LESSON ONE PIPING SYSTEMS

BASIC PIPING DATA

PIPE

MATERIALS USED BY PIPEFITTERS

HISTORY

One of the earliest methods of conveying fluids in the history of mankind was by pipe. The earliest pipe on record was the use of bamboo for moving small quantities of water. As man progressed, he began using hollow logs for piping needs. Probably the first recorded use of metal in piping systems was the use of lead or bronze during the "Bronze" age.

During the excavations at Pompeii, complete water distribution systems fabricated from lead have been uncovered. These systems including probably the first use of metal plug valves, are still workable.

Without piping our modern civilizations and their attendant conveniences could not exist.

DEFINITION

Pipe is a hollow tube used for conveying a flowing media or transmitting pressure. We usually designate the tube as pipe in the applicable line class but the definition includes any similar component, designed as tubing which is used for the same purpose.

MATERIALS OF CONSTRUCTION

The various kinds of material from which pipe is, or can be made is practically endless; among them being steel, iron, brass, copper, lead, aluminum, glass rubber and various types of plastic material. Each one has certain advantages and disadvantages. Many things enter into making a choice of materials. Among the most important of these are commodity, pressure, temperature, size, ease of assembly, availability, and economics.

SIZE

Many years ago pipe was sized by its true inside diameter; i.e., a 1" pipe was actually 1" inside diameter. However, as time went on and the methods of manufacturing were improved and made more standard, and because it became necessary to increase wall thickness to accommodate higher pressures and temperatures, it became necessary to size pipe by "nominal" size rather than actual size. Because it would be too expensive to have a set of thread dies for each wall thickness, in the smaller sizes, the outside diameter was held constant. Thus wall thickness changes affect the internal diameter only and leave the O.D. constant for standardized fitting engagements.

Nominal size refers to the name by which we call a particular size pipe. Nominal size and actual outside diameter of a pipe differ from sizes 1/8" through 12" inclusive. For sizes 14" and larger, the actual outside diameter and the nominal size are identical. 1-1/4", 2-1/2", 3-1/2", and 5" are gradually falling into disuse and not commonly used in refinery type piping.

PIPE SIZE

1. Nominal Size: Pertaining to calling the pipe size by name only.

Example: 2", 3", 4", 6", 8", 12" etc.

2. Actual Outside Diameter or OD: Pertaining to actual outside diameter of a pipe.

Example:

NOMINAL	O.D.
1"	1-5/16"
2"	2-3/8"
3"	3-1/2"
4"	4-1/2"
12"	12-3/4"
14"	14"

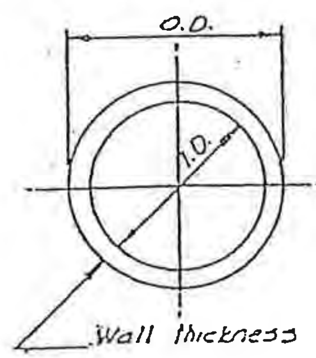


Fig. 1-1

WEIGHT

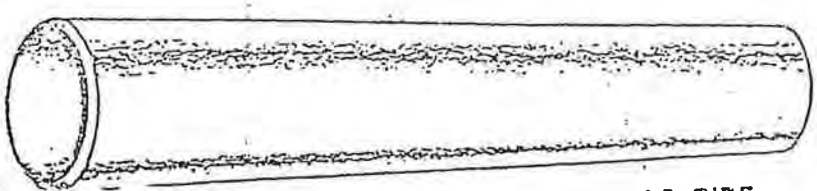
Many years ago the only "weights" of pipe available were classed as standard weight, extra heavy, and double extra heavy, and double extra heavy. Within the last twenty-five or thirty years it became increasingly evident that this system was limited in scope and could become confusing. This was the direct result of increasingly higher pressures and temperatures of the commoditie being handled. Consequently the use of schedule numbers came into being.

LENGTH

Based upon common practice steel pipe usually can be furnished in single random lengths, double random lengths, and under certain circumstances (pipe-line work for example) in even longer lengths. Single random lengths will run from about 16 to 22 feet in length, while double random will run approximately double these figures depending upon the weight of the pipe. Pipe can be ordered to specified fixed lengths but this costs more.

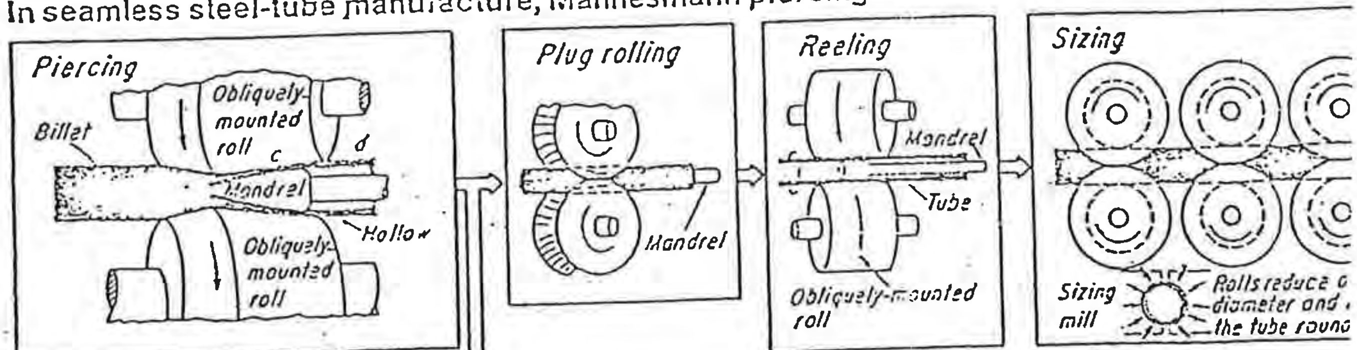
TYPES OF MANUFACTURE

Many years ago pipe was made by taking a flat piece of "skelp" forming it into a rough tube shape while hot, overlapping the edges, bringing them to a welding heat and hammering the two edges together to form a homogenous bond. This method is still in use today for some of the cheaper, lower quality pipe in certain limited sizes. It is known as "furnace-welded" pipe. Pipe is manufactured several different ways today. Of these ways, we use the electric resistance welded and seamless pipe the most frequent. Seamless pipe did not become a reality until the Mannesmann process was developed in Germany.

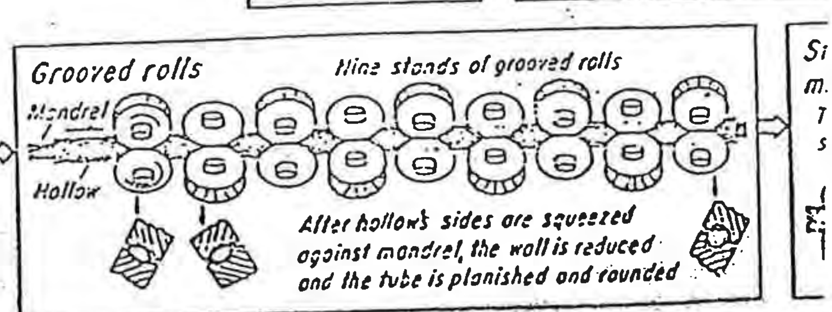


SEAMLESS PIPE

In seamless steel-tube manufacture, Mannesmann piercing makes severest demands on meta



In the piercing operation, the high-quality forged billet is drawn over the mandrel by oblique rolls. The metal separates by itself at *b*; the mandrel merely smooths the inner surface. The hollow is oval-shaped at c, but by *d* it has taken a circular form. Subsequent operations thin and smooth the wall, and establish final diameter of finished pipe.



Today, almost all of our seamless pipe is made with this method or a variant. The mill is called a piercing mill in which, by means of special shape rollers, a hot billet is drawn over a mandrel which by displacement of the internal metal produces a "hole" through the middle. This piercing bar is then sized, straightened, and tested ready for shipment.

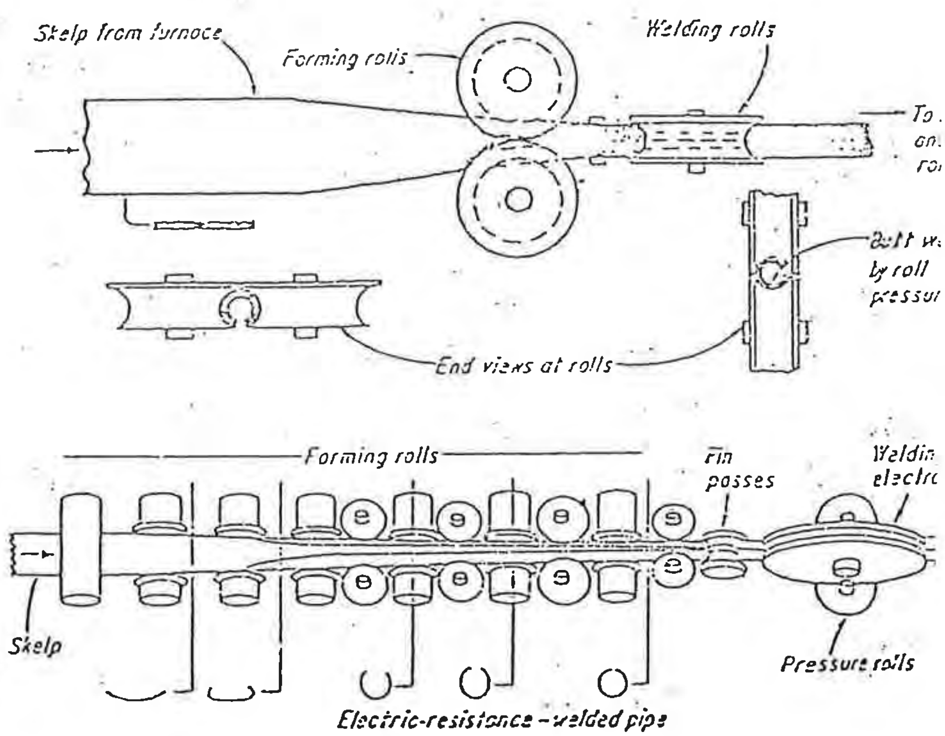
Welded seam pipe has become more popular in recent years, due mainly to improved welding techniques and non-destructive testing methods.

Electric Resistance-Welded pipe is manufactured from coiled strips of sheet steel. The joint is produced by the heat obtained from resistance of the pipe to the flow of electric current in a circuit of which the pipe is a part, and by the application of pressure to the joint.

ROLLED & WELDED PIPE

Butt-welding and resistance welding add no metal to pipe

These are two high-production methods for making standard sizes and weights of pipe. In butt-welded pipemaking, forming rolls shape narrow plate into a nearly full circle; the hot metal is then squeezed together to fuse the sides of the seam. In the electric-resistance welding method fin-pass rolls trim the facing edges of the curled skelp to prepare them for welding and to get accurate dimensions. Pressure rolls force the joint edges together and the tube passes a welding roll of two electrode halves with electric insulation between them. Since the two halves straddle the pipe joint, welding current passes between the electrodes through the pipe joint, where resistance to current flow produces the desired heat to fuse the metal. Excess metal is then trimmed off on outside and inside of the weld seam.



DETERMINING WALL THICKNESS

Wall thicknesses are generally covered in the Piping Material Specifications by calling out the Schedule No. for a large majority of sizes. However, as pressures and temperatures increase, and sometimes the corrosion allowance, it becomes necessary to calculate the required wall thicknesss for each specific case. Please note that generally as the specifications change into higher pressure classes, wall thickness calculations must be made for smaller size pipe. Wall thicknesses are calculated by strict adherence to the rules set forth in the Code for Pressure Piping.

WALL THICKNESS: Pertains to the thickness of the pipe wall.

a. O.D. is constant
b. I.D. will vary

Example:

NOMINAL	SCHEDULE	WALL THICKNESS	I.D.
8"	Std. Wt.	.322	7.981
8"	Sch. 80	.500	7.625
8"	Sch. 120	.719	7.187
8"	XX Strong	.875	6.875

Fig. 1-4

GRADES

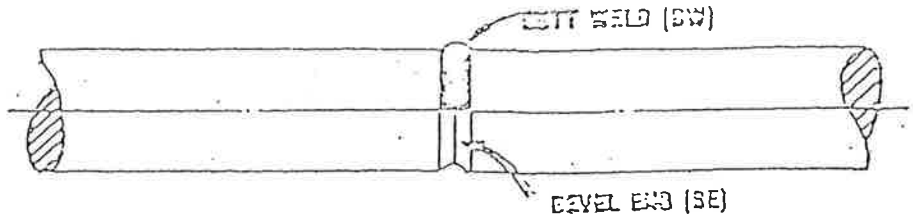
In steel pipe, the word "grade" designates divisions within different types based on carbon content or mechanical properties (tensile and yield strengths). The tensile strength is the ultimate amount of stretching the steel can bear without breaking. The yield strength is the maximum amount of stretching steel can bear before it becomes permanently deformed or before it loses its ability to return to its original shape.

Grade A has lower tensile and yeild strengths than Grade B steel. This is because it has less carbon content. Grade A is more ductile and is better for cold bending and close coiling applications.

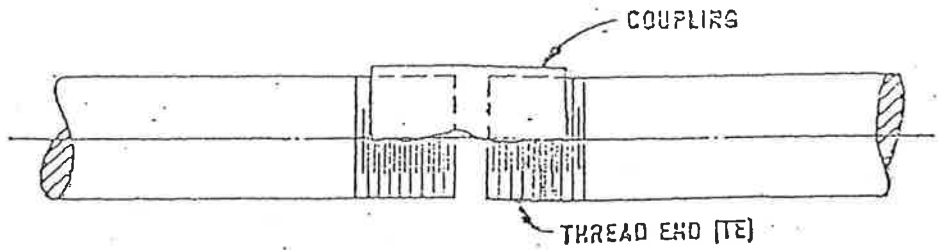
Grade B is better for applications where pressure, structural strength and collapse are factors. It is also easier to machine because of its higher carbon content. It is generally accepted that Grade B welds as well as Grade A.

ENDS

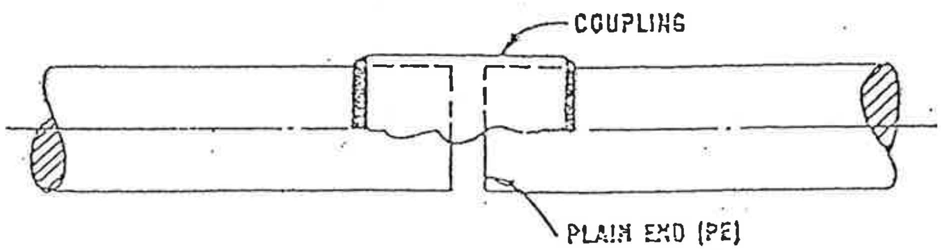
Steel pipe is generally specified TE (Threaded End), PE (Plain End), BE (Beveled End).



BUTT-WELD



SCREWED CONNECTION



SOCKET-WELD CONNECTION

Fig. 1-5

Materials Used By Pipefitters

I. General Types of Piping Used in the Refinery

A. Steel Piping

Most all lines are made of either schedule 40 or 80 steel pipe. The "schedule" or pipe, refers to the wall thickness of that piece of pipe. Schedule 40 steel pipe has a thinner wall thickness than does schedule 80, therefore, does not give the strength nor the service that may be expected from schedule 80 pipe. Generally, the schedule of pipe to be used is determined by the type of service the pipe will be subjected to. Some controlling factors are pressure, temperature, type of process and corrosion characteristics.

B. Stainless Steel Piping

Several different types of alloy steels are used in the refinery. The engineer in charge of the job should determine which type he should use. One of the common types is 304 or 18-8 which means 18% chromium and 8% nickel. Another type is 314 or 14-13-3, 16% chromium, 13% nickel and 3% molybdenum. Then there are type 309 or 25-12, type 310 or 25-20.

C. Cast Iron Pipe

This type of pipe is used in very few places in the refinery. We have a few cast iron water mains and some cast iron sewer lines. Cast iron pipe is hard and brittle. The wall thickness is much greater in relation to carbon steel pipe to compensate for this brittleness.

D. Transite Pipe

Transite pipe is a composition of cement and asbestos. It is made in a series of sizes ranging from 2 inches up.

E. Plastic Pipe

Plastic pipe is easy to handle because of its light weight. It is resistant to chemical and electrolytic attack. Schedule 40 and 80 are used in the refinery.

F. Copper Tubing

Copper tubing which has been annealed is used throughout the refinery in sizes 1/8 inch to 1 inch.

G. Stainless Steel Tubing

Tubing of different alloys, usually type 304 or type 316 is used throughout the refinery in sizes 1/4 inch to 1 inch.

H. Clay Tile

Clay tile is made of clay. It comes in a variety of sizes ranging from 3 inches to 36 inches and larger.

I. Lead Pipe.

Lead Pipe is soft and easily crushed so it must be handled carefully.

II. Methods of Manufacturing Various Types of Pipe

A. Cast Iron Pipe

This type pipe is manufactured by the molding process. A mold of the proper length and diameter and shape, such as ells, tees, flanges, and etc. is made using molding sand. The mold is then joined together leaving a hole (spruce hole) for pouring and a hole (riser) to allow gases to escape. Molten cast iron is then poured into the spruce hole and the hot iron fills all of the mold and comes out the second hole or the riser. After cooling, the mold is removed leaving a finished piece of pipe.

B. Transite Pipe

Transite pipe is made of asbestos, cement and water. It is generally made by a rolling process.

C. Plastic Pipe

Plastic pipe is manufactured by the extrusion method.

D. Copper Tubing

Copper tubing is made by drawing a copper bar through a die and over a bar of the desired diameter. Copper tubing is made in different hardness for different uses.

E. Stainless Steel Tubing

Stainless steel tubing is made by the extrusion method--the same as copper tubing.

F. Clay Tile

Clay tile is made of clay and baked similar to ceramics.

G. Lead Pipe

Lead pipe is rolled and welded.

III. The Use of Various Types of Pipe

A. Seamed pipe is seldom used in this refinery. Seamless pipe, however, is commonly used for all purposes, varying only in different schedules. The most commonly used is schedule 80 or schedule 40 in sizes from 1/2 inch up to 8 inches. For special applications we use schedules 100, 120, 160 and XX strong. The wall thickness of a pipe depends on the size of that pipe. For example, the wall thickness of schedule 40 two inch pipe is .154 inches. The wall thickness of schedule 40 four inch pipe is .237 inches.

Steel pipe 2 inches and larger is normally schedule 40.

All black steel pipe 1-1/2 inches and smaller is at least schedule 80 in the refinery. This is necessary for added strength in high temperatures and/or pressures and to allow for corrosion.

B. Schedule 40 carbon steel pipe of any non-seamless type in sizes 1-1/2 inch and smaller may be used without special approval for utility piping (air and water) not over 125 psi or 125° provided it is galvanized to permanently differentiate it from other small pipe. Never use galvanized pipe in a process lines.

C. Stainless Steel Piping

Stainless steel piping is used where high temperature or strong corrosive elements are present such as furnace tubes, heat exchanger tubes, and piping in some of the chemical plants.

D. Cast Iron Pipe

Cast iron pipe is usually used where the pressure is under 150 psi and there is a negligible amount of heat. It is used in sewer lines and water mains.

E. Transite Pipe

Transite pipe is used for underground water lines and electrical conduit.

F. Plastic Pipe

Plastic pipe is used in water lines and chlorine lines in the refinery.

G. Copper Tubing

Copper tubing is used in instrument air systems, small lubricating oil lines and water lines. Piping and other equipment is often "steam traced" with copper tubing.

H. Stainless Steel Tubing

Stainless steel tubing is used in process piping systems in addition to those systems listed for copper tubing.

I. Clay Tile Pipe

Clay tile pipe is used in sewer systems.

J. Lead Pipe

Lead pipe is used in acid lines where the pressure and temperature is low.

IV. Mechanical Characterisitics of Various Types of Piping

A. Steel Pipe

Steel pipe will expand and contract according to the temperature of the product carried and in some cases allowance must be made for this. On installing a high temperature line over a great distance, an expansion joint should be made in the line to allow for this expanding and contracting.

B. Cast Iron Pipe

Cast iron pipe is brittle and easily broken.

C. Transite Pipe

Transite Pipe is brittle and easily broken. In addition, a form of sea life has been known to eat transite pipe.

D. Plastic Pipe

Plastic pipe is tougher than cast iron, transite or clay tile pipe. It is elastic, and will withstand considerable shock. However, it must be adequately supported and the temperature and pressure cannot be excessive.

E. Copper Tubing

Copper tubing can be bent or formed to most any shape with ease. It will expand or contract more than steel pipe.

F. Stainless Steel Tubing

Stainless steel tubing must be bent with tubing benders. It is much more difficult to bend than copper tubing.

G. Clay Tile

Clay tile pipe is brittle and easily broken.

H. Lead Pipe

Lead pipe is soft and easily crushed, so it must be handled carefully.

V. Methods of Joining various Types of Piping

A. In this refinery, steel pipe is joined together with welded joints, flanged joints and threaded joints. When threading pipe, we may make use of hand dies and/or power pipe machines. A pipe thread is a tapered thread and your fitting should run on 3-5 turns by hand before using a wrench to finish tightening the joint.

B. Cast Iron Pipe

Cast iron pipe is usually leaded and caulked in the joints. All cast iron pipe joined together in this manner is made with bell and spigot ends leaving a space which may be partially filled with oakum, a caulking material, and then the remaining space is filled with molten lead. Cement may be used instead of lead in some cases where there is no pressure involved such as in sewer lines.

C. Transite Pipe

Transite pipe is put together using a prefabricated coupling pressed over two rubber rings, one on each joint of pipe. This requires considerable pressure and is accomplished by using two jacks (similar to bumper jacks used on automobiles) to pull the coupling over the rubber rings.

D. Plastic Pipe

One type of plastic pipe used in the refinery is put together with slip-on fittings and a bonding agent. Another type uses a heating element between the pipes which melts the pipe ends. The heater is then removed and the pipes are butted together to make the joint. Some plastic pipes are threaded with regular pipe dies and screwed together.

E. Copper Tubing

Copper tubing connections are usually made with compression type fittings. Flared fittings and soldered joints are occasionally used.

F. Stainless Steel Tubing

Stainless steel tubing connections are usually made with compression type fittings. Flared fittings are occasionally used.

G. Tile Pipe

Okum and cement have been used for years to join tile pipe sewers. Acid sewers have required a combination of wool and sulpher to seal the joints. Recently a plastic compression joint which is formed on the pipe at the factory has been used in most all services with great success.

H. Lead Pipe

Lead pipe is connected with flanges or welded joints.

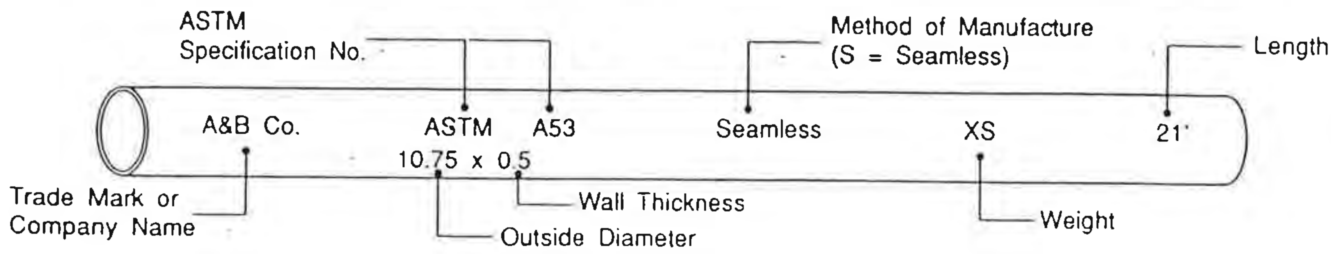


Illustration #9 – Typical ASTM Pipe Marking

Pipe Identification and Marking

Steel pipe is available in numerous manufacturing classifications, grades, weights, schedule numbers, sizes, and lengths. For this reason it is important to be able to interpret steel pipe's identification markings. Steel pipe can be identified by paint stencil, or stamped markings on the pipe itself or by a tag attached to smaller sized bundles of pipe.

The American Society for Testing and Materials (ASTM) require pipe made to their specifications to be labeled with the following:

- Manufacturer's Name (trademark or brand may be used).
- Pipe manufacturing method:
  F = Furnace butt welded, continuous welded
  E = Electric resistance welded
  S = Seamless
- Weight of Pipe: Std., XS., or XXS.
- Specification Number; ASTM specification number.
- Length: units pipe was ordered in.

In addition to the above marking, certain ASTM pipe classifications may require pipe to be marked with:

- Grade of pipe.
- Hydrostatic Test Pressure or:
  — NH when not tested
  — Schedule Number
  — S for supplementary requirements
  — Pipe size

An example of ASTM marking on pipe is given in illustration #9

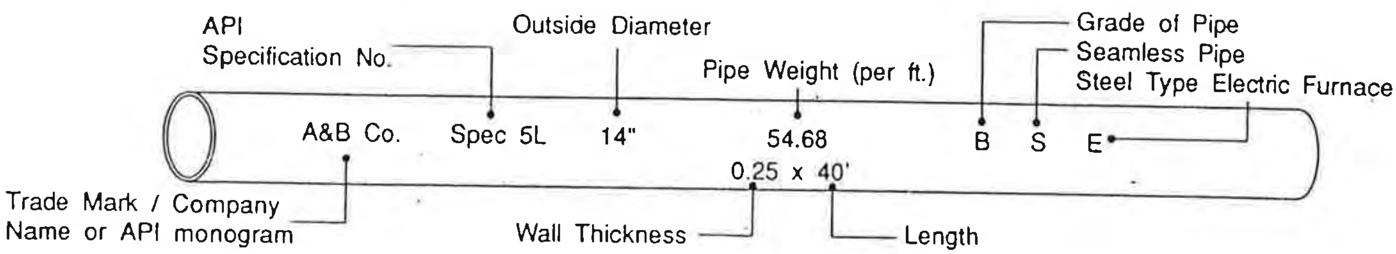


Illustration #10 – Typical API Pipe Marking

The American Petroleum Association (API) Require pipe conforming to their specifications to be marked with the following:

- Manufacturer's Name or Mark
- API's Specification Number
- Diameter: either the nominal or outside diameter in inches
- Weight per Foot

- Grade: API's grades use numbers following letters to indicate minimum yield strength
- Process of Manufacture:
  S = Seamless
  E = Welded, except butt-welded
  F = Butt-welded
  SW = Spiral welded
- Type of Steel:
  — E-Electric-furnace steel
  — R-Rephosphorized steel (class 11) no marking required for open hearth or basic-oxygen steel
- Heat Treatment:
  — HN-Normalized or normalized/tempered
  — HS-Subcritical stress relieved
  — HA-Subcritical age hardened
  — HQ-Quench and tempered
- Test Pressure: if pressure is higher than in tables

An example of API marking on pipe is given in illustration #10.

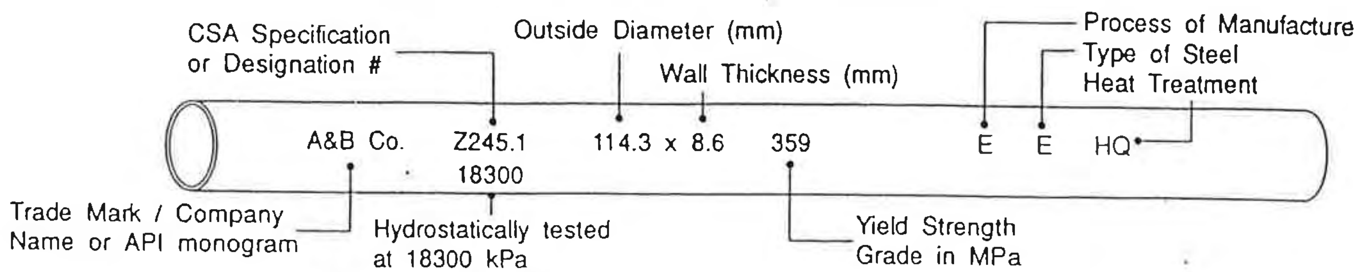


Illustration #11 – Typical CSA Pipe Marking

The Canadian Standards Association (CSA) require pipe made to their specifications to be marked with the following:

- Manufacturer's Name or Mark.
- Specified Outside Diameter, in millimetres.
- Specified Wall Thickness, in millimetres.
- Grade of Pipe (CSA Z245.1 Grades range from 172 to grade 550 inclusive).
- Sour Service: if pipe is intended for this use it must be labeled with the symbol SS
- Process of Manufacture:
  - — E-Electric welded or submerged arc welded pipe
  - — F-Butt welded pipe
- Type of Steel:
  - — E = electric furnace steel.
  - — Open hearth or oxygen steel: no mark required.
- Heat Treatment: if required.
- Length: in metres to two decimal places.
- Hydrostatic Test Pressure: if applicable.

An example of CSA marking on pipe is given in illustration #11.

EQUIPMENT & TERMS

The student is about to meet a completely new language. The piping drafter 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 drafter.

Process Plant Terms

Refinery

A refinery is a plant that takes crude oil (a liquid) 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 for use as fuel gas 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. A refinery tank farm will consume 75%–80% of the refinery's land.

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 actually 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.

Condensate systems are usually divided into two separate systems, the low pressure and the high pressure system. Steam condensate from 600# pressure and below will be routed into the low pressure condensate system. If the steam system is over 600# pressure, the condensate will be returned through the high pressure condensate system.

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.

Fuel oil is routed to fired heaters throughout the refinery via a circulating system, which has a fuel oil supply and a fuel oil return header. This is done to keep the oil from setting up in the line during low flow. These lines are insulated and steam traced, also, to keep them warm.

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.

Instrument air is routed to all the plant's pneumatic instruments, and the piping is usually galvanized steel to keep rust particles from finding their way into the instruments. Galvanizing prevents rust.

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. Some firms call this chilled water.

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, $150 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 1/2″ and 3/4″ 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.

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 drafter 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 gasoline. Many plant vessels 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. They may be 10′ to 40′ in diameter. Instead of fractionating trays, some have "packed beds."

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. Some reactors are horizontal.

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. Most of this liquid is pumped to the top tray of the fractionation tower and is called "reflux." The rest of the liquid is product.

Vessels are fabricated in accordance with the ASME Section VIII Code.

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 called a "floating roof," 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 are supported by vertical legs made from pipe.

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 balloon must have compressed air.

Fired Heaters or Furnaces

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—radiant and convection. The radiant 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 radiant section and just below the stack. The inlet to heaters is usually in this convection section. The convection section of fired heaters often generates superheated 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 1,000°F or more. Stacks are needed to create ''draft'' so burners will have air to aid combustion.

Valve Types and Uses

Valves

Valves stop or open and regulate flow. Some valves are huge and some are very small. While reading of these valve types, refer to the valve drawings shown in Chapter 13.

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.

Specific color codes for lines in the Los Angeles Refinery are as follows:

Classification	**Color Field [Background]**	**Color of Letters for Legend**
Fire Protection (Firewater, Foam)	Red	White
Nitrogen	Purple	White
Air Lines (All)	Blue	White
Water Lines (Unless covered elsewhere)	Green	White
Steam, Condensate, Boiler Feedwater	Black	White
Corrosives, Caustics, Acids	Brown	White
Hydrogen Sulfide - Streams of Greater than 500 ppm	Orange	Black
Hydrocarbon	Grey	Black
Other Hazardous Material including Ammonia & Hydrogen	Yellow	Black
Out of service line (completely isolated and evacuated).	Silver	White

- Color will be used in intermittent displays at a minimum of 200-foot intervals in units.

Los Angeles Refinery Line Labeling Color Standard

Stream	Color
Hydrocarbon	Grey
H_2S Rich Streams (>500ppm)	Orange
Corrosives (caustic, acid)	Brown
Water	Green
Fire (firewater, foam)	Red
Air	Blue
Nitrogen	Purple
Steam (incl. cond. BFW)	Black
Other Hazardous (H_2, NH_3)	Yellow
Out of Service (isolated & evacuated)	Silver

Material	Color code stripes (2 stripes should be adjacent to each other)
Carbon Steel	None
C - ½ molybdenum	Solid orange
Cast iron	Solid green
1- ¼ % chromium – ½ % molybdenum steel	Solid yellow
2 – ¼ % chromium – 1 % molybdenum steel	Solid blue
5 % chromium – ½ % molybdenum steel	Solid white
Copper-Nickel (all alloys)	Solid red
9% chromium – 1% molybdenum steel	Solid brown
Type 310 stainless steel	2 solid green
Type 410 stainless steel (CK-20)	2 solid tan
Type 304 stainless steel	Solid black
Type 304L stainless steel (CF-3)	2 solid black
Type 316 stainless steel	Solid gray
Type 316L stainless steel (CF-3M)	2 solid gray
Type 317L stainless steel (CG-8M)	2 solid blue
Type 321 stainless steel	2 solid blown
Type 347 stainless steel (CF-8C)	2 solid orange
Incoloy 800	2 solid white
Incoloy 825	Solid Purple
Inconel 625	Solid tan
Alloy 20 (CN-7M)	2 solid red
Hastelloy C-276	2 solid purple
Duplex stainless steel 2205 (CD-3MN)	2 solid yellow
Monel (all alloys)	1 solid black, one solid yellow

- Fittings, Shapes and Bars: Stripe entire length as shown in Figure 1A
- Flanges: Stripe across edge up to hub, as shown in Figure 1B
- Plates, Sheets and Stripes: Stripe along any two edges or on surface near edge for entire length, as shown in Figure 1C.
- Valves: Stripe across body from flange to flange (depending on material anywhere along its length, as shown in Figure 1E.
- RTJ Rings: One or two transverse stripes (depending on the material) anywhere along it length, as shown in Figure 1E.
- Pipe and Tubes: One or two transverse stripes (depending on the material) marked the entire length of the pipe, as shown in Figure 1F.
- Paints: Paints used for color coding shall be durable and distinctive. Paints containing sulfur, chlorine, lead, or copper shall not be used
- Surface: Surface to be color coded shall be clean and free of dirt, loose scale and oil
- Manufacturer Markings: Color coding shall not obscure the permanent manufactures' markings required by applicable ASTM or ASME material specifications.
- All Components: All of the alloy components on reconditioned valves and check valves shall be PMI inspected prior to assembly.
- Where color coding is not available for a particular alloy, the alloy identifier such as the ASTM designator and UNS number shall be used.

UTILITY STATIONS

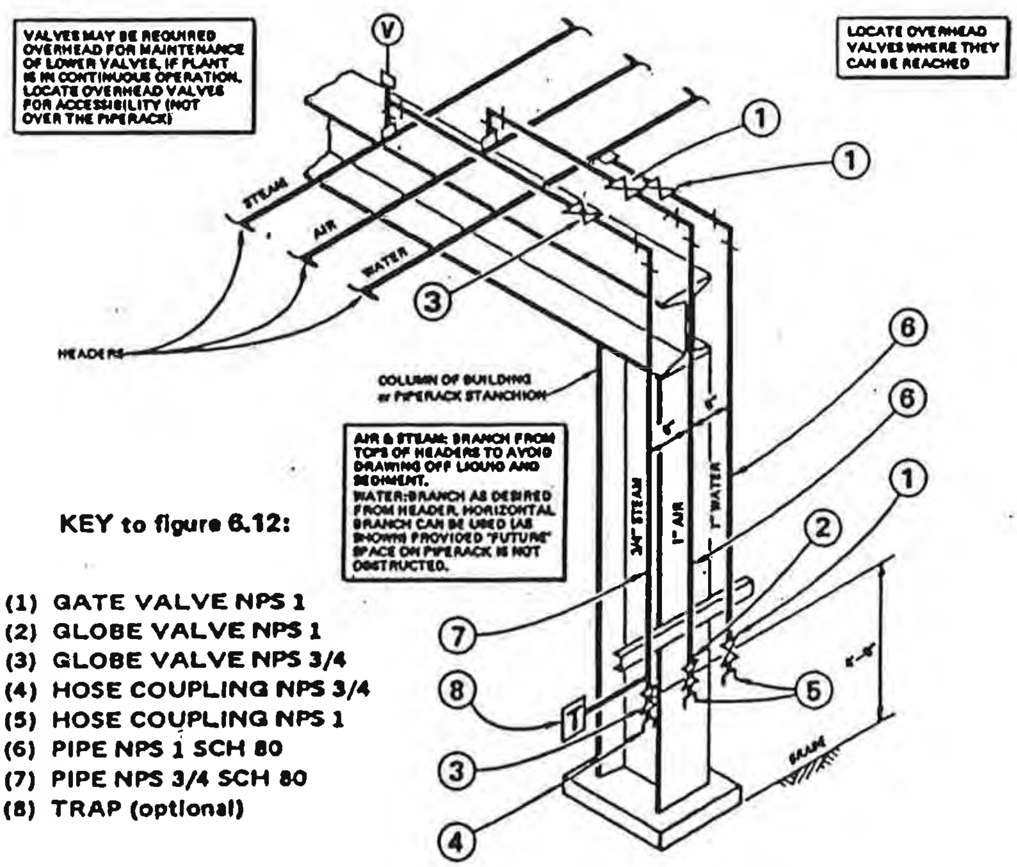
A utility station usually comprises three service lines carrying steam, compressed air and water. The steam line is normally ¾-inch minimum, and the other two services are usually carried in 1-inch lines. These services are for cleaning local equipment and hosing floors. (Firewater is taken from points fed from an independent water supply.)

The steam line is fitted with a globe valve and the air and water lines with gate valves. All are terminated with hose connections about 3½ ft above floor or grade. A utility station should be located at some convenient steel column for supporting, and all areas it is to serve should be reachable with a 50-ft hose.

Most companies have a standard design for a utility station. Figure 6.12 shows a design for a standard station which can be copied onto one of the design drawings for reference, or otherwise supplied with the drawings to the erecting contractor who usually runs the necessary lines. A notation used on plan views to indicate the station and services required is:

SERVICES:	STEAM, AIR, WATER	AIR, WATER	STEAM, WATER	STEAM, AIR
STATION SYMBOL:	S A W	A W	S W	S A

UTILITY STATION — FIGURE 6.12

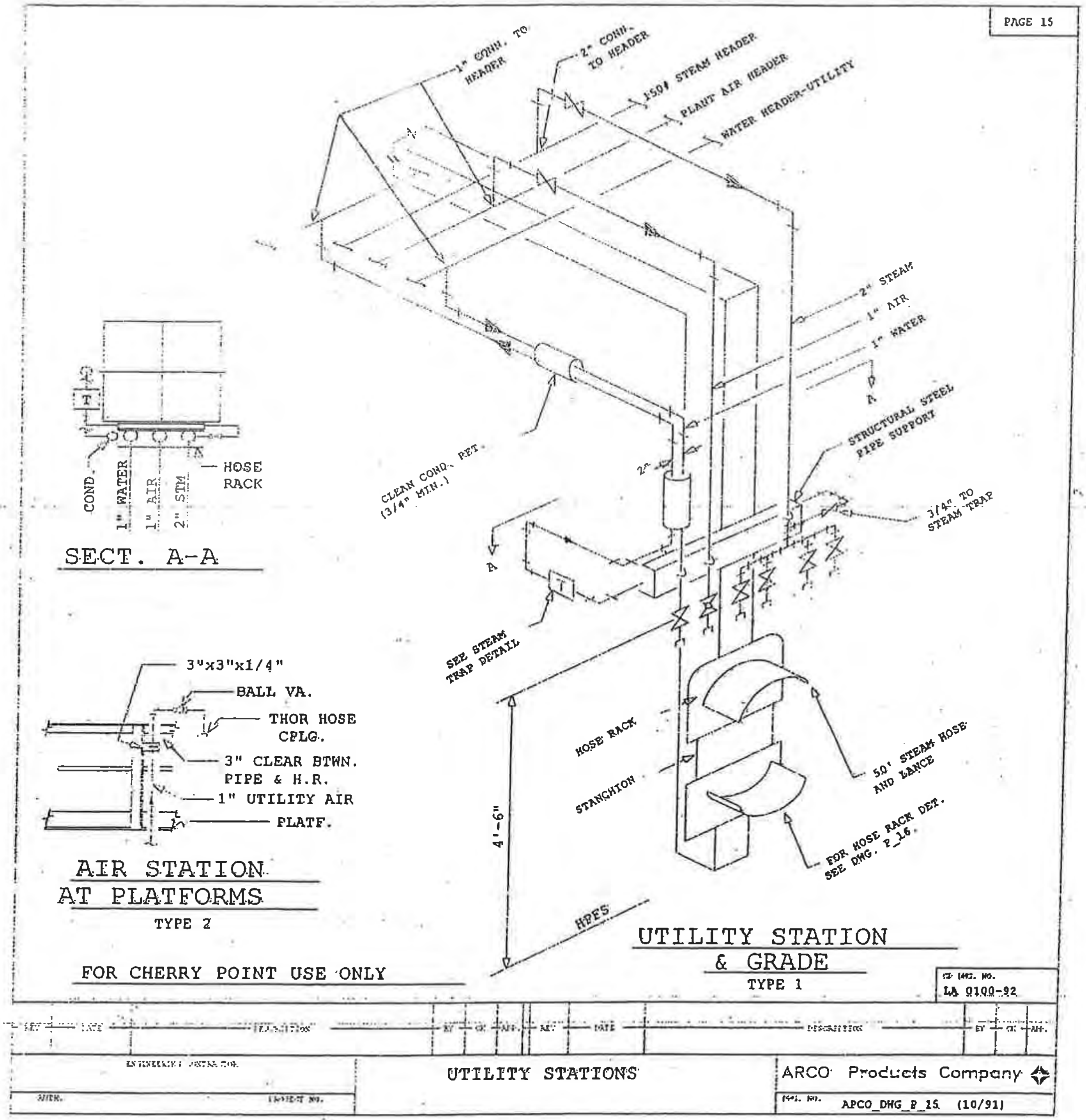


KEY to figure 6.12:

(1) GATE VALVE NPS 1
(2) GLOBE VALVE NPS 1
(3) GLOBE VALVE NPS 3/4
(4) HOSE COUPLING NPS 3/4
(5) HOSE COUPLING NPS 1
(6) PIPE NPS 1 SCH 80
(7) PIPE NPS 3/4 SCH 80
(8) TRAP (optional)

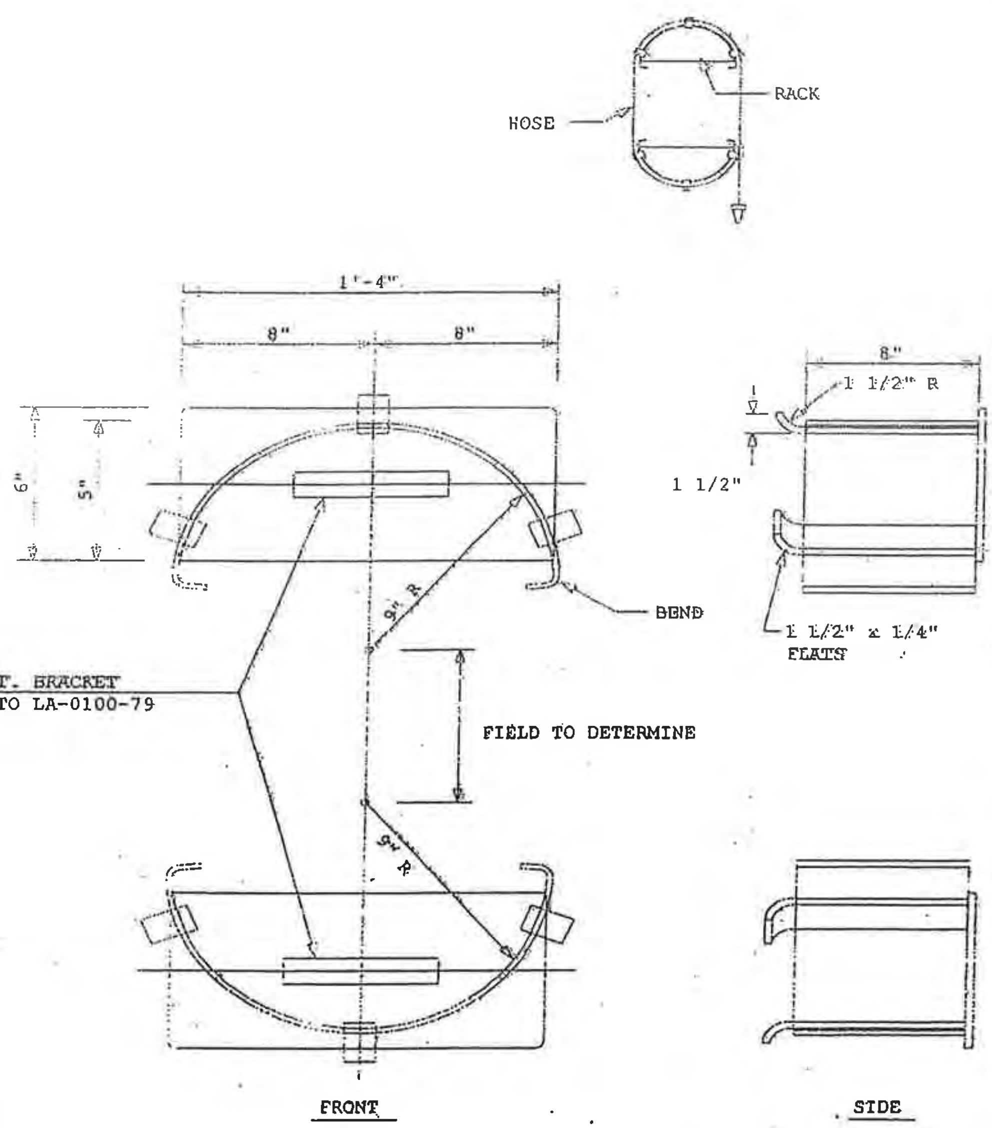
PIPING GRAPHIC STANDARD

P15 - UTILITY STATIONS



PIPING GRAPHIC STANDARD

P16 - HOSE RACK DETAIL



NOTE:
MAKE FROM NO. 10 GA. PLATE EXCEPT AS NOTED. ROUND ALL CORNERS.
RACK TO BE GALVANIZED.

LA 0100-76

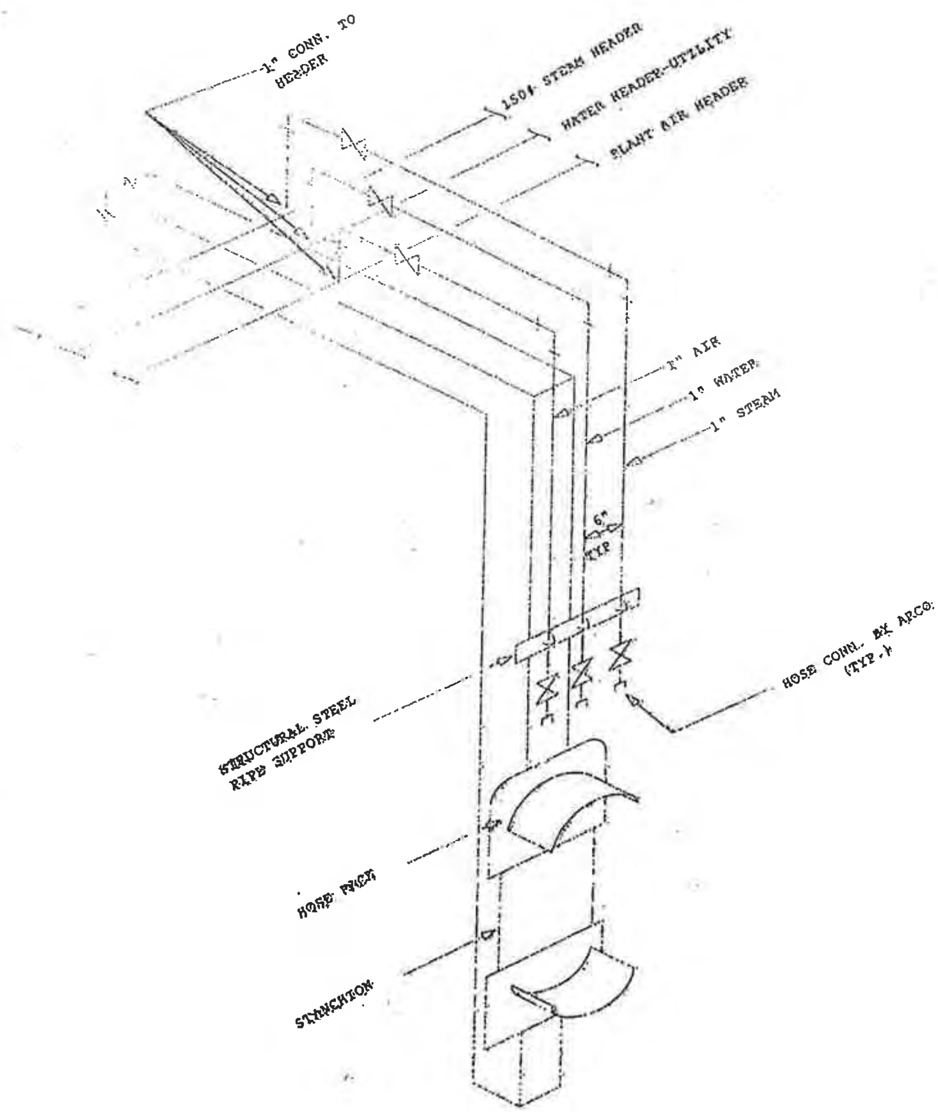
HOSE RACK DETAIL

ARCO Products Company

ARCO_DWG_P_16 (10/91)

P17 - UTILITY STATION BELOW HDRS

PAGE 17



MATERIAL TO CONFORM TO SPECIFIED LINE CLASS, ARCO STANDARD 205.

FOR LAB USE ONLY

REV	DATE	DESCRIPTION	BY	CK	APP.	REV	DATE	DESCRIPTION	BY	CK	APP.

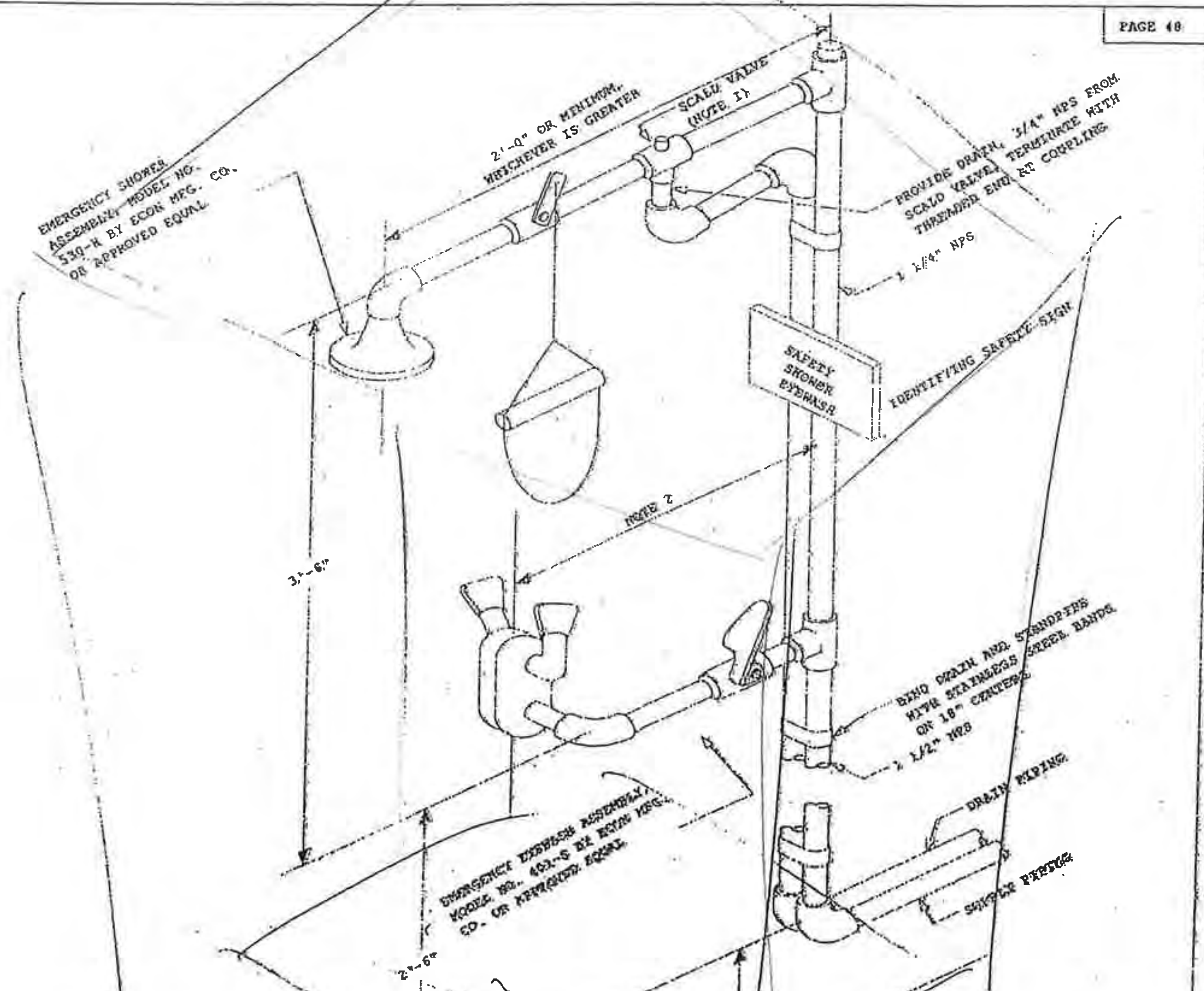
UTILITY STATION BELOW HDRS.

ARCO Products Company

ARCO DWG P 17

PIPING GRAPHIC STANDARD

P44 - COMBINATION EMERGENCY CHAIN PULL SHOWER AND EYEWASH



FOR LAB USE ONLY

NOTES

1. SCALD VALVE OGONTZ 1 1/4" FF 90 APP TO PREVENT INJURY BY WATER OVERHEATED BY STEAM TRACING OR PIPING EXPOSURE TO SUN.
2. HOLD THIS DIMENSION TO MINIMUM PRACTICAL.
3. ARRANGEMENT SHOWN IS FOR NON-FREEZING CLIMATE.

COMBINATION EMERGENCY CHAIN PULL SHOWER AND EYEWASH

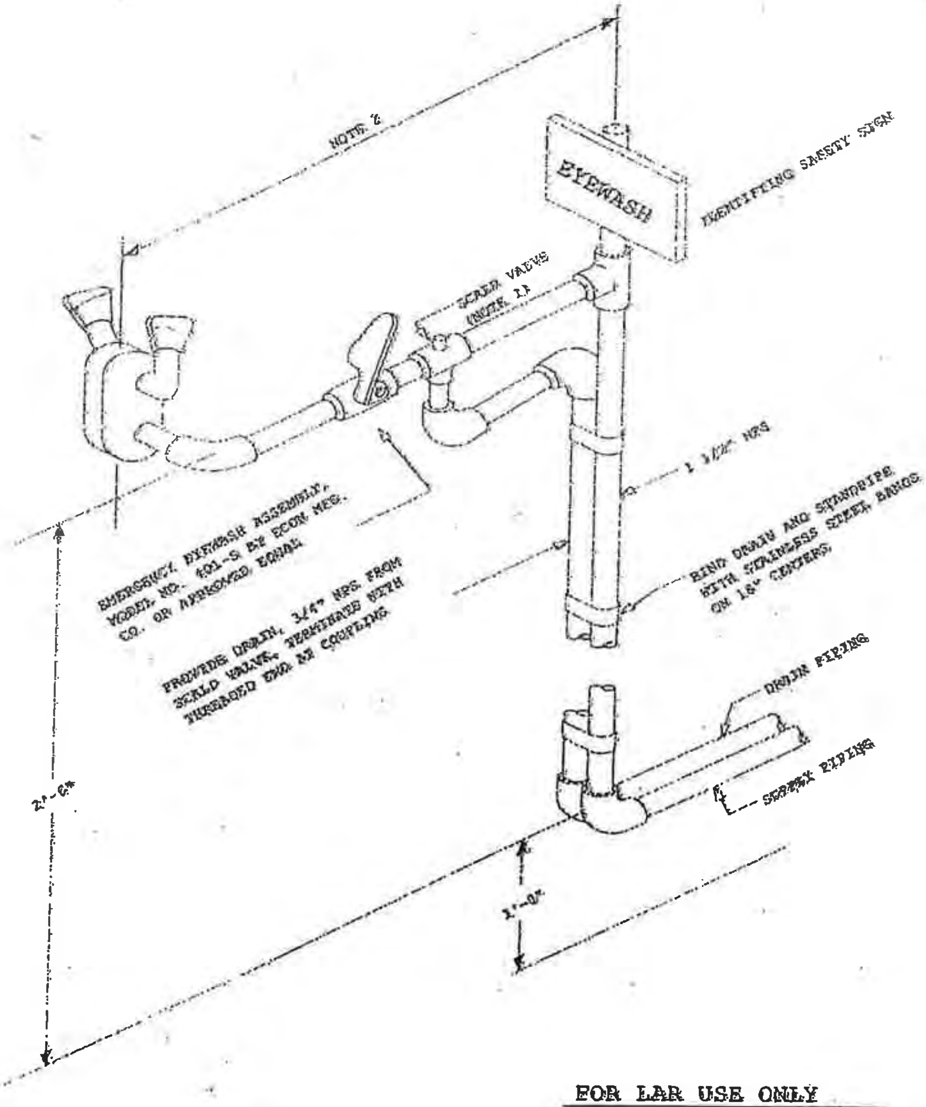
ARCO Products Company

ARCO DWG P 44 (10/91)

PIPING GRAPHIC STANDARD

P45 - EMERGENCY EYEWASH

PAGE 49



FOR LAR USE ONLY

NOTES

1. SCALD VALVE [illegible] TO PREVENT INJURY BY WATER OVERHEATED BY STEAM TRACING OR PIPING EXPOSURE TO SUN.
2. HOLD THIS DIMENSION TO MINIMUM PRACTICAL.
3. ARRANGEMENT SHOWN IS FOR NON-FREEZING CLIMATE.

REV	DATE	DESCRIPTION	BY	CK	APP	APP	DATE	DESCRIPTION	BY	CK	APP

ENGINEERING APPROVALS

EMERGENCY EYEWASH

ARCO Products Company

DATE | PROJECT NO. | DWG. NO. ARCO DWG P-45 (10/91)

ASME Number	Explanation
SA-36*	Covers carbon steel shapes, plates, and bars of structural quality for use in riveted, bolted, or welded construction of bridges and buildings, and for general structural purposes. When the steel is used in welded construction, welding procedure shall be suitable for the steel and the intended service.
SA-53*	Covers seamless and welded black and hot-dipped galvanized steel pipe in nominal sizes 1/8 in. to 26 in., incl. with nominal (average) wall thickness. Pipe having other dimensions may be furnished provided such pipe com plies with all other requirements of this specification. 1.2 Pipe may be furnished in the following types and grades; 1.2.1 *Type* F—Furnace-butt welded, continuous welded, 1.2.2 *Type* E—Electric-resistance welded, Grades A and B, and 1.2.3 *Type* S—Seamless, Grades A and B. 1.3 Pipe ordered under this specification is suitable for welding, and suitable for forming operatings involving coiling, bending and flanging, subject to the following qualifications; 1.3.1 Type F is not intended for flanging. 1.3.2 When Types S and E are required for close coiling or cold bending, Grade A should be specified. This provision is not intended to prohibit the cold bending of Grade B pipe. 1.3.3 When pipe is required for close coiling, this should be specified on the order. 1.3.4 Type E may be furnished either non-expanded or cold expanded at the option of the manufacturer. When pipe is cold expanded, the amount of expansion shall not exceed 1.5% of the O.D. pipe size.
SA-105	Covers forged carbon steel piping components for ambient and higher-temperature service in pressure systems. Included are flanges, fittings, valves and similar parts to specified dimensions or to dimensional standards such as those ANSI and API specifications.

*Identical with ASTM Specifications
**Identical with ASTM Specifications with revisions or additions

ASME Number	Explanation
SA-106**	Covers seamless carbon steel pipe for high-temperature service in nominal sizes 1/8 in. to 26 in. inclusive. With nominal(average) wall thickness as given in ANSI B36.10. Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of these specifications. Pipe ordered under this specification shall be suitable for bending, flanging and similar forming operations.
A-120	This specification covers black and hot-dipped galvanized welded and seamless steel pipe in nominal sizes 1/8in. to 16 in. inclusive with nominal (average) wall thickness. Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of this specification . Pipe ordered under this specification is intended for ordinary uses in steam,water,gas, and air lines, but is not intended for close coiling or bending, or high-temperature service. No to this specification, except hydrostatic test which shall be made at the mills, as this specification is intended to cover pipe purchased mainly from jobber's stocks.
SA-134**	Covers electric-fusion(arc)-welded straight seam or spiral seam steel plate pipe 16 in. and over in diameter (inside or outside as specified by purchaser), with wall thicknesses up to ¾ in.,inclusive. Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of these specifications. The pipe is intended for conveying liquid, gas or vapor.
SA-135*	Covers two grades of electric-resistance-welded steel pipe in nominal sizes 2 in. to 30 in. inclusive with nominal(average) wall thickness up to 0.500 in. (12.70 mm), inclusive and in nominal sizes ¾ to 5 in. inclusive with nominal(average) wall thickness 0.083 in. (2.11 mm) to 0.134 in. (3.40mm) depending on size. Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of this specification. The pipe is intended for conveying liquid, gas or vapor: and only Grade A is adapted for flanging and bending.

ASME Specifications

ASME Number	Explanation
SA-155**	Covers electric-fusion-welded steel pipe suitable for high-pressure service and for use at high, intermediate, or lower temperatures, depending upon grade of material specified in outside diameters 16 in. and larger with wall thicknesses up to 3,000 in. incl.
SA-178*	Covers electric-resistance-welded tubes made of carbon steel and intended for use as boiler tubes, boiler flues, superheater flues, and safe ends. The tubing sizes and thicknesses usually furnished to this specification are ½ in. to 5. in. O.D. and 0.035 in. to 0.320 in. inclusive in minimum wall thickness.
SA-179*	Covers seamless cold-drawn low-carbon steel tubes for tubular heat exchangers, condensers, and similar heat transfer apparatus. Covers tubes 1/8 to 3 In., incl. In outside diameter.
SA-181*	Covers forged or rolled steel pipe flanges, forged fittings and valves and parts for general service. Two grades or material are covered, designated as grades I and II, respectively, and are classified In accordance with their chemical and physical properties.
SA-182*	Covers forged or rolled alloy-steel pipe flanges, forged fittings and valves and parts intended for high-temperature service. The term "forgings" used in this specification shall be understood to cover one of all of the products mentioned above, either forged or rolled.
SA-192*	Covers seamless carbon steel boiler and superheater tubes for high-pressure service. The tubing sizes and thicknesses usually furnished to this specification are ½ in. to 7 in. O.D. and 0.085 in. to 1.000 in., Inclusive in minimum wall thickness.

*Identical with ASTM Specifications
**Identical with ASTM Specifications with revisions or additions

ASME Number	Explanation
SA-199*	Covers several grades of chromium-molybdenum and chromium-molybdenum silicon seamless cold-drawn intermediate alloy steel tubes for heat exchangers, condensers, and similar heat transfer apparatus. The tubing Sizes usually furnished to this specification are 1/8 in. to 3 in. O.D.
SA-209*	Covers several grades of seamless carbon-molybdenum alloy-steel boiler and super-heater tubes. Covers tubes ½ to 5 in., incl., in minimum wall thickness.
SA-210*	Covers seamless medium-carbon steel boiler tubes and boiler flues, including safe ends, arch and stay tubes, and superheater tubes. The tubing sizes and thicknesses usually furnished to this specification are ½ in. to 5 in. O.D. and 0.035 In. to 0.500 In.. inclusive in minimum wall thickness.
SA-213*	Covers seamless ferritic and austenitic steel boiler and superheater tubes and austenitic steel heat exchanger tubes, designated Grades T 5, TP 304, etc. These steels are listed in Tables I and II, respectively. Grades IP 304 H, TP 316 H. TP 321 H. TP 347 H, and IP 348 H are modifications of Grades TP 304, TP 316, TP 321. TP 347, and TP 348. and are intended for high-temperature service such as for superheaters and reheaters. The tubing sizes and thicknesses usually furnished to this specification are 1/8 in. in inside diameter to 5 in. in outside diameter and 0.015 in. to 0.500 In., inclusive, in minimum wall thickness..
SA-214*	Covers electric-resistance-welded carbon steel tubes to be used for heat exchangers, condensers, and similar heat-transfer apparatus. The tubing sizes usually furnished to this specification are to 3 in. O.D. inclusive.

ASME Specifications

ASME Number	Explanation
SA-226*	Covers electric-resistance-welded carbon steel boiler and superheater tubes for high-pressure service. The tubing sizes and thicknesses usually furnished to this specification are ½ in. to 5 in. O.D. and 0.085 in. to 0.360 in., inclusive in minimum wall thickness.
SA-234**	Covers wrought carbon steel and alloy steel fittings of seamless and welded construction for use in pressure piping and in pressure vessel fabrication for service at moderate and elevated temperatures. The term "fitting" applies to butt-welding, socket-end, and threaded end parts such as 45-deg and 90 deg elbows. 180-deg return bends, caps, tees,reducers, lap-joint stub ends, and other types as covered by the latest revision of ANSI B16.9, MSS SP48, and ANSI B16.11.
SA-249*	Covers welded tubes made from the austenitic steels with various grades intended for such use as boiler, superheater, heat exchanger, or condenser tubes. Grades TP 304H, TP 316H,TP 321 H,TP 347H, and TP 348H are modifications of grades TP 304, TP 316, TP 321., TP 347, and TP 348. and are intended for high-temperature Ser vice such as for superheaters and reheaters. The tubing sizes and thickness usually furnished to this specification are 1/8 in. in inside diameter to 5 in. in outside diameter and 0.015 in. to 0.320 In., incl. in minimum wall thickness.
SA-250**	Covers several grades, designated T 1, T 1a. T lb. of electric-resistance-welded, carbon-molybdenum alloy-steel boiler and super heater tubes. The tubing sizes and thicknesses usually furnished to this specification are T/2 in. to 5 in. O.D. and 0.035 in. to 0.320 in., inclusive in minimum wall thickness..

*Identical with ASTM Specifications

**Identical with ASTM Specifications with revisions or additions

ASME Number	Explanation
SA-268**	Covers nine grades of stainless steel tubing for general corrosion-resisting and high-temperature service. These grades are commonly known as the "straight-chromium" types and are characterized by being ferro-magnetic. Two of these grades, TP 410 and TP 329 (Table 1). are amenable to hardening by heat treatment, and the high-chromium. ferritic alloys are sensitive to notch-brittle ness on slow cooling to ordinary temperatures. These features should be recognized in the use of these materials. Grade 409 may be ordered with no final heat treatment pro vided the purchase order so specifies and the material meets all of the other requirements of the specifications.
SA-312**	Covers seamless and welded austenitic steel pipe intended for high-temperature and general corrosive service. Sixteen grades are covered. Grades TP 304H,TP 316H, TP 321H, TP 347H and TP 387H are modification of Grades TP 304, TP 316, TP 321, TP347 and TP 387, and are Intended for high-temperature service.
SA-333**	Covers nominal (average) wall seamless and welded carbon and alloy steel pipe intended for use at low temperatures, Several grades of ferritic steel are included. Some product sizes may not be available under this specification because heavier wall thicknesses have an adverse affect on low-temperature impact properties
SA-334*	Covers several grades of seamless and welded carbon and alloy-steel tubes intended for use at low temperatures. Some product sizes may not be available under this specification because heavier wall thicknesses have an adverse effect on low-temperature impact properties..

ASME Specifications

ASME Number	Explanation
SA-335**	Covers nominal (average) wall seamless alloy-steel pipe intended for high-temperature service. Pipe ordered to this specification shall be suitable for bending, flanging (van. stoning), and similar forming operations, and for fusion welding. Selection will depend upon design, service conditions, mechanical properties, and high-temperature characteristics.
SA-350*	Covers carbon and alloy steel forged or rolled flanges, forged fittings, valves and parts intended for low-temperature service.
SA-358**	Covers electric-fusion-welded austenitic chromium-nickel alloy steel pipe suitable for Corrosive or high-temperature service, or both. (Although no restrictions are placed on the sizes of pipe which may be furnished under this specification, commercial practice is commonly limited to sizes not less than 8-in. (203-mm) nominal diameter.) Covers seven grades of alloy steel. The selection of the proper alloy and requirements for heat treatment shall be at the discretion of the purchaser, dependent on the service conditions to be encountered. Two classes of pipe are covered as follows: *Class* 1—All welded joints to be completely examined by radiography. *Class* 2—No radiographic examination required.
SA-376**	Covers seamless austenitic steel pipe in tended for high-temperature central-station service. Among the ten grades covered are five H grades which are specifically intended for high-temperature service.
SA-376**	Covers wrought fittings for pressure piping made from austenitic stainless steel. The term "fittings" applies to butt-welding, socket-welding, or threaded parts such as 45-deg and 90-deg elbows, 180-deg return bends, caps, tees, reducers, lap-joint stub ends, and other types as covered by the latest revision of ANSI B16.9 ANSI B16.11 and MSS Standard Practice SP-43.

*Identical with ASTM Specifications

**Identical with ASTM Specifications with revisions or additions

ASME Number	Explanation
SA-409**	Covers straight seam or spiral seam electric-fusion-welded, light wall, austenitic chromium-nickel alloy steel pipe for corrosive or high-temperature service. The sizes covered are 14 to 30 in. (355 to 762 mm) incl. in nominal diameter with extra light (schedule 5S) and light (schedule 10S) wall thicknesses.
SA-423*	Covers seamless and electric resistance welded low allow steel tubes for pressure containing parts such as economizers or other applications where corrosion resistance is important. The tubing sizes and thicknesses usually furnished to this specification are ½ in. to 5 in. O.D. and 0.035 in. to 0.500 in. inclusive in minimum wall thickness.
A-714-75 (YOLOY)	Covers seamless and welded high-strength low-alloy steel pipe in nominal sizes ½ to 26 in., inclusive. Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of this specification. This material is intended for pressure piping service, and other general purposes, where savings in weight or added durability are important.

API Number	AMERICAN PETROLEUM INSTITUTE SPECIFICATIONS (PIPE)
API 5-L	Covers welded and seamless steel pipe for use in conveying gas, water, and oil. Used mainly in the oil and natural gas industries. Seamless and electric-weld covers two grades: Grade A (30,000 psi Min Yield) and Grade *B* (35.000 psi Min Yield). Butt-welded manufacture is covered by two classes: Class I (25,000 psi Min Yield) and Class II (28,000 psi Min Yield). Size range *1/8* inch to 36 inch nominal diameters.
API 5LX	Covers more rigorously tested line pipe, having greater tensile and bursting strengths. Size range 4 ½ O.D. to 42 inch O.D.. in grades X 42 (42,000 psi Min Yield) to X 65 (65,000 psi Min Yield). Not intended for high temperature service.

Inspection Ticket and Repair/MES Procedure Flow Diagram

1. Inspector fills out parts A,B,C,D & E

2. The inspector determines the job priority and corrective action for repairs based on the conditions and service of the equipment for part F & G.

3. The inspector shall generate a Work Order number for part H if not already done so by any other department.

PERP

4. The inspector fills in the required PERP number for part H.

5. The inspector fills in the inspection requirements and "Hold Points" for part J. and forwards the inspection ticket to the Database Administrator.

6. The Database Administrator shall input all necessary information into the Ticket and Procedure Database and retain the original ticket in the inspection vault for "Traveler" distribution.

7. The inspector shall contact and communicate with appropriate departments that an inspection ticket has been issued.

8. The Database Administrator will forward the "colored" inspection ticket copies to the appropriate department.
"WHITE" : Original vault file "BLUE" : Operations Dept.
"GREEN" : Maintenance Dept. "YELLOW" : Inspector copy

9. The Maintanence Planner shall acquire the "Traveler" from the Database Administrator. The "Traveler shall be signed out prior to release into the field. The Maintanence Planner issues the "Traveler" to their appropriate Maintanence Foreman.

10a. The Maintanence Forman shall retain the "Traveler" until the entire work scope is completed and all Inspection requirements "Pre & Post" are signed-off for completion.

11. The Maintenance Foreman, Inspection and Operations representatives shall sign & date the "Traveler" for final completion of the "Traveler". The Maintanence Forman shall forward the completed "Traveler to the Maintenance Planner.

12. The Maintenance Planner shall return the completed "Traveler" to Database Administrator.

13. The Database Administrator shall update the Ticket and Procedure database back log status and file the "Travelers" into their appropriate file. ~END~

Repair Procedure and MES Prodcedure

4. The Inspector shall forward the Inspection Ticket to the Database Administrator. The Database Administrator shall input all necessary information into the Ticket and Procedure Database and forward the inspection ticket to the appropriate Facility Support Engineer for resolution. The Facility Support Engineer shall sign and date part I.

5. The inspector shall contact and communicate with appropriate departments that an inspection ticket has been issued.

6. The Database Administrator will forward the "colored" inspection ticket copies to the appropriate departments.
"WHITE" : Original vault file "BLUE" : Operations Dept.
"GREEN" : Maintenance Dept. "YELLOW" : Inspector copy

7. Once there is a written Repair Procedure or MES Procedure, both Engineering and Inspection shall approve the procedure.

8. The Inspector will log the written Repair Procedure into the Repair Procedure log book and issue a unique number for that particular procedure or the Engineer will log the written MES Proc. into the MES Procedure log book and issue a unique number for that particular procedure. The Inspector or Engineer shall forward the original Procedure to the Datasbase Administrator.

9. The Database Administrator will input all necessary information into the Ticket and Procedure database and retain the original Procedure in the inspection vault for "Traveler" distribution.

10. The Maintanence Planner shall acquire the "Traveler" from the Database Administrator. The "Traveler" shall be signed out prior to release into the field. The Maintanence Planner issues the "Traveler" to their appropriate Maintanence Foreman.

LEGEND

EVENT: A ticket that documents a mechanical deficiency, identified by product leakage. (eg. Pipework, Exchanger, Furnaces, Pressure Vessels, and Tankage) (exclusions: Flange leaks and Valve land leaks)

PREVENT: A ticket that documents a mechanical deficiency, identified by On-Stream Inspection.

WPCOND: Waiting for plant condition.
W.O.: Work Order Number
PERP: "Pre Engineered Repair Procedure"
MES: Maintanence Engineering Services
PWHT: Post Weld Heat Treatment
U.G: Underground
PT: Liquid Penetrant Examination
MT: Magnetic Particle Examination
UT: Ultrasonic Examination
VT: Visual Examination
FSE: Facility Support Engineer
INSP: Inspection