

به نام خدا



# مرکز دانلود رایگان مهندسی متالورژی و مواد

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## PIPING MATERIALS

## SELECTION OF MATERIALS

Selection of materials for a specific application requires a knowledge of current industry-wide practices. Research organizations are constantly seeking improved methods for handling the ever increasing problems encountered in the fluid transportation of modern industry. Pressures now cover the range from high vacuum to several thousand pounds per square inch. Temperatures of  $-300^{\circ}\text{F}$  to  $1500^{\circ}\text{F}$  are now encountered rather frequently and these extremes may be exceeded in tomorrow's discoveries. Solids, semi-

solids and slurries are conveyed in piping with considerable success. All manner of corrosive fluids and solvents are piped with comparative ease and safety. The entire piping industry has met these challenging problems with a wide assortment of metallic and non-metallic piping materials and protective coatings.

The severe service conditions found in main steam and reheat lines of central power stations have been successfully handled with a variety of materials. A list of piping materials available is shown on this page.

## Pipe and Tubing Materials

Material and Common Name	A.S.T.M. Designation	General Applications*
<b>CARBON STEEL</b>		
Welded	A-53	Steam and water piping as encountered in Steam Power Plant piping such as main steam lines, bleed steam lines, boiler feed lines, boiler blow-off lines, drain piping; up to 750° F. Non-corrosive gas and air lines in process piping.
Electric Resistant Welded	A-135	
Electric Fusion Welded	A-134	
	A-139	
	A-155	
Seamless	A-53	
	A-106	
Spiral Welded	A-211	
<b>LOW ALLOY STEEL</b>		
Carbon Moly	A-335 P1	For services where temperatures are above 750° F as encountered in high pressure and temperature main steam and reheat lines. The particular selection depends on operating temperature and corrosion considerations.
1/2% Chrome - 1/2% Moly	A-335 P2, A-369 FP2, A-155 A-387A	
1% Chrome - 1/2% Moly	A-335 P12, A-369 FP12, A-155 A-387B	
1 1/2% Chrome - 1/2% Moly	A-335 P11, A-369 FP11, A-155 A-387C	
2 1/2% Chrome - 1% Moly	A-335 P22, A-369 FP22, A-155 A-387D	
<b>INTERMEDIATE ALLOYS</b>		
4-6% Chrome - 1/2% Moly	A-335 P5	Processing as encountered in Oil Refineries, air pre-heaters where highly corrosive or oxidizing conditions exist, catalytic processing units.
4-6% Chrome w/Silicon	A-335 P5b	
4-6% Chrome w/Titanium	A-335 P5c	
4-6% Chrome w/Columbium	A-335 P5c	
7% Chrome - 1/2% Moly	A-335 P7	
9% Chrome - 1% Moly	A-335 P9	
3 1/2% Nickel seamless and resistant welded	A.S.T.M. A-333 Grade 3	Low temperature process piping where resistance against high impact values are required.
<b>STAINLESS STEEL</b>		
18% Chrome - 8% Nickel	A-312 TP 304 & H & L, A-358 TP 304	Piping for nuclear and fossil Central Station work, radiant superheaters, internal combustion engine exhaust pipes, corrosion resistance services.
18% Chrome - 12% Nickel	A-312 TP 316 & H & L, A-358 TP 316	
18% Chrome - 12% Nickel	A-312 TP 317	
18% Chrome - 10% Nickel	A-312 TP 321 & H	
18% Chrome - 10% Nickel	A-312 TP 347 & H, A-358 TP 347	
<b>COPPER PIPE</b>	B-42	Process steam, air and water piping.
<b>COPPER TUBE</b>	B-88	Instrumental lines and domestic use.
<b>ALUMINUM ALLOYS</b>	These alloys are available in 2S, 3S, 4S, 24S, 52S, and 61S or under A.S.T.M. Chemical designations 990A, 111A, MG11A, CG42A, GR20A and GS11A respectively	
		Corrosion resistance services.

\* General applications are subject to the various code limitations, and specific service conditions.

## ITT GRINNELL -- PIPING DESIGN AND ENGINEERING

Flanges, fittings, bolting material and gaskets are covered in succeeding pages.

If structural stability is a factor of consideration, the limiting temperature in general practice for use of Carbon Steel is 750° F and for Carbon Moly Steel is 850° F, whereas, if stability is not to be considered 900-1000° F for Carbon Steel and 950-1050° F for Carbon Moly Steel are the limiting temperatures.

Temperature ranges as practiced in fossil type Central Power Stations for Low Alloy Steels are:  $\frac{1}{2}$  Chrome  $\frac{1}{2}$  Moly 750-950° F, 1 Chrome  $\frac{1}{2}$  Moly 850-975° F,  $1\frac{1}{4}$  Chrome  $\frac{1}{2}$  Moly 900-1000° F and 2 $\frac{1}{4}$  Chrome 1 Moly up to a design maximum of 1050° F.

The Intermediate Alloys have limiting temperatures

for short time service between 1200-1300° F and the Austenitic Steels have been used up to 1600° F for special services.

In Oil Refinery work the "Chrome Steels," 4-6%, 7%, 9%, and 13% Chrome, have found considerable favor for high temperature service for oxidation and corrosion resistance.

Suitable materials for the sub-zero or low temperature applications include fine grain carbon steel, nickel steel alloys, and austenitic stainless steels.

The corrosive conditions found in the chemical and process industries have been successfully overcome with

Fitting and Flange Materials

Classification	Material Specification	Dimension Specification	General Applications
CAST IRON Screwed Fittings	A.S.T.M. A126	ANSI B16.4	Steam, air, gas and oil piping not over 400° F.
Flanges and Flanged	A.S.T.M. A126	ANSI B16.1 (25-800 lb)	
MALLEABLE IRON Screwed Fittings and Flanges	A.S.T.M. A47 or A197	ANSI B16.3 (150-300 lb)	Air and gas piping below 550° F.
CAST CARBON STEEL Screwed Flanged	A.S.T.M. A95 A.S.T.M. A95 & A216	ANSI B16.5	Steam, water, power, refinery and gas piping up to 750° F or in excess according to adjusted ratings in A.S.A. B16e.
FORGED CARBON STEEL Screwed Flanges and Flanged Fittings	A.S.T.M. A105 A.S.T.M. A105 A.S.T.M. A181	ANSI B16.5 ANSI B16.5 ANSI B16.5	Refinery, gas, power and non corrosive piping up to 750° F. Above 750° F alloys are used.
WELDING-CARBON AND ALLOY STEEL Butt Welded Fittings Socket Welding and Threaded Fittings	A.S.T.M. A234 A.S.T.M. A105	ANSI B16.9 ANSI B16.11	Carbon steel for steam, water, power, refinery, gas and non corrosive piping up to 750° F. Above 750° F alloys are used.
BRASS OR BRONZE Screwed Fittings	A.S.T.M. B62	ANSI B16.15 (125-250 lb)	Steam, water, gas and oil piping
Screwed Flanges and Flanged Fittings	A.S.T.M. B62 (150 lb)	ANSI B16.24 ANSI B16.24	A.S.T.M. B61 up to 500° F A.S.T.M. B62 up to 400° F.
Solder Fittings	A.S.T.M. B62	ANSI B16.18	
ALLOY STEEL Cast	A.S.T.M. A217	ANSI B16.5	High temperature and pressure steam, oil and corrosion resistance services. The particular selection depends on operating temperature and corrosion considerations.
Forged	A.S.T.M. A182	ANSI B16.5	
Stainless	A.S.T.M. A182	Made to order	
Heat Resistant	A.S.T.M. A297	Made to order	
COPPER Solder Fittings	No established standards		With copper pipe and tube
ALUMINUM Screwed Fittings and Flanges	No established standards		With aluminum pipe below 400° F

\* Adopted as ANSI Standard



## PIPING MATERIALS

a variety of metallic and non-metallic piping materials. In the interest of economy and structural strength many of these materials are applied to piping by the techniques of cladding, plating, lining or coating. The table of pages 107 to 112 indicates the relative resistance of several piping materials to the corrosive effects of certain chemical substances which are commonly encountered in this class of work.

The severe erosive effects of slurries and semi-solids is adequately offset with the use of soft rubber linings. The true measures of proper material selection are safety and economy. Knowledge of the research and practical experience of the piping industry is the key to this objective.

Pipe and tubing is made in the following materials in addition to those materials shown in the table.

Piping Material	Uses
Admiralty Metal	Corrosion Resistance
Brass	Corrosion Resistance
Bronze	Corrosion Resistance
Cast Iron	Underground water and gas — Corrosion Resistance
Cement-Asbestos	Corrosion
Clay-Sewer (Vitrified Clay)	Underground Sewer
Concrete-Sewer	Underground Sewer
Dowmetal	Corrosion Resistance
Glass	Corrosion Resistance
Hastelloy	Corrosion Resistance
Lead	Corrosion Resistance
Monel	Corrosion Resistance
Muntz Metal	Corrosion Resistance
Nichrome	High Temperature and Corrosion Resistance
Nickel-Copper-Zinc	Corrosion Resistance
Nickel-Manganese	Corrosion Resistance
Plastic	Corrosion Resistance
Porcelain	Corrosion Resistance
Reinforced Concrete	Underground

## Piping Material

Rubber  
Tin  
Wood  
Zinc

## Uses

Corrosion and Erosion Resistance  
Non-Contaminating  
Corrosion Resistance  
Corrosion Resistance

## Bolting

For the average low and medium pressure installations bolts are made up in staggered sequence with open end wrenches which will usually result in adequately tight joints. For the high pressure and temperature joints it becomes increasingly more important to make up each stud to a definite tension. Torque wrenches are sometimes used for this purpose.

In exceptional cases where a more positive method is desired the studs may be tightened until a definite elongation has been attained.

For this condition an initial cold tension of 30,000 to 35,000 PSI in each stud is recommended. Since the Modulus of Elasticity of stud material is  $30 \times 10^6$  PSI a tension of 30,000 PSI would result in a unit

elongation of  $\frac{30,000}{30 \times 10^6} = 0.001$  inches per inch of

effective length. The effective length is the distance between nut faces plus one nut thickness. Special studs with ground ends are required to make micrometer measurements for this purpose. After the joint has been in service periodic checks of the actual cold lengths as compared with the tabulated lengths will detect any permanent elongation of the studs. Permanent elongation will indicate over stressing and creep. When these conditions become severe new studs may be required to properly maintain the joint.

## Bolting Material

Material and Appearance	Material Specification	Threaded to	Dimensional Specification	Applications
Steel Machine Bolts and Nuts	A.S.T.M. A-307	ANSI B1.1	ANSI B18.2 Hex. ANSI B18.2 Heavy Hex	General Service
Nuts for Carbon and Alloy Steel	A.S.T.M. A-194	ANSI B1.1	ANSI B18.2	High Pressure and Temperature
Alloy Steel and Stainless Steel Bolts and Studs	A.S.T.M. A-193	ANSI B1.1	ANSI B18.2.2	High Pressure and Temperature
Alloy Steel Bolts, Studs and Stud Bolts Nuts for Alloy Steel Bolts, Studs and Stud Bolts	A.S.T.M. A-320 A.S.T.M. A-194	ANSI B1.1 ANSI B1.1	ANSI B18.2 Heavy Hex	Low Temperature Service

\* Adopted as ANSI Standard.

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## ITF GRINNELL — PIPING DESIGN AND ENGINEERING

## Gaskets

Standards of design and material for gaskets are ANSI B16.20 for ring joint gaskets and ANSI B16.21 for non-metallic gaskets. A wide assortment of metallic and non-metallic flat ring or full face gaskets are available for the wide variety of commercial applications.

Gasket materials are usually softer than the flange faces in order to preserve the flange. The gasket is therefore expendable for continued making and breaking of the joint. In most "soft" gaskets their mechanical strength is low, dictating a minimum thickness consistent with adequate sealing properties. Extremely soft materials, such as rubber, are made full face to reduce unit pressure and minimize crushing. Flat ring

gaskets for raised face flanges have an outside diameter which matches the inside edge of the bolts or studs. The inside diameter is determined by the size of the "hole" in the flange plus an allowance for distention inward at the time of make up. This allowance varies with different materials making it necessary to rely upon recommendations of the gasket manufacturer. Tongue and groove and male and female gaskets are cut to fit the female part of the union.

Modern design practice tends toward the elimination of flanged joints with the substitution of all welded lines. This procedure overcomes the flange maintenance problems.

Gasket Materials

Fluid	Application	Gasket Material
Steam (High Pressure)	Temps. up to 1000° F.	Spiral Wound Comp. Asbestos
	Temps. up to 1000° F.	Steel, Corrugated or Plain
	Temps. up to 1000° F.	Monel, Corrugated or Plain
	Temps. up to 1000° F.	Hydrogen-Annealed Furniture Iron
	Temps. up to 1000° F.	Stainless Steel 12 to 14% Chromium, Corrugated
	Temps. up to 1000° F.	Ingot Iron, Special Ring-Type Joint
	Temps. up to 750° F.	Comp. Asbestos
Steam (Low Pressure)	Temps. up to 600° F.	Woven Asbestos
	Temps. up to 600° F.	Copper, Corrugated or Plain
Water	Temps. up to 220° F.	Red Rubber—Wire Inserted
Water	Hot—Medium and High Pressures.	Black Rubber, Red Rubber—Wire Inserted
	Hot—Low Pressures	Brown Rubber—Cloth Inserted
	Hot	Comp. Asbestos
	Cold	Red Rubber—Wire Inserted
	Cold	Black Rubber
Oils (Hot)	Cold	Soft Rubber
	Cold	Asbestos
	Cold	Brown Rubber—Cloth Inserted
	Cold	
Oils (Cold)	Temps. up to 750° F.	Comp. Asbestos
	Temps. up to 1000° F.	Ingot Iron, Special Ring-Type Joint
Air	Temps. up to 212° F.	Cork-Fiber
	Temps. up to 300° F.	Neoprene Comp. Asbestos
Gas	Temps. up to 750° F.	Comp. Asbestos
	Temps. up to 220° F.	Red Rubber
	Temps. up to 1000° F.	Spiral Wound Comp. Asbestos
	Temps. up to 220° F.	
Acids	(Varies—See section on Corrosion)	Sheet Lead or Alloy Steel
	Hot or Cold Mineral Acids	Comp. Blue Asbestos
		Woven Blue Asbestos
Ammonia	Temps. up to 1000° F.	Asbestos—Metallic
	Temps. up to 700° F.	Comp. Asbestos
	Weak Solutions	Red Rubber
	Hot	Thin Asbestos
	Cold	Sheet Lead



## PIPING MATERIALS

## CORROSION

Corrosion occurs when an electric potential forces ions of the corroding material into aqueous solution. This reaction will continue so long as the material is in contact with water, or water vapor, and the material remains anodic (negative voltage) to its environment. The voltage may result from, (1) the electrode potential of the material, (2) external sources, or, (3) from a combination of the two. Electrode potential is the characteristic of any material to be anodic (negative) or, cathodic (positive) in relation to other materials.

The rate of corrosion may be economically retarded by:

1. Selection of costlier "corrosion resistant" material.
2. Application of protective coatings.
3. Deactivation of the corrosive fluid.
4. Cathodic protection of the base material.

Piping materials are subject to internal and/or external corrosion. Internal corrosion can usually be predicted and controlled since the nature of the fluid is known. External corrosion is the more difficult to foresee due to the variety of atmospheric and soil conditions which may exist around a single pipe line. Notable among these are the stray currents and acid soils encountered by underground lines.

Corrosion resistant materials are usually best adapted to specific uniform conditions which can be predicted.

These materials include the stainless steels, lead, nickel, copper, tin, aluminum, and their alloys. Various plastic, mineral, and other non-metallic materials are included in this group.

Protective coating, cladding, lining, plating and painting may be readily adapted to internal and external protection of the less expensive base materials. Coatings include cement, asphalt, tar, and waxes. Cladding with stainless steel and lining with cement, rubber, porcelain, plastic and synthetic rubbers or plating with metals offer many possible solutions to corrosion resistance.

Deoxidation or de-activation of the corrosive fluid may be economically justified in many process applications. An example of this is the deaerating of boiler feed water.

Cathodic protection of piping has been successfully applied to some underground installations by imposing a direct current positive potential to the pipe in relation to the ground. A more recent commercial application of the same principal is the use of an expendable anodic material in mildly corrosive systems.

The following table indicates the corrosion resistant qualities of some of the more common piping materials to various chemical reagents. More detailed information is available from the chemical supplier or from the manufacturer of the various piping materials.

CHEMICAL RESISTANCE OF PIPING MATERIALS

G-Good F-Fair D-Depends on Conditions U-Unsuitable

Chemical	Exposure Conditions	2S Aluminum	Red Brass	Cast Iron	Copper	Lead	Low Carbon Steel	Monel	Stainless Steels			Wrought Iron	Glass	Natural Hard Rubber	Natural Soft Rubber
									304	316	347				
Acetic Acid	100%: Rm	G							D	G	D		G		
	Glacial; 212°	G													
	5%: aerated; 86°		G-F	U	G		D	U				D		G	D
	5-50%: un-aerated; boil							G		D					
	80% Storage							G	F	G					
Acetic Anhydride	Glacial; boil							G							
	20% & 100%: 100°F	G	G-F	D	G		G		G	G	G	G		G	D
Acetone	Boil							G	F	G			G		
Acetylene		G	G	G	G	G	G	G	G	G	G	G	G	U	F
Air		G	U	C	G	G	G	G	G	G	G	G	G	G	U
Alum		G-F	G-F	D	G		U		D	G	D	D	G	G	G
Aluminum Chloride	10%: boil							F	G	G	G				
Aluminum Chloride		D	F-D	D	D		D	G	U	D	U		G	G	G
Aluminum Fluoride		D		D				F	D	D	D		D	D	D
Aluminum Sulphate		G-F	F-G	D	G		U	G	G	G	G		G	G	G
Amines		D	F-D	G	D	G	G	G	G	G	G		G	D	U
Ammonia	Dry	G	G												
	Moist	U	U												
	2.7%: 70°F aerated			G	U		G		G	G	G	G	D	G	G
	Concentrated; 70°F							G	G	G					

1. The information given in this table has been tabulated from various references, for use as a general guide. Before specific applications are made all service conditions, such as pressures, temperatures, concentrations, operating cycles, etc., should be reviewed with the manufacturer or fabricator.

\* Spaces left blank in the "Exposure Conditions" column indicate information on exact test conditions unavailable.

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## ITT GRINNELL - PIPING DESIGN AND ENGINEERING

## CHEMICAL RESISTANCE OF PIPING MATERIALS (Continued)

G-Good  
F-Fair  
D-Depends on Conditions  
U-Unsuitable

Chemical	Exposure Conditions	2S Aluminum	Red Brass	Cast Iron	Copper	Lead	Low Carbon Steel	Monel	Stainless Steels			Wrought Iron	Glass	Natural Hard Rubber	Natural Soft Rubber
									304	316	347				
Ammonium Chloride	Dry Powders	G													
	5%: boil		U	G	U	D	D	G	D	D	D	G	G	G	G
	23-40%: boil in Evap. 216°F							G							
	Saturated at 70°F							G	G	G					
Ammonium Hydroxide		F	U	G	U	G	D	D	G	G			D	D	D
Ammonium Nitrate		F	U	D	U	G	D	D	G	G			D	D	D
Ammonium Phosphate		U	D-F	G	U		D	G	G	G	G		G	G	G
Ammonium Sulphate	5% Max; Rm	G						G	G	G	G		G	G	G
	Sat. +5% Sulphuric; 150°F		D-F	G	F		G	G	G	G	G		G	G	G
	10%: boil							G							
Amyl Acetate		G	G	G	G		D	G	G	D	G				
Amyl Alcohol		G	G	G	G	G	D	G	G	G	G		G	U	U
Aniline, Aniline Oil		U		G	U		D	G	G	G	G		G	F	U
Aniline Dyes				D	U		U	G	G	G	G		G	U	U
Asphalt		G		G	G		U	G	G	G	G		G	U	U
Barium Chloride		U	D	G	D		F	G	G-D	G-D	G-D		G	G	G
Barium Hydroxide		U		G	U	U	F	G	G	G	G		G	G	G
Barium Sulphide				G	U	G	F	G	G	G	G				
Beer		G		G	G		U	G	G	G	G				
Best Sugar Liquors		G		G	G		U	G	G	G	G				
Benzene, petroleum ether, naphtha							G	G	G	G	G				
Benzol		G		G	G	G	D	G	G	G	G				
Black Sulphate		G	G	G	G		D	G	G	G	G		G	U	U
Liquor				G	F		G	G	G				G	U	U
Black Furnace Gas				G	F		G	G	G						
Borax		F		G	F	U	G	D	D		G				G
Boric Acid		G	G	D	F	G	G	G	G	G	G		G	G	D
	4%: 104°F	G					U	G	G	G	G		G	G	G
Bromine		G					U	G	U	U	U		D	D	D
	Dry		G		G		G	G							
	Moist		D		D		U	G							
Butane		G					G	G	G						
Butyl Acetate		G	G	G	G	G	G	G	G	G	G		G	U	U
Butyl Alcohol							G	G	G	G	G				
Butanol		F	G	G	G	G	F	G	G	G	G		G	U	U
Calcium Bisulphate		D		U	U	G	F	F	G	G	G		G	D	G
Calcium Chloride		U	F-G	G	G			G	D	G	D		G	D	D
	35% in Evap. 160°-320°F							G					G	G	G
Calcium Hydroxide		U	G	G	G	D	G	G	F	G	F		F	G	G
Calcium Hypochlorite	Rm	D													
			F-D	D	D		F		D	G	D			D	D
	3 g. p.l. max free Cl <sub>2</sub> 70°F														
	Over 3 g. p.l. max free Cl <sub>2</sub> 70°F							G							
	2%: 70°							U							
	Under 77°F: agitation							F	D	G	D				
Cake Liquors													D		
Case Sugar Liquors		G		G	G	G	G	G	G	G	G				G
Carbon Disulphide		G		G	U		G	G	G	G	G				G
Carbon Dioxide	Dry	G	G	G	G	G	G	G	G	G	G				U
	Wet	F	U	D	U	U	F	G	G	G	G		G	G	G
Carbon Monoxide	Hot	G	D	G	U	G	D	D	G	G	G		G	G	G
Carbon Tetrachloride		D	D	D	D	F	D	G	D	D	D		G	U	U
Carbonic Acid		G	U	D	U	D	F	G	G	G	G		G	U	U
Castor Oil		G		G				F	G	G	G		G	G	G

1. The information given in this table has been tabulated from various references, for use as a general guide. Before specific applications are made all service conditions, such as pressures, temperatures, concentrations, operating cycles, etc., should be reviewed with the manufacturer or fabricator.

\*Spaces left blank in the "Exposure Conditions" column indicate information on exact test conditions unavailable.



## PIPING MATERIALS

## CHEMICAL RESISTANCE OF PIPING MATERIALS (Continued)

Chemical	Exposure Conditions	2S Aluminum	Red Brass	Cast Iron	Copper	Lead	Low Carbon Steel	Monel	Stainless Steels			Wrought Iron	Glass	Natural Hard Rubber	Natural Soft Rubber
									304	316	347				
China Wood Oil, Tung Oil		G		G			F	G	G	G					
Chloroacetic Acid	100%: 158°F	D	F-D		D		F	G	G	F	C		G	D	U
Chlorinated Solvents	Dry	G						G	G				G		U
Chlorine	Wet	U			G	C	G-F	G	G			G	G	G	U
	Dry	U			U	F	U		D			G	G	G	U
	Moist	G	G	D	G	G	G-F	G	F	G	U	G	G	D	D
	Dry: to 800°F	U	D		D		U		U	F	U	G			
Chlorosulphonic Acid		G	U		F	F	D	F	F	F	F		G		U
Chromic Acid	10% Aque: Rm	F	U		U		Q						G		U
	Saturated: to boil												G		U
	5%: 70°F			U			U		U-D	U-D	U		G	D	U
Citric Acid		G-F	G	D	D	G	F	G	G	G	G		G		U
Coke Oven Gas								G	G	G	G		G		U
Copper Chloride		U			G		G	G	G	G	G		G	G	G
Copper Sulphate		U	G-F	D	G	G	U	F	U	U	U	G	G	G	D
	10%: 60°F: unperated	U					U	G	G	G	G		G	G	D
Corn Oil		G						G	G	G	G		G		U
Cotton Seed Oil		G		G			G	G	G	G	G		G		U
Cresolate		G		D	G		G	G	G	G	G		G		U
Cresols, Cresylic Acid		G		G	G		G	G	G	G	G		G		U
		G-F	G	D	G	D	G	F	G	G		G	G		U
Dowtherm A		G			U		G					G	G	U	U
Dowtherm E		U			G		G					G			U
Ethers		G	D	G	D	G	D	G	G	G	G		G	U	U
Ethyl Acetate		F		G			G-D	G	G	G	G		G	U	U
Ethyl Cellulose				G				G	G	G	G		G	U	U
Ethyl Chloride		U	G	U	G	G	G	G	G	G	G		G	U	U
Ethylene Glycol		G-D		G	G	G	G	G	G	G	G		G	U	U
Ferric Chloride		U	U	U	U		U	U	U	F	U		G	D	G
Ferric Sulphate		F	U	U	U		U	U	U	F	U		G	G	G
Ferrous Sulphate		G	D-F	D	D		D	G	G	G	G		G	G	G
Formaldehyde	38% Rm No free formic acid	G-F											G	G	G
	40%: 70°F—Boil		G	U	G	G	G	G	D	D	D		G	G	D
Formic Acid		D	U	G	D	D	D	G	D	G	D		G	G	D
Freon		G			G	G	G	G	D	G	D		G	G	D
Fuel Oil		D	G	G	G	D	D	G	D	D	D		G	G	D
Fuel Oil, Acid		D			G	D	D	G	G	G	G		G		U
Furfural		G		G	G		G	G	D	G	D		G		U
Gasoline	Sour	D		D	D	G	F-U	G	D	G	G		G	D	U
	Refined	G		G	G		G	G	G	G	G		G	D	U
Gelatin		G		D	G		G	G	G	G	G		G	D	U
Glycerol		G		D	G		G	G	G	G	G		G	D	U
Glycol		G		G			G	G	G	G	G		G	G	G
Glycerin, glycerol		G-D		G			G	G	G	G	G		G	G	G
Green Sulphate		G	G	G	F	G	G	G	G	G	G		G	F	F
Liquor													G	G	G
Hydrobromic Acid		U		U	D	D	D	U	U	U					G
Hydrocarbons (Aliphatic)		G	G		G			G	G	G	G		G	D	U
Hydrocarbons (Aromatic)		G	G		G			G	G	G	G		G	D	U
Hydrochloric Acid	0.5%: Boil	U	D	U	D	U	U	G	G	G	G		G	U	U
	1% aerated and agitated 70°F							G	G	G	G		G	G	G
Hydrocyanic Acid		G	G	G	G	D	D	G	G	G	G		G		U
Hydrofluoric Acid		U	D	U	D	G	L	D	U	U	U		U	D	D

1. The information given in this table has been tabulated from various references for use as a general guide. Before specific applications are made all service conditions, such as pressures, temperatures, concentrations, operating cycles, etc., should be reviewed with the manufacturer or fabricator.

\* Spaces left blank in the "Exposure Conditions" column indicate information on exact test conditions unavailable.



## ITT GRINNELL — PIPING DESIGN AND ENGINEERING

## CHEMICAL RESISTANCE OF PIPING MATERIALS (Continued)

Chemical	Exposure Conditions	2S Aluminum	Red Brass	Cast Iron	Copper	Lead	Low Carbon Steel	Monel	Stainless Steels			Wrought Iron	Glass	Natural Hard Rubber	Natural Soft Rubber
									304	316	347				
Hydrofluoric Acid	10%: 70°F							G							
Hydrofluosilicic Acid	Vapors: 212°F					D				G					
Hydrogen Gas	Cold	U	G	U	G	G	U	G	D	D	D		D	G	G
	Hot	D			G	G	G	G	G	G			G	G	G
Hydrogen Peroxide	30-95%	G			U	U	U	G	G	G	G		D	F	F
	30%: 86°F		G-D	U	D	G	U		D	G	D		G	D	D
Hydrogen Sulphide	Dry, Cold	G	F	D	U	G	G	G	G	G	G		G	D	D
	Dry, Hot	G	F	D	U	G	G	G	G	G	G		G	D	D
	Wet, Cold	G	U	D	U	F		G	G	G	G		G	D	D
	Wet, Hot	G	U	D	U	F		G	G	G	G		G	D	D
Iodine	*	U	U	U	U	U	U	U	U	U	U		G	D	D
	Dry: 70°F												G	D	D
	Moist: 70°F								U				G	D	D
Kerosene		G			G	G	G	G	G	G	G		G		D
Lacquers		G			D		D	G	G	G			G		D
Lacquer Solvents		G			D		D	G	G	G					D
Lactic Acid	*	G-F	G	G	G		U	G	G	G			G	G	D
	5%: 70°F unacrated												G		D
	45%: Storage: Rm												G		D
	30-60%: evap; boil at 115°F												G		D
	5%: 70°F							U					G		D
Linseed Oil		G		G	G	G	G	G	G	G	G		G		D
Lubricating Oils	Sour	D		D	G	G	G	G	G	G	G		G		D
	Refined	G			G	G	U	G	D	G	G		G		F
Magnesium Chloride	Dry Powders	G											G		F
	Solution: Rm	F											G		F
	*		G-F	G	F-D	F	F		D	G	D		G	G	G
	48%: boil at 330°F								G	D	D		G	G	G
	5%: 70°F								F	G			G		
Magnesium Hydroxide		U			U		F	G	G	G			G		
Magnesium Sulphate		G-D	G	G	G	G	G-F	G	G	G	G		G	G	G
Mercuric Chloride	Dilute Solutions	U	U	G	U	U	U	U	U	U	U		G	G	G
Mercury		U	U	G	U	U	U	U	U	U	U		G	G	G
Methyl Alcohol, methanol		F	G	G	G	G	G	G	G	G	G		G	G	G
Methyl Chloride		U		G	G	G	G	G	G	G	G		G	U	G
Milk		G		D	G	G	U	G	G	G	G		G	G	D
Mineral Oils		G		G	G	G	U	G	G	G	G		G	G	D
Natural Gas		G		G	D	G	G	G	G	G			G		D
Nickel Chloride	Solution	U					U	D	F	F	F		G		F
Nickel Sulphate	Hot & Cold	U					U	D	F	F	F		G		F
Nitric Acid	Over 80%	G		G	U	U	U	G	G	G	G		G		G
	Under 80%	F-U											G		
	*		U	D	U	U	U	U					G	D	U
	All %: Rm								G	G	G		U	G	U
	65%: Boil								G	G	G		U	G	U
Nitrobenzene		G	G	G	F	D	G	G	G	G	G		G	U	U
Oleic Acid	*	G	G	D	D		F	G	G	G	G		G	D	U
	concentrated, agitated, aerated: 200°F Max						G						G	D	U
	Boil												G	D	U
Oilum Spirits		U	U	G	U	F	G	G	D	D	D		G	U	U
Oxalic Acid	*	D	G	D	G	U	U		D	D	D		G	D	D
	Dry Powders	G											G	D	D
Oxygen	20-50%: 100-175°F												G		
	Cold	G	G	G	G	G	G	G	G	G	G		G	D	D
	Less than 500°F	G	G	G	G	U	G	G	G	G	G		G	D	D
	500-1000°F	D			U	U		G	G	G	G				U

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\* Spaces left blank in the "Exposure Conditions" column indicate information on exact test conditions unavailable.

## PIPING MATERIALS

## CHEMICAL RESISTANCE OF PIPING MATERIALS (Continued)

G-Good F-Fair D-Depends on Conditions U-Unsuitable

Chemical	Exposure Conditions	2S Aluminum	Red Brass	Cast Iron	Copper	Lead	Low Carbon Steel	Monel	Stainless Steels			Wrought Iron	Glass	Natural Hard Rubber	Natural Soft Rubber
									304	316	317				
Oxygen	Over 1000°F	U			U	U		U	U	U	G		D		U
Palmitic Acid		G		D	D	D	F-D	G	G	G			G		F
Petroleum Oils, Crude	Less than 500°F	G		G	D	D	G	D	G	G			G	D	D
	Over 500°F	G			U	U		U	G	G			G	U	U
	Over 1000°F	U			U	U		U	D	D	G		G	U	U
Phenol (Carbolic Acid)	Rm -212°F Moisture inhibits action	G													
Phosphoric Acid		U	D	D	D	F-D	U	G	G	G	G	U	G	D	U
	12%; 212°F; unagitated							G					G		
	85%; aerated, agitated, 70°F								G	G			G	G	G
	40% Max; 212°F Max agitation												G		
Picric Acid	Molten	F			U	U	F	U	G	G	G		G	G	G
	Water Solution	U		G	U	U	U	D	G	G	G		G	G	G
Potassium Chloride		D		G	G	G	U	G	D	G	G		G	G	G
Potassium Cyanide		U		G	U	U	F	G	G	G	G		G	G	G
Potassium Hydroxide		U	D	G	D	U	F	G	G	G	G	G	D	G	G
Potassium Sulphate		G	G	G	G	G	F	G	G	G	G		G		G
Producer Gas		G		G	D	G	G	G	G	G	G		G		
Propane						G	G	G	G	G	G				
Sewage		F		G	D	G	U	G	F	F	F		D		D
Soap Solutions				G	D	G	G	G	G	G	G	G	G		D
Sodium Bicarbonate, baking soda		G		G	D	G	F	G	G	G	G	G	D		G
Sodium Bisulphate		D		G	F	G	F-D	G	D	D	D		G	G	G
Sodium Carbonate	0.1% Max Over 0.1%	G													
		F-U													
Sodium Chloride	Dry Powders	G		G-F	G	G		G	G	G	G	G	D	G	G
	Saturated; 200°F	G-F	G-F	D	G	D-U	D-U	G	D	G	D		G	G	G
	Cold; Sat. Sol. 70°F	U	G										G		
	Hot; Sat. at 212°F	D											G		
Sodium Cyanide		U		G	U	F	F	G	G	G	G		G	G	G
Sodium Hydroxide		U	D-F	G	D	U	F	G	G	G	G	G-D	D	G	G
	50%; 180°F														
	75%; 275°F														
Sodium Hypochlorite		U	D-F		D		U	F	D	G	D	U	D	D	G
	50%; 180°F												D		
	75%; 275°F												D		
Sodium Metaphosphate		G			D	G	F	G	G						G
Sodium Nitrate		G-D	G	D	G		G	G	F	G	G	G	G	G	G
	27%; 122°F														
Sodium Perborate		G					F	G	G	G			G		D
Sodium Peroxide		G					F	G	G	G			D		D
Sodium Phosphate, monobasic		G			D		F	G		G			D	G	G
Sodium Phosphate, dibasic		G			G		F	G		G			D	G	G
Sodium Phosphate, tribasic		U			U	G	G	G		G			D	G	G
Sodium Silicate		D		G	D	U	G	G	G	G			D	G	G
Sodium Sulphate		D		G	G	G	F	G	G	G	G	G	G	G	G
Sodium Sulphide	Solution	U	U	G	U	D	G	G				G	D	G	G
	Dry Powders	G		D	G	D	F	F	G	D	G	G	D	G	G
	50%; 320°F								G	G	G				
	Saturated								U		G				
Sodium Sulphite	Solution	G-F													
	Dry Powders	G													

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\* Spaces left blank in the "Exposure Conditions" column indicate information on exact test conditions unavailable.

## ITT GRINNELL — PIPING DESIGN AND ENGINEERING

## CHEMICAL RESISTANCE OF PIPING MATERIALS (Continued)

G-Good F-Fair D-Depends on Conditions U-Unsuitable

Chemical	Exposure Conditions	2S Aluminum	Red Brass	Cast Iron	Copper	Lead	Low Carbon Steel	Monel	Stainless Steels			Wrought Iron	Glass	Natural Hard Rubber	Natural Soft Rubber
									304	316	347				
Sodium Sulphate	7.5% + 2% NaHCO <sub>3</sub> ; 75°F	G	G-F	G	G	G	G	G	G	G	G	G	G	G	G
	Rm							G							
	Solution in pulp and paper ind.								G	G					
Sodium Thiosulphate	1-5% Sol.; Rm Dry Powders	G								G					
Soybean Oil		G	D	G	D	G	U	G	G	G	G	G	G	G	G
Stannic Chloride		U		F	U		U	D	G	G	D	G	G	G	D
Steam	Less than 500°F	G	G	G	G	D	G	G	G	G	G	G	G	G	G
	500°-1000°F	D	U	U	D	U	D	D	G	G	G	G	G	G	D
	Over 1000°F	U	U	U	U	U	U	U	G	G	G	D	D		U
Stearic Acid	Boil	G	D	D	G	G	G	G	G	G	G	U	G		U
Sulphur		G			D		U	G					G	D	D
	Solid		D-F				G		D	D	D		D	D	D
	Molten; 260°F							G							
	Molten; 500°F														
	Boil; 830°F							F							
Sulphur Chloride		U		G	U	G	D	G	U	D	D		G	U	U
Sulphur Dioxide	Dry	G		G		G	D	G	D	D	D		G	D	D
	Moist		G		G		G	G	D	D	D		G	D	D
	Gas; 70-575°F		G-F		G			U	G	G	G		G		
Sulphuric Acid									G						
	Dilute Conc.	G	U	U	U	G	U	G	G	G	G	U	G	D	D
	High Conc. Hot	U	U	D	U	U	G	U	U	D	U		G	G	
	High Conc. Cold	U	U	G	U	G	G	U	U	D	U		G	G	
Sulphurous Acid		F	F-G	G	G	G	U	F	D	D	D	G	G	D	D
	1% 68°F												G		
	Saturated; 70°F							F					G		
Sulphur Trioxide, dry		G			G	G	G	G	G			G			G
Tannic Acid		D			G	U	U	G	F	G	G				G
Trichlorethylene	Dry	G	G		G	U	U	G	F	G	G		G	G	G
	Moist		F				U						G		
	Boil			D	G				D	G	D		G	U	U
Tar		G-F	D	G	D	U	G	G					G	U	U
Tartaric Acid		G		G	G	G	U	G	G	G	G	G	G		D
Toluene		G	G	G	G	G	D	G	G	G	G	G	G	G	G
Turpentine		G	D	G	D	G	G	G	G	G	G	G	G	U	U
Vinegar		G-D			D		U	G	F	G	G		G	D	D
Water, acid mine, cont g oxidizing salts		D		D	D	U	U	G	G			G	G	G	G
Water, acid mine, no oxidizing salts		G		G			U	G				G	G	G	G
Water, fresh, (tap, etc.)		G	G	G	G	G	D	G	G	G		G	G	G	G
Water, distilled, lab grade		G		U	U	U	U	D	G	G		U	G	G	G
Water, return condensate		G	G		G	G	F	G	G	G		G	G	G	G
Water, seawater		G		G	D	G	F-U	G	F	F		G	G	G	G
Whiskey and Wines				G		U		G	F	G			G	G	G
Zinc Chloride		U		D	U	G	U	G	G-D	G-D		U	G	D	D
Zinc Sulphate		D	G	G	U	G	D	G	G	G	G	G	G	G	G

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\* Spaces left blank in the "Exposure Conditions" column indicate information on exact test conditions unavailable.



## PIPING MATERIALS

## PRESSURE — TEMPERATURE RATINGS

PRESSURE — TEMPERATURE RATINGS OF PLAIN END PIPE OF TYPES  
COMMONLY USED IN POWER PLANT PIPING SYSTEMS

Pressure-temperature ratings tabulated on the following pages of carbon steel and low alloy steel pipe commonly used in power plant piping systems within the scope of the Code for Pressure Piping, ANSI B31.1 — 1973 and Section I on Power Boilers of the 1974 ASME Boiler and Pressure Vessel Code. No allowances have been included in these ratings for fabrication tolerances,

such as thinning due to bending. The allowable stress values and formulae used are in accordance with all addenda, interpretations, and/or revisions applicable to these codes in effect Dec. 31, 1975. Pipe wall thicknesses and weights are as given in ANSI B36.10 — 1975 and ANSI B36.19 — 1975.

The following formulae were used for the pressure-temperature ratings published in this bulletin:

B31.1 — 1973 Piping Code, Paragraph 104

ASME Power Boiler Code, Section I, Paragraph PG-27.2.2

$$P = \frac{2SE(t_m - A)}{D_o - 2y(t_m - A)}$$

$$P = \frac{2SE(t_m - C)}{D_o - 2y(t_m - C)}$$

Where  $t_m$  = Minimum pipe wall thickness in inches (87½% of nominal wall thickness)

$P$  = Maximum internal service pressure in pounds per square inch gage. Where the calculated maximum allowable working pressure exceeds an even unit of 10, the next higher unit of 10 may be used.

$D_o$  = Outside diameter of pipe in inches.

$E$  = An efficiency factor for longitudinal welded pipe. Pressure-temperature ratings shown in this bulletin are based on  $E = 1.00$ . Reference must be made to the applicable Code to determine the  $E$  factor for all pipe other than seamless.

$S$  = Allowable stress in material due to internal pressure, at the design temperature, in pounds per square inch.

$C$  = Allowance for threading and structural stability.

.065 inch for ½ to 3½ inch pipe size.

.000 for 4 inch pipe size and larger.

$A$  = .000" for plain end pipe, or depth of thread or groove for threaded or grooved end pipe

\*NOTE. No allowance has been made herein for corrosion and/or erosion — if such allowances are required, as determined by the designer, they shall be added to "C" in the applicable formulae above and the reduced allowable pressure calculated thereunder

$y$  = a coefficient having values as follows:

Temp. °F	900° and below	950°	1000°	1050°	1100°
Ferritic Steels	0.4	0.5	0.7	0.7	0.7

NOTE:  $y$  may be interpolated between the 50°F intervals in the above table

Section I of the Code for Pressure Piping states: "(1) Upon prolonged exposure to temperatures above 775°F, the carbide phase of carbon steel may be converted to graphite, and (2) upon prolonged exposure to temperatures above 875°F the carbon phase of Carbon-Molybdenum steel may be converted to graphite." There are similar limitations in Section I of the ASME Boiler Code. In view of these limitations, pressure-temperature ratings are not tabulated in this bulletin for temperatures above these values. Also, pressure-temperature ratings are not tabulated for temperature levels where allowable

stress values are not given at the same temperature in both the Code for Pressure Piping and the ASME Boiler Code.

The applicable Code should be checked to assure that selection of pipe to any specification is within the code limitations.

For permissible allowances for variations in Pressure and Temperature, reference should be made to paragraph 102.2.4 in the Code for Pressure Piping and paragraph PG-58 in the ASME Boiler Code.

NOTE. Pressure-temperature ratings tabulated on the following pages can be used under ASME Boiler and Pressure Vessel Code Section I, for piping 4" nominal size and larger

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## ITT GRINNELL -- PIPING DESIGN AND ENGINEERING

PRESSURE -- TEMPERATURE RATINGS  
OF PLAIN END

Seamless Carbon Steel Pipe to ASTM A53 Grade B and ASTM A106 Grade B

TEMPERATURE, DEGREES F. —				-20 TO 650	700	750	775
ALLOWABLE STRESS "S" PSI —				15,000	14,300	12,900	11,850
Pipe Size Inches	Schedule Number	Wall Designation	Wall Thickness Inches	Maximum Working Pressure, PSI			
$\frac{1}{2}$ (0.840)	40	STD	0.109	3743	3568	3219	2957
	80	XS	0.147	5252	5007	4517	4149
	160	—	0.188	6992	6665	6012	5523
	—	XXS	0.294	12153	11586	10451	9601
$\frac{3}{4}$ (1.050)	40	STD	0.113	3059	2916	2631	2417
	80	XS	0.154	4299	4099	3697	3396
	160	—	0.219	6426	6126	5526	5076
	—	XXS	0.308	9712	9269	8352	7672
1 (1.315)	40	STD	0.133	2847	2714	2449	2249
	80	XS	0.179	3960	3775	3405	3126
	160	—	0.250	5764	5495	4957	4553
	—	XXS	0.358	8820	8408	7585	6968
1 $\frac{1}{2}$ (1.660)	40	STD	0.140	2363	2253	2032	1807
	80	XS	0.191	3282	3129	2823	2593
	160	—	0.250	4425	4218	3805	3495
	—	XXS	0.382	7194	6858	6187	5683
1 $\frac{1}{2}$ (1.900)	40	STD	0.145	2118	2020	1822	1674
	80	XS	0.200	2983	2844	2565	2356
	160	—	0.281	4233	4131	3726	3423
	—	XXS	0.400	6481	6179	5574	5120
2 (2.375)	40	STD	0.154	1787	1703	1536	1411
	80	XS	0.218	2579	2458	2217	2037
	160	—	0.344	4231	4034	3639	3342
	—	XXS	0.436	5538	5279	4762	4375
2 $\frac{1}{2}$ (2.875)	40	STD	0.203	1954	1863	1681	1544
	80	XS	0.276	2708	2581	2328	2129
	160	—	0.375	3766	3590	3239	2975
	—	XXS	0.552	5823	5551	5007	4600
3 (3.500)	40	STD	0.216	1693	1614	1456	1338
	80	XS	0.300	2398	2286	2063	1895
	160	—	0.438	3598	3430	3094	2842
	—	XXS	0.600	5114	4875	4398	4040
3 $\frac{1}{2}$ (4.000)	40	STD	0.226	1546	1474	1330	1221
	80	XS	0.318	2284	2177	1964	1804
	160	—	0.438	3598	3430	3094	2842
	—	XXS	0.600	5114	4875	4398	4040
4 (4.500)	40	STD	0.237	1433	1383	1232	1132
	80	XS	0.337	2076	1979	1785	1640
	120	—	0.438	2740	2612	2356	2164
	160	—	0.581	3379	3222	2906	2670
5 (5.563)	40	STD	0.258	1260	1201	1083	995
	80	XS	0.375	1856	1770	1596	1466
	120	—	0.500	2521	2403	2168	1991
	160	—	0.625	3202	3052	2753	2529
6 (6.625)	40	STD	0.270	1153	1101	991	913
	80	XS	0.375	1656	1570	1406	1296
	120	—	0.500	2221	2103	1868	1691
	160	—	0.625	2902	2752	2453	2229

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## PIPING MATERIALS

PRESSURE — TEMPERATURE RATINGS  
OF PLAIN END

Seamless Carbon Steel Pipe to ASTM A53 Grade B and ASTM A106 Grade B

TEMPERATURE, DEGREES F. ———				-20 TO 650	700	750	775
ALLOWABLE STRESS "S" PSI ———				15,000	14,300	12,900	11,850
Pipe Size Inches	Schedule Number	Wall Designation	Wall Thickness Inches	Maximum Working Pressure, PSI			
6 (6.625)	40	STD	0.280	1143	1090	983	903
	80	XS	0.432	1794	1710	1542	1417
	120	—	0.562	2369	2258	2037	1871
	160	—	0.719	3082	2933	2651	2435
	—	XXS	0.864	3767	3591	3240	2976
8 (8.625)	20	—	0.250	778	741	669	614
	30	—	0.277	861	821	740	680
	40	STD.	0.322	1007	960	866	796
	60	—	0.406	1277	1217	1098	1009
	80	XS	0.500	1588	1514	1366	1254
	100	—	0.594	1900	1812	1634	1501
	120	—	0.719	2323	2215	1998	1835
	140	—	0.812	2648	2524	2277	2092
	—	XXS	0.875	2868	2734	2466	2266
10 (10.750)	160	—	0.906	2977	2838	2560	2352
	20	—	0.250	621	592	534	491
	30	—	0.307	766	730	659	605
	40	STD.	0.365	912	869	784	720
	60	XS	0.500	1264	1205	1087	998
	80	—	0.594	1510	1439	1298	1193
	100	—	0.719	1842	1756	1584	1455
	120	—	0.844	2182	2080	1877	1724
	140	XXS	1.000	2612	2490	2246	2063
12 (12.750)	160	—	1.125	2963	2825	2548	2341
	20	—	0.250	522	498	449	413
	30	—	0.330	693	660	596	547
	—	STD	0.375	788	751	678	622
	40	—	0.406	854	814	735	675
	—	XS	0.500	1060	1010	911	837
	60	—	0.562	1195	1139	1027	944
	80	—	0.688	1472	1403	1266	1163
	100	—	0.844	1823	1738	1568	1440
14 (14.000)	120	XXS	1.000	2178	2077	1873	1721
	140	—	1.125	2468	2352	2122	1949
	160	—	1.312	2911	2775	2503	2299
	10	—	0.250	475	453	409	375
	20	—	0.312	594	567	511	469
	30	STD	0.375	716	683	615	566
	40	—	0.438	839	800	722	663
	—	XS	0.500	963	918	828	760
	60	—	0.594	1148	1095	988	907
16 (16.000)	80	—	0.750	1460	1392	1256	1154
	100	—	0.938	1846	1760	1587	1458
	120	—	1.094	2169	2068	1866	1714
	140	—	1.250	2501	2384	2150	1975
	160	—	1.406	2835	2703	2438	2240



## ITT GRINNELL — PIPING DESIGN AND ENGINEERING

PRESSURE — TEMPERATURE RATINGS  
OF PLAIN END

Seamless Carbon Steel Pipe to ASTM A53 Grade B and ASTM A106 Grade B

TEMPERATURE, DEGREES F —				-20 TO 650	700	750	775
ALLOWABLE STRESS "S" PSI —				15,000	14,900	12,900	11,850
Pipe Size Inches	Schedule Number	Wall Designation	Wall Thickness Inches	Maximum Working Pressure, PSI			
16 (16.000)	10	—	0.250	415	396	357	328
	20	—	0.312	519	495	446	410
	30	STD	0.375	625	596	538	494
	40	XS	0.500	840	800	722	663
	60	—	0.656	1108	1056	953	875
	80	—	0.844	1439	1372	1237	1137
	100	—	1.031	1771	1688	1523	1399
	120	—	1.219	2113	2015	1817	1669
	140	—	1.438	2517	2400	2165	1988
	160	—	1.594	2812	2680	2418	2221
18 (18.000)	10	—	0.250	369	351	317	291
	20	—	0.312	461	439	396	364
	30	STD	0.375	553	529	477	438
	40	XS	0.438	649	619	558	513
	60	—	0.500	744	710	640	588
	80	—	0.562	838	799	721	662
	100	—	0.750	1126	1074	968	890
	120	—	0.938	1420	1354	1221	1122
	140	—	1.156	1766	1684	1519	1395
	160	—	1.375	2118	2019	1822	1673
20 (20.000)	10	—	0.250	331	316	285	262
	20	STD	0.375	499	475	429	394
	30	XS	0.500	669	637	575	528
	40	—	0.594	797	759	685	629
	60	—	0.812	1098	1046	944	867
	80	—	1.031	1404	1338	1207	1109
	100	—	1.281	1760	1678	1514	1391
	120	—	1.500	2079	1982	1788	1642
	140	—	1.750	2446	2332	2104	1932
	160	—	1.969	2776	2646	2387	2193
22 (22.000)	10	—	0.250	301	287	259	238
	20	STD	0.375	453	432	389	358
	30	XS	0.500	607	579	522	479
	40	—	0.875	1074	1024	924	849
	60	—	1.125	1392	1327	1197	1099
	80	—	1.375	1715	1635	1475	1355
	100	—	1.625	2045	1949	1758	1615
	120	—	1.875	2380	2269	2046	1880
	140	—	2.125	2719	2592	2338	2148
	160	—	2.344	301	287	259	238
24 (24.000)	10	—	0.250	276	263	237	218
	20	STD	0.375	415	395	356	327
	30	XS	0.500	556	530	478	439
	40	—	0.562	625	596	538	494
	60	—	0.688	768	732	660	607
	80	—	0.969	1091	1040	938	862
	100	—	1.219	1383	1318	1189	1092
	120	—	1.531	1753	1671	1508	1385
	140	—	1.812	2093	1995	1806	1651
	160	—	2.062	2399	2287	2063	1895
26 (26.000)	10	—	0.250	252	240	216	198
	20	STD	0.375	381	363	327	300
	30	XS	0.500	511	488	441	405
	40	—	0.562	581	556	504	466
	60	—	0.688	701	672	616	574
	80	—	0.969	951	908	824	766
	100	—	1.219	1181	1134	1034	966
	120	—	1.531	1431	1380	1266	1188
	140	—	1.812	1681	1626	1496	1398
	160	—	2.062	1931	1872	1726	1618

## ITT GRINNELL -- PIPING DESIGN AND ENGINEERING

PRESSURE -- TEMPERATURE RATINGS  
OF PLAIN END

Seamless Stainless Alloy Steel Pipe to ASTM A312 &amp; A376 Grade TP-304 &amp; TP-304H

Temperature, Degrees F. —			-20 TO 100	200	300	400	500	600	650	700
Allowable Stress "S" PSI —			18,700	17,700	16,600	16,100	15,900	15,900	15,900	15,900
Pipe Size	Schedule Number	Wall Thickness	Maximum Working Pressure, PSI							
1/2	10S	.083	3493	3306	3101	3007	2970	2970	2970	2970
	40S	.109	4651	4402	4128	4004	3954	3954	3954	3954
	80S	.147	6548	6198	5813	5638	5568	5568	5568	5568
	160	.188	8716	8250	7737	7504	7411	7411	7411	7411
	XXS	.294	15151	14341	13450	13044	12882	12882	12882	12882
3/8	10S	.083	2753	2606	2444	2371	2341	2341	2341	2341
	40S	.113	3814	3610	3386	3284	3243	3243	3243	3243
	80S	.154	5360	5073	4758	4615	4557	4557	4557	4557
	160	.219	8011	7582	7111	6897	6811	6811	6811	6811
	XXS	.308	12108	11460	10748	10424	10295	10295	10295	10295
1/4	10S	.109	2868	2714	2546	2469	2438	2438	2438	2438
	40S	.133	3550	3360	3151	3058	3018	3018	3018	3018
	80S	.179	4937	4673	4382	4250	4198	4198	4198	4198
	160	.250	7186	6802	6379	6187	6110	6110	6110	6110
	XXS	.358	10996	10408	9761	9467	9349	9349	9349	9349
1/8	10S	.109	2243	2123	1991	1931	1907	1907	1907	1907
	40S	.140	2946	2788	2615	2536	2505	2505	2505	2505
	80S	.191	4092	3873	3632	3523	3479	3479	3479	3479
	160	.250	5516	5221	4897	4749	4690	4690	4690	4690
	XXS	.382	8969	8489	7962	7722	7626	7626	7626	7626
1/16	10S	.109	1483	1403	1316	1276	1260	1260	1260	1260
	40S	.145	2641	2500	2345	2274	2246	2246	2246	2246
	80S	.200	3719	3520	3301	3202	3162	3162	3162	3162
	160	.281	5402	5113	4795	4651	4593	4593	4593	4593
	XXS	.400	8080	7648	7173	6957	6870	6870	6870	6870
2	10S	.109	1545	1463	1372	1331	1314	1314	1314	1314
	40S	.154	2227	2108	1977	1918	1894	1894	1894	1894
	80S	.218	3215	3043	2854	2768	2733	2733	2733	2733
	160	.344	5275	4993	4682	4541	4485	4485	4485	4485
	XXS	.436	6904	6535	6129	5944	5870	5870	5870	5870
2 1/2	10S	.120	1407	1332	1249	1211	1196	1196	1196	1196
	40S	.203	2436	2306	2163	2097	2071	2071	2071	2071
	80S	.276	3375	3195	2996	2906	2870	2870	2870	2870
	160	.375	4695	4444	4168	4043	3992	3992	3992	3992
	XXS	.552	7259	6871	6444	6250	6172	6172	6172	6172
3	10S	.120	1150	1088	1020	990	977	977	977	977
	40S	.216	2111	1998	1874	1817	1795	1795	1795	1795
	80S	.300	2990	2830	2654	2574	2542	2542	2542	2542
	160	.438	4485	4245	3982	3862	3814	3814	3814	3814
	XXS	.600	6375	6034	5659	5489	5420	5420	5420	5420
3 1/2	10S	.120	1000	949	890	863	853	853	853	853
	40S	.226	1928	1825	1711	1660	1639	1639	1639	1639
	80S	.318	2752	2605	2443	2370	2340	2340	2340	2340

Note: These ratings reflect the use of the higher of two stress values permitted under ANSI B 31.1 Power Piping Section, see note in introduction

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## PIPING MATERIALS

PRESSURE — TEMPERATURE RATINGS  
OF PLAIN END

Seamless Stainless Alloy Steel Pipe to ASTM A312 &amp; A376 Grade TP-304 &amp; TP-304H

Temperature Degrees F —			750	800	850	900	950	1,000	1,050	1,100	1,150	1,200
Allowable Stress "S" PSI —			15,500	15,100	14,900	14,600	14,300	13,700	12,100	9,700	7,700	6,000
Pipe Size	Schedule No.	Wall Thickness	Maximum Working Pressure, PSI									
1/8	10S	.083	2895	2821	2783	2727	2671	2559	2260	1846	1524	1187
	40S	.109	3855	3755	3705	3631	3556	3407	3009	2474	2069	1612
	80S	.147	5428	5267	5217	5112	5007	4797	4237	3520	3013	2348
	160	.188	7225	7038	6945	6805	6665	6386	5640	4742	4172	3251
	XXS	.294	12558	12234	12072	11829	11586	11100	9804	8552	8242	6422
1/4	10S	.083	2282	2223	2194	2150	2105	2017	1782	1450	1186	924
	40S	.113	3161	3080	3039	2978	2917	2794	2468	2020	1673	1303
	80S	.154	4443	4328	4271	4185	4099	3927	3468	2862	2415	1881
	160	.219	6640	6469	6383	6254	6126	5869	5183	4341	3785	2949
	XXS	.308	10036	9777	9647	9453	9259	8870	7834	6715	6188	4821
1/2	10S	.109	2377	2316	2285	2239	2193	2101	1856	1511	1238	964
	40S	.133	2942	2866	2828	2771	2714	2601	2297	1877	1550	1208
	80S	.179	4092	3986	3934	3854	3775	3617	3194	2630	2208	1720
	160	.250	5956	5803	5726	5610	5496	5265	4650	3876	3345	2606
	XXS	.358	9114	8879	8761	8585	8409	8056	7115	6060	5497	4284
3/4	10S	.109	1859	1811	1787	1751	1715	1643	1451	1178	958	747
	40S	.140	2442	2379	2347	2300	2253	2158	1906	1553	1273	992
	80S	.191	3392	3304	3260	3195	3129	2998	2648	2170	1803	1405
	160	.250	4572	4454	4395	4307	4218	4041	3569	2948	2492	1942
	XXS	.382	7434	7242	7146	7002	6858	6571	5803	4887	4314	3361
1 1/4	10S	.109	1229	1197	1181	1157	1134	1086	959	775	625	487
	40S	.145	2189	2133	2104	2062	2020	1935	1709	1390	1136	885
	80S	.200	3082	3003	2963	2903	2844	2724	2406	1968	1628	1269
	160	.281	4477	4362	4304	4217	4131	3957	3495	2885	2435	1898
	XXS	.400	6698	6525	6438	6309	6179	5920	5228	4381	3823	2979
2	10S	.109	1281	1248	1231	1207	1182	1132	1000	808	653	508
	40S	.154	1846	1798	1775	1739	1703	1632	1441	1169	951	741
	80S	.218	2664	2596	2561	2510	2458	2355	2080	1697	1396	1087
	160	.344	4372	4259	4203	4118	4034	3864	3413	2816	2373	1849
	XXS	.436	5722	5575	5501	5390	5279	5058	4467	3718	3197	2491
2 1/2	10S	.120	1166	1136	1121	1099	1076	1031	910	735	593	462
	40S	.203	2019	1967	1941	1902	1863	1785	1576	1280	1044	813
	80S	.276	2798	2726	2689	2635	2581	2473	2184	1783	1469	1145
	160	.375	3892	3791	3741	3666	3591	3440	3038	2498	2091	1629
	XXS	.552	6017	5861	5784	5687	5551	5318	4697	3917	3383	2636
3	10S	.120	953	928	916	898	879	842	744	600	482	376
	40S	.216	1750	1704	1682	1648	1614	1545	1366	1107	900	701
	80S	.300	2478	2414	2382	2335	2287	2191	1935	1576	1293	1008
	160	.438	3718	3622	3574	3502	3430	3286	2902	2384	1990	1551
	XXS	.600	5284	5148	5080	4977	4875	4670	4125	3424	2924	2278
3 1/2	10S	.120	831	810	799	783	767	735	649	523	420	327
	40S	.226	1598	1557	1536	1505	1474	1412	1247	1010	819	638
	80S	.318	2281	2222	2193	2149	2105	2016	1781	1449	1186	924

Note 1 These ratings reflect the use of the higher of two stress values permitted under ANSI B 31.1 Power Piping Section, see note in introduction

Note 2 Grade 304 may be used at Temperatures over 1000 F. provided the carbon is 0.04 percent or higher



## FTT GRINNELL PIPING DESIGN AND ENGINEERING

PRESSURE - TEMPERATURE RATINGS  
OF PLAIN END

Seamless Stainless Alloy Steel Pipe to ASTM A312 &amp; A376 Grade TP-304 &amp; TP-304H

Temperature Degrees F ———			-29 TO 100	200	300	400	500	600	650	700
Allowable Stress "S" PSI ———			18,700	17,700	16,600	16,100	15,900	15,900	15,900	15,900
Pipe Size	Schedule Number	Wall Thickness	Maximum Working Pressure, PSI							
4	10S	.120	889	842	789	766	756	756	756	756
	40S	.237	1786	1691	1586	1538	1519	1519	1519	1519
	80S	.337	2587	2449	2297	2226	2200	2200	2200	2200
	120	.438	3416	3233	3032	2941	2904	2904	2904	2904
	160	.531	4213	3988	3740	3627	3582	3582	3582	3582
	XXS	.674	5478	5185	4863	4716	4638	4638	4638	4638
5	10S	.134	800	757	710	689	680	680	680	680
	40S	.258	1570	1486	1394	1352	1335	1335	1335	1335
	80S	.375	2314	2191	2054	1993	1968	1968	1968	1968
	120	.500	3143	2975	2790	2706	2672	2672	2672	2672
	160	.625	3991	3778	3543	3436	3394	3394	3394	3394
	XXS	.750	4870	4609	4323	4193	4141	4141	4141	4141
6	10S	.134	670	634	595	577	570	570	570	570
	40S	.280	1425	1349	1265	1227	1212	1212	1212	1212
	80S	.432	2236	2116	1985	1923	1901	1901	1901	1901
	120	.562	2953	2795	2621	2542	2511	2511	2511	2511
	160	.719	3843	3637	3411	3308	3267	3267	3267	3267
	XXS	.864	4697	4445	4169	4044	3993	3993	3993	3993
8	10S	.148	571	540	507	491	485	485	485	485
	20	.250	969	917	860	835	824	824	824	824
	30	.277	1073	1016	953	924	913	913	913	913
	40S	.322	1256	1189	1115	1081	1068	1068	1068	1068
	60	.406	1592	1507	1413	1370	1353	1353	1353	1353
	80S	.500	1980	1874	1757	1704	1683	1683	1683	1683
	100	.594	2369	2242	2103	2040	2014	2014	2014	2014
	120	.719	2896	2742	2571	2494	2463	2463	2463	2463
	140	.812	3301	3124	2930	2842	2807	2807	2807	2807
	XXS	.875	3576	3384	3174	3078	3040	3040	3040	3040
10	10S	.163	506	479	450	436	431	431	431	431
	20	.250	775	733	688	667	659	659	659	659
	30	.307	955	904	848	822	812	812	812	812
	40S	.365	1137	1076	1009	979	967	967	967	967
	60S	.500	1575	1491	1398	1356	1339	1339	1339	1339
	80	.594	1882	1781	1671	1720	1600	1600	1600	1600
	100	.719	2296	2173	2038	1977	1952	1952	1952	1952
	120	.844	2721	2575	2415	2342	2313	2313	2313	2313
	140	1.000	3256	3082	2891	2803	2769	2769	2769	2769
	160	1.125	3694	3496	3279	3180	3141	3141	3141	3141
12	10S	.180	468	443	416	403	398	398	398	398
	20	.250	651	617	578	561	554	554	554	554
	30	.330	863	817	766	743	734	734	734	734
	40S	.375	982	930	872	846	835	835	835	835
	40	.406	1065	1008	945	917	906	906	906	906
	80S	.500	1321	1250	1173	1137	1123	1123	1123	1123
	60	.562	1489	1410	1322	1282	1266	1266	1266	1266
	80	.688	1835	1737	1629	1580	1560	1560	1560	1560
	100	.841	2273	2152	2018	1957	1933	1933	1933	1933
	120	1.000	2716	2571	2411	2338	2309	2309	2309	2309
	140	1.125	3076	2912	2731	2649	2616	2616	2616	2616
	160	1.312	3629	3435	3221	3124	3085	3085	3085	3085

Note: These ratings reflect the use of the higher of two stress values permitted under ANSI B 31.1 Power Piping Section, see note in introduction.

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## PIPING MATERIALS

PRESSURE — TEMPERATURE RATINGS  
OF PLAIN END

## Seamless Stainless Alloy Steel Pipe to ASTM A312 &amp; A376 Grade TP-304 &amp; TP-304H

Temperature Degrees F ———			750	800	850	900	950	1,000	1,050	1,100	1,150	1,200
Allowable Stress "S" PSI ———			15,500	15,100	14,900	14,600	14,300	13,700	12,100	9,700	7,700	6,000
Pipe Size	Schedule Number	Wall Thickness	Maximum Working Pressure, PSI									
4	10S	.120	737	718	709	694	680	651	575	463	371	289
	40S	.237	1480	1442	1423	1395	1366	1309	1156	935	757	590
	80S	.337	2145	2089	2062	2020	1979	1896	1674	1361	1112	866
	120	.438	2831	2758	2722	2667	2612	2502	2210	1805	1488	1159
	160	.531	3492	3402	3357	3289	3222	3056	2726	2236	1860	1450
	XXS	.674	4541	4424	4365	4277	4189	4013	3545	2927	2473	1927
5	10S	.134	663	646	637	625	612	586	518	417	334	260
	40S	.258	1302	1268	1251	1226	1201	1151	1016	822	663	517
	80S	.375	1918	1869	1844	1807	1770	1696	1497	1216	990	771
	120	.500	2605	2538	2504	2454	2403	2302	2033	1658	1363	1062
	160	.625	3308	3223	3180	3116	3052	2924	2583	2116	1756	1368
	XXS	.750	4036	3932	3880	3802	3724	3568	3151	2594	2175	1695
6	10S	.134	555	541	534	523	512	491	434	349	279	217
	40S	.280	1181	1151	1136	1113	1090	1044	922	745	601	468
	80S	.432	1853	1806	1782	1746	1710	1638	1447	1174	955	744
	120	.562	2448	2384	2353	2305	2258	2163	1911	1556	1276	996
	160	.719	3185	3103	3062	3000	2939	2815	2486	2035	1686	1314
	XXS	.864	3893	3792	3742	3667	3591	3441	3039	2499	2091	1630
8	10S	.148	473	461	455	445	436	418	369	297	237	185
	20	.250	803	783	772	757	741	710	627	505	405	316
	30	.277	890	867	855	838	821	786	695	560	450	350
	40S	.322	1041	1014	1000	980	960	920	812	656	528	411
	60	.406	1319	1285	1268	1243	1217	1166	1030	833	679	524
	80S	.500	1641	1599	1577	1546	1514	1450	1281	1038	842	656
	100	.594	1964	1913	1888	1850	1812	1736	1533	1246	1014	790
	120	.719	2401	2339	2308	2261	2215	2122	1871	1526	1251	975
	140	.812	2736	2665	2630	2577	2524	2418	2136	1743	1435	1118
	XXS	.875	2954	2887	2849	2792	2734	2620	2311	1891	1562	1217
10	160	.906	3076	2997	2957	2898	2838	2719	2402	1964	1625	1266
	10S	.165	420	409	404	395	387	371	328	263	210	164
	20	.250	642	625	617	605	592	567	501	403	323	252
	30	.307	792	771	761	746	730	700	618	498	399	311
	40S	.365	942	918	906	888	869	833	736	593	477	372
	80S	.500	1306	1272	1255	1230	1205	1154	1019	824	665	518
	90	.594	1560	1520	1500	1469	1439	1379	1218	986	799	623
	100	.719	1903	1854	1829	1792	1756	1682	1486	1206	981	765
	120	.844	2255	2197	2168	2124	2080	1993	1760	1432	1171	913
	140	1.000	2699	2629	2595	2542	2490	2386	2107	1719	1415	1102
12	160	1.125	3062	2983	2943	2884	2825	2706	2390	1955	1617	1260
	10S	.180	388	378	373	365	358	343	303	243	194	151
	20	.250	540	526	519	509	498	477	421	339	271	211
	30	.330	716	697	688	674	660	633	559	450	361	281
	40S	.375	814	793	783	767	751	720	636	512	411	320
	40	.406	883	860	849	832	814	780	699	566	446	348
	80S	.500	1095	1067	1053	1031	1010	968	855	690	556	433
	60	.562	1234	1202	1187	1163	1139	1091	964	779	628	489
	80	.688	1521	1482	1462	1433	1403	1341	1187	961	779	607
	100	.814	1884	1836	1811	1775	1738	1665	1471	1194	971	757
12	120	1.000	2251	2193	2164	2120	2077	1990	1757	1429	1169	911
	140	1.125	2550	2484	2451	2402	2359	2254	1991	1622	1332	1038
	160	1.312	3008	2930	2891	2833	2775	2659	2348	1920	1587	1236

Note 1 These ratings reflect the use of the higher of two stress values permitted under ANSI B 31.1 Power Piping Section; see note in introduction.

Note 2 Grade 304 may be used at Temperatures over 1000 F provided the carbon is 0.04 percent or higher.

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## PIPING MATERIALS

## PRESSURE — TEMPERATURE RATINGS FOR CAST AND FORGED STEEL PIPE FLANGES, FLANGED FITTINGS, FLANGED AND BUTT-WELD END VALVES

## Introductory Notes:

1. The pressure — temperature ratings in Tables 2.1 to 2.23 inclusive apply to all products covered by ANSI B16.5 — 1973. Valves conforming to the requirements of this standard must in other respects merit these ratings.

2. All ratings are the maximum allowable non-shock pressures (psig) at the tabulated temperatures (°F) and may be interpolated between the temperatures shown.

3. It is assumed temperatures of the material as shown in tables 2.1 to 2.23 inclusive is the temperature of the contained fluid.

Information in the Introductory notes, Table 1 on Materials and Pressure-Temperature Ratings, was extracted from American Standard Steel, Pipe Flanges, and Flanged Fittings (ANSI B16.5 — 1973) with the permission of the publisher. The American Society of Mechanical Engineers, 10 East 40th Street, New York 14, N. Y.

4. The use of these ratings requires gaskets conforming to the following requirements:

- Ring joint gasket dimension shall conform to ANSI B16.20.
- For flanges with raised face, or with large male-and-female face, gaskets shall conform with limiting dimensions of Appendix E of ANSI B16.5.
- For flanges having large or small tongue-and-groove faces, all gaskets except solid flat metal gaskets shall cover the bottom of the groove with minimum clearance. Solid flat metal gaskets shall have contact width not greater than shown for group III gaskets of Appendix E ANSI B16.5.
- For flanges with small male-and-female face, care must be taken to insure that adequate

bearing surface is provided for the gaskets. This applies particularly where the joint is made on the end of the pipe.

5. General. The products covered by this standard shall be either steel castings or steel forgings and the bolts, nuts, etc., shall be steel, all as listed in the respective ASTM specifications referred to in Table 1.

6. Products used within the jurisdiction of the ASME Boiler and Pressure Vessel Code and the ANSI Code for Pressure Piping are subject to the maximum temperature and stress limitations upon the material and piping stated therein.

7. The ratings at —20 to 100F given for the materials covered in Tables 2.1 to 2.23 incl., shall also apply at lower temperatures. The ratings for low temperature service of the cast and forged materials listed in ASTM A352 and A350 shall be taken the same as the —20 to 100F ratings for carbon steel in Tables 2.1 to 2.23 incl.

Some of the materials listed in the rating tables undergo a decrease in impact resistance at temperatures lower than —20F to such an extent as to be unable to safely resist shock loading, sudden changes of stress or high stress concentrations. Therefore, products that are to operate at temperatures below —20F shall conform to the rules of the applicable Codes under which they are to be used.

8. Bolting. Alloy steel bolting made of materials given in Table 1 shall be used for all flanges covered by this standard, except bolting for Class 150 and 300 flanges at temperatures of 500F and lower may be made of Grade B of ASTM A307, "Specifications for Low Carbon Steel Externally and Internally Threaded Standard Fasteners," or better.

\* Adopted as ANSI Standard.



## ITT GRINNELL — PIPING DESIGN AND ENGINEERING

TABLE 1. LIST OF MATERIAL SPECIFICATIONS  
Applicable ASTM Specifications

TABLE NO.	MATERIAL GROUP NO.	FORGINGS		CASTINGS		PLATE		BARS & SHAPES		TUBULAR PRODUCTS	
		Grade	Notes	Grade	Notes	Grade	Notes	Grade	Notes	Grade	Notes
2.1	Group 1.1	A105 A350-LF2 A350-LF3	(1)(3) (10) (10)	A216-WCB	(1)	A203-B A516-70 A516-70 A203-E	(1) (1) (1)	A105	(1)(3)	A105-C A155-KCF70 A155-KCF70 A155-CM70 A155-CM75 A155-P12 A359-FP12 A155-1CR-1.SMO-AN A155-WCR-1/4MO-NT	(1)
2.2	Group 1.2					A387A-NT A387A-AN A387B-AN					
2.3	Group 1.3					A387B-NT A387C-AN A387D-AN					
2.4	Group 1.4			A216-WCC	(1)						
2.5	Group 1.5	A350-LF1 A350-LF4	(10) (10)			A516-60 A516-60	(1) (1)	A306-60	(1)	A106-B A155-KCF60 A155-KCF60 A155-KCF65	(1)
2.6	Group 1.6			A352-LC8 A352-LC2 A352-LC3	(10) (10) (10)	A516-65 A516-65 A203-A A203-D	(1) (1) (1) (1)	A306-65	(8)		
2.7	Group 1.7	A182-F1	(2)	A217-WC1 A352-LC1 A217-WC4 A217-WC5 A217-WC6	(2)(4) (4) (4) (4) (4)	A203-A A204-B A204-C A387C-NT	(2) (2) (2) (2)	A182-F1			
2.8	Group 1.8	A182-F2						A182-F2			
2.9	Group 1.9	A182-F11 A182-F12 A182-F22 A182-F23 A182-F5						A182-F11			
2.10	Group 1.10			A217-WC9	(4)	A387D-NT		A182-F22			
2.11	Group 1.11					A357		A182-F21			
2.12	Group 1.12							A182-F5		A355-P50 A155-5CR	
2.13	Group 1.13	A182-F5A		A217-C5 A217-C12	(4) (4)	A182-F5A A182-F9					
2.14	Group 1.14	A182-F9									
2.15	Group 2.1	A182-F304 A182-F304H	(5) (5)			A240-304	(5)(7)	A479-304		A430-FP304 A376-TP304 A312-TP304 A358-304	(5)(7) (5) (5) (5)
2.16	Group 2.2			A351-CF8 A351-CF3	(9) (9)						
2.17	Group 2.3	A182-F310	(5)	A351-CH20	(5)	A240-310S	(5)	A479-310S		A358-310	

## PIPING MATERIALS

TABLE 1. LIST OF MATERIAL SPECIFICATIONS (cont'd)

TABLE NO.	MATERIAL GROUP NO.	FORGINGS		CASTINGS		PLATE		BARS & SHAPES		TUBULAR PRODUCTS	
		Grade	Notes	Grade	Notes	Grade	Notes	Grade	Notes	Grade	Notes
2.18	Group 2.4	A182-F347 A182-F348	(5) (5)	A351-CF8C	(5)	A240-347	(5)	A479-347 A479-348		A430-FP347 A376-TP347 A312-TP347 A358-347	(5)(7) (5) (5) (5)
2.19	Group 2.5	A182-F321	(5)			A240-321	(5)(7)	A479-321		A430-FP321 A376-TP321 A312-TP321	(5)(7) (5) (5)
2.20	Group 2.6	A182-F316 A182-F316H	(5) (5)			A240-316 A240-317	(5)(7) (5)(7)	A479-316		A430-FP316 A376-TP316 A312-TP316 A358-316	(5)(7) (5) (5) (5)
2.21	Group 2.7			A351-CF8M A351-CF3M	(6) (8)						
2.22	Group 2.8	A182-304L				A240-304L		A479-304L		A312-304L	
2.23	Group 2.9	A182-316L				A240-316L		A479-316L		A312-316L	
BOLTING (All Groups) A193, A194, A307, A320, A354, A453, A540, A564, A637, A638, A639											

## General Notes:

(a) Materials shall not be used beyond temperature limits specified in the governing Code.

(b) Materials shown with suffix NT are normalized and tempered.

(c) Materials shown with suffix AN are annealed.

## Notes:

(1) Upon prolonged exposure to temperatures above about 800F (425C), the carbide phase of carbon steel may be converted to graphite.

(2) Upon prolonged exposure to temperatures above about 875F (470C), the carbide phase of carbon-molybdenum steel may be converted to graphite.

(3) Only killed steel shall be used above 850F (455C).

(4) Use normalized and tempered material only.

(5) At temperatures over 1000F (540C), only use when the carbon is 0.04 percent or higher.

(6) For temperatures above 800F (425C), only use when the carbon content is 0.04 percent and above.

(7) For temperatures above 1000F (540C), use only if the material is heat treated by heating to a minimum temperature of 1900F (1040C) and quenching in water or rapidly cooling by other means.

(8) For service temperatures above 850F (455C), it is recommended that killed steels containing not less than 0.10 percent residual silicon be used.

(9) Not for use above 850F (455C).

(10) Not for use above 650F (340C).

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## MATERIALS: GROUP 1.1

A105 A106-C A155-CM70  
 A155-CM75 A155-KC70 A155-KCF70  
 A203-B A203-E A216-WCB  
 A350-LF2 A350-LF3  
 A515-70 A516-70

TABLE 2.1

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	285	740	985	1480	2220	3705	6170
200	260	675	900	1350	2025	3375	5625
300	250	655	875	1310	1970	3280	5470
400	245	635	845	1265	1900	3170	5280
500	230	600	800	1195	1795	2995	4990
600	210	545	730	1095	1640	2735	4560
650	205	535	715	1075	1610	2685	4475
700	205	535	710	1065	1600	2665	4440
750	195	505	670	1010	1510	2520	4200
800	160	410	550	825	1235	2055	3430
850	105	265	355	535	800	1335	2230
900	65	170	230	345	515	855	1430
950	40	105	135	205	310	515	855
1000	20	50	70	105	155	255	430

## MATERIALS: GROUP 1.2

A155-1/2CR-1/2Mo-NT A155-1CR-1.5Mo-AN A335-P12  
 A369-FP12 A387A-AN A387A-NT  
 A387B-AN

TABLE 2.2

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	225	585	785	1175	1760	2935	4895
200	225	585	785	1175	1760	2935	4895
300	225	585	785	1175	1760	2935	4895
400	225	585	785	1175	1760	2935	4895
500	225	580	775	1165	1745	2910	4850
600	210	565	755	1130	1695	2830	4715
650	205	550	730	1100	1650	2745	4575
700	205	530	710	1060	1590	2655	4425
750	180	470	625	940	1410	2350	3915
800	160	460	615	920	1380	2295	3830
850	105	450	600	900	1345	2245	3745
900	65	430	570	855	1285	2145	3570
950	40	365	490	735	1100	1835	3055
1000	20	215	285	425	640	1065	1770
1050		170	230	345	515	855	1430
1100		95	130	190	290	480	800
1150		50	70	105	155	255	430
1200		35	45	70	105	170	285



## PIPING MATERIALS

## MATERIALS: GROUP 1.3

A155-1CR-NT    A155-1-1/4CR-AN    A155-2-1/4CR-AN  
 A135-P22    A335-P11    A369-FP11  
 A369-FP22    A387B-NT    A387C-AN  
 A387D-AN

TABLE 2.3

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	235	615	825	1235	1850	3085	5145
200	220	575	770	1150	1730	2840	4800
300	210	555	740	1105	1660	2765	4610
400	205	540	720	1080	1615	2695	4490
500	205	530	705	1055	1585	2645	4405
600	195	515	685	1030	1545	2570	4285
650	190	500	665	995	1495	2490	4150
700	185	480	640	965	1445	2405	4010
750	180	470	625	940	1405	2345	3910
800	160	460	615	920	1380	2305	3840
850	105	445	595	895	1340	2230	3720
900	65	435	580	870	1300	2170	3615
950	40	375	505	755	1130	1885	3145
1000	20	255	345	515	770	1285	2145
1050		170	230	345	515	855	1430
1100		95	130	190	290	480	800
1150		50	70	105	155	255	430
1200		35	45	70	105	170	285

## MATERIAL: GROUP 1.4

A-216-WCC

TABLE 2.4

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	285	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	250	745	995	1490	2235	3725	6205
400	245	730	975	1465	2195	3660	6105
500	230	710	945	1420	2130	3550	5915
600	210	690	920	1380	2075	3455	5760
650	205	680	910	1360	2045	3405	5675
700	205	665	890	1335	2000	3335	5555
750	195	505	670	1010	1510	2520	4200
800	160	410	550	825	1235	2055	3430
850	105	265	355	535	800	1335	2230
900	65	170	230	345	515	855	1430
950	40	105	135	205	310	515	855
1000	20	50	70	105	155	255	430

## ITT GRINNELL — PIPING DESIGN AND ENGINEERING

## MATERIALS GROUP 1.5

A106-B      A155-KC60      A350-LF4      A155-KCF60  
A516-60      A306-60      A515-60      A350-LF1

TABLE 2.5

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	800	1500	2500
-20 TO 100	235	615	825	1235	1850	3085	5145
200	215	560	750	1125	1685	2810	4680
300	210	545	730	1095	1640	2735	4560
400	205	530	705	1055	1585	2645	4405
500	195	505	670	1010	1510	2520	4200
600	175	455	610	915	1370	2285	3805
650	170	450	600	895	1345	2240	3735
700	170	445	590	890	1335	2220	3705
750	165	430	575	860	1290	2150	3585
800	140	370	495	740	1110	1850	3085
850	105	265	355	535	800	1335	2230
900	65	170	230	345	515	855	1430
950	40	105	135	205	310	515	855
1000	20	50	70	105	155	255	430

## MATERIALS GROUP 1.6

A352-LC2      A203-A      A306-65      A155-KC65  
A352-LC3      A203-D      A515-65      A155-KCF65  
A352-LCB           A516-65

TABLE 2.6

TEMPERATURE IN °F	WORKING PRESSURE IN PSI						
	150	300	400	600	800	1500	2500
-20 TO 100	265	695	925	1390	2085	3470	5785
200	250	655	875	1310	1970	3280	5470
300	245	640	850	1275	1915	3190	5315
400	235	615	820	1235	1850	3085	5140
500	225	580	775	1165	1745	2910	4850
600	205	535	710	1065	1600	2665	4440
650	200	520	695	1045	1565	2610	4355
700	195	515	690	1035	1555	2590	4320
750	180	475	630	945	1420	2365	3940
800	150	390	520	780	1170	1955	3255
850	115	305	405	610	915	1525	2540
900	85	220	295	445	670	1115	1850
950	60	155	205	310	460	770	1285
1000	30	85	115	170	255	430	715

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## PIPING MATERIALS

## MATERIALS: GROUP 1.7

A182-F1  
A217-WC1A204-A  
A352-LC1

A204-B

TABLE 2.7

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	265	695	925	1390	2085	3470	5785
200	260	680	905	1360	2035	3395	5655
300	250	650	870	1305	1955	3260	5435
400	245	640	855	1280	1920	3200	5330
500	230	620	830	1245	1865	3105	5175
600	210	605	805	1210	1815	3025	5040
650	205	595	795	1195	1790	2985	4970
700	205	585	780	1170	1755	2920	4870
750	195	555	740	1110	1665	2775	4630
800	160	535	715	1070	1605	2675	4455
850	105	495	660	985	1480	2470	4115
900	65	430	570	855	1285	2145	3570
950	40	290	390	585	875	1455	2430
1000	20	190	250	375	565	945	1570

## MATERIALS: GROUP 1.8

A182-F2  
A217-WC5

A204-C

A217-WC4

TABLE 2.8

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	285	750	1000	1500	2250	3750	6250
200	260	710	950	1425	2135	3560	5930
300	250	675	895	1345	2020	3365	5605
400	245	660	880	1315	1975	3290	5485
500	230	640	855	1285	1925	3210	5350
600	210	605	805	1210	1815	3025	5040
650	205	590	785	1175	1765	2940	4905
700	205	570	755	1135	1705	2840	4730
750	195	555	740	1110	1665	2775	4630
800	160	545	725	1085	1630	2715	4525
850	105	510	685	1025	1535	2560	4270
900	65	480	640	960	1440	2400	4000
950	40	345	455	685	1030	1715	2855
1000	20	215	285	425	640	1065	1770



## ITT GRINNELL — PIPING DESIGN AND ENGINEERING

## MATERIALS: GROUP 1.9

A182-F11  
A387-C-NT

A182-F12

A217-WC6

TABLE 2.9

TEMPERATURE IN °F		WORKING PRESSURES IN PSI						
		150	300	400	600	900	1500	2500
-20 TO	100	285	750	1000	1500	2250	3750	6250
	200	260	710	950	1425	2135	3560	5930
	300	250	675	895	1345	2020	3365	5605
	400	245	660	880	1315	1975	3290	5485
	500	230	640	855	1285	1925	3210	5350
	600	210	605	805	1210	1815	3025	5040
	650	205	590	785	1175	1765	2940	4905
	700	205	570	755	1135	1705	2840	4730
	750	195	530	710	1065	1585	2655	4430
	800	160	505	675	1015	1520	2535	4230
	850	105	485	650	975	1460	2435	4055
	900	65	450	600	900	1345	2245	3745
	950	40	375	505	755	1130	1885	3145
	1000	20	225	295	445	670	1115	1855
	1050		135	185	275	410	685	1145
	1100		95	130	190	290	480	800
	1150		50	70	105	155	255	430
	1200		35	45	70	105	170	285

## MATERIALS: GROUP 1.10

A182-F22

A217-WC9

A387-D-NT

TABLE 2.10

TEMPERATURE IN °F		WORKING PRESSURES IN PSI						
		150	300	400	600	900	1500	2500
-20 TO	100	285	750	1000	1500	2250	3750	6250
	200	260	715	955	1430	2150	3580	5965
	300	250	675	900	1355	2030	3385	5640
	400	245	650	865	1295	1945	3240	5400
	500	230	640	855	1280	1920	3200	5330
	600	210	640	855	1280	1920	3200	5330
	650	205	635	850	1270	1905	3180	5295
	700	205	635	845	1265	1900	3170	5280
	750	195	600	800	1200	1800	3000	5000
	800	160	585	775	1165	1750	2915	4855
	850	105	540	720	1085	1625	2710	4515
	900	65	480	640	960	1440	2400	4000
	950	40	375	505	755	1130	1885	3145
	1000	20	265	355	535	800	1335	2230
	1050		200	265	400	595	995	1655
	1100		115	150	225	340	565	945
	1150		105	135	205	310	515	855
	1200		70	90	135	205	345	570

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## PIPING MATERIALS

MATERIAL: GROUP 1.11

A182-F21

TABLE 2.11

TEMPERATURE IN °F		WORKING PRESSURES IN PSI						
		150	300	400	600	900	1500	2500
-20 TO	100	285	750	1000	1500	2250	3750	6250
	200	260	750	1000	1500	2250	3750	6250
	300	250	745	995	1490	2235	3725	6205
	400	245	730	975	1465	2195	3660	6105
	500	230	710	945	1420	2130	3550	5915
	600	210	685	915	1370	2055	3430	5715
	650	205	670	890	1335	2005	3345	5570
	700	205	645	865	1295	1940	3235	5395
	750	195	500	665	1000	1500	2505	4170
	800	160	475	635	955	1430	2385	3970
	850	105	455	605	905	1360	2265	3770
	900	65	410	550	825	1235	2055	3430
	950	40	310	410	615	925	1545	2570
	1000	20	240	320	480	720	1200	2000
	1050		190	250	375	565	945	1570
	1100		135	185	275	410	685	1145
	1150		95	125	185	280	465	770
	1200		50	70	105	155	255	430

MATERIALS: GROUP 1.12

A155-SCR

A335-P5b

A182-F5

A357

TABLE 2.12

TEMPERATURE IN °F		WORKING PRESSURES IN PSI						
		150	300	400	600	900	1500	2500
-20 TO	100	235	615	825	1235	1850	3085	5145
	200	220	575	770	1150	1730	2880	4800
	300	210	555	740	1105	1660	2765	4610
	400	205	540	720	1080	1615	2695	4490
	500	205	530	705	1055	1585	2645	4405
	600	195	515	685	1030	1545	2570	4285
	650	190	500	665	995	1495	2490	4150
	700	185	480	640	965	1445	2405	4010
	750	170	450	600	900	1345	2245	3745
	800	160	440	585	880	1315	2195	3655
	850	105	410	550	825	1235	2055	3430
	900	65	355	470	705	1060	1765	2945
	950	40	260	345	520	780	1305	2170
	1000	20	190	255	385	575	960	1600
	1050		140	185	280	420	705	1170
	1100		105	135	205	310	515	855
	1150		70	90	135	205	345	570
	1200		45	60	90	135	225	370

## ITT GRINNELL -- PIPING DESIGN AND ENGINEERING

## MATERIALS: GROUP 1.13

A182-F5A

A217-C5

TABLE 2.13

TEMPERATURE IN °F	WORKING PRESSURES PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	285	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	250	745	995	1490	2235	3725	6205
400	245	730	975	1465	2195	3660	6105
500	230	710	945	1420	2130	3550	5915
600	210	690	920	1380	2075	3455	5760
650	205	680	910	1360	2045	3405	5675
700	205	665	890	1335	2000	3335	5555
750	195	550	730	1095	1645	2745	4570
800	160	495	665	995	1490	2485	4145
850	105	440	585	880	1315	2195	3655
900	65	355	470	705	1060	1765	2945
950	40	260	345	520	780	1305	2170
1000	20	190	255	385	575	960	1600
1050		140	185	280	420	705	1170
1100		105	135	205	310	515	855
1150		70	90	135	205	345	570
1200		45	60	90	135	225	370

## MATERIALS: GROUP 1.14

A182-F9

A217-C12

TABLE 2.14

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	285	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	250	745	995	1490	2235	3725	6205
400	245	730	975	1465	2195	3660	6105
500	230	710	945	1420	2130	3550	5915
600	210	690	920	1380	2075	3455	5760
650	205	680	910	1360	2045	3405	5675
700	205	665	890	1335	2000	3335	5555
750	195	600	800	1200	1800	3000	5000
800	160	585	775	1165	1750	2915	4855
850	105	530	705	1055	1585	2640	4400
900	65	450	600	900	1345	2245	3745
950	40	370	495	740	1110	1850	3085
1000	20	290	390	585	875	1455	2430
1050		190	250	375	565	945	1570
1100		115	150	225	340	565	945
1150		75	100	150	225	375	630
1200		50	70	105	155	255	430



## PIPING MATERIALS

## MATERIALS: GROUP 2.1

A182-F304  
A312-TP304  
A430-FP304

A182-304H  
A350-304  
A479-304

A240-304  
A376-TP304

TABLE 2.15

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	235	615	825	1235	1850	3085	5145
200	195	515	685	1030	1545	2570	4285
300	175	465	615	925	1390	2315	3855
400	165	425	570	850	1275	2130	3550
500	155	400	530	800	1195	1995	3325
600	145	375	500	750	1125	1870	3120
650	140	370	490	735	1105	1840	3070
700	140	365	485	730	1090	1820	3035
750	135	355	475	710	1070	1780	2965
800	130	345	460	690	1035	1730	2880
850	105	340	455	680	1020	1695	2830
900	65	335	445	665	1000	1665	2775
950	40	325	435	655	980	1635	2725
1000	20	320	430	640	965	1605	2675
1050		320	430	640	965	1605	2675
1100		300	400	605	905	1510	2515
1150		265	350	530	790	1320	2200
1200		205	275	410	615	1030	1715
1250		160	215	320	485	805	1345
1300		125	170	255	380	635	1055
1350		100	135	200	300	495	830
1400		75	100	150	225	375	630
1450		60	80	115	175	290	485
1500		40	55	80	125	205	345

## MATERIALS: GROUP 2.2

A351-CF3

A351-CF8

TABLE 2.16

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	235	615	825	1235	1850	3085	5145
200	195	515	685	1030	1545	2570	4285
300	175	455	605	905	1360	2265	3770
400	155	405	540	805	1210	2015	3360
500	145	375	500	750	1125	1870	3120
600	135	355	475	710	1070	1780	2965
650	135	350	465	700	1050	1750	2915
700	130	345	460	690	1035	1730	2880
750	130	340	455	685	1025	1705	2845
800	130	335	450	675	1010	1685	2810
850	105	335	445	665	1000	1665	2775
900	65	330	440	660	985	1645	2745
950	40	320	430	640	965	1605	2675
1000	20	310	415	620	930	1555	2590
1050		310	410	615	925	1545	2570
1100		255	345	515	770	1285	2145
1150		195	260	390	585	975	1630
1200		155	205	310	465	770	1285
1250		110	145	220	330	550	915
1300		80	110	165	245	410	685
1350		60	80	125	185	310	515
1400		50	65	95	145	240	400
1450		35	45	70	105	170	285
1500		25	30	50	70	120	200

## ITT GRINNELL — PIPING DESIGN AND ENGINEERING

## MATERIALS. GROUP 2.3

A182-F310  
A358-310A240-310S  
A479-310S

A351-CH20

TABLE 2.17

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	235	615	825	1235	1850	3085	5145
200	215	555	740	1110	1665	2775	4630
300	195	515	685	1030	1545	2570	4285
400	190	490	655	980	1470	2450	4080
500	175	465	615	925	1390	2315	3855
600	170	440	585	875	1315	2190	3650
650	165	430	570	855	1285	2140	3565
700	160	420	555	835	1255	2090	3480
750	160	410	550	825	1235	2055	3430
800	155	400	530	800	1195	1995	3325
850	105	390	520	780	1175	1955	3255
900	65	385	510	765	1150	1915	3190
950	40	370	495	745	1115	1860	3105
1000	20	335	450	670	1010	1680	2800
1050		245	325	485	730	1215	2030
1100		170	230	345	515	855	1430
1150		125	165	245	370	615	1030
1200		85	115	170	255	430	715
1250		50	65	95	145	240	400
1300		25	30	50	70	120	200
1350		15	20	25	40	70	115
1400		10	15	20	30	50	85
1450		5	10	15	20	35	55
1500		5	10	15	20	35	55

## MATERIALS: GROUP 2.4

A182-F347  
A312-TP347  
A376-TP347  
A479-347A182-F348  
A351-CF8C  
A430-FP347  
A479-348A240-347  
A358-347

TABLE 2.18

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	235	615	825	1235	1850	3085	5145
200	210	545	725	1090	1635	2725	4545
300	195	505	670	1010	1510	2520	4200
400	180	475	635	950	1425	2375	3960
500	170	445	590	890	1335	2220	3705
600	160	420	560	845	1265	2110	3515
650	160	410	550	825	1235	2055	3430
700	155	400	535	800	1205	2005	3345
750	150	395	525	790	1185	1975	3290
800	150	390	520	780	1175	1955	3255
850	105	380	505	760	1140	1905	3170
900	65	370	495	740	1110	1850	3085
950	40	370	490	735	1105	1840	3070
1000	20	350	465	700	1050	1750	2915
1050		350	465	700	1050	1750	2915
1100		310	415	625	935	1560	2600
1150		210	280	420	625	1045	1745
1200		150	200	300	455	755	1255
1250		115	150	225	340	565	945
1300		75	100	150	225	375	630
1350		50	70	105	155	255	430
1400		40	55	80	125	205	345
1450		30	40	60	95	155	255
1500		25	30	50	70	120	200

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## PIPING MATERIALS

## MATERIALS:

## GROUP 2.5

A182-F321  
A376-TP321A240-321  
A430-FP321A312-TP321  
A479-321

TABLE 2.19

TEMPERATURE IN °F		WORKING PRESSURES IN PSI						
		150	300	400	600	900	1500	2500
-20 TO	100	235	615	825	1235	1850	3085	5145
	200	200	525	695	1045	1570	2615	4355
	300	180	465	625	935	1400	2335	3890
	400	160	425	565	850	1270	2120	3530
	500	150	395	525	785	1180	1965	3275
	600	145	375	500	750	1125	1870	3120
	650	140	365	490	730	1100	1830	3050
	700	140	360	480	720	1080	1800	3000
	750	135	355	475	710	1070	1780	2965
	800	135	355	470	710	1060	1770	2950
	850	105	350	465	700	1050	1750	2915
	900	65	350	465	695	1045	1740	2895
	950	40	345	460	690	1035	1730	2880
	1000	20	345	460	685	1030	1720	2865
	1050		315	420	630	945	1575	2630
	1100		235	315	475	710	1185	1970
	1150		170	230	345	515	855	1430
	1200		125	165	245	370	615	1030
	1250		85	115	170	255	430	715
	1300		60	80	115	175	290	485
	1350		40	50	75	115	190	315
	1400		25	30	50	70	120	200
	1450		15	25	35	50	85	145
	1500		10	15	20	30	50	85

## MATERIALS:

## GROUP 2.6

A182-F316  
A240-317  
A376-TP316A182-F316H  
A312-TP316  
A430-FP316A240-316  
A358-316  
A479-316

TABLE 2.20

TEMPERATURE IN °F		WORKING PRESSURES IN PSI						
		150	300	400	600	900	1500	2500
-20 TO	100	235	615	825	1235	1850	3085	5145
	200	205	530	710	1060	1590	2655	4425
	300	185	480	640	960	1440	2395	3995
	400	170	440	585	880	1320	2200	3670
	500	155	410	545	820	1230	2045	3410
	600	150	385	515	775	1160	1935	3225
	650	145	380	505	760	1140	1905	3170
	700	145	370	495	745	1115	1860	3105
	750	140	365	490	730	1100	1830	3050
	800	140	360	485	725	1085	1810	3015
	850	105	360	475	715	1075	1790	2985
	900	65	355	475	710	1070	1780	2965
	950	40	350	470	705	1055	1760	2930
	1000	20	350	465	700	1050	1750	2915
	1050		350	465	700	1050	1750	2915
	1100		350	465	700	1050	1750	2915
	1150		320	425	640	955	1595	2655
	1200		255	340	505	760	1270	2115
	1250		185	245	370	555	925	1545
	1300		140	185	280	420	705	1170
	1350		105	135	205	310	515	855
	1400		75	100	150	225	375	630
	1450		60	80	115	175	290	485
	1500		40	55	80	125	205	345



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## ITT GRINNELL — PIPING DESIGN AND ENGINEERING

## MATERIALS:

## GROUP 2.7

A351-CF3M

A351-CF8M

TABLE 2.21

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	235	615	825	1235	1850	3085	5145
200	205	535	715	1070	1605	2675	4455
300	185	485	645	970	1455	2425	4045
400	175	455	610	915	1370	2285	3805
500	170	450	600	895	1345	2240	3735
600	165	435	580	870	1310	2180	3635
650	165	430	570	855	1285	2140	3565
700	160	420	560	845	1265	2110	3515
750	160	410	550	825	1235	2055	3430
800	155	405	540	810	1215	2025	3375
850	105	400	530	800	1195	1995	3325
900	65	400	530	800	1195	1995	3325
950	40	400	530	795	1195	1990	3315
1000	20	390	520	780	1175	1955	3255
1050		365	485	725	1090	1815	3030
1100		320	430	645	965	1610	2685
1150		275	365	550	825	1370	2285
1200		205	275	410	615	1030	1715
1250		180	240	365	545	910	1515
1300		135	185	275	410	685	1145
1350		105	135	205	310	515	855
1400		75	100	150	225	375	630
1450		60	80	115	175	290	485
1500		40	55	80	125	205	345

## MATERIALS:

## GROUP 2.8

A182-F304L

A240-304L

A479-304L

A312-304L

TABLE 2.22

TEMPERATURE IN °F	WORKING PRESSURES IN PSI						
	150	300	400	600	900	1500	2500
-20 TO 100	195	515	685	1030	1545	2570	4285
200	170	440	585	875	1315	2190	3650
300	150	395	525	785	1180	1965	3275
400	140	360	480	720	1080	1800	3000
500	130	335	445	670	1005	1675	2795
600	120	320	425	640	955	1595	2655
650	120	315	415	625	940	1565	2605
700	115	305	410	615	920	1535	2555
750	115	300	405	605	905	1510	2520
800	115	295	395	590	890	1480	2470
850	105	290	390	585	875	1460	2435

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## PIPING MATERIALS

MATERIALS:

GROUP 2.9

A182-F316L

A240-316L

A312-316L

TABLE 2.23

TEMPERATURE IN °F		WORKING PRESSURES IN PSI						
		150	300	400	600	900	1500	2500
-20 TO	100	195	515	685	1030	1545	2570	4285
	200	165	435	580	870	1300	2170	3615
	300	150	390	520	780	1165	1945	3240
	400	135	355	470	710	1060	1770	2950
	500	125	325	435	655	980	1635	2725
	600	120	310	410	615	925	1545	2570
	650	115	300	400	600	900	1500	2505
	700	115	295	390	590	885	1470	2450
	750	110	290	385	575	865	1440	2400
	800	110	280	375	565	845	1410	2350
	850	105	275	370	550	825	1380	2295

TABLE 3. HYDROSTATIC TEST PRESSURES

		TEST PRESSURES BY CLASS - All pressures are in pounds per square inch gage (psig).													
		150		300		400		600		900		1500		2500	
TABLE NO.	MATERIAL GROUP NO.	SHELL	SEAT	SHELL	SEAT	SHELL	SEAT	SHELL	SEAT	SHELL	SEAT	SHELL	SEAT	SHELL	SEAT
2.1	1.1	450	315	1125	825	1500	1085	2225	1630	3350	2440	5575	4075	9275	6785
2.2	1.2	350	245	900	645	1200	865	1775	1290	2650	1935	4425	3230	7350	5385
2.3	1.3	375	260	925	675	1250	905	1875	1360	2775	2035	4650	3395	7725	5660
2.4	1.4	450	315	1125	825	1500	1100	2250	1650	3375	2475	5625	4125	9375	6875
2.5	1.5	375	260	925	675	1250	905	1875	1360	2775	2035	4650	3395	7725	5660
2.6	1.6	400	290	1050	765	1400	1015	2100	1530	3150	2295	5225	3815	8700	6365
2.7	1.7	400	290	1050	765	1400	1015	2100	1530	3150	2295	5225	3815	8700	6365
2.8	1.8	450	315	1125	825	1500	1100	2250	1650	3375	2475	5625	4125	9375	6875
2.9	1.9	450	315	1125	825	1500	1100	2250	1650	3375	2475	5625	4125	9375	6875
2.10	1.10	450	315	1125	825	1500	1100	2250	1650	3375	2475	5625	4125	9375	6875
2.11	1.11	450	315	1125	825	1500	1100	2250	1650	3375	2475	5625	4125	9375	6875
2.12	1.12	375	260	925	675	1250	905	1875	1360	2775	2035	4650	3395	7725	5660
2.13	1.13	450	315	1125	825	1500	1100	2250	1650	3375	2475	5625	4125	9375	6875
2.14	1.14	450	315	1125	825	1500	1100	2250	1650	3375	2475	5625	4125	9375	6875
2.15	2.1	375	260	925	675	1250	905	1875	1360	2775	2035	4650	3395	7725	5660
2.16	2.2	375	260	925	675	1250	905	1875	1360	2775	2035	4650	3395	7725	5660
2.17	2.3	375	260	925	675	1250	905	1875	1360	2775	2035	4650	3395	7725	5660
2.18	2.4	375	260	925	675	1250	905	1875	1360	2775	2035	4650	3395	7725	5660
2.19	2.5	375	260	925	675	1250	905	1875	1360	2775	2035	4650	3395	7725	5660
2.20	2.6	375	260	925	675	1250	905	1875	1360	2775	2035	4650	3395	7725	5660
2.21	2.7	375	260	925	675	1250	905	1875	1360	2775	2035	4650	3395	7725	5660
2.22	2.8	300	215	775	565	1050	755	1550	1135	2325	1700	3875	2825	6450	4715
2.23	2.9	300	215	775	565	1050	755	1550	1135	2325	1700	3875	2825	6450	4715

NOTE These test pressures are all subject to stipulations in Par. 8 which form a part of this table.

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## ITT GRINNELL -- PIPING DESIGN AND ENGINEERING

## ALLOY-STEEL STUD BOLT DIMENSIONS

Nominal Pipe Size	Diameter of Bolts	Number of Bolts	Length <sup>1</sup> of Stud Bolt		Diameter of Bolts	Number of Bolts	Length <sup>1</sup> of Stud Bolt	
			Ring Joint <sup>1</sup>	1/16" Raised Face <sup>2</sup> and Flat Face			Ring Joint <sup>1</sup>	1/16" Raised Face <sup>2</sup> and Flat Face
			150 Pound Flanges <sup>1</sup>				300 Pound Flanges <sup>1</sup>	
1/2	3/8	4	—	2.50	1/2	4	3.00	2.75
3/4	1/2	4	—	2.50	3/4	4	3.30	3.00
1	5/8	4	3.25	2.75	1	4	3.75	3.25
1 1/4	3/4	4	3.25	2.75	1 1/4	4	3.75	3.25
1 1/2	7/8	4	3.50	3.00	1 1/2	4	4.25	3.75
2	1	4	3.75	3.25	2	8	4.25	3.50
2 1/2	1 1/8	4	4.00	3.50	2 1/2	8	4.75	4.00
3	1 1/4	4	4.25	3.75	3	8	5.00	4.25
3 1/2	1 1/2	8	4.25	3.75	3 1/2	8	5.25	4.50
4	1 3/4	8	4.25	3.75	4	8	5.25	4.50
5	1 7/8	8	4.50	4.00	5	8	5.50	4.75
6	2	8	4.50	4.00	6	12	5.75	5.00
8	2 1/4	8	4.75	4.25	8	12	6.25	5.50
10	2 1/2	12	5.25	4.75	10	16	7.00	6.25
12	2 3/4	12	5.25	4.75	12	16	7.50	6.75
14 OD	3	12	5.75	5.25	14	20	7.75	7.00
16 OD	3 1/4	16	6.00	5.50	16	20	8.25	7.50
18 OD	3 1/2	16	6.50	6.00	18	24	8.50	7.75
20 OD	3 3/4	20	6.75	6.25	20	24	9.00	8.25
24 OD	4	20	7.50	7.00	24	24	10.25	9.25

Nominal Pipe Size	Diameter of Bolts	Number of Bolts	Length <sup>1</sup> of Stud Bolt			Diameter of Bolts	Number of Bolts	Length <sup>1</sup> of Stud Bolt		
			Ring Joint <sup>1</sup>	1/4 Inch Raised Face	Male & Female also Tongue and Groove			Ring Joint <sup>1</sup>	1/4 Inch Raised Face	Male & Female also Tongue and Groove
			100 Pound Flanges <sup>1</sup>					500 Pound Flanges <sup>1</sup>		
1/2	3/8	4	3.00	3.25	3.00	3/8	4	3.00	3.25	3.00
3/4	1/2	4	3.50	3.50	3.25	1/2	4	3.50	3.50	3.25
1	5/8	4	3.75	3.75	3.50	3/4	4	3.75	3.75	3.50
1 1/4	3/4	4	4.00	4.00	3.75	5/8	4	4.00	4.00	3.50
1 1/2	7/8	4	4.25	4.25	4.00	3/4	4	4.25	4.25	3.75
2	1	8	4.50	4.25	4.00	3/4	8	4.50	4.25	4.00
2 1/2	1 1/8	8	5.00	4.75	4.50	3/4	8	5.00	4.75	4.50
3	1 1/4	8	5.25	5.00	4.75	3/4	8	5.25	5.00	4.75
3 1/2	1 1/2	8	5.75	5.50	5.25	3/4	8	5.75	5.50	5.25
4	1 3/8	8	5.75	5.50	5.25	3/4	8	6.00	5.75	5.50
5	1 3/4	8	6.00	5.75	5.50	1	8	6.75	6.50	6.25
6	1 7/8	12	6.25	6.00	5.75	1	12	7.00	6.75	6.50
8	2	12	7.00	6.75	6.50	1 1/4	12	7.75	7.50	7.50
10	2 1/4	16	7.75	7.50	7.25	1 1/4	16	8.75	8.50	8.25
12	2 3/4	16	8.25	8.00	7.75	1 1/4	20	9.00	8.75	8.50
14 OD	3	20	8.50	8.25	8.00	1 3/4	20	9.50	9.25	9.00
16 OD	3 1/4	20	9.00	8.75	8.50	1 3/4	20	10.25	10.00	9.75
18 OD	3 1/2	24	9.25	9.00	8.75	1 3/4	20	11.00	10.75	10.50
20 OD	3 3/4	24	10.00	9.75	9.50	1 3/4	24	11.75	11.50	11.25
24 OD	4	24	11.25	11.00	10.50	1 3/4	24	13.25	13.00	12.75

Extracted from American Standard Steel Pipe Flanges and Flanged Fittings ANSI B16.5 - 1973

All dimensions given in inches

These lengths do not include the height of the joints. A joint is that part of a stud bolt beyond the thread and may be chamfered, rounded or sheared.

Total lengths for lapped joints may be determined as follows: for lapped to lapped, add thickness of both laps; for lapped to 1/16 inch raised face, add one thickness of lap; for lapped to female face on flange, add thickness of lap and 1/4 inch; for lapped to female face on flange, add thickness of one lap only, the minimum thickness of which must be 1/4 inch to serve as a male face; for male and female lapped joint made in the laps, add two thicknesses of pipe, but the lap that serves as the male face must not be less than 1/4 inch.

When groove is made in the lap, add thickness of pipe for each lap.

Nominal  
Pipe  
Size

1/2  
3/4  
1  
1 1/4  
1 1/2  
2  
2 1/2  
3  
4  
5  
6  
8  
10  
12  
14 OD  
16 OD  
18 OD  
20 OD  
24 OD

Nominal  
Pipe  
Size

1/2  
3/4  
1  
1 1/4  
1 1/2  
2  
2 1/2  
3  
4  
5  
6  
8  
10  
12

Extract  
All dim  
These  
Bolt is  
to 1/4  
as a male  
When



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## PIPING MATERIALS

## ALLOY-STEEL STUD BOLT DIMENSIONS (Continued)

Nominal Pipe Size	Diameter of Bolts	Number of Bolts	Length <sup>1</sup> of Stud Bolt			Diameter of Bolts	Number of Bolts	Length <sup>1</sup> of Stud Bolt		
			Ring Joint <sup>2</sup>	$\frac{1}{2}$ Inch Raised Face	Male&Female also Tongue and Groove			Ring Joint <sup>2</sup>	$\frac{1}{2}$ Inch Raised Face	Male&Female also Tongue and Groove
900 Pound Flanges <sup>1</sup>						1500 Pound Flanges <sup>1</sup>				
$\frac{1}{2}$	$\frac{3}{8}$	4	4.25	4.25	4.00	$\frac{3}{8}$	4	4.25	4.25	4.00
$\frac{3}{4}$	$\frac{1}{2}$	4	4.50	4.50	4.25	$\frac{1}{2}$	4	4.50	4.50	4.25
1	$\frac{5}{8}$	4	5.00	5.00	4.75	$\frac{5}{8}$	4	5.00	5.00	4.75
1 $\frac{1}{4}$	$\frac{3}{4}$	4	5.00	5.00	4.75	$\frac{3}{4}$	4	5.00	5.00	4.75
1 $\frac{1}{2}$	1	4	5.50	5.50	5.25	1	4	5.50	5.50	5.25
2	$\frac{7}{8}$	8	5.75	5.75	5.50	$\frac{7}{8}$	8	5.75	5.75	5.50
2 $\frac{1}{2}$	1	8	6.25	6.25	6.00	1	8	6.25	6.25	6.00
3	$\frac{7}{8}$	8	6.00	5.75	5.50	1 $\frac{1}{8}$	8	7.00	7.00	6.75
3 $\frac{1}{2}$	1 $\frac{1}{8}$	8	7.00	6.75	6.50	1 $\frac{1}{4}$	8	7.75	7.75	7.50
5	1 $\frac{1}{4}$	8	7.75	7.50	7.25	1 $\frac{1}{2}$	8	9.75	9.75	9.50
6	1 $\frac{3}{8}$	12	7.75	7.75	7.50	1 $\frac{3}{8}$	12	10.50	10.25	10.00
8	1 $\frac{3}{8}$	12	9.00	8.75	8.50	1 $\frac{3}{8}$	12	12.00	11.50	11.25
10	1 $\frac{3}{8}$	16	9.50	9.25	9.00	1 $\frac{3}{8}$	12	13.25	13.25	13.00
12	1 $\frac{3}{8}$	20	10.25	10.00	9.75	2	16	15.50	14.75	14.50
14 OD	1 $\frac{3}{8}$	20	11.25	10.75	10.50	2 $\frac{1}{4}$	16	17.00	16.00	15.75
16 OD	1 $\frac{3}{8}$	20	11.75	11.25	11.00	2 $\frac{1}{4}$	16	18.50	17.50	17.25
18 OD	1 $\frac{3}{8}$	20	13.50	12.75	12.50	2 $\frac{3}{8}$	16	20.50	19.50	19.00
20 OD	2	20	14.25	13.50	13.50	3	16	22.50	21.50	20.00
24 OD	2 $\frac{3}{8}$	20	17.75	17.25	17.00	3 $\frac{1}{2}$	16	25.75	24.50	24.00

Nominal Pipe Size	Diameter of Bolts	Number of Bolts	Length <sup>1</sup> of Stud Bolt		
			Ring Joint <sup>2</sup>	$\frac{1}{2}$ Inch Raised Face	Male&Female also Tongue and Groove
2500 Pound Flanges <sup>1</sup>					
$\frac{1}{2}$	$\frac{3}{8}$	4	5.25	5.25	5.00
$\frac{3}{4}$	$\frac{1}{2}$	4	5.25	5.25	5.00
1	$\frac{5}{8}$	4	5.75	5.75	5.50
1 $\frac{1}{2}$	1	4	6.50	6.25	6.00
2	1 $\frac{1}{4}$	4	7.25	7.00	6.75
2 $\frac{1}{2}$	1 $\frac{3}{4}$	8	7.50	7.25	7.00
3	2	8	8.25	8.00	7.75
3 $\frac{1}{2}$	2 $\frac{1}{4}$	8	9.25	9.00	8.75
4	2 $\frac{1}{2}$	8	10.75	10.75	10.00
5	3	8	12.75	12.00	11.75
6	3 $\frac{1}{2}$	8	14.50	13.75	13.50
8	4	12	16.00	15.25	15.00
10	4 $\frac{1}{2}$	12	20.50	19.50	19.25
12	5	12	22.50	21.50	21.25

Extracted from American Standard Steel Pipe Flanges and Flanged Fittings ANSI B16.5 — 1973

All dimensions given in inches

<sup>1</sup>These lengths do not include the height of the points. A point is that part of a stud bolt beyond the thread and may be chamfered, rounded or sheared<sup>2</sup>Bolt lengths for lapped joints may be determined as follows: For lapped to lapped, add thickness of both laps; for lapped to  $\frac{1}{16}$  inch raised face, add one thickness of lap; for lapped to  $\frac{1}{4}$  inch male face on flange, add thickness of lap and  $\frac{1}{4}$  inch; for lapped to female face on flange, add thickness of one lap only. The minimum thickness of which must be  $\frac{1}{4}$  inch to serve as a male face, for male and female lapped joint made in the laps, add two thicknesses of pipe, but the lap that serves as the male face must not be less than  $\frac{1}{4}$  inch.<sup>3</sup>When groove is made in the lap, add thickness of pipe for each lap.

۵۷ ناقص است - جدول تکمیلی در صفحه ۵۸

# ITT GRINNELL - PIPING DESIGN AND ENGINEERING

## Table II Application of Gaskets and Grooves to Referenced Standards\*

R Number	FLANGE SIZES											
	ANSI B16.5					API 6A				MSS SP-44		
	150 lbs.	300 to 600 lbs.	900 lbs.	1500 lbs.	2500 lbs.	960 lbs.	2000 lbs.	3000 lbs.	5000 lbs.	150 lbs.	300 to 600 lbs.	900 lbs.
R11		½										
R12			½	½								
R13		¾			¾							
R14			¾	¾								
R15	1											
R16		1	1	1	¾							
R17	1½											
R18		1½	1½	1½	1							
R19	1½											
R20		1½	1½	1½			1½	1½	1½			
R21					1½							
R22	2											
R23		2			1½		2					
R24			2	2				2	2			
R25	2½											
R26		2½			2		2½					
R27			2½	2½				2½	2½			
R28					2½							
R29	3											
† R30		3										
R31		3	3				3	3				
R32					3							
R33	3½											
R34		3½										
R35				3					3			
R36	4											
R37		4	4				4	4				
R38					4							
R39				4								
R40	5								4			
R41		5	5				5	5				
R42					5							
R43	6											
R44				5								
R45		6	6			6	6	6				
R46				6								
R47					6				6			
R48	8											
R49		8	8			8	8	8				
R50				8								
R51					8				8			
R52	10											
R53		10	10			10	10	10				
R54				10								
R55					10				10			
R56	12											
R57		12	12			12	12	12				
R58				12						12	12	
R59	14											
R60					12							
R61		14										
R62			14							14		14

\* End Flanges API 6D and API 600 use Gaskets and Grooves for equivalent Pipe Size ANSI B16.5 or MSS SP-44 Flanges.  
† R30 for Lapped Joint only.

## پیوست ۲:

**انتخاب مواد و مطالبی در مورد PMS پروژه**

در زیر خلاصه شده یک خلاصه شده PMS یک پروژه آورده شده است. ابتدا شرایط کلی و نام گذاری شرح داده شده است.

**1.0 GENERAL**

- 1.1 This specification has been produced using the ASME Code for Pressure Piping –  
 "Process piping", ASME B31.3 - 2002 Edition",  
 "Pipeline transportation systems for liquid hydrocarbons and other liquids" ASME B31.4 - 2002  
 Edition",  
 "Gas transmission and distribution piping systems" ASME B31.8 - 2001 Edition".
- 1.2 Additional requirements of the COMPANY's and/or LICENSOR's Standards have been incorporated or referred to where noted.
- 1.3 The symbols used for identification of the piping class designations shall be as indicated in the following lists:  
 the line class number consists of a maximum of four symbols. the first indicates flange rating, the second indicates corrosion allowance, the third materials of construction, and the fourth denotes the service.
- 1.3.1. The first symbol indicates flange ratings and facings as follows:
- a.) **raised face flanges:**
    - A - class 150
    - B - class 300
    - C - class 400
    - D - class 600
    - E - class 900
    - F - class 1500
    - G - class 2500
  - b.) **ring type joint flanges:**
    - H - class 150
    - J - class 300
    - K - class 400
    - L - class 600
    - M - class 900
    - N - class 1500
    - P - class 2500
  - c.) **lap joint flanges:**
    - A - class 150(\*\*)
    - Q - class 150
    - R - class 300
  - d.) **flat face flanges:**
    - A - class 150(\*\*)
    - S - class 150 @ 16 Bar
    - T - class 300 @ 20 Bar
  - e.) **non-flange rated systems:**
    - U - nom 3000psi. etc)

(\*) As an exception, Piping Class 'A0WW' has been used with 'A' for lap joint flange.

(\*\*) As an exception, Piping Class 'A0SV' has been used with 'A' for flat face flange.



## 1.3.2. The second symbol indicates corrosion allowance as follows:

0	-	indicates nominal C.A. ( nil, 1.0mm, etc.) or that the corrosion and erosion allowance is included in the nominated wall thickness as indicated in the pipe class notes.
1	-	indicates 1.5mm nominal C.A. (1/16")
2	-	indicates 3.0mm C.A. (1/8")
3	-	indicates 5.0 to 6.0mm C.A. (1/4")

As an exception, Piping Class 'S1PW' and 'T1PW' have been used with '1' for C.A. of nil.

## 1.3.3. The third symbol indicates materials as follows:-

A	-	plain or semi-killed carbon steel
B	-	carbon steel
C	-	glass reinforced plastic plain or lined.
D	-	1¼% cr. ½% mo.
E	-	2¼% cr. 1% mo.
F	-	5% cr. ½% mo.
G	-	killed, fine-grained carbon steel impact tested (low temp. service)
H	-	3½% Ni. (low temp. service)
J	-	types 304 or 304L stainless steel
K	-	modified austenitic stainless steels ( h , in grades & c., or special analysis limits)
L	-	types 316 or 316L stainless steel
M	-	types 321 or 347 stainless steel
N	-	cast ductile or grey iron plain or lined.
P	-	RTRP (Reinforced Thermosetting Resin Pipe)
Q	-	carbon steel, cement or epoxy lined
R	-	carbon steel galvanised
S	-	UPVC, C-PVC, ABS - solvent weld or screwed system.
T	-	PP, PVDF, PE - butt/socket fusion or screwed system, HDPE
U	-	carbon steel, cement or epoxy lined -external coated and wrapped for underground.
V	-	titanium/ titanium alloys
W	-	90-10 Cu/Ni
X	-	HYCS clad with nickel/ nickel alloys
Y	-	nickel/ nickel alloys - 'monel', 'hastelloy', 'Inconel', 'Incolloy' etc.
Z	-	aluminium/ aluminium alloys.
f	-	carbon steel refractory lined

The above list may be added to cover special materials, using symbols(2 to 9), as required.

## 1.3.4.

The fourth symbol indicates service or limiting factor as follows:-

- A - instrument air, plant air, nitrogen and non-hydrocarbon utilities, except steam or water services.
- B - light hydrocarbons and general process using ball valves (soft seat limiting)
- C - catalyst - catalyst slurry, fluidised or powdered coke, slurry, and other erosive processes
- D - Non-Sour hydrocarbon and utilities, eg. fuel oil, pilot gas, sweetened propane, etc.
- E - special service valve trim
- F - sulphur service, and/ or jacketed piping systems.
- G - boiler code, (steam, condensate, boiler feed water) ASME or others.
- H - hydrogen or hydrogen rich hydrocarbon mixtures, subject to API 941 service requirements.
- J - acids ( specify by concentration levels.)
- K - chlorine
- L - amine, lean MEG
- M - ammonia
- N - caustic
- O - oxygen
- P - general process (Non-Sour)
- Q - process (sour service), subject to NACE Stds. MR-01-75, TM-02-84 etc., service requirements.
- R - low temperature sour service process (below minus 29°C, subject to NACE Stds. MR0175) includes auto-refrigeration conditions.
- S - steam, condensate, boiler feed water.
- T - tracing by steam, or liquid (eg. hot oil etc.) use symbol F for jacketed systems.
- U - underground installed service .
- V - corrosive service other than in symbols J or Q above (PWHT may be stated on service index).
- W - water services. (cooling, potable, fire-fighting, etc.), CO2 system
- X - category 'm' fluids as determined by plant owners.
- Y - chemical dosing
- Z - special valve packing/ line jointing/ bolting, etc.
- 1 HIC testing required (PWHT may be stated on service index).
- 2 seawater
- 8 ASME B31.8 - HIC testing required (PWHT may be stated on service index)

The above list may be added to cover other specific process or utilities, using symbols(3 to 7), as required.

Line Class	Flange Rating Flange Finish	Temp Range Max. Press. Mat'l Group	Pipe Material Corr. Allow. Bolting Certificates	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
AOLQ	ASME CL150 RF	-29/+200 deg C ASME B16.5 2.3	316L SS 0.0 mm B772H 316 SS Spiral weld	BW, Fgd	Ga, Gl, Ba, Ch	Trim 10	<b>SOUR SERVICE (NACE) - SOUR SERVICE</b> WET SOUR HYDROCARBONS. SOUR HC + SALT + WATER. SOUR WATER + MEG + SALT. SOUR GAS. FUEL GAS. SOUR REFLUX. RICH / SOUR AMINE. SULPHURIC ACID. SOUR WATER @ CONDENSATE STABILISATION UNIT. SOUR VAPOUR / LIQUID ACID GAS  ASME B31.3
AOLR	ASME CL 150 RF	-196/+150 deg C ASME B16.5 2.3	316L SS 0.0 mm B8A/B8M 316 SS Spiral weld	BW, Fgd	Ga, Gl, Ba, Ch	Trim 10	<b>LOW TEMP SOUR SERVICE (NACE) - SOUR SERVICE</b> LOW TEMP SOUR HC. DRY SOUR HYDROCARBON GAS. DRY SOUR HYDROCARBON ETHANE GAS. LIQUID NITROGEN HIGH PRESSURE FLARE DRY. OILY WATER HYDROCARBON LIQUID REFRIGERANT PROPANE LP FUEL GAS  ASME B31.3
AOLY	ASME CL150 RF	-29/+200 deg C ASME B16.5 2.3	316L SS 0.0 mm B772H CNAF	BW, BW, Fgd	Ga, Gl, Ba, Ch	Trim 10	<b>NON-SOUR -</b> CHEM DOSING. SCALE CORR INHIB. DEMULSIFIER. PHOSPHATE DOSING. DEMIN WATER 1/2" TO 1/2" INCLUSIVE DESALINATED WATER 1/2" TO 1/2" INCLUSIVE LUBE OIL SEAL OIL.  ASME B31.3
AOLZ	ASME CL 150 RF	-196/+150 deg C ASME B16.5 2.3	316L SS/321 SS 0.0 mm B8A/B8M 316 SS Spiral weld	BW, Fgd	Ga, Gl, Ba, Ch	Trim 10	<b>LOW TEMP SOUR SERVICE (NACE) - SOUR SERVICE</b> LOW TEMP SOUR HC. DRY SOUR HYDROCARBON GAS. DRY SOUR HYDROCARBON. ETHANE GAS. LIQUID NITROGEN HIGH PRESSURE FLARE DRY. OILY WATER HYDROCARBON LIQUID REFRIGERANT PROPANE LP FUEL GAS  ASME B31.3



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Line Class	Flange Rating Flange Finish	Temp Range Max. Press. Mat'l Group	Pipe Material Corr. Allow. Bolting Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
A0SV	ASME CL 150 FF	Refer to Pipe Class  N/A	C-PVC 0.0 mm B7/2H Elastomer	SW, Fgd	Ba, Ch	C-PVC	CHLORINE
A0WV	ASME CL 150 FF/RF	0/+65 deg C ASME B16.5 N/A	90-10 Cu/Ni 0.0 mm B7/2H Syn Fiber	SW, BW, Fgd	Bv, Ga, Gl, Ch	BRONZE / MONEL	NON-SOUR - NORMALLY DRY SEAWATER FIRE WATER  ASME B31.3
A1AD	ASME CL 150 RF	-20/+200 deg C ASME B16.5 1.1	Killed Carbon Stl 1.5 mm B7/2H Graphite Flat Ring	SW, BW, Fgd	Ga, Gl, Ba, Ch	Trim 8	NON-SOUR - LP FUEL GAS, DIESEL, SWEETENED PROPANE, HC PROCESS (SWEET/DRY), NITROGEN, NON-SOUR CLOSED PROCESS DRAINS, BUTANE PRODUCT / BUTANE, FLARE GAS, FRESH COOLING WATER, LEAN MEG METHANOL, GLYCOL(MEG)  ASME B31.3
A1AS	ASME CL 150 RF	-20/+200 deg C ASME B16.5 1.1	Killed Carbon Stl 1.5 mm B7/2H 316 SS Spiral wld	SW, BW, Fgd	Ga, Gl, Ch	Trim 1 / 8	NON-SOUR - LP STABILISED CONDENSATE PRODUCT, LP BOILER FEED WATER, LP BOILER BLOWDOWN LP STEAM, LP CONDENSATE, NITROGEN RELIEF LINE  ASME B31.3
A1AV	ASME CL 150 RF	-20/+200 deg C ASME B16.5 1.1	Killed Carbon Stl + FW-HT 1.5 mm B7/2H 316 SS Spiral wld	BW, Fgd	Ga, Gl, Ba, Ch	Trim 8	<del>SOUR SERVICE (HACE)</del> - DRY SOUR HC FLARE GAS (AT BGCS), DRY SOUR HC GAS CONDENSED HC LIQUID, SOUR PROPANE  ASME B31.3
A1GP	ASME CL 150 RF	-40/+200 deg C ASME B16.5 1.3	Inspect tested Killed (Fine grain CS 1.5 mm L74 316 SS Spiral wld	SW, BW, Fgd	Ga, Gl, Ba, Ch	Trim 12	NON-SOUR - LOW TEMP SERVICE PROPANE REFRIGERANT PROPANE  ASME B31.3

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Line Class	Flange Rating Flange Finish	Temp Range Max. Press Mat'l Group	Pipe Material Corr. Allow. Bolted Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
A1GQ	ASME CL150 RF	-46/+200 deg C ASME B16.5 1.3	Impact tested Killed / Fine grain CS + PWHT 1.5 mm B7M 316 SS Spiral weld	BW, Flgd	Ba, GL Ba, Ch	Trim 12	<b>SOUR SERVICE (NACE) - LOW TEMP SERVICE</b> MARINE AND PROPANE FLARE GAS DRY LOW TEMP HYDROCARBON  ASME B31.3
A1GR							NOT REQUIRED. Use A1GP.
A1RA	ASME CL150 RF/FF	0/+85 deg C 232 psig N/A	CS Galv 1.5 mm B72H Graphite Flat Ring	Thrd. Flgd	Ga, GL Ba, Ch	Trim 8	<b>NON-SOUR -</b> DRY INSTRUMENT AIR DRY UTILITY AIR DRY FIRE WATER  ASME B31.3
A2A1	ASME CL150 RF	-29/+300 deg C ASME B16.5 1.1	Killed Carbon St + HIC + PWHT 3.0 mm B72H 316 SS Spiral weld	BW, Flgd	Ga, GL Ch, Ba	Trim 12	<b>SOUR SERVICE (NACE) -</b> WET SOUR HC LIQUID WET SOUR VAPOUR SOUR STRIPPED WATER HC CONDENSATE + WATER + H <sub>2</sub> S + CO <sub>2</sub> + MEG WET SOUR HC + MEG + WATER WET SOUR HC + MEG + WATER + SALT HC CONDENSATE WITH H <sub>2</sub> S + CO <sub>2</sub> SOUR WET ACID GAS H <sub>2</sub> S SOUR WET OFFGAS / GAS CONDENSATE PRODUCT @ STABILIZER SOUR AMINE DRAINS TO SUMP (ATMOSPHERIC) SOUR HYDROCARBON CLOSED DRAINS OFFSPEC CONDENSATE SOUR GLYCOLATED WATER WET RICH AMINE LEAN SOUR AMINE AMINE DRAINS SOUR HYDROCARBON DRAINS SOUR HC GAS LP FLARE WET GLYCOL/MEG NITROGEN OILY WATER RELIEF LINE SOUR WATER  (USE WITH UNDERGROUND PIPING) ASME B31.3
A2A3							NOT REQUIRED. Use A2A1
A2AD	ASME CL150 RF	-29/+200 deg C ASME B16.5 1.1	Killed Carbon St 3 mm B72H Graphite Flat Ring	BW, BW, Flgd	Ga, GL Ba, Ch	Trim 8	<b>NON-SOUR -</b> STRIPPED WATER DISULPHIDE OIL WET NON SOUR HYDROCARBONS WATER/MEG/SALT  ASME B31.3
A2AF							NOT REQUIRED

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Line Class	Flange Rating Flange Finish	Temp Rating Max. Press. Mat'l Group	Pipe Material Corr. Allow Bolting Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
A2AN	ASME CL150 RF	-29/+80 deg C ASME B16.5 1.1	Killed Carbon Stl + (PWHT) 3.0 mm B7/2H Graphite Flat Ring	BW, Flgd	Ga, Gt, Ch, Ba	MONEL Trim 9	<b>CALUSTIC:</b> SODIUM HYDROXIDE (4%-20% CONCENTRATION TEMP RANGE 0 TO 48 DEG C) (50% CONCENTRATION TEMP RANGE 48 TO 80 DEG C). POST WELD HEAT TREATMENT REQUIRED. SAFETY SHIELD TO BE INSTALLED OVER FLANGED JOINTS.  ASME B31.3
A2AS							NOT REQUIRED. Use A1AS
A2AV							NOT REQUIRED. Use A2A1
A2BW	ASME CL150 RF	0/+85 deg C NON-PRESSURE	Carbon Stl 3.0 mm	BW	-	-	<b>NON-SOUR - UNDERGROUND</b> NON-PRESSURE DRINKING OILY WATER SEWER
A2G1	ASME CL150 RF	-46/+200 deg C ASME B16.5 1.3	Impact tested Killed /Fine grain CS + H8C + PWHT 3.0 mm L7/4 316 SS Spiral weld	BW, Flgd	Ga, Gt, Ba, Ch	Trim 12	<b>SOUR SERVICE (NACE) - LOW TEMP SERVICE -</b> LOW TEMP SOUR HC TO WET/DRY LP/HP FLARE HEADER HYDROCARBON LIQUID LP FUEL GAS  ASME B31.3
A2GP	ASME CL150 RF	-46/+200 deg C ASME B16.5 1.3	Impact tested Killed /Fine grain CS 3.0 mm L7/4 316 SS Spiral weld	SW, BW, Flgd	Ga, Gt, Ba, Ch	Trim 12	<b>NON-SOUR - LOW TEMP SERVICE</b> PROPANE REFRIGERANT PROPANE GAS BLOWDOWN HP FLARE DRY OILY WATER  ASME B31.3
A2GQ							NOT REQUIRED. Use A2G1
A2RA	ASME CL150 RF/FF	0/+85 deg C 232 psig N/A	CS Galv 3.0 mm B7/2H Graphite Flat Ring	Flgd, BW, Flgd	Ga, Gt, Ba, Ch	Trim 8	<b>NON-SOUR -</b> WET COMPRESSED AIR  ASME B31.3
A3A1	ASME CL150 RF	-29/+200 deg C ASME B16.5 1.1	Killed Carbon Stl + H8C + PWHT 3.0 mm B7/2H 316 SS Spiral weld	BW, Flgd	Ga, Gt, Ch, Ba	Trim 12	<b>SOUR SERVICE (NACE) -</b> SOUR HC LIQUID & VAPOUR SOUR WATER SOUR HC TO WET LP/HP FLARE HEADER SOUR WET HYDROCARBON CLOSED DRAIN HEADER LP FUEL GAS OILY WATER UTILITY WATER LP FLARE HYDROCARBON GAS  (USE WITH UNDERGROUND PIPING) ASME B31.3
A3AJ	ASME CL150 RF	-29/+90 deg C ASME B16.5 1.1	Killed Carbon Stl 3.0 mm B7/2H GNAF	BW, Flgd	Ga, Gt, Ba, Ch	ALLOY 20 Trim 13	SULPHURIC ACID H <sub>2</sub> SO <sub>4</sub> (CONC 95 TO 98%) Safety shields to be installed over flanged joints  ASME B31.3



Line Class	Flange Rating Flange Finish	Temp Range Max. Press. Mat'l Group	Pipe Material Corr. Allow. Bottoms Gaslets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
A9G1	ASME CL 150 RF	-46/+200 deg C ASME B16.5 1.1	Impact tested /Killed /Fine grain CS +HIC+ PWHT 5.0 mm 1 7/8 316 SS Spiral weld	BW, Fld	Ga, Gl, Ba, Ch	Trim 12	<b>SOUR SERVICE (NACE) - LOW TEMP SERVICE -</b> HP FLARE DRY HP/LP FLARE WET HYDROCARBON GAS LP FUEL GAS  ASME B31.3
B0LQ	ASME CL300 RF	-29/+200 deg C ASME B16.5 2.3	316L SS 0.0 mm B7/2H 316 SS Spiral weld	BW, Fld	Ga, Gl, Ba, Ch	Trim 10	<b>SOUR SERVICE (NACE) - SOUR SERVICE</b> SOUR REFLUX WET SOUR HYDROCARBON SOUR HC + SALT + WATER SOUR WATER + MEG + SALT SOUR AMINE ACID GAS SOUR GAS SOUR WATER & CONDENSATE STABILISATION UNIT SOUR VAPOUR / LIQUID  ASME B31.3
B0LR	ASME CL300 RF	-106/+150 deg C ASME B16.5 2.3	316L SS 0.0 mm B8M/M 316 SS Spiral weld	BW, Fld	Ga, Gl, Ba, Ch	Trim 10	<b>LOW TEMP SOUR SERVICE (NACE) - SOUR SERVICE</b> LOW TEMP SOUR HC DRY SOUR HYDROCARBON GAS DRY SOUR HYDROCARBON ETHANE GAS LIQUID NITROGEN  ASME B31.3
B0LY	ASME CL300 RF	-29/+200 deg C ASME B16.5 2.3	316L SS 0.0 mm B7/2H CNAF	SW, BW, Fld	Ga, Gl, Ba, Ch	Trim 10	<b>NON SOUR -</b> CHEM DOSING SCALE CORR INHB DEMIN WATER - 1/2" TO 1/2" INCLUSIVE DESALINATED WATER 1/2" TO 1/2" INCLUSIVE UTILITY WATER - 1/2" TO 1/2" INCLUSIVE LUBE OIL SEAL OIL PHOSPHATE DOSING  ASME B31.3
B1AB PIPE LINE SCOPE	ASME CL300 RF	-29/+80 deg C 45.00 barg	API 5L X52 1.5 mm B7/2H 316 SS Spiral weld	BW, Fld	Ba Ch	Trim 12	<b>SOUR SERVICE (NACE)</b> LIQUID HYDROCARBON  ASME B31.4
B1AD	ASME CL300 RF	-29/+200 deg C ASME B16.5 1.1	Killed Carbon St 1.5 mm B7/2H Graphite Flat Ring	SW, BW, Fld	Ga, Gl, Ba, Ch	Trim 8	<b>NON SOUR -</b> HP FUEL GAS DIESEL NITROGEN SWEETENED PROPANE HC PROCESS (SWEET/DRY) BUTANE PRODUCT LEAN MEG  ASME B31.3
B1AP	ASME CL300 RF	-29/+80 deg C 45 barg ASME B16.5 1.1	Carbon St 1.5 mm B7/2H Graphite Flat Ring	Fld	Ga	Trim 5	<b>NON SOUR -</b> LIQUID HC CONDENSATE  ASME B31.3

Line Class	Flange Rating Flange Finish	Temp Range Max. Press. Mat'l Group	Pipe Material Corr. Allow. Bolting Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
B1AS	ASME CL300 RF	-29/+400 deg C ASME B16.5 1.1	Killed Carbon Stl 1.5 mm B7/2H 316 SS Spiral wld	SW, BW, Fgd	Ga, GL, Ch	Trim 1 / 5	<b>NON-SOUR</b> - MP STABILISED CONDENSATE PRODUCT BOILER FEED WATER BOILER BLOWDOWN MP STEAM / CONDENSATE LP STEAM CONDENSATE  ASME B31.3
B1AV	ASME CL300 RF	-29/+200 deg C ASME B16.5 1.1	Killed Carbon Stl + PWHT 1.5 mm B7/2H 316 SS Spiral wld	BW, Fgd	Ga, GL, Ba, Ch	Trim 8	<b>SOUR SERVICE (NACE)</b> - DRY SOUR HC GAS SOUR PROPANE  ASME B31.3
B1GP	ASME CL300 RF	-46/+300 deg C ASME B16.5 1.3	Impact tested Killed / Fine grain CS 1.5 mm L7/4 316 SS Spiral wld	SW, BW, Fgd	Ga, GL, Ba, Ch	Trim 12	<b>NON-SOUR - LOW TEMP SERVICE</b> PROPANE REFRIGERANT PROPANE GAS BLOWDOWN  ASME B31.3
B1GQ	ASME CL300 RF	-46/+200 deg C ASME B16.5 1.3	Impact tested Killed / Fine grain CS + PWHT 1.5 mm L7/4 316 SS Spiral wld	BW, Fgd	Ga, GL, Ba, Ch	Trim 12	<b>SOUR SERVICE (NACE) - LOW TEMP SERVICE</b> - LOW TEMP DRY HYDROCARBON DRY SOUR EXPORT GAS  ASME B31.3
B1RW	ASME CL300 RF/FF	0/+55 deg C 500 psig N/A	CS Gals 1.5 B7/2H Graphitic Flat Ring	Thrd, BW, Fgd	Ga, GL, Ba, Ch	Trim 8	<b>NON-SOUR</b> - CO2 SYSTEM  ASME B31.3
B1UP PIPE LINE SCOPE	ASME CL300 RF	-29/+80 deg C 45.0 barg	API 5L X52 1.5 mm B7/2H Graphitic Flat Ring	Fgd	Ga	Trim 8	<b>NON-SOUR</b> - LIQUID HC CONDENSATE  ASME B31.4
B2A1	ASME CL300 RF	-29/+200 deg C ASME B16.5 1.1	Killed Carbon Stl + HC + PWHT 3.0 mm B7/2H 316 SS Spiral wld	BW, Fgd	Ga, GL, Ch, Ba	Trim 12	<b>SOUR SERVICE (NACE)</b> - WET SOUR HC LIQUID WET SOUR VAPOUR SOUR STRIPPED WATER @ SOUR WATER STRIPPER HC CONDENSATE + WATER + H2S + CO2 + MEG WET SOUR HC + MEG + WATER WET SOUR HC + MEG + WATER + SALT HC CONDENSATE WITH H2S + CO2 SOUR WET ACID GAS H2S SOUR WET OFFGAS / GAS CONDENSATE PRODUCT @ STABILISER SOUR AMINE DRAINS TO SUMP (ATMOSPHERIC) SOUR HYDROCARBON CLOSED DRAINS OFFSPEC CONDENSATE SOUR GLYCOLATED WATER WET RICH AMINE LEAN SOUR AMINE GLYCOL(MEG)  ASME B31.3

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Line Class	Flange Rating Flange Finish	Temp Range Max. Press Mat'l Group	Proc Material Corr. Allow. Bolting Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
B2A3							NOT REQUIRED Use B2A1
B2A0	ASME CL300 RF	-29/+300 deg C ASME B16.5 1.1	Killed Carbon S&S 3 mm B772H Graphite Flat Ring	SW, BW, Figt	Ga, GL, Ba, Ch	Trim 5	NON-SOUR - BUTANE STRIPPED WATER  ASME B31.3
B2AN	ASME CL300 RF	-29/+305 deg C ASME B16.5 1.1	Killed Carbon S&S + (PWHT) 3.0 mm B772H Graphite Flat Ring	BW, Figt	Ga, GL, Ch, Ba	MONEL TRIM 9	CAUSTIC SODIUM HYDROXIDE (4%-20% CONCENTRATION TEMP RANGE 0 TO 49 DEG C) (10% CONCENTRATION TEMP RANGE 40 TO 49 DEG C). POST WELD HEAT TREATMENT REQUIRED. SAFETY SHIELD TO BE INSTALLED OVER FLANGED JOINTS.  ASME B31.3
B2G1	ASME CL300 RF	-49/+200 deg C ASME B16.5 1.3	Inspect tested /Killed /Fine grain CS+ HIC + PWHT 3.0 mm L774 316 SS Spiral wmd	BW, Figt	Ga, GL, Ba, Ch	Trim 12	SOUR SERVICE (NACE) - LOW TEMP SERVICE - WET SOUR HC VAPOUR/LIQUID WET SOUR GAS  ASME B31.3
B2G0							NOT REQUIRED. Use B2G1
B3A1	ASME CL300 RF	-29/+200 deg C ASME B16.5 1.1	Killed Carbon S&S + HIC + PWHT 3.0 mm B772H 316 SS Spiral wmd	BW, Figt	Ga, GL, Ch, Ba	Trim 12	SOUR SERVICE (NACE) - SOUR HYDROCARBON LIQUID & VAPOUR SOUR WATER  ASME B31.3
D0AQ PIPE LINE SCOPE	ASME CL 600 RF	-29/+100 deg C 100 barg	API 5L X85 0.0 mm B772H 316 SS Spiral wmd	BW, Figt	Ch, Ba	Trim 12	SOUR SERVICE (NACE) DRY SOUR EXPORT GAS PIPELINE FROM GAS PLANT  ASME B31.8
D0LQ	ASME CL600 RF	-29/+300 deg C ASME B16.5 2.3	316L SS 0.0 mm B772H 316 SS Spiral wmd	BW, Figt	Ga, GL, Ba, Ch	Trim 10	SOUR SERVICE (NACE) - SOUR SERVICE SOUR REFLUX SOUR AMINE WET SOUR GAS RICH - LEAN AMINE CO2 + H2S ACID GAS WET SOUR HYDROCARBONS SOUR VAPOUR / LIQUID  ASME B31.3
D0LR	ASME CL600 RF	+150/+150 deg C ASME B16.5 2.3	316L SS 0.0 mm B8M/W 316 SS Spiral wmd	BW, Figt	Ga, GL, Ba, Ch	Trim 10	LOW TEMP SOUR SERVICE (NACE) - SOUR SERVICE LOW TEMP DRY SOUR HYDROCARBON GAS  ASME B31.3
D0LY	ASME CL600 RF	-29/+200 deg C ASME B16.5 2.3	316L SS 0.0 mm B772H 316 SS Spiral wmd	SW, BW, Figt	Ga, GL, Ba, Ch	Trim 10	NON-SOUR - CHEM DOSING SCALE CORR INHIB PHOSPHATE DEAUMINATED WATER UTILITY WATER  ASME B31.3





Line Class	Flange Rating Flange Finish	Temp Range Max. Press. Melt Group	Pipe Material Corr. Allow Boltting Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
D2G1	ASME CL600 RF	-45/+200 deg C ASME B16.5 1.3	Impact tested Killed / Fine grain CS+ HIC + PWHT 3.0 mm L774 316 SS Spiral weld	BW, Fgd	Ga, Gl, Ba, Ch	Trim 12	<u>SOUR SERVICE (NACE) - LOW TEMP SERVICE -</u> WET SOUR HC VAPOUR/LIQUID WET SOUR GAS  ASME B31.3
D3A1	ASME CL600 RF	-29/+200 deg C ASME B16.5 1.1	Killed Carbon St + HIC + PWHT 8.0 mm B72H 316 SS Spiral weld	BW, Fgd	Ga, Gl, Ch, Ba	Trim 12	<u>SOUR SERVICE (NACE) -</u> SOUR WATER HYDROCARBON LIQUID CLOSED DRAIN  ASME B31.3
M0LQ	ASME CL900 RTJ	-29/+180 deg C 95.55 Bar 2.3	316L SS 0.0 mm B72H 316 SS Octagonal Ring	BW, Fgd	Ga, Gl, Ba, Ch	Trim 10	<u>SOUR SERVICE (NACE) - WET -</u> <u>SWEET - SOUR SERVICE -</u> SOUR HC LIQUID & VAPOUR WET SOUR HC LIQUID & VAPOUR WITH H <sub>2</sub> S + CO <sub>2</sub> + WATER HYDROCARBON WITH H <sub>2</sub> S+CO <sub>2</sub> +WATER WET SOUR HYDROCARBON GAS RICH - LEAN AMINE CO <sub>2</sub> + H <sub>2</sub> S ACID GAS PHOSPHATE SOUR VENTS HYDROCARBON LIQUID  ASME B31.3
M0LR	ASME CL900 RTJ	-150/+85 deg C 85 Bar 2.3	316L SS 0.0 mm B6MNM 316 SS Octagonal Ring	BW, Fgd	Ga, Gl, Ba, Ch	Trim 10	<u>LOW TEMP. SOUR SERVICE</u> <u>(NACE) - WET - SWEET /</u> <u>WET SOUR SERVICE -</u> LOW TEMP DRY SOUR HYDROCARBON GAS  ASME B31.3
M1AD	ASME CL900 RTJ	-29/+100 deg C ASME B16.5 1.1	Killed Carbon St 1.5 mm B72H Soft Iron Octagonal Ring	SW, BW, Fgd	Ga, Gl, Ba, Ch	Trim 8	<u>NON-SOUR -</u> +HYDROCARBON UTILITIES (eg FUEL OIL, PILOT GAS, etc.)  ASME B31.3
M1AV	ASME CL900 RTJ	-29/+100 deg C 100.00 Bar 1.1	Killed Carbon St + PWHT 1.5 mm B72H Soft Iron Octagonal Ring	BW, Fgd	Ga, Gl, Ba, Ch	Trim 8	<u>SOUR SERVICE (NACE) -</u> SOUR HC GAS (DRY)  ASME B31.3
M1GP	ASME CL900 RTJ	-40/+85 deg C 100.00 Bar 1.1	Impact tested Killed / Fine grain CS + PWHT 1.5 mm L7M 316 SS Octagonal Ring	SW, Fgd	Ga, Gl, Ba, Ch	Trim 12	<u>NON-SOUR SERVICE - LOW TEMP</u> <u>SERVICE -</u> PROPANE REFRIGERANT PROPANE GAS BLOWDOWN HP FUEL GAS  ASME B31.4

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Line Class	Flange Rating Flange Finish	Temp Range Max. Press. Mat'l Group	Pipe Material Corr. Allow. Bolt Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
M2A1	ASME CL900 RTJ	-29/+100 deg C 139.00 Barg 1.1	Killed Carbon Stl + HIC + PWHT 3.0 mm B772H Soft Iron Octagonal Ring	BW, Fgd	Ge, Gl, Ch, Ba	Trim 12	<b>SOUR SERVICE (NACE) -</b> WET SOUR HC LIQUID WET SOUR VAPOUR SOUR STRIPPED WATER @ SOUR WATER STRIPPER HC CONDENSATE + WATER + H2S + CO2 + MEG WET SOUR HC + MEG + WATER WET SOUR HC + H2S + CO2 + MEG + WATER + SALT (INLET) HC CONDENSATE WITH H2S + CO2 WET SOUR ACID GAS H2S WET SOUR OFFGAS / GAS CONDENSATE PRODUCT STABILISER SOUR HYDROCARBON CLOSED DRAINS WET RICH AMINE LEAN AMINE AMINE DRAINS HYDROCARBON GAS GLYCOL(MEG) HYDROCARBON LIQUID METHANOL  ASME B31.3
M2A3							NOT REQUIRED. USE M2A1.
M2A8 PIPE LINE SCOPE	ASME CL900 RTJ	-29/+100 deg C 139.00 Barg 1.1	Killed Carbon Stl + HIC + PWHT 3.0 mm B772H Soft Iron Octagonal Ring	BW, Fgd	Ge, Gl, Ch, Ba	Trim 12	<b>SOUR SERVICE (NACE) -</b> FOR SLUG CATCHER INLET WET SOUR HC LIQUID WET SOUR VAPOUR MEG  ASME B31.3
M2A9 PIPE LINE SCOPE	ASME CL900 RTJ	-29/+90 deg C 139.00 Barg	API 5L X85 + HIC + PWHT 3.0 mm B772H Soft Iron Octagonal Ring	BW, Fgd	Ge, Gl, Ch	Trim 12	<b>SOUR SERVICE (NACE) -</b> SUBSEA GAS PIPELINE FROM PLATFORM TO GAS PLANT  ASME B31.3
M2G1	ASME CL900 RTJ	-46/+100 deg C 139.00 Barg 1.1	Impact tested Killed / Fine grain CS + HIC + PWHT 3.0 mm L74 316 SS Octagonal Ring	BW, Fgd	Ge, Gl, Ba, Ch	Trim 12	<b>SOUR SERVICE (NACE) - LOW TEMP SERVICE -</b> WET SOUR HC VAPOUR/LIQUID  ASME B31.3



Line Class	Flange Rating Flange Finish	Temp Range Max. Press. Mat'l Group	Pipe Material Corr. Allow. Boll'ng Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
N3A1	ASME CL900 RTJ	-29/+85 deg C 139.00 Barg 1.1	Killed Carbon S&S + HIC + PWHT 5.0 mm B7/2H Soft Iron Octagonal Ring	BW, Fld	Ge, Gl, Ch, Ba	Trim 12	<b>SOUR SERVICE (NACE) –</b> GAS EQUALIZATION LINE ERD1 AT SLUG CATCHER WET SOUR HC + H <sub>2</sub> S + CO <sub>2</sub> + MEG + WATER + HYDROCARBON LIQUID GLYCOL(MEG)  ASME B31.3
N3A8 PIPE LINE SCOPE	ASME CL900 RTJ	-29/+85 deg C 139.00 Barg 1.1	Killed Carbon S&S + HIC + PWHT 6.0 mm B7/2H Soft Iron Octagonal Ring	BW, Fld	Ge, Gl, Ch, Ba	Trim 12	<b>SOUR SERVICE (NACE) –</b> FOR SLUG CATCHER WET SOUR HC LIQUID WET SOUR VAPOUR MEG  ASME B31.3
N3A9 PIPE LINE SCOPE	ASME CL1500 RTJ	-29/+80 deg C 232.00 Barg	API 5L X70 + PWHT 1.0 mm B7/2H Soft Iron Octagonal Ring	BW, Fld	Ch, Ba	Trim 12	<b>SOUR SERVICE (NACE) –</b> SUBSEA MEG LIQUID LINE  ASME B31.4
N4LO	ASME CL1500 RTJ	-29/+120 deg C 159.00 Barg 2.3	316L SS 0.0 mm B7/2H 316 SS Octagonal Ring	BW, Fld	Ge, Gl, Ba, Ch	Trim 10	<b>SOUR SERVICE (NACE) – WET –</b> <b>SWEET – SOUR SERVICE</b> WET SOUR HC LIQUID & VAPOUR WITH H <sub>2</sub> S + CO <sub>2</sub> + WATER RICH – LEAN AMINE CO <sub>2</sub> + H <sub>2</sub> S ACID GAS SOUR WATER GAS FROM MOL SIEVES SOUR HC LIQUID & VAPOUR HYDROCARBON WITH H <sub>2</sub> S+CO <sub>2</sub> +WATER WET SOUR HYDROCARBON GAS HP FLARE WET HYDROCARBON LIQUID METHANOL  ASME B31.3
N1AD	ASME CL1500 RTJ	-29/+85 deg C 232.00 barg 1.1	Killed Carbon S&S 1.5 mm B7/2H Soft Iron Octagonal Ring	BW, Fld	Ge, Gl, Ba, Ch	Trim 8	<b>NON-SOUR –</b> LEAN MEG / NoCl METHANOL GLYCOL(MEG) CLOSED DRAIN  ASME B31.3



در لیست های زیر بصورت نمونه جزئیات یکی از کلاس های Piping آورده شده است.

PIPING CLASS		A01Q									
SERVICE		SOUR - HC PROCESS WET SOUR HYDROCARBON SOUR HC + SALT + WATER SOUR GAS, ACID GAS, SOUR REFLUX, RICH / SOUR AMINE SULPHURIC ACID SOUR WATER + MEG + SALT SOUR WATER COND. STABILISATION UNIT SOUR VAPOUR / LIQUID FUEL GAS					CORROSION ALLOWANCE 0.0MM VALVE PACKING GROUP A PWHT /STRESS RELIEF None WELD QUALITY 5% Random INSPECTION Radiography (see SPY-2-0000-TY-SP-009.)				
RATING CLASS		150 RF.									
MATERIAL		316L STAINLESS STEEL (see Note 14.)NACE MR-01-75									
SERVICE LIMITS		ASME B16.5 to 200 degC									
PRESS./TEMP		degC	-29 to 38	100	150	200					
RATING		barG	15.8	13.2	12.0	11.0					
Size & WT range.											
NPS	½"	¾"	1"	1¼"	2"	3"	4"	6"	8"	10"	12"
Schedule	80S	80S	80S	80S	40S	40S	40S	10S	10S	10S	10S
WT. mm	3.73	3.91	4.55	5.08	3.91	5.49	6.02	3.40	3.76	4.19	4.57
NPS	14"	16"	18"	20"	22"	24"					
Schedule	10S	10S	10S	10S	10S	10S					
WT. mm	4.78	4.78	4.78	5.54	5.54	6.35					
ITEM	SIZE (ins.) FROM TO		DESCRIPTION				SPECIFICATION				NOTE
PIPE	½"	1 ½"	Seamless, Plain ends				ASTM A312 TP 316L				1.
	2"	8"	Seamless, Bevel ends				ASME B36.19M				
	10"	24"	SAW Weld Seam Bevel ends				ASTM A358 Gr.316L, Cl.3				
PIPE NIPPLES	½"	1¼"	Seamless, Ends to suit, W/t to suit pipe				ASTM A312 TP 316L				25.
FLANGES	½"	1¼"	Class 150# RF WN ) Bore to				ASTM A182 Gr.F316L				1.
	2"	24"	Class 150# RF WN ) match pipe				ASNE B16.5				
	¾"	24"	Class 150# RF Blind								
BRANCH FITTINGS	Refer to Section 5, Table 4.										6.
UNIONS		NOT TO BE USED. USE FLANGES									
EW FITTINGS	½"	8"	Seamless, wrought SS w/t to match pipe				ASTM A403 Gr.WP316L				
	10"	24"	Weld Seam SS w/t to match pipe				ASME B16.9 ASTM A403 Gr.WP316L-W ASME B16.9				



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PIPING CLASS		A01Q		
ITEM	SIZE FROM TO (ins.)	DESCRIPTION	SPECIFICATION	NOTE
BW & SCREWED FITTINGS		(NOT TO BE USED). (USE BW FITTINGS)	ASTM A403 Gr.WP316L,	1.
SWAGE NIPPLES	½" 1½"	Seamless, W/t to suit pipe	ASTM A403 Gr.WP316L MSS-SP-95	1
PLUGS	½" 1½"	NOT TO BE USED. USE FLANGES	ASTM A182 F316L ASME B16.5	70
GASKETS	½" 24"	4.5mm th'k Class 150# Spiral Wound, Graphite filled, Type 316 SS windings, Stainless steel inner and outer rings, 3mm th'k	ASME B16.20	
FLANGE BOLTING	All sizes	Stud bolts Nuts ( Heavy Hex.) PTFE coated	ASTM A193 Gr.B7 ASTM A194 Gr.2H	
FIG.8, SPADES & SPACERS	½" 24"	Stainless Steel Plate	ASTM A240 TP 316L ASME B16.48 (SPY-2-0000-PI-SD-001)	
Y-type STRAINERS	½" 2"	ASTM A182 Gr. 316L Body, 150#, Flanged ends  ASTM A351 Gr.CF3M Body, 150#, Flanged ends	MANUFACTURER'S STD.  MANUFACTURER'S STD.	
T-type STRAINERS	3" 12"	ASTM A403 Gr.WP316L Body, 150#, Flanged ends	SEE PIPING STD DRAWINGS. (SPY-2-0000-PI-SD-001)	

## PIPING CLASS A01Q

VALVES ( see also Note 10 below )

TYPE	SIZE (ins.) FROM TO	ASME RATING	ENDS	TRIM (API No.)	DESCRIPTION	CODE No.	Notes
GATE VALVE	½" 24"	150	RF FLGD	316 SS (10)	Forged SS Body, ASTM A182 Gr.F316L, Reduced Bore, BB, OS&Y, BG, Solid Wedge to API 602 NACE MR-01-75		1,4
	2" 24"	150	RF FLGD	316 SS (10)	Cast SS Body, ASTM A351 Gr.CF3M, BB, OS&Y, BG, Flexible Wedge to API 600 API 600, NACE MR-01-75		2.
GLOBE VALVE	½" 2"	150	RF FLGD	316 SS (10)	Forged SS Body, ASTM A182 Gr.F316L, BB, OS&Y, BG, Swivel Plug Type Disc. BS 5352, NACE MR-01-75		
	2" 8"	150	RF FLGD	316 SS (10)	Cast SS Body, ASTM A351 Gr.CF3M, BB, OS&Y, BG, Swivel Plug Disc. BS 1873, NACE MR-01-75		2.
CHECK VALVE	½" 2"	150	RF FLGD	316 SS (10)	Forged SS Body, ASTM A182 Gr.F316L, Horizontal Piston Type, BC BS 5352, NACE MR-01-75		61.
	2" 24"	150	WAFER	316SS (10)	Cast SS body, ASTM A351 Gr.CF3M, Dual plate, retainerless, API 604, NACE MR-01-75		

Y6

Alternative check valve for use with liquids only

2"	24"	150	RF FLGD	316 SS (10)	Cast SS Body, ASTM A351 Gr. CF3M, Swing Type, BC SS 1868, NACE MR-01-75	
BALL VALVE (See Note 101)	1/2"	6"	RF FLGD	316SS	SS Body, ASTM A182 Gr. F316L/ A351 Gr. CF3M, SS Ball & Stem. thermoplastic seats Design B65351 NACE MR-01-75	27,101
BALL VALVE (See Note 101)	8"	24"	RF FLGD	316SS	SS body, ASTM A182 Gr. F316L/ A351 Gr. CF3M, SS Ball & Stem thermoplastic seat insert. Design to API 6D, B16.34 NACE MR-01-75	2,27,101

## PIPING CLASS                      A01Q

NOTES

1. The minimum line size in this class is 1/2"NPS. Size 1/2"NPS is included for Instrument connections only. When it is necessary to use threaded connections in this class the wall thickness shall be Sch. 160. Threaded connections shall be used only for Instrument purposes.
2. See GENERAL NOTES para.19.2 for Gear operated gate and globe valves.
4. Use for Vent, Drain and Instrument connections.
6. Limit size of Weldolet outlet to 4" NPS.
10. Refer to Project Spec. "Technical requirements for the Supply of Valves" - for supplementary requirements for valves in Sour service.
14. All materials used in this class shall comply with the requirements of NACE Std. MR-01-75. Refer also to Section 9 of this Specification for additional Sour Service requirements.
25. Use for Instrument connections only.
27. Lines using soft-seat Ball valves shall be limited to the P/T values advised by the Valve manufacturer. Temperatures will normally be limited to 200°C max.
61. Piston type check valves to be installed in horizontal position only.
70. Plugs shall not be used in this pipe class, use flange and blind flange where required for vents and drains.
101. Soft seated Ball valves to be used in non contaminated service conditions only, ie, do not use where the service contains (or may contain) abrasive particles, abrasive fluid, or services with high rates of thermal expansion.

در زیر کد و استاندارد هایی را که متعلقات لوله کشی صنعتی را توصیف کرده اند آورده شده اند.

#### b). International Codes and Standards.

##### ASME Standards

B16.5 - 1998	Pipe Flanges and Flanged Fittings (NPS 1/2 Through NPS 24)
B16.9 - 2001	Factory-Made Wrought Steel Buttwelding Fittings
B16.10 - 2000	Face to Face and End to End Dimensions of Valves
B16.11 - 2001	Forged Fittings, Socket-Welding and Threaded
B16.20 - 2000	Metallic Gaskets for Pipe Flanges – Ring Joint, Spiral Wound and Jacketed
B16.21 - 1992	Nonmetallic Flat Gaskets for Pipe flanges
B16.25 - 1997	Buttwelding
B16.34 - 1998	Valves – Flanged, Threaded, and Welding End
B16.47 - 1998	Large Diameter Steel Flanges (NPS 26 Through NPS 60)
B16.48 - 1997	Steel Line Blanks
B31.3 - 2002	Process Piping
B31.4 - 2002	Pipeline transportation systems for liquid hydrocarbons and other liquids
B31.8 - 2001	Gas transmission and distribution piping systems.
B36.10M - 2000	Welded and Seamless Wrought Steel Pipe
B36.19M - 1994	Stainless Steel Pipe
B1.20.1 - 2001	Pipe Threads, General Purpose(Inch)
B46.1 - 2002	Surface Texture

##### ASTM Standards

B88 - 1999	Seamless Copper Water Tube
A105 - 2002	Carbon Steel Forgings for Piping Applications
A106 - 1999	Seamless Carbon Steel Pipe for High-Temperature Service
A153 - 2003	Zinc Coating(Hot-Dip) on Iron and Steel Hardware
A182 - 2002	Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature
A193 - 2001	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
A194 - 2001	Carbon and Alloy Steel Nuts for Bolts for High-Temperature and High-Temperature Service
A216 - 1998	Steel Casting, Carbon, Suitable for Fusion Welding, for High-Temperature Service
A234 - 2002	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperature
A240 - 2002	Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessel
A312 - 2001	Seamless and Welded Austenitic Stainless Steel Pipes
A320 - 2002	Alloy Steel Bolting Materials for Low Temperature Service
A333- 1999	Seamless and Welded Steel Pipe for Low Temperature Service

YY

A350 - 2002	Carbon and Low Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components
A351 - 2000	Casting, Austenitic, Austenitic-Ferritic(Duplex), for Pressure-Containing Parts
A352 - 2000	Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
A358 - 2001	Electric Fusion Welded Austenitic Chromium-Nickel Alloy Steel Pipe for High Temperature Service
A403 - 2002	Wrought Austenitic Stainless Steel Piping Fittings
A420 - 2002	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low Temperature Service
A516 - 2001	Impact Tested Carbon Steel Plate
A671 - 2001	Standard Specification for Electric Fusion Welded Steel Pipe for Atmospheric and Lower Temperature
A672 - 2001	Electric-Fusion-Welded Steel Pipe for High Pressure Service at Moderate Temperatures
A694 - 2000	Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service
A860 - 2000	Wrought High-Strength Low-Alloy Steel Butt-Welding Fittings
A960 - 2003	Common Requirements for Wrought Steel Piping Fittings
B148 - 2003	Aluminum-Bronze Sand Castings
B151 - 1994	Copper-Nickel-Zinc Alloy(Nickel Silver) and Copper-Nickel Rod and Bar
B265 - 1999	Titanium and Titanium Alloy Strip, Sheet, and Plate
B337 - (Discontinued)	Specification for Seamless and Welded Titanium Alloy Pipe
B348 - 2000	Titanium and Titanium Alloy Bars and Billets
B363 - 2000	Seamless and Welded Unalloyed Titanium and Titanium Alloy Welding Fittings
B367 - 1998	Titanium and Titanium Alloy Castings
B381 - 2000	Titanium and Titanium Alloy Forgings
B466 - 2003	Seamless Copper-Nickel Pipe and Tube
B467 - 2003	Welded Copper-Nickel Pipe
B861 - 2001	Titanium and Titanium Alloy Seamless Pipe
B862 - 2001	Titanium and Titanium Alloy Welded Pipe
D520 - 2000	Standard Specification for Zinc Dust Pigment
D1418 - 2001	Rubber and Rubber Latexes - Nomenclature
D2310 - 2001	Machine-Made "Fibreglass" Pipe
D2996 - 2001	Filament-Wound "Fibreglass" Pipe
F439 - 2002	Chlorinated Poly(Vinyl Chloride)(CPVC) Plastic Pipe Fittings, Schedule 80
F441 - 2002	Chlorinated Poly(Vinyl Chloride)(CPVC) Plastic Pipe, Schedule 40 and Schedule 80
F493 - 1997	Solvent Cements for Chlorinated Poly(Vinyl Chloride)(CPVC) Plastic Pipe and Fittings



YA

**British Standards**

BS 1133 - 1991	Temporary Protection of Metal Surfaces Against Corrosion
BS 1873 - 1975	Steel Globe & Globe Stop & Check Valves
BS 1868 - 1975	Steel Check Valve
BS 2870 - 1980	Rolled Copper and Copper Alloys, Sheet, Strip and Foil
BS 2871 - 1972	Copper and Copper Alloys, Tube Part 1, Part 2 & Part 3
BS 2872 - 1989	Copper and Copper Alloy, Forging Stock and Forgings
BS 2875 - 1969	Copper and Copper Alloy, Plate
BS 5154 - 1991	Copper Alloy Globe, Globe Stop and Check, Check and gate Valves
BS 5155 - (Superseded by BS EN 593)	Specification for Lined Butterfly Valves
BS EN 593 - 1998	Metallic Butterfly Valves
BS 5352 - (Superseded by BS EN ISO 15761)	Specification for Forged Globe and Check Valves
BS EN ISO 15761 - 2002	Steel Gate, Globe & Check Valves for Size DN 100 and Smaller
BS 5351 - 1990	Steel Ball Valves
BS 5146 - 1974	Inspection and Test of Valves
BS 6364 - 1984	Valves for Cryogenic Service

**API Standards**

API 5L - 2000	Specification for Line Pipe
API 600 - 2001	Bolted Bonnet Steel Valves
API 602 - 1998	Compact Steel Gate Valves – Forged, Threaded, Welding, and Extended-Body Ends
API 607 - 1998	Fire Test for Soft Seated Quarter Turn Valves
API 609 - 1997	Butterfly Valves : Double Flanged, Lug & Wafer Type
API 6FA - 1999	Fire Test For Valves
API 6D - 2002	Pipeline Transportation Systems – Pipeline Valves

**MSS-SP Standards**

MSS-SP-43 - 2001	Wrought Stainless Steel Butt-Welding Fittings
MSS-SP-25 - 1998	Standard Marking System For Valves, Fittings, Flange and Unions
MSS-SP-75 - 1998	Specification for High Test Wrought Buttwelding Fittings
MSS-SP-95 - 2000	Swage(d) Nipples & Bull Plugs

**NACE Standards**

MR01-75-01	Metal For Sulfide Stress Cracking and Stress Corrosion Cracking in Sour Oilfield Environments
TM02-84-96	Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen Induced Cracking

**EEMUA Standards**

**EEMUA 144 - 1987 90/10 Copper Nickel Alloy Piping For Offshore Application –  
Specification : Tubes Seamless & Welded.**

**EEMUA 145 - 1987 90/10 Copper Nickel Alloy Piping For Offshore Application –  
Specification : Flanges Composite & Solid**

**EEMUA 146 - 1987 90/10 Copper Nickel Alloy Piping For Offshore Application –  
Specification : Fittings**

**MILITARY Specifications**

**MIL-P-21035            Paint, High Zinc Dust Content, Galvanizing, Repair**

## پیوست ۳


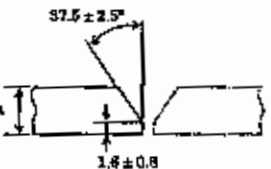
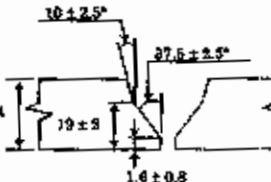
مطالب مفیدی در مورد تیرانس های *Piping*، ملزومات و ...

در این پیوست سعی شده است نکات مفیدی در مورد لوله کشی در زمینه های مختلف

ارایه شود.

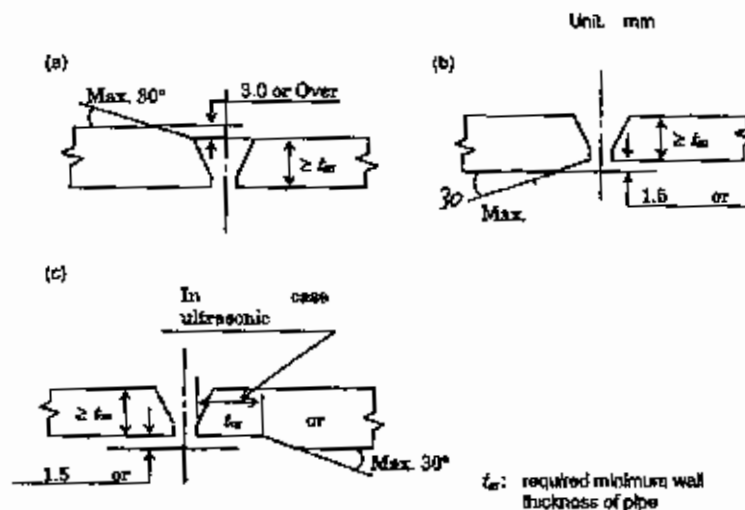
شکل ۱ نحوه انتخاب روش لبه سازی لوله و اتصالات در جوش لب به لب نشان داده شده است.

Unit: mm

Thickness of Pipe	Type of End	Shape of Groove
$t \leq 3$	I	
$1 \leq 22$	V	
$t > 22$	Double-V	

شکل ۱: اندازه و نوع شیار جوش لب به لب بر حسب ضخامت

در شکل ۲ نحوه فیتاپ سر جوش هایی که دارای ضخامت متفاوت می باشند آورده شده است.



شکل ۲: نحوه فیتاپ ضخامت های متفاوت

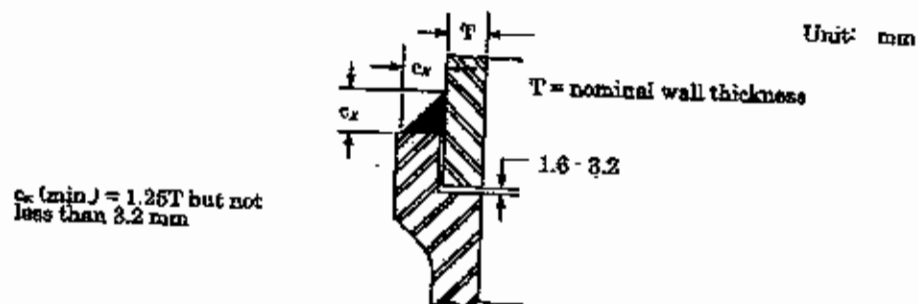
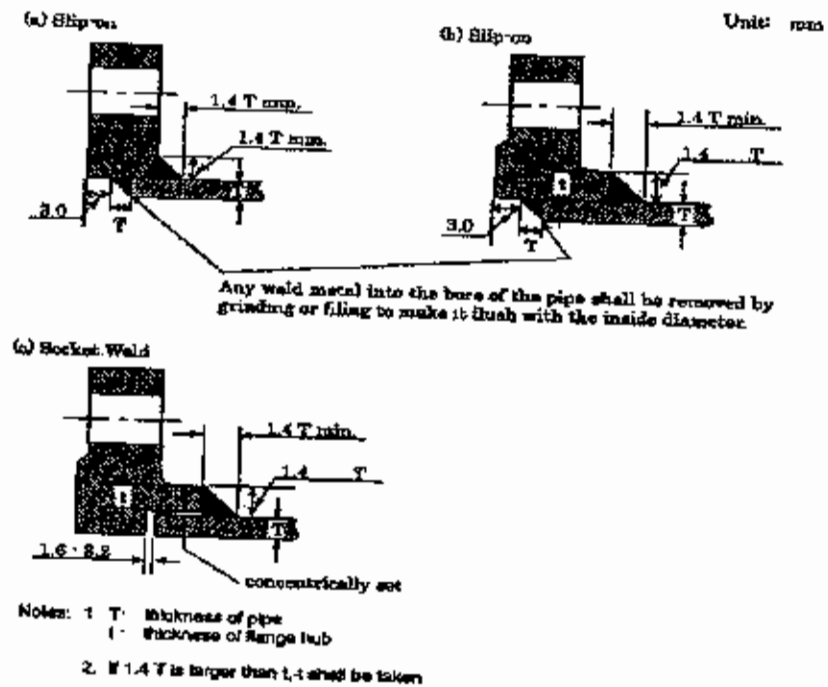
در شکل ۳ حداقل فاصله شعاعی بین درز جوش های لوله و اتصالات جوشی پشت سر هم نشان

داده شده است.





در شکل ۶ اندازه جوش های فیلت در حالت های فلنج اسلپ و ون و سوکتی و سر جوش سوکتی نشان داده شده اند.



شکل ۶: اندازه جوش های فیلت

در جدول ۱ شرایط پیش گرمایش برای چندین مواد لوله کشی صنعتی براساس ضخامت

بحث شده است.

جدول ۱: راهنمای *Preheat* برای متريال های متفاوت

Material Specification			Nominal wall thickness T (mm)	Preheat Temperature (°C)
P-No.	ASTM	NPS		
1	API 5L Gr.B A106 Gr.B A333 Gr.6 A671 Gr.B65, CL22 A672 Gr.B60, CL22	ALL	$t < 25$	Not required <sup>(1)</sup>
			$t \geq 25$	80 and above
1 NACE MR.0175	A106 Gr. B A333 Gr.6 A571 Gr. B65 CL22	ALL	$t < 25$	Not required <sup>(1)</sup>
			$t \geq 25$	80 and above
8 Inc NACE	A312.TP. 316L A358.Gr.316L,CL3	ALL	All	Not required <sup>(1)</sup>
34	ASTM B466 C70600 90-10CuNi	ALL	All	Not required
51	TITANIUM	ALL	N/A	N/A

<sup>(1)</sup> In a case where the ambient temperature is below 5 °C, preheating to a temperature of 40 °C minimum shall be applied to P-1 and P-8.

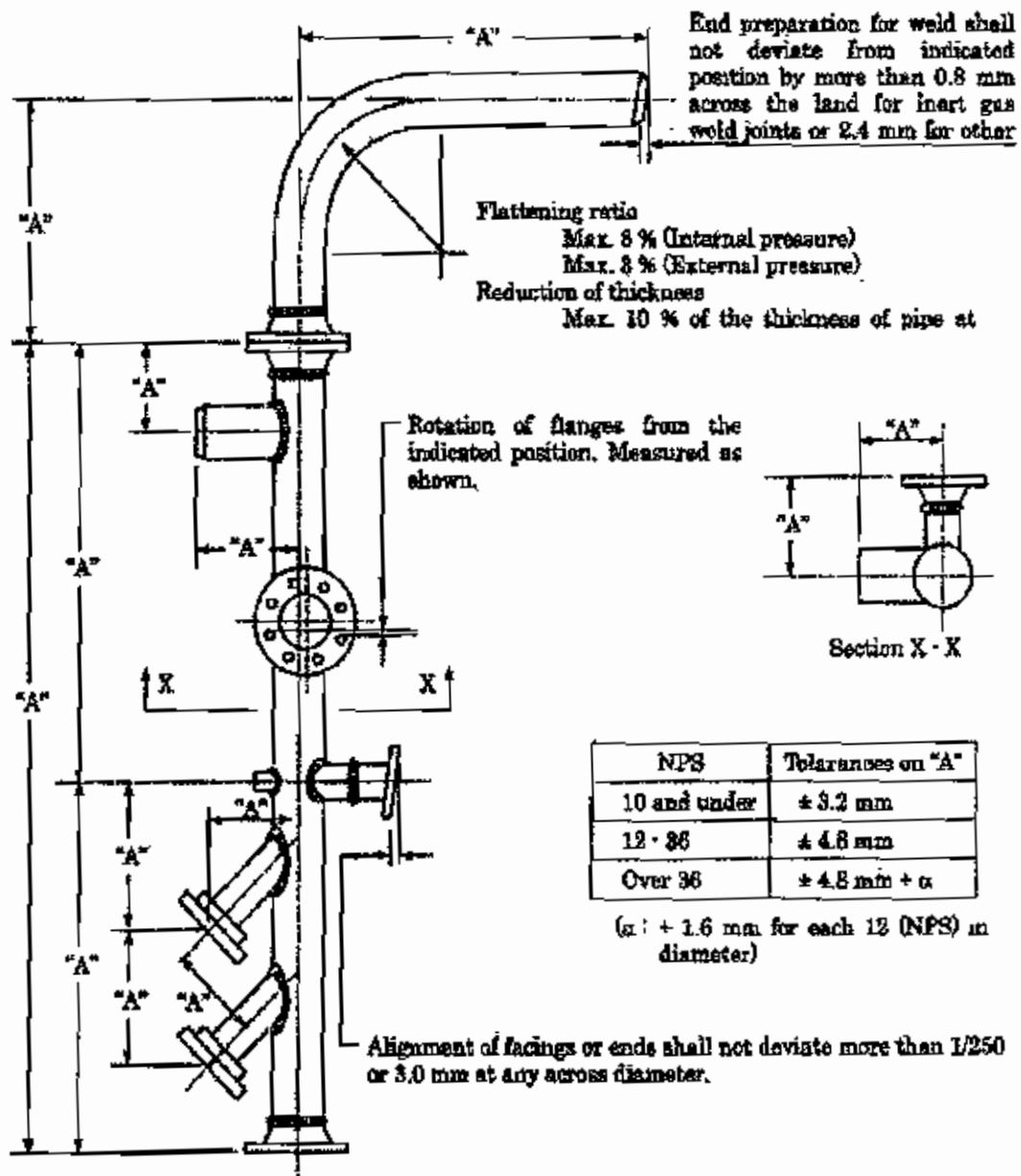
در جدول ۲ شرایط *PWHT* برای چند نوع متريال شرح داده شده است.

جدول ۲: شرایط *PWHT*

P.No	ASTM Material	Pipe Size (NPS)	Nominal Wall Thickness <sup>(1)</sup>	Temp (°C)	Holding Period at Temp. (h)	Min Holding Period	Max Heating rate (°C/h) Rh	Max Cooling Rate (°C/h) Rc
1	API 5L, Gr B A106, Gr B A333 Gr.6 A671 Gr.B65, CL22 A672 Gr.B60, CL22	ALL	> 16mm	593 to 640	2.5min per mm	60min	Rh < 220 x 25/T Max. 220 °C/h Min. 55 °C/h	Rc < 280 x 25/T Max. 280 °C/h Min. 55 °C/h

در شکل ۷ تیرانس های نصب و فابریکیشن اسپول برای طول ، انشعابات، محل فلنج، ترازى و شاغولى لبه های لوله و فلنج، صافى و کاهش ضخامت در حالت خم کردن لوله و .. آورده شده است.

$$NPS = \text{Nominal Pipe Size}$$



Application of Pipe Fabrication

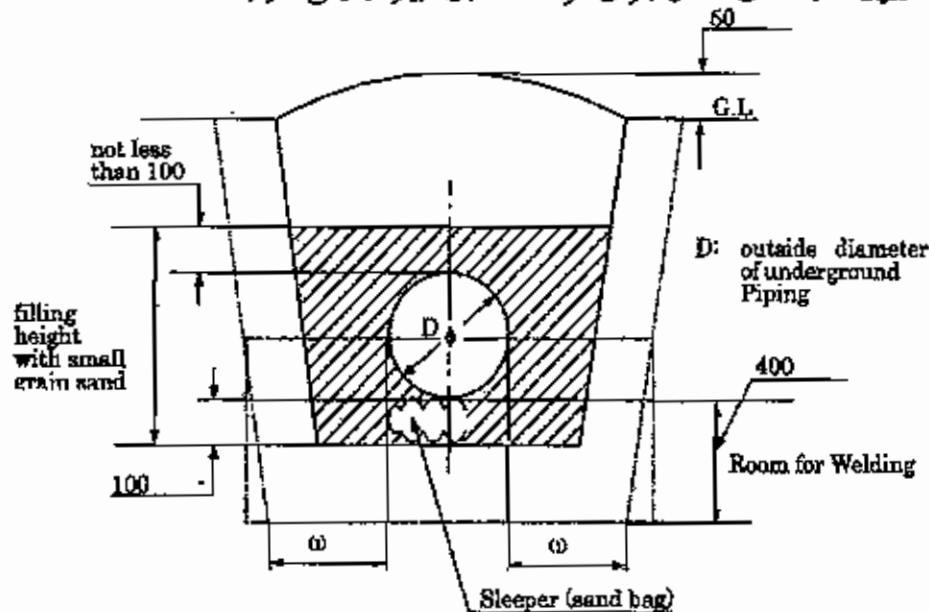
شکل ۷: تolerانس های فابریکیشن در اسپول سازی و نصب

در جدول ۳ شرایط خم کردن لوله بصورت کار سرد بحث شده است.

جدول ۳: شرایط خم لوله در حالت سرد

Type of Piping	Material	Size (NPS)	Type of Bending
Process and Utility Pressure Piping	Carbon Steel	$D \leq 1 \frac{1}{2}$	Cold
	Stainless Steel	$D \leq 1$	Cold

در شکل ۸-۱۱ اندازه های کانال برای لوله گذاری زیر زمینی آورده شده است.



ω : Room for Welding 500 - 600 mm

شکل ۸-۱۱: اندازه ها در عملیات لوله گذاری زیر زمینی

در جدول ۴ معیار پذیرش چندین عیب جوشکاری در بازرسی چشمی مورد بحث و بررسی قرار گرفته اند.

جدول ۴: معیار های پذیرش چند نوع عیب جوشکاری در بازرسی چشمی

After Welding

Examination and Testing		Acceptance Criterion										
(a) Visual examination of weld	Crack	None										
	Under cut Girth weld and Branch connection	Lesser 1.0 mm or 0.25 t. But for low temperature service and high temperature service materials, under cut is not permitted.										
	Overlap (Coldlap)	Less than 1.0 mm										
	Throat thickness of fillet weld	Over 0.8 t (Half/Full Cupling) Over 1.0 t (SC/5W Flange) (t: thinner pipe thickness)										
	Weld reinforcement or internal weld protrusion (Root Penetration)	<table><tr><th>Wall Thickness</th><th>Max. (mm)</th></tr><tr><td>8.4 or under</td><td>1.6</td></tr><tr><td>over 8.4 upto 12.7</td><td>3.2</td></tr><tr><td>over 12.7 upto 25.4</td><td>4.0</td></tr><tr><td>over 25.4</td><td>4.8</td></tr></table>	Wall Thickness	Max. (mm)	8.4 or under	1.6	over 8.4 upto 12.7	3.2	over 12.7 upto 25.4	4.0	over 25.4	4.8
	Wall Thickness	Max. (mm)										
	8.4 or under	1.6										
	over 8.4 upto 12.7	3.2										
	over 12.7 upto 25.4	4.0										
over 25.4	4.8											
Weld scars from jigs and arc strikes	Visual check and no defect. Liquid penetrant examination as per following part (b) for high temperature and low temperature service.											
Lack of fusion												
Girth weld and Branch connection	Nil											
Incomplete penetration												
Girth weld and Branch connection	Lesser 0.8 mm or 0.2 t, but not more than 38 mm cumulative length in any 150 mm of weld length depth $\leq 0.2 t$ . But for low temperature service and high temperature service materials, incomplete penetration is not permitted.											
Surface porosity	None											



در جدول ۵ مواد بر اساس کلاس *Piping* برای تست های غیر مخرب دسته بندی شده اند.

جدول ۵: کلاس بندی مواد برای تست های غیر مخرب

Material Type	Examination Class		
	Class I	Class II	Class III
Carbon steel (all services excluding low pressure air, water and N <sub>2</sub> )	900-2500#	150-600#	-
Carbon steel (low pressure air, water and N <sub>2</sub> ), Cement lined carbon steel	-	-	150#
300 series stainless steel (all services excluding low pressure air, water and N <sub>2</sub> )	900-2500#	150-600#	-
300 series stainless steel (low pressure air, water and N <sub>2</sub> )	-	-	150#
Cu-based alloy (all services)	900-2500#	150-600#	-
Titanium, Dissimilar metal welds	150-2500#	-	-

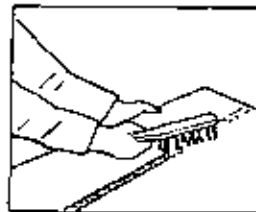
در جدول ۶ درصد انجام تست های غیر مخرب جوشکاری (چشمی، رادیو گرافی، التراسونیک، ذرات مغناطیسی و مواد نفوذ کننده) براساس دسته بندی جدول ۵ لیست شده اند.

جدول ۶: تعیین درصد انجام تست های غیر مخرب بر اساس کلاس تست

Examination Class <sup>(1)</sup>	NDE Method	Material Type	%NDE for Weld Type			
			Butt Welds	Branch Welds	Fillet & Socket welds	Attachment Welds
I	Visual	All	100	100	100	100
	RT	All	100 <sup>(2)</sup>	100 <sup>(2)</sup>	<sup>(2)</sup>	-
	UT	Carbon, 300 series stainless steels, & Cu-based alloy, Titanium. (t>19mm)	100 <sup>(2)(3)</sup>	100 <sup>(2)(4)</sup>	-	-
	MT <sup>(5)</sup>	Carbon steels	100	100	100	10 <sup>(6)</sup>
	PT	300 series stainless steels & Cu-based alloys	100	100	100	10
II	Visual	All	100	100	100	100
	RT	All	5 <sup>(7)</sup>	5 <sup>(7)</sup>	<sup>(7)</sup>	<sup>(7)</sup>
	MT	Carbon steels	5 <sup>(7)</sup>	5 <sup>(7)</sup>	5 <sup>(7)</sup>	5 <sup>(7)</sup>
	PT	300 series stainless steels & Cu-based alloys	5 <sup>(7)</sup>	5 <sup>(7)</sup>	5 <sup>(7)</sup>	5 <sup>(7)</sup>
III	Visual	All	100	100	100	100
	RT	All	5 <sup>(7)</sup>	<sup>(7)</sup>	<sup>(7)</sup>	-
	MT	Carbon steel	5 <sup>(7)</sup>	5 <sup>(7)</sup>	5 <sup>(7)</sup>	-
	PT	300 series stainless steel	5 <sup>(7)</sup>	5 <sup>(7)</sup>	5 <sup>(7)</sup>	-

در شکل ۹ مراحل انجام عملیات اسیدشویی (Pickling) جهت تمیز کاری جوشها (معمولا

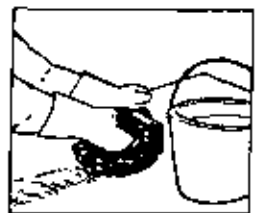
جوشهای فولاد ضد زنگ) نشان داده شده است.



جوش را برس بزنید



خمیر را با برس بر روی جوش بمالید ، بگذارید حداقل ۵۰ دقیقه بر روی جوش بمالد تا اثر کند .



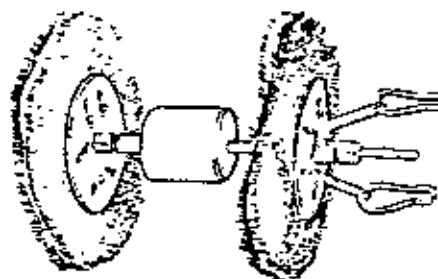
با یک برس ضد زنگ مرطوب و با استفاده از یک کلاف میخی ضد زنگ مرطوب ، جوش را پاک کنید .



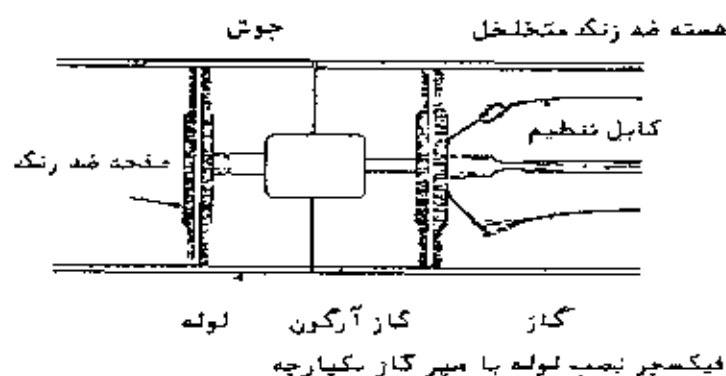
جوش را بطور کامل با آب بشوئید

#### شکل ۹: مراحل انجام عملیات اسید شویی

همچنانکه می دانیم برای ایجاد سپر گاز بی اثر در پاس ریشه در سائز های بالا از فیکسچرهای خاصی استفاده می شود که نمونه آنها در شکل ۱۰ نشان داده شده است.



فیکسچر برای تامین سپر گاز ریشه



شکل ۱۰: یک نوع فیکسچر برای ایجاد سپر گاز بی اثر در ریشه سر جوش

پیوست ۴:

## نمونه هایی از اتصالات لوله کشی و ابعاد و اندازه

در حالت کلی اتصالات و ملزومات لوله کشی صنعتی به ترتیب زیر طبقه بندی می شوند.

معرفی و تشریح اقلام و اتصالات نرمال و خاص مورد استفاده در Piping :

۱- لوله و تیوب ( Pipe & Tube )

۲- زانونی ( Elbow 90,45 )

۳- زانوهای بریده شده ( Trimmed Elbow )

۴- زانوی دوسایزی یا چپقی ( Red. Elbow )

۵- سه راهی هم سایز ( Equal Tee )

۶- سه راهی غیر هم سایز ( Reducing Tee )

۷- سه راهی با زاویه ۱۲۰ درجه ( Y-type Tee )

۸- سه راهی با زوایای ۳۰ و ۴۵ درجه ( Lateral Tee )

۹- سه راهی با زوایای سه بعدی

۱۰- چهار راه ( Cross )

۱۱- کاهنده متقارن ( Conc. Reducer )

۱۲- کاهنده نامتقارن ( Ecc. Reducer )

۱۳- Ecc. & Conc. Swage

۱۴- Red. Insert

۱۵- کوبلینگ کاهنده ( Red. Coupling )

۱۶- کوبلینگ هم سایز ( Full Coupling )

۱۷- نیم کوبلینگ ( Half Coupling )

۱۸- Olet

۱۹- مهره ماسوره ( Union )

۲۰- تکه لوله آماده ( Nipple )

۲۱- درپوش ( Cap )

۲۲- درپوش ( Plug )

۲۳- فلنج ( Flange )

۲۴-۵- واشر ( Gasket )

۲۵- پیچ و مهره ( Bolt & Nut )

۲۶- شیرآلات شامل :

Gate Valve - ۱-۲۶

Globe Valve - ۲-۲۶

Ball Valve - ۳-۲۶

Plug Valve - ۴-۲۶

Butterfly Valve - ۵-۲۶

Angle Valve - ۶-۲۶

Safty Valve - ۷-۲۶

Relief Valve - ۸-۲۶

Swing Check Valve - ۹-۲۶

Lift Check Valve - ۱۰-۲۶

Dual Plate Check Valve - ۱۱-۲۶

None Return Valve (NRV) - ۱۲-۲۶

Arc Valve ( For Min. Flow ) - ۱۳-۲۶



۱۴-۲۶- شیر دیافراگمی ( Diaphragm Valve )

۲۷- تله بخار ( Steam Trap )

۲۸- صافی ( Strainer )

۲۹- اندازه گیرنده های جریان ( Flow Meters )

۳۰- اندازه گیرنده های سطح سیال ( Level Gauges )

۳۱- لرزه گیر ( Flexible Joint )

۳۲- قطعات انبساطی ( Expansion Joints )

۳۳- ادوات نمونه گیری ( Sample Connections )

۳۴- آرام کننده جریان ( Flow Straightner )

۳۵- اتصالات عینکی ( Spectacle Blind & Spacer )

۳۶- دیسک اطمینان ( Rupture Disc )

۳۷- Desuperheater

۳۸- صدا خفه کن ( Silencer )

در زیر لیست بعضی از استانداردها که اتصالات را معرفی کرده اند آورده شده اند. ابعاد و اندازه های کلیه اتصالات مطابق استاندارد *ASME* بصورت جدولی در فایل های *CD* پیوستی آورده شده اند. در صفحات بعدی نمونه هایی از اشکال اتصالات نشان داده شده اند.

### Codes and Standards

*The design shall be to the latest International Codes and standards.  
These shall include but not be limited to the following:*

<i>ANSI B1.20.1</i>	<i>Pipe Threads</i>
<i>ANSI B16.5</i>	<i>Pipe Flanges and Flanged Fittings</i>
<i>ANSI B16.9</i>	<i>Wrought Steel Butt Welding Fittings</i>
<i>ANSI B16.11</i>	<i>Forged Steel fitting, Socket Welding and Threading</i>
<i>ANSI B16.20</i>	<i>Ring Joint Gaskets and Grooves for Steel Pipe Flanges</i>
<i>ANSI B16.21</i>	<i>Nonmetallic Gasket for Pipe Flanges</i>
<i>ANSI B16.25</i>	<i>Butt Welding Ends</i>

ANSI B16.34	Valves-Flanged, Threaded, and Welding End
ANSI B16.47	Large Diameter Carbon Steel Flanges
ANSI B18.2.2	Square and Hexagon Nuts
ASME B31.3	Process Piping
ASME B31.4	Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols
ASME B31.8	Gas Transmission and Distribution Piping Systems
ANSI B36.10	Welded and Seamless Wrought Steel Pipe
ANSI B36.19	Stainless Steel Pipe
API 5L	Specification for Line Pipe
API 594	Wafer Check Valves
API 599	Steel and Ductile Iron Plug Valves
API 600	Steel Gate Valves, Flanged and Butts Welding Ends
API 601	Metallic Gasket for Raised Face Pipe Flanges and Flanged Connections (double-jacketed corrugated and spiral wound)
API 602	Compact Steel Gate Valves
API 607	Fire Test for Soft Seated Quarter-Turn Valves
API 609	Lug and Wafer Type Butterfly Valves
API 6D	Specification for Pipeline Valves
API 6FA	Fire Test for Valves
ASTM	American Society for Testing and Materials
BS 1580	Unified Screw Threads Part 1 & 2
BS 1873	Steel Globe and Globe Stop and Check Valves (Flanged & Butt-Weld Ends)
BS 1868	Steel Check Valves (Flanged and Butt Welding Ends for Petroleum Petrochemical and Allied Industries)
BS 6755	Testing of Valves
BS 5351	Steel Ball Valves for the Petroleum, Petrochemical and Allied Industries
BS 5352	Steel Wedge Gate, Globe and Check Valves
NACE MR0175	Standard Material Requirements Sulfide Stress Cracking Resistant Metallic Materials for Oil Field Equipment
MSS SP-6	Contact Faces of Pipe Flanges and Connecting-end Flanges of Valves and Fittings

MSS SP-44	Steel Pipe Line Flanges
MSS SP-67	Butterfly Valves
MSS SP-68	High Pressure-Offset Seat Butterfly Valves
MSS SP-75	Specification for High Test Wrought Welding Fittings.
MSS SP-80	Bronze Gate, Globe Angle and Check alves
MSS SP-83	Class 3000, Steel Pipe Unions, Socket Welding and Threaded
MSS SP-95	Swage(d) Nipples and Bull Plug
MSS SP-97	Forged Carbon Steel Branch Outlet Fittings
	Socket Welding Threaded and Butt Welding Ends.
AWWA-C950	Fiberglass Pressure Pipe
DIN 8074	High-Density Polyethylene (PE-HD) Pipes

#### 4.2 Valves

Weld end valves shall be specified with bore to match fittings.  
Flanged end valves of 26" and larger shall be in accordance with ANSI B16.47, Series "A".

Valves	Size	Design	Fire-safe
Gate	1/2"-1-1/2"	API 602	-
	2"-24"	API 600	-
	26" & over	ANSI B	-
Globe	1/2"-1-1/2"	BS 5352	-
	2"-24"	BS 1873	-
Check	1/2"-1-1/2"	BS 5352	-
	2"-4"	BS 1868	-
	Wafer Type	API 594	-
Ball	1/2"-1-1/2"	*BS 5351	BS 6755
	2" & over	API 6D	API 6FA
Plug	1"-24"	API 6D	API 6FA
Butterfly	3"-24"	API 609	API 6FA
	26" & over	MSS SP-	API 6FA

Note : \* - Basic design code for CL.900 and CL.1500 shall be ANSI B 16.34.

The following table for gear operation shall be used as minimum requirement except that manufacturer's recommendation shall govern when manufacturer's recommendation is more stringent.

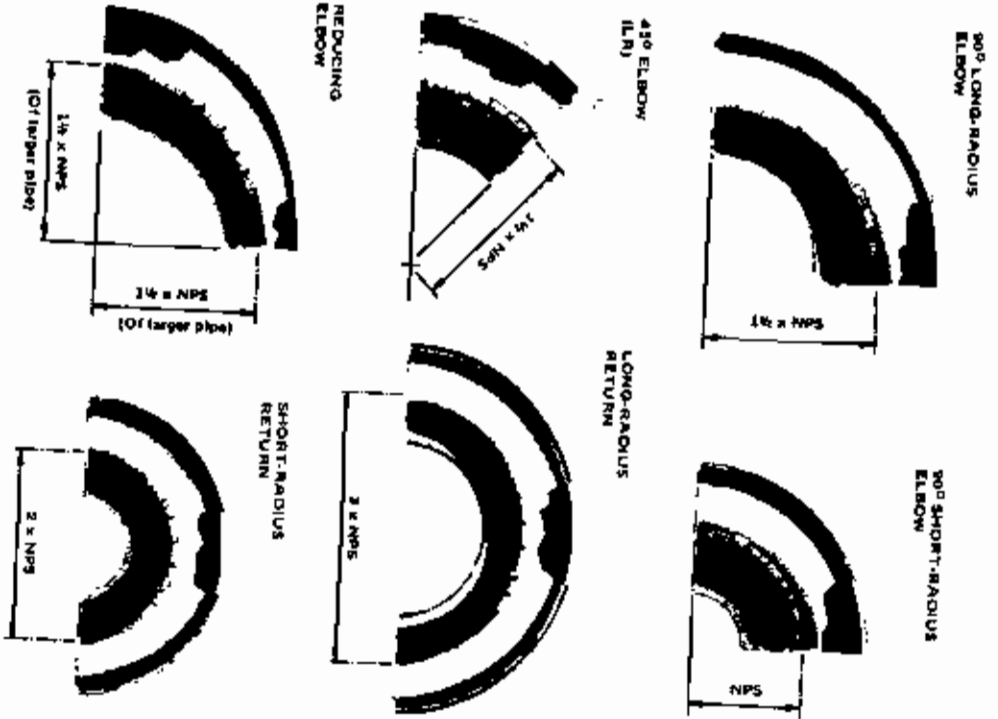
Gear Operated	CL.150	CL.300	CL.600	CL.900
Gate	16" & 7	12" & over	12" &	8" &
Globe	10" &	10" & over	10" &	6" &
Ball / Plug	8" & over	6" & over	6" & over	6" &
Butterfly	8" & over	8" & over	-	-





ELBOWS & RETURNS

FIGURE 2.2



**REDUCER (or INCREASER)** joins a larger pipe to a smaller one. The two available types, concentric and eccentric, are shown. The eccentric reducer is used when it is necessary to keep either the top or the bottom of the line level—offset equals  $\frac{1}{2} \times$  (larger ID minus smaller ID).

**REDUCERS**

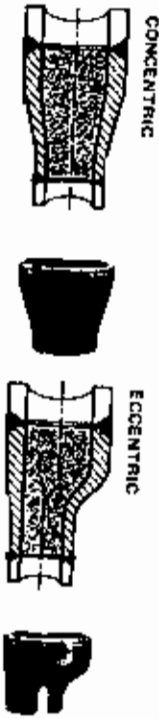
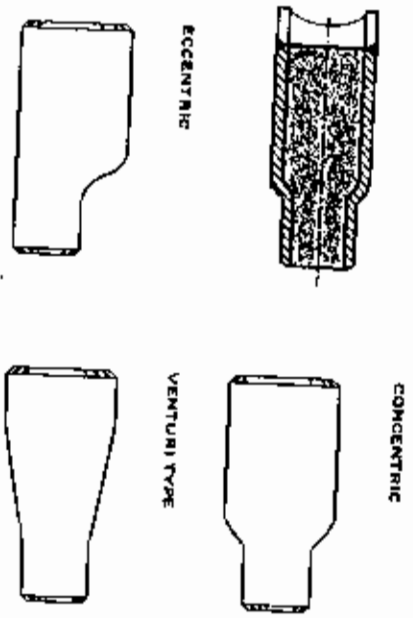


FIGURE 2.3

**SWAGE** is employed to connect butt-welded piping to smaller screwed or socket-welded piping. In butt-welded lines, used as an alternative to the reducer when greater reductions in line size are required. Regular swages in concentric or eccentric form give abrupt change of line size, as do reducers. The 'venturi' swage allows smoother flow. Refer to table 2.3 for specifying swages for joining to socket-welding items, and to table 2.4 for specifying swages for joining to screwed piping. For offset, see 'Reducer'.

**SWAGES, or SWAGED NIPPLES**

FIGURE 2.4



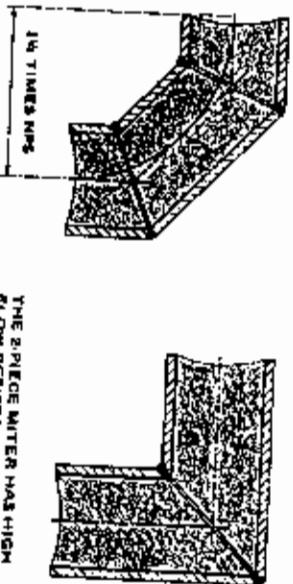
**MITERED ELBOWS** are fabricated as required from pipe—they are not fillings. The use of miters to make changes in direction is practically restricted to low-pressure lines 10-inch and larger if the pressure drop is unimportant; for these uses regular elbows would be costlier. A 2-piece, 90-degree miter has four to six times the hydraulic resistance of the correct-radius regular long-radius elbow, and should be used with caution. A 3-piece 90-degree miter has about double the resistance to flow of the regular long-radius elbow—refer to table F-10. Constructions for 3-, 4-, and 5-piece miters are shown in tables M-2.

**2-PIECE & 3-PIECE MITERS**

**3-PIECE MITER**

**2-PIECE MITER**

FIGURE 2.5



THE 2-PIECE MITER HAS HIGH FLOW RESISTANCE (SEE TABLE F-10)

CHART  
2.1

FIGURES  
2.1-2.5

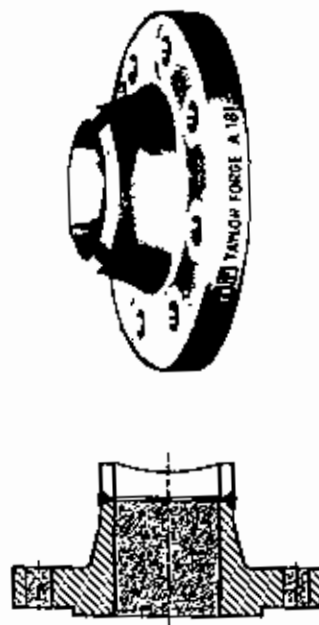
2  
2.4  
3.1

The following five flange types are used for butt-welded lines. The different flange ratings available are discussed in 2.8.

**WELDING-NECK FLANGE, REGULAR & LONG** *Regular welding-neck flanges are used with butt-welding fittings.* Long welding-neck flanges are primarily used for vessel and equipment nozzles, rarely for pipe. Suitable where extreme temperature, shear, impact and vibratory stresses apply. Rigidity of the bore is maintained. Refer to tables F for bore diameters of these flanges.

WELDING-NECK FLANGE

FIGURE 2.5



**SLIP-ON FLANGE** is properly used to flange pipe. Slip-on flanges can be used with long-tangent elbows, reducers, and swages (not usual practical). The internal weld is slightly more subject to corrosion than the butt weld. The flange has poor resistance to shock and vibration. It introduces irregularity in the bore. It is cheaper to buy than the welding-neck flange, but is costlier to assemble. It is easier to align than the welding-neck flange. Calculated strengths under internal pressure are about one third that of the corresponding welding-neck flanges. The pipe or fitting is set back from the face of the flange a distance equal to the wall thickness  $-0'' + 1/16''$ .

SLIP-ON FLANGE

FIGURE 2.7



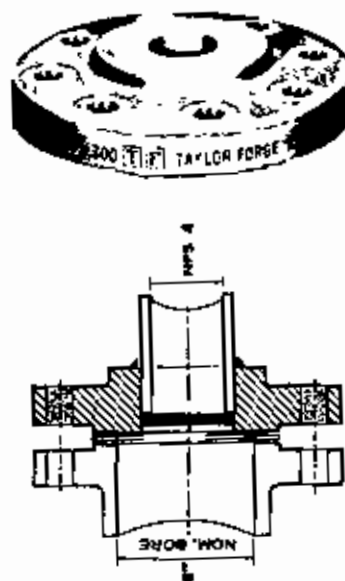
**REDUCING FLANGE** Suitable for changing line size, but should not be used if abrupt transition would create undesirable turbulence, as at pump connections. Available to order in welding-neck and eccentric types, and usually from stock in slip-on type. Specify by nominal pipe sizes, stating the size of the larger pipe first. Example: a slip-on reducing flange to connect a NPS 4 pipe to a Class 150 NPS 6 line-size flange is specified:

RED FLG NPS 6 x 4 Class 150 SO

For a welding-neck reducing flange, correct bore is obtained by giving the pipe schedule number or manufacturers' weight of the pipe to be welded on.

REDUCING SLIP-ON FLANGE

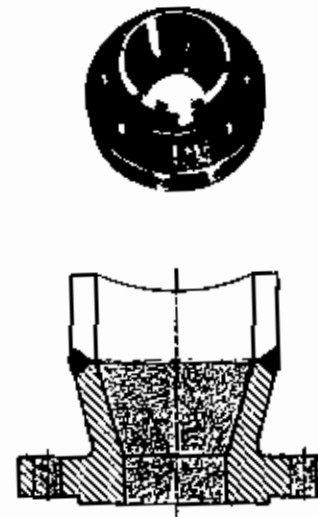
FIGURE 2.8



**EXPANDER FLANGE** Application as for welding-neck flange—see above. Increases pipe size to first or second larger size. Alternative to using reducer and welding-neck flange. Useful for connecting to valves, compressors and pumps. Pressure ratings and dimensions are in accord with ANSI B16.5.

EXPANDER (or INCREASED) FLANGE

FIGURE 2.9



**LAP JOINT, or "VAN STONE", FLANGE** Economical if costly pipe such as stainless steel is used, as the flange can be of carbon steel and only the lap-joint stub and neck be of the fine material. A stub end must be used in a lap joint, and the cost of the two items must be considered. If both stub and flange are of the same material they will be more expensive than a welding-neck flange. Useful where alignment of bolt holes is difficult, as with spools to be attached to flanged nozzles of vessels.

LAP-JOINT FLANGE (with Stub-end)

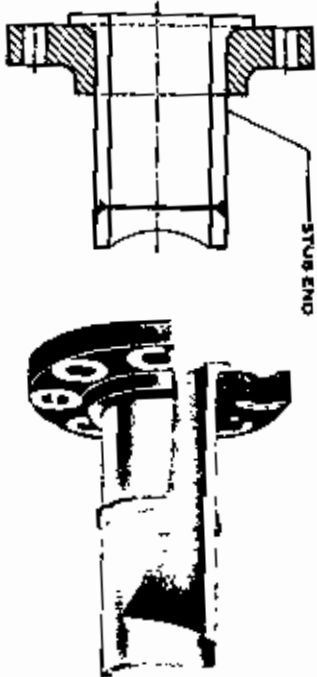


FIGURE 2.10

## BUTT-WELDING FITTINGS FOR BRANCHING FROM BUTT-WELDED SYSTEMS

2.1.2

**STUB-IN** Term for a branch pipe welded directly into the side of the main pipe run—it is not a fitting. This is the commonest and least expensive method of welding a full-size or reducing branch for pipe 2-inch and larger. A stub-in can be reinforced by means set out in 2.11.

STUB-IN

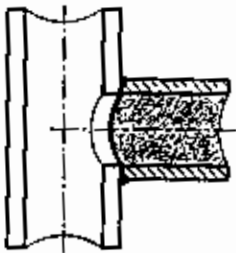


FIGURE 2.11

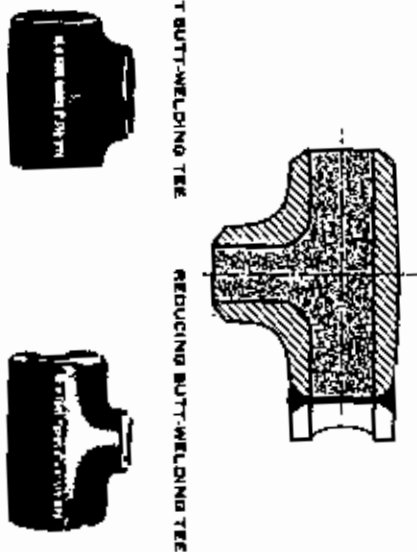
**BUTT-WELDING TEES, STRAIGHT or REDUCING**, are employed to make 90-degree branches from the main run of pipe. Straight tees, with branch the same size as the run, are readily available. Reducing tees have branch smaller than the run. Bullhead tees have branch larger than the run, and are very seldom used but can be made to special order. None of these tees requires reinforcement. Reducing tees are ordered as follows:—

**SPECIFYING SIZE OF BUTT-WELDING REDUCING TEES**

NOM TO SPECIFY TEES:	RUN INLET	RUN OUTLET	BRANCH	EXAMPLE
REDUCING ON BRANCH	6"	6"	4"	RED TEE 6 x 6 x 4

BUTT-WELDING TEES

FIGURE 2.12



STRAIGHT BUTT-WELDING TEE

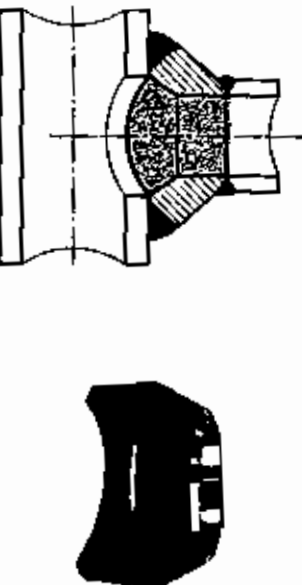
REDUCING BUTT-WELDING TEE

The next four branching fittings are made by Bonney Forge. These fittings offer an alternate means of connecting into the main run, and do not require reinforcement. They are preshaped to the curvature of the run pipe.

**WELD-O-LET** makes a 90-degree branch, full-size or reducing, on straight pipe. Closer manholeing is possible than with tees. Flat-based weld-lets are available for connecting to pipe caps and vessel heads.

WELD-O-LET

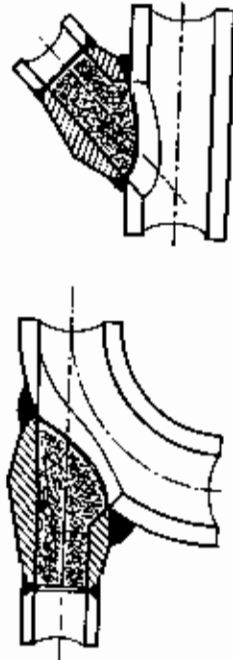
FIGURE 2.13



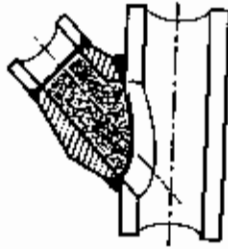
FIGURES  
2.8-2.13

**BUTT-WELDING ELBOLET** makes a reducing tangent branch on long-radius and short-radius elbows.

**ELBOLET**  
**FIGURE 2.14**



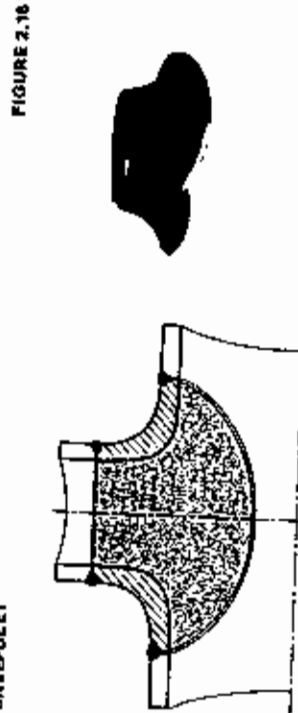
**BUTT-WELDING LATROLET**  
**FIGURE 2.15**



**BUTT-WELDING LATROLET** makes a 45-degree reducing branch on straight pipe.

**SWEEPOLET** makes a 90-degree reducing branch from the main run of pipe. Primarily developed for high-yield pipe used in oil and gas transmission lines. Provides good flow pattern, and optimum stress distribution.

**SWEEPOLET**



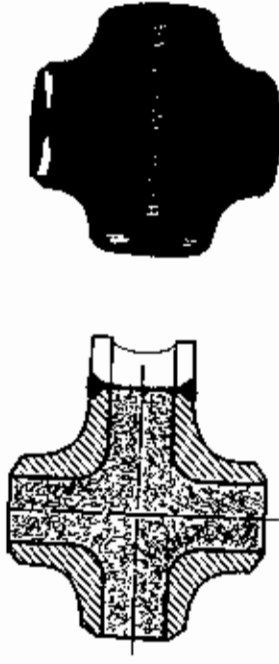
**FIGURE 2.16**

The next three fittings are usually used for special designs:

**CROSS, STRAIGHT or REDUCING** Straight crosses are usually stock items. Reducing crosses may not be readily available. For economy, availability and to minimize the number of items in inventory, it is preferred to use tees, etc., and not crosses, except where space is restricted, as in marine piping or 'is-vamp' work. Reinforcement is not needed.

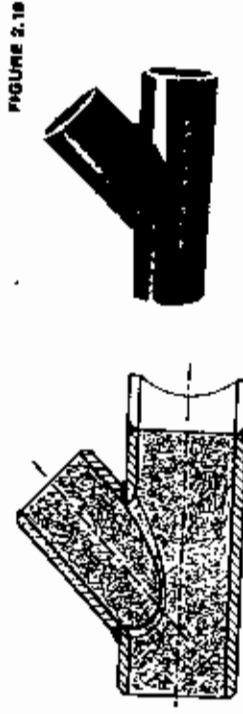
**BUTT-WELDING CROSS**

**FIGURE 2.17**



**LATERAL, STRAIGHT or REDUCING**, permits odd-angled entry into the pipe run where low resistance to flow is important. Straight laterals with branch bore equal to run bore are available in STD and XS weights. Reducing laterals and laterals at angles other than 45 degrees are usually available only to special order. Reinforcement is required where it is necessary to restore the strength of the joint to the full strength of the pipe. Reducing laterals are ordered similarly to butt-welding tees, except that the angle between branch and run is also stated.

**LATERAL**



**FIGURE 2.18**

**SHAPED NIPPLE** Now rarely used, but can be obtained from stock in 90- and 45-degree angles, and in any size and angle, including offset, to special order. The run is field-cut, using the nipple as template. Needs reinforcement if it is necessary to bring the strength of the joint up to the full strength of the pipe.

**SHAPED NIPPLE**



**FIGURE 2.19**



## CLOSURES

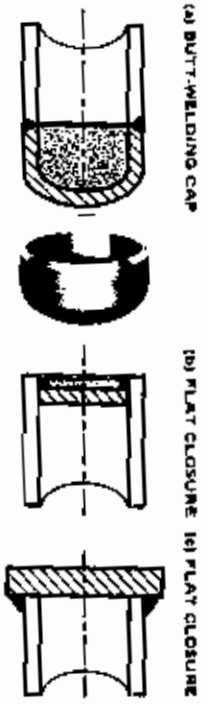
2.3.3

CAP is used to seal the end of pipe. (See figure 2.20(a) )

**FLAT CLOSURES** Flat plates are normally cut especially from platestock by the fabricator or erector. (See figure 2.20 (b) and (c).)

### THREE WELDED CLOSURES

FIGURE 2.20



ELLIPSOIDAL, or DISHED, HEADS are used to close pipes of large diameter, and are similar to those used for constructing vessels.

## COMPONENTS FOR SOCKET-WELDED PIPING SYSTEMS

2.4

### WHERE USED:

For lines conveying flammable, toxic, or expensive material, where no leakage can be permitted. For steam: 300 to 600 PSI, and sometimes 150 PSI steam. For corrosive conditions, see Index under "Corrosion".

### ADVANTAGES OF JOINT:

- (1) Easier alignment on small lines than butt welding. Tack welding is unnecessary.
- (2) No weld metal can enter bore.
- (3) Joint will not leak, when properly made.

### DISADVANTAGES OF JOINT:

- (1) The 1/16-inch recess in joint (see chart 2.2) pockets liquid.
- (2) Use not permitted by ANSI B31.1, 1989 if severe vibration or service corrosion is anticipated.

### HOW JOINT IS MADE:

The end of the pipe is finished flat, as shown in chart 2.2. It is located in the fitting, valve, flange, etc., and a continuous fillet weld is made around the circumference.

## SOCKET-WELDED PIPING

CHART 2.2

Chart 2.2 shows the ratings of pipe, fittings and valves that are commonly combined, or may be used together. The chart is a guide only, and not a substitute for a project specification.

SOCKET-WELDED PIPING CHART 2.2					
CARBON-STEEL PIPE & FORGED-STEEL FITTINGS					
END PREPARATION OF PIPE, AND METHOD OF JOINING TO FITTING, FLANGE, VALVE, OR EQUIPMENT					
MAXIMUM LINE SIZE NORMALLY SOCKET WELDED	NPS 1/2		NPS 1/2 to NPS 4		
AVAILABILITY OF FORGED-STEEL SOCKET-WELDED FITTINGS	NPS 1/2 to NPS 4		NPS 1/2 to NPS 4		
WEIGHTS OF PIPE AND PRESSURE RATING CLASSES OF FITTINGS WHICH ARE COMPATIBLE	PIPE		FITTINGS		
	SCHEDULE NUMBER	WGT. LB/FT	WGT. LB/FT	CLASS	CLASS
	SCH 40	XS	SCH 40	SCH 160	XS
	SCH 80	XS	SCH 160	SCH 180	XS
	SCH 100	XS	SCH 180	SCH 200	XS
	SCH 120	XS	SCH 200	SCH 220	XS
	SCH 140	XS	SCH 220	SCH 240	XS
	SCH 160	XS	SCH 240	SCH 260	XS
	SCH 180	XS	SCH 260	SCH 280	XS
	SCH 200	XS	SCH 280	SCH 300	XS
	SCH 220	XS	SCH 300	SCH 320	XS
	SCH 240	XS	SCH 320	SCH 340	XS
	SCH 260	XS	SCH 340	SCH 360	XS
	SCH 280	XS	SCH 360	SCH 380	XS
	SCH 300	XS	SCH 380	SCH 400	XS
	SCH 320	XS	SCH 400	SCH 420	XS
	SCH 340	XS	SCH 420	SCH 440	XS
	SCH 360	XS	SCH 440	SCH 460	XS
	SCH 380	XS	SCH 460	SCH 480	XS
	SCH 400	XS	SCH 480	SCH 500	XS
	SCH 420	XS	SCH 500	SCH 520	XS
	SCH 440	XS	SCH 520	SCH 540	XS
	SCH 460	XS	SCH 540	SCH 560	XS
	SCH 480	XS	SCH 560	SCH 580	XS
	SCH 500	XS	SCH 580	SCH 600	XS
	SCH 520	XS	SCH 600	SCH 620	XS
	SCH 540	XS	SCH 620	SCH 640	XS
	SCH 560	XS	SCH 640	SCH 660	XS
	SCH 580	XS	SCH 660	SCH 680	XS
	SCH 600	XS	SCH 680	SCH 700	XS
	SCH 620	XS	SCH 700	SCH 720	XS
	SCH 640	XS	SCH 720	SCH 740	XS
	SCH 660	XS	SCH 740	SCH 760	XS
	SCH 680	XS	SCH 760	SCH 780	XS
	SCH 700	XS	SCH 780	SCH 800	XS
	SCH 720	XS	SCH 800	SCH 820	XS
	SCH 740	XS	SCH 820	SCH 840	XS
	SCH 760	XS	SCH 840	SCH 860	XS
	SCH 780	XS	SCH 860	SCH 880	XS
	SCH 800	XS	SCH 880	SCH 900	XS
	SCH 820	XS	SCH 900	SCH 920	XS
	SCH 840	XS	SCH 920	SCH 940	XS
	SCH 860	XS	SCH 940	SCH 960	XS
	SCH 880	XS	SCH 960	SCH 980	XS
	SCH 900	XS	SCH 980	SCH 1000	XS
	SCH 920	XS	SCH 1000	SCH 1020	XS
	SCH 940	XS	SCH 1020	SCH 1040	XS
	SCH 960	XS	SCH 1040	SCH 1060	XS
	SCH 980	XS	SCH 1060	SCH 1080	XS
	SCH 1000	XS	SCH 1080	SCH 1100	XS
	SCH 1020	XS	SCH 1100	SCH 1120	XS
	SCH 1040	XS	SCH 1120	SCH 1140	XS
	SCH 1060	XS	SCH 1140	SCH 1160	XS
	SCH 1080	XS	SCH 1160	SCH 1180	XS
	SCH 1100	XS	SCH 1180	SCH 1200	XS
	SCH 1120	XS	SCH 1200	SCH 1220	XS
	SCH 1140	XS	SCH 1220	SCH 1240	XS
	SCH 1160	XS	SCH 1240	SCH 1260	XS
	SCH 1180	XS	SCH 1260	SCH 1280	XS
	SCH 1200	XS	SCH 1280	SCH 1300	XS
	SCH 1220	XS	SCH 1300	SCH 1320	XS
	SCH 1240	XS	SCH 1320	SCH 1340	XS
	SCH 1260	XS	SCH 1340	SCH 1360	XS
	SCH 1280	XS	SCH 1360	SCH 1380	XS
	SCH 1300	XS	SCH 1380	SCH 1400	XS
	SCH 1320	XS	SCH 1400	SCH 1420	XS
	SCH 1340	XS	SCH 1420	SCH 1440	XS
	SCH 1360	XS	SCH 1440	SCH 1460	XS
	SCH 1380	XS	SCH 1460	SCH 1480	XS
	SCH 1400	XS	SCH 1480	SCH 1500	XS
	SCH 1420	XS	SCH 1500	SCH 1520	XS
	SCH 1440	XS	SCH 1520	SCH 1540	XS
	SCH 1460	XS	SCH 1540	SCH 1560	XS
	SCH 1480	XS	SCH 1560	SCH 1580	XS
	SCH 1500	XS	SCH 1580	SCH 1600	XS
	SCH 1520	XS	SCH 1600	SCH 1620	XS
	SCH 1540	XS	SCH 1620	SCH 1640	XS
	SCH 1560	XS	SCH 1640	SCH 1660	XS
	SCH 1580	XS	SCH 1660	SCH 1680	XS
	SCH 1600	XS	SCH 1680	SCH 1700	XS
	SCH 1620	XS	SCH 1700	SCH 1720	XS
	SCH 1640	XS	SCH 1720	SCH 1740	XS
	SCH 1660	XS	SCH 1740	SCH 1760	XS
	SCH 1680	XS	SCH 1760	SCH 1780	XS
	SCH 1700	XS	SCH 1780	SCH 1800	XS
	SCH 1720	XS	SCH 1800	SCH 1820	XS
	SCH 1740	XS	SCH 1820	SCH 1840	XS
	SCH 1760	XS	SCH 1840	SCH 1860	XS
	SCH 1780	XS	SCH 1860	SCH 1880	XS
	SCH 1800	XS	SCH 1880	SCH 1900	XS
	SCH 1820	XS	SCH 1900	SCH 1920	XS
	SCH 1840	XS	SCH 1920	SCH 1940	XS
	SCH 1860	XS	SCH 1940	SCH 1960	XS
	SCH 1880	XS	SCH 1960	SCH 1980	XS
	SCH 1900	XS	SCH 1980	SCH 2000	XS
	SCH 1920	XS	SCH 2000	SCH 2020	XS
	SCH 1940	XS	SCH 2020	SCH 2040	XS
	SCH 1960	XS	SCH 2040	SCH 2060	XS
	SCH 1980	XS	SCH 2060	SCH 2080	XS
	SCH 2000	XS	SCH 2080	SCH 2100	XS
	SCH 2020	XS	SCH 2100	SCH 2120	XS
	SCH 2040	XS	SCH 2120	SCH 2140	XS
	SCH 2060	XS	SCH 2140	SCH 2160	XS
	SCH 2080	XS	SCH 2160	SCH 2180	XS
	SCH 2100	XS	SCH 2180	SCH 2200	XS
	SCH 2120	XS	SCH 2200	SCH 2220	XS
	SCH 2140	XS	SCH 2220	SCH 2240	XS
	SCH 2160	XS	SCH 2240	SCH 2260	XS
	SCH 2180	XS	SCH 2260	SCH 2280	XS
	SCH 2200	XS	SCH 2280	SCH 2300	XS
	SCH 2220	XS	SCH 2300	SCH 2320	XS
	SCH 2240	XS	SCH 2320	SCH 2340	XS
	SCH 2260	XS	SCH 2340	SCH 2360	XS
	SCH 2280	XS	SCH 2360	SCH 2380	XS
	SCH 2300	XS	SCH 2380	SCH 2400	XS
	SCH 2320	XS	SCH 2400	SCH 2420	XS
	SCH 2340	XS	SCH 2420	SCH 2440	XS
	SCH 2360	XS	SCH 2440	SCH 2460	XS
	SCH 2380	XS	SCH 2460	SCH 2480	XS
	SCH 2400	XS	SCH 2480	SCH 2500	XS
	SCH 2420	XS	SCH 2500	SCH 2520	XS
	SCH 2440	XS	SCH 2520	SCH 2540	XS
	SCH 2460	XS	SCH 2540	SCH 2560	XS
	SCH 2480	XS	SCH 2560	SCH 2580	XS
	SCH 2500	XS	SCH 2580	SCH 2600	XS
	SCH 2520	XS	SCH 2600	SCH 2620	XS
	SCH 2540	XS	SCH 2620	SCH 2640	XS
	SCH 2560	XS	SCH 2640	SCH 2660	XS
	SCH 2580	XS	SCH 2660	SCH 2680	XS
	SCH 2600	XS	SCH 2680	SCH 2700	XS
	SCH 2620	XS	SCH 2700	SCH 2720	XS
	SCH 2640	XS	SCH 2720	SCH 2740	XS
	SCH 2660	XS	SCH 2740	SCH 2760	XS
	SCH 2680	XS	SCH 2760	SCH 2780	XS
	SCH 2700	XS	SCH 2780	SCH 2800	XS
	SCH 2720	XS	SCH 2800	SCH 2820	XS
	SCH 2740	XS	SCH 2820	SCH 2840	XS
	SCH 2760	XS	SCH 2840	SCH 2860	XS
	SCH 2780	XS	SCH 2860	SCH 2880	XS
	SCH 2800	XS	SCH 2880	SCH 2900	XS
	SCH 2820	XS	SCH 2900	SCH 2920	XS
	SCH 2840	XS	SCH 2920	SCH 2940	XS
	SCH 2860	XS	SCH 2940	SCH 2960	XS
	SCH 2880	XS	SCH 2960	SCH 2980	XS
	SCH 2900	XS	SCH 2980	SCH 3000	XS
	SCH 2920	XS	SCH 3000	SCH 3020	XS
	SCH 2940	XS	SCH 3020	SCH 3040	XS
	SCH 2960	XS	SCH 3040	SCH 3060	XS
	SCH 2980	XS	SCH 3060	SCH 3080	XS
	SCH 3000	XS	SCH 3080	SCH 3100	XS
	SCH 3020	XS	SCH 3100	SCH 3120	XS
	SCH 3040	XS	SCH 3120	SCH 3140	XS
	SCH 3060	XS	SCH 3140	SCH 3160	XS
	SCH 3080	XS	SCH 3160	SCH 3180	XS
	SCH 3100	XS	SCH 3180	SCH 3200	XS
	SCH 3120	XS	SCH 3200	SCH 3220	XS
	SCH 3140	XS	SCH 3220	SCH 3240	XS
	SCH 3160	XS	SCH 3240	SCH 3260	XS
	SCH 3180	XS	SCH 3260	SCH 3280	XS
	SCH 3200	XS	SCH 3280	SCH 3300	XS
	SCH 3220	XS	SCH 3300	SCH 3320	XS
	SCH 3240	XS	SCH 3320	SCH 3340	XS
	SCH 3260	XS	SCH 3340	SCH 3360	XS
	SCH 3280	XS	SCH 3360	SCH 3380	XS
	SCH 3300	XS	SCH 3380	SCH 3400	XS
	SCH 3320	XS	SCH 3400	SCH 3420	XS
	SCH 3340	XS	SCH 3420	SCH 3440	XS
	SCH 3360	XS	SCH 3440	SCH 3460	XS
	SCH 3380	XS	SCH 3460	SCH 3480	XS
	SCH 3400	XS	SCH 3480	SCH 3500	XS
	SCH 3420	XS	SCH 3500	SCH 3520	XS
	SCH 3440	XS	SCH 3520	SCH 3540	XS
	SCH 3460	XS	SCH 3540	SCH 3560	XS
	SCH 3480	XS	SCH 3560	SCH 3580	XS
	SCH 3500	XS	SCH 3580	SCH 3600	XS
	SCH 3520	XS	SCH 3600	SCH 3620	XS
	SCH 3540	XS	SCH 3620	SCH 3640	XS
	SCH 3560	XS	SCH 3640	SCH 3660	XS
	SCH 3580	XS	SCH 3660	SCH 3680	XS
	SCH 3600	XS	SCH 3680	SCH 3700	XS
	SCH 3620	XS	SCH 3700	SCH 3720	XS
	SCH 3640	XS	SCH 3720	SCH 3740	XS
	SCH 3660	XS	SCH 3740	SCH 3760	XS
	SCH 3680	XS	SCH 3760	SCH 3780	XS
	SCH 3700	XS	SCH 3780	SCH 3800	XS
	SCH 3720	XS	SCH 3800	SCH 3820	XS
	SCH 3740	XS	SCH 3820	SCH 3840	XS
	SCH 3760	XS	SCH 3840	SCH 3860	XS
	SCH 3780	XS	SCH 3860	SCH 3880	XS</

## FITTINGS & FLANGES FOR SOCKET-WELDED SYSTEMS

2.4.1

Dimensions of fittings and flanges are given in tables D-8 and F-1 thru F-6.



**FULL-COUPLING** (termed 'COUPLING') joins pipe to pipe, or to a nipple, swage, etc.

**FULL-COUPLING**

FIGURE 2.21



**REDUCER** joins two different diameters of pipe.

**REDUCER**

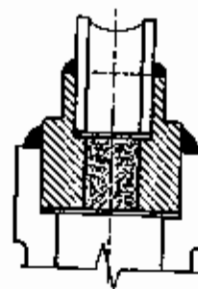
FIGURE 2.22



**REDUCER INSERT** A reducing fitting used for connecting a small pipe to a larger fitting. Socket-ended reducer inserts can be made in any reduction by boring standard forged blanks.

**SOCKET-WELDING REDUCING INSERTS**

FIGURE 2.23



**SOCKET-ENDED FITTING, FLANGE, OR EQUIPMENT**

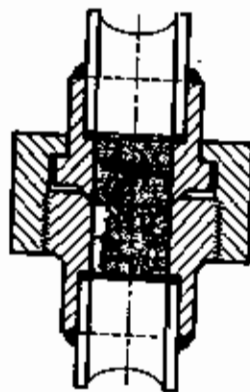
**THREE FORMS OF REDUCER INSERT.**



**UNION** is used primarily for maintenance and installation purposes. This is a screwed joint designed for use with socket-welded piping systems. See explanation in 2.5.1 of uses given under 'threaded union'. Union should be screwed tight before the ends are welded, to minimize warping of the seat.

**SOCKET-WELDING UNION**

FIGURE 2.24



**SWAGED NIPPLES** According to type, these allow joining: (1) Socket-ended items of different sizes—this type of swaged nipple has both ends plain (PBE) for insertion into socket ends. (2) A socket-ended item to a larger butt-welding pipe or fitting—this type of swaged nipple has the larger end beveled (BLE) and the smaller and plain (PSE) for insertion into a socket-ended item. A swaged nipple is also referred to as a 'swage' (pronounced 'swadge') abbreviated on drawings as 'SWG' or 'SWG NIPP'. When ordering a swage, state the weight designations of the pipes to be joined. For example, NPS 2 (SCH 40) x NPS 1 (SCH 80). Examples of the different end terminations that may be specified are as follows:

TABLE 2.3  
SPECIFYING SIZE & END FINISH OF SOCKET-WELDING SWAGES

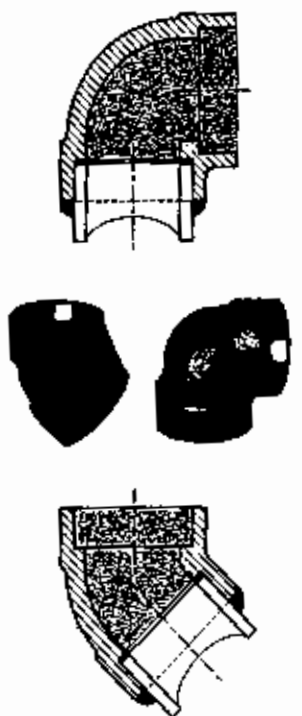
SWAGE FOR JOINING —	LARGER NO.	SMALLER	EXAMPLE NOTE ON DRAWING
SW FITTING OR PIPE	SW ITEM	SW ITEM	SWG 1½ x 1 PBE
ABBREVIATIONS:			SWG 2 x 1 BLE-PSE
			SW = Socket welding, BW = Butt welding
			PBE = Plain both ends, PLE = Plain large end
			PSE = Plain small end, BLE = Bevel large end

**SWAGE (PBE)**

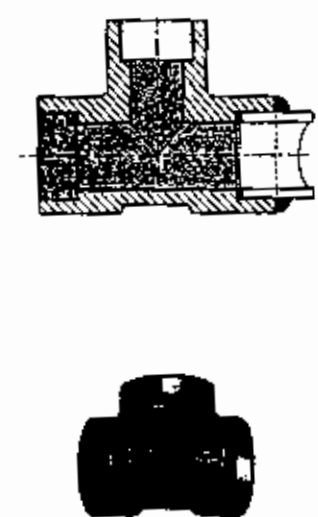
FIGURE 2.25



ELBOWS make 90- or 45-degree changes of direction in the run of pipe.  
SOCKET-WELDING ELBOWS



SOCKET-WELDING TEE



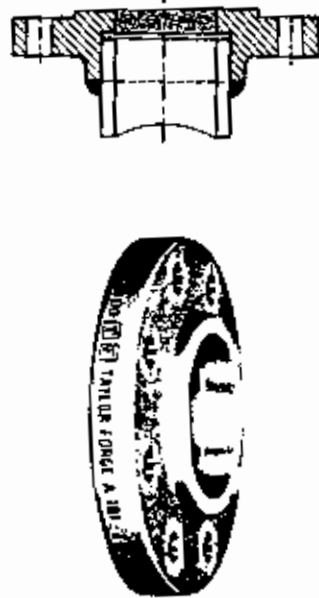
2  
4.1  
4.2

SOCKET-WELDING FLANGE Regular type is available from stock. Reducing type is available to order. For example, a reducing flange to connect a NPS 1 pipe to a Class 150 NPS 1½ line-size flange is specified:

RED FLG NPS 1½ x 1 Class 150 SW

SOCKET-WELDING FLANGE

FIGURE 2.27



LATERAL makes full-size 45-degree branch from the main run of pipe.  
SOCKET-WELDING LATERAL

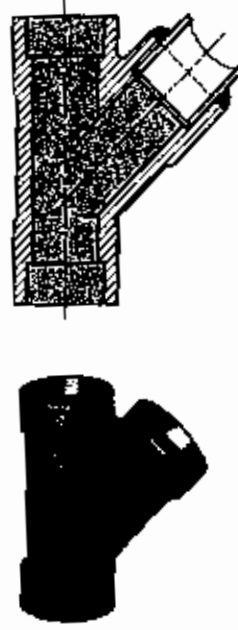


FIGURE 2.28

CROSS Flanges for butt-welding cross apply—see 2.3.2. Reducing crosses are custom-fabricated by boring standard forged blanks.  
SOCKET-WELDING CROSS

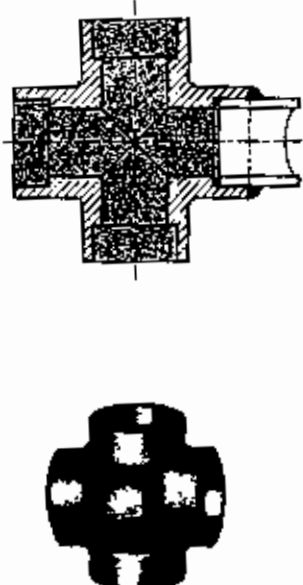


FIGURE 2.29

## FITTINGS FOR BRANCHING FROM SOCKET-WELDED SYSTEMS

2.4.2

### BRANCH FROM SOCKET-WELDED RUN

TEE, STRAIGHT or REDUCING, makes 90-degree branch from the main run of pipe. Reducing tees are custom-fabricated by boring standard forged blanks.

#### SPECIFYING SIZE OF SOCKET-WELDING TEES

HOW TO SPECIFY TEE	RUN INLET	RUN OUTLET	BRANCH	EXAMPLE
REDUCING ON BRANCH	1½"	1½"	1"	RED TEE 1½ x 1½ x 1
REDUCING ON RUN (SPECIAL APPLICATIONS ONLY)	1½"	1"	1½"	RED TEE 1½ x 1 x 1½

FIGURES  
2.27-2.30

TABLE  
2.3

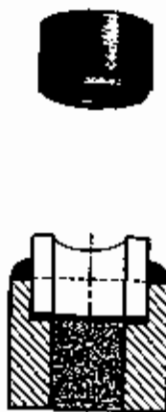
## FITTINGS FOR SOCKET-WELDED BRANCH FROM VESSEL OR BUTT-WELDED MAIN RUN

2.4.3

**HALF-COUPLING** The full-coupling is not used for branching or for vessel connections, as the half-coupling is the same length and is stronger. The half-coupling permits 90-degree entry into a larger pipe or vessel wall. The socketlet is more practicable as shaping is necessary with the coupling.

**SOCKET-WELDING HALF-COUPLING**

FIGURE 2.37

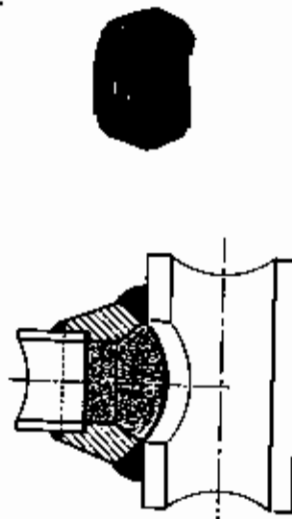


The next four fittings are made by Bonney Forge and offer an alternate method of entering the main pipe run. They have the advantage that the beveled welding ends are shaped to the curvature of the run pipe. Reinforcement for the butt-welded piping or vessel is not required.

**SOCKETLET** makes a 90-degree branch, full-size or reducing, on straight pipe. Flat-based socketlets are available for branch connections on pipe caps and vessel heads.

**SOCKETLET**

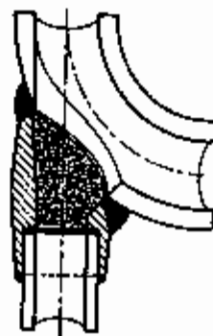
FIGURE 2.38



**SOCKET-WELDING ELBOWLET** makes a reducing tangent branch on long radius and short-radius elbows.

**SOCKET-WELDING ELBOWLET**

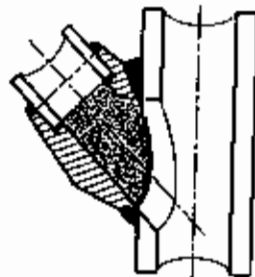
FIGURE 2.39



**SOCKET-WELDING LATROLET** makes a 45-degree reducing branch on straight pipe.

**SOCKET-WELDING LATROLET**

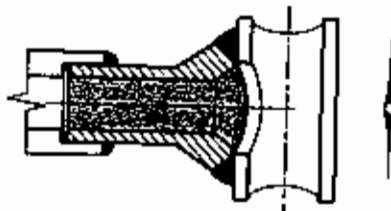
FIGURE 2.34



**NIPOLET** A variant of the socketlet, having integral plain nipple. Primarily developed for small valued connections—see figure 8.47.

**NIPOLET**

FIGURE 2.35



**STUB-IN** See comments in 2.3.2. Not preferred for lines under 2-inch due to risk of weld metal entering line and restricting flow.

**CLOSURE**

2.4.4

**SOCKET-WELDING CAP** seals plain-ended pipe.

**SOCKET-WELDING CAP**

FIGURE 2.36





## COMPONENTS FOR SCREWED PIPING SYSTEMS

2.5

### WHERE USED:

For lines conveying services, and for smaller process piping

### ADVANTAGES:

- (1) Easily made from pipe and fittings on site
- (2) Minimizes fire hazard when installing piping in areas where flammable gases or liquids are present

### DISADVANTAGES:

- (1)\* Use not permitted by ANSI B31.1-1989, if severe erosion, crevice corrosion, shock, or vibration is anticipated, nor at temperatures over 925 F. (Also see footnote table F-9)
- (2) Possible leakage of joint
- (3)\* Seal welding may be required—see footnote to chart 2.3
- (4) Strength of the pipe is reduced, as forming the screwthread reduces the wall thickness

\* These remarks apply to systems using forged-steel fittings.

## FITTINGS & FLANGES FOR SCREWED SYSTEMS

2.5.1

Screwed piping is piping assembled from threaded pipe and fittings.

Threaded malleable-iron and cast-iron fittings are extensively used for plumbing in buildings. In industrial applications, Class 150 and 300 galvanized malleable-iron fittings and similarly rated valves are used for drinking water and air lines. Dimensions of malleable-iron fittings are given in table D-11.

In process piping, forged-steel fittings are preferred over cast-iron and malleable-iron fittings (although their pressure/temperature ratings may be suitable), for their greater mechanical strength. To simplify material specifications, drafting, checking, purchasing and warehousing, the overall economics are in favor of utilizing as few different types of threaded fittings as possible. Dimensions of forged-steel threaded fittings are given in table D-8.

**FULL-COUPLING** (termed "COUPLING") joins pipe or items with threaded ends.

### FULL-COUPLING

FIGURE 2.37



## SCREWED PIPING

CHART 2.3

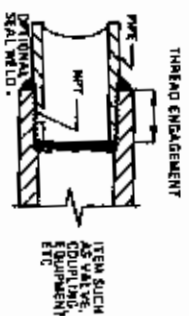
Chart 2.3 shows the ratings of pipe, fittings and valves that are commonly combined, or may be used together. The chart is a guide only, and not a substitute for a project specification.

## SCREWED PIPING

### CARBON-STEEL PIPE & FORGED-STEEL FITTINGS

## CHART 2.3

END PREPARATION OF PIPE, AND METHOD OF JOINING TO FITTING, FLANGE, VALVE OR EQUIPMENT



MAXIMUM LINE SIZE NOMINALLY THREADED

NPS 1 1/2

AVAILABILITY OF FORGED-STEEL THREADED FITTINGS

NPS 1/8 TO NPS 6

WEIGHTS OF PIPE AND PRESSURE RATING CLASSES OF FITTINGS WHICH ARE COMPATIBLE

SCHEDULE NUMBER	SCH 40	SCH 60	XXS	XXS
WEIGHT	STD	XS	XXS	XXS
FITTING CLASS	2000	3000	6000	6000

MOST COMMON COMBINATION THE MINIMUM CLASS FOR FITTINGS PREFERRED IN MOST INSTANCES FOR MECHANICAL STRENGTH IS 3000. CHOICE OF MATERIAL OR HEAVIERWEIGHT PIPE & FITTING WILL DEPEND ON PRESSURE, TEMPERATURE AND JOINT CORROSION ALLOWANCE REQUIRED. PIPE NPS 1/8 AND SMALLER IS USUALLY ORDERED TO ASTM SPECIFICATION A-106 GRADE B, REFER TO 2.14 UNDER STEELS.

## VALVES

MINIMUM PRESSURE RATING CLASS	CONTROL VALVES (USUALLY FLANGED)	USUALLY 300 (SEE 3.1.10)
	VALVES OTHER THAN CONTROL VALVES	
		600 (ANSI 600 (API))

\* ANSI B31.1.0 states that seal welding shall not be considered as contributive to the strength of the joint.

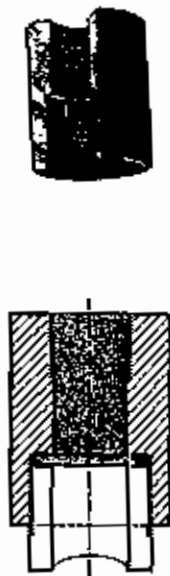
SEAL WELDING APPLICATIONS

On pipe: On all threaded connections within boundary limits, with the exception of piping carrying air or other inert gas, and water. On flanges: On flanges for hydrocarbon service and for lines conveying dangerous, toxic, corrosive or valuable fluids.

**REDUCING COUPLING, or REDUCER,** joins threaded pipes of different sizes. Can be made in any reduction by boring and tapping standard forged blanks.

#### REDUCING COUPLING

FIGURE 2.36



**NIPPLES** join unions, valves, strainers, fittings, etc. Basically a short length of pipe either fully threaded (close nipple) or threaded both ends (TBE), or plain one end and threaded one end (POE-TOE). Available in various lengths -refer to table D-11. Nipples can be obtained with a Victrolite groove at one end.

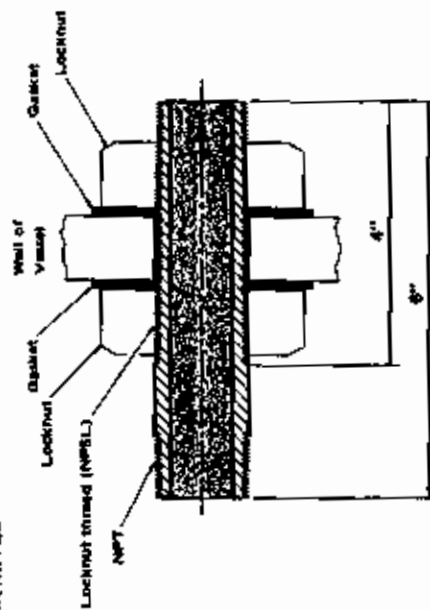
#### NIPPLES FOR THREADED ITEMS

FIGURE 2.38

(a) CLOSE NIPPLE (b) LONG or SHORT NIPPLE (TBE) (c) NIPPLE (POE-TOE)



(d) TANK NIPPLE

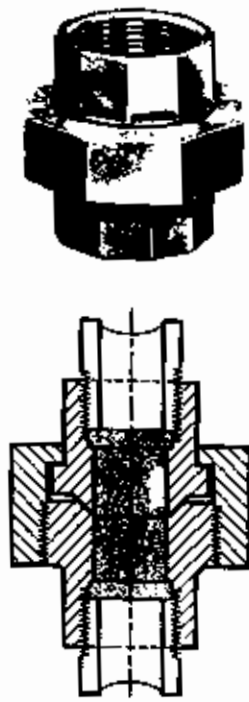


**TANK NIPPLE** is used for making a screwed connection to a non-pressure vessel or tank in low-pressure service. Overall length is usually 6 inches with a standard taper pipe thread at each end. On one end only, the taper pipe thread runs into a ANSI lock-nut thread.

**UNION** makes a joint which permits easy installation, removal or replacement of lengths of pipe, valves or vessels in screwed piping systems. Examples to remove a valve it must have at least one adjacent union, and to remove piping from a vessel with threaded connections, each outlet from the vessel should have one union between valve and vessel. Ground-faced joints are preferred, although other facings are available.

#### THREADED UNION

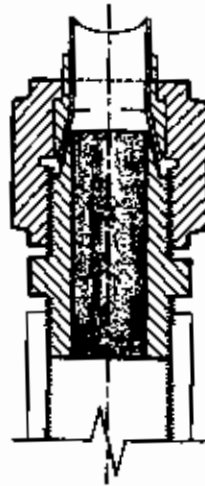
FIGURE 2.40



**PIPE-TO-TUBE CONNECTOR** For joining threaded pipe to tube. Figure 2.41 shows a connector fitted to specially-flared tube. Other types are available.

#### PIPE-TO-TUBE CONNECTOR

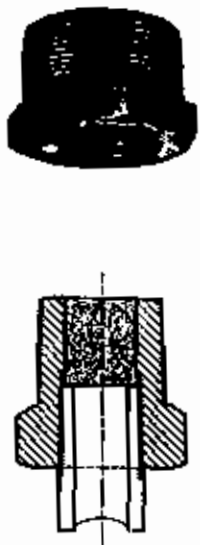
FIGURE 2.41



**HEXAGON BUSHING** A reducing fitting used for connecting a smaller pipe into a larger threaded fitting or nozzle. Has many applications to instrument connections. Reducing fittings can be made in any reduction by boring and tapping standard forged blanks. Normally not used for high-pressure service.

#### HEXAGON BUSHING

FIGURE 2.42



**SWAGED NIPPLE** This is a reducing fitting, used for joining larger diameter to smaller diameter pipe. Also referred to as a 'swage (pronounced 'sweage') and abbreviated as 'SWG' or 'SWG NIPPLE' on drawings. When ordering a swage, state the weight designations of the pipes to be joined. For example, NPS 2 (SCH 40) x NPS 1 (SCH 80). A swage may be used for joining: (1) Screwed piping to screwed piping, (2) Screwed piping to butt-welded piping, (3) Butt-welded piping to a threaded nozzle on equipment. It is necessary to specify on the piping drawing the terminations required.

TABLE 2.4  
SPECIFYING SIZE & END FINISH OF THREADED SWAGES

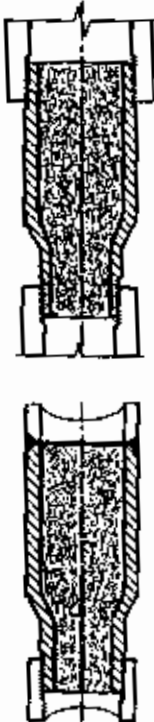
SWAGE FOR JOINING — LARGER — SMALLER		EXAMPLE NOTE ON DRAWING
THRD ITEM BW ITEM or PIPE	THRD ITEM BW ITEM*	SWG 1½ x 1 TBE
THRD ITEM*	THRD ITEM*	SWG 2 x 1 BLE-TSE
		SWG 3 x 2 TLE-BSE

ABBREVIATIONS:

BW = Butt welding  
THRD = Threaded  
TBE = Threaded both ends  
TSE = Threaded small end  
TLE = Threaded large end  
TOE = Threaded one end  
BLE = Beveled large end  
BSE = Beveled small end

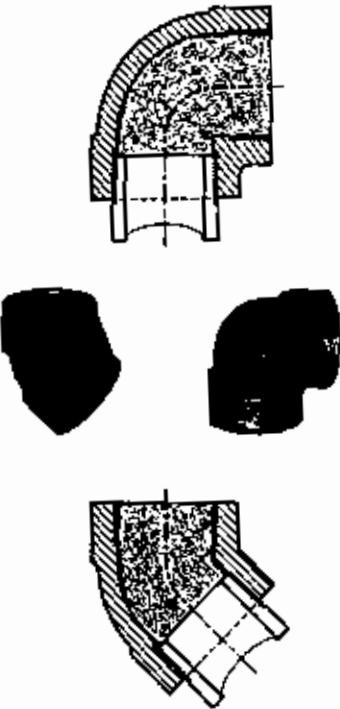
\* A larger threaded item is seldom joined to a smaller butt-welding item. However, the connection of a butt-welded line to a threaded nozzle on a vessel is an example.

FIGURE 2.43  
SWAGED NIPPLES, TBE and BLE-TSE



**ELBOWS** make 90- or 45-degree changes in direction of the run of pipe. Street elbows having an integral nipple at one end (see table D-11), are available.

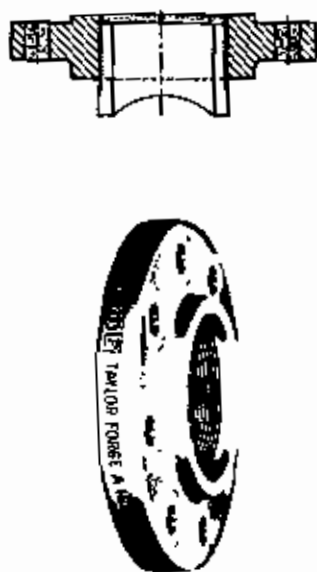
FIGURE 2.44  
THREADED ELBOWS, 45 and 90 DEGREE



**THREADED FLANGES** are used to connect threaded pipe to flanged items. Regular and reducing types are available from stock. For example, a reducing flange to connect a NPS 1 pipe to a Class 150 NPS 1½ line-size flange is specified:

RED FLG NPS 1½ x 1 Class 150 THRD

FIGURE 2.45  
THREADED FLANGE



**FITTINGS FOR BRANCHING FROM  
SCREWED SYSTEMS**

FIGURE 2.52

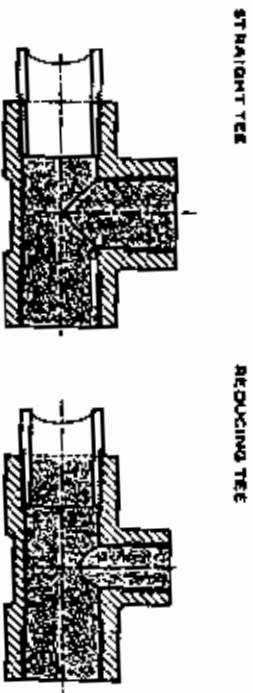
**BRANCH FROM SCREWED MAIN RUN**

**TEE, STRAIGHT or REDUCING**, makes a 90-degree branch from the run of pipe. Reducing tees are made by boring and tapping standard forged blanks.

FIGURE 2.46  
SPECIFYING SIZE OF THREADED REDUCING TEES

HOW TO SPECIFY TEES	MAIN INLET	MAIN OUTLET	BRANCH	EXAMPLE
REDUCING ON BRANCH	1½"	1½"	1"	RED TEE IN. 1½ x 1
REDUCING ON MAIN	1½"	1"	1½"	RED TEE IN. 1" x 1½"

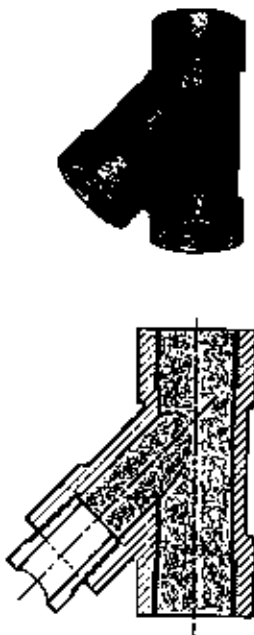
FIGURE 2.46  
THREADED TEES, STRAIGHT and REDUCING





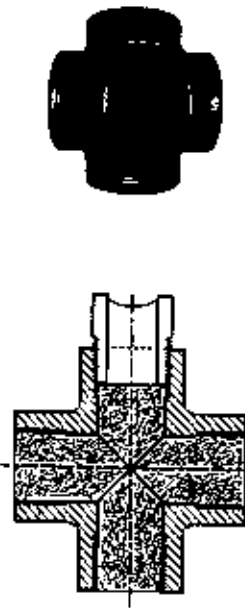
**LATERAL** makes full-size 45-degree branch from the main run of pipe.

**FIGURE 2.47**



**CROSS** Remarks for butt-welding cross apply – see 2.3.2. Reducing crosses are made by boring and tapping standard forged blanks.

**FIGURE 2.48**



**FITTINGS FOR SCREWED BRANCH FROM VESSEL OR BUTT-WELDED MAIN RUN**

**HALF-COUPLING** can be used to make 90-degree threaded connections to pipes for instruments, or for vessel nozzles. Welding heat may cause embrittlement of the threads of this short fitting. Requires shaping.

**FIGURE 2.49**



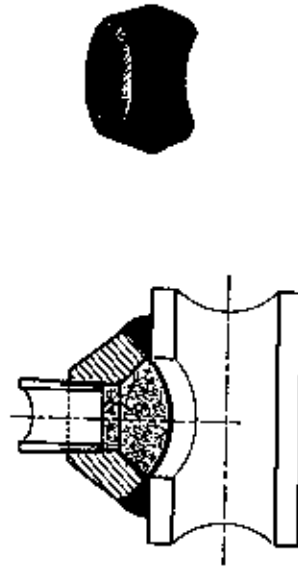
**FULL-COUPLING** Superior to half-coupling. Also requires shaping for connecting to pipe.

**TANK NIPPLE** See 2.5.1, figure 2.39(d).

The next four fittings for branching are made by Boron Forge. These fittings offer a means of joining screwed piping to a welded run, and for making instrument connections. The advantages are that the welding end does not require reinforcement and that the ends are shaped to the curvature of the run pipe.

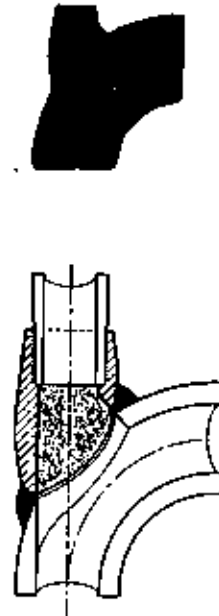
**THREDOLET** makes a 90-degree branch, full or reducing, on straight pipe. Flat-based throdolets are available for branch connections on pipe caps and vessel heads.

**FIGURE 2.50**



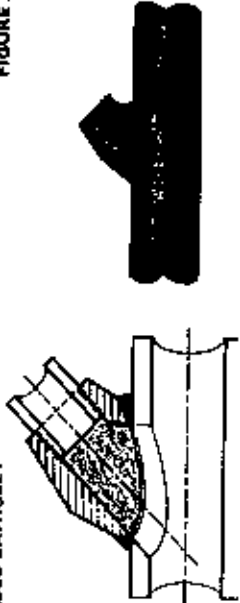
**THREADED ELBOLET** makes reducing tangent branch on long-radius and short radius elbows.

**FIGURE 2.51**



**THREADED LATROLET** makes a 45-degree reducing branch on a straight pipe

**FIGURE 2.52**

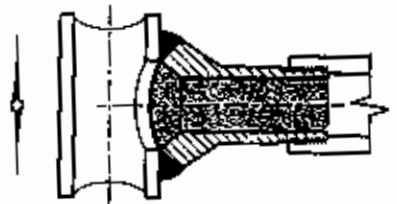




**THREADED NIPPLE** A variant of the threaded with integral threaded nipple. Primarily developed for small valved connections—see figure 6-47

#### THREADED NIPPLE

FIGURE 2.5.3



**STUB-IN** See comments in 2.3.2. Not preferred for branching from pipe smaller than NPS 2 as weld metal may restrict flow.

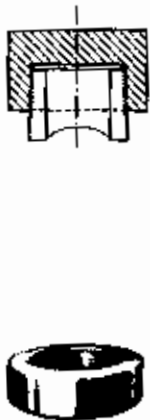
#### CLOSURES

2.5.4

**CAP** seals the threaded end of pipe.

#### THREADED CAP

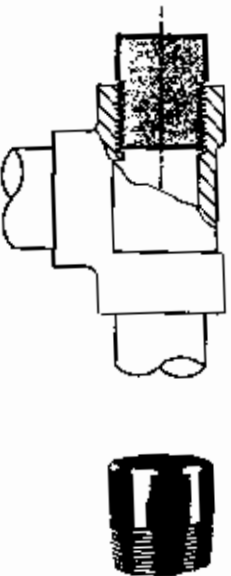
FIGURE 2.5.4



**BARSTOCK PLUG** seals the threaded end of a fitting. Also termed 'round-head plug'.

#### BARSTOCK PLUG (NTEE)

FIGURE 2.5.5



#### PIPE THREADS

2.5.5

Standard ANSI/ASME B1.20.1 defines general purpose pipe threads: tapered and straight threads for pipe (and fittings, etc.). For the same nominal pipe size, the number of threads per inch is the same for straight and tapered threads. Most pipe joints are made using the tapered thread form.

Tapered and straight threads will mate. Taper/taper and taper/straight (both types) joints are self sealing with the use of pipe dope (a compound spread on the threads which lubricates and seals the joint on assembly), or plastic tape (Teflon). Tape is wrapped around the external thread before the joint is assembled. A straight/straight screwed joint requires locknuts and gaskets to ensure sealing - see fig. 2.39 (d).

Standard ANSI B1.20.3 defines 'dryseal' threads. Dryseal threads seal against line pressure without the use of pipe dope or tape. The seal is obtained by using a modified thread form of sharp crest and flat root. This causes interference (metal-to-metal contact) between the engaged threads, and prevents leakage through the spiral cavity of mating threads.

Symbols used for specifying threads:

N = American National Standard Thread Form, P = Pipe, T = Taper, C = Coupling, F = Fuel & Oil, H = Hose coupling, I = Intermediate, L = Locknut, M = Mechanical, R = Railing fittings, S = Straight

#### ANSI B1.20.1: PIPE THREADS, GENERAL PURPOSE

##### Taper Pipe Thread

- Rigid mechanical joint for Railings

##### Straight Pipe Thread:

- Internal, in Pipe Couplings

- Free-fitting, Mechanical Joints for Fixtures

- Loose-fitting, Mechanical Joints with Locknuts

- Loose-fitting, Mechanical Joints for Hose Couplings

NPT  
NPT R

#### ANSI B1.20.3: DRYSEAL PIPE THREADS

##### Taper Pipe Thread:

- Dryseal Standard

- Dryseal SAE Short (NPTF type, shortened by one thread) PT-F-SAE SHORT  
Straight Pipe Thread (internal only):

- Dryseal, Fuel (for use in soft/ductile materials)

- Dryseal, Intermediate (for use in hard/brittle materials)

NPTF  
NPT R

(NPTF is the only type that ensures sealing against line pressure. If there is no objection to its use, pipe dope may be used with all threads to improve sealing, and lessen galling of the threads.)

Specify pipe threads by - NPS - Threads per inch - Thread type

Example: 3 - 8 NPT

## FLANGE FACINGS, BOLTS & GASKETS

2.6

### FLANGE FACINGS & FINISHES

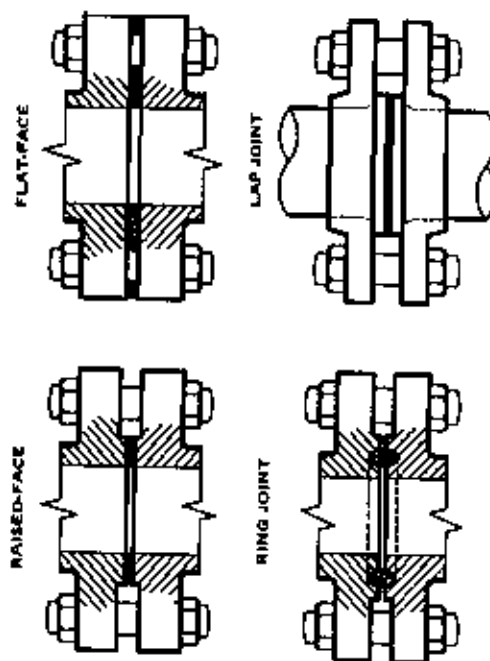
2.6.1

Many facings for flanges are offered by flange manufacturers, including various 'tongue and groove' types which must be used in pairs. However, only four types of facing are widely used, and these are shown in figure 2.56

The raised face is used for about 80% of all flanges. The ring-joint facing, employed with either an oval-section or octagon-section gasket, is used mainly in the petrochemical industry.

#### THE MOST-USED FLANGE FACINGS

FIGURE 2.56



The RAISED FACE is 1/16-inch high for Classes 150 and 300 flanges, and 1/4-inch high for all other classes. Class 250 cast-iron flanges and flanged fittings also have the 1/16-inch raised face.

*Suppliers' catalogs give 'length thru hub' dimensions which include the 0.06-inch raised face on flanges in Classes 150 and 300, but exclude the 0.25-inch raised face on flanges in Classes 400 thru 2500. Tables F include the raised face for all flange Classes.*

**FLAT FACE** Most common uses are for mating with non-steel flanges on bodies of pumps, etc. and for mating with Class 125 cast-iron valves and fittings. Flat-faced flanges are used with a gasket whose outer diameter equals that of the flange – this reduces the danger of cracking a cast-iron, bronze or plastic flange when the assembly is tightened

**RING-JOINT FACING** is a more expensive facing, and considered the most efficient for high-temperature and high-pressure services. Both flanges of a pair are alike. The ring-joint facing is not prone to damage in handling as the surfaces in contact with the gasket are recessed. Use of facings of this type may increase as hollow metal O-rings gain acceptance for process chemical seals.

**LAP-JOINT FLANGE** is shaped to accommodate the stub end. The combination of flange and stub end presents similar geometry to the raised-face flange and can be used where severe bending stresses will not occur. Advantages of this flange are stated in 2.3.1.



The term 'finish' refers to the type of surface produced by machining the flange face which contacts the gasket. Two principal types of finish are produced, the 'serrated' and 'smooth'.

Forged-steel flanges with raised-face are usually machined to give a 'serrated-concentric' groove, or a 'serrated-spiral' groove finish to the raised-face of the flange. The serrated-spiral finish is the more common and may be termed the 'stock' or 'standard finish' available from suppliers.

The pitch of the groove and the surface finish vary depending on the size and class of the flange. For raised-face steel flanges, the pitch varies from 24 to 40 per inch. It is made using a cutting tool having a minimum radius at the tip of 0.06-inch. The maximum roughness of surface finish is 125-500 microinches.

'Smooth' finish is usually specially-ordered, and is available in two qualities (1) A fine machined finish leaving no definite tool marks. (2) A 'mirror-finish', primarily intended for use without gaskets.

#### BOLT HOLES IN FLANGES

2.6.2

Bolt holes in flanges are equally spaced. Specifying the number of holes, diameter of the bolt circle and hole size sets the bolting configuration. Number of bolt holes per flange is given in tables F.

Flanges are positioned so that bolts straddle vertical and horizontal centerlines. This is the normal position of bolt holes on all flanged items.

#### BOLTS FOR FLANGES

2.6.3

Two types of bolting are available: The studbolt using two nuts, and the machine bolt using one nut. Both boltings are illustrated in figure 2.57. Studbolt thread lengths and diameters are given in tables F.

Studbolts have largely displaced regular bolts for bolting flanged piping joints. Three advantages of using studbolts are:

- (1) The studbolt is more easily removed if corroded
- (2) Confusion with other bolts at the site is avoided
- (3) Studbolts in the less frequently used sizes and materials can be readily made from round stock

## پیوست ۵:

**سپورت و آویز های لوله کشی صنعتی:****کدها و استانداردها:**

سپورت های لوله کشی باید طبق ملزومات *ASME B31.3* طراحی شوند. کدهای جهانی شکل ۱ به موضوع سپورت مربوط می شوند.

BS 3974	PIPE HANGERS, SLIDER AND ROLLER TYPE SUPPORTS ~ 1981 EDITION
ASME B1.1	UNIFIED INCH SCREW THREADS – 1989 EDITION
ASME B 18.2.1	SQUARE AND HEX BOLTS AND SCREWS (INCH SERIES ) ~ 1986 EDITION
ASME B18.2.2	SQUARE AND HEX NUTS (INCH SERIES) – 1987 EDITION
ASME B31.3	PROCESS PIPING – 2002 EDITION
AISC ASD MANUAL	MANUAL OF STEEL CONSTRUCTION ; ALLOWABLE STRESS DESIGN – 1989 EDITION
JIS B2706	CONED DISC SPRINGS – 2001 EDITION
MSS-SP-58	PIPE HANGERS AND SUPPORTS - MATERIALS, DESIGN, AND MANUFACTURE – 2002 EDITION
MSS-SP-69	PIPE HANGERS AND SUPPORTS - SELECTION AND APPLICATION – 2002 EDITION
MSS-SP-89	PIPE HANGERS AND SUPPORTS-FABRICATION AND INSTALLATION PRACTICES – 1998 EDITION

شکل ۱: لیست کدهای مربوط به سپورت

**طراحی:**

در مورد طراحی و انتخاب سپورت ها باید موارد زیر رعایت گردد.

- سیستم های لوله کشی صنعتی باید جهت جلوگیری از خیز زیاد، ارتعاش بیش از حد، بار بیش از حد و تنش اضافی باید بوسیله سپورت ها ، گایدها و ثابت کننده ها مهار شوند.
- موقعیت و شماره معرفی شده به سپورت ها باید در ایزو و پلان لوله کشی مارک شود.
- همه گاید ها و ثابت کننده ها و فنر های نشان داده شده در آنالیز تنش باید در نظر گرفته شوند و بدون اجازه مهندس تنش نباید حذف یا اضافه شوند.
- سپورت های قابل تنظیم باید در نقاط ابتدایی اتصال لوله کشی به تجهیزات دوواری همچون پمپ و کمپرسور فراهم گردد.

- در انتخاب و طراحی ساپورت برای خطوط بدون عایق باید تِلرانس ارتفاعی در نقاط تماس با بتن یا سازه در نظر گرفت که از خوردگی نقطه‌ای سیستم جلوگیری شود.
- در سیستم‌های لوله کشی غیر فلزی، لوله کشی عایق سرد و لوله کشی که نیاز به *PWHT* دارد باید از ساپورت‌های کلمپی استفاده شود.
- الکتروود و فیلر مناسب باید مطابق *WPS* لوله کشی انتخاب شوند.
- ساپورت‌ها تا حد امکان در محل‌های نزدیک به نقاط تغییر جهت خط قرار داده شوند اما باید انعطاف‌پذیری خط در نظر گرفته شود.
- برای کاهش نیروی اصطکاک در محل‌های در تماس و احتمال جابجایی زیاد از پد‌های لغزشی تفلن استفاده شود.
- خطوط دارای عایق نباید بصورت مستقیم روی ساپورت گذاشته شوند و باید از کفشک یا *Cradle* استفاده شود.
- ساپورت گذاری خطوط *Steam Tracing* باید به گونه‌ای باشد که نصب متعلقات استیم ترسینگ مختل نشود.
- برای جلوگیری از خوردگی گالوانیک بین کلمپ‌های کربن استیل و دیگر مواد دیگر باید بوسیله یک لایه لاستیک یا فیبر شیشه و یا مواد عایق کننده کلمپ و لوله از هم جدا شوند.
- مگر اینکه موارد دیگری ذکر شده باشد و گرنه بار مجاز روی ساپورت تا دمای ۳۵۰ درجه سانتی گراد برای کربن استیل و ۴۵۰ درجه برای فولاد آلیاژی معتبر می باشد. و برای دماهای بیشتر باید محاسبات آنالیز تنش اجرا گردد.
- همه ساپورت‌ها باید در محل شاپ اسمبل و جوش شوند. مگر اینکه مواردی در نقشه ذکر شده باشد که در سایت جوش شوند.
- همه قطعات رزوه‌ای باید بصورت پیچ دست راست باشند مگر اینکه ذکر شده باشد که *LH* می باشند.
- وقتی امکان اینکه از ساپورت استاندارد استفاده شود موجود نیست باید از ساپورت‌های ویژه استفاده گردد و نقشه‌های آنها باید جداگانه تهیه گردد.
- همه ساپورت‌های متصل به لوله کشی ماشین آلات دووار باید فضای کافی جهت اجازه دادن به جابجایی هنگام روشن کردن را داشته باشند.
- ساپورت‌ها نباید مشکلاتی را برای شیرها و تجهیزات از لحاظ فضایی ایجاد کنند.
- ساپورت‌ها نباید به فنداسیون و کابل‌ها در تماس باشند.
- ساپورت‌های لوله کشی باید طوری جایگذاری شوند که امکان باز و بسته کردن لوله کشی از دستگاهها در موقع تعمیرات و جایگذاری صافی‌ها و غیره وجود داشته باشد.



- در مورد ساپورت های سیستم های غیر فلزی باید دستورالعمل شرکت های سازنده باید رعایت گردد.

#### متریال:

- مواد *ASTM A36* یا معادل آن برای مواد ساپورت های فلزی بکار برده می شود.
  - موادی که مستقیماً به لوله جوش می شوند باید مطابق جدول ۱ باشند غیر از پد های تقویتی که باید همان مواد اصلی باشند.
  - در جدول ۲ ضخامت دیواره لوله ساپورت های لوله ای آورده شده است.
- جدول ۱: انتخاب مواد برای ساپورت

Material Selection Table

Piping Material	Support Material		
	Pipe	Parts directly welded to pipe	Shape steel & others
Carbon Steel	A106 Gr. B API 5L Gr. X52 API 5L Gr. X65 API 5L Gr. X70 A672 Gr. B85 CL22	ASTM A283 Gr. C	ASTM A36
Low Temperature Carbon Steel	ASTM A333 Gr. 6 A671 Gr. CC60 CL22	ASTM A516 Gr. 60	ASTM A36

Piping Material	Support Material		
	Pipe	Parts directly welded to pipe	Shape steel & others
Stainless steel	ASTM A312 - TP316L ASTM A358-Gr.316L, CL3	ASTM A240 - TP316L	ASTM A36

#### جدول ۲: ضخامت لوله برای ساپورت های مفصلی

Wall thickness of trunion pipe used for support shall be as follows.

Pipe Material	Pipe Size	Wall Thickness
Carbon Steel	up to 1-1/2"	SCH. 80
	2" & over	SCH. STD
Stainless Steel	up to 1-1/2"	SCH. 40S
	2" & over	SCH. 10S

- در جدول ۳ مواد قابل جابجایی و معادل مجاز برای نبشی، ناودانی و تیر آهن آورده شده اند.
- ساپورت های فنری باید دارای پوشش رنگ پودری باشند و محفظه آنها باید مطابق *ASTM A153 or A123* گالوانیزه عمیق شوند.

- همگی ساپورت های نوآرهای  $U$  شکل، بولت های  $U$  شکل، بولت های چشمی، بولت های مقمره ای، بولت های معمولی، قلاب<sup>ها</sup>، کلمپ ها و مهره های آنها باید *ASTM A153 or A123* گالوانیزه عمیق شوند.

جدول ۳: مواد مجاز معادل

Member	Members designed.	Acceptable Alternatives	Remark
Angle	30 x 30 x 3	50 x 50 x 5	
	50 x 50 x 6	60 x 60 x 6	
	65 x 65 x 6	70 x 70 x 7	
	75 x 75 x 9	80 x 80 x 8	
	90 x 90 x 10	90 x 90 x 9	
	100 x 100 x 10	100 x 100 x 10	
Channel	100 x 50 x 5 x 7.5	120 x 55 x 7 x 9	
	125 x 65 x 6 x 8	140 x 60 x 7 x 10	
	150 x 75 x 6.5 x 10	160 x 6.5 x 7.5 x 10.5	
	200 x 90 x 8 x 13.5	200 x 75 x 8.5 x 11.5	
	250 x 90 x 9 x 13	250 x 90 x 9 x 13	
	300 x 90 x 9 x 13	300 x 90 x 9 x 13	

Member	Members designed.	Acceptable Alternatives	Remark
H-Beam	100 x 100 x 6 x 8	120 x 120 x 6.5 x 11	
	125 x 125 x 6.5 x 9	120 x 120 x 6.5 x 11	
	150 x 150 x 7 x 10	180 x 160 x 8 x 13	
	175 x 175 x 7.5 x 11	180 x 180 x 8.5 x 14	
	200 x 200 x 8 x 12	200 x 200 x 9 x 15	
	250 x 250 x 9 x 14	240 x 240 x 10 x 17	
	300 x 200 x 9 x 14	300 x 300 x 11 x 19	

### فاصله ساپورت گذاری:

- فاصله ساپورت گذاری و پایپ رک ها تقریباً باید ۶ متر باشد. برای خطوط زیر ۲ " که فاصله آنها کافی نمی باشد، ساپورت های میانی باید فراهم گردد. ساپورت گرفتن از خطوط بزرگتر مگر اینکه بهترین راه باشد مجاز نیست.
- در جدول ۴ فاصله مجاز برای بین دو ساپورت مجاور برای هر سایز لوله لیست شده است.
- فاصله ها بر اساس فرمول زیر که با حالت تیر با انتهای گیر دار و تیر بصورت تکیه گاه ساده منطبق است.

$$L = \sqrt[4]{\frac{1920 EID}{19W}}$$

Where,

L = Span (mm),

D = Deflection (mm)

W = Distributed weight (Kg/mm)

E = Modulus of elasticity (Kg/mm<sup>2</sup>)I = Second moment of area (mm<sup>4</sup>)

- برای درجه حرارت بیشتر از ۲۰ درجه سانتی گراد باید محدودیت تنش مجاز در آن اعمال شود.

- فاصله سابلورت لوله براساس حداکثر تنش مجاز تعریف شده در *ASME B31.3* باید باشد و

نباید خیز بیشتر از ۱۲ mm باشد.

جدول ۴: فضای مجاز بین سابلورت ها بر اساس سایز لوله و حداکثر خیز ۱۲ mm

Maximum Piping Span for All Areas  
(at max. deflection 12mm)

Nominal Pipe Size (inch)	SCH. NO.	Pipe Span (m)			
		Empty	Water Full	Empty + Insulation	Water Full + Insulation
3/4	40	3.9	3.7	2.6	2.5
	80	3.8	3.7	2.8	2.7
	160	3.7	3.7	2.9	2.8
	XXS	3.6	3.6	2.9	2.8
1	40	4.4	4.2	3.1	3.0
	80	4.3	4.2	3.3	3.3
	160	4.2	4.1	3.3	3.4
	XXS	4.1	4.0	3.4	3.4
1-1/2	40	5.3	5.0	4.0	3.9
	80	5.2	5.0	4.3	4.2
	160	5.1	5.0	4.4	4.3
	XXS	5.0	4.9	4.5	4.3
2	10S	6.0	5.4	4.7	4.3
	40 (STD)	6.0	5.5	4.8	4.5
	80	5.9	5.7	5.0	4.9
	160	5.8	5.7	5.1	5.1
3	10S	7.4	6.3	5.8	5.4
	40 (STD)	7.3	6.7	6.0	5.7
	80	7.2	6.8	6.2	5.9
	160	7.1	6.8	6.4	6.2
4	10S	8.4	7.0	6.7	6.1
	40 (STD)	8.3	7.5	7.0	6.6
	80	8.2	7.6	7.2	6.9
6	10S	10.2	8.1	8.5	7.4
	40 (STD)	10.1	8.9	8.9	8.2
	80	10.0	9.2	9.1	8.6
	120	9.9	9.3	9.3	8.8
8	10S	11.7	8.9	9.8	8.3
	20	11.6	9.8	10.6	9.3
	30	11.6	9.9	10.6	9.4
	40 (STD)	11.6	10.0	10.7	9.6
	60	11.5	10.3	10.7	9.8
	80	11.4	10.4	10.7	10.0
	100	11.4	10.5	10.8	10.1

## ادامه جدول ۴

Nominal Pipe Size (inch)	SCH. NO.	Pipe Span (m)			
		Empty	Water Full	Empty + Insulation	Water Full + Insulation
10	10S	13.1	9.7	11.2	9.2
	20	13.0	10.6	11.9	10.1
	30	13.0	10.9	11.9	10.4
	40 (STD)	12.9	11.1	12.1	10.7
	60	12.9	11.4	12.1	11.0
	80	12.8	11.6	12.2	11.2
	100	12.7	11.7	12.2	11.4
12	10S	14.2	10.7	12.5	10.2
	20	14.2	11.1	13.0	10.8
	30	14.1	11.7	13.1	11.2
	STD	14.1	11.9	13.1	11.4
	40	14.1	12.0	13.3	11.6
	60	14.0	12.4	13.3	12.0
	80	13.9	12.6	13.4	12.2
	100	13.9	12.8	13.4	12.4
14	20	14.8	12.0	13.7	11.6
	30(STD)	14.8	12.3	13.9	11.9
	40	14.8	12.5	13.9	12.1
	60	14.7	13.0	14.0	12.6
	80	14.6	13.2	14.1	12.9
	100	14.5	13.4	14.1	13.1
16"	10S	16.0	11.6	14.1	11.1
	20	15.9	12.6	14.7	12.2
	30(STD)	15.9	12.9	14.9	12.6
	40	15.8	13.4	15.0	13.0
	60	15.7	13.8	15.1	13.4
	80	15.6	14.1	15.1	13.8
	100	15.5	14.3	15.1	14.0
18	20	16.9	13.1	15.6	12.7
	STD	16.8	13.5	15.9	13.1
	30	16.8	13.8	15.9	13.4
	40	16.8	14.2	16.0	13.9
	60	16.7	14.7	16.1	14.3
	80	16.6	14.9	16.1	14.6
	100	16.5	15.1	16.1	14.9



## ادامه جدول ۴:

Nominal Pipe Size (inch)	SCH. NO.	Pipe Span (m)			
		Empty	Water Full	Empty + Insulation	Water Full + Insulation
20	20(STD)	17.8	14.0	16.8	13.7
	30	17.7	14.6	16.8	14.2
	40	17.7	14.9	16.9	14.6
	60	17.6	15.4	17.0	15.1
	80	17.5	15.7	17.0	15.5
	100	17.4	16.0	17.0	15.7
24	20(STD)	19.5	14.9	18.4	14.6
	30	19.4	15.8	18.6	15.5
	40	19.4	16.3	18.7	15.9
	60	19.3	16.9	18.7	16.6
	80	19.2	17.2	18.7	17.0
	100	19.0	17.5	18.7	17.3
26	STD	20.3	15.3	19.2	15.1
	20	20.3	16.0	19.3	15.7
28	STD	21.1	15.7	20.0	15.5
	20	21.0	16.4	20.0	16.1
	30	21.0	17.0	20.2	16.7
30	STD	21.8	16.0	20.7	15.9
	20	21.8	16.8	20.8	16.5
32	STD	22.5	16.3	21.5	16.0
	20	22.5	17.2	21.5	16.9
34	STD	23.3	16.7	22.2	16.3
	20	23.2	17.5	22.4	17.2
36	STD	23.9	17.0	22.8	16.7
	20	23.9	17.9	22.9	17.6
38	STD	24.6	17.3	23.5	17.0
40	STD	25.2	17.5	24.1	17.3
42	STD	25.9	17.8	24.8	17.6
44	STD	26.5	18.0	25.4	17.9
46	STD	27.1	18.3	26.0	18.1
48	STD	27.7	18.5	26.6	18.4

- جدول ۵ اشاره به حداکثر فاصله برای گاید ها در حالت عمودی و افقی دارد. این فاصله ها حد اکثرند و ممکن است با فاصله ستون ها در رک ها تغییر کنند. این فواصل براساس خطوط مستقیم می باشند و شامل گاید برای کنترل جابجایی های حرارتی در لوپ های انبساطی نمی شود.

## جدول ۵: فضای مجاز بین ساپورت های گاید در حالت افقی و قائم

Maximum Spacing of Pipe Guides

Nominal Pipe Size (Inch)	Vertical Lines (m)	Horizontal Lines (m)	Remark
3/4	3.5	10	
1	4	12	
1-1/2	4.5	12	
2	5.5	18	
3	6.5	18	
4	7.5	24	
6	9	24	
8	10	24	
10	11	30	
12	12	30	
14	12.5	30	
16	13	35	See Para. c) below
18	13.5	36	See Para. c) below
20	14	42	See Para. c) below
22	14	42	See Para. c) below
24	15	46	See Para. c) below
26	15.5	47	See Para. c) below
28	16	48	See Para. c) below
30	16	49	See Para. c) below
32	16.5	51	See Para. c) below
34	17	54	See Para. c) below
36	17	55	See Para. c) below
38	17	55	See Para. c) below
40	17.5	57	See Para. c) below
42	17.5	58	See Para. c) below
44	18	60	See Para. c) below
46	18	62	See Para. c) below
48	18.5	63	See Para. c) below

## نوع و علائم ساپورت:

نوع ساپورت ها مطابق جدول ۶ تعریف می شوند.

- کلیپ ساپورت های روی مخازن برای جایگذاری لوله ها باید توسط شرکت های سازنده فراهم شوند. محاسبات بار و ساخت و اتصال آنها باید توسط شرکت سازنده انجام پذیرد.

## جدول ۶: نوع ساپورت ها

Support types are defined as follows :

Anchor	- A support fixing the pipe completely
Guide	- A support restricting the movement perpendicular to pipe axis, but the axial movement is allowed
Hanger	- A support hanging the piping
Spring	- A resilient support which allows vertical movement
Resting Support	- A simple support bearing the pipe weight only
Directional Stop	- A support restricting the movement of a certain direction
Hold Down	- A support restricting vibration of the pipe.
Pipe Pad & Gusset	- A support reinforcing pipe strength.

-سیستم شماره گذاری ساپورت ها از یک سیستم ۵ جزئی مطابق حالت زیر تعین می کند.

R	F	3	1	F	-	B	6	1	0	0	1
(1)	(2)	(3)				(4)		(5)			

شماره گذاری باید شامل موارد زیر باشد

۱ + کاراکتر اول نشان دهنده نوع ساپورت که از یک یا دو حرف مطابق زیر تشکیل می شود. مطابق لیست زیر

A	- Anchor
D	- Directional Stop
G	- Guide
H	- Hanger
R	- Resting Support
S	- Spring, Pipe Shoe (see note 2 below)
T	- Trunnion
HD	- Hold Down (see note 1 below)
PS	- Pipe Pad, Gusset and Lug (see note 1 below)

توجه ۱: وقتی این نوع ساپورت بکار برده می شود کاراکتر دوم لازم نیست.

۲: فقط کاراکتر ۱ و ۳ برای این نوع ساپورت تخصیص داده می شود.

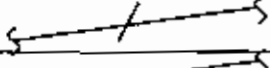
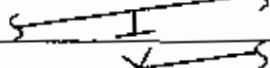
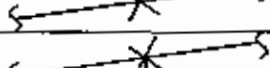
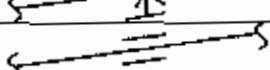
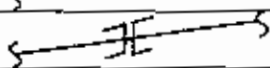

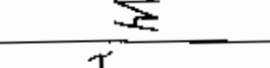

۳ + کاراکتر دوم نشان دهنده محل نصب ساپورت می باشد، که از یک حرف تشکیل می شود. مانند لیست زیر:

C	- Concrete
F	- Foundation
S	- Structure
V	- Vessel
R	- Riser Pipe

۴ + کاراکتر سوم نشان دهنده شماره سریال استاندارد ساپورت لوله می باشد که یک عدد ۲ رقمی و یک حرف بعنوان زیر نوع می باشد.

- ۴+ کاراکتر چهارم نشان دهنده ناحیه اجرایی آن ساپورت در سایت می باشد. ( ۳ حرف و رقم )
- ۵+ کاراکتر پنجم نشان دهنده شماره ترتیبی ساپورت ها در کل آن ناحیه می باشد.
- سیمبل و نشان ساپورت ها در نقشه های ایزو متریک مطابق جدول ۷ می باشد.

جدول ۷ : سیمبل ساپورت ها در ایزوها

Isometric Drawing		: Resting support without shoe
		: Resting support with shoe
		: Anchor support without shoe
		: Anchor support with shoe
		: Guide support
		: Directional stopper
		: Spring supports
		: Resting support with trunnion
3D Model	Symbols of pipe support in 3D model shall be shown real shape.	

-در بعضی از پروژه ها برای بیان ارتفاع کفشک ها و کرادل ها از علائم خاص مانند جدول ۸ استفاده می کنند.

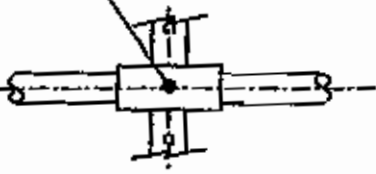
جدول ۸ : بیان ارتفاع کفشک ها و کرادل ها بصورت علائم

Type				Description
S1-b	S1-c	S1-d	S1-e	Shoe for hot insulated pipe
H=100	H=150	H=200	H=250	
S5-b	S5-c	S5-d	S5-e	Shoe for heat treated line
H=100	H=150	H=200	H=250	
S4-a	S4-b	S4-c	S4-d	Cradle for cold insulated pipe
H=50	H=100	H=150	H=200	
		S4-e	S4-f	
		H=250	H=300	
S6-H100	S6-H120	S6-H150		Shoe for bare and sloped line shoe height varies.
S10-b	S10-c	S10-d	S10-e	Shoe for low friction

-طبق موارد ذکر شده در بالا یک نمونه از اسم گذاری ساپورت ها در جدول ۹ آورده شده است.



جدول ۹: یک نمونه از اسم گذاری ساپورت

Marking	Description
<div> <b>S1-C</b>  <b>RS11- B61001</b> </div> 	Shoe of 150mm height for carbon steel pipe shall be attached to the piping and standard support "RS11" type shall be installed on existing steel structure.

### ساخت و نصب ساپورت:

- همه جوش المان ها باید بطور کامل جوش شوند و جوش از نوع درز دار باشد.
- به غیر از ساپورت های کوچک که دارای فضای محدود برای علامت گذاری مس باشند، بقیه باید توسط علامت گذتری سنبه و ماتریس عدد و حروف علامت گذاری مشخص شوند.
- استامپ های غیر حک شده باید بصورت خوانا در یک تگ ماندگار و بصورت محافظه کارانه به اجزای ساپورت متصل شوند.
- سیستم لوله کشی باید قبل از تست هیدرو استاتیک ساپورت و گاید گذاری شود.
- ساپورت های انبساطی باید در محل مناسب قبل از تست قفل شوند و بعد از تست دوباره مطابق دستورالعمل سازنده تنظیم شوند.
- باید بر روی ساپورت های قفل شده یک تگ اعلامی مبنی بر اینکه سیستم در حالت قفل است زده شود. تا هنگام در سرویس قرار گرفتن سیستم قفل آزاد شود.
- برای اطمینان از اینکه جابجایی ساپورت های لغزنده محدود نشده است باید سطح درگیر تمیز و عاری از مواد خارجی باشد.

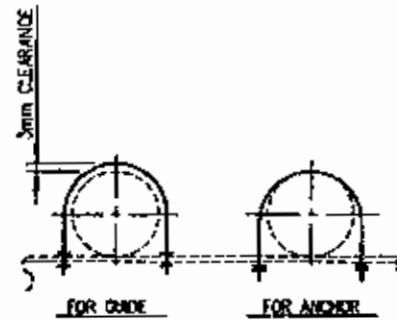
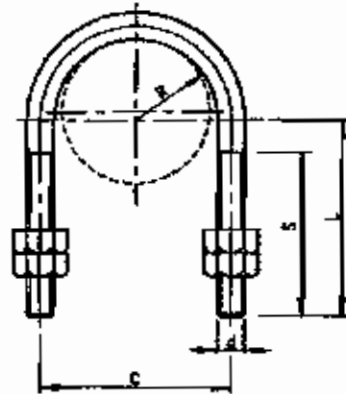
## PIPING SUPPORT ATTACHMENT DWG. ST-A4-1001

U - BOLT

UBT

REV.

07



UNIT (mm)

PIPE SIZE (INCH)	PIPE O.D.	R	d (UNC)	C	L	S	WEIGHT (kg)
1/2"	21.3	14.0	1/4"	36	45	45	0.1
3/4"	26.7	16.0	1/4"	40	50	50	0.1
1"	33.4	18.5	1/4"	45	55	50	0.1
1-1/2"	48.3	25.0	3/8"	60	80	50	0.2
2"	60.3	32.5	3/8"	75	85	50	0.2
2-1/2"	73.0	39.0	1/2"	90	75	55	0.4
3"	88.9	46.5	1/2"	105	85	56	0.4
4"	114.3	58.5	5/8"	135	100	60	0.5
6"	168.3	87.0	5/8"	190	130	70	1.0
8"	219.1	112.5	3/4"	245	185	80	2.1
10"	273.1	140.0	3/4"	300	195	90	2.4
12"	323.9	163.5	1"	355	240	120	4.3
14"	355.6	183.0	1"	380	260	120	4.7
16"	405.4	208.0	1"	440	280	120	5.1
18"	457.2	235.5	1"	485	310	120	5.6
20"	508.0	257.5	1-1/4"	545	330	140	9.8
24"	609.6	310.0	1-1/4"	630	390	140	11.1

## NOTE

## 1. MATERIAL

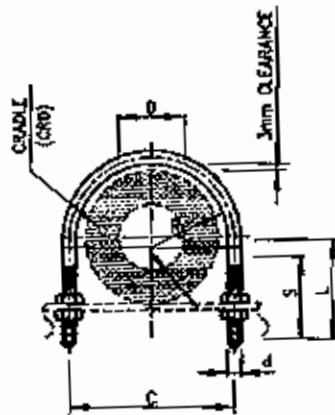
- U-BOLT : A36-GALV.
- NUTS : A563 GRA-GALV.

## 2. FOR APPLICATION ON

AF-51, AS-8, AS-50, GS-8, GS-21, GS-24, GS-50, GV-23, GV-24, GV-26,  
PS-3, RS-44, RS-62, RS-63, RS-64, RS-84, RV-23, RV-24, RV-26, TR-1, TR-2

3. GALVANIZED U-BOLT SHALL NOT BE IN DIRECT CONTACT WITH THE STAINLESS STEEL PIPE. NON ASBESTOS SHEET (1mm THICKNESS) SHALL BE INSERTED BETWEEN GALVANIZED U-BOLT AND STAINLESS STEEL PIPE.

## PIPING SUPPORT ATTACHMENT DWG. ST-A4-1002

U-BOLT  
(FOR COLD INSULATED PIPE)REV.  
D7

FOR GUIDE

UNIT (mm)

PIPE SIZE (mm)	R					
	25-50	51-100	101-150	151-200	201-250	
	T=50	T=100	T=150	T=200	T=250	
1/2"	68	112	162	-	-	
3/4"	88	138	188	-	-	
1"	68	118	168	-	-	
1-1/2"	82	126	176	226	-	
2"	82	136	187	237	-	
2-1/2"	94	140	196	246	-	
3"	98	146	196	246	-	
4"	112	162	212	262	-	
6"	140	187	237	289	-	
8"	162	212	262	315	365	
10"	196	246	289	350	380	
12"	226	274	315	365	415	

UNIT (mm)

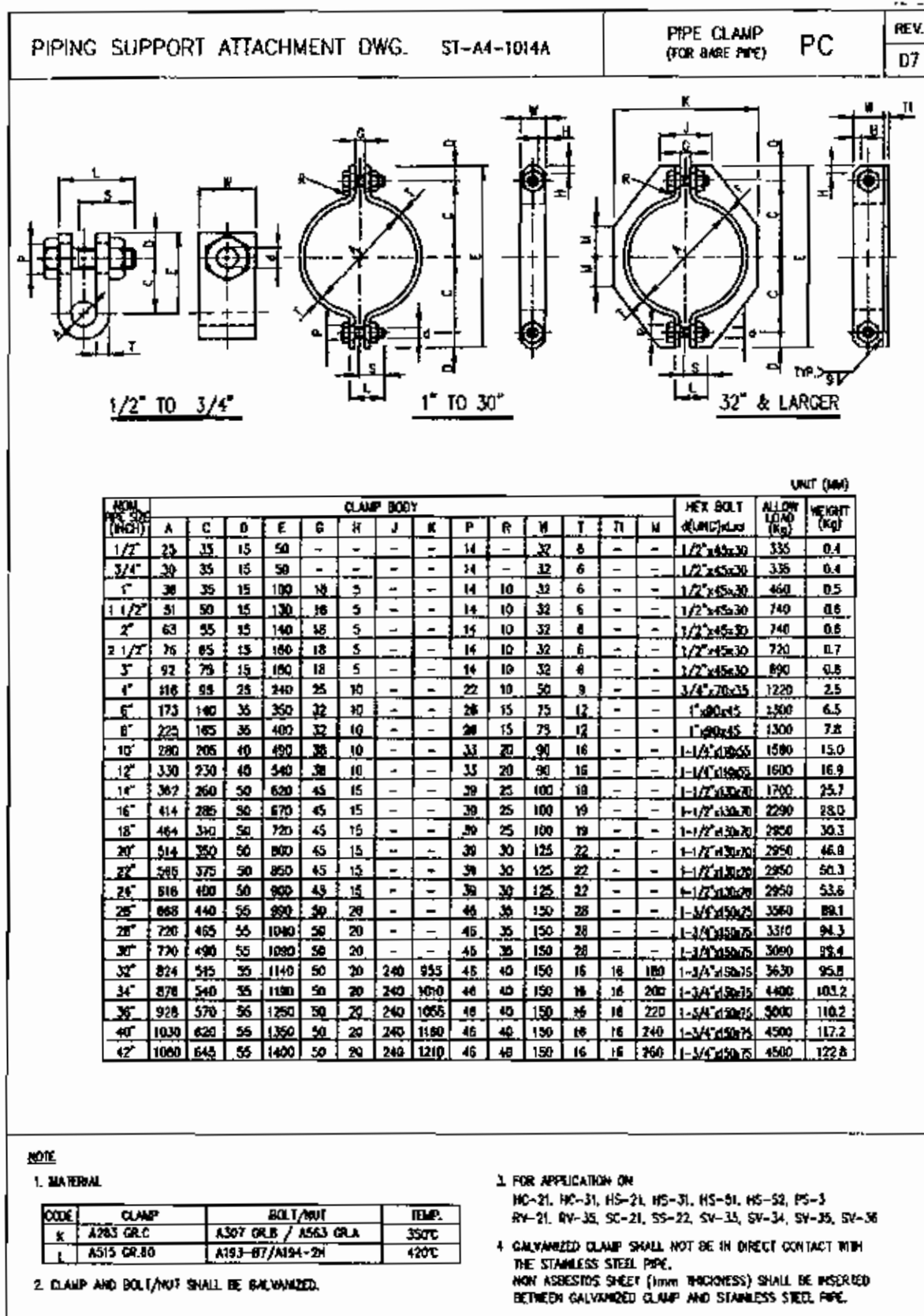
R	d (UNC)	C	L	S	WEIGHT (kg)
68	1/2"	148	190	70	0.5
82	1/2"	178	120	70	0.6
96	1/2"	204	135	70	0.6
112	1/2"	236	150	70	0.7
118	1/2"	246	160	70	0.7
126	5/8"	268	170	80	1.4
135	5/8"	286	180	80	1.5
140	5/8"	296	185	80	1.5
146	5/8"	306	190	80	1.6
162	5/8"	340	210	80	1.7
168	5/8"	352	215	80	1.8
176	3/4"	372	230	100	2.9
187	3/4"	394	240	100	3.1
196	3/4"	412	250	100	3.2
212	3/4"	444	265	100	3.4
226	1"	476	285	120	5.3
237	1"	488	305	120	5.5
246	1"	516	315	120	5.7
262	1"	546	330	120	6.0
274	1"	572	340	120	6.1
288	1-1/4"	606	370	150	10.5
315	1-1/4"	660	385	150	11.2
338	1-1/4"	706	420	150	11.8
365	1-1/4"	760	445	150	12.6
389	1-1/4"	806	470	150	13.3
415	1-1/4"	860	485	150	14.1

## NOTE

## 1. MATERIAL

- U-BOLT : A36-GALV.
- NUTS : A563 GRA - GALV.

## 2. FOR APPLICATION ON : G5-33, GY-41, GY-54

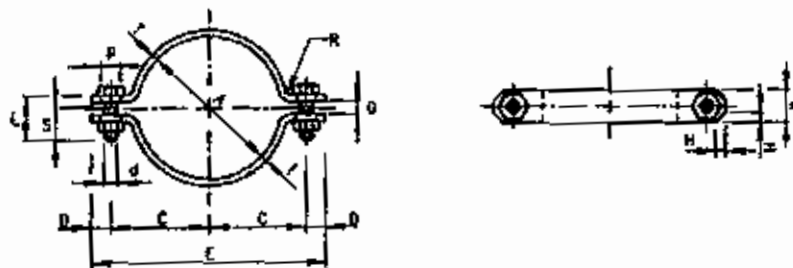




## PIPING SUPPORT ATTACHMENT DWG. ST-A4-1014B

PIPE CLAMP  
(FOR CLAMP SHOE)

PCS

REV.  
07

PIPE SIZE	CLAMP BODY										HEX BOLT d(UNC)xLxH	ALLOW LOAD (kg)	WEIGHT (kg)
	A	C	D	E	F	G	H	I	J	K			
1/2"	25	35	15	50	18	5	14	10	32	6	1/2"x45x30		0.4
3/4"	30	35	15	50	18	5	14	10	32	6	1/2"x45x30		0.4
1"	36	35	15	100	18	5	14	10	32	6	1/2"x45x30		0.5
1 1/2"	51	50	15	130	18	5	14	10	32	6	1/2"x45x30		0.6
2"	63	55	15	140	18	5	14	10	32	6	1/2"x45x30		0.6
2 1/2"	76	65	15	160	18	5	14	10	32	6	1/2"x45x30		0.7
3"	92	75	15	180	18	5	14	10	50	6	1/2"x45x30		1.3
4"	138	95	25	240	25	10	22	10	50	9	3/4"x70x35		2.9
6"	173	140	35	350	32	10	22	15	50	9	3/4"x80x45		3.8
8"	225	165	35	400	32	10	22	15	50	8	3/4"x80x45		4.4
10"	280	205	40	490	38	10	26	20	75	12	1"x100x55		10.1
12"	330	230	40	540	38	10	26	20	75	12	1"x100x55		11.2
14"	362	260	50	620	45	15	26	25	75	12	1"x100x55		12.7
16"	414	285	50	670	45	15	26	25	75	12	1"x100x55		13.8
18"	464	310	50	720	45	15	26	25	75	12	1"x100x55		14.9
20"	514	350	50	800	45	15	26	30	75	12	1"x100x55		16.4
22"	566	375	50	850	45	15	26	30	75	12	1"x100x55		17.6
24"	616	400	50	900	45	15	26	30	75	12	1"x100x55		18.7
26"	668	440	55	950	50	20	26	35	75	12	1"x110x65		20.4
28"	720	465	55	1040	50	20	26	35	75	12	1"x110x65		21.5
30"	770	490	55	1090	50	20	33	35	90	16	1-1/4"x120x75		37.6
32"	824	515	55	1140	50	20	33	40	90	16	1-1/4"x120x75		39.4
34"	876	540	55	1190	50	20	33	40	90	16	1-1/4"x120x75		41.2
36"	928	570	55	1250	50	20	33	40	100	19	1-1/2"x130x75		57.7
40"	1030	620	55	1350	50	20	33	40	100	19	1-1/2"x130x75		62.4
42"	1080	645	55	1400	50	20	33	40	100	22	1-1/2"x130x75		74.4

SEE DWG NO. ST-A4-1108  
FOR MAXIMUM ALLOWABLE LOADS

## NOTE

## 1. MATERIAL

CODE	CLAMP	BOLT/NUT	TEMP.
K	A283 GR.C	A307 GR.B / A563 GR.A	350°C
L	A515 GR.60	A193-B7/A194-2H	420°C

## 2. CLAMP AND BOLT/NUT SHALL BE GALVANIZED.

## 3. FOR APPLICATION ON

S-5, S-7, GS-5, GS-7

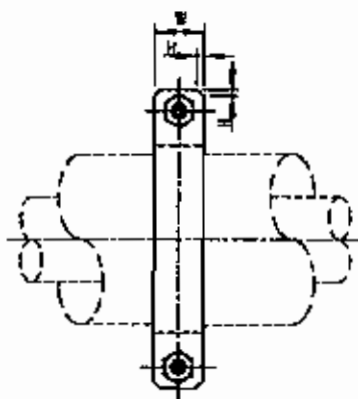
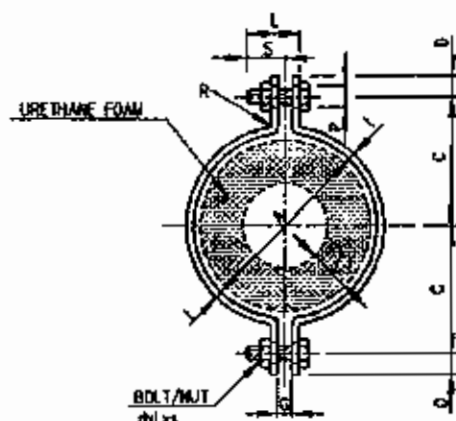
## 4. GALVANIZED CLAMP SHALL NOT BE IN DIRECT CONTACT WITH THE STAINLESS STEEL PIPE. NON ASBESTOS SHEET (1mm THICKNESS) SHALL BE INSERTED BETWEEN GALVANIZED CLAMP AND STAINLESS STEEL PIPE.

## PIPING SUPPORT ATTACHMENT DWG. ST-A4-1016

PIPE CLAMP PCC  
(FOR COLD INSULATED PIPE)

REV.

D7



		A (FOR EACH PIPE SIZE)																				UNIT (mm)
WFS. TAG	CRADLE TAG	1/2	3/4	1	1-1/2	2	2-1/2	3	4	6	8	10	12	14	16	18	20	22	24	26	28	30
25-50	T=50	136	136	136	163	163	192	192	224	274	324	392	430	474	530	576	630	678	730	778	836	879
51-109	T=100	224	236	236	254	274	279	292	324	374	430	492	530	578	630	678	730	778	830	870	920	970
109-150	T=150	324	336	336	354	374	382	392	430	474	530	578	630	678	730	778	830	870	920	970	1020	1070
151-200	T=200	-	-	-	454	474	492	492	530	578	630	678	730	778	830	870	920	970	1020	1070	1120	1170
201-250	T=250	-	-	-	-	-	-	-	-	-	730	778	830	870	920	970	1020	1070	1120	1170	1220	1270
251-300	T=300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1120	1170	1220	1270	1320	1370

																						UNIT (mm)	
A	C	D	G	R	W	H	P	t	d(UNC)±0.5	ALLOW. (mm)	WEIGHT (kg)	A	C	D	G	R	W	H	P	t	d(UNC)±0.5	ALLOW. (mm)	WEIGHT (kg)
136	105	25	32	30	50	10	22	6	3/4"x75x55	780	0.8	678	440	60	60	30	150	20	52	22	2"x215x105	8000	31.4
163	120	25	32	40	50	10	22	8	3/4"x75x55	780	0.8	730	465	60	60	30	150	20	52	22	2"x215x105	8000	33.4
182	130	25	32	40	75	10	22	6	3/4"x75x55	780	0.8	778	485	60	60	30	150	20	52	25	2"x215x105	8000	40.2
224	150	25	32	40	75	10	22	6	3/4"x75x55	780	1.5	830	500	60	60	30	150	20	52	25	2"x215x105	8000	41.5
238	155	25	32	40	75	15	22	9	3/4"x75x55	780	2.3	870	540	60	60	30	150	20	52	25	2"x215x105	8000	44.8
252	160	25	32	40	75	15	22	9	3/4"x75x55	780	2.4	820	585	60	60	30	150	20	52	25	2"x215x105	8000	47.0
274	180	40	38	15	80	15	33	12	1-1/4"x100x65	3100	4.4	970	585	60	60	35	150	20	52	20	2"x240x125	8000	55.4
279	190	40	38	15	90	15	33	12	1-1/4"x100x65	3100	4.8	1020	620	60	60	35	150	20	52	20	2"x240x125	8000	58.0
292	200	40	38	15	90	15	33	12	1-1/4"x100x65	3100	4.7	1030	645	60	60	35	150	20	52	20	2"x240x125	8000	60.8
324	220	40	38	15	90	15	33	12	1-1/4"x100x65	3100	5.2	1120	670	60	60	35	150	20	52	20	2"x240x125	8000	63.1
336	230	40	38	15	90	15	33	12	1-1/4"x100x65	3100	5.5	1130	700	60	60	40	150	20	52	32	2"x240x125	8000	75.3
351	250	50	45	20	100	15	38	16	1-1/2"x120x65	4500	8.8	1220	725	60	60	40	150	20	52	32	2"x240x125	8000	78.2
374	260	50	45	20	100	15	38	16	1-1/2"x120x65	4500	9.0	1220	750	60	60	40	150	20	52	32	2"x240x125	8000	80.2
382	270	50	45	20	100	15	38	16	1-1/2"x120x65	4500	8.3	1320	775	60	60	40	150	20	52	32	2"x240x125	8000	84.1
430	280	50	45	20	100	20	38	18	1-1/2"x120x65	4500	8.8	1370	800	60	60	40	150	20	52	32	2"x240x125	8000	87.0
451	310	55	55	25	125	20	48	18	1-3/4"x150x65	5800	15.9												
474	320	55	55	25	125	20	48	18	1-3/4"x150x65	5800	16.5												
482	330	55	55	25	125	20	48	18	1-3/4"x150x65	5800	17.1												
530	350	55	55	25	125	20	48	19	1-3/4"x150x65	5800	17.9												
548	360	55	55	25	125	20	48	19	1-3/4"x150x65	5800	18.5												
578	380	60	60	30	150	20	52	22	2"x215x105	8000	27.4												
630	415	60	60	30	150	20	52	22	2"x215x105	8000	29.4												

**NOTE**

## 1. MATERIAL

CODE	CLAMP	BOLT/NUT	TEMP.
K	A263 GR.C	A307 GR.B / A563 GR.A	350°C
L	A515 GR.50	A193-B7/A194-2H	420°C

### 3. FOR APPLICATION ON

HC-21, HC-31, HS-1, HS-11, HS-13, HS-21, HS-31,  
MS-51, RV-41, RV-43, RV-45, RV-53, RV-55, SC-21,  
SS-21, SS-22, SV-51, SV-52

2. CLAMP AND BOLT/NUT SHALL BE GALVANIZED.

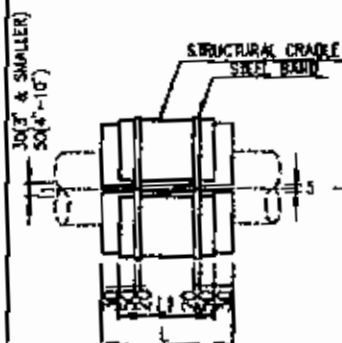
## PIPING SUPPORT ATTACHMENT DWG.

ST-A4-1019

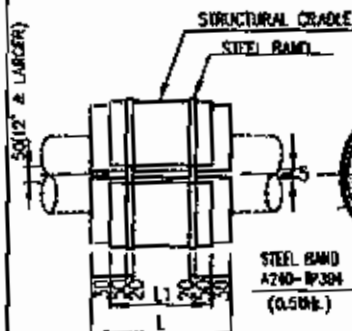
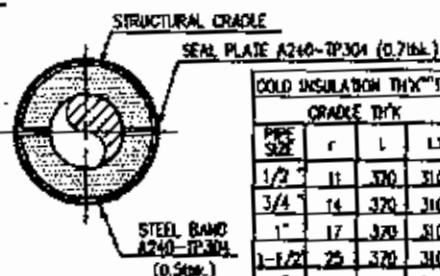
CRADLE CRD  
(FOR COLD INSULATED PIPE)

REV.

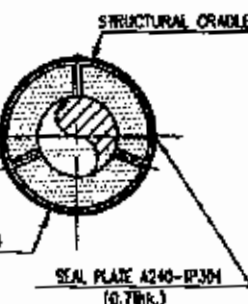
07



10" &amp; SMALLER



12" TO 60"



				UNIT (mm)							
				COLD INSULATION THK "1"		25-50	51-100	101-150	151-200	201-250	251-300
				CRADLE THK		H=50	H=100	H=150	H=200	H=250	H=300
PIPE SIZE	R	L	L1	R							
1/2"	11	370	310	61	111	161	-	-	-	-	-
3/4"	14	370	310	84	114	184	-	-	-	-	-
1"	17	370	310	87	117	187	-	-	-	-	-
1-1/2"	25	370	310	75	125	175	225	-	-	-	-
2"	31	370	310	81	131	181	231	-	-	-	-
2-1/2"	37	370	310	87	137	187	237	-	-	-	-
3"	45	420	360	95	145	195	245	-	-	-	-
4"	58	420	360	108	158	208	258	-	-	-	-
6"	80	420	360	135	185	235	285	-	-	-	-
8"	110	420	360	160	210	260	310	360	-	-	-
10"	137	420	360	187	237	287	337	387	-	-	-
12"	162	420	360	212	262	312	362	412	-	-	-
14"	178	420	360	228	278	328	378	428	-	-	-
16"	204	420	360	254	304	354	404	454	-	-	-
18"	228	420	360	279	329	379	429	479	-	-	-
20"	254	420	360	304	354	404	454	504	554	-	-
22"	280	420	360	330	380	430	480	530	580	-	-
24"	305	420	360	355	405	455	505	555	605	-	-
26"	331	420	360	381	431	481	531	581	631	-	-
28"	356	420	360	406	456	506	556	606	656	-	-
30"	381	420	360	431	481	531	581	631	681	-	-
32"	407	420	360	457	507	557	607	657	707	-	-
34"	432	420	360	482	532	582	632	682	732	-	-
36"	458	420	360	508	558	608	658	708	758	-	-
40"	508	420	360	558	608	658	708	758	808	-	-
42"	534	420	360	584	634	684	734	784	834	-	-
44"	559	420	460	609	659	709	759	809	859	-	-
48"	610	520	480	660	710	760	810	860	910	-	-
52"	641	520	460	711	761	811	861	911	961	-	-
54"	686	520	460	736	786	836	886	936	986	-	-
60"	762	520	480	812	862	912	962	1012	1062	-	-

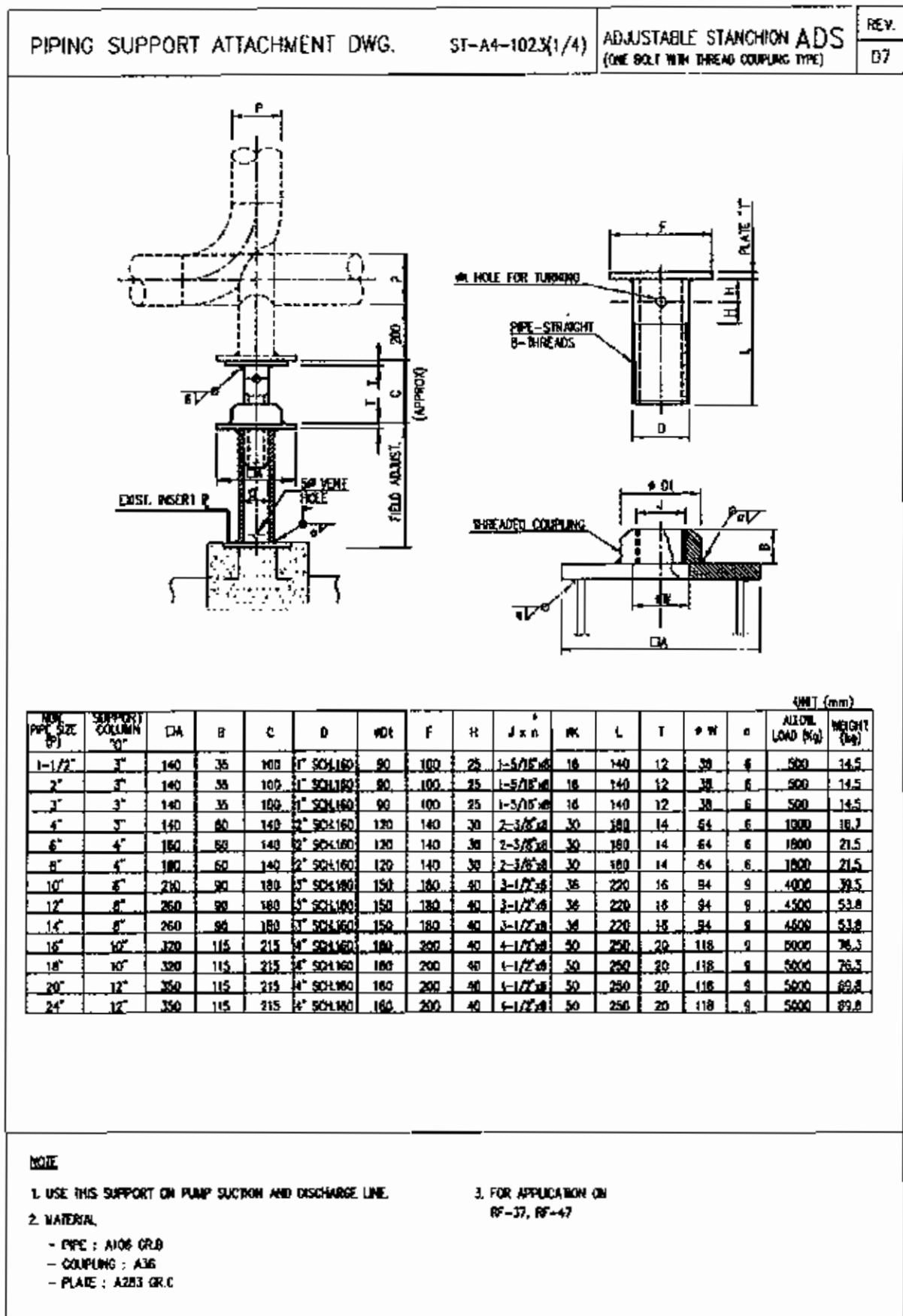
## NOTE

## 1. MATERIAL

- URETHANE FOAM : SEE DWG. NO. ST-A4-1022
- STRUCTURAL CRADLE : A283 GRC W/10% CR GALV
- STRUCTURAL CRADLE THK : SEE TABLE OF ST-A4-1104
- SEAL PLATE : A240-TP304
- STEEL BAND : A240-TP304

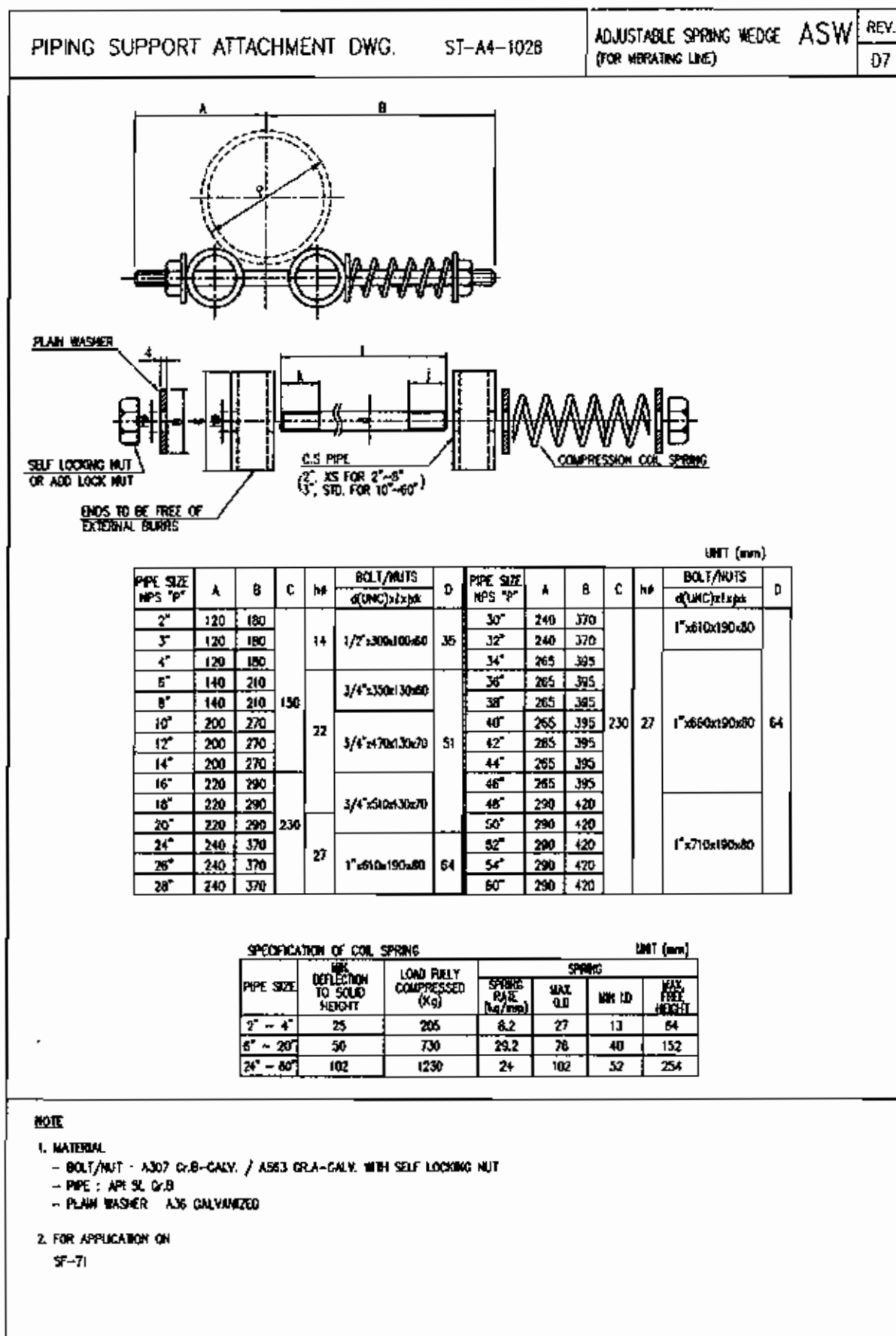
## 2. FOR APPLICATION ON

- GS-35, GS-34, GV-41, GV-42, GV-51, GV-52, GV-53, HC-21,
- HC-31, HS-11, HS-13, HS-21, HS-31, HS-51, RV-41, RV-43,
- RV-45, RV-51, RV-53, RV-55, SC-21, SS-21, SS-22, SV-52



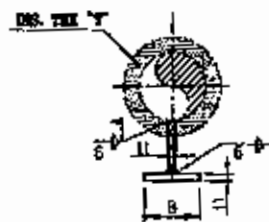
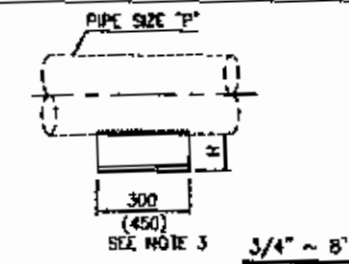




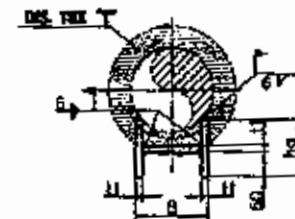
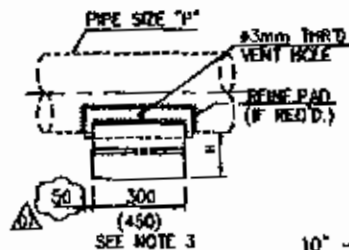


## PIPING SUPPORT STANDARD DWG.

ST-A4-1101 (1 OF 2)

SHOE S-1  
(FOR HOT INSULATED PIPE: SLIDE TYPE)REV  
D7

UNIT (mm)					
PIPE SIZE NPS	H	STEEL B	2 H	*ALLOW. LOAD(Kg)	WEIGHT (kg)
3/4" ~ 2-1/2"	100	100		850	4.2
3" ~ 6"		150	9	1370	5.3
8"		130		1370	5.3
2" ~ 2-1/2"	150	100		800	5.3
3" ~ 6"		150	9	940	6.4
8"		150		940	6.4
2" ~ 2-1/2"	200	150		800	2.4
3" ~ 6"		150	9	710	7.4
8"		150		710	7.4



					UNIT (mm)	
PIPE SIZE NPS 1/2"	H	No	STEEL #		ALLOW LOAD (kg)	WEIGHT (kg)
			B	11		
10"	100	123	150	9	7200	8.4
12"		126	200	9	8500	9.6
14"		123			8000	9.5
16"		120			5500	9.3
18"		149	300	12	4500	16.9
20"		143			4000	16.6
22"		136			3500	16.3
24"	135	3000			16.1	
10"	150	172	150	9	5500	10.5
12"		185	200	9	5000	12.1
14"		181			4500	11.9
16"		176			4000	11.7
18"		198	300	12	3500	19.7
20"		191			3000	19.3
22"		186			2500	19
24"	182			2300	18.8	

					UNIT (mm)	
PIPE SIZE NPS	H	hg	STEEL #		ALLOW. LOAD (Kg)	WEIGHT (kg)
			B	ti		
10"	200	223	150	9	5300	12.6
12"		224	200	9	5000	13.8
14"		223			4500	13.7
16"		230			4000	13.5
18"		248			3500	22.8
20"		243	300	12	3000	22.2
22"		236			2500	21.9
24"		235			2300	21.8
10"	272	150			9	4700
12"	250	285	200	9	4700	16.3
14"		281			4500	16.2
16"		278			4000	15.9
18"		298			3500	25.3
20"		291	300	12	3000	24.9
22"		286			2500	24.6
24"		282			2300	24.4

## NOTE

## 1. MATERIAL

- PARTS DIRECTLY WELDED TO PIPE : SAME AS RUN PIPE OR MAT'L TABLE.

CODE	RUN PIPE	PARTS DIRECTLY WELDED TO PIPE
K	A106 GR.B A572 GR. 65, CL22 API 5L GR. B API 5L GR. X52 API 5L GR. X65 API 5L GR. X70	A283 GR.C
X	A312 TP316L	A240-TP316L
L	A333 GR. 8 A671 GR. 60, CL22	A516 GR. 60

- OTHERS PART : A36

## 2. SHOE HEIGHT

H	INS. THK 1/2"	CODE	H	INS. THK 1/2"	CODE
100	UP TO 75	b	200	126 TO 175	d
150	76 TO 125	c	250	176 TO 225	e

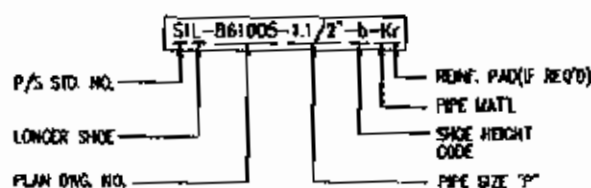
3. WHEN PIPE LONGITUDINAL EXPANSION EXCEEDS 100 mm, A LONGER SHOE WILL BE USED AND DESIGNATED BY ADDING AN "L" TO THE END OF SYMBOL.

4. REIN. PADS ARE REQUIRED FOR 10" &amp; LARGER STAINLESS STEEL PIPE

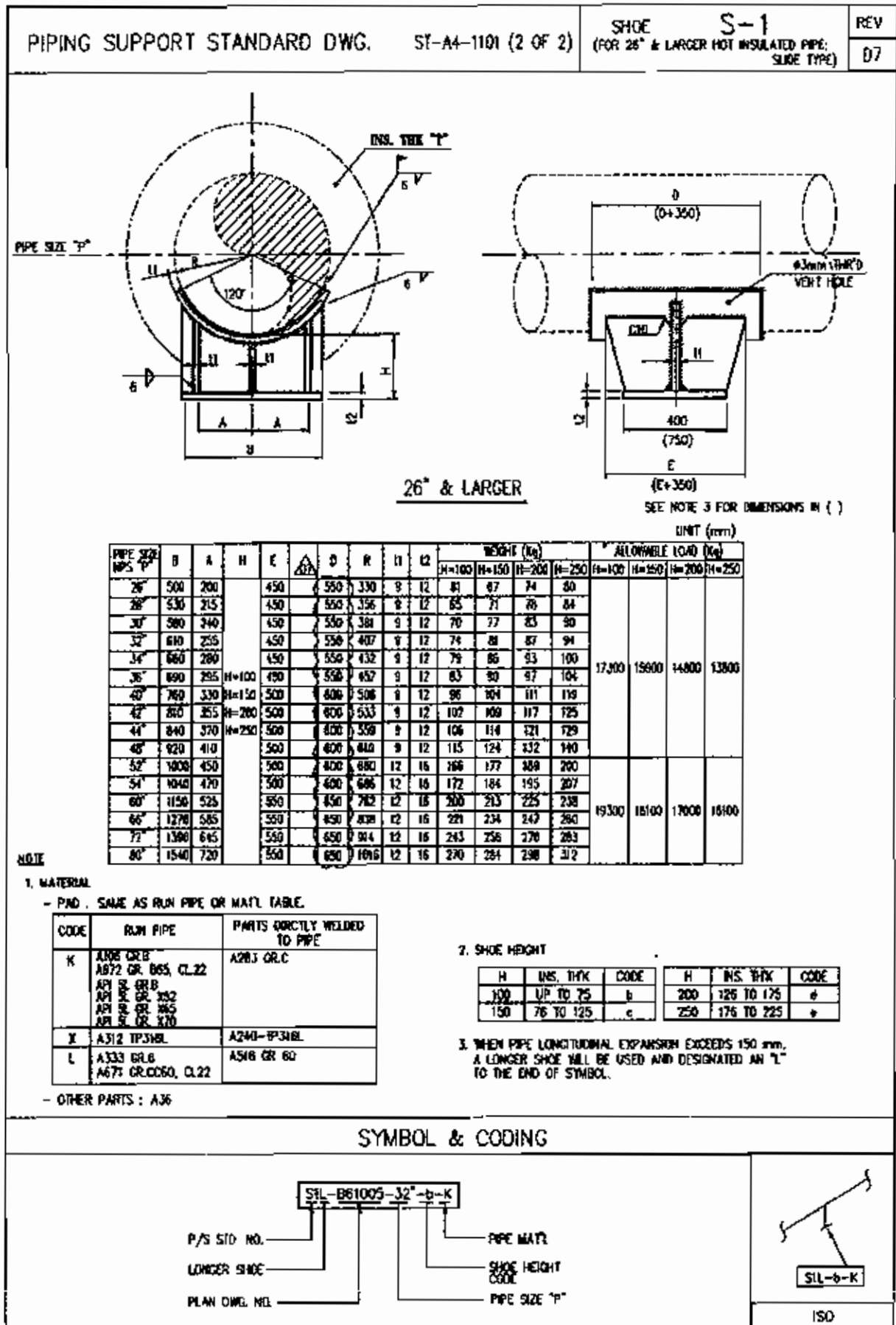
5. FOR LINES 20" &amp; OVER CARBON STEEL PIPE AND THOSE WITH WALL THICKNESS LESS THAN STANDARD WEIGHT SHALL BE CHECKED TO DETERMINE THE NEED FOR REINFORCING PAD.

6. SEE DWG. NO. ST-A4-0001 FOR THE SIZE OF SHAPE STEEL.

## SYMBOL &amp; CODING

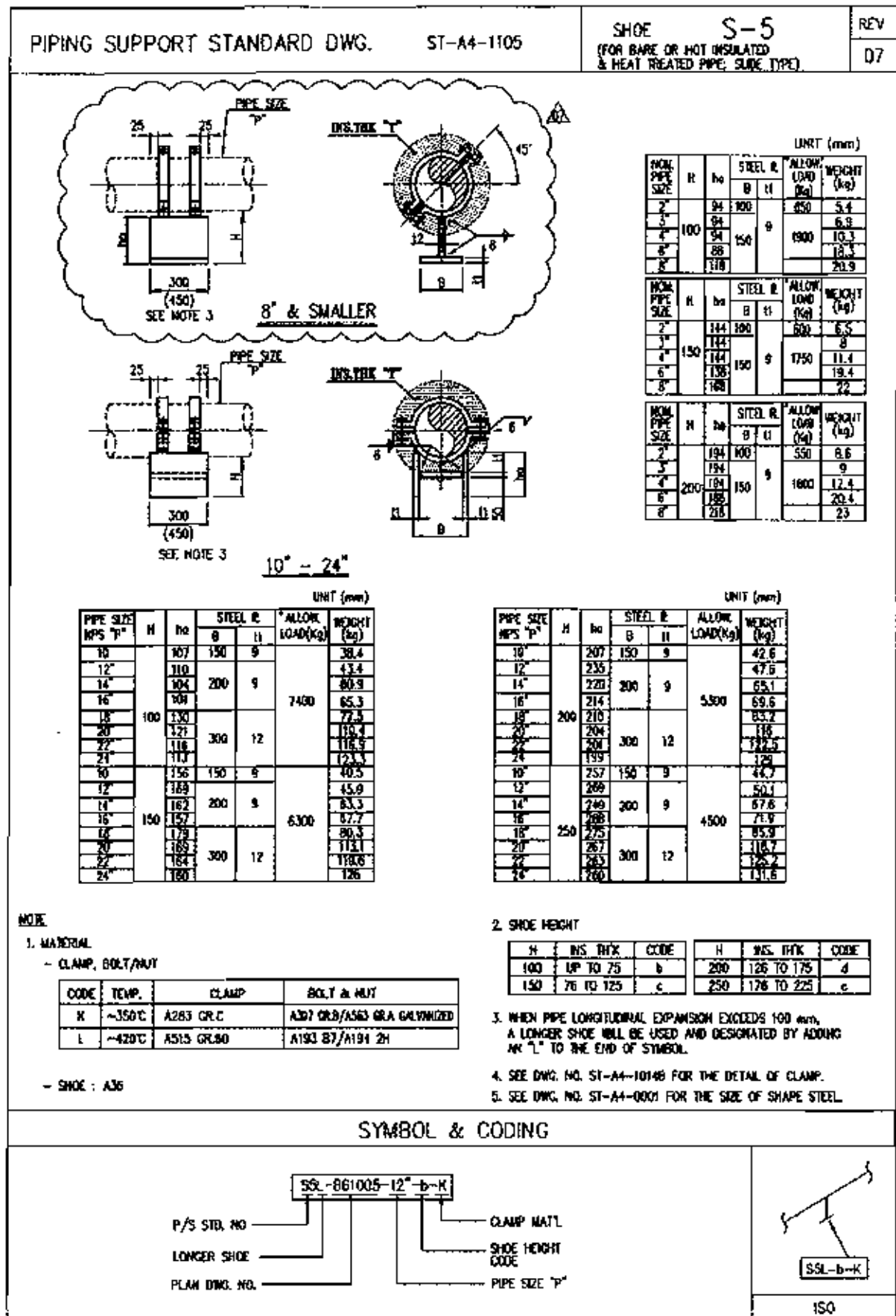


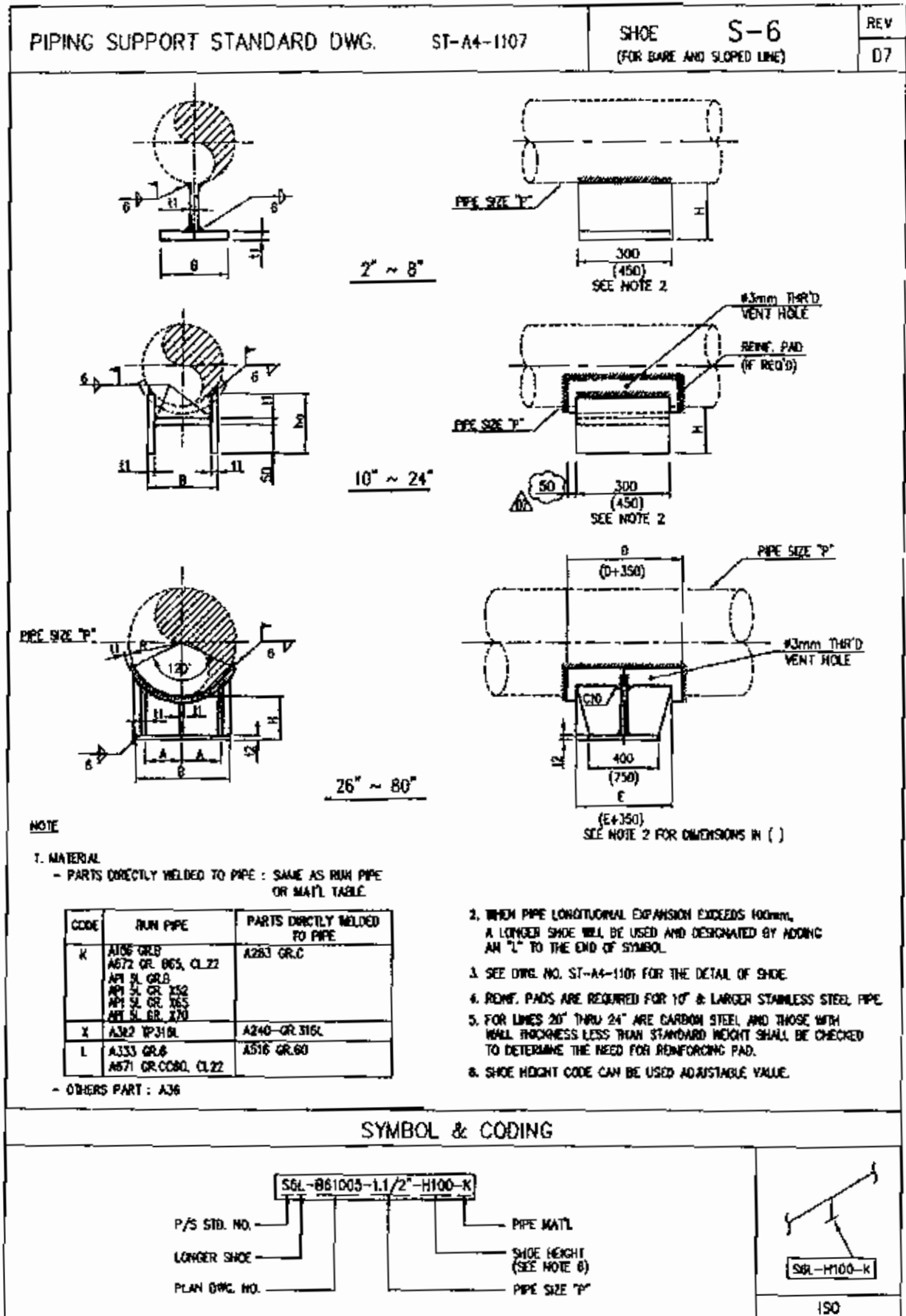
ISO

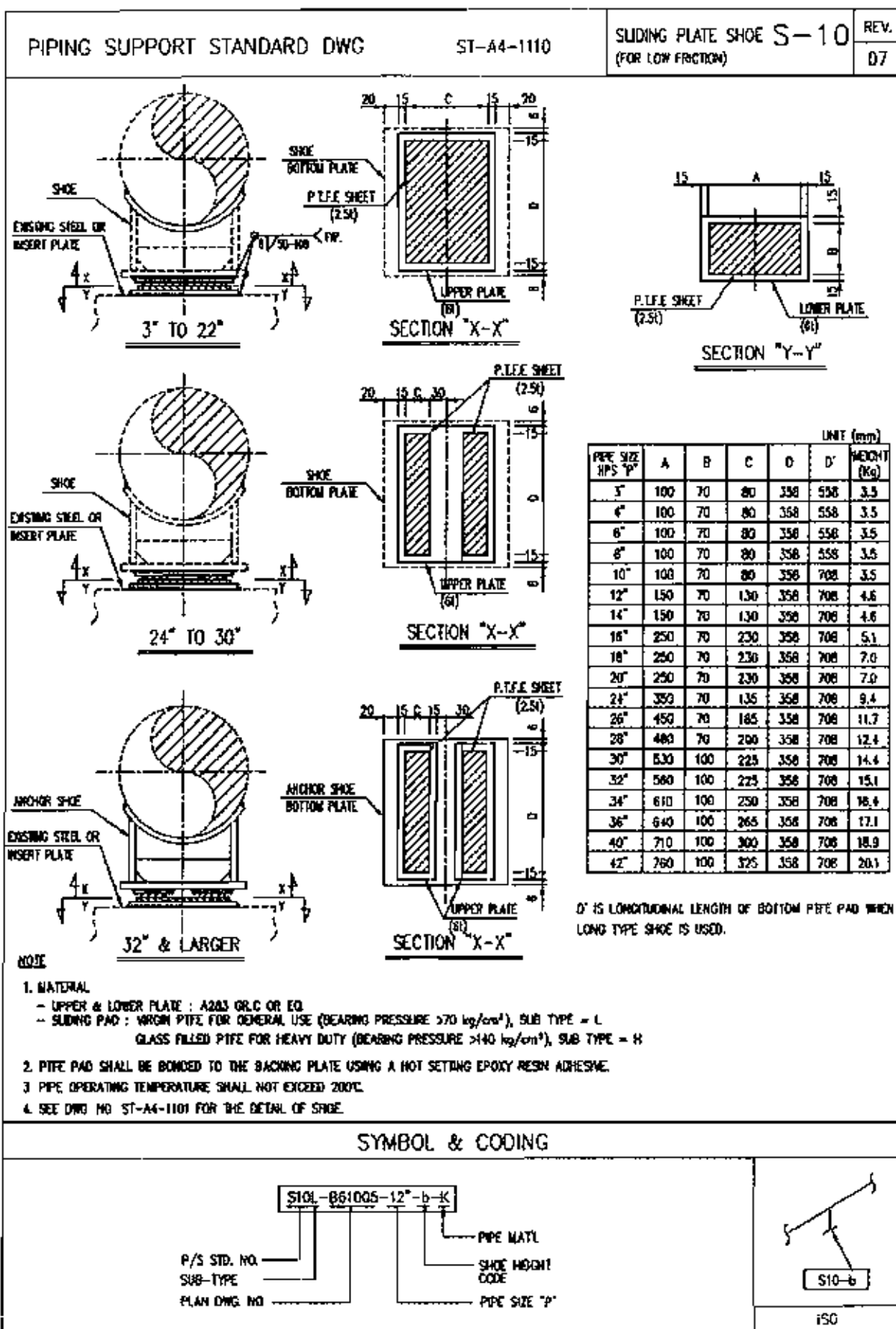






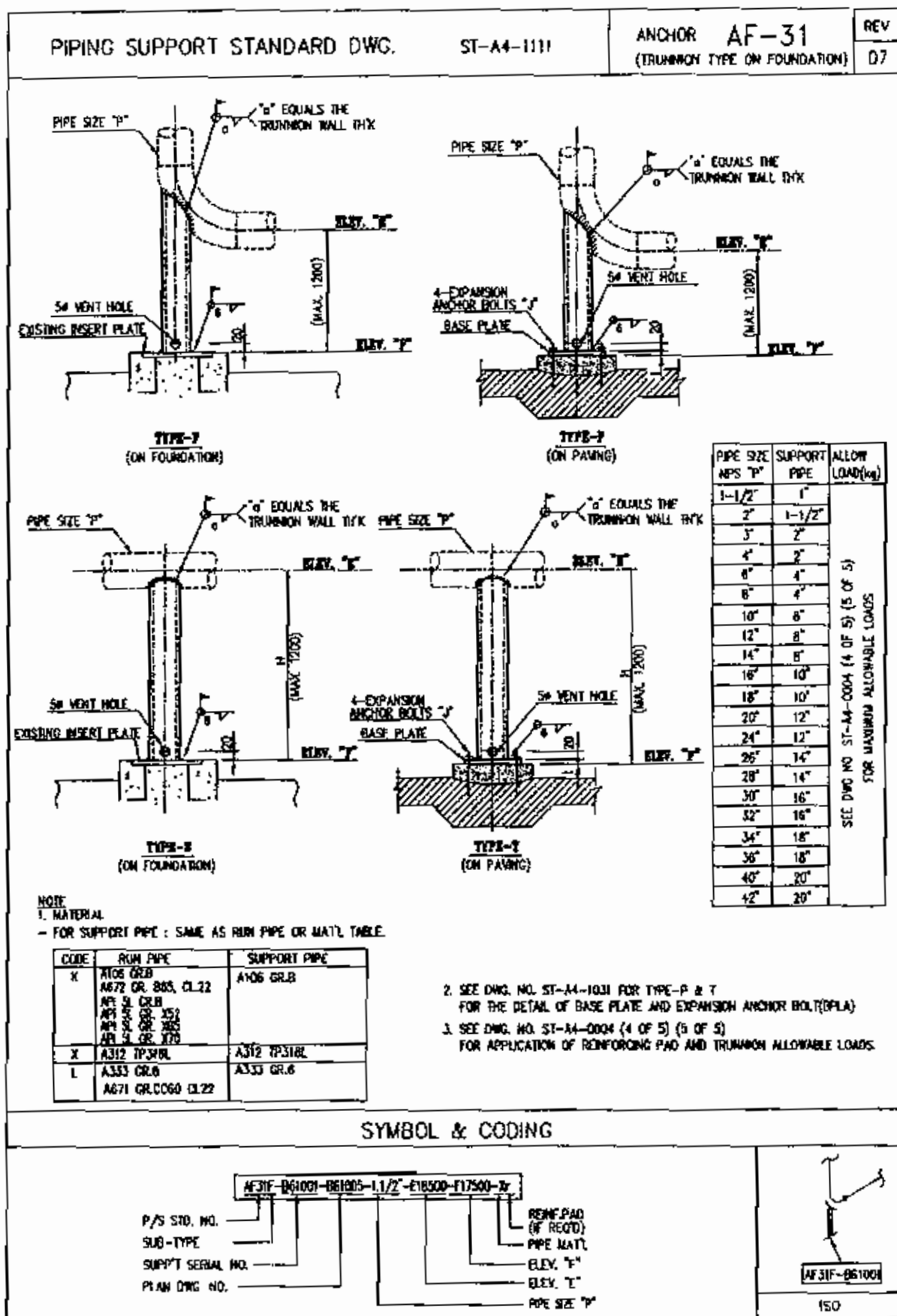


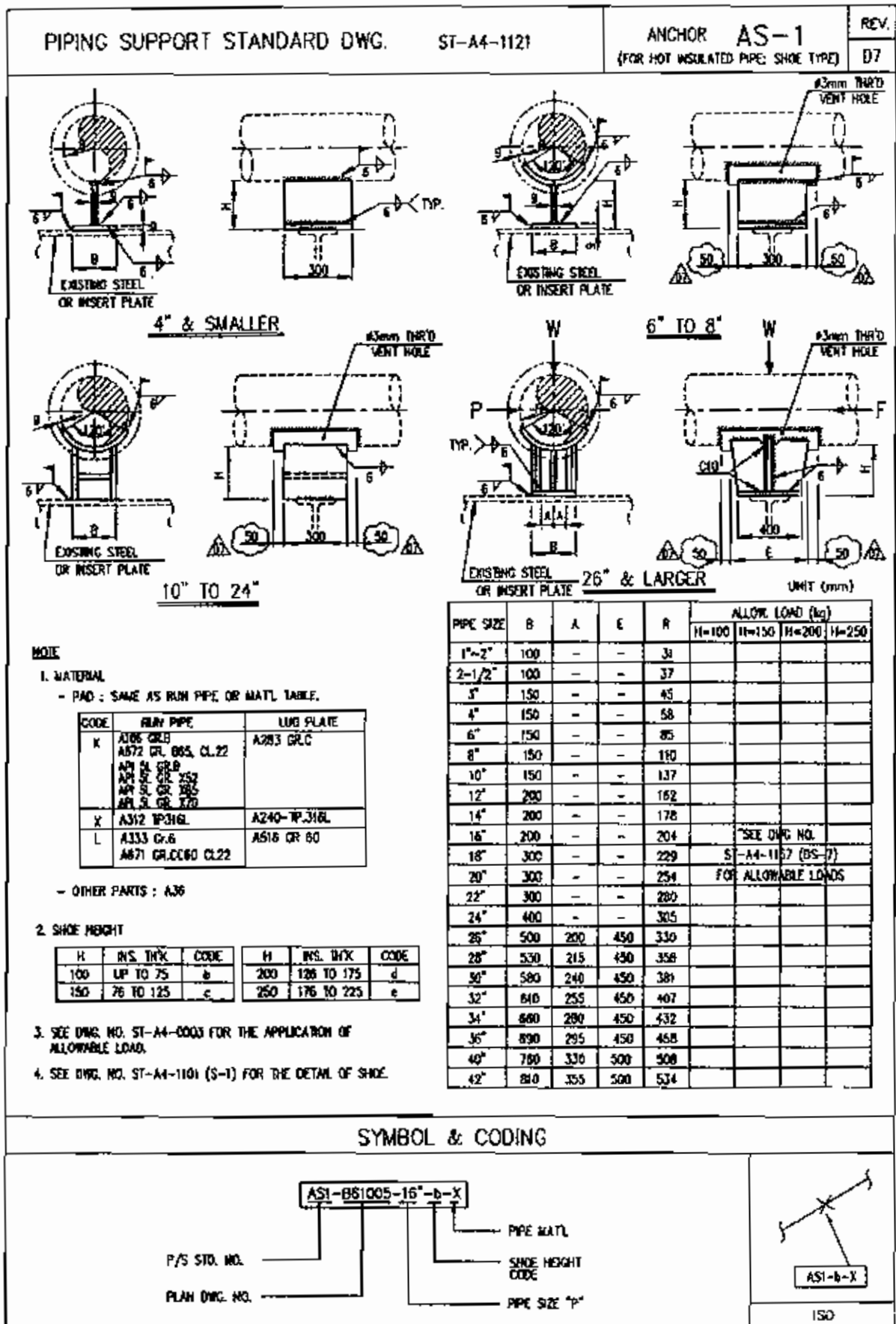






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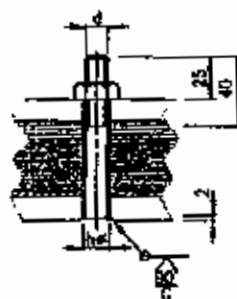
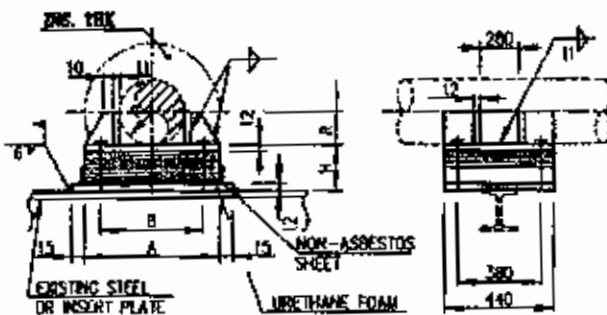
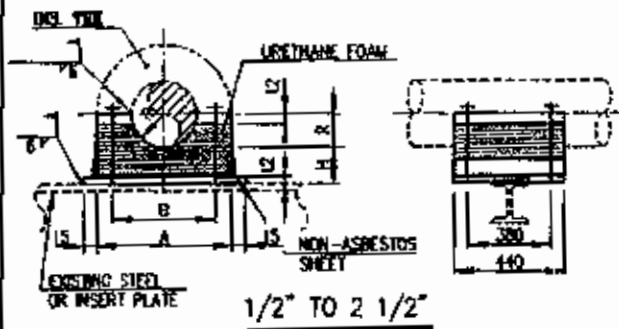
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## PIPING SUPPORT STANDARD DWG. ST-A4-1124

ANCHOR AS-4  
(FOR COLD INSULATED PIPE  
URETHANE BLOCK TYPE)

REV

D7



DETAIL FOR BOLT/NUT

NOM. PIPE SIZE	A	B	R	b4	t1	t2	BOLT/NUT (4, LMC)	URETHANE (mm)	ALLOW. LOAD (kg)	WEIGHT (kg)
1/2"	100	65	11	11	4.5	6	3/8"	200	4.9	4.9
3/4"	110	70	14	11	4.5	6	3/8"	650	5.4	5.4
1"	115	75	17	11	4.5	6	3/8"	650	5.6	5.6
1-1/2"	130	90	25	11	4.5	6	3/8"	650	6.1	6.1
2"	140	100	31	11	4.5	6	3/8"	650	6.5	6.5
2-1/2"	160	120	37	11	4.5	6	3/8"	650	7.1	7.1
3"	190	140	45	14	4.5	6	1/2"	1370	12.7	12.7
4"	210	165	58	14	4.5	6	1/2"	1800	14.3	14.3
6"	270	215	85	14	4.5	6	1/2"	2500	18.3	18.3
8"	320	265	110	14	6	9	1/2"	2500	32.5	32.5
10"	370	315	137	14	6	9	1/2"	4000	36.1	36.1
12"	425	370	162	14	6	9	1/2"	3800	43.3	43.3
14"	480	405	178	14	6	9	1/2"	3800	48.7	48.7
16"	530	455	204	14	6	9	1/2"	3600	53.8	53.8
18"	570	505	229	14	6	9	1/2"	3600	58.8	58.8
20"	630	555	254	14	6	9	1/2"	3800	64.3	64.3
22"	680	610	280	14	6	9	1/2"	3500	68.8	68.8
24"	740	660	305	14	6	9	1/2"	3500	75.4	75.4
26"	810	725	330	18	9	12	5/8"	3300	109.5	109.5
28"	860	775	356	18	9	12	5/8"	3300	117.1	117.1
30"	940	815	381	18	9	12	5/8"	3100	125.3	125.3
32"	970	880	407	18	9	12	5/8"	3100	131.2	131.2
34"	1020	930	432	18	9	12	5/8"	3000	138.7	138.7
36"	1070	980	458	18	9	12	5/8"	3000	146.1	146.1
40"	1180	1090	508	18	9	12	5/8"	3400	160.9	160.9
42"	1220	1150	534	22	9	12	3/4"	3400	168.7	168.7
44"	1295	1200	559	22	9	12	3/4"	3800	177.4	177.4
48"	1380	1250	610	22	9	12	3/4"	3800	191.4	191.4
52"	1470	1300	661	22	9	12	3/4"	3800	204.1	204.1
54"	1560	1455	686	22	9	12	3/4"	3600	215.4	215.4
60"	1720	1605	762	22	9	12	3/4"	3600	236.8	236.8

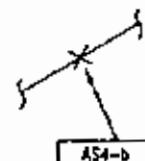
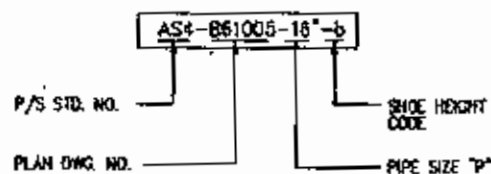
## NOTE

## 1. MATERIAL

- URETHANE FOAM : SEE DWG. NO. ST-A4-1022
- PARTS DIRECTLY WELDED TO PIPE : A240-TP316L
- BOLT/NUT : A320 08/A194 GR.4
- PLATE : A516 GR. 60
- OTHER PARTS : A36

COLD INSUL. THK	SHOE HEIGHT	CODE
25 ~ 50	50	a
51 ~ 100	100	b
101 ~ 150	150	c
151 ~ 200	200	d
201 ~ 250	250	e

## SYMBOL &amp; CODING



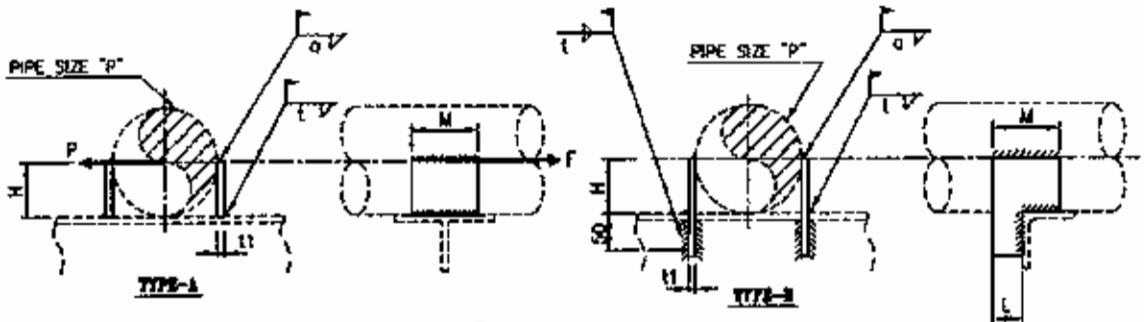
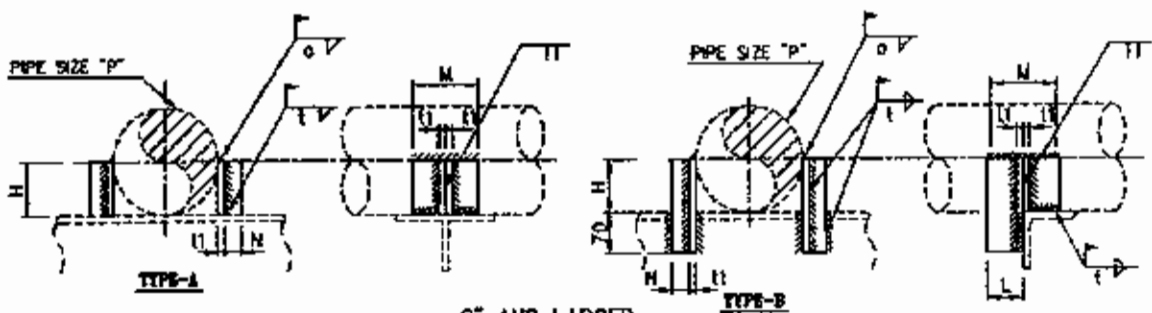
ISO

PIPING SUPPORT STANDARD DWG. SY-A4-1125

ANCHOR AS-5  
(FOR LOW TEMP. C.S BARE PIPE)

REV

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4" AND SMALLER6" AND LARGER

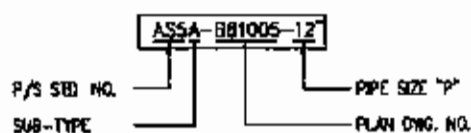
## NOTE

1. MATERIAL  
- PLATE : ASSA GR.60

PIPE SIZE NPS "P"	DIMENSIONS							HEIGHT (Kg)	ALLOW LOAD (Kg)	
	M	N	11	a	t	H	L		Feet	Feet
1/2"	75	-	9	9	6	11	35	0.1	2250	2250
3/4"	75	-	9	9	8	14	35	0.1	2250	2200
1"	75	-	9	9	8	17	35	0.3	2250	1900
1-1/2"	75	-	9	9	8	25	35	0.3	2250	1450
2"	75	-	9	9	8	31	35	0.6	2250	1200
2-1/2"	100	-	9	9	8	37	50	0.8	2250	1200
3"	100	-	9	9	8	45	50	0.8	3000	1500
4"	100	-	9	9	8	58	50	0.8	3000	1200
6"	150	65	9	9	6	83	75	3.3	3150	1670
8"	150	65	9	9	6	109	75	4.3	3150	1300
10"	150	65	9	9	6	134	75	5.3	3150	1020
12"	150	65	9	9	6	160	75	6.4	3150	870

UNIT (mm)

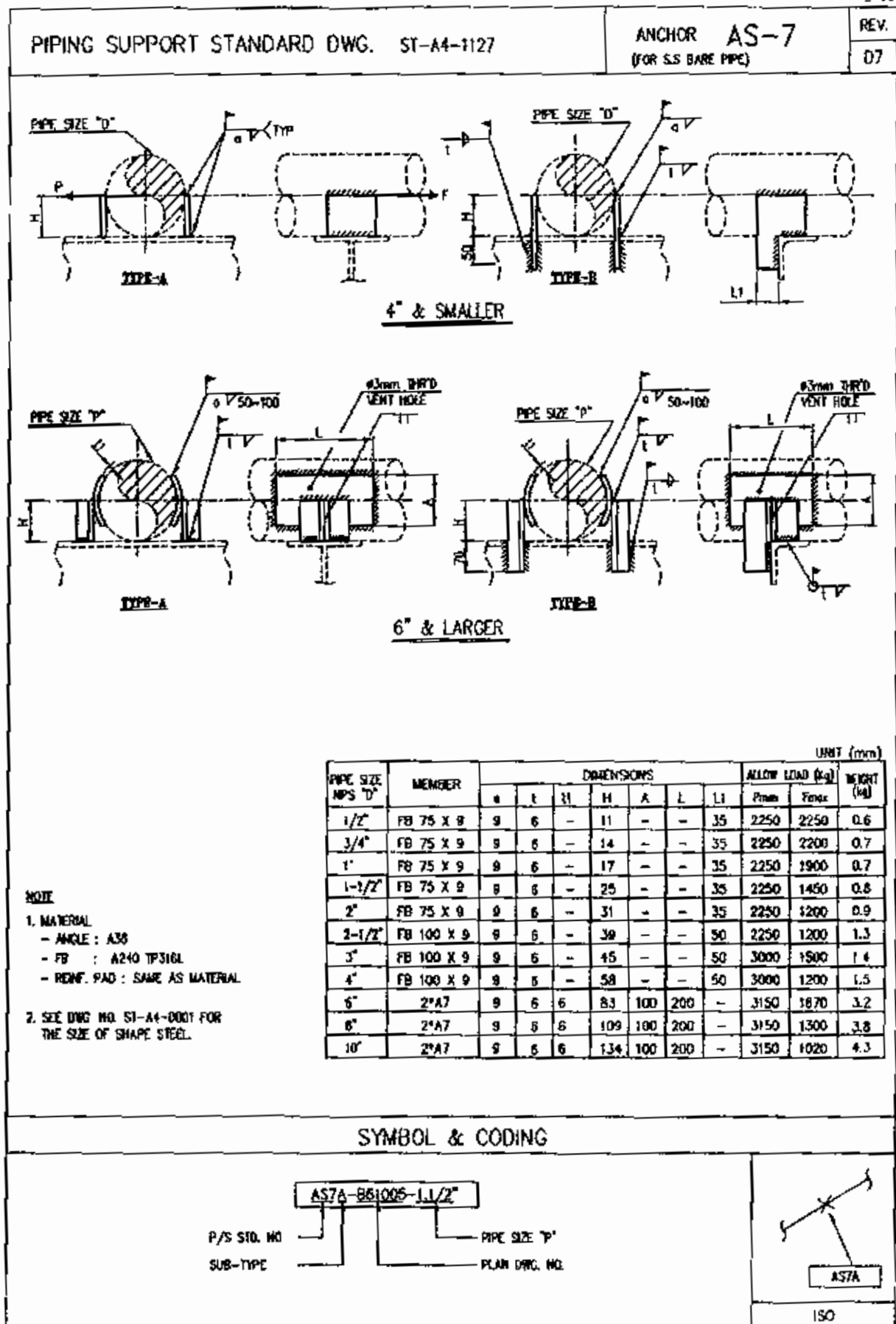
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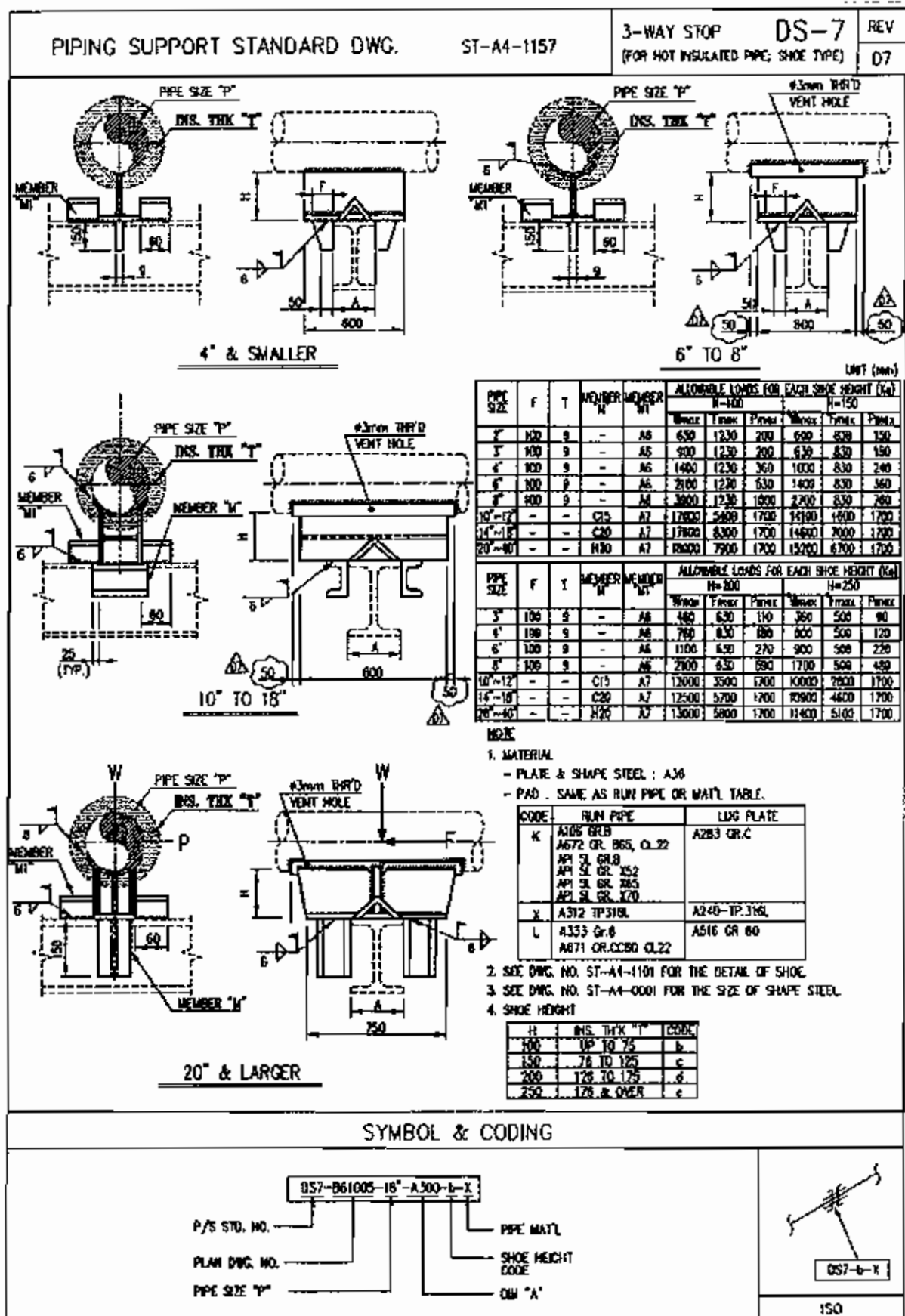


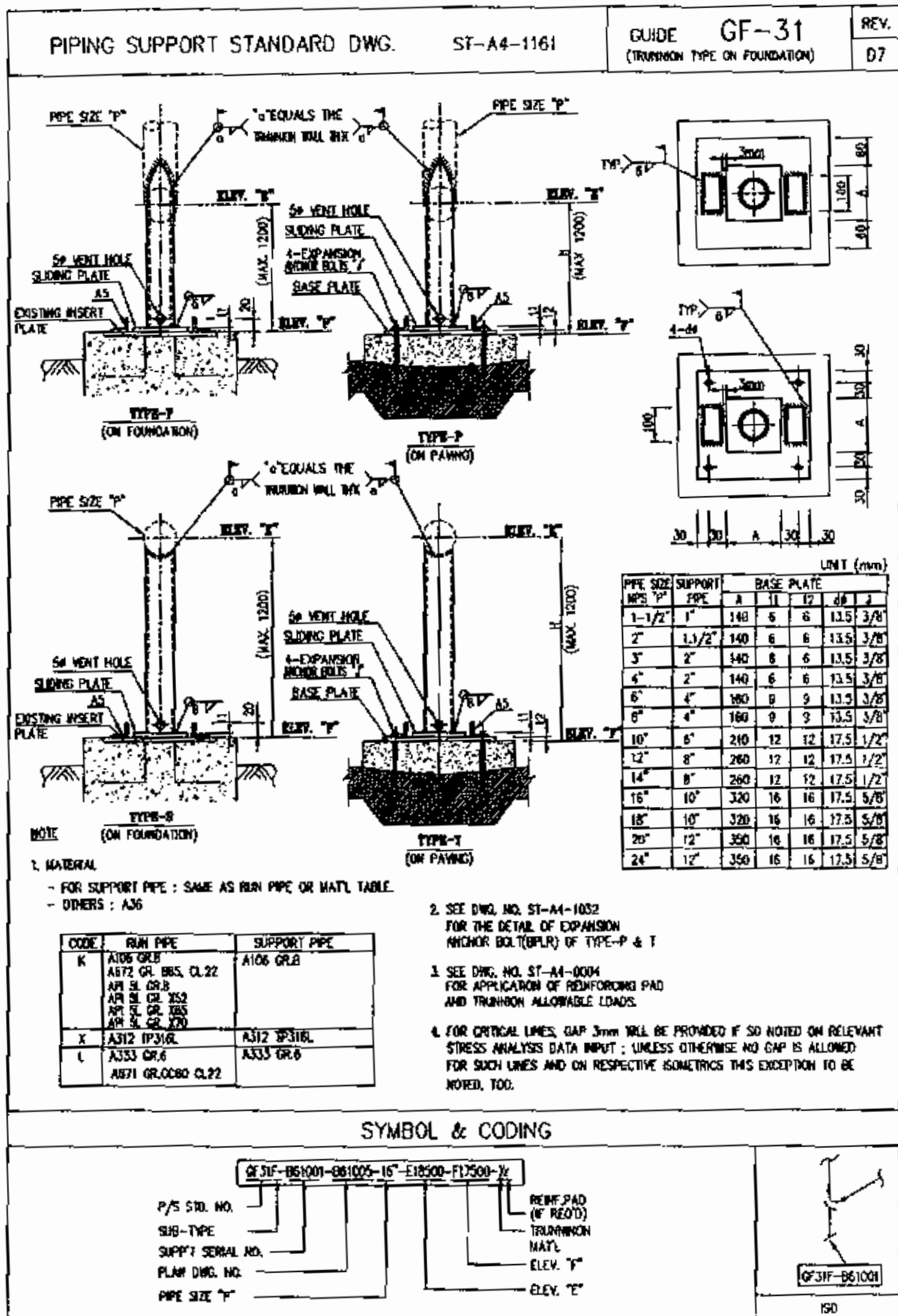
ISO

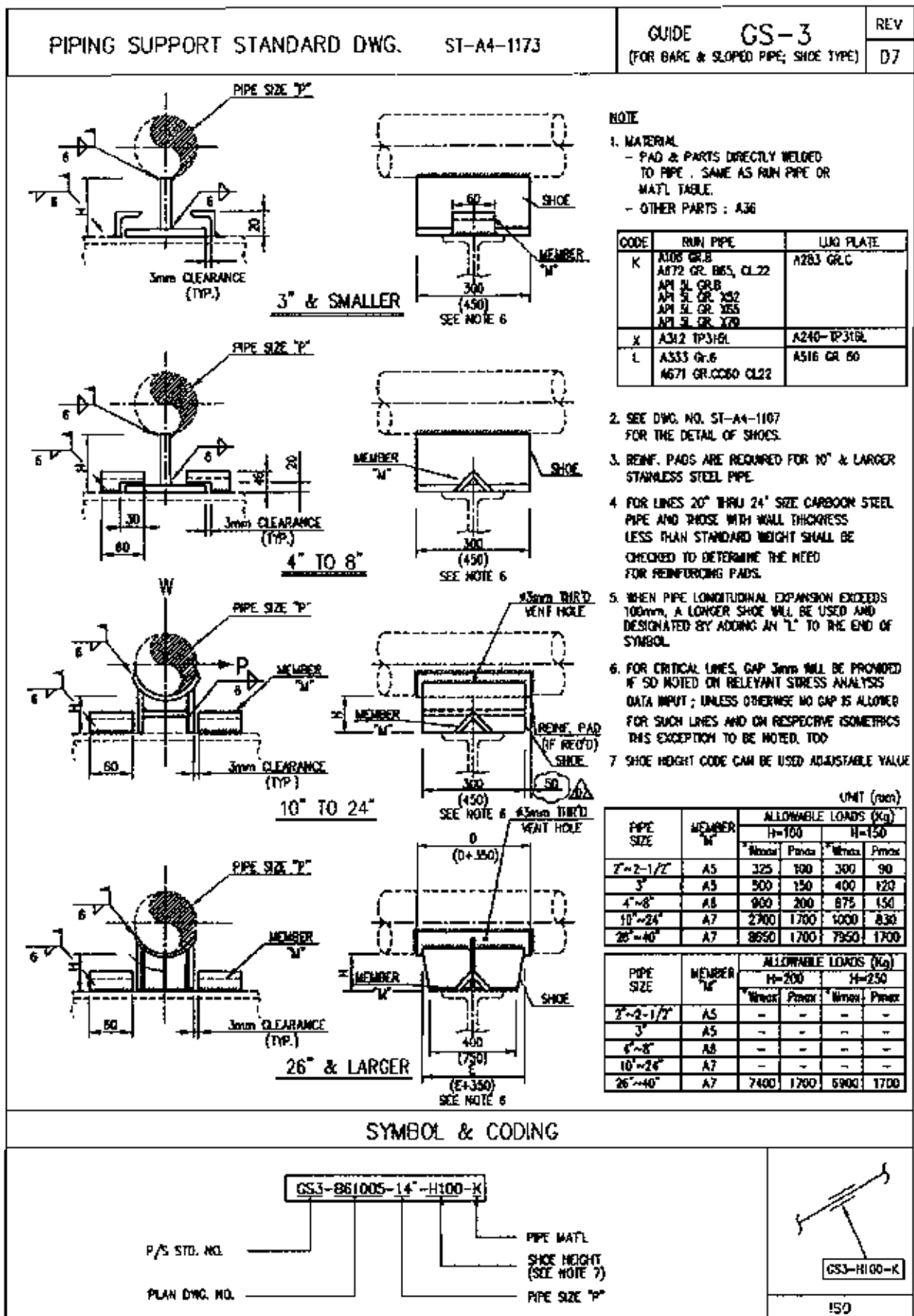


۱۳۷

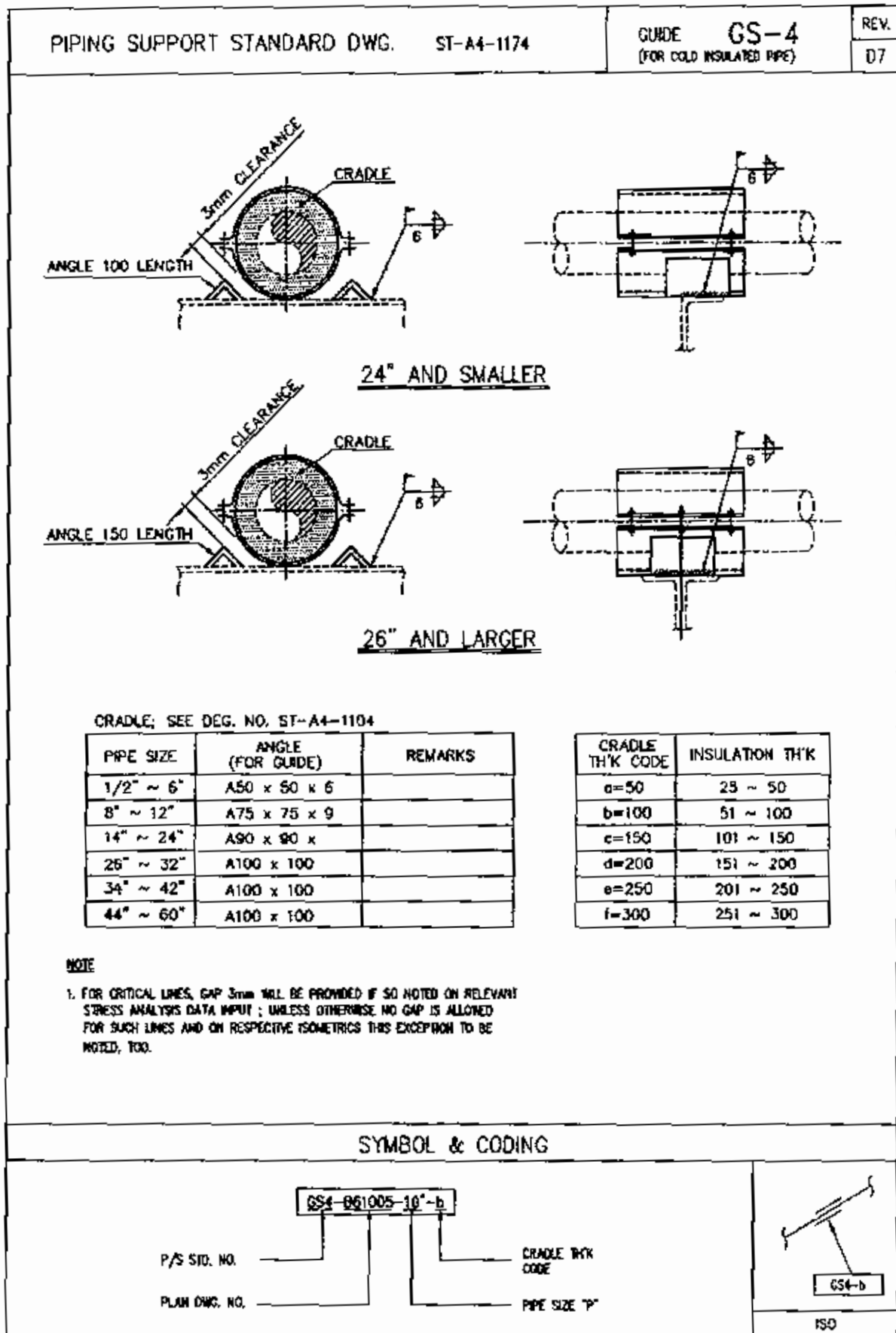


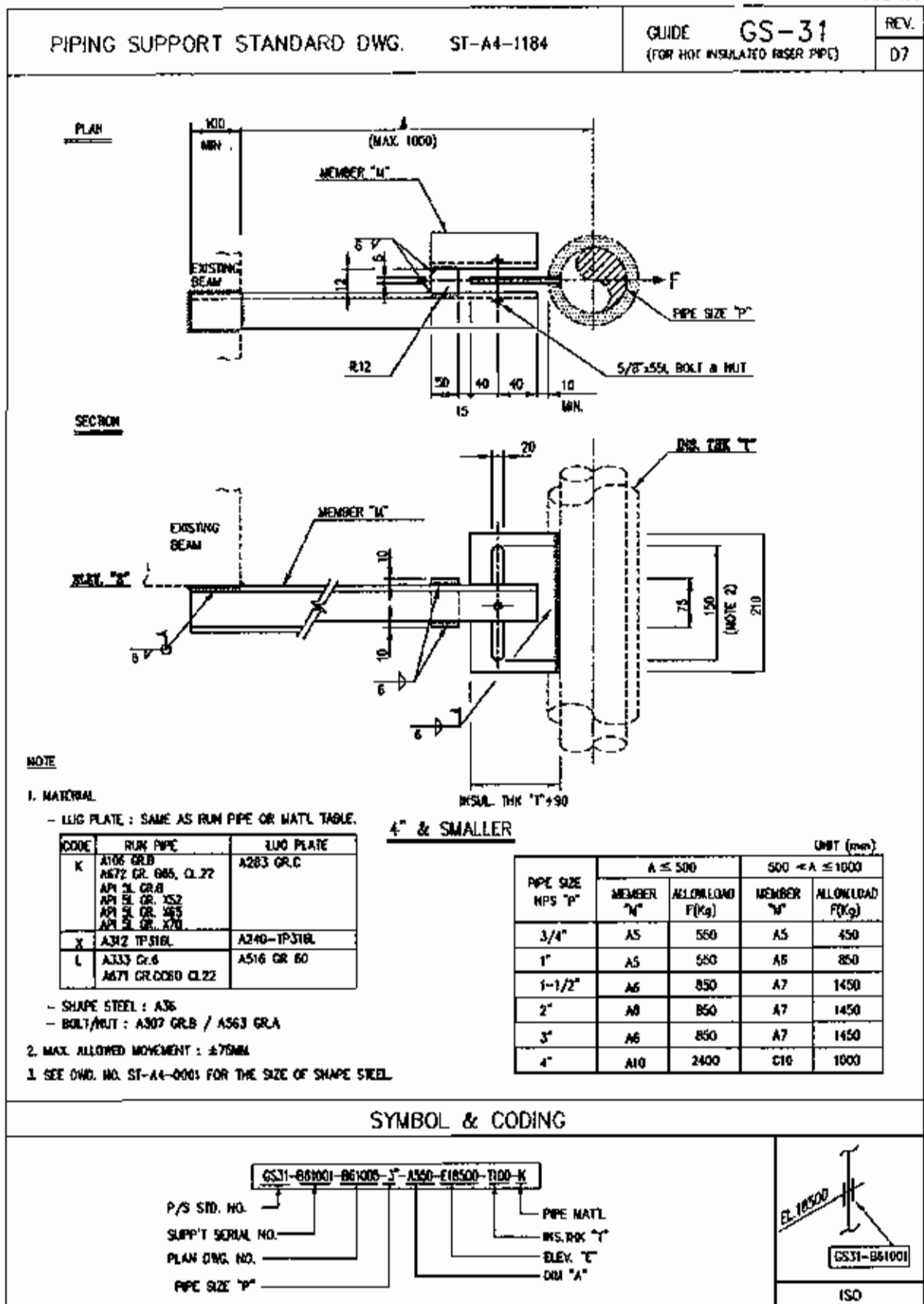














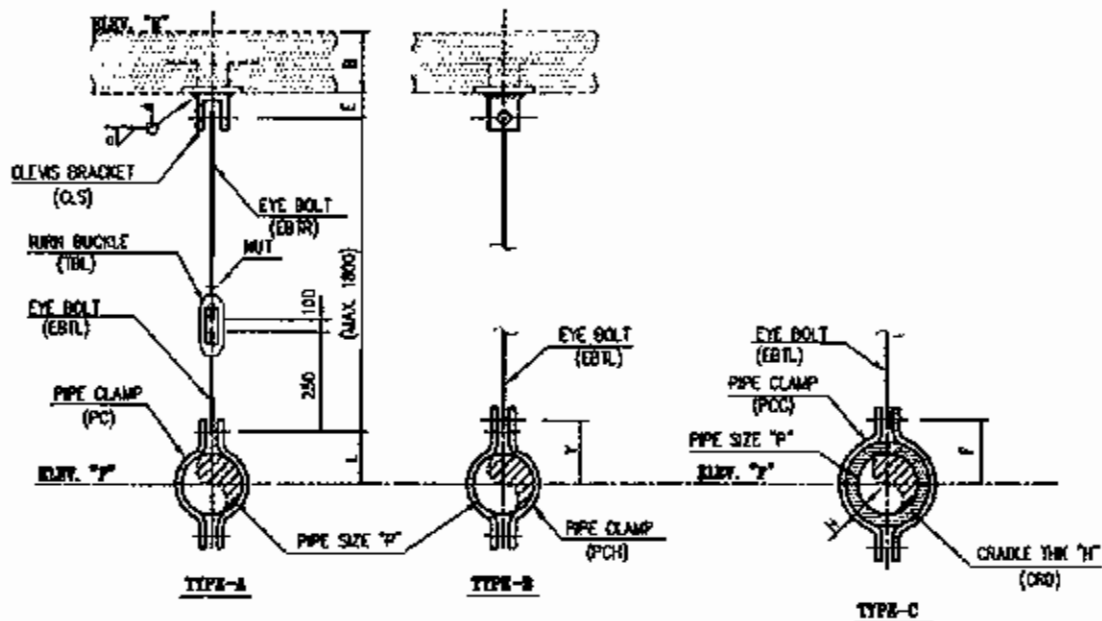
## PIPING SUPPORT STANDARD DWG.

ST-A4-1212

HANGER HC-11  
(UNDER CONCRETE)

REV.

D7



PIPE SIZE NPS "P"	ROD SIZE (inch)	E	F	Y	L	g	UNIT (mm)	ALLOWED (Kg)
1/2"	3/8"	50	SEE ST-A4-1016 (POC)	100	35	6		275
3/4"	3/8"	50		100	35	6		275
1"	3/8"	90		110	35	6		275
1-1/2"	3/8"	50		135	50	6		275
2"	3/8"	50		145	55	6		275
3"	1/2"	50		165	75	6		615
4"	5/8"	50		195	95	6		820
6"	3/4"	50		260	140	6		1230
8"	1"	75		300	165	6		2250
10"	1-1/8"	75		345	205	6		3630
12"	1-1/4"	75		370	230	6		3630
14"	1-1/4"	90		420	260	6		3630
16"	1-1/2"	90		445	285	9		5280
18"	1-1/2"	90		470	310	9		5280
20"	1-3/4"	90		520	350	9		7120
24"	1-3/4"	90		580	400	9		7120

## NOTE

1. MATERIAL  
- CLAMP, BOLT/NUT

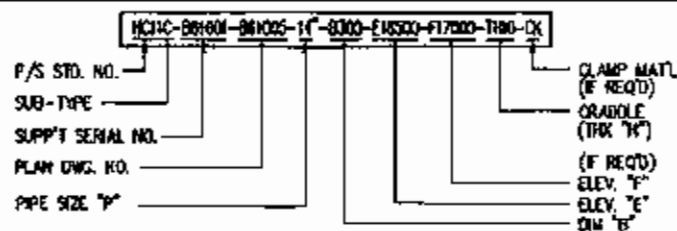
CODE	TEMP.	CLAMP	BOLT & NUT
K	~350°C	A283 GR.C	A307 GR.B GALV./A583 GR.A-GALV.)
L	~420°C	A516 GR.60	A193 GR.B7/A194 2H

- OTHER PARTS : A36

2. SEE Dwg. NO. ST-A4-1008/1009/1010/1011/1013  
FOR THE DETAIL OF HANGER ASSEMBLY.

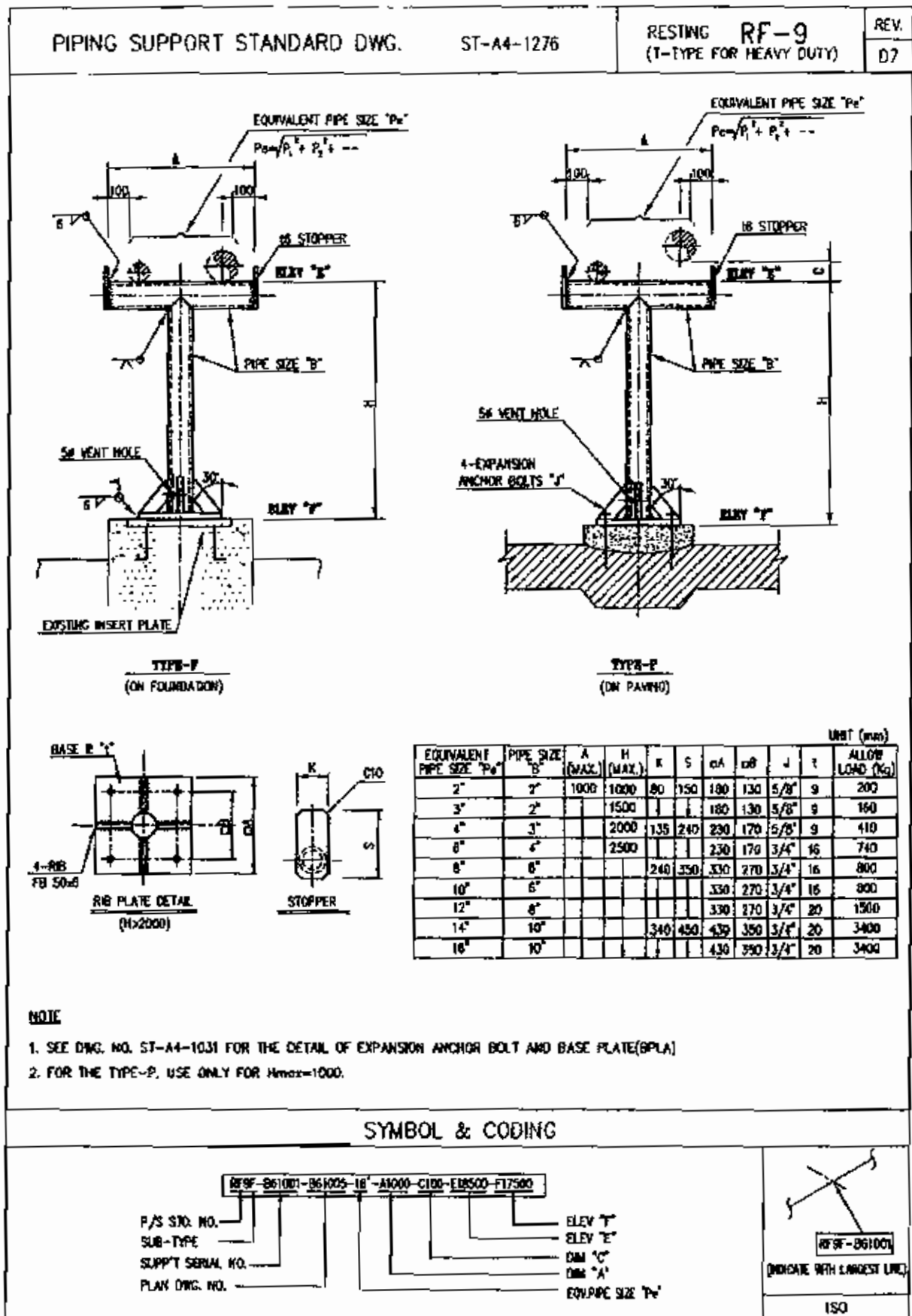
3. SEE Dwg. NO. ST-A4-1019 FOR CRADLE(CRD) THK "H"

## SYMBOL &amp; CODING



ISO





# محصولات جوشکاری آما

## ۱ - الکترودهای جوشکاری دستی آما

### الکترودهای روتیلی

### Rutile Electrodes

خصوصیات و موارد کاربرد Characteristics & Applications	ISO 2560	DIN 1913	AWS/ASME SFA5.1	کد شناسایی آما AMA Trade Name
برای جوشکاری فولادهای ساختمانی، کشتی سازی و مخازن در تمام حالت. Suitable for structural steels, shipbuilding steels and storage tanks in all positions.	E 432 R12	E 4322 R(C)3	E 6013	<b>23AK</b>
برای جوشکاری فولادهای ساده ساختمانی و کشتی سازی در تمام حالت. Suitable for structural steels in all positions.	E 432 R22	E 4321 R3	E 6013	<b>180D</b>
الکتروود روتیلی با پوشش ضخیم برای جوشکاری ورقهای ضخیم و کارهای نسبتاً سنگین صنعتی و اسکلت های فلزی. Thick covered electrode for welding of thick plate and structural steels			E 7014	<b>1008A</b>
الکتروود روتیلی با مقدار سیلیسیم کم مناسب برای بازسازی و تعمیر وان های گالوانیزه. Rutile electrode containing low Si is particularly suited for repair of galvanizing bath		E 4343R R(B)7	E 6013	<b>1531</b>
برای جوشکاری فولادهای ساختمانی، کشتی سازی و ریختگی در تمام حالت. Suitable for structural, shipbuilding and cast steels in all positions.	E 432 R12	E 4322 R(C)3	E 6013	<b>2000</b>
برای جوشکاری فولادهای ساختمانی، کشتی سازی در حالت افقی، تخت و سربالای. Suitable for structural, shipbuilding steels in horizontal and flat, vertical up positions.	E 512 RR22	E 5122 RR6	E 6013	<b>2000A</b>
الکتروود روتیلی برای جوشکاری فولادهای بدون آلیاژ ساختمانی و مخازن. Rutile electrode for welding in the fabrication of storage tanks and structural in non alloy steels.		E 4333 R(C)3	E 6013	<b>MK14</b>
الکتروود روتیلی - سلولزی مناسب برای جوش سرازیر در لوله کشی های گاز خنکی، قابلیت جوشکاری در تمام حالت. Rutile - cellulosic electrode suitable for downward welding of gas pipelines With Small Diameters.	E 432 R12	E 4322 R(C)3	E 6013	<b>P. L</b>

### الکترودهای با جایگزینی زیاد

### Electrodes with High Metal Recovery

خصوصیات و موارد کاربرد Characteristics & Applications	ISO 2560	DIN 1913	AWS/ASME SFA5.1	کد شناسایی آما AMA Trade Name
الکتروود روتیلی با روپوش ضخیم حاوی پودر آهن با جایگزینی ۱۶۰٪ مناسب برای جوشکاری سازه های فلزی در حالت تخت و افقی. Heavily coated rutile electrode containing iron powder with 160 %metal recovery, suitable for steel construction in flat and horizontal positions	E 512RR 16032	E 5122 RR 11160	E 7024	<b>1118 K</b>
الکتروود فلزی با راندهای بالا و جایگزینی فلز جوش ۱۶۵٪ و دارای چقرمگی بالا که در حالت تخت و گوشه ای کاربرد دارد. High efficiency electrode having a weld metal recovery of 165% and weld metal is very tough preferably used for welding fillet and flat.			E 7028	<b>1617 K</b>

## Basic Electrodes

## الکترودهای قلیایی

کد شناسایی آما AMA Trade Name	AWS/ASME SFA 5.1	DIN 8529	ISO 2560	خصوصیات و موارد کاربرد Characteristics & Applications
1007F	E 7016			الکتروده قلیایی برای جوشکاری اتصالی فولادهای پرکربن، مخازن تحت فشار و مقاوم در برابر ترک خوردن. Suitable for joint welding of high carbon and high pressure vessels steels Resistable against cracking
1177 F	E 7018-1	E SY4276 MnB	E 515 B20	الکتروده قلیایی برای جوشکاری معازن تحت فشار و فولادهای پر کربن باحدود ۱۱۵٪ جابجی. Basic electrode for high pressure vessels and high carbon steels with 115% metal recovery.
1230 F	E 7018	E 5154 B10	E 515 B1 10 20H	الکتروده قلیایی برای جوشکاری مخازن تحت فشار و فولادهای پر کربن (حدود ۰/۴ درصد) Basic electrode for high pressure vessels and high carbon steels up to 0.4% C.
1232 F	E 7018	E 5154 B10		الکتروده قلیایی با پایداری قوس خوب برای جوشکاری مخازن تحت فشار و فولادهای پر کربن. (حدود ۰/۴ درصد) Basic electrode with good arc stability for high pressure vessels and high carbon steels up to 0.4% C.
1280 M	E 7018	E 5154 B10		الکتروده قلیایی دور روپوشه با جدانشدن سرباره خوب و پایداری قوس عالی در جوشکاری بشیار باریک. Double coated basic electrode with good slag removal and very good arc stability in narrow gap welding.

## Cellulosic Electrodes

## الکترودهای سلولزی

کد شناسایی آما AMA Trade Name	AWS/ASME SFA 5.1, 5.5	DIN 1913	ISO 2560	خصوصیات و موارد کاربرد Characteristics & Applications
1045P	E 6010	E 4332 C4	E 433 C19	الکتروده سلولزی با نفوذ بالا برای پاس ریشه در تمام حالت مخصوصاً حالت سرازیر این الکتروده بویژه برای جوشکاری لوله ها و مخازن مناسب می باشد. (جابجی ۹۰٪) Cellulosic electrode with deep penetration, used as a root layer in all positions especially vertical-down, particularly suitable for pipes and storage tanks. (Recovery 90%)
1047P	E 6010			الکتروده سلولزی با پایداری قوس خوب در تمام حالت و نفوذ بالا که برای جوشکاری لوله ها و مخازن مناسب می باشد. Cellulosic electrode with good arc stability in all position and suitable for pipes and tanks with deep penetration.
1048P	E 7010 G			الکتروده سلولزی با پایداری قوس خوب که برای جوشکاری لوله های فولادی با استحکام بالا مناسب می باشد. Cellulosic electrode with good arc stability suitable for high strength pipe steels.
1049P	E 8010 G			الکتروده سلولزی با پایداری قوس خوب در تمام حالت که برای جوشکاری لوله های فولادی با استحکام بالا مناسب می باشد. Cellulosic electrode with good arc stability in all position suitable for high strength pipe steels.
1707NP	E 7010-A1			الکتروده سلولزی مولیبدن دار که مشابه الکتروده E 6010 بوده ولی استحکام مکانیکی بالاتری دارد. Cellulosic electrode containing Mo similar to E 6010 but has more mechanical strength.

## Electrodes for Stainless and Heat Resistant Steels الکترودهای جوشکاری برای فولادهای زنگ تزن و مقاوم به حرارت

کد شناسایی آما AMA Trade Name	AWS/ASME SFA 5.4	DIN 8556	ISO 3581	خصوصیات و موارد کاربرد Characteristics & Applications
1071 R	E 410-15	E 131 B20 +	E 131 B20 +	برای جوشکاری اتصالی فولادهای مارتنزیتی - فریتی با ۱۲ تا ۱۴٪ کروم، ایجاد لبه روکشی سخت و مقاوم به سایش، حرارت و پوسته شدن. Suitable for joint welding of martensitic ferritic steels with 12-14 % Cr, used in hard facing as a layer resistable against abrasion.

برای جوشکاری اتصالی و روکشی در فولادهای مقاوم به حرارت با ۲۵٪ کروم . Suitable for joint welding and surfacing on heat resistant steels with 25% Cr.	E 2520 B20 +	E 2520 B20 +	E 310-15	1312 J
الکتروود روتیلی که برای جوشکاری فولادهای کرومی مقاوم به حرارت و خوردگی و روکشی به کار می رود . Basic electrode for welding of stainless and heat resistant chromium steels and used for surfacing.				1367 MR
الکتروود روتیلی با کربن خیلی کم . مناسب برای جوشکاری اتصالی و روکشی در فولادهای کروم - نیکل ۸/۱۸ . Low carbon-ELC-Rutile electrode suitable for joint welding and surfacing on 18Cr / 8Ni steels.	E 199 LR26	E 199 LR 26	E 308L-16	1460 JA
الکتروود روتیلی با کربن خیلی کم برای جوشکاری اتصالی و روکشی در فولادهای کروم - نیکل مولیبدن ۲/۸/۱۸ . مقاوم به خوردگی شیمیایی . Low carbon - ELC - Rutile electrode suitable for joint welding and surfacing on 18Cr/8Ni/2Mo steels resistable against chemical corrosion.	E 19123 LR26	E 19123 LR26	E 316L-16	1460 JB
الکتروود روتیلی برای جوشکاری اتصالی و روکشی در فولادهای ثابت شده و نشده کروم - نیکل ۸/۱۸ مقاوم به خوردگی شیمیایی . Rutile electrode suitable for joint welding and surfacing on stabilized and non stabilized steels 18Cr/8Ni resistant against chemical corrosion		E 199 Nb R26	E 347-16	1461 JA
الکتروود روتیلی برای جوشکاری اتصالی و روکشی در فولادهای ثابت شده و نشده کروم - نیکل مولیبدن ۲/۸/۱۸ مقاوم به خوردگی شیمیایی . Rutile electrode suitable for joint welding and surfacing on stabilized and non stabilized steels 18Cr/8Ni/2Mo resistant against chemicals.		E 19123 NbR26	E 318-16	1461 JB
برای جوشکاری اتصالی بین فولادهای پر آلیاژ و فولادهای غیر آلیاژی با ایجاد لایه واسطه در روکشی سخت . Suitable for joint welding of high alloy steels to non - alloy steels depositing buffer layer in hard facing.	E 2312 LR23	E 2312 LR23	E 309L-16	1464 JA
الکتروود اوستنیتی فریتی برای جوشکاری اتصالی فولادهای غیر همجنس که دمای کاری آن تا ۳۰۰ °C است . Austenitic ferritic electrode for joining dissimilar steels, highest operating temperature is 300 °c		E 23132 LR23	E 309 MOL16	1464 JB
الکتروود اوستنیتی فریتی با مقدار ۲۵ تا ۳۰٪ فریت برای جوشکاری فولادهای بد جوش و غیر همجنس که فلز جوش آن مقاوم به ترک می باشد . Ferritic austenitic electrode with a delta - ferrite content of 25-30% for joining of dissimilar steels. It features high resistance to cracking and is therefore indicated for difficult to weld steels.				1465 J
الکتروود روتیلی که برای اتصال فولادهای غیر همجنس و روکشی استفاده می شود . فلز جوش آن تا دمای ۱۰۰۰ °C پخته نمی شود و مقاوم به ترک نیز می باشد بطوریکه برای جوشکاری فولادهای بد جوش نیز به کار می رود . Rutile electrode for joining of dissimilar steels and for surfacing purposes. The weld metal is non - scaling up to 1100°C it features high resistance to cracking and is therefore indicated for difficult to weld steels.		E 299 R23	E 312- 16	1468 J
برای جوشکاری اتصالی فولادهای پر آلیاژ به غیر آلیاژی و مناسب برای جوشکاری گوشه ای با جدا شدن سرباره خوب . Suitable for joint welding of high to non-alloy steels and suitable for fillet welding with good slag removal .			E 309 L- 17	1474 JB7
الکتروود روتیلی برای جوشکاری فولادهای مقاوم به حرارت تا دمای ۱۰۵۰ °C Rutile electrode for welding of heat resistant steels up to 1050 °c		E 2520 R26	E 310-16	1507 JA
برای جوشکاری فولادهای بد جوش و لایه تنش گیر و روکشی سخت در ریلها ، زنجیر تانک و امثال آن . Suitable for difficult to weld steels and used as a buffer layer and hard facing in rails.	E 188 Mn B20	E 188 Mn B20	E 307-15	1803 J
الکتروود حاوی کروم - نیکل - منگنز برای جوشکاری فولادهای بد جوش و غیر همجنس و فولادهای منگیزی و نیز به عنوان لایه تنش گیر . Electrode with Cr-Ni-Mn for welding of dissimilar steels and high manganese steels and used as a buffer layer.			E 307-15	1090 V



# الکترودهای جوشکاری برای فولادهای ساختمانی دانه ریز Electrodes for Fine Grain Structural Steels

خصوصیات و موارد کاربرد Characteristics & Applications	ISO 3580	DIN 8529	AWS/ASME SFA5.5	کد شناسایی AMA Trade Name
برای جوشکاری فولادهای دانه ریز با استحکام بالا، فولادهای ریختگی. Suitable for welding of fine grain high strength structural steels, cast steel.		E Y8953 Mn2NiCrMoB	E 12018-G	1024 N
الکترودهای قلیایی مقاوم به ترک برای جوشکاری فولادهای دانه ریز با استحکام بالا مورد استفاده در لوله های تحت فشار و دیگها. Basic electrode suitable for welding of high tensile fine grain structural steels, pressure vessels-pipe and boiler crack resistant.		E Y5076 Mn1NiBH5	E 8018-G	1282 N
برای جوشکاری فولادهای دانه ریز مورد استفاده در مخازن تحت فشار - خط لوله و دیگها. Suitable for Welding of fine grain structural steels, pressure vessels, pipelines and boilers.		E Y6975 Mn2NiCrMoB	E 10018-G	1292 N
الکترودهای قلیایی برای جوشکاری فولادهای ساختمانی ضخیم و مقاوم به خوردگی جوی. Basic electrode for thick structural steels of similar composition and resistant to atmospheric corrosion.		E Y38651 NiCuB	E 7018-G	1301 N
الکترودهای قلیایی مناسب برای فولادهای استحکام بالایی دانه ریز، مقاوم در برابر ترک. Basic electrode suitable for fine grain structural steels, highly resistant crack.		E SY5576Mn 1NiMoBH5	E 9018-G	1385 NC
الکترودهای قلیایی با فلز جوش عاری از ترک و چقرمه با خلوص متالورژیکی عالی. Basic electrode for producing crack free and tough welded joints weld metal is of extremely high metallurgical purity.		E SY42761 NiBH5	E 7018-G	1398 N
الکترودهای قلیایی کم کربن با فلز جوش عاری از ترک و با چقرمگی بسیار خوب. Low carbon basic electrode with crack free and very good tough weld metal.			E 7018C2L	1414 N
الکترودهای قلیایی برای جوشکاری فولادهای ساختمانی ضخیم و مقاوم به خوردگی جوی. Basic electrode for thick structural steels of similar composition and resistant to atmospheric corrosion.			E 8018-W	1416 N
الکترودهای قلیایی کم هیدروژن برای اتصالات مورد جوشکاری با چقرمگی بالا و مقاوم در برابر ترک. Low hydrogen basic electrode for producing crack free and tough welded joints		E S/42872 NiBH5	E 8018-C1	1420 N
الکترودهای قلیایی کم هیدروژن که جوش آن مقاوم به ترک و چقرمه می باشد. Low hydrogen basic electrode for producing crack free and tough welded joints.		E SY42761 NiBH5	E 8018-C3	1422 NA
الکترودهای قلیایی کم هیدروژن که جوش آن مقاوم به ترک و چقرمه می باشد. Low hydrogen basic electrode for producing crack free and tough welded joints.			E 8018-C3	1423 N
الکترودهای قلیایی با خواص مکانیکی عالی که جوش آن مقاوم به ترک بوده و از چقرمگی خوبی برخوردار می باشد. Basic electrode with excellent mechanical properties for producing crack free and tough weld metal.			E9018M	1428 NC
الکترودهای قلیایی حاوی منگنز - کروم - نیکل - مولیبدن برای جوشکاری مخازن بزرگ حامل گاز مایع و مقاوم در برابر ترک. Basic electrode containing Mn-Cr-Ni-Mo Suitable for welding of large vessels containing liquid gas resistant against crack.		E Y6975 Mn2NiCrMoB	E 11018-M	1432 N
الکترودهای قلیایی با استحکام بالا و چقرمگی خوب که جوش آن از نظر آزمایش رادیوگرافی از کیفیت مناسبی برخوردار می باشد. Basic electrode with high strength and good tough weld metal. Welds are X-ray quality			E12018M	1433 NA
الکترودهای قلیایی که جوش آن چقرمگی خوبی دارد و بخاطر هیدروژن کم در برابر ترک مقاوم است. Basic electrode for producing crack free and tough welded joints, weld metal having a low hydrogen content.			E 7016-G	1437 B

## Electrodes for Creep Resistant Steels

## الکترودهای جوشکاری برای فولادهای مقاوم به خزش

خصوصیات و موارد کاربرد Characteristics & Applications	ISO 3580	DIN 8575	AWS/ASME SFA 5.5	کد شناسایی آما AMA Trade Name
الکترو د قلیایی مولیبدن دار مقاوم به ترک که برای جوشکاری مخازن و دیگها تا دمای کاری $500^{\circ}\text{C}$ مناسب می باشد. Basic electrode of crack resistant used in the construction of pressure vessels, boilers subjected up to $500^{\circ}\text{C}$		E MoB20+	E 7016-A1	1181NC
برای جوشکاری لوله و مخازن نیروگاهها و فولاد های سماتنه و یهسازی شده حاوی حدود ۲٪ کروم مقاوم به خزش. Suitable for Welding of pipes, storage tanks boilers and cemented steels containing up to 2% Cr resistant against creep.	E 2CrMo B20	E CrMo 2B20	E 9018-B3	1245 N
برای جوشکاری مخازن و خطوط لوله در نیروگاهها، صنایع سنگین، نفت و پتروشیمی. For storage tanks vessels and pipelines in power plants, oil and heavy industries.	E Mo B20	E Mo B20+	E 7018-A1	1261 N
برای جوشکاری فولادهای مخزن سازی و مقاوم به خزش و دیگها. Suitable for welding of vessel building steels resistant to creep, boilers.	E 1CrMo B20	E CrMo 1B20	E 8018-B2	1263 N
الکترو د قلیایی برای جوشکاری دیگ ها و مخازن تحت فشار تا دمای کاری $600^{\circ}\text{C}$ . Basic electrode for welding of boilers, pressure vessels subjected to operating temperatures up to $600^{\circ}\text{C}$		E CrMo 5B20+	E 502-15	1366 N2
الکترو د قلیایی برای جوشکاری فولادهای مقاوم به خزش مورد استفاده در توربین های آبی تا دمای کاری $570^{\circ}\text{C}$ . Basic electrode for welding of creep resistant steels used in the construction of water turbine subjected to operating temperatures up to $570^{\circ}\text{C}$ .			E 8018-G	1379 4VN
الکترو د قلیایی کم هیدروژن برای جوشکاری فولادهای مقاوم به خزش مورد استفاده در مخازن تحت فشار و دیگ ها تا دمای کاری $570^{\circ}\text{C}$ . Basic type low hydrogen electrode for welding of creep resistant steels used in the construction of pressure vessels, boilers subjected up to $570^{\circ}\text{C}$ .			E 8016-B2	1410 N
برای جوشکاری فولادهای مخزن سازی و مقاوم به خزش و دیگها. Suitable for welding of vessel building steels, resistant against creep, boilers.			E 8018-B2 L	1419 N
الکترو د قلیایی کم کربن که برای جوشکاری فولادهای مقاوم به خزش و مخازن تحت فشار بالا تا دمای کاری $500^{\circ}\text{C}$ . Low carbon basic electrode for welding of creep resistant steels and high pressure vessels up to $500^{\circ}\text{C}$ .			E 9018-B3L	1426 N

## Electrodes for nickel alloys

## الکترودهای مخصوص آلیاژهای نیکل

خصوصیات و موارد کاربرد Characteristics & Applications	DIN 1736	AWS/ASME SFA 5.11	کد شناسایی آما AMA Trade Name
الکترو د قلیایی با ۶۵٪ نیکل و ۱۹٪ کروم که برای جوشکاری فولادها و آلیاژهای نیکلی مقاوم به حرارت و خوردگی و سرما مناسب می باشد. Basic electrode with 65% Ni and 19% Cr for welding of heat and corrosion and cryogenic resistant nickel alloys and steels.	EL-Ni Cr19 Nb	E Ni Cr Fe-3	1604 G
الکترو د قلیایی با ۶۹٪ نیکل و ۱۶٪ کروم و ۸٪ آهن که برای جوشکاری فولادها و آلیاژهای نیکلی مقاوم به حرارت و خوردگی و سرما مناسب می باشد. Basic electrode with 69% Ni, 16% Cr and 8% Fe for welding of heat and corrosion and cryogenic resistant nickel alloys and steels	EL-Ni Cr15 Fe Nb	E NiCrFe-2	1609 G
الکترو د قلیایی با ۶۳٪ نیکل، ۲۲٪ کروم و ۹٪ مولیبدن که برای جوشکاری آلیاژهای نیکل - کروم - مولیبدن مقاوم به خوردگی بالا و اتصال آنها به فولادهای بدون آلیاژ یا کم آلیاژ و پر آلیاژ و نیز فولادهای نیکلی مقاوم به سرما مناسب می باشد. Basic electrode with 63% Ni, 22% Cr & 9% Mo for welding of highly corrosion resistant nickel chromium molybdenum alloys and joining to unalloyed, low alloy and high alloy steels and suitable for cryogenic nickel alloyed steels.	EL-NiCr Mo-3	E NiCrMo-3	1611 G

## Electrodes for Hardfacing Applications

## الکترودهای روکشی سخت

خصوصیات و موارد کاربرد Characteristics & Applications	ISO	DIN 8555	AWS/ASME SFA 5.13	کد شناسایی آما AMA Trade Name
برای تعمیر و ساخت لبه های بریده ابزارهایی مثل صفحه تراش، تیغه فرز، مته خزانده، برافرو و مته مارپیچی. For repairing and manufacturing of cutting blades, milling, reaming, turning, planing, drills, etc.		E 4UM-60-65-S	E Fe5-B	1105 V
برای روکش مقاوم به سایش و تنش با سختی ۶۲-۵۷ راکول (C) که فقط با سنگ قابل ماشینکاری می باشد. For surfacing deposit with 57-62 RC hardness. Machinable by grinding only.		E 6UM-60	-	1600 V
الکتروود قلیایی با ۱۵۰٪ جایگزینی برای روکشی سخت. Basic coated electrode with 160% metal recovery for surfacing deposit.		E 10-UM-60-R	-	1602 V
برای روکش سخت مقاوم به سایش و ضربه مانند لبه بیل های خاکبرداری، فکهای سنگ شکن و امثال آن با سختی ۴۷-۳۷ راکول (C). For surfacing resistable against impact abrasion, deposit up to 37- 47 RC hardness. Crash jaw bucket leeth.		E1-UM-400	-	1622 V
برای روکشی سخت با مقاومت خوب در برابر سایش و تنشهای فشاری و ضربه - تعمیر قالبها. For hard surfacing wear resisting parts subjected to abrasion, impact and shock also die repairing		E 6 UM-55-GP	-	1639 V
برای جوشکاری ترمیمی و روکشی در فولادهای اوستنیتی منگنز دار مانند ریلها. For repairing and surfacing of austenitic steels containing Mn, e.g. Rails.		E 7UM-200K	E FeMn	1760 V

## Electrodes for Cast Iron

## الکترودهای مخصوص چدن

خصوصیات و موارد کاربرد Characteristics & Applications	DIN 8573	AWS/ASME SFA 5.15	کد شناسایی آما AMA Trade Name
برای جوشکاری چدن های غیر قابل ماشینکاری مانند پایه ماشین ها، میله های چدنی و اصلاح معایب قطعات چدنی. for welding of unmachinable cast iron for example machine basis, cast iron bar, cast iron parts repairing.		E ST	1012 G
برای جوشکاری چدن های خاکستری و همچنین اتصال چدن خاکستری به فولاد و تعمیر قطعات ریختگی و شکسته شده قابل تراش و سوهانکاری. Suitable for welding of gray cast iron, nodular and for joint welding of gray cast iron to steel, also for repairing of machinable broken casting.	E Ni BG22	E Ni-CI	1094 Ni
برای جوشکاری چدن با گرافیت لایه ای، چدن چکش خوار، چدن نشکن. Suitable for welding of cast iron with lamellar graphite, white and black heart malleable cast iron, nodular cast iron.	E Ni Cu BG22	E Ni cu-B	1094 MO
برای جوشکاری چدن نشکن، چدن چکش خوار، چدن نشکن اوستنیتی، اتصال چدن به فولاد. For welding of Nodular cast iron, white and black malleable cast iron, austenitic nodular cast iron, joining of cast iron to steel		E Ni Fe-CI	1094 Ni Fe

## Electrode for Gouging &amp; Cutting

## الکتروود برش و شیارزنی

برای برش، سوراخ کردن و شیارزنی فولادهای معمولی، زنگ نزن، پرمنگنر، چدن خاکستری و برنز. Suitable for cutting, gouging and piercing of mild, stainless and high manganese steels, gray cast iron and bronze.	-	-	-	1006 Y
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## Electrodes for Non Ferrous Metals

## الکترودهای آلومینیوم و برنز

خصوصیات و موارد کاربرد Characteristics & Applications	ISO	DIN 1732 DIN 1733	AWS/ASME SFA 5.6/5.3	کد شناسایی آما AMA Trade Name
مخصوص جوشکاری آلیاژهای آلومینیوم حاوی سیلیسیم و اتسال آلیاژهای آلومینیوم غیرهمجنس. Suitable for welding of aluminium alloys containing Al and Si and for joining dissimilar aluminium alloys.		S-AISI 5	E 4043	1075 SP
مخصوص جوشکاری آلومینیوم خالص. Suitable for welding of pure aluminium.		EL-AL 99.5	E 1100	1075 A
الکتروده برنزی برای اتصال و روکشی مس و آلیاژهای مس، روکشی مس بر روی فولاد و چدن خاکستری. Bronze electrode for joint welding and hardfacing of copper and copper alloys. Also for hardfacing of copper on steels, cast steel and gray cast iron.		S CuSn 7	E CuSn-C	1328 G

## ۲- سیم جوشهای مخصوص جوشکاری با گاز محافظ

## MIG / MAG Welding Wires

## سیم جوشهای میگ / مگ برای جوشکاری با گاز محافظ

خصوصیات و موارد کاربرد Characteristics & Applications	EN	DIN	AWS/ASME	کد شناسایی آما AMA Trade Name
سیم جوش های غیر آلیاژی برای جوشکاری فولادهای ساختمانی و اولیه. Unalloyed wire for MIG / MAG welding of structural steels, pipe steels.			SFA 5.18 ER 70S-2.....7 ER 70S-G	ER 70S-X
سیم جوش با آلیاژ متوسط برای جوشکاری لوله های فولادی و دیگ های مقاوم به خزش. Medium alloyed wire for MIG/MAG welding of pipe steels and creep resistant boiler			SFA 5.28 ER 80S-G	ER 80S-G
سیم جوش زنگ نزن اوستنیتی کم کربن برای جوشکاری فولادهای کروم - نیکل مقاوم به خوردگی. Austenitic stainless low carbon wire for MIG/MAG welding of corrosion resistant Cr- Ni steels.			SFA 5.9 ER 308 L(SI)	ER 308L(SI)
سیم جوش زنگ نزن اوستنیتی - فریتی برای جوشکاری فولادهای پر آلیاژ به فولادهای کم آلیاژ و غیر آلیاژی. Austenitic ferritic wire for MIG/MAG welding of high alloy to unalloyed or low alloy steels.			SFA 5.9 ER 309L	ER 309L
سیم جوش زنگ نزن کاملاً اوستنیتی برای جوشکاری فولادهای مقاوم به حرارت حاوی ۲۵٪ کروم و ۲۰٪ نیکل. Fully austenitic stainless wire for MIG/MAG welding of heat resistant steels containing 25% Cr and 20 % Ni.			SFA 5.9 ER 310	ER 310
سیم جوش زنگ نزن اوستنیتی با کربن خیلی کم برای جوشکاری فولادهای کروم - نیکل - مولیبدن مقاوم به خوردگی. Austenitic stainless wire in extra low carbon quality for MIG/MAG welding of corrosion resistant Cr Ni Mo steels.			SFA 5.9 ER 316(SI)	ER 316L(SI)
سیم جوش زنگ نزن اوستنیتی پایدار شده برای جوشکاری فولادهای کروم - نیکل - مولیبدن مقاوم به خوردگی. Stabilized austenitic stainless wire for MIG/MAG welding of corrosion resistant Cr Ni Mo steels.			SFA 5.9 ER 318	ER 318
سیم جوش زنگ نزن اوستنیتی پایدار شده برای جوشکاری فولادهای کروم - نیکل مقاوم به خوردگی. Stabilized austenitic stainless wire for MIG/MAG welding of corrosion resistant Cr Ni steels.			SFA 5.9 ER 347(SI)	ER 347(SI)



## MIG/MAG welding wires

## سیم جوشهای میگ / مگ برای جوشکاری با گاز محافظ

خصوصیات و موارد کاربرد Characteristics & Applications	EN 758	DIN	AWS/ASME	کد شناسایی آما AMA Trade Name
سیم جوش غیر آلیاژی برای جوشکاری فولادهای ساختمانی و لوله. Unalloyed wire for MIG/MAG welding of structural steels, pipe steels.		(DIN 8559) SG2		SG2
سیم جوش غیر آلیاژی برای جوشکاری فولادهای ساختمانی و لوله. Unalloyed wire for MIG/MAG welding of structural steels, pipe steels.		(DIN 8559) SG3		SG3

## TIG Welding Wires

## سیم جوشهای تیگ برای جوشکاری با گاز محافظ

خصوصیات و موارد کاربرد Characteristics & Applications	EN	DIN	AWS/ASME	کد شناسایی آما AMA Trade Name
سیم جوش های غیر آلیاژی برای جوشکاری فولادهای ساختمانی و لوله. Unalloyed wire for TIG welding of structural steels, pipe steels.			SFA 5.18 ER 70S-2...7 ER 70S-G	ER 70S-X
سیم جوش با آلیاژ متوسط برای جوشکاری لوله های فولادی و دیگهای مقاوم به خزش. Medium alloyed wire for TIG welding of pipe steels and creep resistant boiler			SFA 5.28 ER 80S-G	ER 80S-G
سیم جوش زنگ نزن اوستنیتی کم کربن برای جوشکاری فولادهای کروم - نیکل مقاوم به خوردگی. Austenitic stainless low carbon wire for TIG welding of corrosion resistant Cr-Ni steels.			SFA 5.9 ER 308 L	ER 308 L
سیم جوش زنگ نزن اوستنیتی فریتی برای جوشکاری فولادهای پر آلیاژ به فولادهای کم آلیاژ و غیر آلیاژی. Austenitic ferritic wire for TIG welding of high alloy to unalloyed or low alloy steels			SFA 5.9 ER 309L	ER 309 L
سیم جوش زنگ نزن کاملاً اوستنیتی برای جوشکاری فولادهای مقاوم به حرارت حاوی ۲۵% کروم و ۲۰% نیکل. Fully austenitic stainless wire for TIG welding of heat resistant steels containing 25% Cr and 20% Ni			SFA 5.9 ER 310	ER 310
سیم جوش زنگ نزن اوستنیتی با کربن خیلی کم برای جوشکاری فولادهای کروم - نیکل مولیبدن مقاوم به خوردگی. Austenitic stainless wire in extra low carbon quality for TIG welding of corrosion resistant Cr Ni Mo steels.			SFA 5.9 ER 316	ER 316L
سیم جوش زنگ نزن اوستنیتی پایدار شده برای جوشکاری فولادهای کروم - نیکل - مولیبدن مقاوم به خوردگی. Stabilized austenitic stainless wire for TIG welding of corrosion resistant CrNi Mo steels.			SFA- 5.9 ER 316	ER 318
سیم جوش زنگ نزن اوستنیتی پایدار شده برای جوشکاری فولادهای کروم - نیکل مقاوم به خوردگی. Stabilized austenitic stainless wire for TIG welding of corrosion resistant CrNi steels.			SFA 5.9 ER 347	ER 347

## TIG Welding Wires

## سیم جوشهای تیگ برای جوشکاری با گاز محافظ

خصوصیات و موارد کاربرد Characteristics & Applications	E 758	DIN	AWS/ASME	کد شناسایی آما AMA Trade Name
سیم جوش غیر آلیاژی برای جوشکاری فولادهای ساختمانی و لوله. Unalloyed wire for TIG welding of structural steels, pipe steels.		(DIN 8559) WSG2		WSG2
سیم جوش غیر آلیاژی برای جوشکاری فولادهای ساختمانی و لوله. Unalloyed wire for TIG welding of structural steels, pipe steels.		(DIN 8559) WSG3		WSG3

## Tubular Cored Wires For GAS Welding

## الکترودهای توپودری برای جوشکاری با گاز محافظ

خصوصیات و موارد کاربرد Characteristics & Applications	EN 758	DIN	AWS/ASME	کد شناسایی آما AMA Trade Name
الکتروده توپودری با مغزی پودر فلزی برای جوشکاری فولادهای : ساختمانی ، دیگ سازی ، دانه ریز ، کشتی سازی ، لوله و ریختگی . Tubular metal cored wire, suitable for welding : unalloyed structural steels, boiler plates, fine grain structural steels, shipbuilding steels, pipe steels, cast steels.	T 46 4 MM2		(A-5.20) E 71T-1	<b>AMA MC 10</b>
الکتروده توپودری روتیلی با قابلیت انجماد سریع سرباره برای جوشکاری فولادهای : عمومی ساختمانی ، دیگ سازی ، دانه ریز ساختمانی ، کشتی سازی . استاندارد API ، ریختگی و لوله . Tubular cored wire of rutile type with rapidly solidifying slag, suitable for welding : unalloyed structural steels, boiler plates, fine grain structural steels, shipbuilding steels, steels to API- standard, cast steels	T 46 4 PM1	(DIN 8559) SGR1 M21Y4643	(A-5.20) E 71T-1	<b>AMA FC 14</b>
الکتروده توپودری روتیلی با قابلیت انجماد سریع سرباره برای جوشکاری فولادهای : ساختمانی ، غیر آلیاژی ، دیگ سازی ، لوله ، استاندارد API ، دانه ریز ساختمانی ، کشتی سازی . Tubular cored wire of rutile type with rapidly solidifying slag suitable for welding unalloyed structural steels, boiler plates , pipe steels, steels to API standard, fine grain structural steels, shipbuilding steels.	T 46 41Ni PM1		(A-5.29) E 81T1-Ni1	<b>AMA FC 20</b>
الکتروده توپودری روتیلی با بازیابی بالا مناسب برای فولادهای ساختمانی و کشتی سازی . Tubular cored wire of rutile type with high metal recovery suitable for structural steels, shipbuilding steels and etc.	T 462 PM1H5 T 462 PC1H5		E71T-1MH4 E71T-1H4	<b>AMA FC 14HD</b>
الکتروده توپودری قلیایی برای جوشکاری فولادهای : ساختمانی ، دیگ سازی ، لوله ، مقاوم به پیری . استاندارد API ، دانه ریز ساختمانی ، کشتی سازی ، ریختگی . Tubular cored wire of basic type suitable for welding : unalloyed structural steels, boiler plates, non ageing steels , steels to API standard , fine grain structural steels, shipbuilding steels, cast steels	T 42 4BC3 T 42 4BM3	(DIN 8559) SGB1 CY4254	(A-5.20) E 70T-5	<b>AMA FC 31</b>
الکتروده توپودری با آلیاژ متوسط قلیایی برای روکش کاری سخت و مقاوم به فرسایش برای قطعات و دستگاههای حفاری ، تیغه ها ، دندانه ها ، تقاله ها ، چکشها ، فک ها با سختی ۵۲ تا ۵۷ راکول ( C ) . Medium alloy tubular cored wire of basic type , designed for tough and wear resistant hard facing deposits on excavator parts, craper blades, dipper teeth, conveyors, beaters, crusher jaws hardness 52-57 (RC) as-welded.		(DIN 8555) MSG6-65		<b>AMA MC 56</b>
الکتروده با مغزی پودر فلزی با جوش دارای استحکام کششی بالا مناسب برای ماشین آلات راه سازی ، جرثقیل های سقفی ، وسائط نقلیه ریلی . Tubular metal cored wire for welding steels with high tensile strength suitable for earth moving equipments, bridge cranes, rolling stock constructions			(A-5.29) E 91T1-G	<b>AMA MC 141</b>
الکتروده با مغزی پودر فلزی با جوش دارای استحکام تسلیم بالا مناسب برای ماشین آلات راه سازی ، جرثقیل های سقفی ، دستگاه های بالابر . Tubular metal cored with high tensile yield strength suitable for earth moving equipment, bridge cranes, lifting devices.			(A-5.29) E 110T5-K4	<b>AMA MC 142</b>

## ۳- پودرها و سیم جوش های زیر پودری

## Fluxes and wires for submerged arc welding:

## پودرها و سیم جوش های زیر پودری برای:

- \* General structural steels      \* Fine grain structural steels
- \* Heat resistant steels        \* Cryogenic steels
- \* Non ageing steels

- \* فولادهای مقاوم به سرما و پیری
- \* فولادهای دانه ریز

- \* فولادهای عمومی ساختمانی
- \* فولادهای مقاوم به حرارت

FLUX		پودر		سیم جوش توصیه شده جهت مصرف به همراه پودر WIRE recommended to be combined with flux
استاندارد DIN 32522	استاندارد EN 760	کد شناسایی پودر های آما AMA Trade Name	کد شناسایی سیم جوش آما AMA Trade Name	
B MS 189 AC 8 SKM	A MS 189 AC	AMA- OP 155	AMA OE-S1	
			AMA OE-S2	
		پودر منگنز - سیلیکاتی مخصوص جوشکاری سرعت های بالا ترجیحاً برای جوشکاری ورق های نازک.	AMA OE-S2 Mo	
		Manganese-Silicate type flux for high Speed welding preferably used for welding thin Plates.	AMA OE-S2 Cr Mo1	
B MS 188 AC SKM-HP5	A MS 188 AC H5	AMA- OP 176	AMA OE-S1	
		پودر منگنز - سیلیکاتی برای جوشکاری دو طرفه در یک پاس لوله های قطر و لوله های اسپیرال بصورت جوش لب به لب و گوشه ای در سرعت های بالا.	AMA OE-S2	
		Manganese - Silicate type flux for welding large diameter pipes and thin walled Spiral pipes at high speed welding.	AMA OE-S2Mo	
B CS 177 AC 10M	A CS 177 AC	AMA- OP 119	AMA OE-S1	
		پودر کلسیم - سیلیکاتی مخصوص جوشکاری فولادهای عمومی ساختمانی، فولادهای دانه ریز ساختمانی، مخازن تحت فشار و لوله سازی یا فرایند جوشکاری دوسیمه و چند سیمه در سرعت های بالا و همچنین جوشکاری دو طرفه در یک پاس.	AMA OE-S2	
		Calcium-silicate type flux for welding general structural steels, pressure vessel, pipe as well as fine grain structural steels. It is suited for twin-wire, tandem and multi wire welding at high speed.	AMA OE-S3	
			AMA OE-S2Mo	
B CS 198 AC 12M	A CS 198 AC	AMA- OP 143	AMA OE-S1	
		پودر کلسیم - سیلیکاتی مخصوص جوشکاری فولادهای ساختمانی، مخازن تحت فشار و لوله سازی یا فرایند دوسیمه، پشت سر هم و چند سیمه در سرعت های بالا و همچنین فرایند جوشکاری دو طرفه در یک پاس.	AMA OE-S2	
		Calcium - Silicate type flux for welding general structural steels, pressure vessel and pipe steels. It is suited for twin- wire, tandem and multi wire welding at high speed.	AMA OE-S2Mo	
B AR 188 AC 10 SKM	A AR 188 AC	AMA- OP 181	AMA OE-S1	
		پودر آلومینات - روتیلی مخصوص جوشکاری فولادهای ساختمانی، مخازن تحت فشار و لوله سازی بویژه برای فرایند جوشکاری دوسیمه، پشت سر هم و چند سیمه در سرعت های نسبتاً بالا.	AMA OE-S2	
		Aluminate - rutile type flux for welding general structural steels, pressure vessel and pipe steels at high speed welding applying the twin - wire, tandem and multi wire welding.	AMA OE-S2 Mo	
			AMA OE-S2 Cr Mo1	
B AR 188 AC 10 SKM	A AR 188 AC	AMA- OP 185	AMA OE-S1	
		پودر آلومینات - روتیلی مخصوص جوشکاری فولادهای ساختمانی، مخازن تحت فشار و لوله سازی بویژه برای فرایند جوشکاری دوسیمه، پشت سر هم و چند سیمه در سرعت های نسبتاً بالا.	AMA OE-S2	
		Aluminate - rutile type flux for welding general structural steels, pressure vessel and pipe steels at high speed applying the twin - wire, tandem and multi wire welding.	AMA OE-S2 Mo	
			AMA OE-S2 Cr Mo1	
B AR 197 AC 10 SKM	AAR 197 AC	AMA UNIVERSAL	AMA OE-S1	
		پودر آلومینات - روتیلی مخصوص جوشکاری فولادهای ساختمانی، مخازن تحت فشار و لوله سازی که برای فرایند جوشکاری پشت سر هم، دوسیمه و چند سیمه در سرعت های بالا مناسب است.	AMA OE-S2	
		Aluminate - rutile type flux for welding general structural steels, pressure vessel and pipe steels at high speed welding applying the twin - wire, tandem and multi wire welding.	AMA OE-S2 Mo	
			AMA OE-S2 Cr Mo1	
B AB 187 AC 10M	A AB 167 AC	AMA- OP 123	AMA OE-S1	
		پودر آلومینات - گلیسیلی مخصوص جوشکاری فولادهای ساختمانی، مخازن تحت فشار و لوله سازی که برای فرایند جوشکاری پشت سر هم، چند سیمه و نیز جوشکاری دو طرفه در یک پاس مناسب می باشد.	AMA OE-S2	
		Aluminate - basic type flux for welding general structural steels, pressure vessel and pipe steels. It is suited for twin - wire, multi wire welding as well as in welding from both side in one pass.	AMA OE-S2 Mo	



SA AB 167 AC H5		AMA- OP 132	AMA OE-S1
			AMA OE-S2
پودر آلومینات - قلیایی برای ساخت لوله های نفت و گاز بصورت جوشکاری خطی و لوله های اسپیرال با فرایند جوشکاری پشت سر هم و چند سیمه (تا پنج سیم) در سرعت های بالا.			AMA OE-S2 Mo
Aluminate - basic type flux for welding spiral pipes, longitudinal and circumferential welding of oil and gas pipes using tandem and multi wire welding at high speeds.			AMA OE-S4
SA AB 167AC 13M HP5		AMA- OP 139	AMA OE-S2
پودر آلومینات - قلیایی برای ساخت لوله ها بصورت خطی و لوله های اسپیرال و نیز اتصال آنها بصورت محیطی با فرایند جوشکاری پشت سر هم و چند سیمه در سرعت های بالا.			AMA OE-S2Mo
Aluminate - basic type flux for welding spiral pipes, longitudinal and circumferential welding of pipes and also for joining of pipes using tandem and multi wire welding at high speeds			AMA OE-S4
			AMA OE-S03
B FB 153 DC 8 HP5    A FB 153 DCHP5		AMA- OP 41 TT	AMA OE-S2 Mo
			AMA OE-S2 Cr Mo1
			AMA OE-S1 Cr Mo2
پودر فلوراید - قلیایی برای جوشکاری فولادهای دانه ریز با استحکام بالا و فولادهای مقاوم به خزش که فلز جوش آن از چقرمگی خوبی برخوردار است.			AMA OE-Ni38R
Fluoride - basic type flux for welding high tensile fine grain steels and creep resistant steels with very tough weld metal			AMA OE-S3 Ni Mo1
			AMA OE-S2 Ni2
			AMA OE-S2
			AMA OE-S3
B FB 155 AC 10MHP7    A FB 155 AC		AMA- OP 121 TT	AMA OE-S03
			AMA OE-S2 Mo
			AMA OE-S3 Mo
			AMA OE-S2 Cr Mo1
پودر فلوراید - قلیایی مخصوص جوشکاری فولادهای دانه ریز با استحکام بالا که فلز جوش آن در دماهای زیر صفر از چقرمگی بالایی برخوردار بوده و در مقابل پیری مقاوم است و برای فرایند جوشکاری پشت سر هم و چند سیمه مناسب می باشد.			AMA OE-S1 Cr Mo2
Fluoride - basic type flux, preferably used for welding high strength fine grain steels, as well as cryogenic steels and ageing. It is suited for tandem and multi wire welding.			AMA OE-Ni38 R
			AMA OE-S2Ni2
			AMA OE-S3 Ni Mo1
B FB 165 AC 12MHP5    A FB 165 AC HP5		AMA- OP 122	AMA OE-S2
پودر فلوراید - قلیایی مخصوص جوشکاری فولادهای ساختمانی دانه ریز، مخازن تحت فشار و لوله سازی که برای جوشکاری پشت سر هم و چند سیمه و نیز جوشکاری دو طرفه در یک پاس مناسب می باشد.			AMA OE-S3
Fluoride - basic type flux for welding general structural steels, pressure vessel and pipe steels as well as fine grain structural steels. It is suited for tandem and multi wire welding.			AMA OE-S2 Mo

## Fluxes and wires for joint welding of austenitic stainless steels

## پودرها و سیم جوش های زیر پودری مخصوص فولادهای زنگ نزن اوستنیتی

FLUX			پودر	سیم جوش توصیه شده جهت مصرف به همراه پودر
استاندارد DIN 32522	استاندارد EN 769	کد شناسایی پودر های آما AMA Trade Name	کد مواد Material No	کد شناسایی سیم جوش های آما AMA Trade Name
B FB 563745 DC 8K	A FB 263 DC	AMA -OP 71 Cr	1.4316	AMA OE - 199 nc
			1.4551	AMA OE - 199 Nb
			1.4430	AMA OE - 191 23 nc
			1.4576	AMA OE - 191 23 Nb
پودر فلوراید - قلیایی مخصوص با کربن خیلی کم برای جوشکاری فولادهای زنگ نزن اوستنیتی و مقاوم به حرارت.				
Fluoride - basic type flux of extra low carbon quality for welding austenitic stainless and heat resistant steels.				



	1.4316	AMA OE - 199 nc
	1.4551	AMA OE - 199 Nb
B FB 655456 AC 8MHP5    A FB 255 AC    AMA - OP 76	1.4430	AMA OE - 19123 nc
	1.4576	AMA OE - 19123 Nb
پودر فلوراید - قلیایی مخصوص برای جوشکاری فولادهای زنگ نزن اوستنیتی و مقاوم به حرارت.	1.4462	AMA OE - 233 nc
	1.4829	AMA OE - 2212
Fluoride - basic type flux for welding austenitic Stainless and heat resistant steels.	1.4455	AMA OE - 2016 nc

## Fluxes and wires for Wear resistant and hardsurfacing applications

## پودرها و سیم جوش های زیر پودری مخصوص روکشی سخت

FLUX	پودر		سیم جوش توصیه شده جهت مصرف به همراه پودر Wire recommended to be combined with flux		
استاندارد DIN 32522	استاندارد EN 762	AMA Trade Name	کد شناسایی مفتولهای آما	AMA Trade Name	کد شناسایی سیم جوشهای آما
B CS 397 CCrMo AC 8    A CS 397 AC    AMA-OP 250 A					
AMA OE-S1					
پودر آلیاژی برای روکشی سخت قطعات ماشین آلات راهسازی و معادن، دنده های متحرک، ریل و غلنگهای نگهدارنده.					
Alloy - bearing type flux for hardfacing purposes. It is suited for hardfacing of machine parts, driving gears, ralls, support rolls of caterpillars.					
B CS 397 CCrMo AC 8    A CS 397 AC    AMA-OP 350 A					
AMA OE-S1					
پودر آلیاژی برای روکشی سخت قطعات ماشین آلات راهسازی و معادن و سخت کاری سطحی با سختی نسبتاً بالا.					
Alloy - bearing type flux for hardfacing purposes. It is suited for hardfacing of couplings, piston rod end earth moving equipment.					

## SAW Backing Flux

## پودر پشت بند برای جوشکاری زیر پودری

خصوصیات و موارد کاربرد Characteristics & Applications	کد شناسایی آما AMA Trade Name
پودر آگلومره شده قلیایی که به عنوان پشت بند در جوشکاری زیر پودری با پشت بند مسی استفاده می شود.	AMA - OP10U
Agglomerated basic flux specially designed for use as copper backing flux.	

## سنگهای خشن سایي و برش

کیفیت سنگهای برش و سایش بر دور آما با ۳ سال سابقه تحقیق و تجربه نزد صنعتگران بخوبی شناخته شده است .

قدرت زیاد در سایش، سرعت بالا در برش، مقاومت در برابر از هم پاشیدگی و طول عمر زیاد وجوه مشخصه سنگهای برش و سایش آما میباشد که اینک با تضمین کیفیت و با کسب استاندارد مدیریت کیفیت ISO 9002 در خدمت صنایع کشور است . استفاده از لایه Fiber glass به همراه رزین امکان سرعت محیطی تا ۸ متر در ثانیه را تضمین میکند .

شرکت صنعتی آما قادر است به غیر از سنگهای رزینی، سنگهای سرامیکی و بدون رزین را جهت تیز کردن ابزار صنعتی و سایش و پرداخت تیغه های فولادی و غیره بر حسب نیاز مشتریان تولید نماید.

کلیه محصولات شرکت صنعتی آما قبل از بسته بندی توسط واحد کنترل کیفیت به طور دقیق مورد آزمایش و ارزیابی قرار میگیرد و در صورت تایید، بسته بندی می گردد. از مشخصات بارز سنگهای آما وضعیت بالانس آنهاست. در چهار گلوگاه مهم فرایند تولید عملیات بالانس گیری انجام میگردد. در حال حاضر کارخانه سنگ شرکت صنعتی آما با بهره گیری از مهندسين و متخصصين داخلی و آزمایشگاههای فیزیکی و شیمیایی توانایی رقابت با هر نوع محصولات خارجی و داخلی را دارد.

### سنگهای مخصوص

سنگهای مخصوص آما بر اساس سفارش مشتریان و با توجه به ابعاد مورد نیاز ماشین آلات و کاربرد آن در کارخانجات فرایند تولید عرضه می گردد.

کد شناسایی	کاربرد سنگ
400	جهت دور تراشی سنگ
410	جهت سایش فنرهای لوله
420	جهت تیز کردن و سایش تیغه های فولادی
430	جهت برش آجر و آجر نسوز
440	جهت سایش چدن
450	جهت سایش ابزارهای صنعتی
460	جهت سایش و پرداخت لنت
470	جهت پوست کندن گندم و جو - آسیاب
480	جهت تیز کردن تیغه دستگاه روکش چوب
490	جهت کف سابی
500	جهت سایش و پرداخت لاستیک

### Grinding steel

### سنگهای خشن سایي آهن و فولاد

Type	Size	r.P.M
M-165	110x4x(16or22)	11000
M-165	115x4x(16or22)	11000
M-165	115x6.5x(16or22)	11000
M-165	180x4x22	8500
M-165	180x6.5x22	8500
M-165	180x10x22	8500
M-165	230x4x22	6500
M-165	230x6.5x22	6500
M-165	230x8x22	6500
M165-SUPER	115x6.5x22(16or22)	11000
M165-SUPER	180x6.5x22	8500
M165-SUPER	180x8x22	8500
M165-SUPER	230x6.5x22	6500

### Grinding Stainless Steel سنگهای خشن سایي فولاد ضد زنگ

Type	Size	r.P.M
C-144	110x7x(16or22)	11000
C-144	110x6.5x(16or22)	11000
C-144	180x4x22	8500
C-144	180x6.5x22	8500
C-144	180x8x22	8500
C-144	230x4x22	6500
C-144	230x6.5x22	6500

### Grinding cast iron

### سنگهای خشن سایي چدن

Type	Size	r.P.M
F-158	110x6.5x(16or22)	11000
F-158	115x4x(16or22)	11000
F-158	115x6.5x(16or22)	11000
F-158	180x4x22	8500
F-158	180x6.5x22	8500
F-158	180x8x22	8500

### Grinding Aluminium سنگهای خشن سایي آلومینیم و مس

Type	Size	r.P.M
L-155	110x6.5x(16or22)	11000
L-155	115x4x(16or22)	11000
L-155	180x6.5x22	11000
L-155	180x6.5x22	8500
L-155	230x8x22	6500

## Cutting & Grinding Wheels

The quality of products of such as fast speed cutting and grinding wheels with 30 year of experience is well know among workmen .

AMA's grinding and cutting wheels have these characteristics :

Grinding with high power, Cutting with high speed and strength against dissoultion. And now with the guarantee of quality and achieving the standard of managment ISO 9002 is giving service to the country's industries .

The velocity of 80 m/s is guaranteed by using fiberglass and resin

In addition to resinoid bonded wheels : AMA INDUSTRIAL COMPANY is capable of manufacturing ceramic stones is order to sharpening of industrial tools and grinding and finishing steel edges and etcetera according to customer's requirement .

### Cutting cast Iron

سنگهای برش چدن

Type	Size	r.P.M
F-158B	110x2.5x(16or22)	11000
F-158B	115x2.5x(16or22)	11000
F-158B	180x2.5x22	8500
F-158B	230x2.5x22	6500
F-158B	300x3x40	5500
F-158B	300x3.5x40	5500
F-158B	400x4x40	4500

### Cutting Aluminium

سنگهای برش آلومینیم و مس

Type	Size	r.P.M
L-155B	110x2.5x(16or22)	11000
L-155B	115x2.5x(16or22)	11000
L-155B	180x2.5x22	8500
L-155B	230x2.5x22	6500
L-155B	300x3x40	5500
L-155B	300x4x40	5500

### Cutting Stone

سنگهای برش سنگ ، بتون و سرامیک

Type	Size	r.P.M
P-129	180x2.5x22	8500
P-129	230x3x22	6500
P-129	300x3.5x40	5500
P-129	300x4x40	5500
P-129	400x4x40	4500

از گروه سنگهای P-129 میتوان جهت برش با سایزهای انت و لاستیک نیز استفاده کرد

### Cutting steel

سنگهای برش آهن و فولاد

Type	Size	r.P.M
M-138	115x2.5x(16or22)	11000
M-138	180x2.5x22	8500
M-138	230x2.5x22	6500
M-138	300x3x40	5500
M-138	300x4x40	5500

### Cutting Stainless Steel

سنگهای برش آهن و فولاد ضد زنگ

Type	Size	r.P.M
C-144B	110x4x(16 or 22)	11000
C-144B	115x2.5x(16 or 22)	11000
C-144B	180x2.5x22	8500
C-144B	230x2.5x22	6500
C-144B	300x3x40	5500
C-144B	300x4x40	5500

