	6¾
	2½	70	80	60	10¾	8	11½	8
	*3	100	120	80	11¾	8½	12½	8½
	4	...	180	130	...	...	14	9¾
	5	...	250	240	...	...	15¾	10¾
	6	...	330	260	...	...	17½	11¾
	8	...	620	510	...	...	21	14
	10	...	920	760	...	...	24½	15
	12	...	1290	1015	...	...	28	16¾
400 Pound	4	...	200	190	...	...	16	10
	5	...	270	265	...	...	18	12
	6	...	395	310	...	...	19½	12½
	8	...	680	580	...	...	23½	14½
	10	...	900	820	...	...	26½	15¼
	12	...	1250	1150	...	...	30	16⅞
600 Pound	1¼	...	38	32	...	...	9	6¼
	1½	...	58	40	...	...	9½	6¾
	2	...	70	55	...	...	11½	7
	2½	...	105	70	...	...	13	8¼
	*3	...	140	100	...	...	14	9
	4	...	260	170	...	...	17	10¼
	5	...	400	300	...	...	20	12¾
	6	...	530	420	...	...	22	13½
	8	...	900	740	...	...	26	15¼
	10	...	1440	880	...	...	31	18¾
	12	...	1970	1200	...	...	33	21½
900 Pound	3	...	180	155	...	...	15	9½
	4	...	340	240	...	...	18	11
	6	...	640	500	...	...	24	13¾
	8	...	1180	890	...	...	29	16½
1500 Pound	1½	...	110	80	...	...	12	8¼
	2	...	160	130	...	...	14½	9¾
	2½	...	245	170	...	...	16½	10½
	3	...	280	210	...	...	18½	11¼
	4	...	630	390	...	...	21½	13¼
	5	...	950	480	...	...	26½	15¼
	6	...	1360	780	...	...	27¾	15¾
	8	...	2100	1320	...	...	32¾	18¼

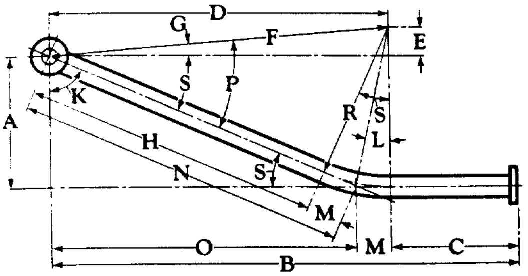
***3-inch Cranelap Joints:** When 3-inch 300 and 600-pound flanged valves with ring joint facing are to be bolted to Cranelap Joints, orders must so specify. A groove of special pitch diameter is required, see page 334 for dimensions.

Radius of Pipe Bends						
Inches	Feet	90° Bends	180° Bends	270° Bends	360° Bends	540° Bends
1		1½″	3″	4¾″	6¼″	9½″
2		3	6¼	9½	12½	18¾
3	¼	4¾	9½	14¼	18¾	28¼
4		6¼	12½	18¾	25¼	37¾
5		7¾	15¾	23½	31½	47¼
6	½	9½	18¾	28¼	37¾	56½
7		11	22	33	44	66
8		12½	25¼	37¾	50¼	75½
9	¾	14¼	28¼	42½	56½	84¾
10		15¾	31½	47¼	62¾	94¼
11		17¼	34½	51¾	69	103¾
12	1	18¾	37¾	56½	75½	113
12.5		19¾	39¼	59	78½	117¾
14		22	44	66	88	132
15	1¼	23½	47	70¾	94¼	141¼
16		25¼	50¼	75½	100½	150¾
17.5		27½	55	82½	110	165
18	1½	28¼	56½	84¾	113	169¾
20		31½	62¾	94¼	125¾	188½
21	1¾	33	66	99	132	198
24	2	37¾	75½	113	150¾	226¼
25		39¼	78½	117¾	157	235½
30	2½	47¼	94¼	141¼	188½	282¾
32		50¼	100½	150¾	201	301½
36	3	56½	113	169½	226¼	339¼
40		62¾	125¾	188½	251¼	377
48	4	75½	150¾	226¼	301½	452½
50		78½	157	235½	314¼	471¼
56		88	176	264	351¾	527¾
60	5	94¼	188½	282¾	377	565½
64		100½	201	301½	402	603¼
70		110	220	329¾	439¾	659¾
72	6	113	226¼	339¼	452½	678½
80		125¾	251¼	377	502¾	754
84	7	132	263¾	395¾	527¾	791½
90	7½	141¼	282¾	424	565½	848¼
96	8	150¾	301½	452½	603	904¾
100		157	314¼	471¼	628¼	942½
108	9	169½	339¼	509	678½	1017¾
120	10	188½	377	565½	754	1131
132	11	207¼	414¾	622	829½	1244
144	12	226¼	452½	678½	904¾	1357¼
156	13	245	490	735¼	980¼	1470¼
168	14	263¾	527¾	791½	1055½	1583½
180	15	282¾	565½	848¼	1131	1696½
192	16	301½	603	904¾	1206¼	1809½
204	17	320½	640¾	961¼	1281¾	1922½
216	18	339¼	678½	1017¾	1357¼	2035¾
228	19	358	716¼	1074½	1432½	2148¾
240	20	377	754	1131	1508	2262

To find the length of pipe in a bend having a radius not given above, add together the length of pipe in bends whose combined radii equal the required radius.

Example: **Find length of pipe in 90° bend of 5′ 9″ radius.**
Length of pipe in 90° bend of 5′ radius = 94¼″
Length of pipe in 90° bend of 9″ radius = 14¼″

Then, length of pipe in 90° bend of 5′ 9″ radius = 108½″



Example No. 1—**Given A, B, C, R**

$D = B - C$

$E = R - A$

$F = \sqrt{D^2 + E^2}$

$\frac{E}{F} = \sin \angle G$

$H = \sqrt{F^2 - R^2}$

$\frac{R}{F} = \sin \angle P$

$\angle S = \angle P - \angle G$

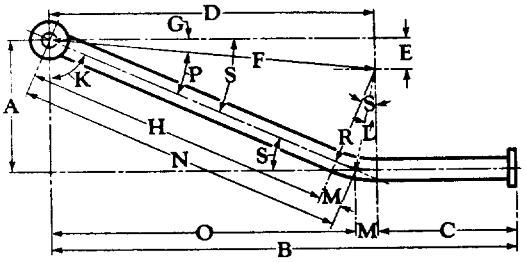
$\angle K = 90° - \angle S$

$\angle L = \frac{1}{2} \angle S$

$M = \tan \angle L \times R$

$N = H + M$

$O = B - C - M$



Example No. 2—**Given A, B, C, R**

$D = B - C$

$E = A - R$

$F = \sqrt{D^2 + E^2}$

$\frac{E}{F} = \sin \angle G$

$H = \sqrt{F^2 - R^2}$

$\frac{R}{F} = \sin \angle P$

$\angle S = \angle P + \angle G$

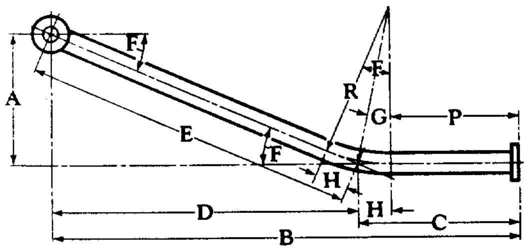
$\angle K = 90° - \angle S$

$\angle L = \frac{1}{2} \angle S$

$M = \tan \angle L \times R$

$N = H + M$

$O = B - C - M$



Example No. 3—**Given A, B, C, R**

$D = B - C$

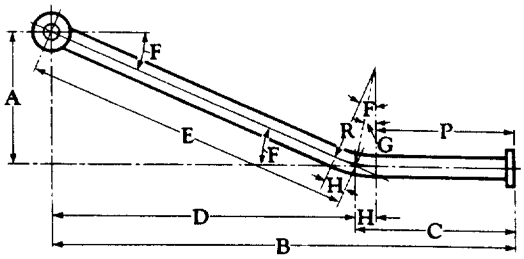
$E = \sqrt{A^2 + D^2}$

$\frac{A}{E} = \sin \angle F$

$\angle G = \frac{1}{2} \angle F$

$H = \tan \angle G \times R$

$P = C - H$



Example No. 4—**Given A, B, C, R**

$D = B - C$

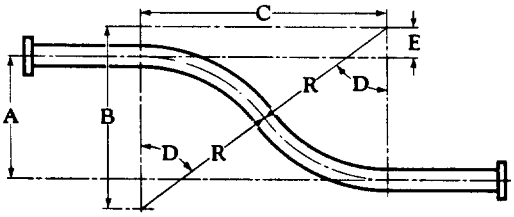
$E = \sqrt{A^2 + D^2}$

$\frac{A}{E} = \sin \angle F$

$\angle G = \frac{1}{2} \angle F$

$H = \tan \angle G \times R$

$P = C - H$

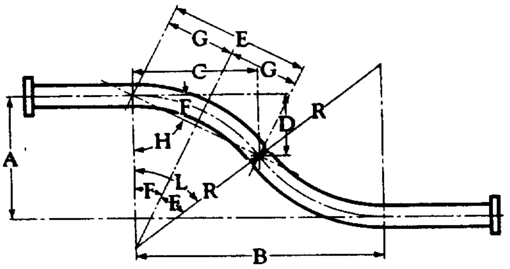


Example No. 5—**Given A, R**

$B = 2R - A$

$C = \sqrt{(2R)^2 - B^2}$

$\frac{C}{2R} = \sin \angle D$



Example No. 6—**Given A, B**

$C = \frac{1}{2} B$

$D = \frac{1}{2} A$

$E = \sqrt{C^2 + D^2}$

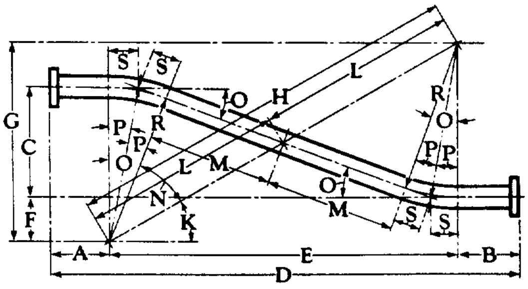
$\frac{D}{E} = \sin \angle F$

$G = \frac{1}{2} E$

$\angle H = 90° - \angle F$

$R = \frac{A^2 + B^2}{4A}$

$L = 2F$



Example No. 7—**Given A, B, C, D, R**

$E = D - A - B$

$F = R - C$

$G = R + F$

$H = \sqrt{E^2 + G^2}$

$G/H = \sin \angle K$

$L = \frac{1}{2} H$

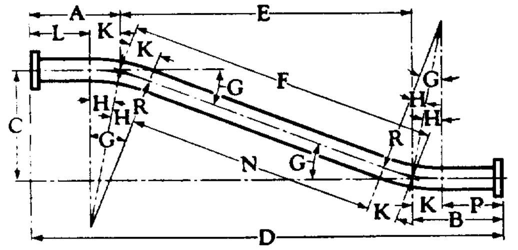
$M = \sqrt{L^2 - R^2}$

$M/L = \sin \angle N$

$\angle O = 90° - \angle K - \angle N$

$\angle P = \frac{1}{2} \angle O$

$S = \tan \angle P \times R$



Example No. 8—Given A, B, C, D, R

$E = D - A - B$

$F = \sqrt{E^2 + C^2}$

$\frac{C}{F} = \sin \angle G$

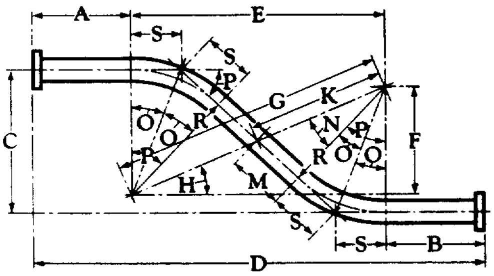
$\angle H = \frac{1}{2} \angle G$

$K = \tan \angle H \times R$

$L = A - K$

$P = B - K$

$N = F - 2K$



Example No. 9—Given A, B, C, D, R

$E = D - A - B$

$F = 2R - C$

$G = \sqrt{E^2 + F^2}$

$\frac{F}{E} = \tan \angle H$

$K = \frac{1}{2} G$

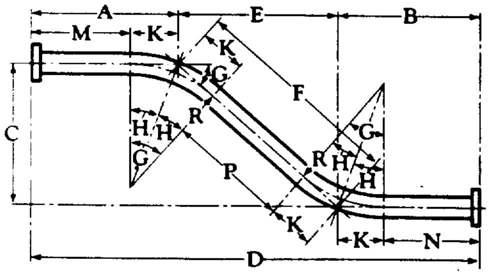
$M = \sqrt{K^2 - R^2}$

$\frac{M}{K} = \sin \angle N$

$\angle P = 90° - \angle H - \angle N$

$\angle O = \frac{1}{2} \angle P$

$S = \tan \angle O \times R$



Example No. 10—Given A, B, C, D, R

$E = D - A - B$

$F = \sqrt{C^2 + E^2}$

$\frac{C}{F} = \sin \angle G$

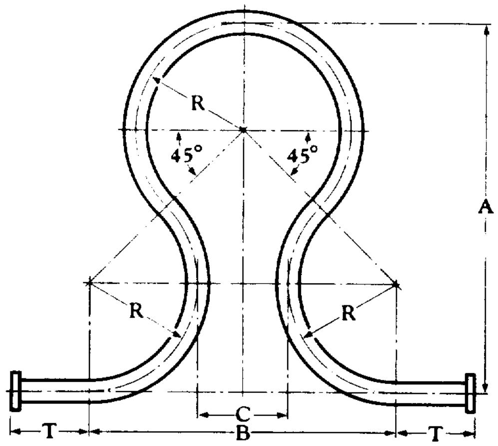
$\angle H = \frac{1}{2} \angle G$

$K = \tan \angle H \times R$

$M = A - K$

$N = B - K$

$P = F - 2K$



Example No. 11—Given R and 45° Angles

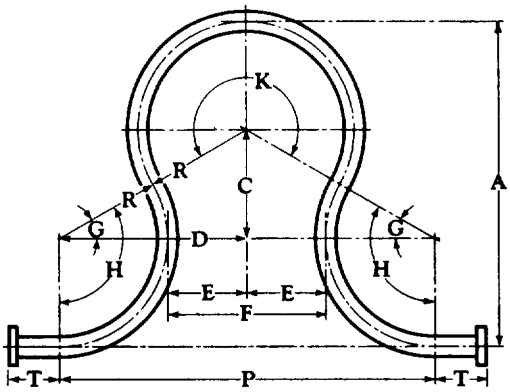
$A = 3.414 \times R$

$B = 2.828 \times R$

$C = 0.828 \times R$

T = Tangent

Length of pipe in bend = $9.425 \times R + 2T$



Example No. 12—Given A, R

$C = A - 2R$

$D = \sqrt{(2R)^2 - C^2}$

$P = 2D$

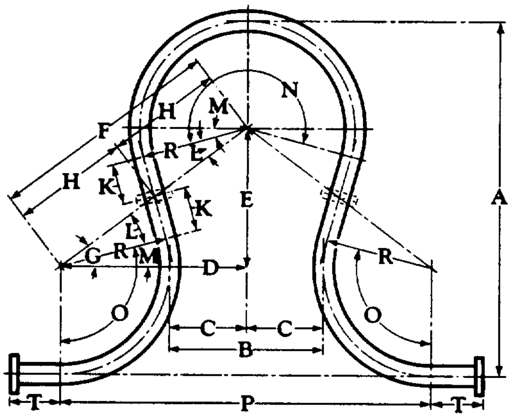
$E = D - R$

$F = 2E$

$C/2R = \sin \angle G$

$\angle H = 90° + \angle G$

$\angle K = 180° + 2 \angle G$



Example No. 13—Given A, B, R

$C = \frac{1}{2} B$

$D = R + C$

$E = A - 2R$

$F = \sqrt{D^2 + E^2}$

$E/F = \sin \angle G$

$H = \frac{1}{2} F$

$K = \sqrt{H^2 - R^2}$

$K/H = \sin \angle L$

$\angle M = \angle G - \angle L$

$\angle N = 180° + 2 \angle M$

$\angle O = 90° + \angle M$

$P = 2D$

SPACING OF PIPE SUPPORTS

Courtesy of Crane Co.

For chart on deflection of horizontal pipe lines, see next page.

When a horizontal pipe line is supported at intermediate points, sagging of the pipe occurs between these supports, the amount of sag being dependent upon the weight of the pipe, fluid, insulation, and valves or fittings which may be included in the line. If the pipe line is installed with no downward pitch, pockets will be formed in each span in which case condensation may collect if the line is transporting steam. In order to eliminate these pockets, the line must be pitched downward so that the outlet of each span is lower than the maximum sag.

Crane has conducted tests to determine the deflection of horizontal standard pipe lines filled with water, in pipe sizes ¾" to 4" inclusive, the results of which have indicated that for pipes larger than 2" and with supports having center to center dimensions greater than 10 feet, the resultant deflection is less than that determined by the use of the formula for a uniformly loaded pipe fixed at both ends. For pipe sizes 2" and smaller, the test deflection was in excess of that determined by the formula for pipe having fixed ends and approached, for the shorter spans, the deflection as determined by the use of the formula for pipe lines having unrestrained ends.

Page 395 gives the deflection of horizontal standard pipe lines filled with water, for varying spans, based upon the results obtained from tests for sizes 2" and smaller, and upon the formula for fixed ends for the larger sizes of pipe. The deflection values given on the chart are twice those obtained from test or calculation, to compensate for any variables including weight of insulation, etc.

The formula given below indicates the vertical distance that the span must be pitched so that the outlet is lower than the maximum sag of the pipe.

$$h = \frac{144\, S^2 y}{36\, S^2 - y^2}$$

where:

h = Difference in elevation of span ends, inches
S = Length of one span, feet
y = Deflection of one span, inches

By eliminating the inconsequential term "$-y^2$" from the denominator, the formula reduces to:

$$h \approx 4\,y$$

The pitch of pipe spans, called the Average Gradient, is a ratio between the drop in elevation and the length of the span. This is expressed as so many inches in a certain number of feet.

$$\text{Average Gradient} = \frac{4\,y}{S}$$

The dotted lines as shown on the chart on the opposite page are plotted from the above formula and indicate average gradients of 1" in 10', 1" in 15', 1" in 20', 1" in 30', and 1" in 40'.

Example: What is the maximum distance between supports for a 4" Standard pipe line assuming a pitch or average gradient of 1" in 30 feet?

Using the chart on the opposite page, find the point where the diagonal dotted line for an average gradient of 1" in 30 feet intersects the diagonal solid line for 4" pipe. From this point, proceed downward to the bottom line where the maximum span is noted to be approximately **22** feet.

Code for Pressure Piping: The Code for Pressure Piping, ASA B 31.1, makes the following statements relative to installations within the scope of the Code:

"**605 (g)** Supports shall be spaced so as to prevent excessive sag, bending and shear stresses in the piping, with special consideration given to those piping sections where flanges, valves, etc., impose concentrated loads. Where calculations are not made, suggested maximum spacing of hangers or supports for carbon steel piping operating at 750° F and lower are given in Table 21a (*see the table below*). "Where greater distance between supports, concentrated loads, higher temperatures, or vibration considerations are involved, special consideration should be given to effects of bending and shear stresses."

"**623 (b)** The design and spacing of supports shall be checked to assure that the sum of the longitudinal stresses due to weight, pressure, and other sustained external loading does not exceed the allowable stress (S value) in the hot condition."

Suggested Maximum Spacing Between Pipe Supports For Straight Runs of Standard Wall and Heavier Pipe (At Maximum Operating Temperature of 750 F)

Nominal Pipe Size Inches	Maximum Span Feet	Nominal Pipe Size Inches	Maximum Span Feet
1	7	8	19
1½	9	10	22
2	10	12	23
2½	11	14	25
3	12	16	27
3½	13	18	28
4	14	20	30
5	16	24	32
6	17	. .	. .

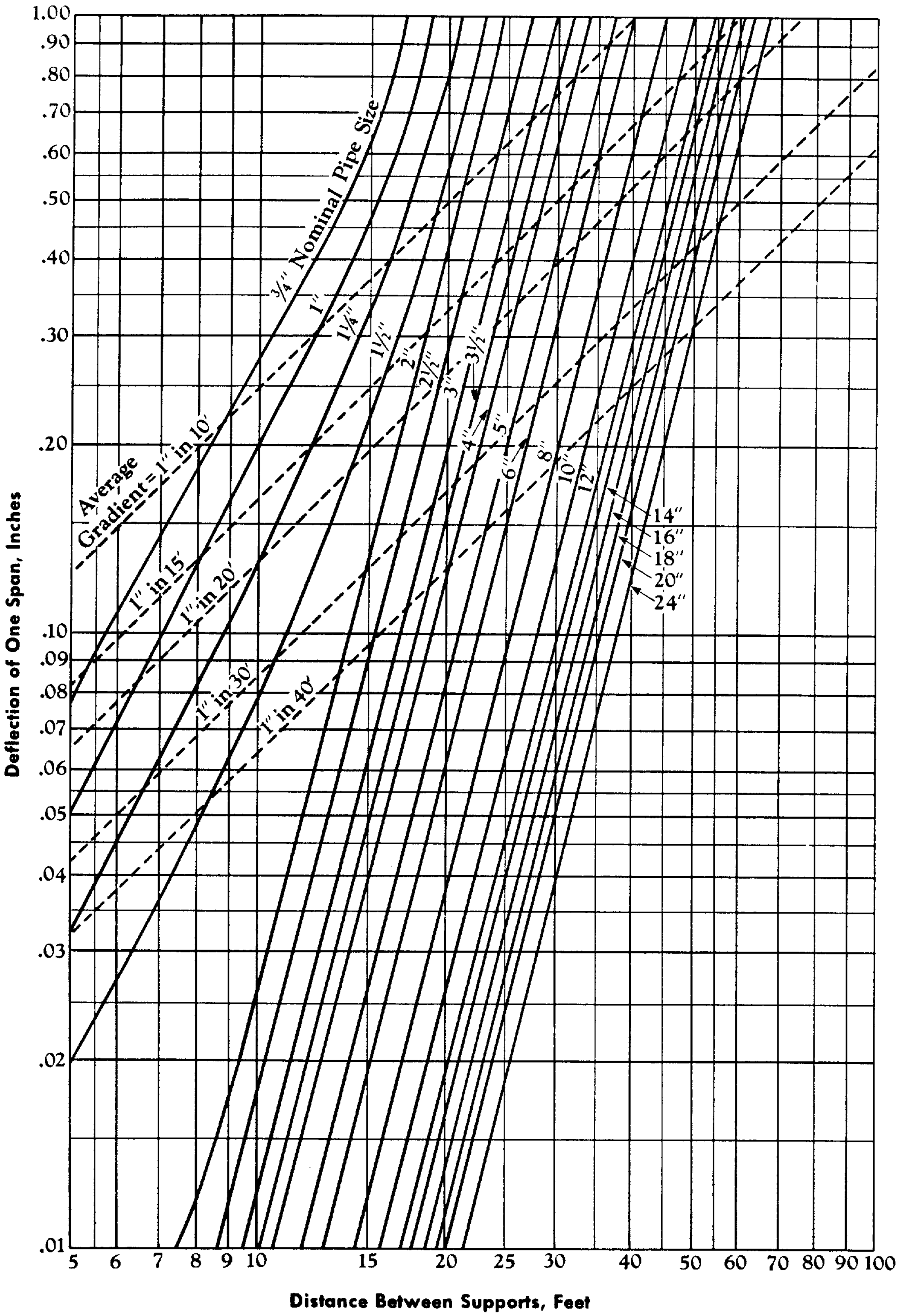
Notes: The values in the table do not apply where there are concentrated loads between supports such as flanges, valves, etc.

Spacing is based on a combined bending and shear stress of 1500 psi when pipe is filled with water and the pitch of the line is such that a sag of 0.1 inch between supports is permissible.

Courtesy of Crane Co.

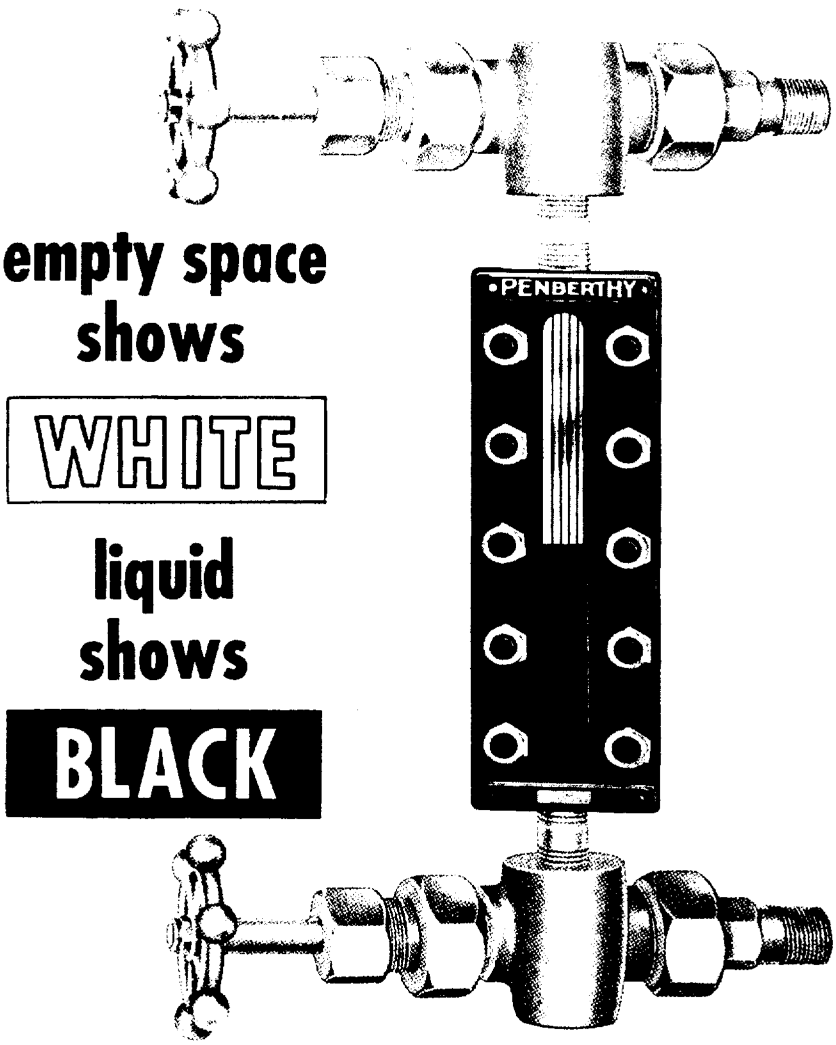
SPACING OF PIPE SUPPORTS

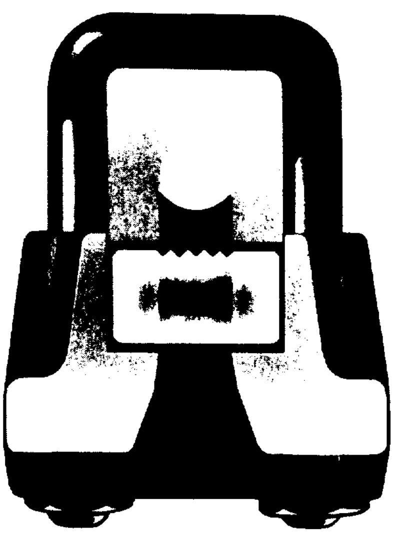
Deflection of Horizontal Pipe Lines
(Based on Standard Pipe Filled with Water)



irect Reading LIQUID LEVEL GAGES
ITEM: Flat Glass-Reflex

Courtesy of Penberthy





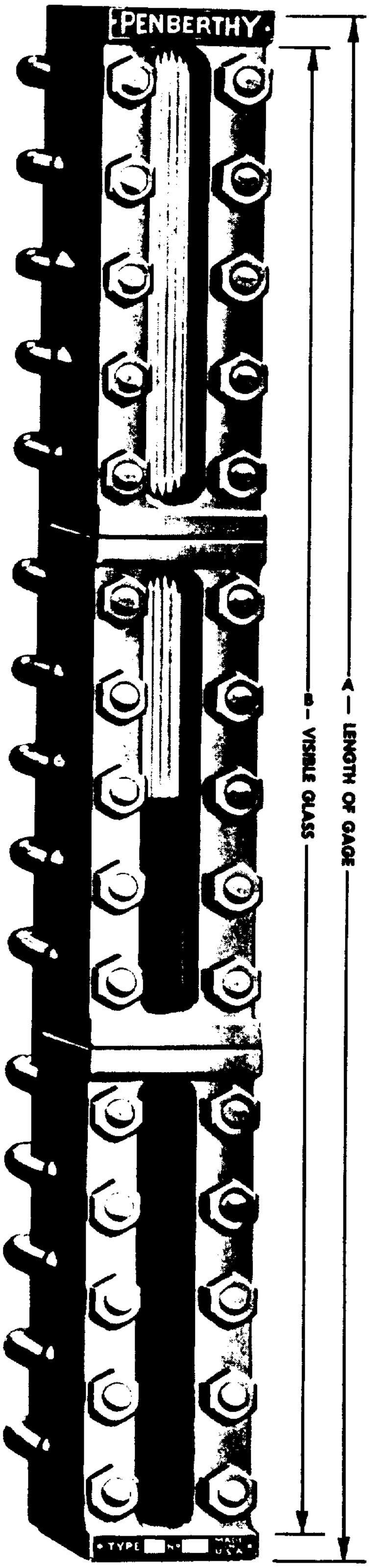
Cross section above illustrates rugged close fitting "U-Bolt" design which minimizes stresses on glass.

enberthy Reflex Liquid Level Gages are preferred herever liquid level must be easily and positively visible and when liquids are under high pressure or at high mperature. You can read the Penberthy Reflex Gage s far as you can distinguish between black and white . . . ere can be no mistake.

The principle of the Reflex glass is based upon the ptical law of total reflection of light when passing from medium of greater refractive power into a medium of ss refractive power. By cutting groove facets at the oper angles in the inner surface of the glass, it is ossible to eliminate all light from the vacant space back of the glass and at the same time permit the passage of light through that portion of the grooves covered with water or other liquid. Thus, a sharp clear line marks the height of water or other liquid above which the air or empty space has a bright mirror-like appearance while the liquid takes the color of the background in the chamber (as black is usually selected for the sake of greater contrast, the liquid appears black).

All gages are rigidly inspected and thoroughly tested in excess of recommended operating conditions. Material used conforms with or exceeds requirements of A.I.S.I., A.S.T.M. and/or A.P.I.-A.S.M.E. for pressures and temperatures recommended.

½" N.P.T. BOTH ENDS



Perfect alignment of frame with glass and gasket assured . . . leaks or glass breakage minimized.

Cover completely encloses sides and ends of glass and gasket, thereby preventing blowouts and danger of accompanying hazard.

For high pressure service the close fit over raised face gland resists distortion of cover due to bolt loading stresses.

- Easy glass or gasket replacement and gage cleaning facilitated by fully accessible RAISED FACE.
- Correct alignment in reassembly.
- Repair of gasket surface without removing assembly from vessel.

General Design—Exceptionally rugged, properly designed, and accurately machined. By removing clamp bolt nuts, conveniently located on front of gage, individual glasses in multiple gages, may be inspected and/or replaced without disturbing other sections of gage.

Liquid Chamber—Temperature-resisting steel. Heat treated to prevent warping, accurately machined and ground. To insure perfect alignment and rigidity, all liquid chambers (single or multiple section) are made in one piece from a solid block of steel. Carbon steel on "X" and "S" group. Alloy steel on "W" group.

Cover—"S" group. Drop forged temperature-resisting steel, with extra heavy beam at each end.

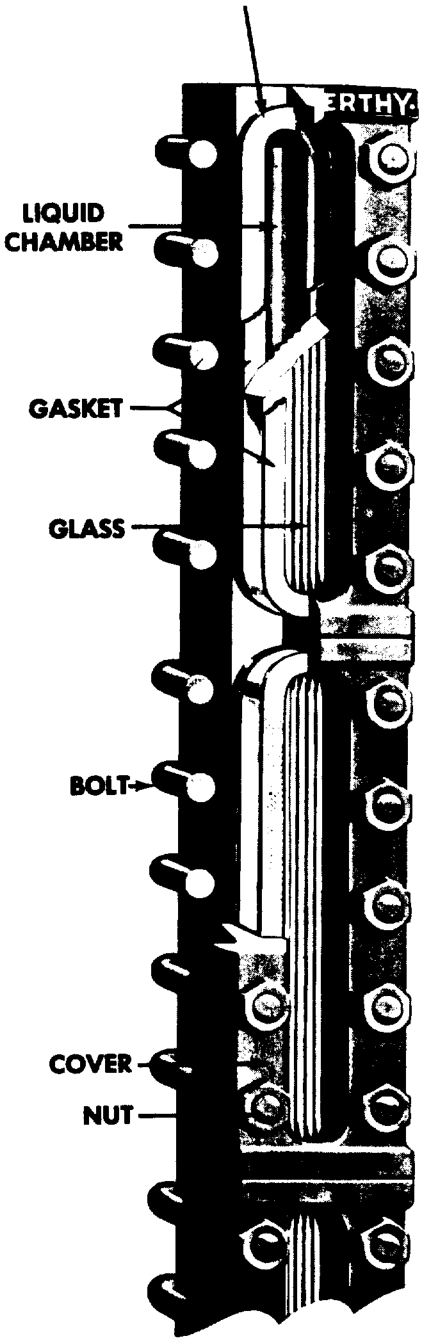
"W" group—Carbon steel made from a solid bar of steel.
"X" group—Navy specification ductile iron. Designed so that when the bolts are tightened to meet the high pressure and temperature service conditions, resulting stresses in various sections of the cover are well within the allowable working stress of the material used. The glass chamber in cover is machined to the contour of the glass, providing full metal backing for the gaskets.

Bolts and Nuts—Alloy steel material for high temperature service; spaced to give a uniform gasket pressure.

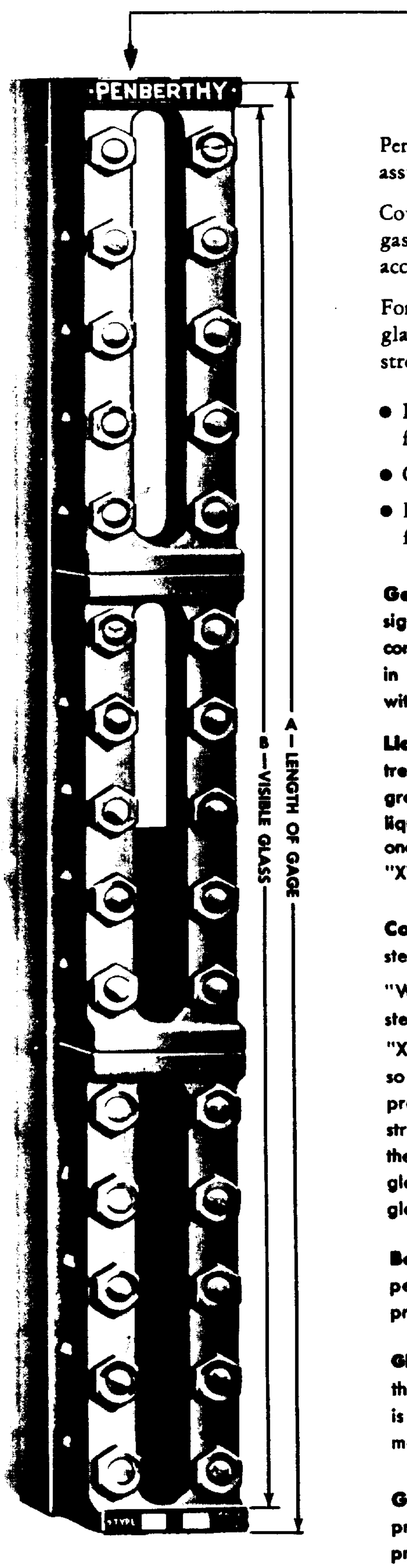
Glass—Due to its greater strength and resistance to thermal shock and erosion, tempered borosilicate glass is used exclusively. Interlocking fracture feature insures maximum safety.

Gaskets—Accurately diecut-design and material used provides adequate resiliency on each side of the glass, preventing excessive compression under high internal pressure.

RAISED GASKET FACE
(ON "S" AND "W" GROUPS)
OFFERS EXCLUSIVE ADVANTAGES



Materials used conform to or exceed the requirements of A.I.S.I., A.S.T.M., and/or A.P.I.-A.S.M.E. specifications for recommended pressures and temperatures. For details on materials refer to technical data section "F."



Perfect alignment of frame with glass and gasket assured . . . leaks or glass breakage minimized.

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- Easy glass or gasket replacement and gage cleaning facilitated by fully accessible RAISED FACE.
- Correct alignment in reassembly.
- Repair of gasket surface without removing assembly from vessel.

General Design—Exceptionally rugged, properly designed, and accurately machined. By removing bolt nuts, conveniently located on front of gage, individual glasses in multiple gages, may be inspected and/or replaced without disturbing other sections of gage.

Liquid Chamber—Temperature-resisting steel. Heat treated to prevent warping, accurately machined and ground. To insure perfect alignment and rigidity, all liquid chambers (single or multiple section) are made in one piece from a solid bar of steel. Carbon steel on "XT" and "ST" group. Alloy steel on "WT" group.

Cover—"ST" group. Drop forged temperature-resisting steel, with extra heavy beam at each end.

"WT" group—Carbon steel made from a solid bar of steel.

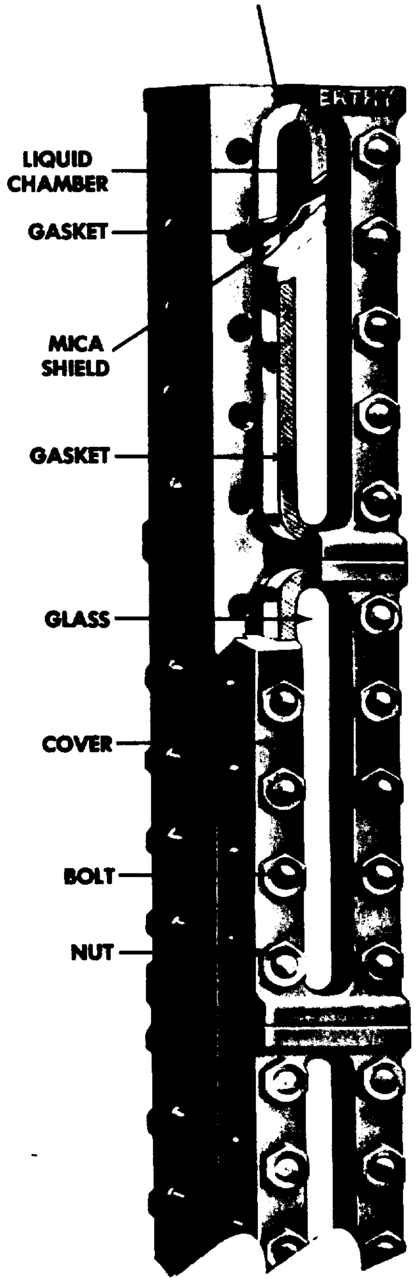
"XT" group—Navy specification ductile iron. Designed so that when the bolts are tightened to meet the high pressure and temperature service conditions, resulting stresses in various sections of the cover are well within the allowable working stress of the material used. The glass chamber in cover is machined to the contour of the glass, providing full metal backing for the gaskets.

Bolts and Nuts—Alloy steel material for high temperature service; spaced to give a uniform gasket pressure.

Glass—Due to its greater strength and resistance to thermal shock and erosion, tempered borosilicate glass is used exclusively. Interlocking fracture feature insures maximum safety.

Gaskets—Accurately diecut-design and material used provides adequate resiliency on each side of the glass, preventing excessive compression under high internal pressure.

RAISED GASKET FACE (ON "ST" AND "WT" GROUPS) OFFERS EXCLUSIVE ADVANTAGES



Materials used conform to or exceed the requirements of A.I.S.I., A.S.T.M., and/or A.P.I.-A.S.M.E. specifications for recommended pressures and temperatures. For details on materials refer to technical data section "F."

Direct Reading LIQUID LEVEL GAGES
ITEM: Special Service Heating and Cooling and/or Design Gages and Valves

Courtesy of Penberthy

For accurate level measurements of liquids whose viscosity tends to vary, or volatile liquids which tend to boil under existing conditions, heating or cooling type gages are available. Gage and valves are traced with heating or cooling medium, either externally or internally as shown and described.

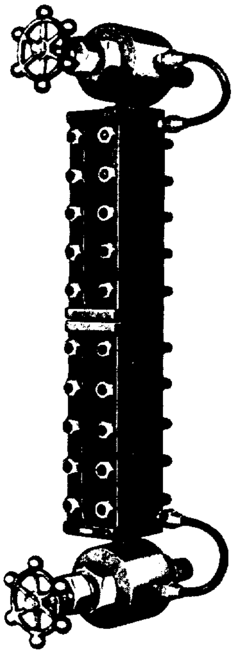


FIG. 1

FIG. 2

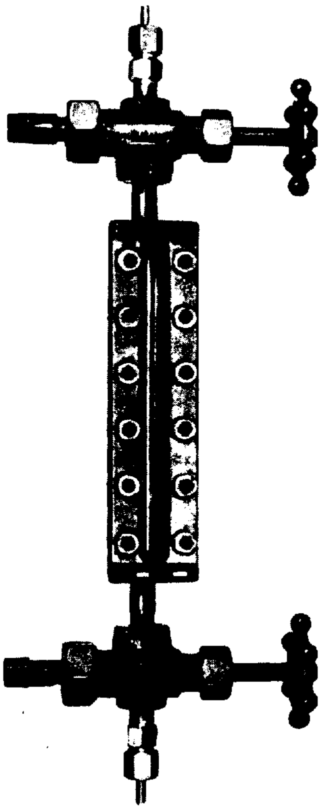


FIG. 3

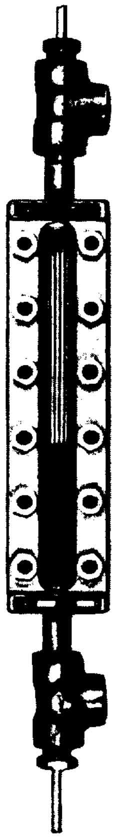


FIG. 4

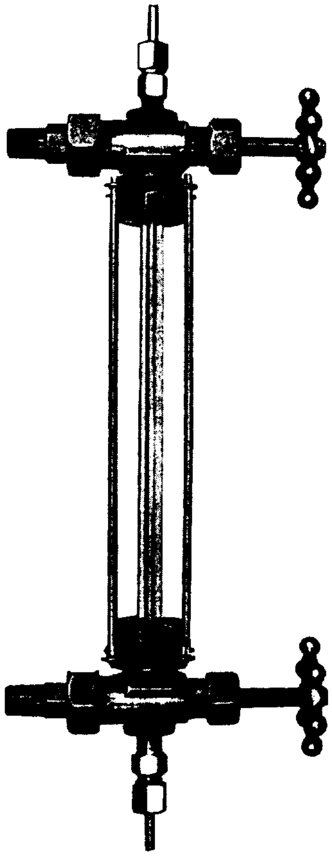


FIG. 5

Fig. 1—External type Reflex gage with integral heating or cooling chamber at the back of liquid chamber.

Fig. 2—External type transparent gage with welded heating or cooling chambers on each side of liquid chamber.

Fig. 3—Standard reflex or transparent type gages and valves with internal heating or cooling stainless steel tube passing through liquid chamber and valves. Tube being held in place with packing adapters in the vent and drain connections of the valves.

Fig. 4—Packing block tees replace valves of Fig. 3 which enables side connection installation.

Fig. 5—Standard ¾" dia. tubular glass gages equipped with heating or cooling tube and packing adapters.

All Penberthy reflex series gages are available with externally heated or cooled feature—transparent type is only available in the ST Series.

When Ordering: For example "S-1108HC" is an S-1108 with external heating or cooling chamber.

For dimensional data of gages and valves see Section D, Page 2.

Courtesy of Penberthy

Valve Centers

FOR PENBERTHY REFLEX AND TRANSPARENT LIQUID LEVEL GAGE SETS

Threaded Gage Connection Types

GAGE TYPE AND MODEL NUMBER[1]						NUMBER OF SECTIONS	VISIBLE GLASS (inches)	DISTANCE BETWEEN VALVE CENTERS IN INCHES[2]		
REFLEX			TRANSPARENT					STANDARD NO. 305 OR NO. 405 VALVES[3] WITH NIPPLES	UNION CONNECTION NO. 325 OR NO. 425 VALVES[3] WITH NIPPLES	CLOSE HOOKUP NOS. 305, 325 OR NOS. 405, 425 VALVES[3&4]
X	S	W	XT	ST	WT					
X-500	S-1100	—	XT-600	ST-1200	—	1	3¾	8½	11¼	3¾
X-501	S-1101	—	XT-601	ST-1201	—	1	4¾	9½	12¼	4¾
X-502	S-1102	—	XT-602	ST-1202	—	1	5¾	10½	13¼	5¾
X-503	S-1103	W-13	XT-603	ST-1203	WT-13	1	6¾	11½	14¼	6¾
X-504	S-1104	W-14	XT-604	ST-1204	WT-14	1	7⅞	12⅝	15⅜	7⅞
X-505	S-1105	W-15	XT-605	ST-1205	WT-15	1	9⅛	13⅞	16⅝	9⅛
X-506	S-1106	W-16	XT-606	ST-1206	WT-16	1	10¼	15	17¾	10¼
X-507	S-1107	W-17	XT-607	ST-1207	WT-17	1	11⅞	16⅝	19⅜	11⅞
X-508	S-1108	W-18	XT-608	ST-1208	WT-18	1	12⅝	17⅜	20⅛	12⅝
X-523	S-1123	W-23	XT-623	ST-1223	WT-23	2	15	19¾	22½	15
X-524	S-1124	W-24	XT-624	ST-1224	WT-24	2	17¼	22	24¾	17¼
X-525	S-1125	W-25	XT-625	ST-1225	WT-25	2	19¾	24½	27¼	19¾
X-526	S-1126	W-26	XT-626	ST-1226	WT-26	2	22	26¾	29½	22
X-527	S-1127	W-27	XT-627	ST-1227	WT-27	2	25¼	30	32¾	25¼
X-528	S-1128	W-28	XT-628	ST-1228	WT-28	2	26¾	31½	34¼	26¾
X-545	S-1145	W-35	XT-645	ST-1245	WT-35	3	30⅜	35⅛	37⅞	30⅜
X-546	S-1146	W-36	XT-646	ST-1246	WT-36	3	33¾	38½	41¼	33¾
X-547	S-1147	W-37	XT-647	ST-1247	WT-37	3	38⅝	43⅜	46⅛	38⅝
X-548	S-1148	W-38	XT-648	ST-1248	WT-38	3	40⅞	45⅝	48⅜	40⅞
X-566	S-1166	W-46	XT-666	ST-1266	WT-46	4	45½	50¼	53	45½
X-567	S-1167	W-47	XT-667	ST-1267	WT-47	4	52	56¾	59½	52
X-568	S-1168	W-48	XT-668	ST-1268	WT-48	4	55	59¾	62½	55
X-56	S-56	W-56	XT-56	ST-56	WT-56	5	57¼	62	64¾	57¼
X-57	S-57	W-57	XT-57	ST-57	WT-57	5	65⅜	70⅛	72⅞	65⅜
X-58	S-58	W-58	XT-58	ST-58	WT-58	5	69⅛	73⅞	76⅝	69⅛
X-67	S-67	W-67	XT-67	ST-67	WT-67	6	78¾	83½	86¼	78¾
X-68	S-68	W-68	XT-68	ST-68	WT-68	6	83¼	88	90¾	83¼
X-77	S-77	W-77	XT-77	ST-77	WT-77	7	92⅛	96⅞	99⅝	92⅛
X-78	S-78	W-78	XT-78	ST-78	WT-78	7	97⅜	102⅛	104⅞	97⅜
X-87	S-87	W-87	XT-87	ST-87	WT-87	8	105½	110¼	113	105½
X-88	S-88	W-88	XT-88	ST-88	WT-88	8	111½	116¼	119	111½
X-97	S-97	W-97	XT-97	ST-97	WT-97	9	118⅞	123⅝	126⅜	118⅞
X-98	S-98	W-98	XT-98	ST-98	WT-98	9	125⅝	130⅜	133⅛	125⅝
X-107	S-107	W-107	XT-107	ST-107	WT-107	10	132¼	137	139¾	132¼
X-108	S-108	W-108	XT-108	ST-108	WT-108	10	139¾	144½	147¼	139¾

(1) Select correct gage by referring to pressure-temperature rating. (See Section "A")

(2) The center-to-center dimension given in table is the minimum distance obtainable between valve centers for the corresponding gage and valves.

Large Chamber Gauge End connected add ⅞" to figures shown.

For other requirements, refer to dimensional data of gage valves. (See Section "B")

(3) Valve centers given in table also apply when gages are used with valves of other sizes in the corresponding Series. (See Section "B")

For gage valve pressure-temperature rating and dimensions. ("See Section B")

(4) Minimum Valve centers for ¾" Close Hook-up Gage is ¾" longer than shown in table for respective gage.

On Transparent gages, requiring several short sections to make up the total visibility desired, less interference in level reading will result if the gage is selected from higher pressure groups. This, however, does not apply to the Reflex type gages.

STANDARD FLANGED CONNECTIONS

(a) All steel flange ratings conform to ASA B16.5-1961 and are indicated on each orifice selector chart, pages 22 through 48. Heavier outlet flanges can be supplied at additional cost. However, the outlet rating does not determine the amount of back pressure that can be superimposed on the outlet beyond those listed on page 22 through 48. Where back pressure limits exceed those listed, please consult the factory for recommendations. All iron flange ratings conform to ASA B16.1 and B16.2-1960. For flange dimensions refer to the dimension table on page 66.

(b) All steel raised face flanges are supplied with a serrated finish on the flange face.

(c) All iron raised face or flat faced flanges are supplied with a smooth surface on the flange face.

(d) All ring joint flanged facings are supplied with octagonal ring groove. For ring joint facing dimensions refer to the dimension table on page 67.

(e) Flange facings other than raised face can be furnished at additional cost except large male inlet facing. This will be supplied without extra cost. Refer to page 65 for available flange facings.

(f) Drilling of both inlet and outlet flanges always straddles the valve center lines. Special drilling can be furnished on application.

SAFETY RELIEF VALVE TRIM ("D" SERIES)

Safety-relief valve trim has not been generally defined. In Lonergan valves, however, it is specifically the nozzle (AISI 304 Stainless Steel) and the disc (Armco 17-4 PH Stainless Steel, hardened) only. For standard bill of materials refer to pages 16, 17 and 51. For corrosive and low temperature services, refer to pages 54 through 57. Please specify if other than standard trim is required.

REPLACEMENT VALVES AND REPAIR PARTS

VALVES. To specify an exact replacement valve, please supply the valve model number, size and serial number. This will assist us in supplying the valve with proper dimensions and materials. The valve serial number is located on the nameplate and stamped on the perimeter of the outlet flange. A proper recommendation will be made, if a specific valve has become obsolete.

REPAIR PARTS. When ordering repair or spare parts, please specify the valve model, size and serial number. Use the part name as listed in the bill of materials in this catalog. For easy identification, each replaceable part in a Lonergan Safety-Relief Valve is marked with its individual part number and material.

SPRINGS. It is Lonergan policy to furnish a spring assembly whenever an order calls for a spring. A spring assembly consists of the spring and a spring step for each end. These are precision fitted to each other. This assures the correct alignment of parts necessary for proper valve operation. The spring assembly should be wired together when not installed in the valve to assure positive spring fit when finally installed. If the set pressure and/or temperature conditions change, please specify, so proper material and new nameplate can be furnished. Spring adjustment is limited and where a change in set pressure is required a new spring assembly may be necessary. Please contact our area representative or our factory when in doubt of spring range information.

INTERCHANGEABILITY OF PARTS FORMS. These forms are available in two arrangements. One form documents the complete history of each item, indicating the size, model, material, cap arrangement, inlet and outlet ratings, serial numbers, valve mark numbers and the individual part numbers of all repair parts. This valve history assures positive replacement of parts and completely describes valve data for your Purchasing, Engineering and Maintenance Departments. Also available on request are forms giving complete interchangeability of repair parts by orifice size. This information minimizes the repair parts inventory that must be carried to provide adequate protection to each facility.

INTERCHANGEABILITY OF CAPS ("D" SERIES)

Lonergan standard construction is a plain screwed cap. This valve can readily be converted to a bolted cap or to a packed lever or to plain lever by simply replacing with the proper lifting lever assembly. See accessories on pages 60 and 61. Test gags are described on page 62. The bill of materials for low temperature and corrosive service is on pages 63 and 64.

DIFFERENTIAL BETWEEN OPERATING AND SET PRESSURES

To obtain maximum performance of a safety-relief valve in process service, it is recommended that the operating pressure not exceed 90% of the valve set pressure.

Due to possible pressure pulsations on pump and compressor discharge lines, the greatest differential allowed is recommended. Pressure pulsations within a system can result in faulty valve operation. Consequently, the safety-relief valve should be set as high as possible above the discharge line pressure. For applications requiring a closer margin between operating pressure and the safety-relief valve set pressure, recommended above, consideration should be given to the use of an "O" Ring Seat Seal. See pages 18 through 21 for complete details.

COLD DIFFERENTIAL TEST PRESSURE RECOMMENDATIONS

Because safety-relief valves for high temperature service are usually tested at atmospheric temperature, it is customary to make some adjustment in the set pressure to compensate for the higher operating temperatures. The higher temperature causes a reduction of valve set pressure as a result of the effect of temperature on the spring and the expansion of the body and bonnet which reduces the spring loading. The table below shows the adjustment made on Lonergan Safety-Relief Valves set on factory test facilities.

Operating Temperature	Increase in Set Pressure at Atmospheric Temperature
—450° F. to 0° F.	none
0° F. to 250° F.	none
250° F. to 1000° F.	3%

NOTE: A complete bulletin on shop test procedure with more detailed factors for temperature compensation is available on request.

LOW SET PRESSURE LIMITS

The minimum set pressures for each series valve are listed below. If low set pressures are required, special springs and parts are available on application. Please contact the factory.

VAK-14 C Series	2 in. Hg
LCT-11 & LCT-20 Series	15 psig
41-W-200 Series	5 psig
43-W-200 Series	5 psig
"D" & "JD" Series	5 psig
"DH" & "JH" Series	8 psig
"DB" & "JDB" Series	15 psig
"DHB" & "JHB" Series	15 psig

INSTALLATION, MAINTENANCE AND ADJUSTMENT

Installation manuals giving complete information on the proper maintenance of Lonergan Safety-Relief Valves are available upon request.

BELLOWS VALVES ("DB" AND "DHB" SERIES)

The Lonergan conventional valve ("D" and "DHB" Series) can easily be converted into a bellows valve in all orifice sizes from D to T by the addition of the bellows assembly and bellows gaskets. This allows easy field conversion and keeps first cost low.

It should be noted that D and E orifices are available with a bellows for corrosive protection of the internal parts only, but they will not be balanced. When a bellows is required for the D and E orifice where constant back pressure is present, compensation can be made with the spring.

In the "DHB" Series, the bellows valve is available only for corrosive or viscous protection of the internal parts and will not be balanced. All bellows are supplied in AISI 316 E.L.C. Stainless Steel as standard. AISI 316 E.L.C. Stainless Steel, Kynar® coated, Monel and other materials are available at additional cost.

VALVES FOR LOW TEMPERATURE SERVICE

Standard valves to meet the requirements of temperatures to -450° F. can be furnished. A bill of materials is shown on pages 57 and 58.

VALVES FOR CORROSIVE SERVICES

Frequently the advantage of design of a full nozzle safety-relief valve is overlooked in corrosive service applications. Until a valve discharges, which may be infrequent, the only parts in contact with the fluid are the wetted parts, nozzle and disc. If standard materials are not suitable for these parts, they can be furnished in corrosion resistant alloys. If contamination of the fluid is objectionable to these parts while discharging, the bellows seal should be considered for the most economical construction. Reference should be made to pages 54 through 58 for bills of materials for most corrosive services.

STEAM JACKETED SAFETY-RELIEF VALVES

Lonergan offers the most complete line of safety-relief valves with integral steam jacketed bodies. The series makes available to the user a valve from the ½" size to the 8" size covering all standard orifices. Please refer to pages 76 through 81 for complete details and specifications.

VACUUM RELIEF VALVES

The model VAK-14C vacuum relief valves are designed for vacuum protection of large storage tanks or vessels. Refer to page 9 for complete details. On special request, these valves are available in a semi-nozzle design with cast iron housing and bronze trim.

HYDRO RELIEF VALVES

A specially designed, non-chattering, liquid relief valve for pump by-pass application or emergency relief where chatter in operation is experienced. Reference should be made to page 50 through 53 for complete details and specifications.

"O" RING SEAT SEALS

Lonergan offers the most complete line of safety-relief valves with "O" ring seat seals. All valves are available to the maximum pressure limit in a variety of "O" ring materials. Refer to pages 18 through 21 for complete details and specifications.

SPECIAL APPLICATION VALVES

Many process applications with exacting requirements demand specially built valves. Lonergan has available many specially designed valves for applications such as back pressures as high as 5000 psig.

If your requirements are beyond the scope of this catalog, we suggest you submit your specifications so we may furnish you with a quotation and design data.

AVAILABLE SPECIAL FEATURES

Lonergan Safety-Relief Valves are available with many special features not illustrated in this catalog. A partial listing follows:

SPECIAL CASTING TESTS

Where required on special order and at additional cost, valve castings can be furnished to meet the requirements of radiography, Class I or Class II, Magnaflux or Dye Penetrant tests, and Charpy Impact tests. Lonergan continuous quality control makes available complete chemical and physical analysis reports on all materials on request.

SPECIAL SEATING SURFACES

Seating surfaces can be hard faced with Stellite No. 6 when specified at additional cost. The standard disc material in Lonergan "D" Series Valves is Armco 17-4 PH Stainless Steel, which is hardened to an equivalent hardness of stellite. When using the standard materials, only the nozzle seat requires hard facing thus reducing procurement and maintenance costs.

SPECIAL FLANGES

To meet most special flange requirements, Lonergan offers a variety of connections beyond the standard arrangements in this catalog. Flat faced inlet and outlet, undrilled flanges, ring joint outlet (except Hastelloy) 300# or 600# outlet where not standard, and butt or socket weld connection (on inlet only) are all available. We also offer flanges to meet standard foreign dimensions.

SPRING ASSEMBLY CORROSION PROTECTION

Springs can be furnished, at additional cost, with protective finishes of lead, zinc, phenolic plastic, epoxy resin and aluminum metallizing.

SPECIAL SPRING MATERIALS

In Lonergan Safety-Relief Valves the standard spring materials are carbon steel, cadmium plated or alloy steel (7%-9% tungsten) nickel plated. Spring materials of special alloys such as alloy steel (17%-19% tungsten), 316 stainless steel, 302 stainless steel, phosphor bronze, K-Monel and inconel are available upon request at additional cost.

SPECIAL BODY MATERIALS

In Lonergan Safety-Relief Valves available, the standard body materials are ASTM A-216 gr. WCB carbon steel or ASTM A-217 gr. WC6 alloy steel. Bodies of special alloys such as Hastelloy "C", Monel, 316 stainless steel, 304 stainless steel, and ASTM A-217 gr. C5 alloy steel are available at additional cost.

BELLOWS COATING

The standard bellows of 316 stainless steel is available with Kynar® coating for corrosive protection at additional cost.

SPECIAL CLEANING

Special clean room facilities permits Lonergan to meet the most rigid cleaning requirements of the cryogenic field. A formal quotation can be made to meet the users specific requirements.

REPAIR TOOLS

Nozzle wrench, lapping discs and lapping plate are available for proper maintenance of Lonergan Safety-Relief Valves. Complete operating, installation and maintenance manuals are available upon request.

® Pennsalt Chemical Corporation.

TO ASSIST YOU IN ORDERING LONERGAN VALVES

We recommend the following information be supplied to enable us to process your order without delay.

a) Quantity*.
b) Inlet and outlet size.
c) Lonergan model designation*.
d) Inlet and outlet flange rating and facing.
e) Materials of construction. If other than standard, refer to pages 54 to 58 for corrosive or low temperature service.
f) "O" Ring Seat Seal. If required, see pages 20 and 21 for materials and pressure-temperature limits.
g) Set pressure*.
h) Back pressure*—Constant or variable.
i) Maximum inlet temperature*.
j) Allowable overpressure*.
k) Service* (Flow Medium)
  1—Gases or Vapors (Molecular Weight or Specific Gravity).
  2—Liquids (Specific Gravity and Viscosity).
l) Required capacity*.
m) Accessories:
  1—Packed lever, plain lever, bolted cap.
  2—"L" lever or "R" lever.
  3—Test gag.
  4—Lonergan Saf-T-Alarm.
  5—Valve operation indicator.
n) Code requirements.

*As a customer service we wish to verify your selection and sizing. To assist us in providing this service, please include the above information.

DEFINITIONS

SAFETY VALVE

An automatic pressure relieving device actuated by the static pressure upstream of the valve, and characterized by rapid, full opening as a pop action. It is used for steam gas or vapor service.

RELIEF VALVE

An automatic pressure relieving device actuated by the static pressure upstream of the valve, which opens in proportion to the increase in pressure over the opening pressure. It is used primarily for liquid service.

SAFETY-RELIEF VALVE

An automatic pressure actuated relieving device suitable for use as either a safety or relief valve, depending on its application.

SET PRESSURE

The set pressure, in pounds per square inch gage, is the inlet pressure at which the pressure relief valve is adjusted to open under service conditions. In a relief or safety-relief valve used in liquid service, the set pressure is to be considered the inlet pressure. At this point the valve starts to discharge under service conditions. In a safety or safety-relief valve used in gas or vapor service, the set pressure is to be considered the inlet pressure at which the valve pops under service conditions.

DIFFERENTIAL SET PRESSURE

The pressure differential in pounds per square inch between the set pressure and the constant, superimposed back pressure. It is applicable only when a conventional type safety-relief valve is being used in service against constant, superimposed back pressure.

COLD DIFFERENTIAL TEST PRESSURE

The set pressure or the differential set pressure at which a safety-relief valve must be set on cold fluid on a test drum, plus a predetermined increase in the cold fluid setting, in pounds per square inch, that will result in the valve opening at the correct set pressure in service when the actual service temperature is higher than that of the cold fluid used in the test drum. This is the pressure at which the valve should be set on shop testing facilities.

OPERATING PRESSURE

The pressure, in pounds per square inch gage, to which the vessel is usually subjected in service. A processing vessel is uually designed for a maximum allowable working pressure, in pounds per square inch gage, which will provide a suitable margin above the operating pressure in order to prevent any undesirable operation of the relief device. (It is suggested that this margin be approximately 10 percent higher, or 25 psi — whichever is greater.)

MAXIMUM ALLOWABLE WORKING PRESSURE

As defined in the construction codes for unfired pressure vessels, the maximum allowable working pressure depends on the type of material, its thickness, and the service conditions used as the basis for design. The vessel may not be operated above this pressure or its equivalent at any metal temperature exceeding that used in its design. Consequently, for that metal temperature, it is the highest pressure at which the primary safety relieving device is set to open.

OVERPRESSURE

The pressure increase over the set pressure of the primary relieving device. It is the same as accumulation only when the relieving device is set at the maximum allowable working pressure of the vessel.

NOTE: From this definition it will be observed that when the set pressure of the first (primary) safety or relief valve to open is less than the maximum allowable working pressure of the vessel, the overpressure may be greater than 10 percent of the set pressure of the safety valve.

ACCUMULATION

Is the pressure increase over the maximum allowable working pressure of the vessel during discharge through the pressure relief valve, expressed as a percent of that pressure, or pounds per square inch.

BLOWDOWN

Is the difference between the set pressure and the reseating pressure of a pressure relief valve, expressed as per cent of the set pressure, or pounds per square inch.

LIFT

The rise of the valve disc in a pressure relief valve when the valve disc moves from the closed position.

BACK PRESSURE

Pressure on the discharge side of a pressure relief valve.

1—CONSTANT BACK PRESSURE

Back pressure which does not change appreciably under any condition of operation whether or not the pressure relief valve is open or closed.

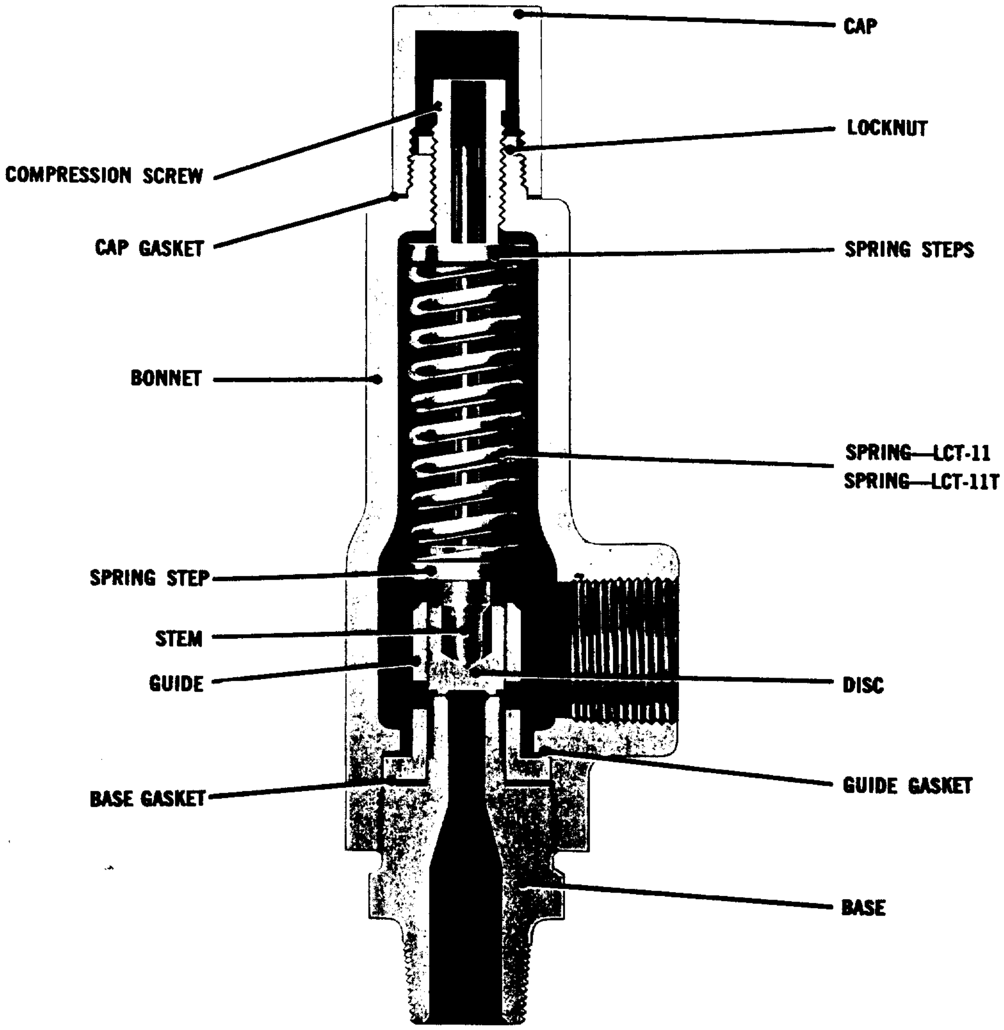
2—VARIABLE BACK PRESSURE

Back pressure which develops as a result of the conditions outlined below:

a) Built-up back pressure. Variable back pressure which develops from essentially atmospheric pressuie as a result of flow through discharge piping after a single pressure relief valve opens.
b) Superimposed Back Pressure. Variable back pressure that is present before the pressure relief valve starts to open.

LONERGAN Safety-Relief Valves
LCT–11 Series
Screwed Connections

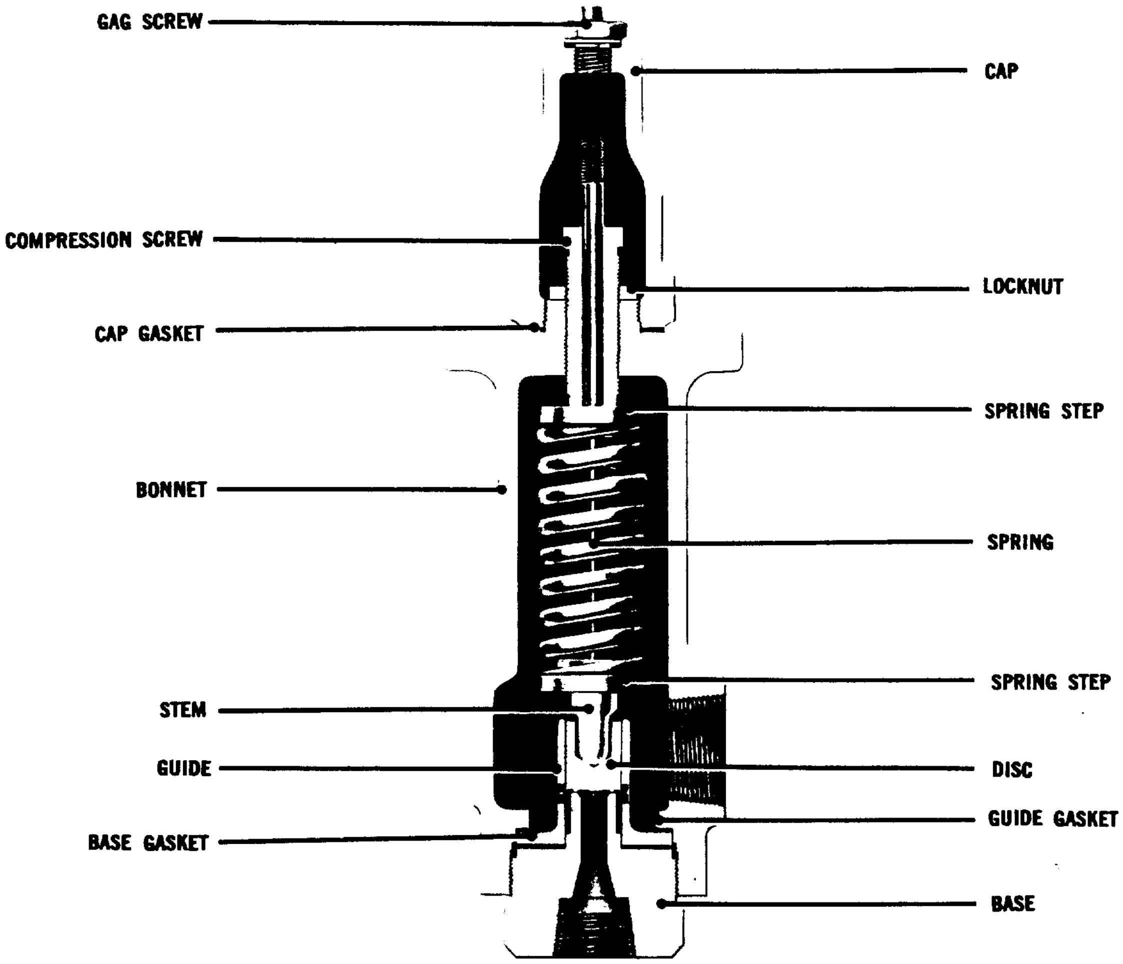
Courtesy of J. E. Lonergan Co.



BILL OF MATERIALS

NAME OF PART	MATERIALS
Cap	AISI C-1117 Carbon Steel
Compression Screw	AISI 416 Stainless Steel
Locknut	AISI 416 Stainless Steel
Gasket, Cap	Soft Iron
Spring Steps	AISI C-1117 Carbon Steel
Bonnet	ASTM A-216, GR. WCB Carbon Steel
Spring—LCT-11	Carbon Steel
Spring—LCT-11T	Tungsten Steel (8.75-9.75)
Stem	AISI 416 Stainless Steel
Disc	AISI 304 Stainless Steel
Guide	AISI 416 Stainless Steel
Gasket, Base & Guide	Soft Iron
Base	AISI 304 Stainless Steel

LONERGAN Safety-Relief Valves
LCT–20 Series
Screwed Connections



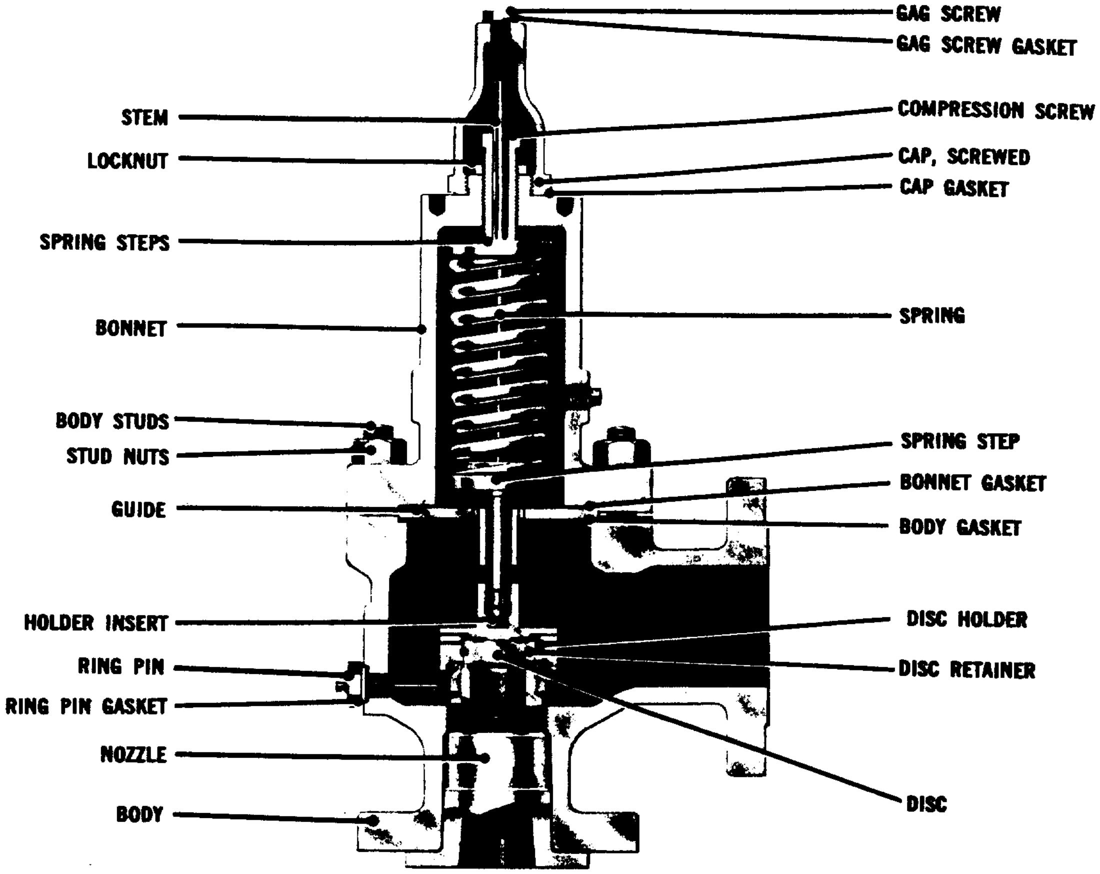
BILL OF MATERIALS

NAME OF PART	MATERIALS
Cap	ASTM A-216, GR. WCB, Carbon Steel
Compression Screw	AISI 416 Stainless Steel
Locknut	AISI 416 Stainless Steel
Gasket, Cap	Soft Iron
Spring Steps	AISI C-1117 Carbon Steel
Bonnet	ASTM A-216, GR. SCB Carbon Steel
Spring—LCT-20	Carbon Steel
Spring—LCT-20T	Tungsten Steel (8.75-9.75)
Stem	AISI 416 Stainless Steel
Disc	AISI 304 Stainless Steel
Guide	AISI 416 Stainless Steel
Gasket, Base & Guide	Soft Iron
Base	AISI 304 Stainless Steel

For service with temperatures exceeding 400°F., the valve model number is followed by a letter "T" to indicate a valve furnished with tungsten steel spring.
For low temperature and corrosive service, special material listing, refer to page 58.
For air, steam and water capacities refer to page 87.
For packed lever-standard, low temperature and corrosive materials, refer to page 63 and for test gag arrangements, refer to page 62.
For steam jacketed applications, refer to page 77.
LCT Series are available with an "O" ring seat seal. Refer to pages 19 through 21 for available materials and pressure-temperature limits.
On applications where the bolted bonnet arrangement is preferred over a threaded joint, this series is available with the bolted bonnet construction and all connections indicated under specifications. When ordering, specify size and type of connections and bolted bonnet construction.

LONERGAN Safety-Relief Valves
D Series
Conventional

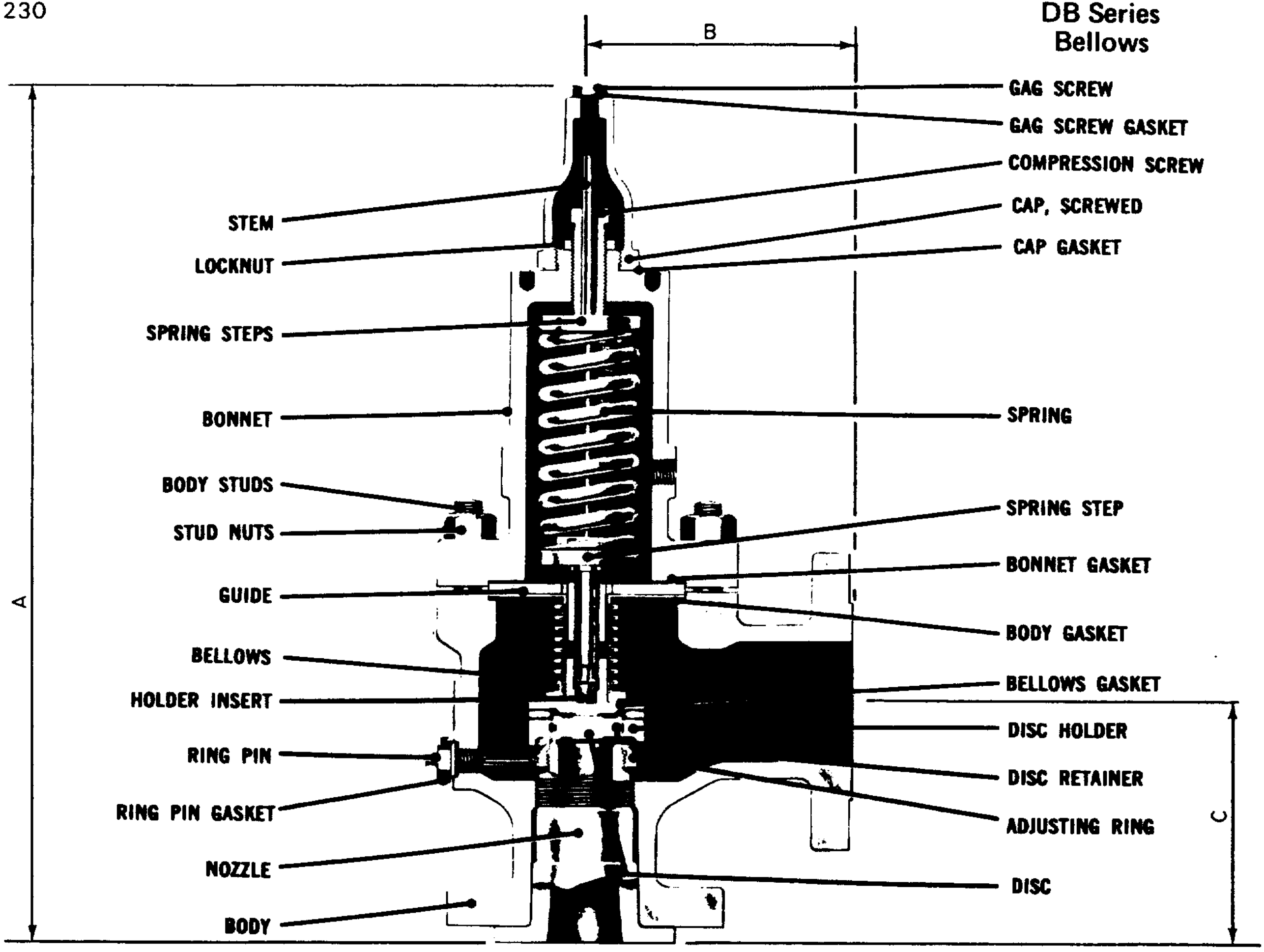
Courtesy of J. E. Lonergan Co.



NAME OF PART	MATERIAL
Gag Screw	AISI 416 Stainless Steel
Gag Screw Gasket	Corrugated Soft Iron
Stem	AISI 416 Stainless Steel
Compression Screw	AISI 416 Stainless Steel
Bonnet Plug	Carbon Steel
Locknut	AISI 416 Stainless Steel
Cap Gasket	Corrugated Soft Iron
Spring Steps	AISI C-1117 Carbon Steel
Body Studs	ASTM A-193 GR B7, Alloy Steel
Stud Nuts	ASTM A-194 GR 2H, Alloy Steel
Bonnet Gasket	Corrugated Soft Iron
Body Gasket	Corrugated Soft Iron
Guide	ASTM A-351 GR CF8, Stainless Steel
Holder Insert	AISI 416 Stainless Steel, Hardened
Ring Pin Gasket	Corrugated Soft Iron
Ring Pin	AISI 416 Stainless Steel
Disc Holder	ASTM A-351 GR CF8, Stainless Steel
Disc Retainer	AISI 302 Stainless Steel
Disc	17-4 PH. Stainless Steel, Hardened
Adjusting Ring	AISI 302 Stainless Steel
Nozzle	ASTM A-351 GR CF8, Stainless Steel
Spring (Note 1)	Carbon Steel
Spring (Note 2)	Tungsten Steel (8.75-9.75)
Cap, Screwed	ASTM A-216, GR WCB. Carbon Steel
Bonnet (Note 3)	ASTM A-216, GR WCB. Carbon Steel
Bonnet (Note 4)	ASTM A-217, GR WC6, Alloy Steel
Body (Note 3)	ASTM A-216, GR WCB, Carbon Steel
Body (Note 4)	ASTM A-217, GR WC6, Alloy Steel

Courtesy of J. E. Lonergan Co.

LONERGAN Safety-Relief Valves
DB Series
Bellows



NAME OF PART	MATERIAL
Gag Screw	AISI 416 Stainless Steel
Gag Screw Gasket	Corrugated Soft Iron
Stem	AISI 416 Stainless Steel
Compression Screw	AISI 416 Stainless Steel
Locknut	AISI 416 Stainless Steel
Cap Gasket	Corrugated Soft Iron
Spring Steps	AISI C-1117 Carbon Steel
Body Studs	ASTM A193 GR B7, Alloy Steel
Stud Nuts	ASTM A194 GR 2H, Alloy Steel
Bonnet Gasket	Corrugated Soft Iron
Body Gasket	Asbestos
Guide	ASTM A-351 GR CF8, Stainless Steel
Holder Insert	AISI 416 Stainless Steel, Hardened
Ring Pin Gasket	Corrugated Soft Iron
Ring Pin	AISI 416 Stainless Steel
Disc Holder	ASTM A-351 GR CF8, Stainless Steel
Disc Retainer	AISI 302 Stainless Steel
Disc	17-4 PH. Stainless Steel, Hardened
Adjusting Ring	AISI 302 Stainless Steel
Nozzle	ASTM A-351 GR CF8, Stainless Steel
Spring (Note 1)	Carbon Steel
Spring (Note 2)	Tungsten Steel (8.75-9.75)
Cap, Screwed	ASTM A-216, GR WCB, Carbon Steel
Bonnet (Note 3)	ASTM A-216, GR WCB, Carbon Steel
Bonnet (Note 4)	ASTM A-217, GR WC6, Alloy Steel
Body (Note 3)	ASTM A-216, GR WCB, Carbon Steel
Body (Note 4)	ASTM A-217, GR WC6, Alloy Steel
Bellows Gasket	Asbestos
Bellows	AISI 316L Stainless Steel

Courtesy of J. E. Lonergan Co.

FLANGED STEEL
SERIES D AND DB SPECIFICATIONS

VALVE SIZE	FLANGE CONNECTION ASA STANDARD		VALVE MODEL		INLET PRESSURE, PSIG AND TEMPERATURE LIMITS				BACK PRESSURE, PSIG LIMIT AT 100°F.		VALVE DIMENSIONS Inches			APPROX WT. LBS.
	INLET	OUTLET	CONV.	BELLOWS	100°F.	450°F.	800°F.	1000°F.	CONV.	BELLOWS	A	B	C	
6 x 8	150# RF or RJ	150# RF	D-10R	DB-10R	100	100			60	60	44½	9 7/16	9½	500
			D-12R	DB-12R		100	92		60	60				
6 x 8	300# RF or RJ	150# RF	D-20R	DB-20R	100	100			60	60	44½	9 7/16	9½	520
			D-22R	DB-22R		100	100		60	60				
6 x 10	300# RF or RJ	150# RF	D-30R	DB-30R	230	230			100	100	48¼	9 7/16	10½	620
			D-32R	DB-32R		230	230		100	100				
6 x 8	300# RF or RJ	150# RF	D-33R	DB-33R			100	100	60	60	44½	9 7/16	9½	520
6 x 10	600# RF or RJ	150# RF	D-50R	DB-50R	300	300			100	100	48¼	9 7/16	10½	660
			D-52R	DB-52R		300	300		100	100				
6 x 10	600# RF or RJ	150# RF	D-53R	DB-53R			300	300	100	100	48¼	9 7/16	10½	660

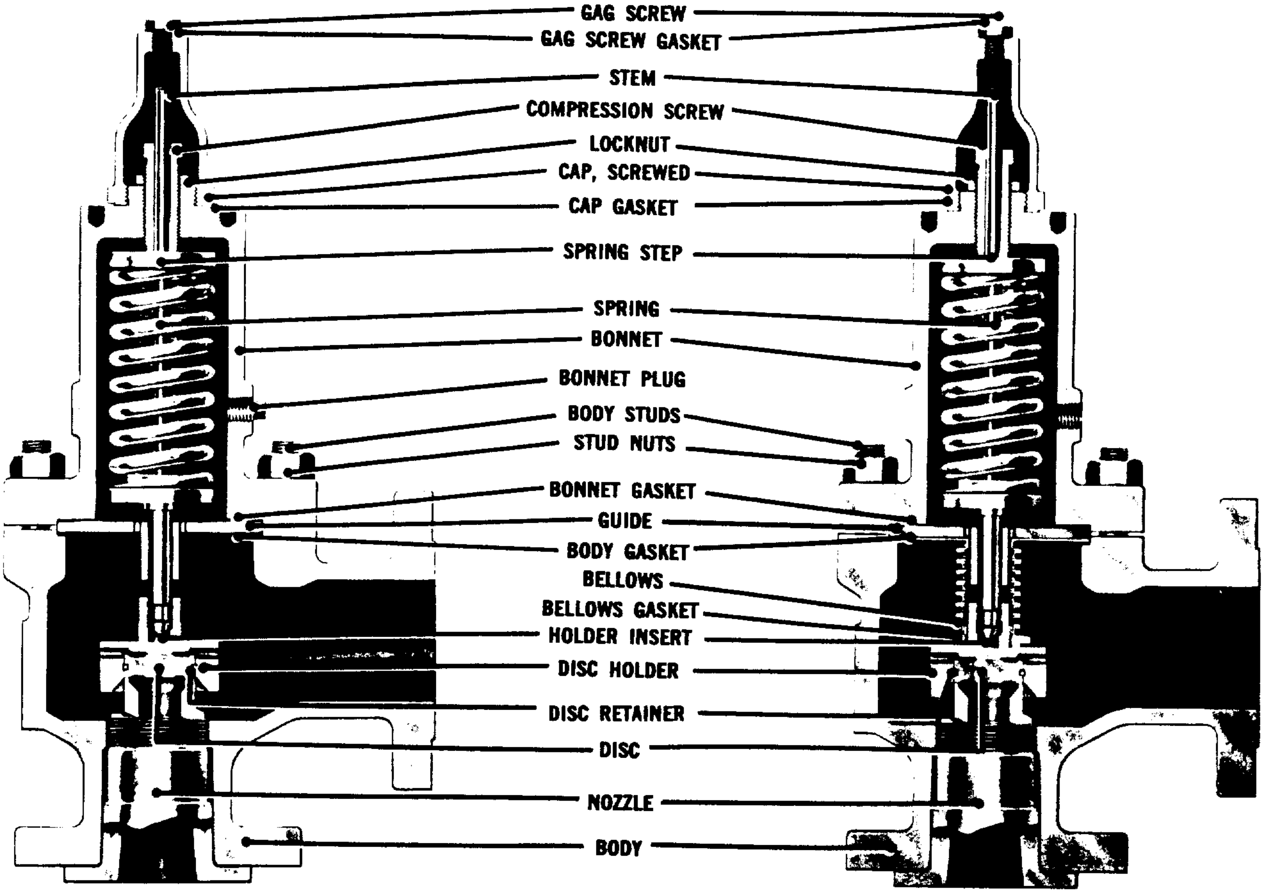
The model designations shown on the selector chart are for conventional valves. Model designations for Bellows and "O" Ring Seat Seal Valves are as follows: DB—Bellows Valve. DO—Conventional Valve with "O" Ring Seat Seal. DBO—Bellows Valve with "O" Ring Seat Seal.

For complete details on "O" Ring Seat Seals see pages 18 to 21.

For model coding of special materials for corrosive and low temperature services, refer to the Bill of Materials listings on pages 54 to 57.

All valves meet the requirements of A.P.I. Standard 526.

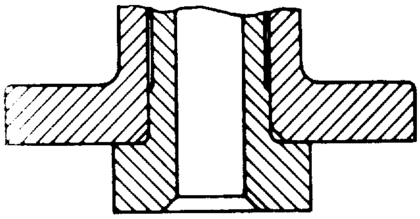
LONERGAN Hydro-Relief Valves
DH AND DHB SERIES



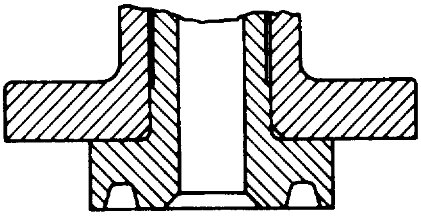
BILL OF MATERIALS

NAME OF PART	DH SERIES	DHB SERIES
Gag Screw	AISI 416 Stainless Steel	AISI 416 Stainless Steel
Gag Screw Gasket	Corrugated Soft Iron	Corrugated Soft Iron
Stem	AISI 416 Stainless Steel	AISI 416 Stainless Steel
Compression Screw	AISI 416 Stainless Steel	AISI 416 Stainless Steel
Bonnet Plug	Carbon Steel	——
Locknut	AISI 416 Stainless Steel	AISI 416 Stainless Steel
Cap Gasket	Corrugated Soft Iron	Corrugated Soft Iron
Spring Steps	AISI C-1117 Carbon Steel	AISI C-1117 Carbon Steel
Body Studs	ASTM A-193 GR B7, Alloy Steel	ASTM A-193 GR B7, Alloy Steel
Stud Nuts	ASTM A-194 GR 2H, Alloy Steel	ASTM A-194 GR 2H, Alloy Steel
Bonnet Gasket	Corrugated Soft Iron	Corrugated Soft Iron
Body Gasket	Corrugated Soft Iron	Asbestos
Guide	ASTM A-351 GR CF8, Stainless Steel	ASTM A-351 GR CF8, Stainless Steel
Holder Insert	AISI 416 Stainless Steel, Hardened	AISI 416 Stainless Steel, Hardened
Disc Holder	ASTM A-351 GR CF8, Stainless Steel	ASTM A-351 GR CF8, Stainless Steel
Disc Retainer	AISI 302 Stainless Steel	AISI 302 Stainless Steel
Disc	17-4 PH, Stainless Steel, Hardened	17-4 PH, Stainless Steel, Hardened
Nozzle	ASTM A-351 GR CF8, Stainless Steel	ASTM A-351 GR CF8, Stainless Steel
Spring (Note 1)	Carbon Steel	Carbon Steel
Spring (Note 2)	Tungsten Steel (8.75-9.75)	Tungsten Steel (8.75-9.75)
Cap, Screwed	ASTM A-216, GR WCB, Carbon Steel	ASTM A-216, GR WCB, Carbon Steel
Bonnet (Note 3)	ASTM A-216, GR WCB, Carbon Steel	ASTM A-216, GR WCB, Carbon Steel
Bonnet (Note 4)	ASTM A-217, GR WC6, Alloy Steel	ASTM A-217, GR WC6, Alloy Steel
Body (Note 3)	ASTM A-216, GR WCB, Carbon Steel	ASTM A-216, GR WCB, Carbon Steel
Body (Note 4)	ASTM A-217, GR WC6, Alloy Steel	ASTM A-217, GR WC6, Alloy Steel
Bellows Gasket	——	Asbestos
Bellows	——	AISI 3161, Stainless Steel

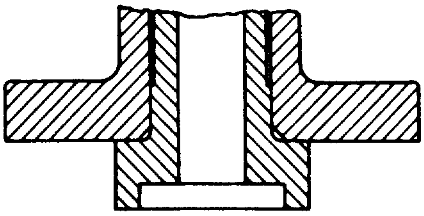
LONERGAN Safety-Relief Valves
AMERICAN STANDARD FLANGES
Standard Flange Facings
Series D, DB, DH and DHB



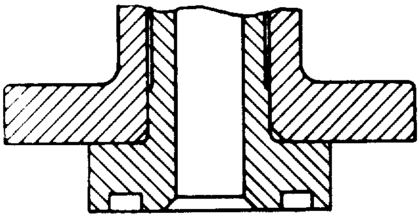
RAISED FACE



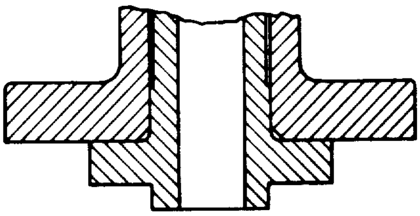
RING JOINT



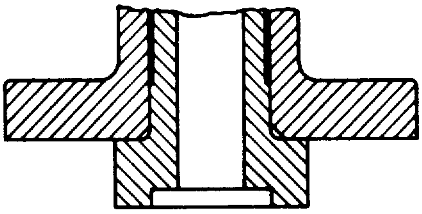
LARGE TONGUE



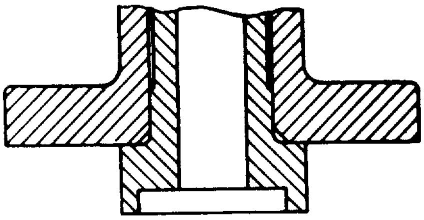
LARGE GROOVE



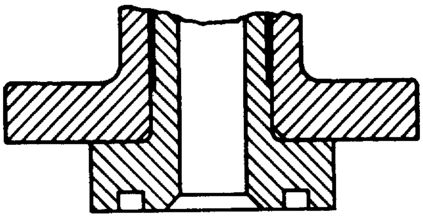
SMALL MALE



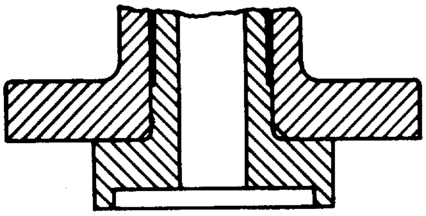
SMALL FEMALE



SMALL TONGUE



SMALL GROOVE



LARGE FEMALE

All flange facings and ratings conform to ASA B16.5-1961. Steel full nozzle valve inlet flange thickness is equal to or greater than ASA minimum thickness. The raised face thickness is greater than ASA standard and inlet thickness "D" dimension should be used for calculating length of stud for inlet bolting on all optional flange facings. Refer to pages 66 and 67 for ASA dimensions for raised face and ring joint.

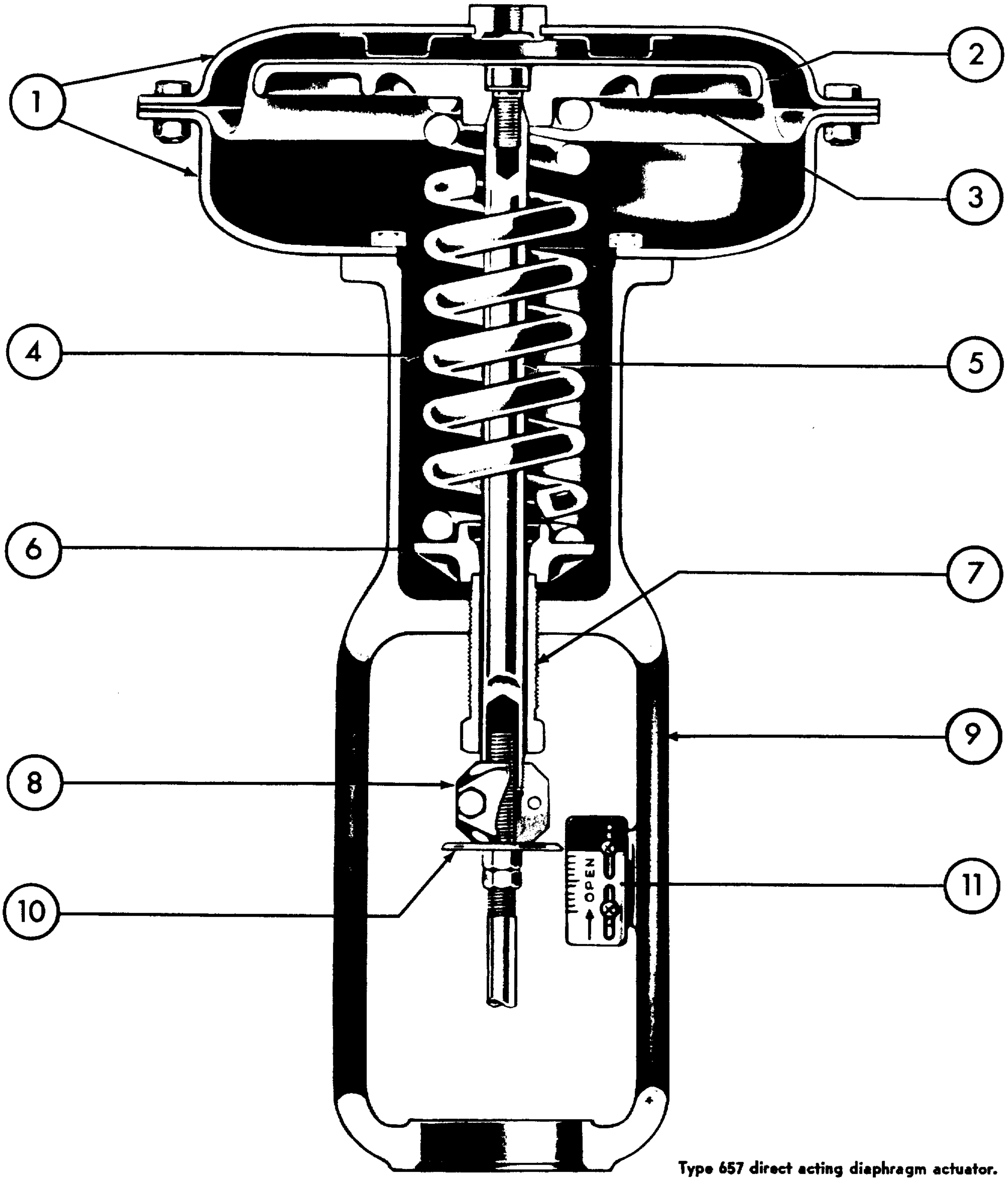
All flange facings are smooth finished. Serrated finish, 1/64" deep, 1/32" pitch, is optional and will be furnished when specified.

The drilling of inlet and outlet flanges straddle the centerlines of the valve.

All ring joint flanges are supplied with octagonal groove. For ring joint outlet face and other available facings, the centerline of inlet to face of outlet dimension increases by the difference in the ASA total flange thickness.

For outlets furnished with heavier than standard flanges the centerline of inlet to face of outlet dimension increases by the difference in the ASA total flange thickness.

Courtesy of Fisher Controls Co.



Type 657 direct acting diaphragm actuator.

1	Diaphragm Case	4	Actuator Spring	7	Spring Adjustor	10	Travel Indicator
2	Diaphragm	5	Actuator Stem	8	Stem Connector	11	Travel Indicator Scale
3	Diaphragm Plate	6	Spring Seat	9	Yoke		

REVERSE ACTING ACTUATOR—TYPE 667

The foregoing description also applies to reverse acting actuators, Type 667. On the Type 667, however, the deep diaphragm case is on top and is vented with an umbrella type screened vent. An asbestos gasket ("O" ring in Sizes 70 and 87) seals the joint between the lower case and the yoke, and double "O" ring seals prevent leakage along the actuator stem. The seal bushing is held in place with a stainless steel wire snap ring. The actuator stem is centerless ground and chrome plated to minimize friction and wear on the "O" rings. Lubricating grease is packed in the bushing upon assembly and no further lubrication is normally required.

Type 667 reverse acting actuators have effective areas and performance which for all practical purposes are the same as those for the Type 657 direct acting actuators. The cross sectional area of the actuator stem is insignificant in relation to the area of the diaphragm and, therefore, subtracts only a negligible portion of the effective area.

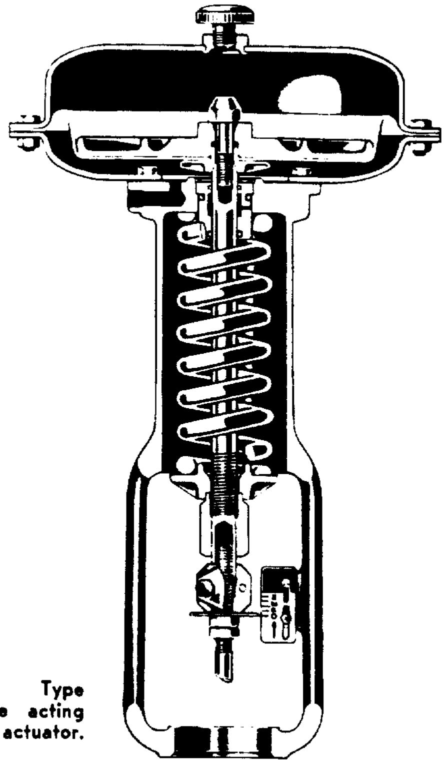


Figure 1-3. Type 667 reverse acting diaphragm actuator.

MATERIALS OF CONSTRUCTION

Name of Part	Sizes 30 through 87	Size 80
Diaphragm Case	Steel, Zinc Plated	High-Tensile Iron
Diaphragm	Buna N, Nylon Fabric	Neoprene, Nylon Fabric
Diaphragm Plate	High-Tensile Iron	High-Tensile Iron
Actuator Stem (Type 657)	Steel, Cadmium Plated	Steel, Cadmium Plated
Actuator Stem (Type 667)	Steel, Chrome Plated	Steel, Chrome Plated
Spring	Silicon Manganese Steel*	Silicon Manganese Steel
Yoke	High-Tensile Iron	High-Tensile Iron
Stem Connector	Stainless Steel	Stainless Steel
Travel Indicator	Stainless Steel	Stainless Steel

*Chromium steel in Sizes 70 and 87

CONSTRUCTION SIZE 80 ACTUATORS

The Type 657 and 667 Size 80 diaphragm actuators are normally supplied on 10", 12" and 16" valve bodies and are intended for high pressure control applications where a great amount of force must be available for accurate positioning of the valve plug. The average effective area of the diaphragm is 283 square inches.

Size 80 actuators utilize high-tensile iron diaphragm case, spring case and yoke with steel bolting and ribbed reinforcement on the flanges for added strength. Springs are silicon manganese steel and are available for instrument pressure ranges of 3 to 15 psi or 6 to 30 psi. Access to the spring adjustor is accomplished by simply removing the steel cover band around the spring case.

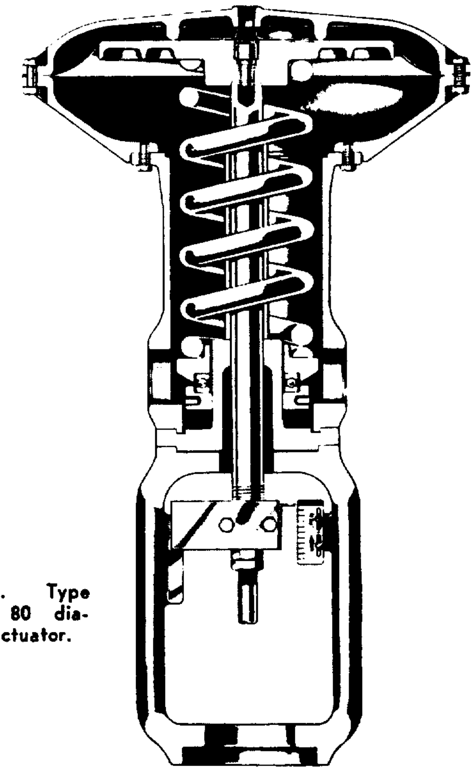


Figure 1-4. Type 657 Size 80 diaphragm actuator.

Courtesy of Fisher Controls Co.

TYPES

Type 657 direct acting actuator. Increasing air pressure on the diaphragm moves the actuator stem downward. With loss of operating medium, the stem moves to the extreme upward position.

Type 667 reverse acting actuator. Increasing air pressure on the diaphragm moves the actuator stem upward. Stem moves to the extreme downward position upon loss of operating medium.

CONSTRUCTION SIZES 30 THROUGH 87

Diaphragm Case—The pressed steel diaphragm case is much heavier than would be required to withstand normal working pressures. The extra thickness of the metal insures against deformation and provides liberal corrosion allowance. One case section is considerably deeper than the other. The major portion of the stroke is in this deep section, thus providing a uniform area throughout the stroke. The shallow section reduces the volume at zero stroke to a minimum which tends to provide a high degree of dynamic stability due to a "high compression ratio" effect, and also improves the frequency response.

The inside and outside of the diaphragm case are heavily zinc plated, iridited, and painted with a protective primer. This is followed by a final painting of the outside surfaces. All cap screws and nuts are cadmium plated steel.

The sealing surfaces of the case slope away from the diaphragm at the outer edge to insure a pressure tight seal inside the bolt circle at the inner edge. The internal upper travel stop in the Type 657 is a steel stamping, permanently welded in place.

Diaphragm—Diaphragm is molded Buna N with a nylon fabric insert. Buna N is used because of its excellent all around properties for this purpose, including high resistance to solvents and chemicals and good flexibility even at low temperatures. The molded diaphragm not only makes the actuator easy to assemble but also provides linearity between the operating pressure and travel, and gives a maximum effective area for a given case diameter. Molded diaphragms in combination with the deep diaphragm case provide a remarkably constant effective area throughout the valve travel. See Figure 1-2. Advantages of a virtually constant effective area include simplified spring selection, improved linearity between pressure and travel, a constant air pressure span for different "start to move" pressures, and a greater thrust producing ability for a given size diaphragm.

Diaphragm Plate—High-tensile iron diaphragm plate fits the molded diaphragm to align the top of the actuator stem and to transmit the diaphragm force to the stem. The connection between the diaphragm plate and the actuator stem has been designed to provide high resistance to torsional and thrust loads, and vibration that may tend to loosen the connection.

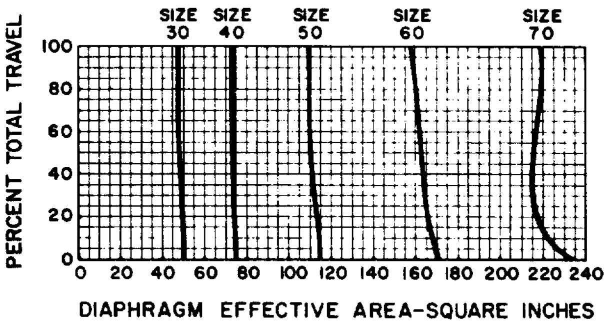


Figure 1-2. Diaphragm effective area curves for Type 657 actuators. Dwg. CF3468

Actuator Spring—Springs are wound from silicon manganese steel (chromium steel in Sizes 70 and 87) and are color coded for easy identification. Standard spring ranges are 3 to 15 psi and 6 to 30 psi. Maximum spring tolerance is ±5% of the spring rate.

Spring Adjustor—Spring adjustor has a hexagon head and is easily accessible for adjustment with standard wrenches.

Stem Connector—Stem connector is a split nut threaded to engage the actuator stem on one end and the valve stem on the other end. The two halves are bolted together to provide a connection that prevents loosening due to torque reactions of valve stem.

Travel Indicator Scale—Stainless steel travel indicator scale is graduated in tenths of total travel to give quick visual indication of valve plug position. The travel indicator is stainless steel with its edges cupped downward to add rigidity and also to provide a definite position reference.

Yoke—One-piece yoke is high-tensile iron since the primary consideration is that the structure be rigid. Careless or rough handling is not likely to cause unnoticed misalignment of parts. The inside diameter of the yoke base is in all cases large enough so that the actuator can be removed from the valve body without disturbing the packing box. Yoke is provided with two tapped bosses for mounting auxiliary equipment such as valve positioner, air set, switches, or controller.

Yoke to Body Connection—The connection of the yoke to the body is accomplished with a rugged forged steel locknut except in Size 87 where the yoke is bolted to the body. These arrangements provide correct alignment of actuator and body plus adequate strength.

Courtesy of Fisher Controls Co.

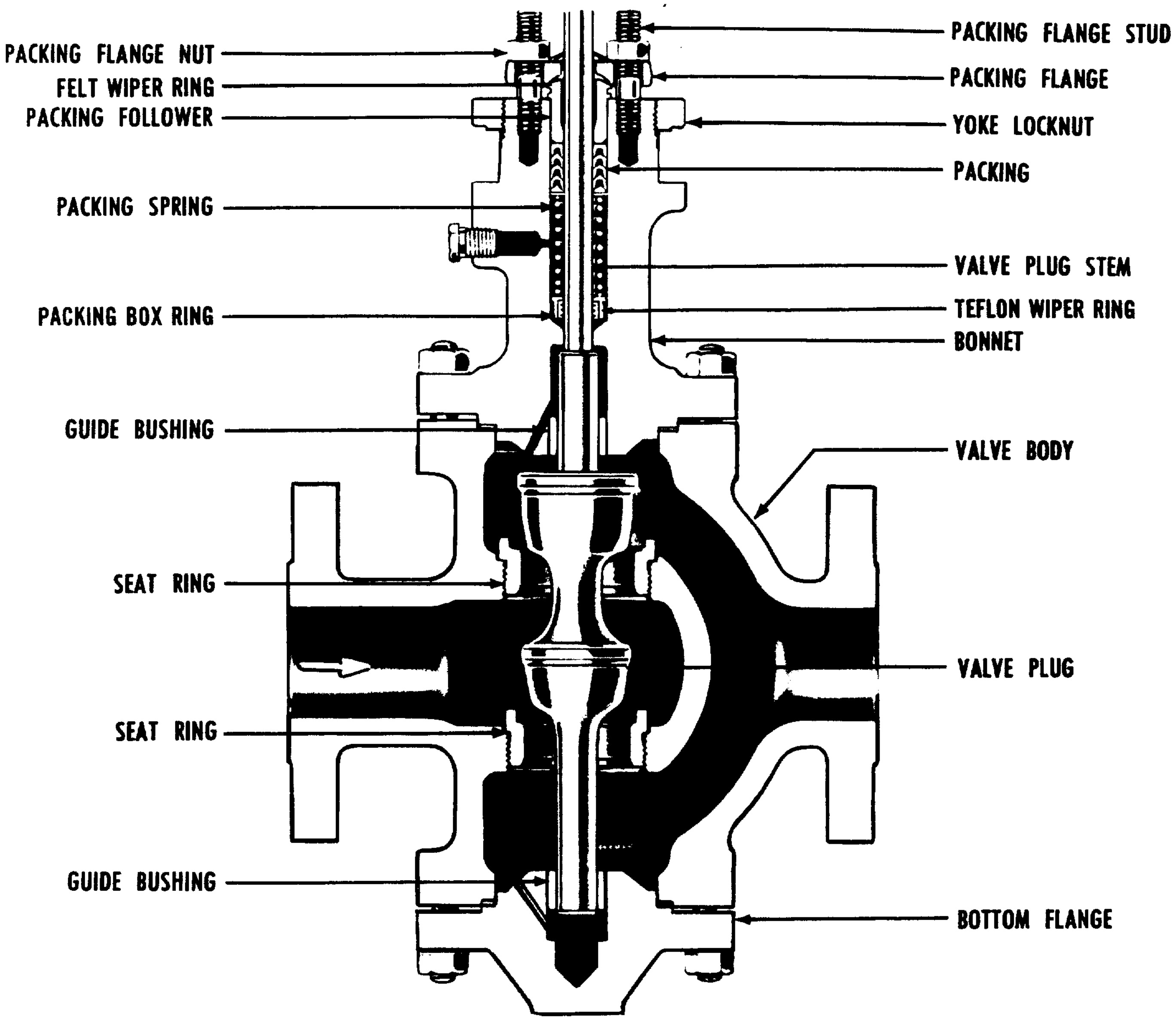


Figure 2-1. Design "A" double port body.

VALVE TRIM

The term "trim" refers to the internal parts of a valve body assembly which come in contact with the controlled fluid. Type 316 stainless steel is Fisher's standard trim material. It is satisfactory for most applications and is generally recommended for fluid temperatures up to 750° F. and pressure drops up to 150 psi. For very high pressure drops or high temperature conditions, a hard surfacing alloy such as Stellite can be used on the wearing parts of the valve plug, seat rings, guide bushings and guide posts. Other alloys such as Monel, Hastelloy "B", Durimet 20 or 440C stainless steel may be selected to combat individual corrosion and erosion problems.

The following tabulation shows standard materials for the various parts of the Fisher Design "A" valve body. This listing does not include all the trim materials that can be supplied. Information on other materials will be furnished on request.

Courtesy of Fisher Controls Co.

STANDARD CONSTRUCTION MATERIALS

Trim Number	1	2	3	9	11	15	30	145
Valve Body, Bonnet, and Bottom Flange	Cast iron, carbon steel, carbon molybdenum steel, chromium molybdenum steel, stainless steel and other alloys							
Valve Plug	316 SS	316 SS Hard Faced Seats (4)	316 SS Hard Faced Seats and Posts (4)	Monel	Hastelloy "B"	Durimet 20	440C SS (7)	"HTTM" (8)
Seat Rings	316 SS	316 SS Hard Faced Seats (4)	316 SS Hard Faced Seats (4)	Monel	Hastelloy "B"	Durimet 20	316 SS Hard Faced Seats (4)	316 SS Hard Faced Seats (4)
Valve Plug Stem	316 SS	316 SS	316 SS	R Monel	Hastelloy "B"	Carpenter 20	316 SS	316 SS
Stem Lock Pin	316 SS	316 SS	316 SS	R Monel	Hastelloy "B"	Carpenter 20	316 SS	316 SS
Guide Bushings	17-4PH SS (5)	17-4PH SS (5)	316 SS Hard Faced Bore (4)	K Monel (6)	Hastelloy "B"	Carpenter 20	17-4PH SS (5)	17-4PH SS (5)
Packing Box Ring	17-4PH SS (5)	17-4PH SS (5)	17-4PH SS (5)	K Monel (6)	Hastelloy "B"	Carpenter 20	17-4PH SS (5)	17-4PH SS (5)
Packing Spring (1)	316 SS	316 SS	316 SS	....	....	....	316 SS	316 SS
Lantern Ring or Spacer (2)	316 SS	316 SS	316 SS	R Monel	Hastelloy "B"	Carpenter 20	316 SS	316 SS
Packing Follower	316 SS	316 SS	316 SS	R Monel	Hastelloy "B"	Carpenter 20	316 SS	316 SS
Packing Flange	Steel, Cadmium Plated	Steel, Cadmium Plated	Steel, Cadmium Plated	Steel, Cadmium Plated	Steel, Cadmium Plated	Steel, Cadmium Plated	Steel, Cadmium Plated	Steel, Cadmium Plated
Body and Packing Flange Studs (3)	Steel	Steel	Steel	Steel	Steel	Steel	Steel	Steel
Body Gaskets	Asbestos	Asbestos	Asbestos	Asbestos	Asbestos	Asbestos	Asbestos	Asbestos

(1) Packing spring is used only with Teflon V-ring packing. On applications where a special alloy trim material is used, the stainless steel spring is replaced by a solid spacer.

(2) Lantern ring is used with packing materials other than Teflon V-ring. Spacer replaces packing spring with Teflon V-ring packing when a special alloy trim material is used.

(3) Standard body studs and packing flange studs are alloy steel (ASTM A193 Grade B7). Stud nuts are heat treated steel (ASTM A194 Grade 2H). Below minus 50° F. strain-hardened studs of Type 304 stainless steel (ASTM A320 Grade B8) should be used; nuts are Type 304 stainless steel (ASTM A194 Grade 8). Cast iron bodies have steel cap screws (SAE Grade 5) for body bolting.

(4) Hard faced with Stellite No. 6.

(5) 17-4PH stainless steel is heat treated and hardened to 40 — 45 Rockwell "C".

(6) K Monel is heat treated and hardened to 27 — 35 Rockwell "C".

(7) 440C stainless steel is heat treated and hardened to 56 — 60 Rockwell "C". The use of 440C stainless steel is restricted to plug type valve plugs in sizes up through 8".

(8) "HTTM" is a "Hard Tough Trim Material" with excellent erosion and abrasion resisting qualities. It has a hardness of 62-63 Rockwell "C" and can be furnished in plug type valve plugs in sizes up through 8".

CONTROL VALVES WITH DESIGN "A" BODIES

Courtesy of Fisher Controls Co.

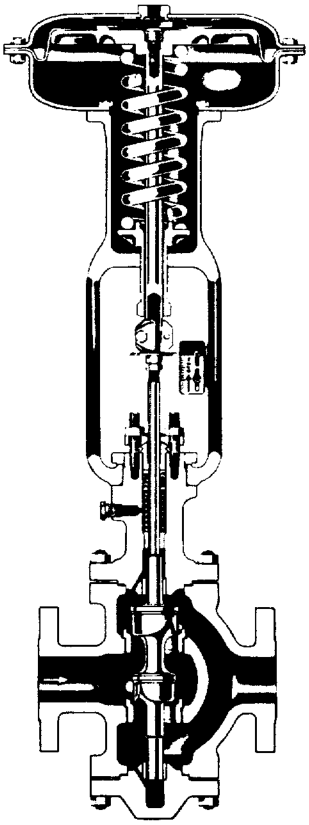


Figure 3-1. Type 657-A control valve with double port, top and bottom guided V-Pup valve plug.

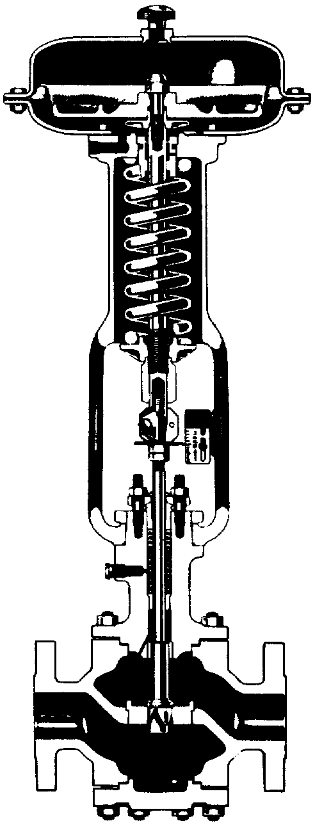


Figure 3-2. Type 667-A control valve with single port, top and port guided Micro-Flute valve plug.

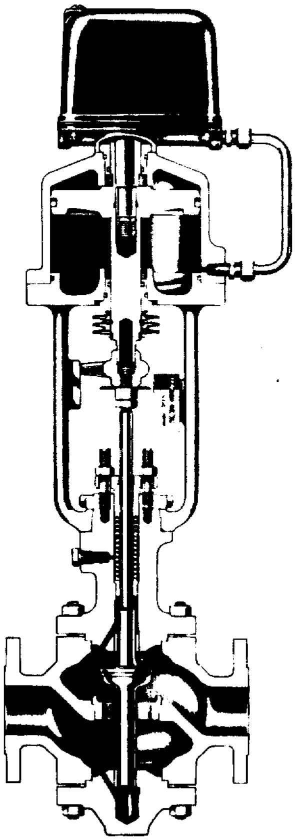
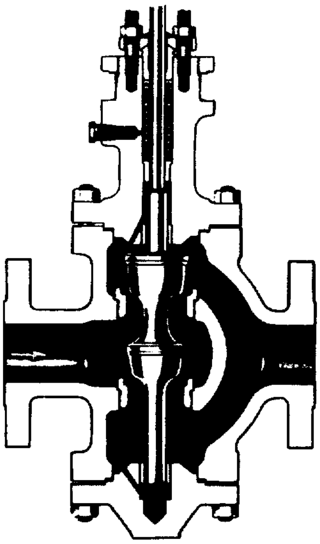


Figure 3-3. Type 470-A control valve with single port, top and bottom guided Throttle Plug valve plug.

Figure 3-4. Double port Design "A" body with top and bottom guided Throttle Plug valve plug.



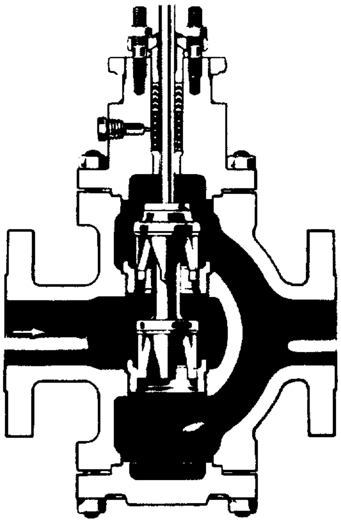
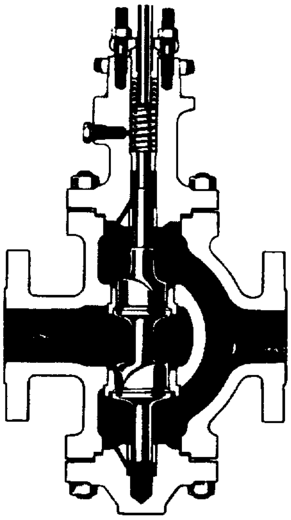


Figure 3-5. Double port Design "A" body with port guided V-Port valve plug.

Figure 3-6. Double port Design "AR" body with reverse acting V-Pup valve plug.



CONTROL VALVES WITH DESIGN "A" BODIES

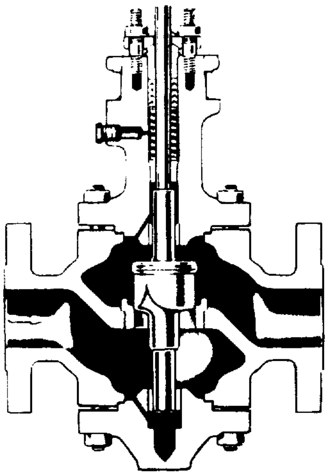


Figure 3-7. Single port Design "A" body with top and bottom guided V-Pup valve plug.

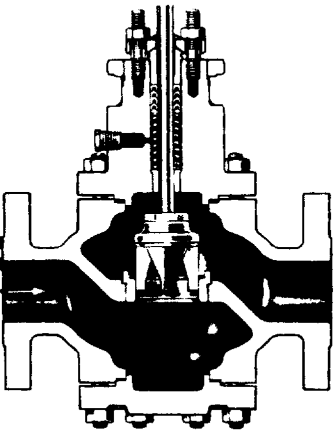


Figure 3-8. Single port Design "A" body with port guided V-Port valve plug.

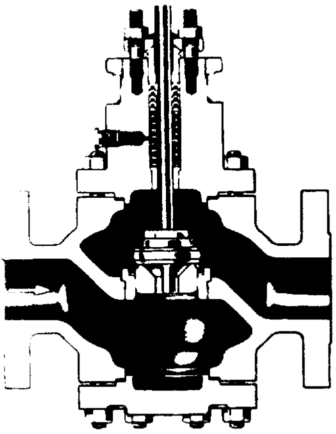


Figure 3-9. Single port Design "A" body with port guided Quick Opening valve plug.

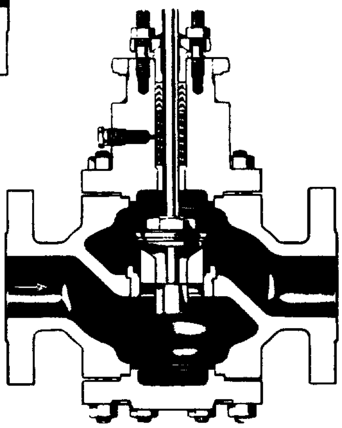


Figure 3-10. Single port Design "A" body with Quick Opening valve plug with "O" ring seat.

Type Numbers—The control valve type number is a combination of the actuator and body type numbers, such as Type 657-A, 667-A, 470-A, etc. When the valve plug is reverse acting (push down to open), "R" is added to the type number as in Type 657-AR.

Actuators—Type 657 direct acting diaphragm actuator, Type 667 reverse acting diaphragm actuator, or any Series 470 piston actuator.

Body Style—Design "A" single or double port globe body.

Body Materials—Cast iron, carbon steel, stainless steel, or other alloys.

Body Sizes—½" through 12" single port; 1" through 16" double port.

End Connections—Screwed ½" through 2". Flanged 1" through 16". Welding ends ½" through 16".

Body Ratings—Cast iron screwed—ASA 250 lb.
Cast iron flanged—ASA 125 or 250 lb.
Carbon steel or alloy steel screwed—ASA 600 lb.
Carbon steel or alloy steel flanged—ASA 150, 300 or 600 lb.

Body Bonnets—Plain, radiation fin, cast or fabricated extension, or bellows seal. Cast extensions are available for body sizes ½" through 8" only. Cast iron bodies are available with plain bonnet only.

Packing Materials—Non-lubricated Teflon V-ring packing is standard. Graphited asbestos, Teflon impregnated asbestos, and other types are also available. Lubricator or lubricator and isolating valve are furnished for those packings that require lubrication.

Trim—316 stainless steel is standard. Other trim materials are available as specified. See the chart on Page 17 for a listing of the more popular trims.

Restricted Trim—40% capacity restricted trim is available in body sizes 1½" through 8".

Valve Plugs—Throttle Plug, Linear Plug, V-Pup, V-Port, Quick Opening, Micro-Form, or Micro-Flute. All valve plugs except the Micro-Form and Micro-Flute are reversible.

Seat Ring—Replaceable screwed in seat ring is standard construction.

Accessories—Top or side mounted handwheel, Type 3560 valve positioner, hydraulic snubber, limit switches, and other accessories are available.

Courtesy of Fisher Controls Co.

ACTUATORS

Type 657 3
Type 667 3
Type 470 4
Type 472 4
Type 473 5
Type 513 5

BODIES

Design "A" Single Port . . . . 6 and 7
Design "A" Double Port . . . . 8 and 9
Design "AA". 10
Design "AC". . . . . .10 and 11
Design "B". 11
Design "BA". 12
Design "BF" 12
Design "BFC" 12
Design "D" 12
Design "DA" 13
Design "DB" & "DBQ". 13
Design "DBA" & "DBAQ". 13
Design "E" 14
Design "EA". 15
Design "GS". 15
Design "HS". 16
Design "K" & "KB" 17
Design "Y" (Iron). 17
Design "Y" (Steel) 18
Design "YY" (Iron) 18
Design "YY" (Steel) 19
Design "Z" 19
Design "ZLA" 19

. . . PROCEDURE . . .

To obtain the overall dimensions of a control valve, add the "D" and "G" body dimensions to the "E" dimension of the actuator. Dimensions for valve bodies with a 5″ boss head are so indicated and these dimensions should be combined with one of the following actuators: Size 80 and 87, Types 657 and 667; Sizes 80, 86, 100 and 130, Type 470; Sizes 80 and 100, Types 472 and 473. Similarly, dimensions for valve bodies that can be furnished with a 1¼″ boss head are so indicated and these dimensions should be combined with the dimensions of the Type 513 or the Type 470, Size 23, actuators.

Example:

Given: 6″ Type 657-A, 150 lb. RF flanged, double port steel body with top and bottom guided valve plug.

From the table below, note that a Size 50 or 60 Type 657 actuator is normally supplied with a 6″ valve. Dimension "E" from Page 3 is 28-7/16″. From Page 8, we see that "G" is 13-5/16″ and "D" is 14-15/16″. Thus, E + G + D = 28-7/16″ + 13-5/16″ + 14-15/16″ = 56-11/16″.

NOTE: When using a valve plug requiring a top guide but not a bottom guide, such as Micro-Form valve plug, use dimension "D" under top and bottom guided and dimension "G" under skirt guided.

. . . STANDARD CONSTRUCTIONS . . .

SERIES 657 AND 667 DIAPHRAGM ACTUATORS

Actuator Size	30	34	40	45	50	60	70	80	87
Effective Area, Sq. In.	46	69	69	105	105	156	220	283	220
Stem Size, In.	3/8	3/8	1/2	1/2	3/4	3/4	3/4	1, 1-1/4	1
Yoke Boss Size, In.	2-1/8	2-1/8	2-13/16	2-13/16	3-9/16	3-9/16	3-9/16	5	5
Body Size, In.	1/2 - 1-1/2	1/2 - 1-1/2	2 - 4	2 - 4	5 - 8	5 - 8	10 - 16	10 - 16	10 - 16

SERIES 470 PISTON ACTUATORS

Actuator Size	23	30	40	43	60	63	64	80	86	100	130
Cylinder Dia., In.	4-3/4	4-3/4	6-1/8	4-3/4	8-1/2	4-3/4	6-1/8	10-3/4	8-1/2	13	17
Stem Size, In.	3/8	3/8	1/2	1/2	3/4	3/4	3/4	1	1	1-1/4	1-1/4
Yoke Boss Size, In.	1-1/4	2-1/8	2-13/16	2-13/16	3-9/16	3-9/16	3-9/16	5	5	5	5
Body Size, In.	1/2 - 2*	1/2 - 1-1/2	2 - 4	2 - 4	5 - 8	5 - 8	5 - 8	10 - 16	10 - 16	10 - 16	10 - 16

*Design 'GS,' 'B' and 'BA' bodies only.

ACTUATORS

Type 657 3
Type 667 3
Type 470 4
Type 472 4
Type 473 5
Type 513 5

BODIES

Design "A" Single Port . . . . 6 and 7
Design "A" Double Port . . . . 8 and 9
Design "AA". 10
Design "AC". . . . . 10 and 11
Design "B". 11
Design "BA". 12
Design "BF". 12
Design "BFC" 12
Design "D" 12
Design "DA" 13
Design "DB" & "DBQ". 13
Design "DBA" & "DBAQ" 13
Design "E" 14
Design "EA". 15
Design "GS". 15
Design "HS". 16
Design "K" & "KB" 17
Design "Y" (Iron). 17
Design "Y" (Steel) 18
Design "YY" (Iron). 18
Design "YY" (Steel) 19
Design "Z" 19
Design "ZLA" 19

. . . PROCEDURE . . .

To obtain the overall dimensions of a control valve, add the "D" and "G" body dimensions to the "E" dimension of the actuator. Dimensions for valve bodies with a 5" boss head are so indicated and these dimensions should be combined with one of the following actuators: Size 80 and 87, Types 657 and 667; Sizes 80, 86, 100 and 130, Type 470; Sizes 80 and 100, Types 472 and 473. Similarly, dimensions for valve bodies that can be furnished with a 1¼" boss head are so indicated and these dimensions should be combined with the dimensions of the Type 513 or the Type 470, Size 23, actuators.

Example:

Given: 6" Type 657-A, 150 lb. RF flanged, double port steel body with top and bottom guided valve plug.

From the table below, note that a Size 50 or 60 Type 657 actuator is normally supplied with a 6" valve. Dimension "E" from Page 3 is 28-7/16". From Page 8, we see that "G" is 13-5/16" and "D" is 14-15/16". Thus, E + G + D = 28-7/16" + 13-5/16" + 14-15/16" = 56-11/16".

NOTE: When using a valve plug requiring a top guide but not a bottom guide, such as Micro-Form valve plug, use dimension "D" under top and bottom guided and dimension "G" under skirt guided.

. . . STANDARD CONSTRUCTIONS . . .

SERIES 657 AND 667 DIAPHRAGM ACTUATORS

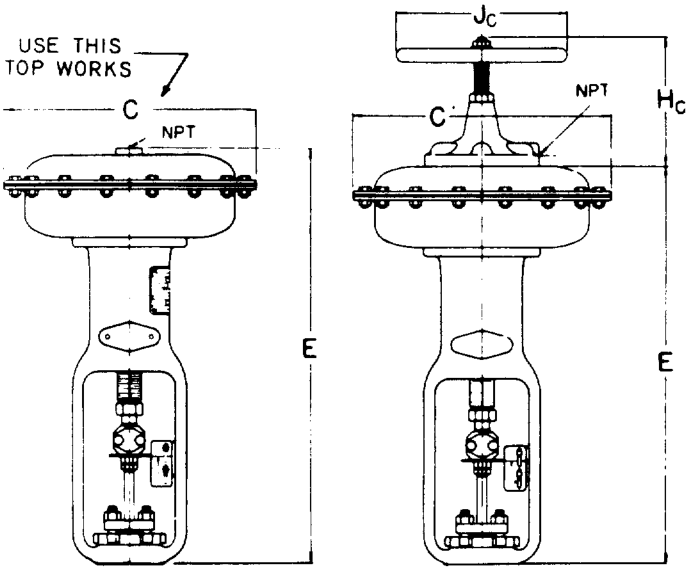
Actuator Size	30	34	40	45	50	60	70	80	87
Effective Area, Sq. In.	46	69	69	105	105	156	220	283	220
Stem Size, In.	3/8	3/8	1/2	1/2	3/4	3/4	3/4	1, 1-1/4	1
Yoke Boss Size, In.	2-1/8	2-1/8	2-13/16	2-13/16	3-9/16	3-9/16	3-9/16	5	5
Body Size, In.	1/2 - 1-1/2	1/2 - 1-1/2	2 - 4	2 - 4	5 - 8	5 - 8	10 - 16	10 - 16	10 - 16

SERIES 470 PISTON ACTUATORS

Actuator Size	23	30	40	43	60	63	64	80	86	100	130
Cylinder Dia., In.	4-3/4	4-3/4	6-1/8	4-3/4	8-1/2	4-3/4	6-1/8	10-3/4	8-1/2	13	17
Stem Size, In.	3/8	3/8	1/2	1/2	3/4	3/4	3/4	1	1	1-1/4	1-1/4
Yoke Boss Size, In.	1-1/4	2-1/8	2-13/16	2-13/16	3-9/16	3-9/16	3-9/16	5	5	5	5
Body Size, In.	1/2 - 2*	1/2 - 1-1/2	2 - 4	2 - 4	5 - 8	5 - 8	5 - 8	10 - 16	10 - 16	10 - 16	10 - 16

*Design 'GS,' 'B' and 'BA' bodies only.

TYPE 657 DIAPHRAGM ACTUATOR

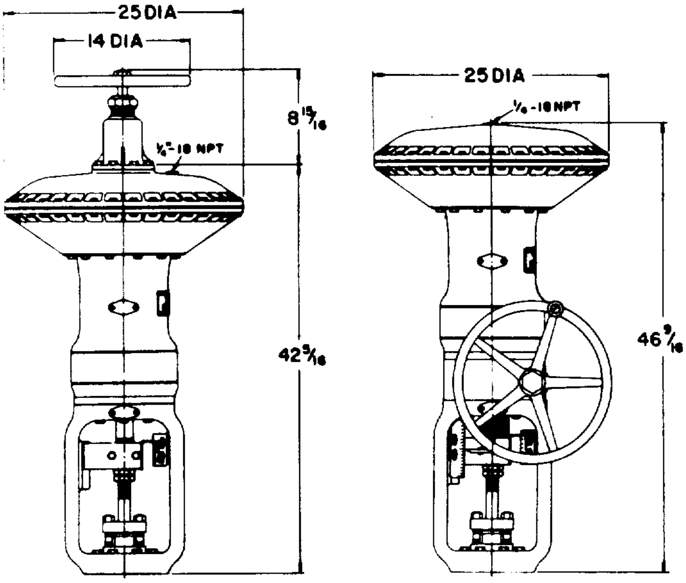


SIZE	E	C	J_c	H_c	NPT
30	17 5/16	11 3/8	6 3/4	4 3/4	1/4 – 18
34	19 5/8	13 1/8	8 3/4	6 7/16	1/4 – 18
40	21 9/16	13 1/8	8 3/4	6 7/16	1/4 – 18
45	25 15/16	16	8 3/4	7 9/16	1/4 – 18
50	28 7/16	16	8 3/4	7 15/16	1/4 – 18
60	28 7/16	18 5/8	8 3/4	7 15/16	1/4 – 18
70	33 1/16	21 1/8	14	12 5/16	1/2 – 14
87	36 15/16	21 1/8	14	12 5/16	1/2 – 14

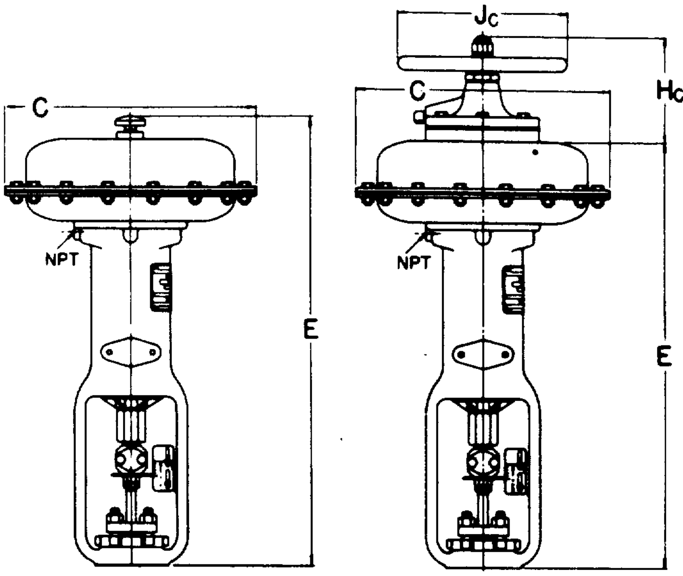
SIZE 87 HAS A 5" BOSS

TYPE 657 - SIZE 80

(5" YOKE BOSS)



TYPE 667 DIAPHRAGM ACTUATOR

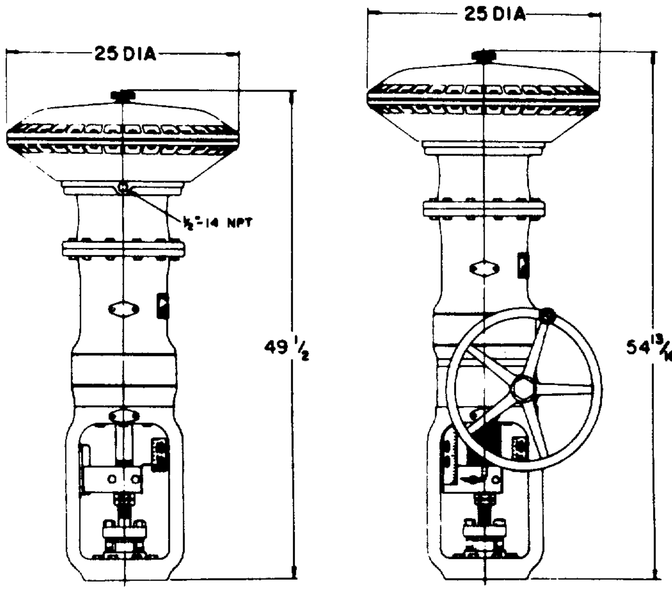


SIZE	E	C	J_c	H_c	NPT
30	18 13/16	11 3/8	6 3/4	4 11/16	1/4 – 18
34	22 9/16	13 1/8	8 3/4	4 3/4	1/4 – 18
40	23 3/8	13 1/8	8 3/4	5 3/8	1/4 – 18
45	30 1/4	16	8 3/4	6 1/4	1/4 – 18
50	30 7/8	16	8 3/4	6 3/8	1/4 – 18
60	30 7/8	18 5/8	8 3/4	6 5/8	1/4 – 18
70	36 3/16	21 1/8	14	11 1/4	1/2 – 14
87	39 1/2	21 1/8	14	11 1/4	1/2 – 14

SIZE 87 HAS A 5" BOSS

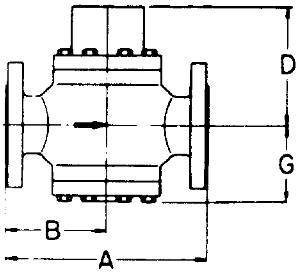
TYPE 667 - SIZE 80

(5" YOKE BOSS)

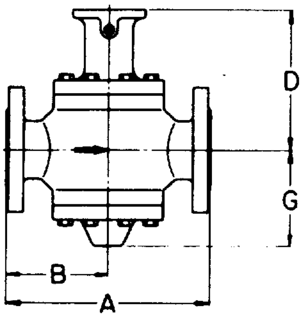


DESIGN "A" SINGLE PORT IRON BODIES

PLAIN BONNET



PORT GUIDED



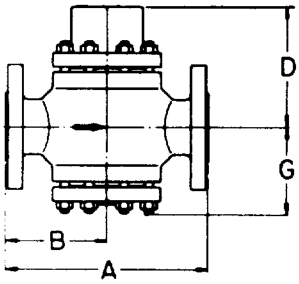
TOP AND BOTTOM GUIDED

SIZE	A			B			G	D	G	D
	SCRD	125 FF	250 RF	SCRD	125 FF	250 RF	PORT GUIDED		T & B GUIDED	
1/2	6		7 1/2	3		3 3/4	3 1/8	4 7/16	3 7/16	5 1/4
3/4	6	7 3/8	7 5/8	3	3 11/16	3 13/16	3 1/8	4 7/16	3 7/16	5 1/4
1	6 1/2	7 1/4	7 3/4	3 1/4	3 5/8	3 7/8	3 3/8	4 11/16	3 11/16	5 1/2
1 1/4	6 1/2	7 7/8	8 3/8	3 1/4	3 15/16	4 3/16	3 3/8	4 11/16	3 11/16	5 1/2
1 1/2	8	8 3/4	9 1/4	4	4 3/8	4 5/8	3 15/16	5 7/16	5	6 1/4
2	9 1/4	10	10 1/2	4 5/8	5	5 1/4	3 15/16	6 3/16	5	7 5/16
2 1/2		10 7/8	11 1/2		5 7/16	5 3/4	4 11/16	6 1/2	6 1/2	8 3/4
3		11 3/4	12 1/2		5 7/8	6 1/4	5 1/4	6 7/8	7 1/8	9 5/16
4		13 7/8	14 1/2		6 15/16	7 1/4	6 7/16	7 7/8	7 13/16	9 9/16
5		15 7/8	16 3/4		7 15/16	8 3/8	7 5/8	9	10 3/4	12 7/16
6		17 3/4	18 5/8		8 7/8	9 5/16	8 9/16	9 5/8	10 1/2	12 5/16
8		21 3/8	22 3/8		10 11/16	11 3/16	9 13/16	10 13/16	11 5/16	13 1/8
10		26 1/2	27 7/8		13 1/4	13 15/16	12 7/16	13 3/16	16	17 5/8

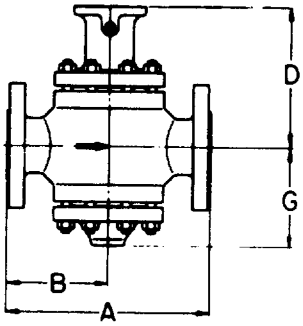
ABBREVIATIONS USED ABOVE: SCRD-SCREWED ENDS
FF-FLAT FACE, RF-RAISED FACE
FLANGE SPECIFICATION REFERENCE: 125 LB.-USAS B16.1
250 LB.-USAS B16b

DESIGN "A" SINGLE PORT STEEL BODIES

PLAIN BONNET

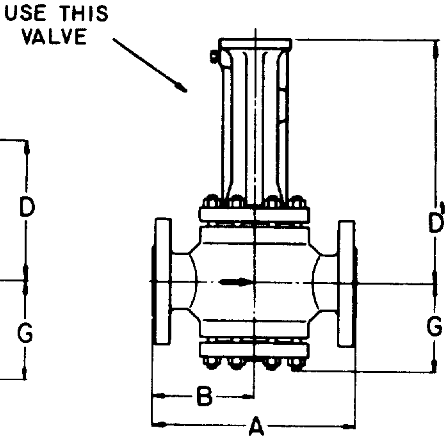


PORT GUIDED

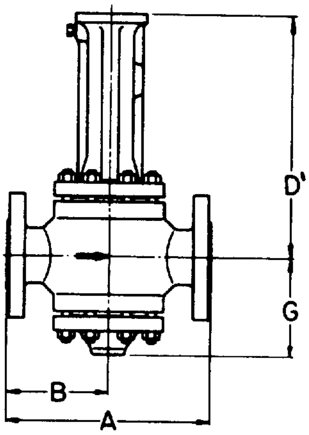


TOP AND BOTTOM GUIDED

EXTENSION BONNET



PORT GUIDED



TOP AND BOTTOM GUIDED

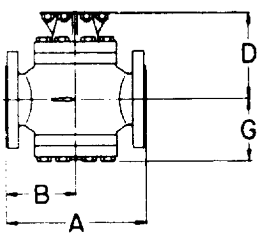
SIZE	A									B									G	D	G	D	D'
	SCRD	150 RF	150 RTJ	300 RF	300 RTJ	400 RF	400 RTJ	600 RF	600 RTJ	SCRD	150 RF	150 RTJ	300 RF	300 RTJ	400 RF	400 RTJ	600 RF	600 RTJ	PORT GUIDED		T & B GUIDED		EXT.
1/2	6			7 1/2	7 15/16	*	†	8	7 15/16	3			3 3/4	3 31/32	*	†	4	3 31/32	3 9/16	4 1/2	3 1/2	5 1/4	7 13/16
3/4	6	7 3/8		7 5/8	8 1/8	*	†	8 1/8	8 1/8	3	3 11/16		3 13/16	4 1/16	*	†	4 1/16	4 1/16	3 9/16	4 1/2	3 1/2	5 1/4	7 13/16
1	6 1/2	7 1/4	7 3/4	7 3/4	8 1/4	*	†	8 1/4	8 1/4	3 1/4	3 5/8	3 7/8	3 7/8	4 1/8	*	†	4 1/8	4 1/8	3 13/16	4 3/4	3 3/4	5 1/2	8 1/16
1 1/4	6 1/2	7 7/8	8 3/8	8 3/8	8 7/8	*	†	9	9	3 1/4	3 15/16	4 3/16	4 3/16	4 7/16	*	†	4 1/2	4 1/2	3 13/16	4 3/4	3 3/4	5 1/2	8 1/16
1 1/2	8	8 3/4	9 1/4	9 1/4	9 3/4	*	†	9 7/8	9 7/8	4	4 3/8	4 5/8	4 5/8	4 7/8	*	†	4 15/16	4 15/16	4 5/8	5 7/16	5 1/8	6 1/4	8 3/4
2	9 1/4	10	10 1/2	10 1/2	11 1/8	*	†	11 1/4	11 3/8	4 5/8	5	5 1/4	5 1/4	5 9/16	*	†	5 5/8	5 11/16	4 5/8	6 5/16	5 1/8	7 5/16	12 3/4
2 1/2		10 7/8	11 3/8	11 1/2	12 1/8	*	†	12 1/4	12 3/8		5 7/16	5 11/16	5 3/4	6 1/16	*	†	6 1/8	6 3/16	5 1/2	6 1/2	6 5/8	8 3/4	13 5/8
3		11 3/4	12 1/4	12 1/2	13 1/8	*	†	13 1/4	13 3/8		5 7/8	6 1/8	6 1/4	6 9/16	*	†	6 5/8	6 11/16	6 1/4	6 7/8	7 1/8	9 5/16	13 15/16
4		13 7/8	14 3/8	14 1/2	15 1/8	15 1/4	15 3/8	15 1/2	15 5/8		6 15/16	7 3/16	7 1/4	7 9/16	7 5/8	7 11/16	7 3/4	7 13/16	7 7/16	7 7/8	8	9 9/16	15 1/16
5		15 7/8	16 3/8	16 3/4	17 3/8	17 1/2	17 5/8	18	18 1/8		7 15/16	8 3/16	8 3/8	8 11/16	8 3/4	8 13/16	9	9 1/16	8 5/8	9	10 5/16	12 7/16	15 7/16
6		17 3/4	18 1/4	18 5/8	19 1/4	19 1/2	19 5/8	20	20 1/8		8 7/8	9 1/8	9 5/16	9 5/8	9 3/4	9 13/16	10	10 1/16	9 5/16	9 9/16	10 11/16	12 5/16	16 1/8
8		21 3/8	21 7/8	22 3/8	23	23 3/8	23 1/2	24	24 1/8		10 11/16	10 15/16	11 3/16	11 1/2	11 11/16	11 3/4	12	12 1/16	10 13/16	10 13/16	11 5/16	13 1/8	17 3/8
10		26 1/2	27	27 7/8	28 1/2	28 7/8	29	29 5/8	29 3/4		13 1/4	13 1/2	13 15/16	14 1/4	14 7/16	14 1/2	14 13/16	14 7/8	13 3/8	13 3/16	16	17 5/8	20

ABBREVIATIONS USED ABOVE: SCRD-SCREWED ENDS, RF-RAISED FACE, RTJ-RING TYPE JOINT
FLANGE SPECIFICATION REFERENCE: 150-300-400-600 LB. USAS B16 5
* DIMENSIONALLY THE SAME AS 600 LB RF
† DIMENSIONALLY THE SAME AS 600 LB RTJ

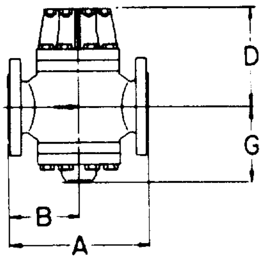
DESIGN "A" SINGLE PORT IRON BODIES

(WITH 5" BOSS BONNET)

PLAIN BONNET



PORT GUIDED



TOP AND BOTTOM GUIDED

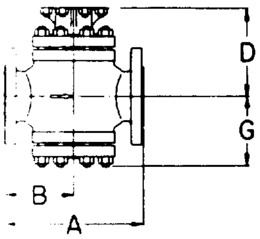
SIZE	A			B			G	D	G	D
	SCRD	125 FF	250 RF	SCRD	125 FF	250 RF	PORT GUIDED		T&B GUIDED	
4		13 7/8	14 1/2		6 15/16	7 1/4	6 7/16	8 7/8	7 15/16	10 3/16
5		15 7/8	16 3/4		7 15/16	8 3/8	7 5/8	9 3/4	10 3/4	13
6		17 3/4	18 5/8		8 7/8	9 5/16	8 9/16	12 7/8	10 1/2	12 7/8
8		21 3/8	22 3/8		10 11/16	11 3/16	9 13/16	11 3/4	11 5/16	13 11/16
10		26 1/2	27 7/8		13 1/4	13 15/16	12 7/16	14 1/8	16	17 7/8
12		29	30 1/2		14 1/2	15 1/4	14 1/2	15 7/8	17 1/4	18 13/16

ABBREVIATIONS USED ABOVE: SCRD-SCREWED ENDS
FF-FLAT FACE, RF-RAISED FACE
FLANGE SPECIFICATION REFERENCE: 125 LB.-USAS B16.1
250 LB.-USAS B16b

DESIGN "A" SINGLE PORT STEEL BODIES

(WITH 5" BOSS BONNET)

PLAIN BONNET



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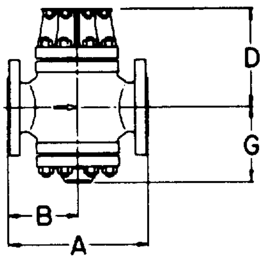
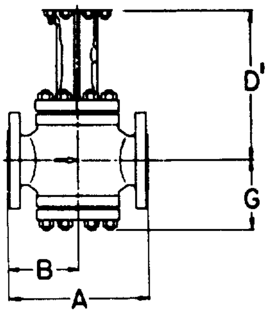
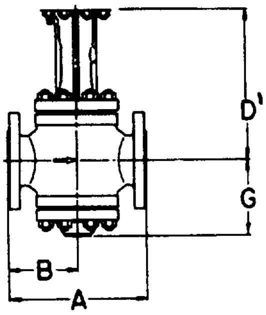


TOP AND BOTTOM GUIDED

EXTENSION BONNET



PORT GUIDED



TOP AND BOTTOM GUIDED

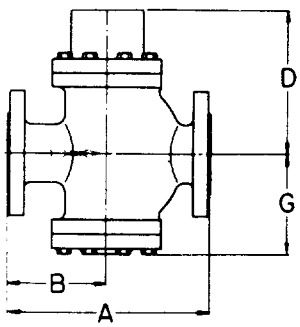
SIZE	A								B								G	D	G	D	D'
	150 RF	150 RTJ	300 RF	300 RTJ	400 RF	400 RTJ	600 RF	600 RTJ	150 RF	150 RTJ	300 RF	300 RTJ	400 RF	400 RTJ	600 RF	600 RTJ	PORT GUIDED		T&B GUIDED		EXT.
3	11 3/4	12 1/4	12 1/2	13 1/8	*	†	13 1/4	13 3/8	5 7/8	6 1/8	6 1/4	6 9/16	*	†	6 5/8	6 11/16	6 1/4	9 11/16	7 1/8	9 9/16	14 5/16
4	13 7/8	14 3/8	14 1/2	15 1/8	15 1/4	15 3/8	15 1/2	15 5/8	6 15/16	7 3/16	7 1/4	7 9/16	7 5/8	7 11/16	7 3/4	7 13/16	7 7/16	9 1/16	8	10 3/16	15 9/16
5	15 7/8	16 3/8	16 3/4	17 3/8	17 1/2	17 5/8	18	18 1/8	7 15/16	8 3/16	8 3/8	8 11/16	8 3/4	8 13/16	9	9 1/16	8 5/8	13	10 15/16	13	16 3/4
6	17 3/4	18 1/4	18 5/8	19 1/4	19 1/2	19 5/8	20	20 1/8	8 7/8	9 1/8	9 5/16	9 5/8	9 3/4	9 13/16	10	10 1/16	9 5/16	12 7/8	10 11/16	12 7/8	17 7/16
8	21 3/8	21 7/8	22 3/8	23	23 3/8	23 1/2	24	24 1/8	10 11/16	10 15/16	11 3/16	11 1/2	11 11/16	11 3/4	12	12 1/16	10 15/16	11 13/16	11 5/16	13 11/16	18 11/16
10	26 1/2	27	27 7/8	28 1/2	28 7/8	29	29 5/8	29 3/4	13 1/4	13 1/2	13 15/16	14 1/4	14 7/16	14 1/2	14 13/16	14 7/8	13 5/8	14 1/8	16	17 7/8	21 3/16
12	29	29 1/2	30 1/2	31 1/8	31 1/2	31 5/8	32 1/4	32 3/8	14 1/2	14 3/4	15 1/4	15 9/16	15 3/4	15 13/16	16 1/8	16 3/16	14 1/2	15 15/16	17 5/16	18 13/16	22 5/16

ABBREVIATIONS USED: RF-RAISED FACE, RTJ-RING TYPE JOINT
FLANGE SPECIFICATION REFERENCE: USAS B16.5
*DIMENSIONALLY THE SAME AS 600 LB. RF
†DIMENSIONALLY THE SAME AS 600 LB. RTJ

Courtesy of Fisher Controls Co.

DESIGN "A" DOUBLE PORT IRON BODIES

PLAIN BONNET



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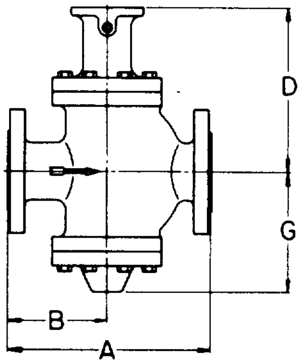


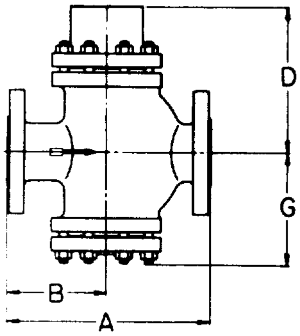
TOP AND BOTTOM GUIDED

SIZE	A			B			G	D	G	D
	SCRD	125 FF	250 RF	SCRD	125 FF	250 RF	PORT GUIDED		T & B GUIDED	
1	6	7 1/4	7 3/4	2 11/16	3 5/8	3 7/8	3 7/8	5 3/16	4 3/16	6
1 1/4	6	7 7/8	8 3/8	2 11/16	3 15/16	4 3/16	3 7/8	5 3/16	4 3/16	6
1 1/2	7 3/4	8 3/4	9 1/4	3 3/4	4 3/8	4 5/8	4 11/16	6 3/16	5 3/4	7
2	9 1/8	10	10 1/2	3 7/8	4 7/8	5 1/8	5 1/4	7 1/2	6 5/16	8 5/8
2 1/2		10 7/8	11 1/2		5 1/16	5 3/8	5 13/16	7 5/8	7 5/8	9 7/8
3		11 3/4	12 1/2		5 3/8	5 3/4	6 9/16	8 3/16	8 7/16	10 5/8
4		13 7/8	14 1/2		6 3/16	6 1/2	8 3/8	9 13/16	9 3/4	11 1/2
5		15 7/8	16 3/4		7	7 7/16	8 13/16	10 3/16	11 15/16	13 5/8
6		17 3/4	18 5/8		7 7/8	8 5/16	11 3/16	12 3/16	13 1/8	14 15/16
8		21 3/8	22 3/8		9 5/8	10 1/8	12 5/8	13 5/8	14 1/8	15 15/16
10		26 1/2	27 7/8		11 1/8	11 13/16	15 1/4	16	18 13/16	20 7/16

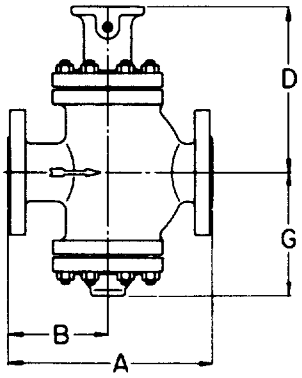
ABBREVIATIONS USED ABOVE: SCRD • SCREWED ENDS
FF • FLAT FACE, RF • RAISED FACE
FLANGE SPECIFICATION REFERENCE: 125 LB. - USAS B16.1
250 LB. - USAS B16b

DESIGN "A" DOUBLE PORT STEEL BODIES

PLAIN BONNET

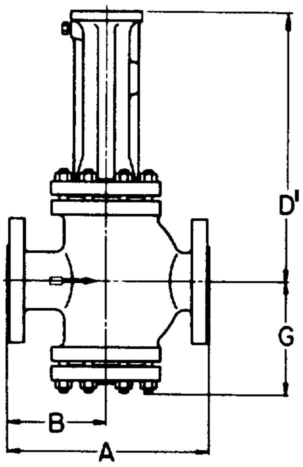


PORT GUIDED

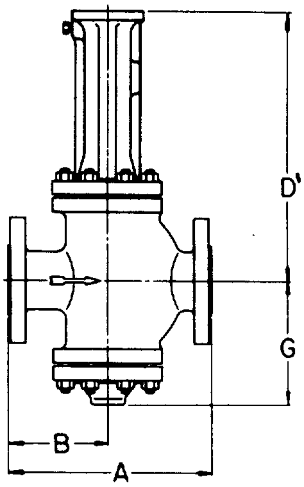


TOP AND BOTTOM GUIDED

EXTENSION BONNET



PORT GUIDED



TOP AND BOTTOM GUIDED

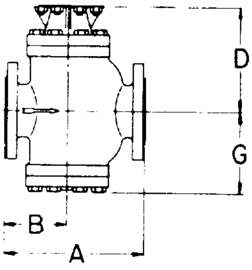
SIZE	A									B									G	D	G	D	D'
	SCRD	150 RF	150 RTJ	300 RF	300 RTJ	400 RF	400 RTJ	600 RF	600 RTJ	SCRD	150 RF	150 RTJ	300 RF	300 RTJ	400 RF	400 RTJ	600 RF	600 RTJ	PORT GUIDED		T & B GUIDED		EXT.
1	6	7 1/4	7 3/4	7 3/4	8 1/4	*	†	8 1/4	8 1/4	2 11/16	3 5/8	3 7/8	3 7/8	4 1/8	*	†	4 1/8	4 1/8	4 5/16	5 1/4	4 1/4	6	8 9/16
1 1/4	6	7 7/8	8 3/8	8 3/8	8 7/8	*	†	9	9	2 11/16	3 15/16	4 3/16	4 3/16	4 7/16	*	†	4 1/2	4 1/2	4 5/16	5 1/4	4 1/4	6	8 9/16
1 1/2	7 3/4	8 3/4	9 1/4	9 1/4	9 3/4	*	†	9 7/8	9 7/8	3 3/4	4 3/8	4 5/8	4 5/8	4 7/8	*	†	4 15/16	4 15/16	5 3/8	6 3/16	5 7/8	7	9 1/2
2	9 1/8	10	10 1/2	10 1/2	11 1/8	*	†	11 1/4	11 3/8	3 7/8	4 7/8	5 1/8	5 1/8	5 7/16	*	†	5 1/2	5 9/16	5 15/16	7 5/8	6 7/16	8 5/8	14 1/16
2 1/2		10 7/8	11 3/8	11 1/2	12 1/8	*	†	12 1/4	12 3/8		5 1/16	5 5/16	5 3/8	5 11/16	*	†	5 3/4	5 13/16	6 5/8	7 5/8	7 3/4	9 7/8	14 1/2
3		11 3/4	12 1/4	12 1/2	13 1/8	*	†	13 1/4	13 3/8		5 3/8	5 5/8	5 3/4	6 1/16	*	†	6 1/8	6 3/16	7 9/16	8 3/16	8 7/16	10 5/8	15 1/4
4		13 7/8	14 3/8	14 1/2	15 1/8	15 1/4	15 3/8	15 1/2	15 5/8		6 3/16	6 7/16	6 1/2	6 13/16	6 7/8	6 15/16	7	7 1/16	9 3/8	9 13/16	9 15/16	11 1/2	17
5		15 7/8	16 3/8	16 3/4	17 3/8	17 1/2	17 5/8	18	18 1/8		7	7 1/4	7 7/16	7 3/4	7 13/16	7 7/8	8 1/16	8 1/8	9 13/16	10 3/16	12 1/8	13 5/8	16 5/8
6		17 3/4	18 1/4	18 5/8	19 1/4	19 1/2	19 5/8	20	20 1/8		7 7/8	8 1/8	8 5/16	8 5/8	8 3/4	8 13/16	9	9 1/16	11 15/16	12 3/16	13 5/16	14 15/16	18 3/4
8		21 3/8	21 7/8	22 3/8	23	23 3/8	23 1/2	24	24 1/8		9 5/8	9 7/8	10 1/8	10 7/16	10 5/8	10 11/16	10 15/16	11	13 3/4	13 5/8	14 1/8	15 15/16	20 3/16
10		26 1/2	27	27 7/8	28 1/2	28 7/8	29	29 5/8	29 3/4		11 1/8	11 3/8	11 13/16	12 1/8	12 5/16	12 3/8	12 11/16	12 3/4	16 3/16	16	18 13/16	20 7/16	22 13/16

ABBREVIATIONS USED ABOVE: SCRD • SCREWED ENDS, RF • RAISED FACE, RTJ • RING TYPE JOINT
FLANGE SPECIFICATION REFERENCE: 150 - 300 - 400 - 600 LB. USAS B16.5
* DIMENSIONALLY THE SAME AS 600 LB. RF
+ DIMENSIONALLY THE SAME AS 600 LB RTJ

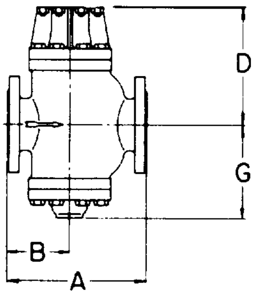
DESIGN "A" DOUBLE PORT IRON BODIES

(WITH 5" BOSS BONNET)

PLAIN BONNET



PORT GUIDED



TOP AND BOTTOM GUIDED

SIZE	A			B			G	D	G	D
	SCRD	125 FF	250 RF	SCRD	125 FF	250 RF	PORT GUIDED		T & B GUIDED	
4		13 7/8	14 1/2		6 3/16	6 1/2	8 3/8	10 13/16	9 3/4	12 1/8
5		15 7/8	16 3/4		7	7 7/16	8 13/16	10 15/16	11 15/16	14 3/16
6		17 3/4	18 5/8		7 7/8	8 5/16	11 3/16	15 1/2	13 1/8	15 1/2
8		21 3/8	22 3/8		9 5/8	10 1/8	12 5/8	14 9/16	14 1/8	16 1/2
10		26 1/2	27 7/8		11 1/8	11 13/16	15 1/4	16 15/16	18 13/16	20 3/4
12		29	30 1/2		12	12 3/4	16 5/8	18	19 3/8	20 15/16
									24 7/16	26 11/16

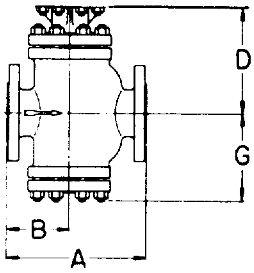
ABBREVIATIONS USED ABOVE: SCRD = SCREWED ENDS
FF = FLAT FACE, RF = RAISED FACE
FLANGE SPECIFICATION REFERENCE: 125 LB. - USAS B16.1
250 LB. - USAS B16b

DESIGN "A" DOUBLE PORT STEEL BODIES

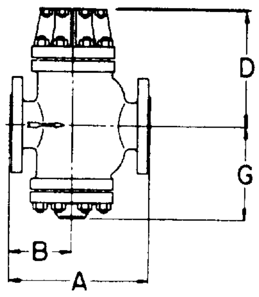
(WITH 5" BOSS BONNET)

PLAIN BONNET

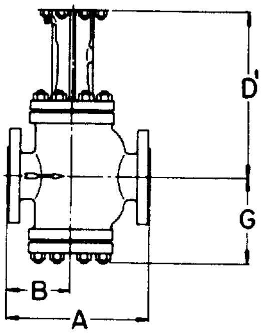
EXTENSION BONNET



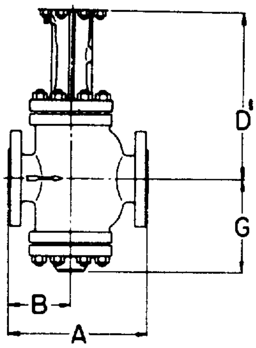
PORT GUIDED



TOP AND BOTTOM GUIDED



PORT GUIDED



TOP AND BOTTOM GUIDED

SIZE	A								B								G	D	G	D	D'
	150 RF	150 RTJ	300 RF	300 RTJ	400 RF	400 RTJ	600 RF	600 RTJ	150 RF	150 RTJ	300 RF	300 RTJ	400 RF	400 RTJ	600 RF	600 RTJ	PORT GUIDED		T & B GUIDED		EXT.
3	11 3/4	12 1/4	12 1/2	13 1/8	*	†	13 1/4	13 3/8	5 3/8	5 5/8	5 3/4	6 1/16	*	†	6 1/8	6 3/16	7 9/16	11	8 7/16	10 7/8	15 5/8
4	13 7/8	14 3/8	14 1/2	15 1/8	15 1/4	15 3/8	15 1/2	15 5/8	6 3/16	6 7/16	6 1/2	6 13/16	6 7/8	6 15/16	7	7 1/16	9 3/8	11	9 15/16	12 1/8	17 1/2
5	15 7/8	16 3/8	16 3/4	17 3/8	17 1/2	17 5/8	18	18 1/8	7	7 1/4	7 7/16	7 3/4	7 13/16	7 7/8	8 1/16	8 1/8	9 13/16	14 3/16	12 1/8	14 3/16	17 15/16
6	17 3/4	18 1/4	18 5/8	19 1/4	19 1/2	19 5/8	20	20 1/8	7 7/8	8 1/8	8 5/16	8 5/8	8 3/4	8 13/16	9	9 1/16	11 15/16	15 1/2	13 5/16	15 1/2	20 1/16
8	21 3/8	21 7/8	22 3/8	23	23 3/8	23 1/2	24	24 1/8	9 5/8	9 7/8	10 1/8	10 7/16	10 5/8	10 11/16	10 15/16	11	13 3/4	14 5/8	14 1/8	16 1/2	21 1/2
10	26 1/2	27	27 7/8	28 1/2	28 7/8	29	29 5/8	29 3/4	11 1/8	11 3/8	11 13/16	12 1/8	12 5/16	12 3/8	12 11/16	12 3/4	16 3/16	16 15/16	18 13/16	20 11/16	24
12	29	29 1/2	30 1/2	31 1/8	31 1/2	31 5/8	32 1/4	32 3/8	12	12 1/4	12 3/4	13 1/16	13 1/4	13 5/16	13 5/8	13 11/16	16 5/8	18 1/16	19 7/16	20 15/16	24 7/16
16	40 3/8	40 7/8	42	42 5/8	43	43 1/8	44	44 1/8	16 15/16	17 3/16	17 3/4	18 1/16	18 1/4	18 5/16	18 3/4	18 13/16	24 3/8	26 13/16	24 15/16	26 13/16	35 7/16

ABBREVIATIONS USED: RF = RAISED FACE, RTJ = RING TYPE JOINT
FLANGE SPECIFICATION REFERENCE: USAS B16.5
* DIMENSIONALLY THE SAME AS 600 LB. RF
† DIMENSIONALLY THE SAME AS 600 LB RTJ

Displacement Level Controllers

The 12000 Series, so called "long range" or "torque tube" types of level controllers, are commonly classified as the "displacement" type. Actually, this designation applies also to ball float type controllers, since the float used for level measurement displaces its own weight in the liquid in which it floats. The distinction is that ball float controllers are "constant-displacement" types and the torque tube variety are "variable-displacement" types.

Constant Displacement Type

The float of the ball float type is partly submerged in the liquid. The weight of the float is generally adjusted by the internal or external counterweights to maintain a half-submerged position to obtain maximum operating force.

In a liquid of a given specific gravity, the weight displacement remains constant, regardless of the level position and the float rises and falls the same amount as the level. Thus, for all practical purposes, the position of the float is a direct indication of level.

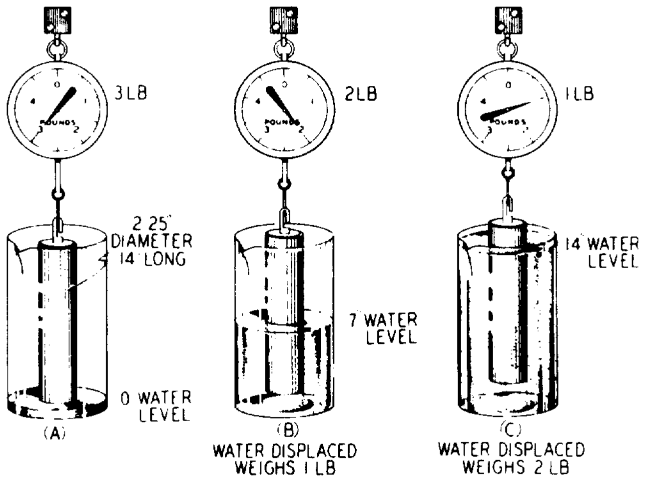


Fig. 1

Variable Displacement Type

In this type (12000 Series), the weight of the displacer is always heavier than that of the liquid displaced at full immersion. The displacement for full level range varies from zero (displacer hanging free) to nearly 100% at the top of the range. Although the displacer rises and falls with level changes, its movement is substantially less than the actual level movement. The difference in movement between displacer and liquid level is dependent on the cross-sectional area of the displacer, the specific gravity of the liquid and the stiffness of the supporting spring, e.g., torque tube. The controller is designed to have a constant displacer volume. Therefore the change in displacer weight (per square inch of displacer cross-sectional area) for each unit change in level remains constant regardless of the level range. Thus, level ranges of from a few inches to several feet can be obtained by varying the cross-sectional area and length of the displacer. (See Fig. 8.)

An adjustment is provided to permit using the controller for a variety of specific gravities or (in interface service) specific gravity differences.

When a body is immersed or partly immersed in any liquid, it loses weight equal to the weight of the liquid displaced. Fig. 1 illustrates a method of using this principle for level measurements in vessels open to atmosphere. The dimensions, volumetric displacement, weight and change in weight of the displacer in this example are the actual values of the commonly used 14" range. This weight must always be enough to submerge the displacer completely in the highest operating specific gravity.

In vessel (A) the displacer is suspended by a spring scale having a range of 0–5 lb and the water level is even with the bottom of the displacer. The full weight of the displacer, which is 3 lb is entirely supported by the spring scale. In vessel (B) the water level is raised from 0" to 7". The displacer now loses weight equal to the weight of the water displaced (1 lb) and the net weight of the displacer becomes 2 lb.

When the water level is raised to 14" in vessel (C) the net displacer weight becomes 1 lb. This increase in water level from 0" to 14" has decreased the net displacer weight from 3 lb to 1 lb, a net change in weight of 2 lb.

As the net weight of the displacer is decreased, the net load on the spring scale is reduced an amount directly proportional to the increase in water level. The volume of water displaced by the 14" increase in level is equal to approximately 56 cubic inches (displacer cross-section area multiplied by the submerged length of displacer) or a weight of 2 lb.

Using an accurate spring scale, the scale dial could be calibrated in terms of level, thus providing a simple and accurate level indicator for liquids of known constant specific gravity. It would be possible to adopt such a measuring device for recording, indication and control of level ranges up to 30 or 40 ft, providing the vessel used was open to atmosphere.

Although the spring scale device would indicate level changes accurately, it would certainly be of little practical value. The most severe limitation is that it would be suitable only for open tanks. In fact, the problem of producing a frictionless seal, useful over a wide range of pressures and temperatures and under a variety of corrosive conditions, is a basic industry problem. The remarkable success of the displacement level instrument lies in the design of this seal now commonly known as the torque tube type.

In Fig. 2 a torsion spring (torque tube) and torque arm have replaced the spring scale device shown in Fig. 1. The torsion spring has been selected with respect to diameter and length so that it will support the weight of the displacer and for all practical purposes, it can be made to indicate net weight or level as previously shown in Fig. 1.

The torsion spring can be either a solid rod or a hollow tube. By using a tube, it is possible not only to use the torsion spring to support the displacer, but also as a frictionless pressure seal. This provides a means of transferring the displacer motion through the wall of a pressure vessel to a suitable measuring device.

Fig. 3 shows an exaggerated sectional view of an actual torque tube subassembly as applied to a liquid level controller. The angular motion in a typical design is from 4° to 5°. This angular motion is used to actuate instruments which transmit air signals proportional to level changes for pneumatic indication, recording or control purposes.

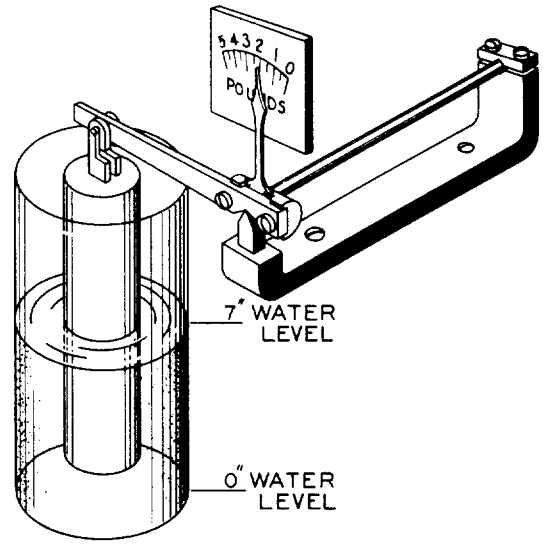


Fig. 2

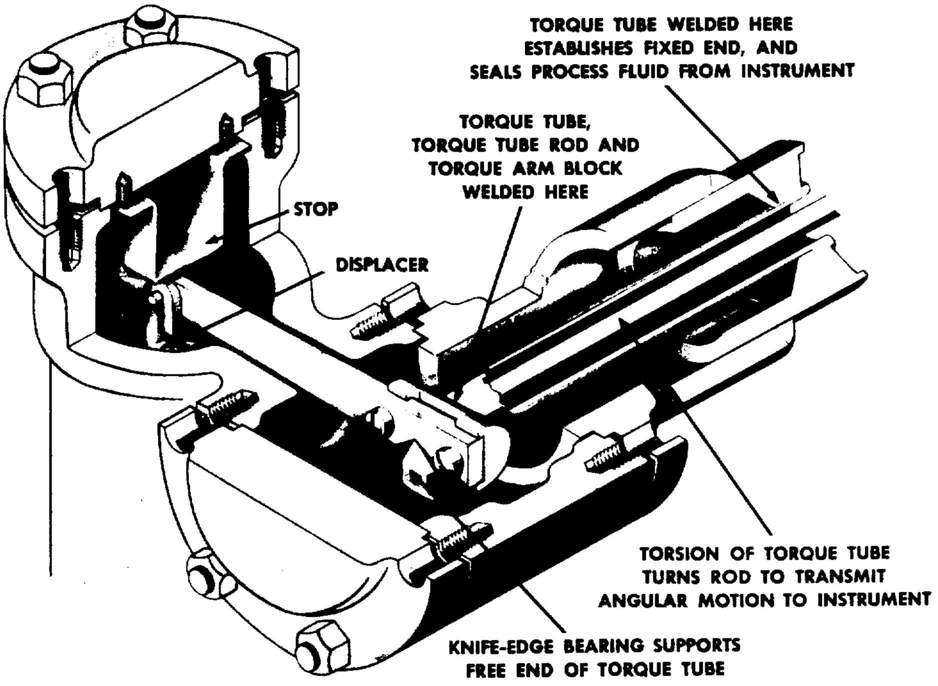


Fig. 3

Liquid Interface

All displacement level measurements are in effect interface measurements in that the measured variable is the level (i.e. interface) between two fluids having different specific gravities, that is, between liquid and gas, liquid and vapor or liquid and liquid. The magnitude of displacer travel is dependent on the interface change and on the specific gravity difference between the upper and lower fluids. On liquid interface service, the displacer is always completely immersed in liquid.

This principle is illustrated in Fig. 4. A 14" range displacer is used to measure the level between distillate and water having specific gravities of 0.8 and 1 respectively. In vessel (A) the displacer weighing 3.0 lb in air is completely immersed in the distillate with the water level even with the bottom of the displacer. The net weight of the displacer (1.4 lb as shown on the spring scale) is the actual weight of the displacer less the weight of the distillate which it displaces. In vessels (B) and (C) the water level is increased first to 7" then to 14" and the net displacer weight is decreased to 1.2 lb and then 1 lb respectively. This reduction in weight is the result of a greater portion of the displacer being immersed in the heavier liquid, i.e. change in interface.

The 12000 Series controllers, because of their responsiveness and wide range of adjustment, are particularly suited for interface service. The standard controller and displacer may be used for specific gravity differences as low as 0.1. In such applications, the specific gravity index is set at 0.5 and the values of the proportional band scale can be interpreted from the graph Fig. 5. On certain applications requiring exceptional sensitivity, the volume and net weight of the displacer can be increased.

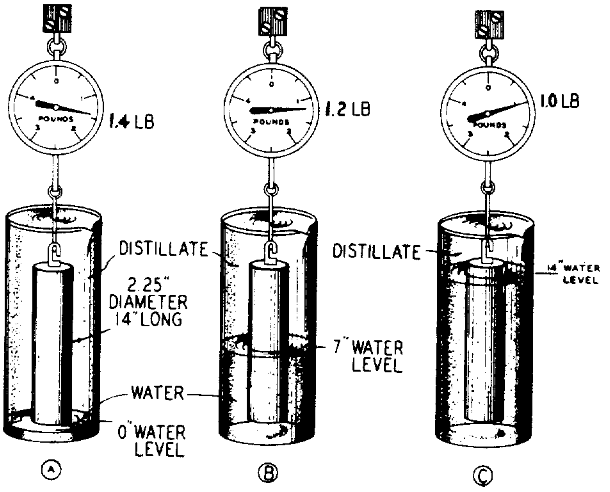


Fig. 4

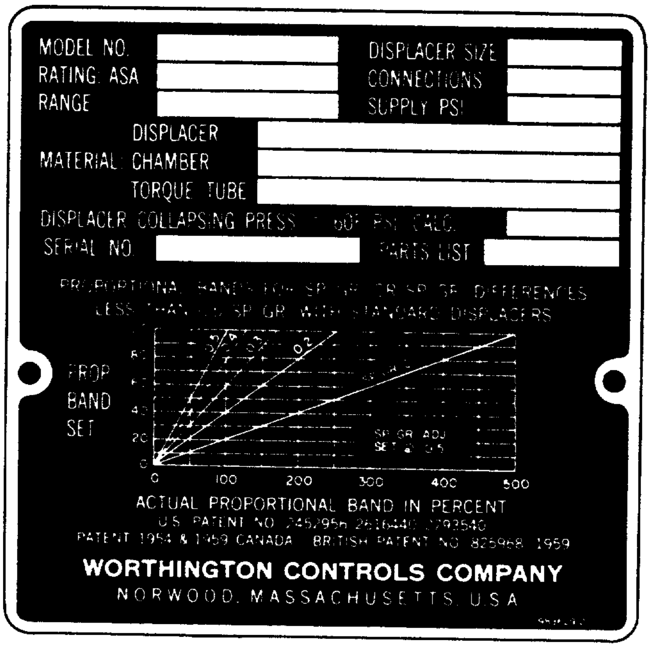
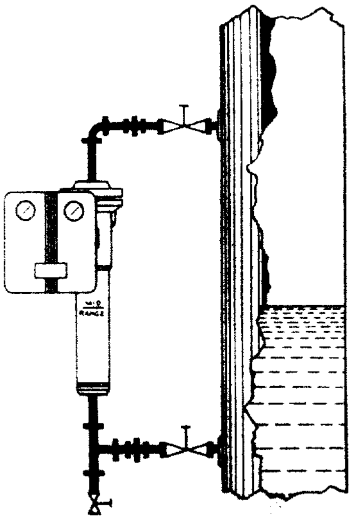


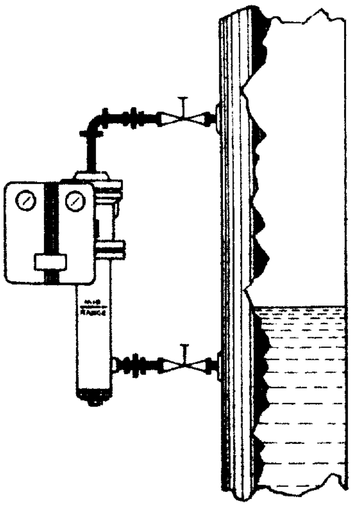
Fig. 5

This serial plate is supplied on all standard level units. For special units a special plate contains comparable information.

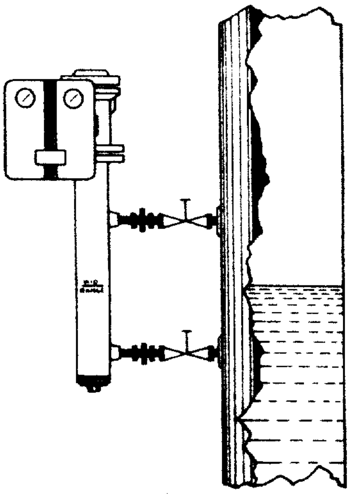
Courtesy of Masoneilan



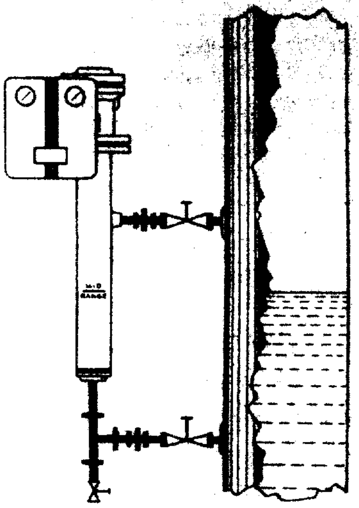
MODEL 12800
TOP AND BOTTOM
SCREWED CONNECTIONS



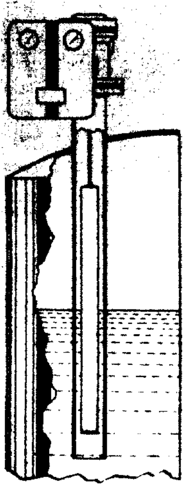
MODEL 12805
TOP AND SIDE
SCREWED CONNECTIONS



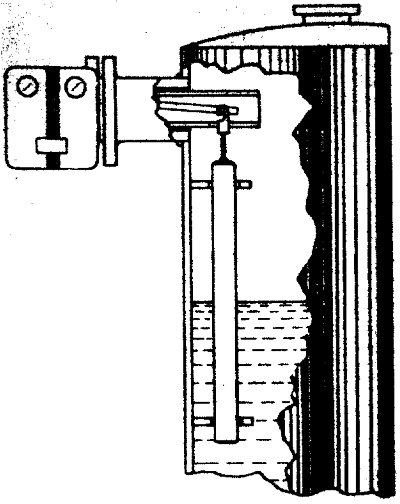
MODEL 12808
SIDE AND SIDE
SCREWED CONNECTIONS



MODEL 12806
SIDE AND BOTTOM
SCREWED CONNECTIONS



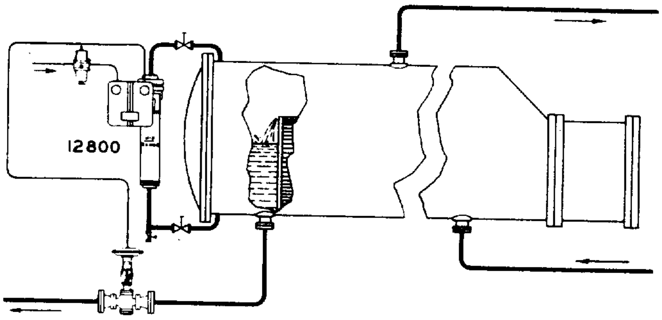
MODEL 12803
TOP VESSEL
FLANGED CONNECTION



MODEL 12804
SIDE VESSEL
FLANGED CONNECTION

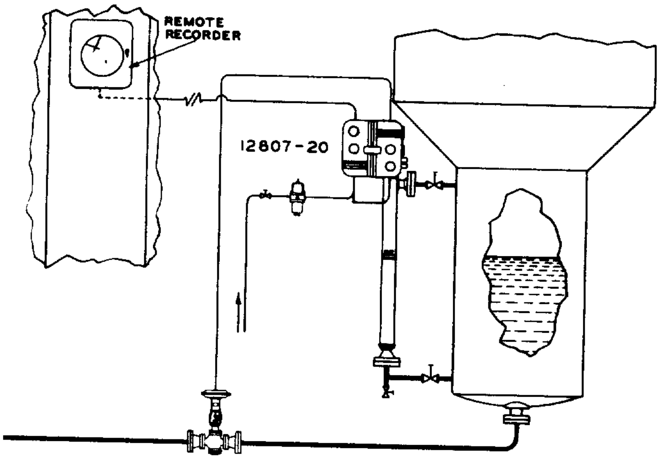
Control of product level within a fractionating tower reboiler

A weir in this kettle type reboiler maintains a constant level around the heating tubes. A 12800 level controller operates a control valve to maintain the rate of draw-off of the bottom product in accordance with the level changes in the downstream side of the weir.



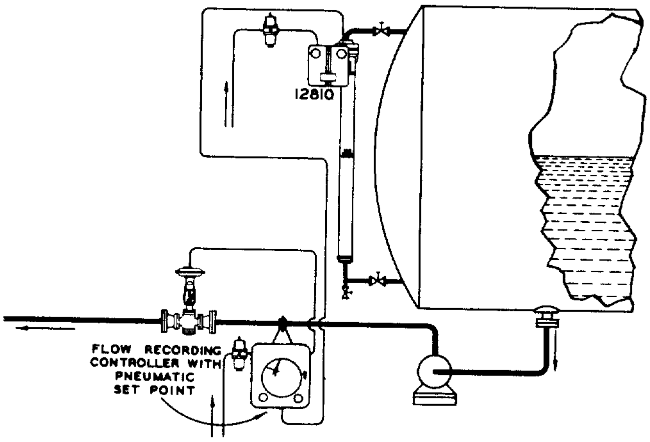
Control and transmission of crude tower level

A 12807-20 side-and-bottom connected controller-transmitter is used on this high temperature application. It controls the valve in the draw-off line from the bottom of the crude fractionating column in accordance with the level changes in the column. An independent pneumatic transmission system measures the level in the vessel which is transmitted to a recorder located at a central panel.



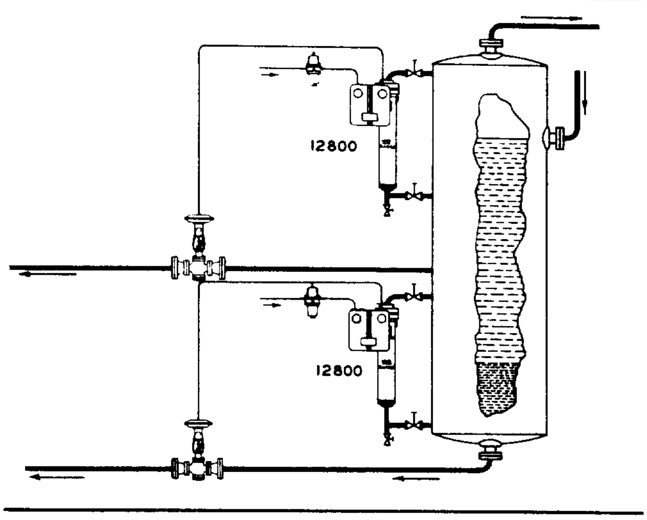
Control of feed rate by pneumatically setting the index of a flow controller

The feed rate through the heating units is stabilized by a flow controller. The 12810 level controller (with reset) averages the level changes within the feed accumulator by pneumatically adjusting the set point of a flow controller.



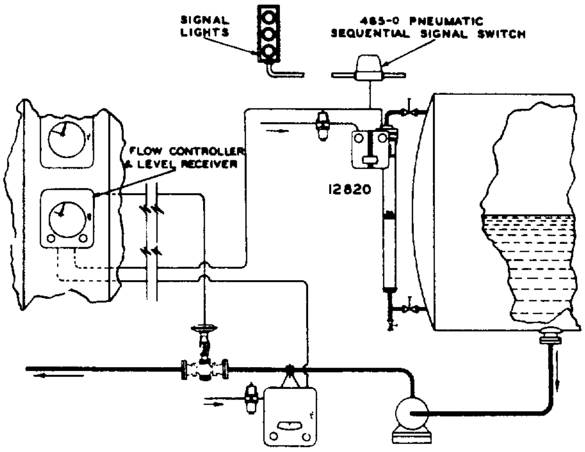
Control of distillate and water levels in a gas and water separator

On applications where three fluid phases exist, such as in a gas-water separator, two level controllers are used: one to control the interface level between the two liquids; the other to maintain the level of the lighter liquid.



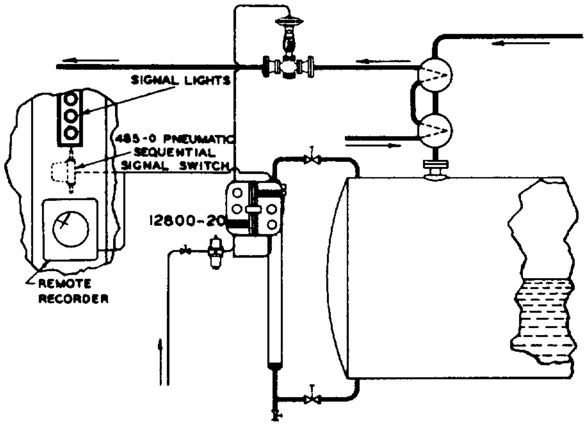
Transmission of level to remote recorder and signal lights

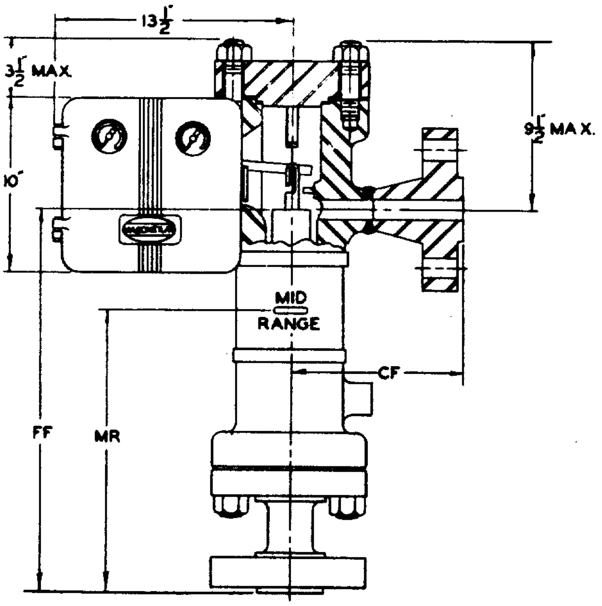
Where the flow to a heater must be maintained at a relatively constant rate (within the limits of the storage capacity available), a 12820 level transmitter is used to transmit the level changes of a feed accumulator to a central panel. A flow controller records on a single chart both the rate of flow which it receives from a flow transmitter located in the discharge line to the heater, and the level. This provides the operator with a continuous record of level and flow which permits him to adjust the flow rate to the existing conditions. A 485-0 sequential switch, which is connected to three signal lights, gives five-position indication of level which can be seen at some distance.

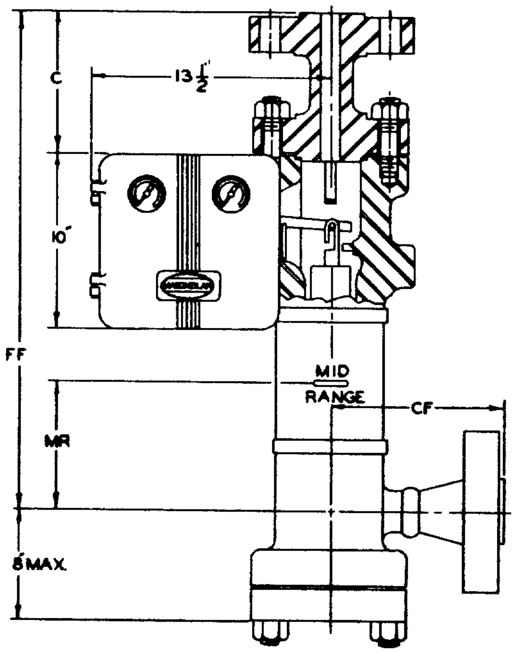


Level transmission and control of a reflux accumulator

Where the exchangers that condense the overhead product from a fractionating tower are operated to produce a reflux supply but no overhead liquid product, the 12800-20 controller-transmitter maintains the level in the reflux accumulator by controlling the flow of water through the condensers. The independent transmission system provides remote indication of level at the control station where it may be correlated with changes in process requirements.



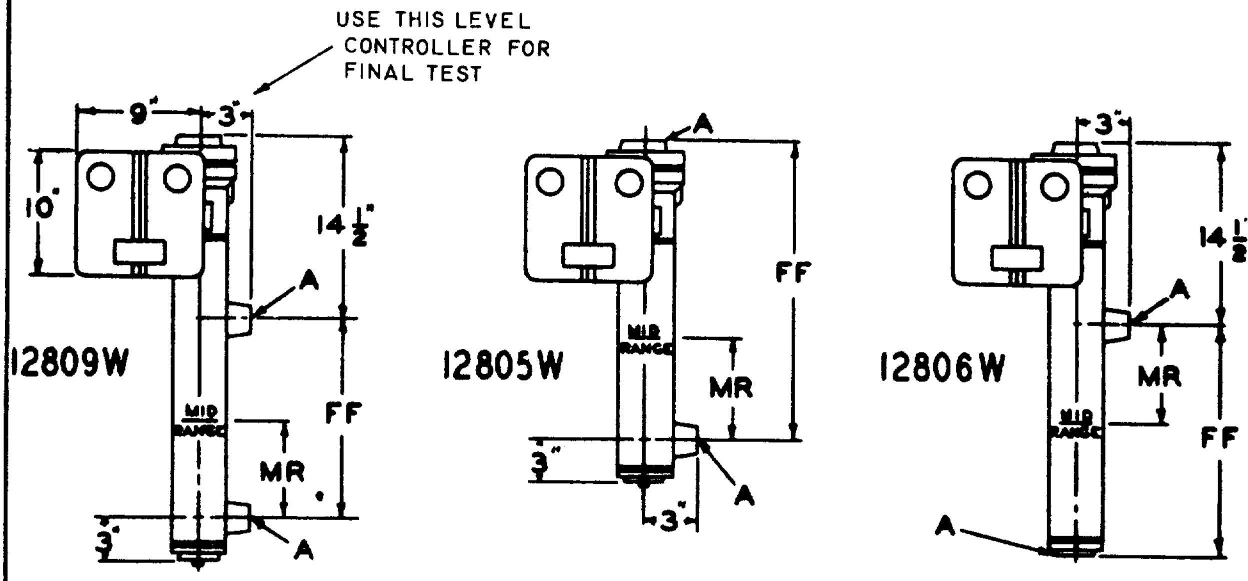




DIMENSIONS

RANGE	12807W				12808W					
	1500 LB.		2500 LB.		1500 LB.			2500 LB.		
	FF	MR	FF	MR	FF	MR	C	FF	MR	C
14″	26″	19″	26⅝″	19⅝″	27″	7″	6¾″	28⅜″	7″	8″
32″	44″	28″	44⅝″	28⅝″	45″	16″	6¾″	46⅜″	16″	8″

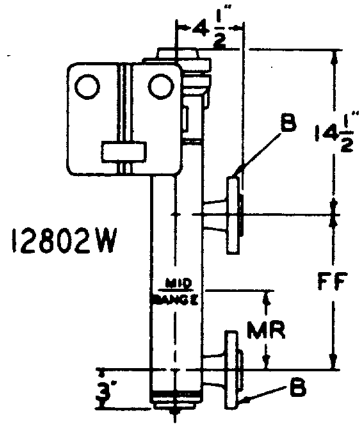
Flange Size & Type	1500 LB. CF	2500 LB. CF
1½″ ASA FACING	7¼″	9⅛″
1½″ R.J. FACING	7¼″	9 3/16″
2″ ASA FACING	8″	9¾″
2″ R.J. FACING	8 1/16″	9 13/16″

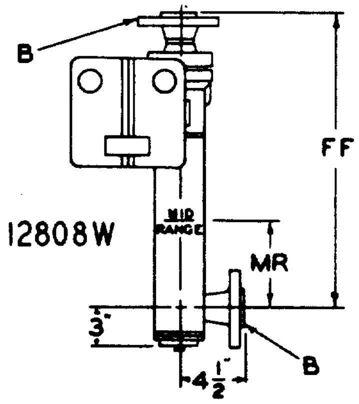


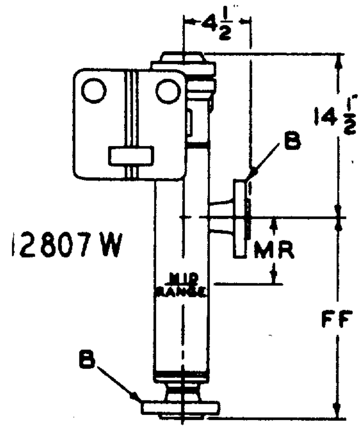
Dimensions (inches)

RANGE	12809W		12805W		12806W	
	FF	MR	FF	MR	FF	MR
14	14	7	20	7	16	7
32	32	16	38	16	34	16
48	48	24	54	24	50	24
60	60	30	66	30	62	30
72	72	36	78	36	74	36
84	84	42	90	42	86	42
96	96	48	102	48	98	48
120	120	60	126	60	122	60

Screwed Connections A = 1½" — 2" NPT — 600 lb. ASA rating







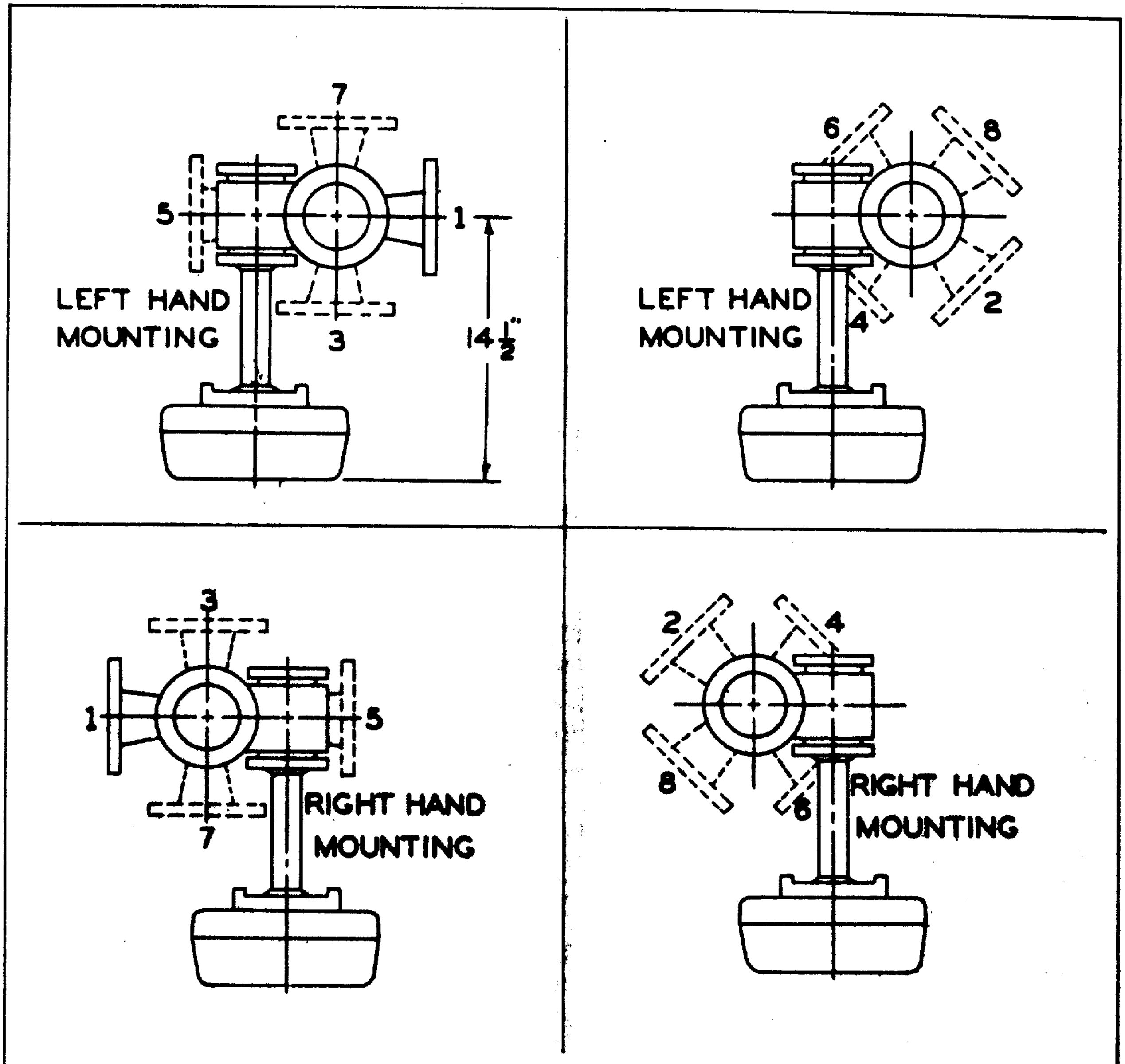
Dimensions (inches)

RANGE	12802W		12808W		12807W	
	FF	MR	FF	MR	FF	MR
14	14	7	22	7	18	7
32	32	16	40	16	36	16
48	48	24	56	24	52	24
60	60	30	68	30	64	30
72	72	36	80	36	76	36
84	84	42	92	42	88	42
96	96	48	104	48	100	48
120	120	60	128	60	124	60

Flanged Connection B = 1½" — 2" size 150 — 300 — 600 lb. ASA rating

ORIENTATION-ALL MODELS

Courtesy of Masoneilan



Flange connection position 1 and left hand instrument position will be supplied unless otherwise specified.
For high pressure chambers (1500 lb. and 2500 ASA) connection positions 1, 3 and 7 only are available.

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