

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°F to 1500°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*
CARBON STEEL		
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	
LOW ALLOY STEEL		
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.
$\frac{1}{2}\%$ Chrome - $\frac{1}{2}\%$ Moly	A-335 P2, A-369 FP2, A-155 A-387A	
1% Chrome - $\frac{1}{2}\%$ Moly	A-335 P12, A-369 FP12, A-155 A-387B	
$1\frac{1}{4}\%$ Chrome - $\frac{1}{2}\%$ Moly	A-335 P11, A-369 FP11, A-155 A-387C	
$2\frac{1}{4}\%$ Chrome - 1% Moly	A-335 P22, A-369 FP22, A-155 A-387D	
INTERMEDIATE ALLOYS		
4-6% Chrome - $\frac{1}{2}\%$ Moly	A-335 P5	Processing as encountered in Oil Refineries, air preheaters 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 - $\frac{1}{2}\%$ Moly	A-335 P7	
9% Chrome - 1% Moly	A-335 P9	Low temperature process piping where resistance against high impact values are required.
$3\frac{1}{2}\%$ Nickel seamless and resistant welded	A.S.T.M. A-333 Grade 3	
STAINLESS STEEL		
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	
COPPER PIPE	B-42	Process steam, air and water piping.
COPPER TUBE	B-88	Instrumental lines and domestic use.
ALUMINUM ALLOYS	These alloys are available in 2S, 3S, 4S, 24S, 52S, and 61S or under A.S.T.M. Chemical designations 990A, M1A, MG11A, CG42A, GR20A and GS11A respectively	Corrosion resistance services.

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

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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	A.S.T.M. A95	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.
Flanged	A.S.T.M. A95 & A216		
FORGED CARBON STEEL Screwed	A.S.T.M. A105	ANSI B16.5	Refinery, gas, power and non corrosive piping up to 750° F. Above 750° F alloys are used.
Flanges and Flanged Fittings	A.S.T.M. A105	ANSI B16.5	
	A.S.T.M. A181	ANSI B16.5	
WELDING-CARBON AND ALLOY STEEL Butt Welded Fittings	A.S.T.M. A234	ANSI B16.9	Carbon steel for steam, water, power, refinery, gas and non corrosive piping up to 750° F. Above 750° F alloys are used.
Socket Welding and Threaded Fittings	A.S.T.M. A105	ANSI B16.11	
BRASS OR BRONZE Screwed Fittings	A.S.T.M. B62	ANSI B16.15 (125-250 lb)	Steam, water, gas and oil piping A.S.T.M. B61 up to 500° F A.S.T.M. B62 up to 400° F.
Screwed Flanges and Flanged Fittings	A.S.T.M. B62 (150 lb)	ANSI B16.24 ANSI B16.24	
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

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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 30×10^6 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.

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 220° F.	Woven Asbestos
	Temps up to 600° F.	Copper, Corrugated or Plain
Water	Hot—Medium and High Pressures.	Red Rubber—Wire Inserted
	Hot—Low Pressures.	Black Rubber, Red Rubber—Wire Inserted
	Hot.	Brown Rubber—Cloth Inserted
Water	Cold.	Comp. Asbestos
	Cold.	Red Rubber—Wire Inserted
	Cold.	Black Rubber
	Cold.	Soft Rubber
	Cold.	Asbestos
Oils (Hot)	Temps up to 750° F.	Brown Rubber—Cloth Inserted
	Temps. up to 1000° F.	Comp. Asbestos
Oils (Cold)	Temps up to 212° F.	Ingot Iron, Special Ring-Type Joint
	Temps. up to 300° F.	Cork-Fiber
Air	Temps. up to 750° F.	Neoprene Comp. Asbestos
	Temps. up to 220° F.	Comp. Asbestos
	Temps. up to 1000° F.	Red Rubber
Gas	Temps. up to 1000° F.	Spiral Wound Comp. Asbestos
	Temps. up to 750° F.	Asbestos—Metallic
	Temps. up to 100° F.	Comp. Asbestos
	Temps. up to 220° F.	Woven Asbestos
Acids	(Varies—See section on Corrosion)	Red Rubber
	Hot or Cold Mineral Acids.	Thin Asbestos
		Sheet Lead or Alloy Steel
Ammonia	Temps up to 1000° F.	Comp. Blue Asbestos
	Temps up to 700° F.	Woven Blue 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 D-Depends on Conditions
F-Fair 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	All%; Rm	G													
	Glacial; 212°	G													
	5% aerated; 86°		G-F	U	G		D	U							
	5-50% un-aerated; boil							G		D					
	80% Storage Glacial; boil 20% & 100%; 100°F							G	F	G					
Acetic Anhydride	*	G	G-F	D	G		G	G	G	G	G		G	G	D
	Boil						G	F	G				G		
Acetone		G	G	G	G	G	G	G	G	G	G	G	G	U	F
Acetylene		G	U	U	U	G	G	G	G	G	G	G	G	G	U
Air		G	G	G	G	G	G	G	G	G	G	G	G	G	G
Alum		G-F	G-F	D	G		U	F	D	G	D	D	G	G	G
	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 Concentrated; 70°F			G	U		G		G	G	G		G	D	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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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						
Ammonium Hydroxide		F	U	G	U	G	D	D	G	G					
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	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		D	G	G	G	G		G	U	U
Aniline, Aniline Oil		U		G	U	G	D	G	G	G	G		G	F	U
Aniline Dyes				D	U		U	G	G	G	G	G	G	U	U
Asphalt		G		G	G		U	G	G	G		G	G	U	U
							G	G	G						
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				
Beet Sugar Liquors		G		G	G		U	G	G	G	G				
Benzene, petroleum ether, naphtha							G	G	G	G	G	G			
Benzol		G	G	G	G	G	D	G	G	G	G				
Black Sulphate Liquor		G	G	G	G		D	G	G	G	G	G	G	U	U
Black Furnace Gas				G	F		G	G	G			G			
Borax		F		G	F	U	G	D	D	G	G				G
Boric Acid		G	G	D	G	G	G	C	G	G	G	G	G	G	G
	1%: 104°F						U	G	G	G	G		G	G	G
Bromine	Dry	G					U	G	U	U	U		D	D	D
	Moist		G		G		G	G							
Butane		G					U								
Butyl Acetate		G	G	G	G	G	G	G	G	G	G				
Butyl Alcohol		G	G	G	G	G	G	G	G	G	G		G	U	U
Butanol		F	G	G	G	G	F	G	G	G	G				
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	G	G
	35% in Evap. 160°-320°F							G							
Calcium Hydroxide		U	G	G	G	D	G	G	F	G	F	G	F	G	G
Calcium Hypochlorite	Rm	D													
			F-D	D	D		F		D	G	D			D	D
	3 g. p.l. max free Cl ₂ 70°F														
	Over 3 g. p.l. max free Cl ₂ 70°F							G							
	2%: 70°						U								
	Under 77°F: agitation						F	D	G	D					
Caliche Liquors												D			
Cane Sugar Liquors		G		G	G	G	G	G	G	G	G				G
Carbon Bisulphide		G		U				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	F	G	G	G
Carbon Tetrachloride														D	D
Carbonic Acid		D	D	D	D	F	D	G	D	D	D		G	U	U
Castor Oil		G	U	D	U	D	F	G	G	G	G		G	G	G
		G		G			F	G	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.

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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						
Chloroacetic Acid	100%: 158°F	D	F-D		D			G	G	F	C		G	D	U
Chlorinated Solvents	Dry	G						G	G				G	D	U
	Wet	U			G	C	G-F	G	G			G	G	G	U
Chlorine	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 500°F	U	D		D		U		U	F	U	G			
Chlorosulphonic Acid								G							
Chromic Acid	10% Max: Rm	G	U		F	F	D	F	F	F	F		G		U
	Saturated: to boil	F	U		U								G		
	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		
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							G	G	G	G		G	G	D
Corn Oil		G						G	G	G	G		G	G	D
Cotton Seed Oil		G		G				G	G	G	G		G	G	D
Cresolate		G		G	D	G	G	G	G	G	G		G		G
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	U
Dowtherm A												G	G	U	U
Dowtherm E		G			U		G					G			U
Ethers												G			U
Ethyl Acetate		G	D	G	D	G	D	G	G	G	G		G	U	U
Ethyl Cellulose		F		G			G-D	G	G	G	G		G	U	U
Ethyl Chloride								G	G	G	G		G	U	U
Ethylene Glycol		U	G	U	G	G	G	G	G	G	G		G	U	U
		G-D		G	G	G	G	G	G	G	G		G	U	U
Ferric Chloride		U	U	U	U		F	U	U	F	U		G	G	G
Ferric Sulphate		F	U	U	U		U	U	F	U			G	G	G
Ferrous Sulphate		G	D-F	D	D		D	G	G-D	G	G-D		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													G	G	D
Freon		D	U	G	D	D	D	G	D	G	D		G	G	D
Fuel Oil		G			G	G	G	G	D	D	D		G	G	D
Fuel Oil, Acid		D	G	G	G	D	D	G	G	G	G		G	G	U
Furfural		G			D	G		G	D	G	D		G		U
Gasoline	Sour							G	G	G	G		G	G	D
	Refined	D		D	D	G	F-U	G	D	G	G		G	D	U
Gelatin		G		G	G		G	G	G	G	G		G	D	U
Glucose		G		G	D	G	U	G	G	G	G		G	D	U
Glycol		G		G			U	G	G	G	G		G	G	G
Glycerin, glycerol		G-D		G			G	G	G	G	G		G	G	G
Green Sulphate Liquor		G	G	G	F	G	G	G	G	G	G		G	G	F
Hydrobromic Acid							G	G				G			G
Hydrocarbons (Aliphatic)		U		U	D	D	D	U	U	U			G	G	G
Hydrocarbons (Aromatic)		G	G		G			G	G	G	G		G	D	U
Hydrochloric Acid		G	G		G			G	G	G	G		G	U	U
	0.5%: Boil	U	D	U	D	U	U	G	G	G	U		G	G	G
	1% aerated and agitated 70°F							G					G	G	G
Hydrocyanic Acid		G	G	G	G	D	D	G	U	G			G		
Hydrofluoric Acid		U	D	U	D	G	L	D	U	U	U		G	G	D

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

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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 Vapors; 212°F														
Hydrofluosilicic Acid															
Hydrogen Gas	Cold Hot	U G	G G	U G	G G	G G	U G	G G	D G	D G	D G		D G	G G	G G
Hydrogen Peroxide	30-95%	G													
Hydrogen Sulphide	30%; 86°F		G-D	U	D	G	U		D	G	D		G	D	D
	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	D	D
Iodine	+														
	Dry; 70°F Moist; 70°F	U	U	U	U	U	U	U	U	U	U		G	D	D
Kerosene		G													
Lacquers		G													
Lacquer Solvents		G													
Lactic Acid	*	G-F	G	G	G										
	5%; 70°F unacrated 45%; Storage; Rm 30-60%; evap; boil at 115°F														
Linseed Oil															
Lubricating Oils	Sour	G		G	G	G	G	G	G	G	G		G		
	Refined	D		D	D	G	U	G	D	G	G		G		D
Magnesium Chloride	Dry Powders	G													
	Solution; Rm	F													
	48%; boil at 330°F 5%; 70°F		G-F	G	F-D	F	F		D	G	D		G	G	G
Magnesium Hydroxide		U													
Magnesium Sulphate					U				F	G	G				
Mercuric Chloride	Dilute Solutions	G-D	G	G	G	G	G-F	G	G	G	G		G	G	G
Mercury		U													
Methyl Alcohol, methanol		U	U	G	U	U	U	U	U	U	U		G	G	G
Methyl Chloride		F	G	G	G	G	G	G	G	G	G		G	G	G
Milk		U													
Mineral Oils		G													
		G													
Natural Gas															
Nickel Chloride	Solution	G													
Nickel Sulphate	Hot & Cold	U													
Nitric Acid	Over 80%	G													
	Under 80%	F-U													
	All %; Rm 65%; Boil		U	D	H	U	F	F					G	D	U
Nitrobenzene		G	G	G	F	D	G	G	G	G	G		G		
Oleic Acid	*	G	G	D	D		F	G	G	G	G		G	U	U
	concentrated, agitated, aerated; 200°F Max Boil														
Oilum Spirits		U	U	G	U	F	G	G					G		
Oxalic Acid	*	D	G	D	G	U	U						G	U	U
	Dry Powders	G											G	D	D
Oxygen	20-50%; 100-175°F														
	Cold	G	G	G	G	G	G	G	G	G	G		G		
	Less than 500°F 500-1000°F	G	G	G	G	G	G	G	G	G	G		G	D	D

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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
Picric Acid	40% Max; 212°F Max agitation												G		
	Molten	F			U	U	F	U	G	G	G		G	G	G
Potassium Chloride	Water Solution	U		G	U	U	U	D	G	G			G	G	G
Potassium Cyanide		U		G	U	U	F	G	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		
Propane						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		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	G													
	Over 0.1%	F-U													
Sodium Chloride	Dry Powders	G	G-F	D	G	D-U	D-U	G	D	G	D	G	G	G	G
	Saturated; 200°F	U						G					G		G
	Cold; Sat. Sol. 70°F	D	G										G		G
Sodium Cyanide	Hot; Sat. at 212°F	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							G							
Sodium Hypochlorite	75%; 275°F							G							
Sodium Hypochlorite	50%; 180°F	U	D-F		D		U	F	D	G	D	U	D	D	G
Sodium Hypochlorite	75%; 275°F							G					D		
Sodium Metaphosphate		G			D	G	F	G	G				G		G
Sodium Nitrate	*	G-D	G	D	G		G	G	F	G	G	G	G	G	G
	27%; 122°F							G					G		G
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	D				G	D	G	
	Dry Powders	G													
	50%; 320°F								G	G	G				
Sodium Sulphite	Saturated							U							
	Solution	G-F													
Sodium Sulphite	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 ₃ ; 75°F	G	G-F	G	G	G	G	G	G	G	G	G	G	G	G
	30m Solution in pulp and paper ind.							G		G	G				
Sodium Thiosulphate	1-5% Sol.; 30m Dry Powders	G								G					
		G													
Soybean Oil		G	D	G	D	G	U	G	G	G	G	G	G	G	G
Stannic Chloride		U		F	U		F	U	D	D	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	U	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			U
Sulphur	Solid	G			D		U	G		D	D	D		D	D
	Molten; 260°F		D-F										D	D	D
	Molten; 500°F							G							
Sulphur Chloride	Boil; 830°F							F							
		U		G	U	G	D	G	U	D	D		G	U	U
		G		G	G		G	G	D	D	D		G-D	D	D
Sulphur Dioxide	Dry							U	G	G	G		G		
	Moist							G	G	G	G		G		
	Gas; 70-575°F		G-F		G			U	G	G	G		G		
Sulphuric Acid															
	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		
Sulphurous Acid	High Conc. Cold	U	U	G	U	G	G	U	G	G	G	G	G		
	1% 68°F	F	F-G	G	G	G	U	F	D	D	D		G	D	D
	Saturated; 70°F							F					G		
Sulphur Trioxide, dry		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					G	U	U
Tartaric Acid		G-F	D	G	D	U	G	G	G		G		G		D
Toluene		G	G	G	G	G	U	D	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
Water, acid mine, cont g oxidizing salts													G		D
Water, acid mine, no oxidizing salts		D		D	D	U	U	G	G		G		G	G	G
Water, fresh, (tap, etc.)		G	G				U	G		U		G	G	G	G
Water, distilled, lab grade		G	G	G	G	G	D	G	G	G		G	G	G	G
Water, return condensate		G		U	U	U	U	D	G	G		U	G	G	G
Water, seawater		G	G		G	G	F	G	G	G		G	G	G	G
Whiskey and Wines		G		G	D	G	F-U	G	F	F		G	G	G	G
Zinc Chloride													G		
Zinc Sulphate		U	D	U	G	U	G	G-D	G-D		U	G	D	D	D

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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			
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
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	0.131	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 1/4 (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 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 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 1/2 (4.000)	40	STD	0.226	1546	1474	1330	1221
	80	XS	0.318	2284	2177	1964	1804
4 (4.500)	40	STD	0.237	1433	1433	1232	1132
	80	XS	0.337	2076	1979	1785	1640
	120	—	0.438	2740	2612	2356	2164
	160	—	0.531	3379	3222	2906	2670
—	XXS	0.674	4394	4189	3779	3471	
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
—	XXS	0.750	3900	3724	3359	3086	

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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
160	—	0.906	2977	2838	2560	2352	
10 (10.750)	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
	160	—	1.125	2963	2825	2548	2341
12 (12.750)	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
	120	XXS	1.000	2178	2077	1873	1721
140	—	1.125	2468	2352	2122	1949	
160	—	1.312	2911	2775	2503	2299	
14 (14.000)	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
	80	—	0.750	1460	1392	1256	1154
	100	—	0.938	1846	1760	1587	1452
	120	—	1.094	2169	2068	1866	1714
	140	—	1.250	2501	2384	2150	1975
	160	—	1.406	2835	2703	2438	2240

**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			
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	555	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
	24 (24,000)	10	—	0.250	276	263	237
20		STD	0.375	415	395	356	327
30		XS	0.500	556	530	478	439
40		—	0.562	625	596	538	491
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	378	360	324	297
	30	XS	0.500	504	480	432	396
	40	—	0.562	570	540	486	450
	60	—	0.688	696	660	594	546
	80	—	0.969	927	880	792	732
	100	—	1.219	1158	1100	990	918
	120	—	1.531	1410	1340	1206	1116
	140	—	1.812	1683	1600	1440	1332
	160	—	2.344	2166	2060	1836	1704

ITT GRINNELL -- PIPING DESIGN AND ENGINEERING

PRESSURE -- TEMPERATURE RATINGS
OF PLAIN END

Seamless Stainless Alloy Steel Pipe to ASTM A312 & A376 Grade TP-304 & 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
3/16	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
1/2	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
2/3	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
3/4	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
3/8	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

PIPING MATERIALS

PRESSURE — TEMPERATURE RATINGS
OF PLAIN END

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

TV

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									
½	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
¾	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	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
1½	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
1¾	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	.209	3082	3003	2963	2903	2844	2724	2406	1958	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
2½	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	4687	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	1554
	XXS	.600	5284	5148	5080	4977	4875	4670	4125	3424	2924	2278
3¾	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.

**PRESSURE — TEMPERATURE RATINGS
OF PLAIN END**

Seamless Stainless Alloy Steel Pipe to ASTM A312 & A376 Grade TP-304 & 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	4658	4658	4658	4658
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	1925	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
160	.906	3712	3513	3295	3196	3156	3156	3156	3156	
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
	80S	.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 & A376 Grade TP-304 & 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	673	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	2964	2887	2849	2792	2734	2620	2311	1891	1562	1217
	160	.906	3076	2997	2957	2898	2838	2719	2402	1964	1625	1266
	10	10S	.165	420	409	404	395	387	371	328	263	210
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
160		1.125	3062	2983	2943	2884	2825	2706	2390	1955	1617	1260
12	10S	.180	388	378	373	355	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
	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.

TABLE 1. LIST OF MATERIAL SPECIFICATIONS
Applicable ASTM Specifications

TABLE NO.	MATERIAL GROUP NO.	FORCINGS		CASTINGS		PLATE		BARS & SHAPES		TUBULAR PRODUCTS	
		Grade	Notes	Grade	Notes	Grade	Notes	Grade	Notes	Grade	Notes
2.1	Group 1.1	A105	(1)(3)	A216-WCB	(1)	A203-B A516-70 A516-70 A203-E	(1) (1) (1)	A105	(1)(3)	A106-C A155-KCF70 A155-KCF70 A155-CM70 A155-CM75	(1)
		A350-LF2	(10)								
		A350-LF3	(10)								
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	(10)	A352-LC6 A352-LC2 A352-LC3	(10) (10) (10)	A516-60 A516-60	(1) (1)	A306-60	(1)	A106-B A155-KCF60 A155-KCF65	(1)
		A350-LF4	(10)								
2.6	Group 1.6					A203-A A203-D		A306-65	(8)		
2.7	Group 1.7	A182-F1	(2)	A217-WC1	(2)(4)	A203-A A204-B	(2) (2)	A182-F1			
		A182-F2		A352-LC1 A217-WC4 A217-WC5	(4) (4)	A204-C		A182-F2			
2.8	Group 1.8	A182-F11		A217-WC6	(4)	A387C-NT		A182-F11			
		A182-F12									
2.10	Group 1.10	A182-F22		A217-WC9	(4)	A387D-NT		A182-F22			
		A182-F21						A182-F21			
2.12	Group 1.12	A182-F5				A357		A182-F5		A355-P50 A155-9CR	
2.13	Group 1.13	A182-F5A		A217-C5	(4)			A182-F5A			
		A182-F9		A217-C12	(4)			A182-F9			
2.15	Group 2.1	A182-F304	(5)	A240-304	(5)(7)	A240-304	(5)(7)	A479-304		A430-FF304 A376-TP304 A312-TP304 A358-304	(5)(7) (5) (5)
		A182-F304H	(5)								
2.16	Group 2.2			A351-CF8 A351-CF3	(8)						
2.17	Group 2.3	A182-F310	(5)	A351-CH20	(5)	A240-310S	(5)	A479-310S		A358-310	

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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	(5)	A351-CF8C	(5)	A240-347	(5)	A479-347	A479-348	A430-FP347	(5)(7)
		A182-F348	(5)							A312-TP347	(5)
2.19	Group 2.5	A182-F321	(5)			A240-321	(5)(7)	A479-321		A430-FP321	(5)(7)
2.20	Group 2.6	A182-F316	(5)			A240-316	(5)(7)	A479-316		A376-TP321	(5)
		A182-F316H	(5)			A240-317	(5)(7)			A430-FP316	(5)(7)
2.21	Group 2.7			A351-CF8M	(6)					A312-TP316	(5)
2.22	Group 2.8	A182-304L		A351-CF3M	(8)	A240-304L		A479-304L		A312-304L	
2.23	Group 2.9	A182-316L				A240-316L		A479-316L		A312-316L	
BOLTING A193, A194, A307, A320, A354, A453, A540, A564, A637, A638, A639 (All Groups)											

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-PP12 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

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MATERIALS: GROUP 1.3

A155-1CR-NT A155-1-1/4CR-AN A155-2-1/4CR-AN
 A335-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

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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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MATERIALS: GROUP 1.7

A182-F1
A204-A
A204-B
A217-WC1
A352-LC1

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	650	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
A204-C
A217-WC4
A217-WC5

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

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MATERIALS: GROUP 1.9

A182-F11 A182-F12 A217-WC6
 A387-C-NT

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	1295	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	1595	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	480	800
	1150			50	70	105	255	430
1200			35	45	70	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
	1150			105	135	205	310	515
1200			70	90	135	205	345	

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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

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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	470	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

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MATERIALS: GROUP 21

A182-F304
A312-TP304
A430-FP304

A182-304H
A358-304
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 22

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

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ITT GRINNELL — PIPING DESIGN AND ENGINEERING

MATERIALS. GROUP 2.3

A182-F310
A358-310

A240-310S
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
A479-347

A182-F348
A351-CF8C
A430-FP347
A479-348

A240-347
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 A240-321 A312-TP321
 A376-TP321 A430-FP321 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 A182-F316H A240-316
 A240-317 A312-TP316 A358-316
 A376-TP316 A430-FP316 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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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).													
TABLE NO.	MATERIAL GROUP NO.	150		300		400		600		900		1500		2500	
		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.

ITT GRINNELL -- PIPING DESIGN AND ENGINEERING

ALLOY-STEEL STUD BOLT DIMENSIONS

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

Nominal Pipe Size	Diameter of Bolts	Number of Bolts	Length ¹ of Stud Bolt			Diameter of Bolts	Number of Bolts	Length ¹ of Stud Bolt		
			Ring Joint ¹	1/4 Inch Raised Face	Male & Female also Tongue and Groove			Ring Joint ¹	1/4 Inch Raised Face	Male & Female also Tongue and Groove
			100 Pound Flanges ¹				300 Pound Flanges ¹			
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	5/8	4	3.75	3.75	3.50
1 1/4	3/4	4	4.00	4.00	3.75	3/4	4	4.00	4.00	3.50
1 1/2	7/8	4	4.25	4.25	4.00	7/8	4	4.25	4.25	3.75
2	1	8	4.50	4.25	4.00	1	8	4.50	4.25	4.00
2 1/2	1 1/8	8	5.00	4.75	4.50	1 1/8	8	5.00	4.75	4.50
3	1 1/4	8	5.25	5.00	4.75	1 1/4	8	5.25	5.00	4.75
3 1/2	1 1/2	8	5.75	5.50	5.25	1 1/2	8	5.75	5.50	5.25
4	1 3/8	8	5.75	5.50	5.25	1 3/8	8	6.00	5.75	5.50
5	1 1/2	8	6.00	5.75	5.50	1 1/2	8	6.75	6.50	6.25
6	1 3/4	12	6.25	6.00	5.75	1 3/4	12	7.00	6.75	6.50
8	2	12	7.00	6.75	6.50	2	12	7.75	7.50	7.00
10	2 1/4	16	7.75	7.50	7.25	2 1/4	16	8.75	8.50	8.25
12	2 1/2	16	8.25	8.00	7.75	2 1/2	20	9.00	8.75	8.50
14 OD	3	20	8.50	8.25	8.00	2 3/4	20	9.50	9.25	9.00
16 OD	3 1/4	20	9.00	8.75	8.50	3	20	10.25	10.00	9.75
18 OD	3 1/2	24	9.25	9.00	8.75	3 1/2	20	11.00	10.75	10.50
20 OD	3 3/4	24	10.00	9.75	9.50	3 3/4	24	11.75	11.50	11.25
24 OD	4	24	11.25	10.75	10.50	4	24	13.25	13.00	12.75

Extracted from American Standard Steel Pipe Flanges and Flanged Fittings ANSI B16.5 - 1975

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.

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

Extract All dimensions These Bolt to 1/4 inch as a male when

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ALLOY-STEEL STUD BOLT DIMENSIONS (Continued)

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

2.75
3.00
3.25
3.25
3.75
3.50
4.00
4.25
4.50
4.50
4.75
5.00
5.50
6.25
6.75
7.00
7.50
7.50
12.25
1.25

male
ve

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

Extracted from American Standard Steel Pipe Flanges and Flanged Fittings ANSI B16.5 — 1973
 All dimension given in inches
¹These 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
²Bolt 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 1/2 inch male 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.
³When groove is made in the lap, add thickness of pipe for each lap.

2-65

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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		1/2										
R12			1/2	1/2								
R13		3/4			1/2							
R14			3/4	3/4								
R15	1											
R16		1	1	1	3/4							
R17	1 1/4											
R18		1 1/4	1 1/4	1 1/4	1							
R19	1 1/2											
R20		1 1/2	1 1/2	1 1/2			1 1/2	1 1/2	1 1/2			
R21					1 1/2							
R22	2											
R23		2			1 1/2		2					
R24			2	2				2	2			
R25	2 1/2											
R26		2 1/2			2		2 1/2					
R27			2 1/2	2 1/2				2 1/2	2 1/2			
R28					2 1/2							
R29	3											
†R30		3										
R31		3	3				3	3				
R32					3							
R33	3 1/2											
R34		3 1/2										
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							
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					14							
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.

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 8.0mm 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. M&T Group	Pipe Material Corr. Allow. Bolting Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
AOLQ	ASME CL150 RF	-20/+200 deg C ASME B16.5 2.3	316L SS 0.0 mm B772H 316 SS Spiral wnd	BW, Flgd	Ga, Gl, Ba, Ch	Trim 10	SOUR SERVICE (NACE) - SOUR SERVICE 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 B8186M 316 SS Spiral wnd	BW, Flgd	Ga, Gl, Ba, Ch	Trim 10	LOW TEMP SOUR SERVICE (NACE) - SOUR SERVICE 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	-20/+200 deg C ASME B16.5 2.3	316L SS 0.0 mm B772H ONAF	BW, BW, Flgd	Ga, Gl, Ba, Ch	Trim 10	NON-SOUR - CHEM DOSING, SCALE CORR INHIB, DEMULSIFIER, PHOSPHATE DOSING, DEMIN WATER 1/2" TO 3/4" INCLUSIVE DESALINATED WATER 1/2" TO 3/4" 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 B8186M 316 SS Spiral wnd	BW, Flgd	Ga, Gl, Ba, Ch	Trim 10	LOW TEMP SOUR SERVICE (NACE) - SOUR SERVICE 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

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+25 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 6	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 wnd	SW, BW, Fgd	Ga, Gl, Ch	Trim 1 / 6	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 + FWHT 1.5 mm B7/2H 316 SS Spiral wnd	BW, Fgd	Ga, Gl, Ba, Ch.	Trim 6	SOUR SERVICE (HACE) - 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 wnd	SW, BW, Fgd	Ga, Gl, Ba, Ch	Trim 12	NON-SOUR - LOW TEMP SERVICE PROPANE REFRIGERANT PROPANE ASME B31.3

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 B72H Graphite Flat Ring	BW, Flgd	Ga, Gt, Ch, Ba	MONEL TRIM 9	CALUSTIC: SODIUM HYDROXIDE (4%-20% CONCENTRATION TEMP RANGE 0 TO 49 DEG C) (50% CONCENTRATION TEMP RANGE 49 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	-	-	NON-SOUR - UNDERGROUND NON-PRESSURE DRIVING OILY WATER SEWER
A2G1	ASME CL150 RF	-46/+200 deg C ASME B16.5 1.3	Impact tested Killed/Fine grain CS + NiC + PWHT 3.0 mm L774 316 SS Spiral weld	BW, Flgd	Ga, Gt, Ba, Ch	Trim 12	SOUR SERVICE (NACE) - LOW TEMP SERVICE - 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 L774 316 SS Spiral weld	SW, BW, Flgd	Ga, Gt, Ba, Ch	Trim 12	NON-SOUR - LOW TEMP SERVICE 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 B72H Graphite Flat Ring	Third, BW, Flgd	Ga, Gt, Ba, Ch	Trim 8	NON-SOUR - WET COMPRESSED AIR ASME B31.3
A3A1	ASME CL150 RF	-29/+200 deg C ASME B16.5 1.1	Killed Carbon Stl + NiC + PWHT 6.0 mm B72H 316 SS Spiral weld	BW, Flgd	Ga, Gt, Ch, Ba	Trim 12	SOUR SERVICE (NACE) - 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 CL 150 RF	-29/+90 deg C ASME B16.5 1.1	Killed Carbon Stl 6.0 mm B72H GNAF	BW, Flgd	Ga, Gt, Ba, Ch	ALLOY 20 Trim 13	SULPHURIC ACID H₂SO₄ (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. Bolting, Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
A9G1	ASME CL 150 RF	-40/+200 deg C ASME B16.5 1.1	Impact tested /Killed /Fine grain CS +HTG+ PW/HT 5.0 mm 1.74 316 SS Spiral wvd	BW, Flgd	Ga, Gl, Ba, Ch	Trim 12	SOUR SERVICE (NACE) - LOW TEMP SERVICE - HP FLARE DRY HP/LP FLARE WET HYDROCARBON GAS LP FUEL GAS ASME B31.3
B0LQ	ASME CL300 RF	-20/+200 deg C ASME B16.5 2.3	316L SS 0.0 mm B7/2H 316 SS Spiral wvd	BW, Flgd	Ga, Gl, Ba, Ch	Trim 10	SOUR SERVICE (NACE) - SOUR SERVICE 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	-100/+150 deg C ASME B16.5 2.3	316L SS 0.0 mm B8M/8M 316 SS Spiral wvd	BW, Flgd	Ga, Gl, Ba, Ch	Trim 10	LOW TEMP SOUR SERVICE (NACE) - SOUR SERVICE LOW TEMP SOUR HC DRY SOUR HYDROCARBON GAS DRY SOUR HYDROCARBON ETHANE GAS LIQUID NITROGEN ASME B31.3
B0LY	ASME CL300 RF	-20/+200 deg C ASME B16.5 2.3	316L SS 0.0 mm B7/2H CNAF	SW, BW, Flgd	Ga, Gl, Ba, Ch	Trim 10	NON-SOUR - CHEM DOSING SCALE CORR INHB DEMION WATER - 1/2" TO 3/4" INCLUSIVE DESALINATED WATER 1/2" TO 3/4" INCLUSIVE UTILITY WATER - 1/2" TO 3/4" INCLUSIVE LUBE OIL SEAL OIL PHOSPHATE DOSING ASME B31.3
B1AB PIPE LINE SCOPE	ASME CL300 RF	-20/+80 deg C 45.00 barg	API 5L X52 1.5 mm B7/2H 316 SS Spiral wvd	BW, Flgd	Ba Ch	Trim 12	SOUR SERVICE (NACE) LIQUID HYDROCARBON ASME B31.4
B1AD	ASME CL300 RF	-20/+300 deg C ASME B16.5 1.1	Killed Carbon St 1.5 mm B7/2H Graphite Flat Ring	SW, BW, Flgd	Ga, Gl, Ba, Ch	Trim 8	NON-SOUR - HP FUEL GAS DIBEL NITROGEN SWEETENED PROPANE HC PROCESS (SWEET/DRY) BUTANE PRODUCT LEAN MEG ASME B31.3
B1AP	ASME CL300 RF	-20/+80 deg C 45 barg ASME B16.5 1.1	Carbon St 1.5 mm B7/2H Graphite Flat Ring	Rgd	Ga	Trim 5	NON-SOUR - 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 wtd	SW, BW, Fgd	Ga, Gl, Ch	Trim 1/5	NON-SOUR - 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 wtd	BW, Fgd	Ga, Gl, Ba, Ch	Trim 8	SOUR SERVICE (NACE) - DRY SOUR HC GAS SOUR PROPANE ASME B31.3
B1GP	ASME CL300 RF	-40/+300 deg C ASME B16.5 1.3	Impact tested Killed / Fine grain CS 1.5 mm L7H 316 SS Spiral wtd	SW, BW, Fgd	Ga, Gl, Ba, Ch	Trim 12	NON-SOUR - LOW TEMP SERVICE PROPANE REFRIGERANT PROPANE GAS BLOWDOWN ASME B31.3
B1GQ	ASME CL300 RF	-40/+200 deg C ASME B16.5 1.3	Impact tested Killed / Fine grain CS + PWHT 1.5 mm L7H 316 SS Spiral wtd	BW, Fgd	Ga, Gl, Ba, Ch	Trim 12	SOUR SERVICE (NACE) - LOW TEMP SERVICE - LOW TEMP DRY HYDROCARBON DRY SOUR EXPORT GAS ASME B31.3
B1RW	ASME CL300 RF/FF	0/+65 deg C 500 psig N/A	CS Galv 1.5 B7/2H Graphite Flat Ring	Thrd, BW, Fgd	Ga, Gl, Ba, Ch	Trim 8	NON-SOUR - CO2 SYSTEM ASME B31.3
B1UP PIPE LINE SCOPE	ASME CL300 RF	-29/+60 deg C 45.0 barg	API 5L X52 1.5 mm B7/2H Graphite Flat Ring	Fgd	Ga	Trim 8	NON-SOUR - LIQUID HC CONDENSATE ASME B31.4
B2A1	ASME CL300 RF	-20/+200 deg C ASME B16.5 1.1	Killed Carbon Stl + HC + PWHT 3.0 mm B7/2H 316 SS Spiral wtd	BW, Fgd	Ga, Gl, Ch, Ba	Trim 12	SOUR SERVICE (NACE) - 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

Line Class	Flange Rating Flange Finish	Temp Range Max. Press Mtl? Group	Pipe Material Corr. Allow. Bolting Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
B2A3							NOT REQUIRED Use B2A1
B2A0	ASME CL300 RF	-20/+300 deg C ASME B16.5 1.1	Killed Carbon S# 3 mm B72H Graphite Flat Ring	SW, BW, Figt	Ga, Gl, Ba, Ch	Trim 5	NON SOUR - BUTANE STRIPPED WATER ASME B31.3
B2A4	ASME CL300 RF	-20/+25 deg C ASME B16.5 1.1	Killed Carbon S# + (PWHT) 3.0 mm B72H 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) (8% CONCENTRATION TEMP RANGE 40 TO 49 DEG C). POST WELD HEAT TREATMENT REQUIRED. SAFETY SHIELD TO BE INSTALLED OVER FLANGED JOINTS. ASME B31.3
B2Q1	ASME CL300 RF	-40/+200 deg C ASME B16.5 1.3	Inspect tested /Killed /Fine grain CS+ HC + PWHT 3.0 mm L74 316 SS Spiral wvd	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
B2Q0							NOT REQUIRED. Use B2Q1
B3A1	ASME CL300 RF	-20/+200 deg C ASME B16.5 1.1	Killed Carbon S# + HC + PWHT 3.0 mm B72H 316 SS Spiral wvd	BW, Figt	Ga, Gl, Ch, Ba	Trim 12	SOUR SERVICE (NACE) - SOUR HYDROCARBON LIQUID & VAPOUR SOUR WATER ASME B31.3
D0A0 PIPE LINE SCOPE	ASME CL 600 RF	-20/+100 deg C 100 barg	API 5L X85 0.0 mm B72H 316 SS Spiral wvd	BW, Figt	Ch, Ba	Trim 12	SOUR SERVICE (NACE) DRY SOUR EXPORT GAS PIPELINE FROM GAS PLANT ASME B31.8
D0L0	ASME CL500 RF	-20/+300 deg C ASME B16.5 2.3	316L SS 0.0 mm B72H 316 SS Spiral wvd	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
D0L1	ASME CL600 RF	+150/+150 deg C ASME B16.5 2.3	316L SS 0.0 mm B8M/W 316 SS Spiral wvd	BW, Figt	Ga, Gl, Ba, Ch	Trim 10	LOW TEMP SOUR SERVICE (NACE) - SOUR SERVICE LOW TEMP DRY SOUR HYDROCARBON GAS ASME B31.3
D0L2	ASME CL600 RF	-20/+200 deg C ASME B16.5 2.3	316L SS 0.0 mm B72H 316 SS Spiral wvd	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 NACE Group	Pipe Material Corr. Allow. Bolt Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
D1AD	ASME CL600 RF	-20/+200 deg C ASME B16.5 1.1	Killed Carbon Stl 1.5 mm B72H 316 SS Spiral wtd	SW, BW, Flgd	Ge, Gl, Ba, Ch	Trim B	<u>NON-SOUR</u> - METHANOL ASME B31.3
D1AS	ASME CL600 RF	-20/+415 deg C ASME B16.5 1.1	Killed Carbon Stl 1.5 mm B72H 316 SS Spiral wtd	SW, BW, Flgd	Ge, Gl, Ch	Trim 1/5	<u>NON-SOUR</u> - HP BOILER BLOWDOWN BOILER FEED WATER HP STEAM SUPERHEATED HP CONDENSATE ASME B31.3
D1AV	ASME CL600 RF	-20/+200 deg C ASME B16.5 1.1	Killed Carbon Stl + PWHT 1.5 mm B72H 316 SS Spiral wtd	BW, Flgd	Ge, Gl, Ba, Ch	Trim B	<u>SOUR SERVICE (NACE)</u> - DRY SOUR EXPORT GAS SOUR PROPANE SOUR HYDROCARBON GAS ASME B31.3
D1GP	ASME CL600 RF	-40/+415 deg C ASME B16.5 1.3	Impact tested Killed / Fine grain CS 1.5 mm L74 316 SS Spiral wtd	SW, BW, Flgd	Ge, Gl, Ba, Ch	Trim 12	<u>NON-SOUR - LOW TEMP SERVICE</u> PROPANE REFRIGERANT PROPANE GAS BLOWDOWN ASME B31.3
D1GQ	ASME CL600 RF	-40/+300 deg C ASME B16.5 1.3	Impact tested Killed / Fine grain CS + PWHT 1.5 mm L74 316 SS Spiral wtd	BW, Flgd	Ge, Gl, Ba, Ch	Trim 12	<u>SOUR SERVICE (NACE) - LOW TEMP SERVICE</u> - DRY SOUR FLARE GAS LOW TEMP DRY HYDROCARBONS LOW TEMP DRY HYDROCARBON GAS ASME B31.3
D2A1	ASME CL600 RF	-20/+300 deg C ASME B16.5 1.1	Killed Carbon Stl + HIC + PWHT 3.0 mm B72H 316 SS Spiral wtd	BW, Flgd	Ge, Gl, Ch, Ba	Trim 12	<u>SOUR SERVICE (NACE)</u> - 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 HYDROCARBON CLOSED DRAINS WET RICH AMINE LEAN SOUR AMINE AMINE DRAINS HYDROCARBON GAS METHANOL SOUR WATER UTILITY WATER ASME B31.3
D2A3							NOT REQUIRED, Use D2A1

Line Class	Flange Rating Flange Finish	Temp Range Max. Press. Melt Group	Pipe Material Corr. Allow Boiling Casting	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 wvd	BW, Fgd	Ga, Gl, Ba, Ch	Trim 12	SOUR SERVICE (NACE) - LOW TEMP SERVICE - WET SOUR HC VAPOUR/LIQUID WET SOUR GAS ASME B31.3
D3A1	ASME CL600 RF	-20/+200 deg C ASME B16.5 1.1	Killed Carbon St + HIC + PWHT 6.0 mm B72H 316 SS Spiral wvd	BW, Fgd	Ga, Gl, Ba, Ch	Trim 12	SOUR SERVICE (NACE) - SOUR WATER HYDROCARBON LIQUID CLOSED DRAIN ASME B31.3
M0L0	ASME CL900 RTJ	-20/+180 deg C 95.55 Barg 2.3	316L SS 0.0 mm B72H 316 SS Octagonal Ring	BW, Fgd	Ga, Gl, Ba, Ch	Trim 10	SOUR SERVICE (NACE) - WET - SWEET - SOUR SERVICE - SOUR HC LIQUID & VAPOUR WET SOUR HC LIQUID & VAPOUR WITH H2S + CO2 + WATER HYDROCARBON WITH H2S+CO2 +WATER WET SOUR HYDROCARBON GAS RICH - LEAN AMINE CO2 + H2S ACID GAS PHOSPHATE SOUR VENTS HYDROCARBON LIQUID ASME B31.3
M0LR	ASME CL900 RTJ	-15/+85 deg C 85 Barg 2.3	316L SS 0.0 mm B84M/M 316 SS Octagonal Ring	BW, Fgd	Ga, Gl, Ba, Ch	Trim 10	LOW TEMP. SOUR SERVICE (NACE) - WET - SWEET / WET SOUR SERVICE - LOW TEMP DRY SOUR HYDROCARBON GAS ASME B31.3
M1AD	ASME CL900 RTJ	-20/+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	NON-SOUR - HYDROCARBON UTILITIES (eg. FUEL OIL, PILOT GAS, etc.) ASME B31.3
M1AV	ASME CL900 RTJ	-20/+100 deg C 100.00 Barg 1.1	Killed Carbon St + PWHT 1.5 mm B72H Soft Iron Octagonal Ring	BW, Fgd	Ga, Gl, Ba, Ch	Trim 8	SOUR SERVICE (NACE) - SOUR HC GAS (DRY) ASME B31.3
M1GP	ASME CL900 RTJ	-40/+85 deg C 100.00 Barg 1.1	Impact tested /Killed /Fine grain CS + PWHT 1.5 mm L774 316 SS Octagonal Ring	SW, Fgd	Ga, Gl, Ba, Ch	Trim 12	NON-SOUR SERVICE - LOW TEMP SERVICE - PROPANE REFRIGERANT PROPANE GAS BLOWDOWN HP FUEL GAS ASME B31.3

Line Class	Flange Rating Flange Finish	Temp Range Max. Press. Mat'l Group	Pipe Material Corr. Allow. Bolling Gaskets	Construction	Valves	Valve Trim (API Trim)	Services & Design Code
M2A1	ASME CL900 RTJ	-20/+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	SOUR SERVICE (NACE) - 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	-20/+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	SOUR SERVICE (NACE) - FOR SLUG CATCHER INLET WET SOUR HC LIQUID WET SOUR VAPOUR MEG ASME B31.3
M2A9 PIPE LINE SCOPE	ASME CL900 RTJ	-20/+100 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	SOUR SERVICE (NACE) - SUBSEA GAS PIPELINE FROM PLATFORM TO GAS PLANT ASME B31.6
M2G1	ASME CL900 RTJ	-40/+100 deg C 139.00 Barg 1.1	Impact tested Killed / Fine grain CS + HIC + PWHT 3.0 mm L7M 316 SS Octagonal Ring	BW, Fgd	Ge, Gl, Ba, Ch	Trim 12	SOUR SERVICE (NACE) - LOW TEMP SERVICE - 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. Bolling 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 S8 + HIC + PWHT 5.0 mm B72H Soft Iron Octagonal Ring	BW, Figd	Ge, Gl, Ch, Ba	Trim 12	SOUR SERVICE (NACE) – GAS EQUALIZATION LINE ERD) AT SLUG CATCHER WET SOUR HC + H2S + CO2 + 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 S8 + HIC + PWHT 6.0 mm B72H Soft Iron Octagonal Ring	BW, Figd	Ge, Gl, Ch, Ba	Trim 12	SOUR SERVICE (NACE) – FOR SLUG CATCHER WET SOUR HC LIQUID WET SOUR VAPOUR MEG ASME B31.3
N3AY PIPE LINE SCOPE	ASME CL1500 RTJ	-29/+80 deg C 232.00 Barg	API 5L X70 + PWHT 1.0 mm B72H Soft Iron Octagonal Ring	BW, Figd	Ch, Ba	Trim 12	SOUR SERVICE (NACE) – 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 B72H 316 SS Octagonal Ring	BW, Figd	Ge, Gl, Ba, Ch	Trim 10	SOUR SERVICE (NACE) – WET – SWEET – SOUR SERVICE WET SOUR HC LIQUID & VAPOUR WITH H2S + CO2 + WATER RICH – LEAN AMINE CO2 + H2S ACID GAS SOUR WATER GAS FROM MOL SIEVES SOUR HC LIQUID & VAPOUR HYDROCARBON WITH H2S+CO2 +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 S8 1.5 mm B72H Soft Iron Octagonal Ring	BW, Figd	Ge, Gl, Ba, Ch	Trim 8	NON SOUR – LEAN MEG / NoCl METHANOL GLYCOL(MEG) CLOSED DRAIN 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
N1AL	ASME CL1500 RTJ	-29/+85 deg C 232.00 barg 1.1	Killed Carbon Stl + HIC +PWHT 1.5 mm B7/2H Soft Iron Octagonal Ring	BW, Flgd	Ga, GL Ba, Ch	Trim 10	SOUR SERVICE (NACE) - MDEA MDEA/EAN MEG/NOCI ASME B31.3
N2A1	ASME CL1500 RTJ	-29/+85 deg C 168.00 barg 1.1	Killed Carbon Stl + HIC 3.0 mm B7/2H Soft Iron Octagonal Ring	BW Flgd	Ga, GL Ba, Ch	Trim 12	SOUR SERVICE (NACE) - WET SOUR HC LIQUID WET SOUR VAPOUR ASME B31.3
Q0TW	ASME CL160 DIN PN 10 RF	0/+85 deg C @ DIN 8074 N/A	H.D.P.E None B7/2H Flare Ring - Nonmetallic	Butt Fusion Flgd	-	-	NON-SOUR DOMESTIC WASTE WATER
Q0VP	ASME CL150 FF/RF	-20/+100 deg C @ ASME B16.5 N/A	TITANIUM 0.0 mm B7/2H Ti Spiral wvd	BW, Flgd	Ga, GL St, Ch, Ba, PI	Titanium/ PFA lined	BIOCIDE / CORROSION INHIBITOR CHLORINE / HOCL/NaOCL
S1PW	ASME CL150 FF	0/+85 deg C Max. 18.0 Barg N/A	RTRP None B7/2H Fluoro cid for below ground. Full Face Nitrile. Elastomeric for drinking water	Mechanical type joint restrained, Flgd	Ga, GL Bl, Ch	Bronze or CS epoxy lined body w/ Zn free Bronze trim. Al-Bronze for B7Fly Disc & Shell	UNDER GROUND AND ABOVE GROUND - SEA COOLING WATER GENERAL COOLING WATER CHEM SEWER FIRE WATER AMINE SEWER DRINKING WATER DEMINEALISED WATER DESALINATED WATER UTILITY WATER BRINE TREATED EFFLUENT SCUM TO SUMP STORM WATER SANITARY / CLEAN EFFLUENT CLOSED DRAIN OILY WATER
T1PW	ASME CL300 FF	0/+85 deg C Max. 20.0 Barg N/A	RTRP None B7/2H Fluoro cid for below ground. Full Face Nitrile.	Mechanical type joint restrained, Flgd	Ga, GL Bl, Ch	Bronze or CS epoxy lined body w/ Zn free Bronze trim	UNDER GROUND AND ABOVE GROUND - FIRE WATER

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.)		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										
END 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				ASTM A403 Gr.WP316L-W ASME B16.9				

PIPING CLASS		A01Q				
ITEM	SIZE (ins.) FROM TO		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, MSE-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"	1½"	ASTM A182 Gr. 316L Body, 150#, Flanged ends	MANUFACTURER'S STD.		
			ASTM A351 Gr.CF3M Body, 150#, Flanged ends	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" 2"	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, Swival 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, retainersless, API 604, NACE MR-01-75		

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 BS 1868, NACE MR-01-75	
BALL VALVE (See Note 101)	1/2"	6"	150	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"	150	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 A0LQ

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

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

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

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.

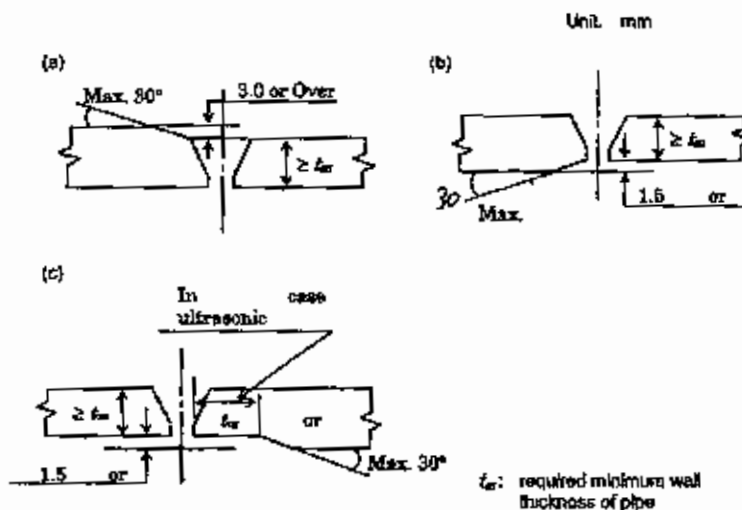
شکل ۱ نحوه انتخاب روش لبه سازی لوله و اتصالات در جوش لب به لب نشان داده شده است.

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

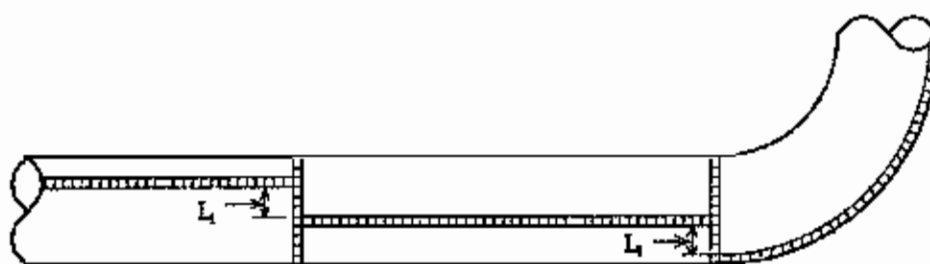
در شکل ۲ نحوه فیتاپ سر جوش هایی که دارای ضخامت متفاوت می باشند آورده شده است.



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.

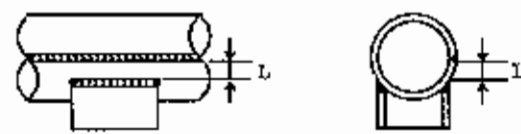
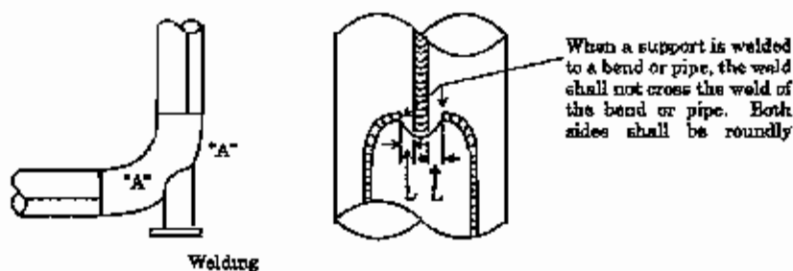


Note : L_1 shall be five times the pipe thickness or over.

شکل ۳: تکرانس عدم همراستایی شیار های جوش لوله ها در موقع فیتاب

در شکل ۴ حداقل فاصله جوش ساپورت ها در حالت های مختلف با درز جوش های لوله ها

و اتصالات مورد بررسی قرار گرفته است



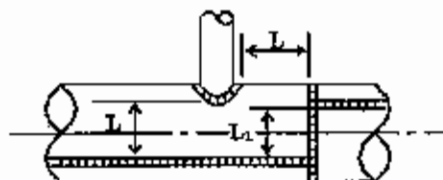
Welding Shoe

Note L shall be minimum 6 mm.

شکل ۴: تکرانس فاصله جوش ساپورت ها از درز جوش لوله

در شکل ۵ فواصل طولی و شعاعی محل انشعاب ها از درز های جوش طولی و عرضی لوله

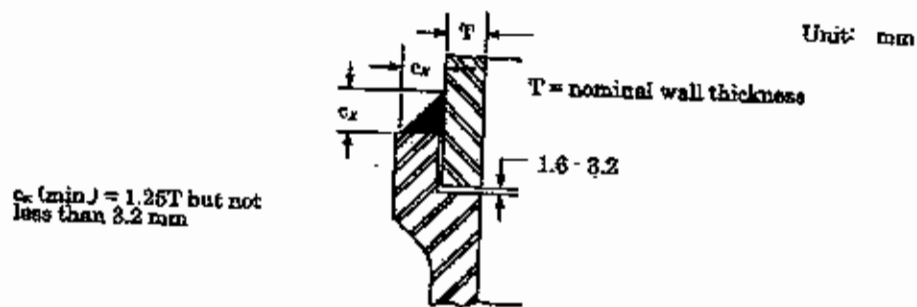
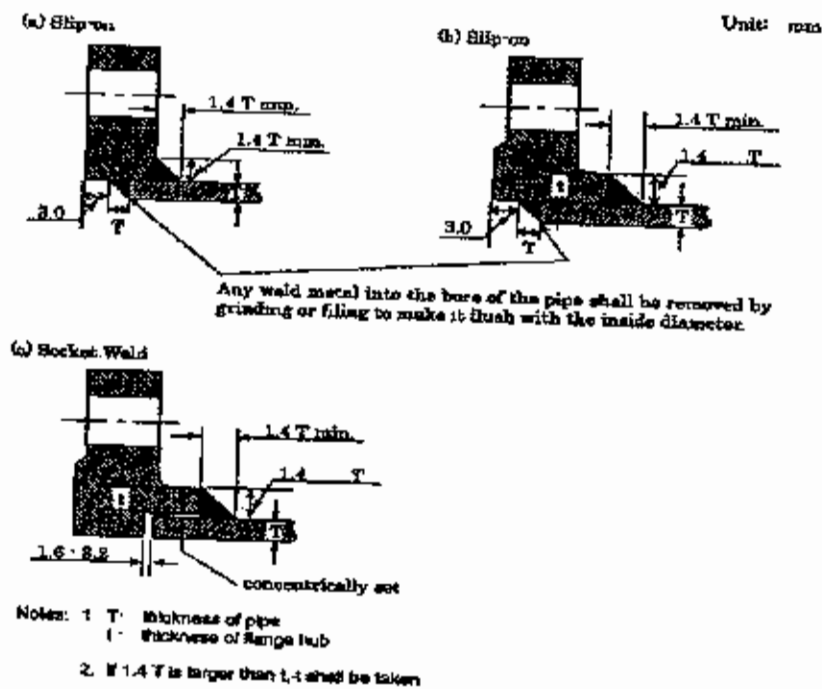
و سر جوش نشان داده شده است.



- Notes:
1. L and L_1 show the distance between both toes of the bead.
 2. L shall be three times the pipe thickness or over.
 3. L_1 shall be five times the pipe thickness or over.

شکل ۵: تکرانس فاصله جوش انشعابات از درز های جوش

در شکل ۶ اندازه جوش های فیلت در حالت های فلنج اسلیپ 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 کنشی صنعتی براساس ضخامت

بحث شده است.

جدول ۱: راهنمای *Perheat* برای متریکال 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 A871 Gr.B85. CL22 A672 Gr.B60. CL22	ALL	t < 25	Not required ⁽¹⁾
			t ≥ 25	80 and above
1 NACE MR.0175	A106 Gr. B A333 Gr.6 A571 Gr. B65 CL22	ALL	t < 25	Not required ⁽¹⁾
			t ≥ 25	80 and above
8 Inc NACE	A312.TP. 316L A358.Gr.316L.CL3	ALL	All	Not required ⁽¹⁾
34	ASTM B466 C70600 90-10CuNi	ALL	All	Not required
51	TITANIUM	ALL	N/A	N/A

⁽¹⁾ 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.

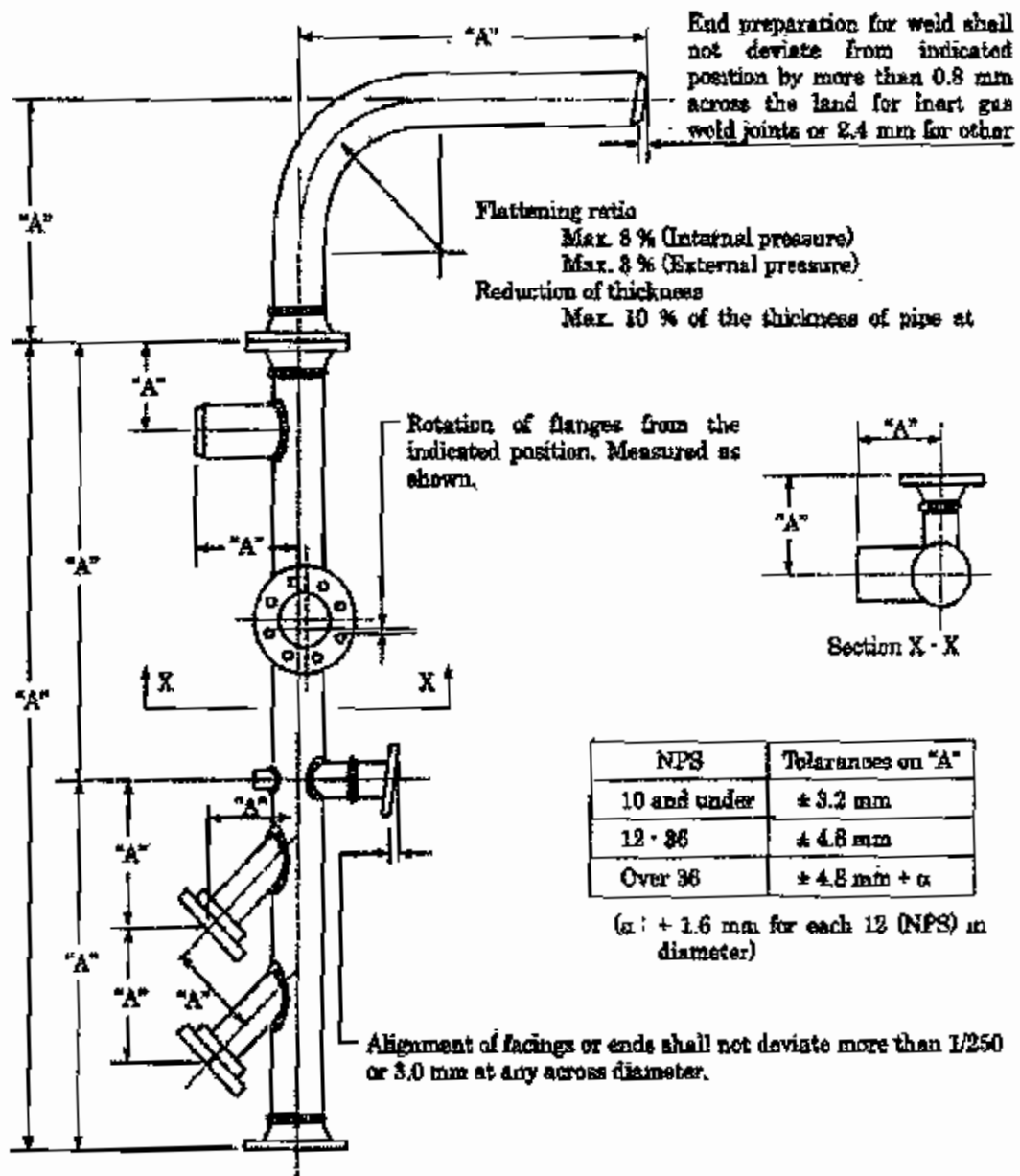
در جدول ۲ شرایط *PWHT* برای چند نوع متریکال شرح داده شده است.

جدول ۲: شرایط *PWHT*

P.No	ASTM Material	Pipe Size (NPS)	Nominal Wall Thickness ⁽¹⁾	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 A871 Gr.B85. 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 ترانس های نصب و فابریکیشن اسپول برای طول، انشعابات، محل فلنج، تراز و شاغولی لبه های لوله و فلنج، صافی و کاهش ضخامت در حالت خم کردن لوله و .. آورده شده است.

NPS = Nominal Pipe Size



Application of Pipe Fabrication

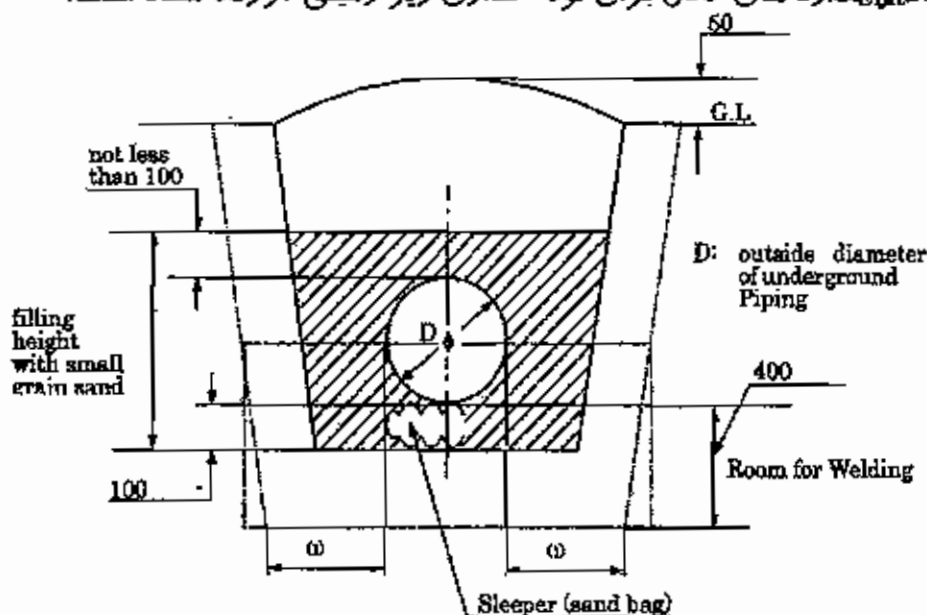
شکل ۷: تolerانس های فابریکیشن در اسپول سازی و نصب

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 ≤ 1 1/2	Cold
	Stainless Steel	D ≤ 1	Cold

در شکل ۸، ابعاد و اندازه‌های کانال برای لوله گذاری زیر زمینی آورده شده است.



w: Room for Welding 500 - 600 mm

شکل ۸: اندازه‌ها در عملیات لوله گذاری زیر زمینی

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

جدول ۴: معیارهای پذیرش چند نوع عیب جوشکاری در بازرسی چشمی

After Welding

Examination and Testing	Acceptance Criterion										
(a) Visual examination of weld	None										
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 (SOFSW Flange) (t: thinner pipe thickness)										
Weld reinforcement or internal weld protrusion (Root Penetration)	<table border="1"> <thead> <tr> <th>Weld Thickness</th> <th>Max. (mm)</th> </tr> </thead> <tbody> <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> </tbody> </table>	Weld 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 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 ₂)	900-2500#	150-600#	-
Carbon steel (low pressure air, water and N ₂), Cement lined carbon steel	-	-	150#
300 series stainless steel (all services excluding low pressure air, water and N ₂)	900-2500#	150-600#	-
300 series stainless steel (low pressure air, water and N ₂)	-	-	150#
Cu-based alloy (all services)	900-2500#	150-600#	-
Titanium, Dissimilar metal welds	150-2500#	-	-

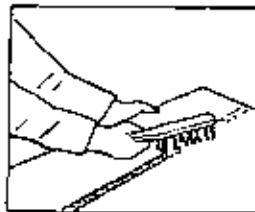
در جدول ۶ درصد انجام تست های غیر مخرب جوشکاری (چشمی، رادیو گرافی، التراسونیک، ذرات مغناطیسی و مواد نفوذ کننده) بر اساس دسته بندی جدول ۵ لیست شده اند.

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

Examination Class ⁽¹⁾	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 ⁽²⁾	100 ⁽²⁾	0 ⁽²⁾	-
	UT	Carbon, 300 series stainless steels, & Cu-based alloy, Titanium. (t>19mm)	100 ⁽²⁾⁽³⁾	100 ⁽²⁾⁽⁴⁾	-	-
	MT ⁽⁵⁾	Carbon steels	100	100	100	10 ⁽⁶⁾
	PT	300 series stainless steels & Cu-based alloys	100	100	100	10
II	Visual	All	100	100	100	100
	RT	All	5 ⁽⁷⁾	5 ⁽⁷⁾	0 ⁽⁷⁾	0 ⁽⁷⁾
	MT	Carbon steels	5 ⁽⁷⁾	5 ⁽⁷⁾	5 ⁽⁷⁾	5 ⁽⁷⁾
	PT	300 series stainless steels & Cu-based alloys	5 ⁽⁷⁾	5 ⁽⁷⁾	5 ⁽⁷⁾	5 ⁽⁷⁾
III	Visual	All	100	100	100	100
	RT	All	5 ⁽⁷⁾	0 ⁽⁷⁾	0 ⁽⁷⁾	-
	MT	Carbon steel	5 ⁽⁷⁾	5 ⁽⁷⁾	5 ⁽⁷⁾	-
	PT	300 series stainless steel	5 ⁽⁷⁾	5 ⁽⁷⁾	5 ⁽⁷⁾	-

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

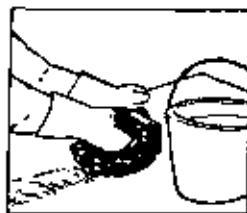
جوشهای فولاد ضد زنگ) نشان داده شده است.



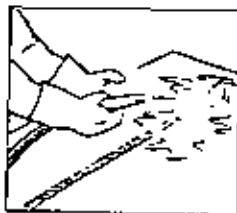
جوش را برس مزنید



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



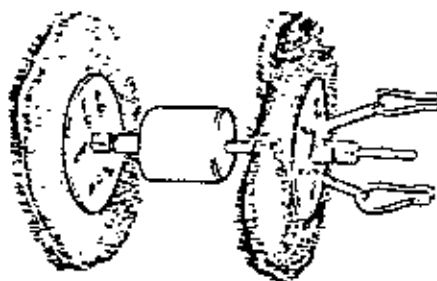
با یک برس ضد زنگ مرطوب و یا با استفاده از یک کلاف میمی ضد زنگ مرطوب ، جوش را پاک کنید .



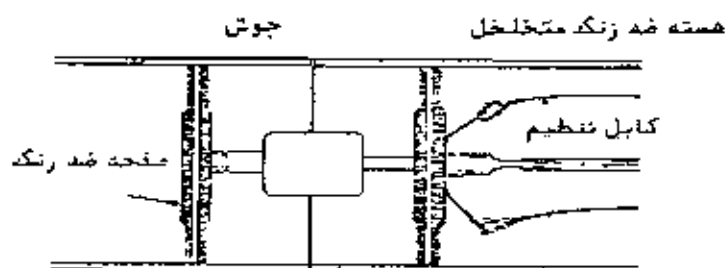
جوش را بطور کامل با آب بشوئید

شکل ۹: مراحل انجام عملیات اسید شویی

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



فیکسچر برای نامین سپر گاز ریشه



گاز آرگون گاز

فیکسچر نصب لوله با سپر گاز بکیارچه

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

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- زانویی (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- کاهشنده متقارن (Conc. Reducer)
- ۱۲- کاهشنده نامتقارن (Ecc. Reducer)
- ۱۳- Ecc. & Conc. Swage
- ۱۴- Red. Insert
- ۱۵- کوبلینگ کاهشنده (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>

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

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

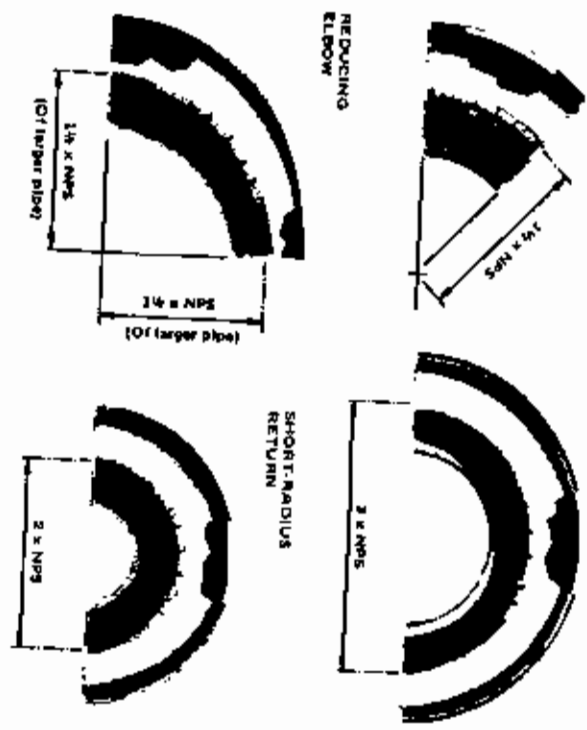
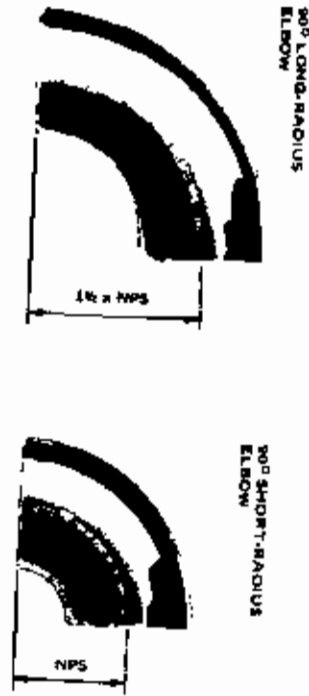
Note : * - Basic design code for CL.900 and CL.1500 shall be
ANSI B 16.34.

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" & ↑	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



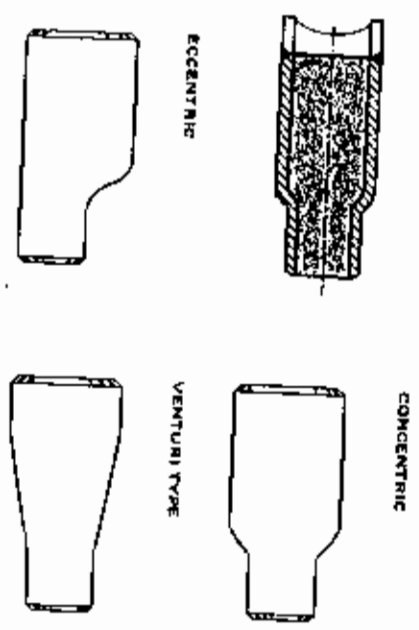
REDUCER (or INCREASER) joins a larger pipe to a smaller one. The two available types, concentric and eccentric, are shown. The eccentric reducer is used when it is necessary to keep either the top or the bottom of the line level—offset equals $\frac{1}{2}$ x (larger ID minus smaller ID).



FIGURE 2.3

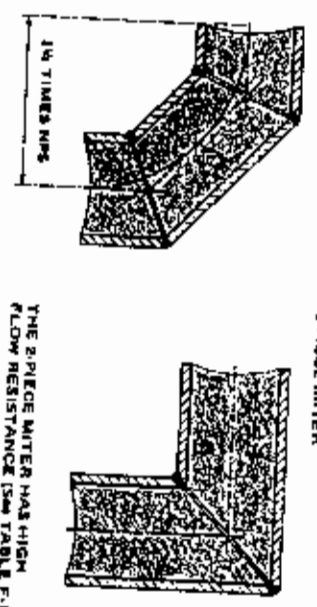
SWAGE is employed to connect butt-welded piping to smaller screwed or socket-welded piping. In butt-welded lines, used as an alternative to the reducer when greater reductions in line size are required. Regular swages in concentric or eccentric form give abrupt change of line size, as do reducers. The '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'.

FIGURE 2.4



MITERED ELBOWS are fabricated as required from pipe—they are not fittings. 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 corresponding 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.

FIGURE 2.5



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

2
2.4
3.1

CHART
2.1

FIGURES
2.1-2.5

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

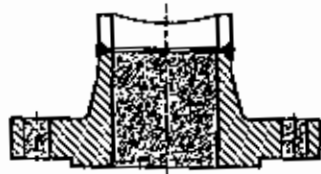


FIGURE 2.5



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

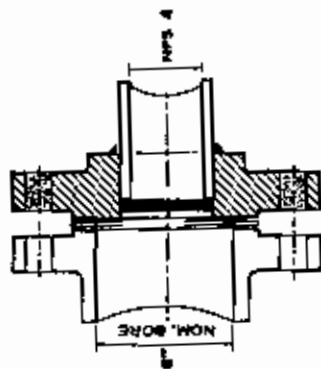


FIGURE 2.6



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

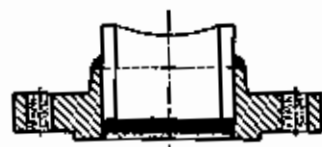


FIGURE 2.7



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 ANST B16.5.

EXPANDER (or INCREASED) FLANGE

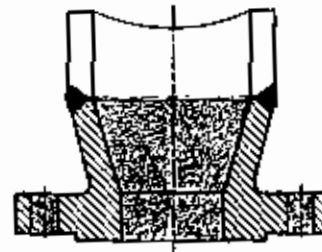


FIGURE 2.8



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 like 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)

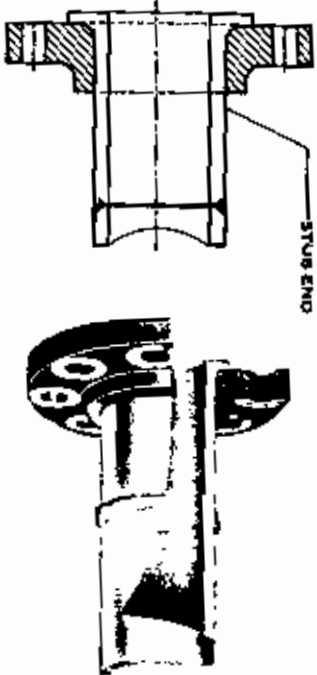


FIGURE 2.10

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

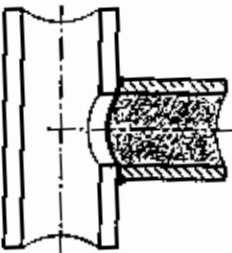


FIGURE 2.11

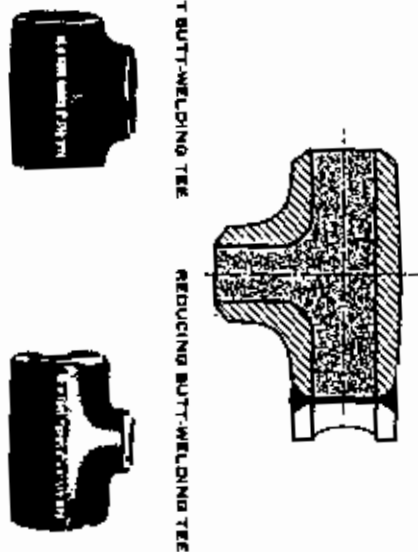
BUTT-WELDING TEES, STRAIGHT or REDUCING, are employed to make 90-degree branches from the main run of pipe. Straight tees, with branch the same size as the run, are readily available. Reducing tees have branch smaller than the run. Bullhead tees have branch larger than the run, and are very seldom used 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

HOW 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

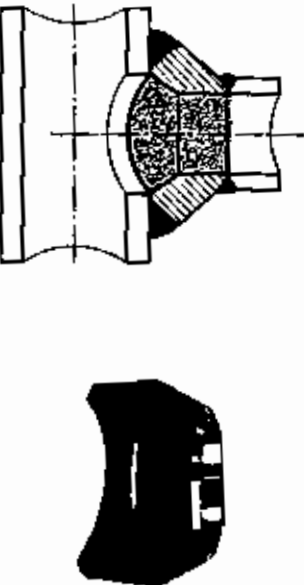
REDUCING BUTT-WELDING TEE

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 pre-shaped to the curvature of the run pipe.

WELDOLET makes a 90-degree branch, full-size or reducing, on straight pipe. Closer manufacturing is possible than with tees. Flat-based weldolets are available for connecting to pipe caps and vessel heads.

WELDOLET

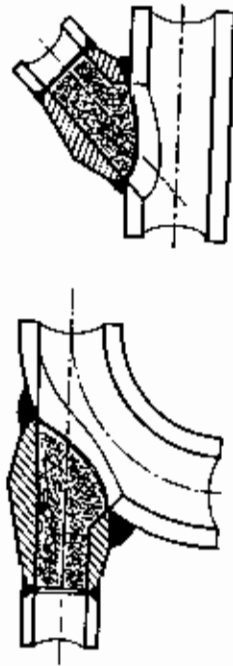
FIGURE 2.13



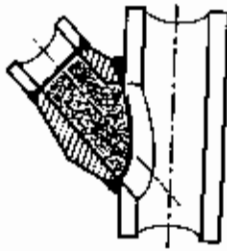
FIGURES 2.8-2.13

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

ELBOWLET
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

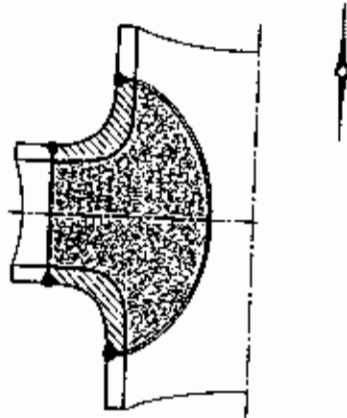


FIGURE 2.16

BUTT-WELDING CROSS

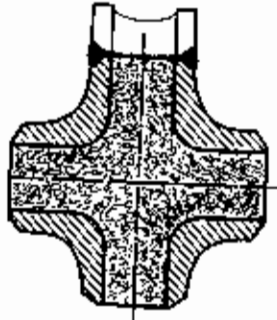


FIGURE 2.17



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

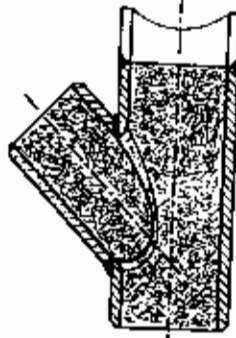


FIGURE 2.18



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

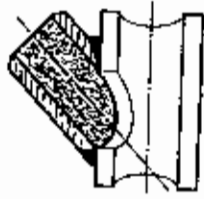


FIGURE 2.19



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.

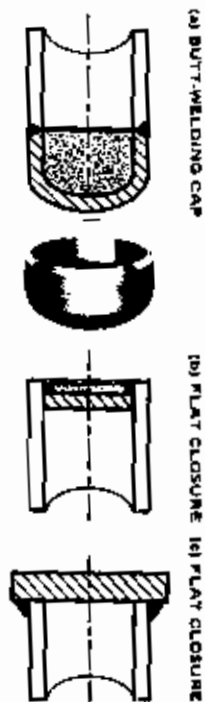
CLOSURES

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 explosive 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 cyclic 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			
CONCENTRIC ITEM SUCH AS ORIFICE, VALVE, ETC.			
MAXIMUM LINE SIZE NORMALLY SOCKET WELDED	NPS 1 1/2 LINE SIZE (UNLESS OTHERWISE SPECIFIED)		
AVAILABILITY OF FORGED-STEEL SOCKET-WELDED FITTINGS	NPS 1/2 to NPS 4		
WEIGHTS OF PIPE AND PRESSURE CLASSES OF FITTINGS WHICH ARE COMPATIBLE	PIPE		FITTINGS
	SCHEDULE NUMBER	SCH 40 SCH 80 SCH 100	
WEIGHTS OF PIPE AND PRESSURE CLASSES OF FITTINGS WHICH ARE COMPATIBLE	PIPE WEIGHT	FITTING CLASS	FITTING MOVED TO
WEIGHTS OF PIPE AND PRESSURE CLASSES OF FITTINGS WHICH ARE COMPATIBLE	FITTING MOVED TO	FITTING MOVED TO	FITTING MOVED TO
<p>NEAREST COMMON COMBINATION: CHOICE OF MATERIAL ON HEAVYWEIGHT PIPE AND FITTING WILL DEPEND ON PRESSURE, TEMPERATURE AND/OR CORROSION ALLOWANCE REQUIRED. PIPE NPS IS AND SMALLER IS USUALLY ORDERED TO ASTM SPECIFICATION A 106 GRADE B NEAR TO 2 1/4" UNDER STEELS.</p>			
VALVES			
MINIMUM PRESSURE (RATING) CLASS	CONTROL VALVES (USUALLY FLANGED)	USUALLY 200 (SEE 2.1.19)	600 (ANSI 600 (API))
	VALVES OTHER THAN CONTROL VALVES		

2.3.2

CHART 2.2

FIGURES 2.14-2.20

Handwritten note: *in Piping Guide*

* ANSI B31.1 recommends a 1/16-inch gap to prevent weld from cracking under thermal stress.
 † Socketwelded fittings are now only made in classes 2000, 3000 and 5000 (ANSI B31.1)

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-8.

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.

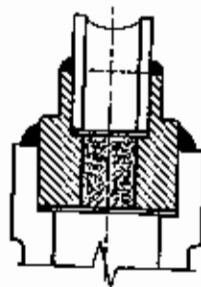
REDUCER



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



SOCKET-ENDED FITTING, FLANGE, OR EQUIPMENT

THREE FORMS OF REDUCER INSERT.

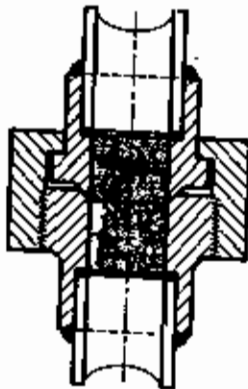


FIGURE 2.23

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 2.5.7 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 end 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 ITEM OR PIPE	SW ITEM	
SW FITTING	SWG 1 1/2	SWG 2	SWG 1 1/2 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

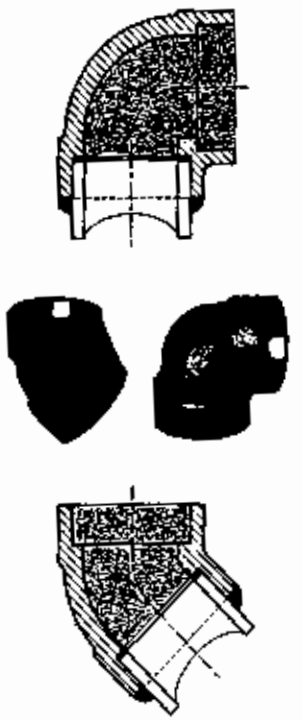


FIGURE 2.26

SOCKET-WELDING TEE

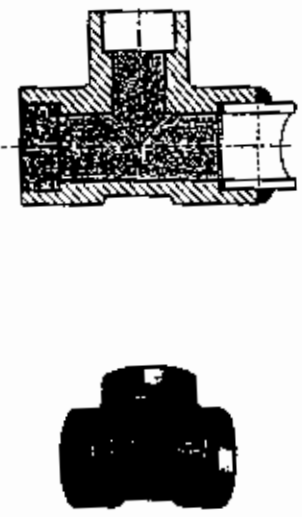


FIGURE 2.28

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

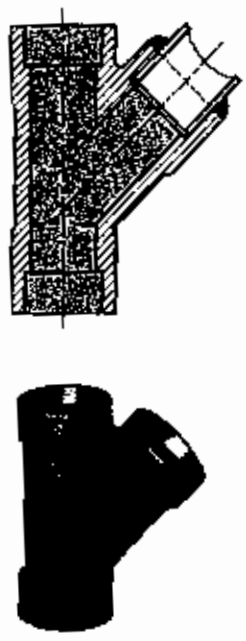


FIGURE 2.29

4-13

FITTINGS FOR BRANCHING FROM SOCKET-WELDED SYSTEMS

2.4.2

BRANCH FROM SOCKET-WELDED RUN

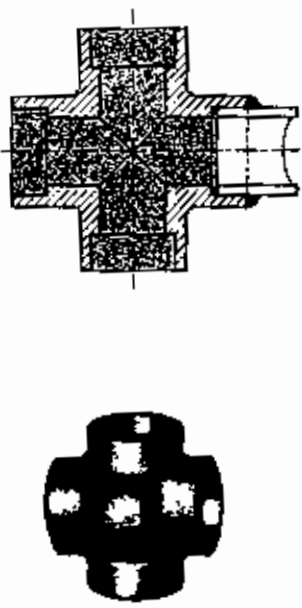
TEE, STRAIGHT or REDUCING, makes 90-degree branch from the main run of pipe. Reducing tees are custom-fabricated by boring standard forged blanks.

SPECIFYING SIZE OF SOCKET-WELDING TEES

HOW TO SPECIFY TEES	MAIN INLET	MAIN OUTLET	BRANCH	EXAMPLE
REDUCING OR BRANCH	1½"	1½"	1"	RED TEE 1½ x 1½ x 1
REDUCING OR MAIN (SPECIAL APPLICATIONS ONLY)	1½"	1"	1½"	RED TEE 1½ x 1 x 1½

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 2.30



FIGURES
2.21-2.30

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

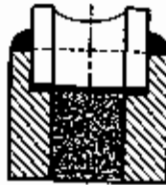


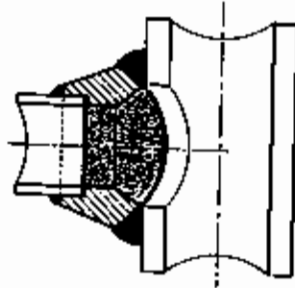
FIGURE 2.31

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 tees and vessel heads.

SOCKETLET

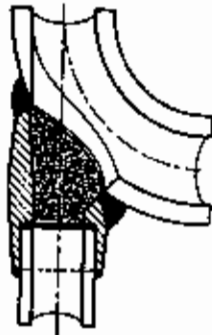
FIGURE 2.33



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

SOCKET-WELDING ELBOWLET

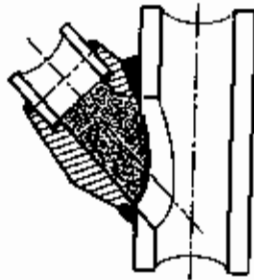
FIGURE 2.35



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

SOCKET-WELDING LATROLET

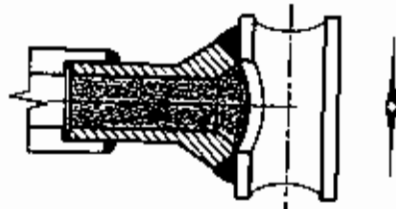
FIGURE 2.34



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

NIPOLET

FIGURE 2.36



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.

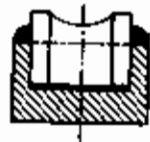
CLOSURE

2.4.4

SOCKET-WELDING CAP seals plain-ended pipe.

SOCKET-WELDING CAP

FIGURE 2.36



COMPONENTS FOR SCREWED PIPING SYSTEMS

2.5

SCREWED PIPING

CHART 2.3

2-4.3
5.1

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-9.

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

FULL-COUPLING

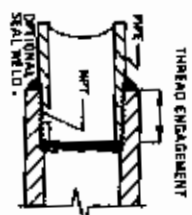
FIGURE 2.37



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

1/2" to 1 1/2"

AVAILABILITY OF FORGED-STEEL THREADED FITTINGS

1/2" to 1 1/2" to 6"

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

WEIGHTS OF PIPE AND PRESSURE RATING CLASSES OF FITTINGS WHICH ARE COMPATIBLE	1/2"		2000	3000	6000
	SCHEDULE NUMBER	WEIGHT			
FITTING CLASS	SCH 40	STD	2000	3000	6000
	SCH 80	XXS			

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 1/2" 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 800 (API))

* ANSI B31.1D notes that seal welding shall not be considered to contribute to the strength of the joint.

SEAL WELDING APPLICATIONS

On-site: On all screwed connections within boundary limits, with the exception of piping carrying air or other inert gas, and water. Off-site: On screwed lines for hydrocarbon service and for lines conveying dangerous, toxic, corrosive or volatile fluids.

FIGURES 2.31-2.37

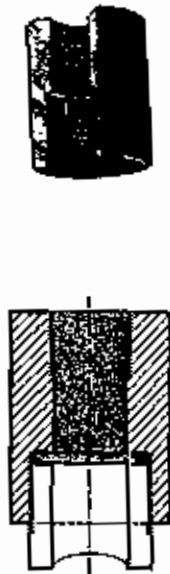
CHART 2.3

4-5

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 (FOE-TDE). Available in various lengths - refer to table D-11. Nipples can be obtained with a Victrolite groove at one end.

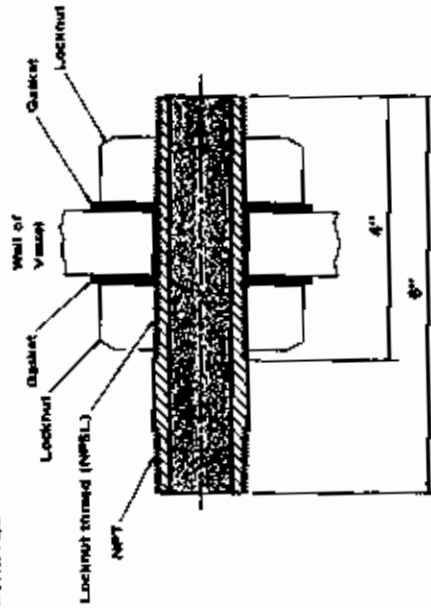
NIPPLES FOR THREADED ITEMS

FIGURE 2.38

- (A) CLOSE NIPPLE
- (B) LONG or SHORT NIPPLE (TBE)
- (C) NIPPLE (FOE-TDE)



(D) TANK NIPPLE

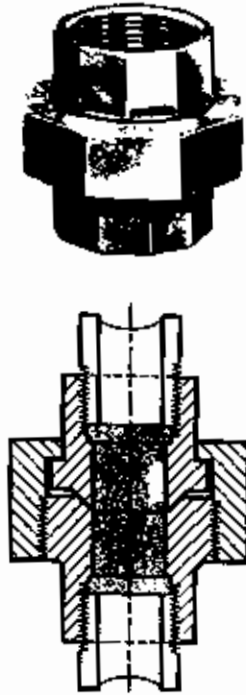


TANK NIPPLE is used for making a screwed connection to a non-pressure vessel or tank in low-pressure service. Overall length is usually 6 inches with a standard taper pipe thread at each end. On one end only, the taper pipe thread runs into a ANSI lock-nut thread.

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

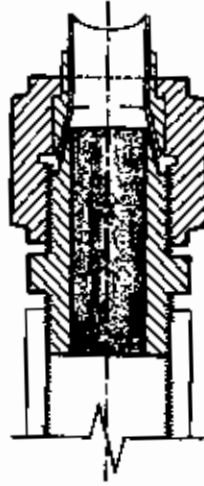
FIGURE 2.40



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

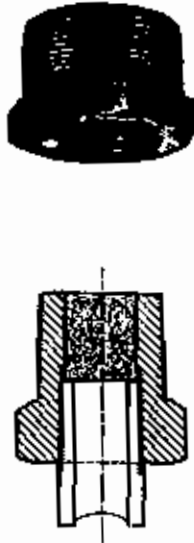
FIGURE 2.41



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 NIPP' 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 2A
SPECIFYING SIZE & END FINISH OF THREADED SWAGES

SWAGE FOR JOINING — LARGER or 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.

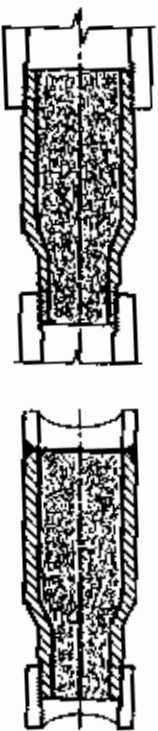
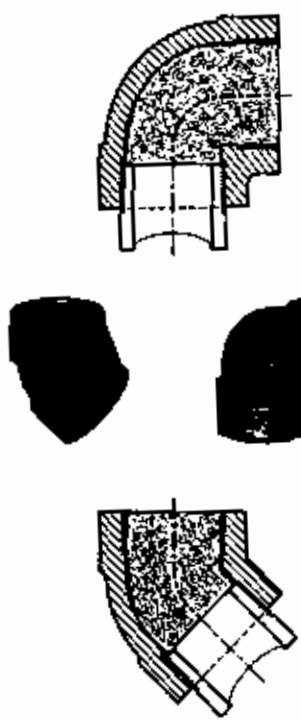


FIGURE 2.43
SWAGED NIPPLES, TBE and BLE-TSE

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 flange-size flange is specified:

RED FLG NPS 1½ x 1 Class 150 THRD

FIGURE 2.45
THREADED FLANGE



**FITTINGS FOR BRANCHING FROM
SCREWED SYSTEMS**

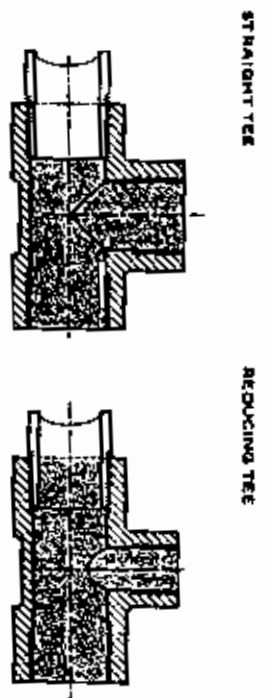
BRANCH FROM SCREWED MAIN RUN

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 OR SWAGING	1½"	1½"	1"	RED TEE IN. 1½ x 1
REDUCING OR MAIN	1½"	1"	1½"	RED TEE IN. 1" x 1½"
SPECIAL APPLICATIONS ONLY				

FIGURE 2.46
THREADED TEES, STRAIGHT and REDUCING

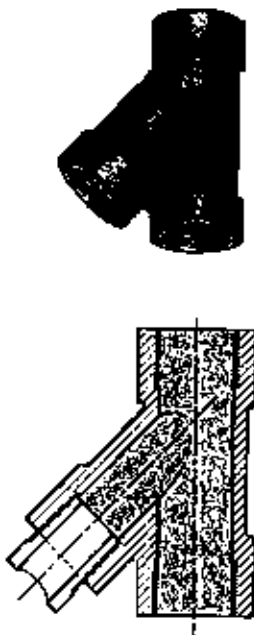


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LATERAL makes full-size 45-degree branch from the main run of pipe.

THREADED LATERAL

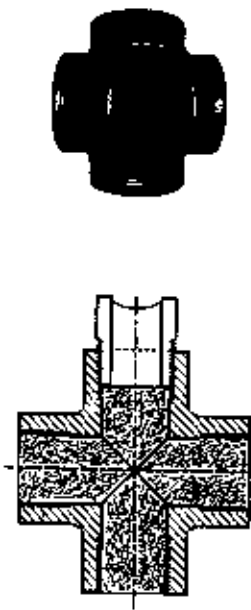
FIGURE 2.47



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

THREADED CROSS

FIGURE 2.48



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

2.5.3

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.

THREADED HALF-COUPLING & FULL-COUPLING

FIGURE 2.49



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

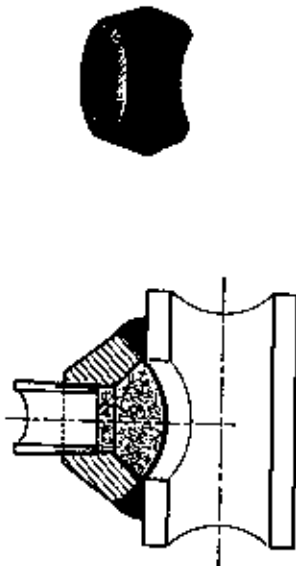
TANK NIPPLE See 2.5.1, figure 2.38(d).

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.

THREDOLET

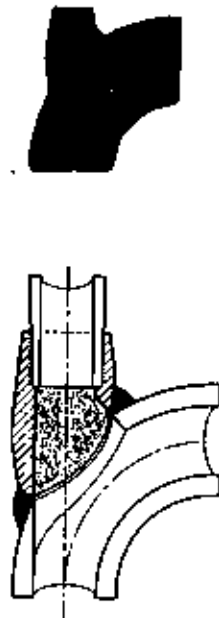
FIGURE 2.50



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

THREADED ELBOLET

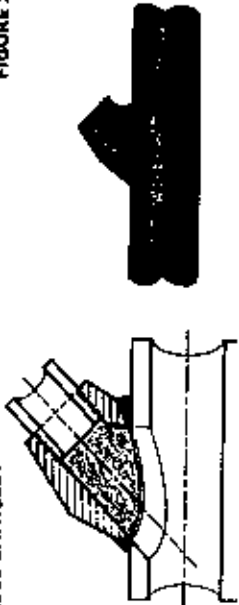
FIGURE 2.51



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

THREADED LATROLET

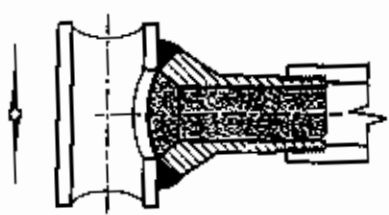
FIGURE 2.52



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

THREADED NIPOLET

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.

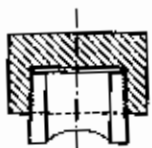
CLOSURES

2.5.4

CAP seals the threaded end of pipe.

THREADED CAP

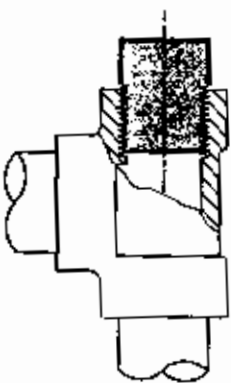
FIGURE 2.5.4



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

BARSTOCK PLUGS (IN TEE)

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 (f).

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: NPT
- Rigid mechanical joint for Railings: NPT R
- Straight Pipe Thread: NPS
- Internal, in Pipe Couplings: NPSM
- Free-fitting, Mechanical Joints for Fixtures: NPSL
- Loose-fitting, Mechanical Joints with Locknuts: NPSH
- Loose-fitting, Mechanical Joints for Hose Couplings: NPSH

ANSI B1.20.3: DRYSEAL PIPE THREADS

- Taper Pipe Thread: NPTF
- Dryseal Standard: NPTF
- Dryseal SAE Short (NPTF type, shortened by one thread) PTF-SAE SHORT
- Straight Pipe Thread (internal only): NPSF
- Dryseal, Fuel (for use in soft/ductile materials): NPSF
- Dryseal, Intermediate (for use in hard/brittle materials): NPSI

(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

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FLANGE FACINGS, BOLTS & GASKETS

2.6

FLANGE FACINGS & FINISHES

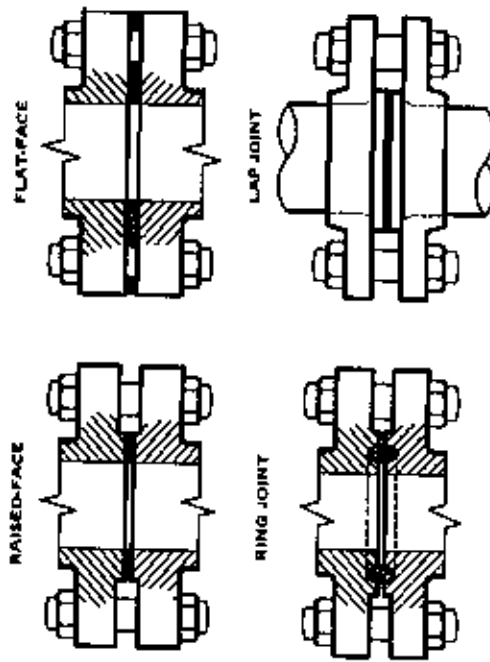
2.6.1

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 expansive 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

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 دووار همچون پمپ و کمپرسور فراهم گردد.

- در انتخاب و طراحی ساپورت برای خطوط بدون عایق باید تیرانس ارتفاعی در نقاط تماس با بتن یا سازه در نظر گرفت که از خوردگی نقطه ای سیستم جلوگیری شود.
- در سیستم های لوله کشی غیر فلزی، لوله کشی عایق سرد و لوله کشی که نیاز به *PWHT* دارد باید از ساپورت های کلمپی استفاده شود.
- الکتروود و فیلر مناسب باید مطابق *WPS* لوله کشی انتخاب شوند.
- ساپورت ها تا حد امکان در محل های نزدیک به نقاط تغییر جهت خط قرار داده شوند اما باید انعطاف پذیری خط در نظر گرفته شود.
- برای کاهش نیروی اصطکاک در محل های در تماس و احتمال جابجایی زیاد از پد های لغزشی نقلن 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 گونه ای باشد که نصب متعلقات استیم ترسینگ مختل نشود.
- برای جلوگیری از خوردگی گالوانیک بین کلمپ های 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 گر نه 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 ساپورت ها باید در محل شاپ اسمبل و جوش شوند. مگر اینکه مواردی در نقشه ذکر شده باشد که در سایت جوش شوند.
- همه قطعات رزوه ای 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 ساپورت های ویژه استفاده گردد و نقشه های آنها باید جداگانه تهیه گردد.
- همه ساپورت های متصل به لوله کشی ماشین آلات دووار باید فضای کافی جهت اجازه دادن به جابجایی هنگام روشن کردن را داشته باشند.
- ساپورت ها نباید مشکلاتی را برای شیرها و تجهیزات از لحاظ فضایی ایجاد کنند.
- ساپورت ها نباید به فنداسیون و کابل ها در تماس باشند.
- ساپورت های لوله کشی باید طوری جایگذاری شوند که امکان باز و بسته کردن لوله کشی از دستگاهها در موقع تعمیرات و جایگذاری صافی ها و غیره وجود داشته باشد.

- در مورد ساپورت های سیستم های غیر فلزی باید دستوالعمل 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. B65 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 مفره ای، بولت های معمولی، قلاب^{ها} هل، کلمپ ها و مهره های آنها باید *ASTM A153 or A123* کالوانیزه 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/mm²)
I = Second moment of area (mm⁴)

- برای درجه حرارت بیشتر از ۲۰ درجه سانتی گراد باید محدودیت تنش مجاز در آن اعمال شود.
- فاصله سائورت لوله براساس حداکثر تنش مجاز تعریف شده در *ASME B31.3* باید باشد و نباید خیز بیشتر از ۱۲ mm باشد.

جدول ۲: فضای مجاز بین سائورت 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 ۸

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 ۸:

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 لوب 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 تعینت 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.

۲+ 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

۳+ 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.	

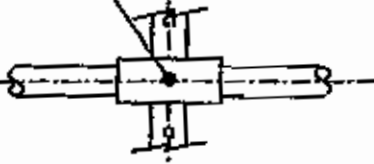
-در بعضی از پروژه ها برای بیان ارتفاع کفشک ها و کرادل ها از علائم خاص مانند جدول ۸ استفاده می کنند.

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

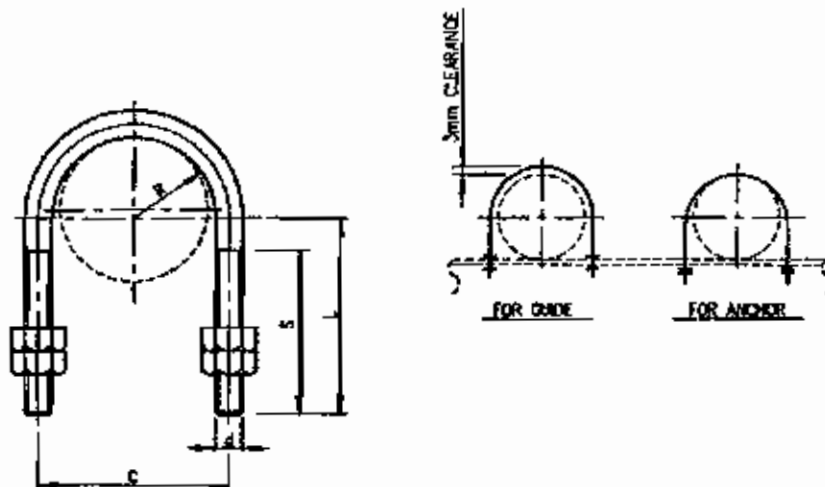
-طبق موارد ذکر شده در بالا یک نمونه از اسم گذاری ساپورت ها در جدول ۹ آورده شده است.

جدول ۹: یک نمونه از اسم گذاری ساپورت

Marking	Description
<div style="border: 1px solid black; padding: 2px;"> S1-C RS11- B61001 </div> 	<p>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.</p>

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.



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"	390	260	120	4.7
16"	406.4	208.0	1"	440	280	120	5.1
18"	457.2	238.5	1"	485	310	120	5.6
20"	508.0	257.5	1-1/4"	545	330	140	8.8
24"	609.6	312.0	1-1/4"	630	390	140	11.1

NOTE

1. MATERIAL

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

2. FOR APPLICATION ON

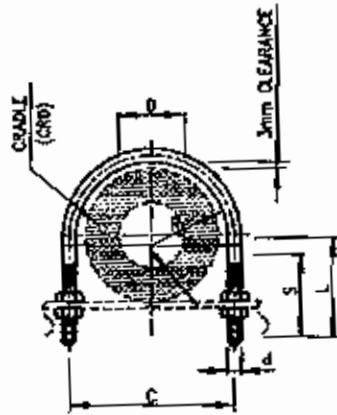
- AF-51, AS-8, AS-50, GS-8, GS-21, GS-24, GS-50, GV-23, GV-24, GV-26,
- PS-3, RS-44, RS-62, RS-63, RS-64, RS-84, RV-23, RV-24, RV-26, TR-1, TR-2

- 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 UBTC
(FOR COOL INSULATED PIPE)

REV.
D7



FOR GUIDE

UNIT (mm)

PIPE SIZE (IN)	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	128	188	-	-
1"	68	118	168	-	-
1-1/2"	82	126	176	226	-
2"	82	136	187	237	-
2-1/2"	88	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	330	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"	296	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
228	1"	476	285	120	5.3
237	1"	488	306	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"	608	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
380	1-1/4"	806	470	150	13.3
415	1-1/4"	860	485	150	14.1

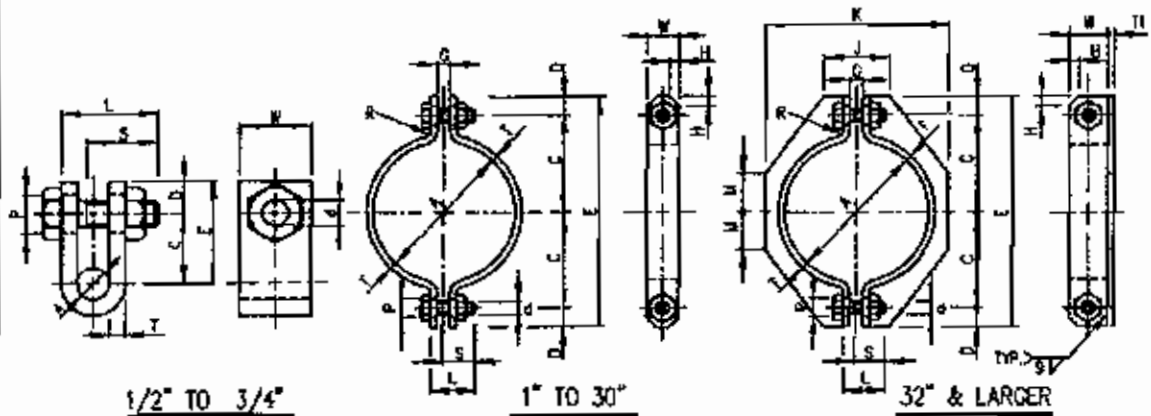
NOTE

1. MATERIAL

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

2. FOR APPLICATION ON : G5-33, GY-41, GY-94

PIPING SUPPORT ATTACHMENT DWG. ST-A4-1014A PIPE CLAMP (FOR BARE PIPE) PC REV. D7



1/2" TO 3/4"

1" TO 30"

32" & LARGER

UNIT (MM)

NOM. PIPE SIZE (INCH)	CLAMP BODY															HEX BOLT (UNC) x L _{CL}	ALLOW. LOAD (Kg)	WEIGHT (Kg)
	A	C	D	E	G	H	J	K	P	R	W	T	TI	M				
1/2	25	35	15	50	-	-	-	-	14	-	32	8	-	-	1/2"x45x30	335	0.4	
3/4	30	35	15	50	-	-	-	-	14	-	32	6	-	-	1/2"x45x30	335	0.4	
1	38	35	15	100	10	5	-	-	14	10	32	6	-	-	1/2"x45x30	460	0.5	
1 1/2	51	50	15	130	16	5	-	-	14	10	32	6	-	-	1/2"x45x30	740	0.6	
2	63	55	15	140	18	5	-	-	14	10	32	8	-	-	3/4"x45x30	740	0.6	
2 1/2	76	65	15	160	18	5	-	-	14	10	32	8	-	-	1/2"x45x30	720	0.7	
3	92	75	15	180	18	5	-	-	14	10	32	8	-	-	1/2"x45x30	890	0.8	
4	116	95	25	240	25	10	-	-	22	10	50	9	-	-	3/4"x70x35	1220	2.5	
5	173	140	35	350	32	10	-	-	28	15	75	12	-	-	1"80x45	1500	6.5	
6	225	185	35	400	32	10	-	-	28	15	75	12	-	-	1"80x45	1500	7.8	
10	280	205	40	490	38	10	-	-	33	20	90	16	-	-	1-1/4"x100x55	1580	15.0	
12	330	230	40	540	38	10	-	-	33	20	90	16	-	-	1-1/4"x100x55	1600	16.9	
14	362	260	50	620	45	15	-	-	39	25	100	18	-	-	1-1/2"x130x70	1700	25.7	
16	414	285	50	670	45	15	-	-	39	25	100	19	-	-	1-1/2"x130x70	2290	33.0	
18	464	310	50	720	45	15	-	-	39	25	100	19	-	-	1-1/2"x130x70	2850	30.3	
20	514	350	50	800	45	15	-	-	39	30	125	22	-	-	1-1/2"x130x70	2950	46.8	
22	565	375	50	850	45	15	-	-	39	30	125	22	-	-	1-1/2"x130x70	2950	50.3	
24	616	400	50	900	45	15	-	-	39	30	125	22	-	-	1-1/2"x130x70	2950	53.6	
26	668	440	55	950	50	20	-	-	45	35	150	28	-	-	1-3/4"x150x75	3560	89.1	
28	720	465	55	1040	50	20	-	-	45	35	150	28	-	-	1-3/4"x150x75	3310	94.3	
30	770	490	55	1080	50	20	-	-	45	35	150	28	-	-	1-3/4"x150x75	3090	93.4	
32	824	515	55	1140	50	20	240	935	45	40	150	16	18	180	1-3/4"x150x75	3630	95.8	
34	878	540	55	1180	50	20	240	910	46	40	150	16	18	200	1-3/4"x150x75	4400	103.2	
36	928	570	55	1250	50	20	240	1055	46	40	150	16	18	220	1-3/4"x150x75	5000	110.2	
40	1030	620	55	1350	50	20	240	1180	46	40	150	16	18	240	1-3/4"x150x75	4500	117.2	
42	1080	645	55	1400	50	20	240	1210	46	40	150	16	18	260	1-3/4"x150x75	4500	122.8	

NOTE

1. MATERIAL

CODE	CLAMP	BOLT/NUT	TEMP.
K	A283 GR.C	A307 OR B / A563 GR.A	350°C
L	A515 GR.80	A193-B7/A194-2H	420°C

2. CLAMP AND BOLT/NUT SHALL BE GALVANIZED.

3. FOR APPLICATION ON

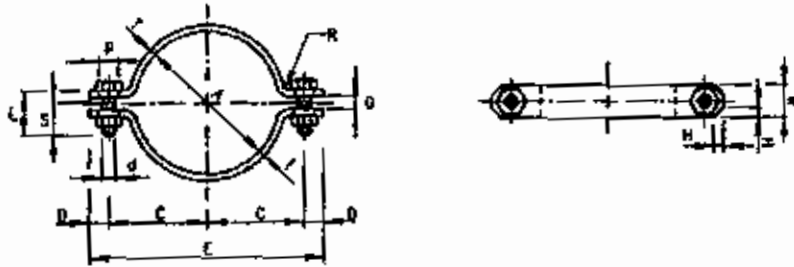
HC-21, HC-31, HS-21, HS-31, HS-51, HS-52, PS-3
 RV-21, RV-35, SC-21, SS-22, SV-33, SV-34, SV-35, SV-36

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-A4-1014B

PIPE CLAMP
(FOR CLAMP SHOE)

PCS

REV.
07

PIPE SIZE	CLAMP BODY										HEX BOLT Ø(UNC) x L x W	ALLOW LOAD (kg)	WEIGHT (kg)
	A	C	D	E	G	H	P	R	W	T			
1/2"	25	35	15	50	18	5	14	10	32	6	1/2" x 15 x 30		0.4
3/4"	30	35	15	50	18	5	14	10	32	6	1/2" x 15 x 30		0.4
1"	36	35	15	100	18	5	14	10	32	6	1/2" x 15 x 30		0.5
1 1/2"	51	50	15	130	18	5	14	10	32	6	1/2" x 15 x 30		0.8
2"	63	55	15	140	18	5	14	10	32	6	1/2" x 15 x 30		0.6
2 1/2"	76	65	15	160	18	5	14	10	32	6	1/2" x 15 x 30		0.7
3"	82	75	15	180	18	5	14	10	50	6	1/2" x 15 x 30		1.3
4"	118	95	25	240	25	10	22	10	50	9	3/4" x 20 x 45		2.9
6"	173	140	35	350	32	10	22	15	50	8	3/4" x 20 x 45		3.8
8"	225	165	35	400	32	10	22	15	50	8	3/4" x 20 x 45		4.4
10"	280	205	40	490	38	10	26	20	75	12	1" x 100 x 55		10.1
12"	330	230	40	540	38	10	26	20	75	12	1" x 100 x 55		11.2
14"	362	260	50	620	45	15	26	25	75	12	1" x 100 x 55		12.7
16"	414	285	50	670	45	15	26	25	75	12	1" x 100 x 55		13.8
18"	464	310	50	720	45	15	26	25	75	12	1" x 100 x 55		14.9
20"	514	350	50	800	45	15	26	30	75	12	1" x 100 x 55		16.4
22"	566	375	50	850	45	15	26	30	75	12	1" x 100 x 55		17.6
24"	616	400	50	900	45	15	26	30	75	12	1" x 100 x 55		18.7
26"	668	440	55	950	50	20	26	35	75	12	1" x 110 x 55		20.4
28"	720	465	55	1040	50	20	26	35	75	12	1" x 110 x 55		21.5
30"	770	490	55	1090	50	20	33	35	90	16	1-1/4" x 120 x 75		37.6
32"	824	515	55	1140	50	20	33	40	90	16	1-1/4" x 120 x 75		39.4
34"	876	540	55	1190	50	20	33	40	90	16	1-1/4" x 120 x 75		41.2
36"	928	570	55	1250	50	20	33	40	100	19	1-1/2" x 130 x 75		57.7
40"	1030	620	55	1350	50	20	33	40	100	19	1-1/2" x 130 x 75		62.4
42"	1080	645	55	1400	50	20	33	40	100	22	1-1/2" x 130 x 75		74.4

UNIT (MM)
SEE DWG NO. ST-A4-1102
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.

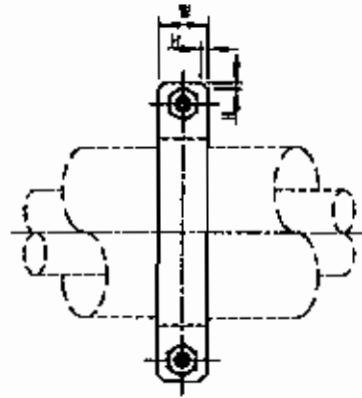
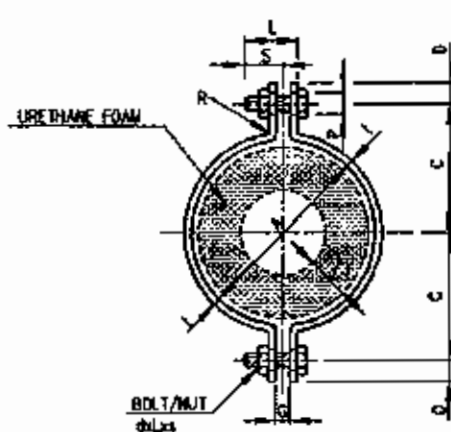
3. FOR APPLICATION ON
5-5, 5-7, 05-5, 05-74. GALVANIZED CLAMP SHALL NOT BE IN DIRECT CONTACT WITH
THE STAINLESS STEEL PIPE.
MIN ASBESTOS SHEET (1mm THICKNESS) SHALL BE INSERTED
BETWEEN GALVANIZED CLAMP AND STAINLESS STEEL PIPE.

PIPING SUPPORT ATTACHMENT DWG.

ST-A4-1016

PIPE CLAMP PCC
(FOR COLD INSULATED PIPE)

REV.
D7



UNIT (mm)

INS. THK	CRADLE THK	A (FOR EACH PIPE SIZE)																					
		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	224	274	324	392	430	474	530	578	630	678	730	778	830	870
51-100	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	

UNIT (mm)

A	C	D	G	R	W	H	P	t	d(UNC) x L x S	ALLOW. WEIGHT (kg)	HEIGHT (mm)	A	C	D	G	R	W	H	P	t	d(UNC) x L x S	ALLOW. WEIGHT (kg)	HEIGHT (mm)
136	105	25	32	10	50	10	22	6	3/4 x 75 x 55	790	0.6	678	440	60	60	30	150	20	52	22	2 x 215 x 105	8000	31.4
163	120	25	32	10	50	10	22	6	3/4 x 75 x 55	790	0.6	730	465	60	60	30	150	20	52	22	2 x 215 x 105	8000	33.4
192	130	25	32	10	75	10	22	6	3/4 x 75 x 55	790	0.8	778	485	60	60	30	150	20	52	25	2 x 215 x 105	8000	40.2
224	150	25	32	10	75	10	22	6	3/4 x 75 x 55	790	1.5	830	520	60	60	30	150	20	52	25	2 x 215 x 105	8000	41.5
236	155	25	32	10	75	15	22	9	3/4 x 75 x 55	790	2.3	870	540	60	60	30	150	20	52	25	2 x 215 x 105	8000	44.6
250	160	25	32	10	75	15	22	9	3/4 x 75 x 55	790	2.4	820	565	60	60	30	150	20	52	25	2 x 215 x 105	8000	47.0
274	180	40	38	15	90	15	33	12	1-1/4 x 100 x 65	3100	4.4	970	585	60	60	35	150	20	52	28	2 x 240 x 125	8000	55.4
279	195	40	38	15	90	15	33	12	1-1/4 x 100 x 65	3100	4.8	1020	620	60	60	35	150	20	52	28	2 x 240 x 125	8000	58.0
292	200	40	38	15	90	15	33	12	1-1/4 x 100 x 65	3100	4.7	900	645	60	60	35	150	20	52	28	2 x 240 x 125	8000	60.6
324	220	40	38	15	90	15	33	12	1-1/4 x 100 x 65	3100	5.2	1120	670	60	60	35	150	20	52	28	2 x 240 x 125	8000	63.1
336	230	40	38	15	90	15	33	12	1-1/4 x 100 x 65	3100	5.5	1120	700	60	60	40	150	20	52	32	2 x 240 x 125	8000	75.3
351	250	50	45	20	100	15	39	16	1-1/2 x 120 x 75	4500	8.8	1220	725	60	60	40	150	20	52	32	2 x 240 x 125	8000	78.2
374	260	50	45	20	100	15	39	16	1-1/2 x 120 x 75	4500	9.0	1220	750	60	60	40	150	20	52	32	2 x 240 x 125	8000	84.2
392	270	50	45	20	100	15	39	16	1-1/2 x 120 x 75	4500	8.3	1320	775	60	60	40	150	20	52	32	2 x 240 x 125	8000	84.1
430	290	50	45	20	100	20	39	16	1-1/2 x 120 x 75	4500	8.8	1370	800	60	60	40	150	20	52	32	2 x 240 x 125	8000	87.0
451	310	55	55	25	125	20	48	18	1-3/4 x 150 x 85	5800	15.9												
474	320	55	55	25	125	20	48	18	1-3/4 x 150 x 85	5800	16.5												
492	330	55	55	25	125	20	48	18	1-3/4 x 150 x 85	5800	17.1												
530	350	55	55	25	125	20	48	18	1-3/4 x 150 x 85	5800	17.9												
548	360	55	55	25	125	20	48	18	1-3/4 x 150 x 85	5800	18.5												
578	390	60	60	30	150	20	52	22	2 x 215 x 105	8000	27.4												
630	415	60	60	30	150	20	52	22	2 x 215 x 105	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.BB	A193-B7/A194-2H	420°C

2. CLAMP AND BOLT/NUT SHALL BE GALVANIZED.

3. FOR APPLICATION ON

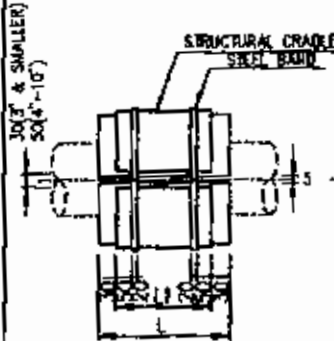
HC-21, HC-31, HS-11, HS-13, HS-21, MS-31, MS-51, RV-41, RV-43, RV-45, RV-53, RV-55, SC-21, SS-21, SS-22, SV-51, SV-52

PIPING SUPPORT ATTACHMENT DWG.

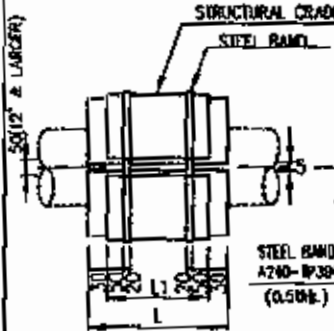
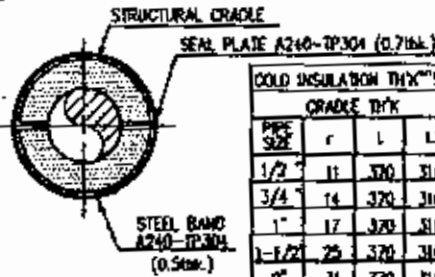
ST-A4-1019

CRADLE CRD
(FOR COLD INSULATED PIPE)

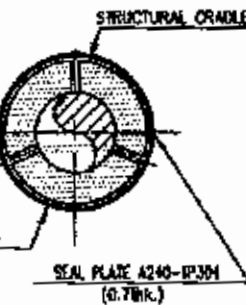
REV.
07



10" & SMALLER



12" TO 60"



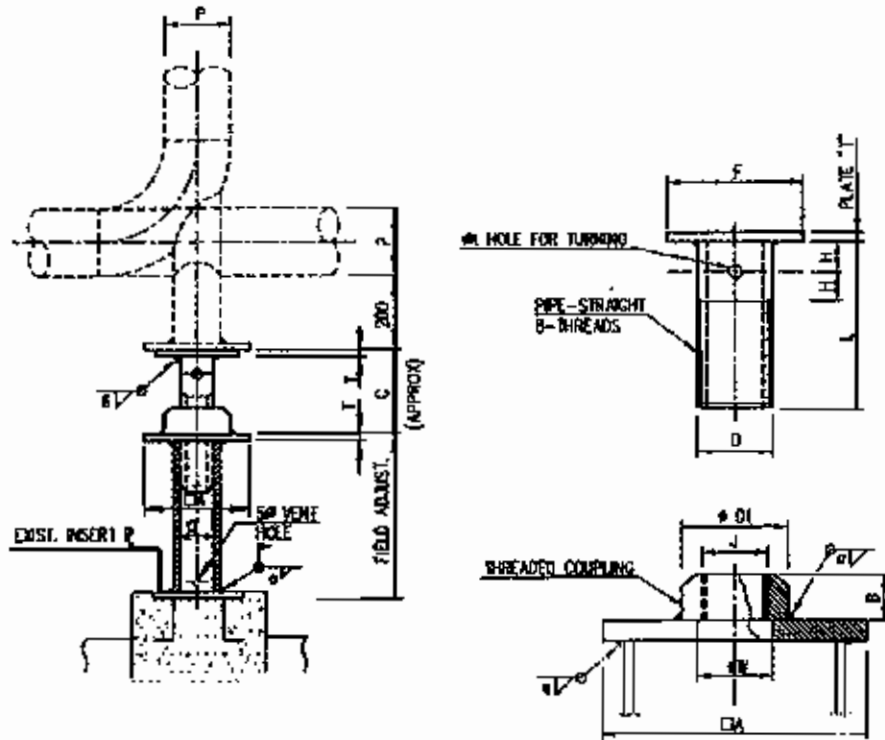
PIPE SIZE	r	L	L1	UNIT (mm)					
				COLD INSULATION THK "1"					
				25-50	51-100	101-150	151-200	201-250	251-300
				H=50	H=100	H=150	H=200	H=250	H=300
				R					
1/2"	11	370	310	61	111	161	-	-	-
3/4"	14	370	310	84	114	184	-	-	-
1"	17	370	310	87	117	187	-	-	-
1-1/2"	25	370	310	75	125	175	225	-	-
2"	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	520	460	609	659	709	759	809	859
48"	610	520	460	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	460	812	862	912	962	1012	1062

NOTE

1. MATERIAL
 - URETHANE FOAM : SEE DWG. NO. ST-A4-1022
 - STRUCTURAL CRADLE : A283 GRC W/10% DP 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, S5-21, S5-22, SV-52

PIPING SUPPORT ATTACHMENT DWG. ST-A4-102X(1/4) ADJUSTABLE STANCHION ADS (ONE BOLT WITH THREAD COUPLING TYPE) REV. 07



PIPE SIZE (NPS)	SUPPORT COLUMN (NPS)	ØA	B	C	D	WGT	F	H	J x n	ØK	L	T	ØW	a	ALLOW. LOAD (Kg)	WEIGHT (kg)
1-1/2"	3"	140	35	100	1" SCH160	80	100	25	1-5/16" x 8	18	140	12	38	6	500	14.5
2"	3"	140	35	100	1" SCH160	80	100	25	1-5/16" x 8	18	140	12	38	6	500	14.5
3"	3"	140	35	100	1" SCH160	90	100	25	1-5/16" x 8	18	140	12	38	6	500	14.5
4"	3"	140	60	140	2" SCH160	120	140	30	2-3/8" x 8	30	180	14	64	6	1000	18.7
6"	4"	180	60	140	2" SCH160	120	140	30	2-3/8" x 8	30	180	14	64	6	1000	21.5
8"	4"	180	60	140	2" SCH160	120	140	30	2-3/8" x 8	30	180	14	64	6	1000	21.5
10"	6"	210	90	180	3" SCH160	150	180	40	3-1/2" x 8	36	220	16	94	9	4000	39.5
12"	6"	260	90	180	3" SCH160	150	180	40	3-1/2" x 8	36	220	16	94	9	4500	53.8
14"	6"	260	90	180	3" SCH160	150	180	40	3-1/2" x 8	36	220	16	94	9	4500	53.8
16"	10"	320	115	215	4" SCH160	180	200	40	4-1/2" x 8	50	250	20	118	9	8000	76.3
18"	10"	320	115	215	4" SCH160	180	200	40	4-1/2" x 8	50	250	20	118	9	5000	76.3
20"	12"	350	115	215	4" SCH160	180	200	40	4-1/2" x 8	50	250	20	118	9	5000	69.8
24"	12"	350	115	215	4" SCH160	180	200	40	4-1/2" x 8	50	250	20	118	9	5000	69.8

NOTE

1. USE THIS SUPPORT ON PUMP SUCTION AND DISCHARGE LINE.

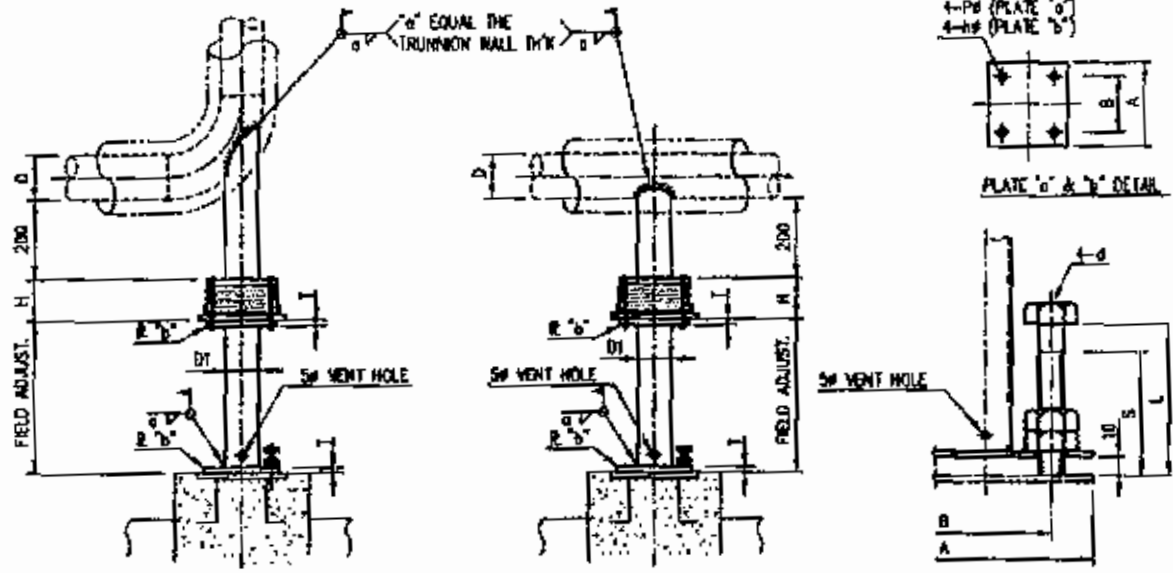
3. FOR APPLICATION ON

2. MATERIAL

RF-37, RF-47

- PIPE : A106 GR.B
- COUPLING : A36
- PLATE : A283 GR.C

PIPING SUPPORT ATTACHMENT DWG. ST-A4-1023(4/4) ADJUSTABLE STANCHION ADS (FOUR BOLT TYPE WITH URETHANE FOAM) REV. 07

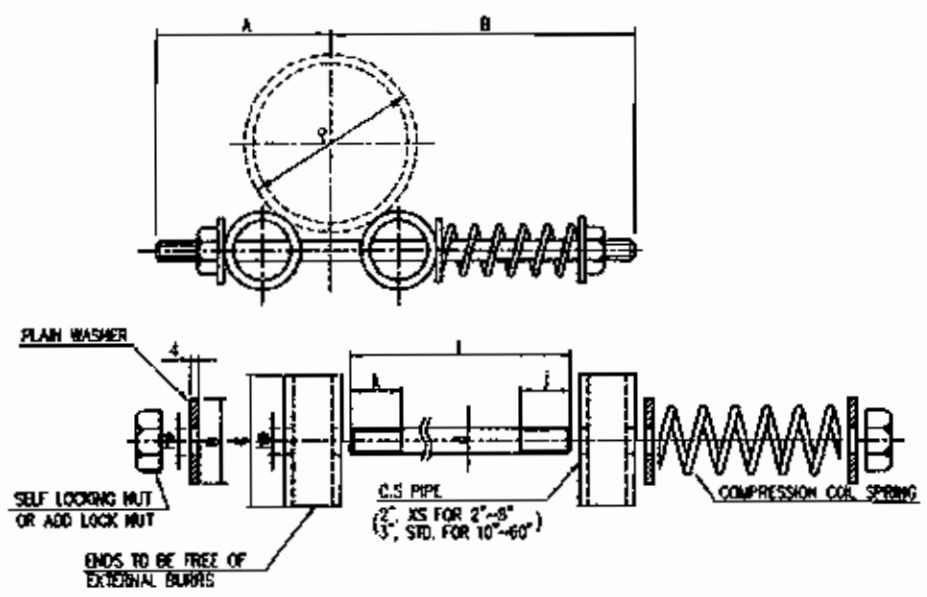


(UNIT : MM)

PIPE SIZE (D)	ALLOW LOAD (KG)	D1	A	B	Γ	Α	d	L	S	H	WEIGHT (KG)	REMARK
ADA-1-1/2"	2000	1-1/2"	140	90	6	18	5/8"	75	65	104	2.85	
2"	2000	1-1/2"	140	90	6	18	5/8"	75	65	104	3.05	
2-1/2"	2000	2"	140	90	8	18	5/8"	75	65	104	3.67	
3"	2000	2"	140	90	8	18	5/8"	75	65	104	4.05	
3-1/2"	2000	2"	140	90	9	18	5/8"	75	85	104	4.43	
4"	2000	2"	140	90	9	18	5/8"	75	85	104	5.03	
5"	2000	4"	150	120	8	18	5/8"	75	85	111	7.5	
6"	2000	4"	150	120	12	18	5/8"	75	85	111	13.1	
10"	2000	6"	210	160	12	18	5/8"	75	85	114	16.7	
12"	3000	8"	280	200	13	22	3/4"	85	75	117	25.1	
14"	3000	8"	280	200	12	22	3/4"	85	75	117	29.2	
16"	3000	10"	320	250	14	22	3/4"	85	75	117	34.8	
18"	3000	10"	320	250	14	22	3/4"	85	75	117	38.7	
20"	3000	12"	350	280	16	22	3/4"	85	75	117	42.1	
22"	3000	12"	350	280	15	22	3/4"	85	75	117	44.8	
24"	3000	12"	350	280	16	22	3/4"	85	75	117	47.5	

NOTE

1. USE THIS SUPPORT ON PUMP SUCTION AND DISCHARGE LINE.
2. MATERIAL
 - TRUNNION : SAME AS RUN PIPE MATERIAL
 - COLUMN : A106 GR.B
 - PLATE : A36
 - BOLT/NUT : A307 GR.B / A563 GR.A WITH GALVANIZED
3. FOR APPLICATION ON DF-43, RF-43



UNIT (mm)

PIPE SIZE NPS "P"	A	B	C	n#	BOLT/NUTS		PIPE SIZE NPS "P"	A	B	C	n#	BOLT/NUTS	
					d(UNC)xLxpk	D						d(UNC)xLxpk	D
2"	120	180	130	14	1/2"x300x100x60	35	30"	240	370	230	27	1"x610x190x80	64
3"	120	180					32"	240	370				
4"	120	180					34"	265	395				
5"	140	210					36"	265	395				
6"	140	210	38"	265	395								
10"	200	270	22	3/4"x350x130x60	51	40"	265	395					
12"	200	270				42"	265	395					
14"	200	270				44"	265	395					
16"	220	290				46"	265	395					
18"	220	290	27	3/4"x510x130x70	64	48"	290	420					
20"	220	290				50"	290	420					
24"	240	370				52"	290	420					
26"	240	370				54"	290	420					
28"	240	370				60"	290	420				1"x710x190x80	

SPECIFICATION OF COIL SPRING

UNIT (mm)

PIPE SIZE	DEFLECTION TO SOLID HEIGHT	LOAD FULLY COMPRESSED (Kg)	SPRING			
			SPRING RATE (kg/mm)	MAX O.D.	WH ID	MAX FREE HEIGHT
2" - 4"	25	205	8.2	27	13	64
6" - 20"	50	730	29.2	76	40	152
24" - 60"	102	1230	24	102	52	254

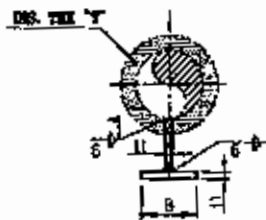
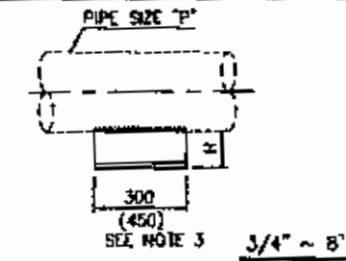
NOTE

1. MATERIAL
 - BOLT/NUT - A307 Gr.B-CALV. / A563 GRA-CALV. WITH SELF LOCKING NUT
 - PIPE : API 5L Gr.B
 - PLAIN WASHER A36 GALVANIZED
2. FOR APPLICATION ON
SF-71

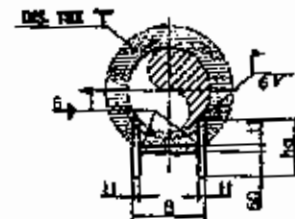
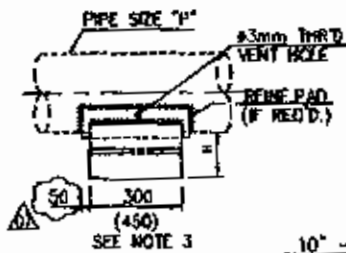
PIPING SUPPORT STANDARD DWG. ST-A4-1101 (1 OF 2)

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

REV
D7



PIPE SIZE NPS "P"	STEEL #		ALLOW. LOAD(Kg)	WEIGHT (kg)
	H	B		
3/4" ~ 2-1/2"	100		650	4.2
3" ~ 6"	100	150	1370	5.3
		130	1370	5.3
2" ~ 2-1/2"	100		600	3.3
	150	150	940	6.4
		150	940	6.4
2" ~ 2-1/2"	150		600	2.4
	200	150	710	7.4
		150	710	7.4



PIPE SIZE NPS "P"	H	ha	STEEL #		ALLOW. LOAD (kg)	WEIGHT (kg)
			B	I		
10"	100	123	150	9	7200	8.4
12"		126		8500	9.6	
14"		123	200	9	8000	9.5
16"		120		5500	9.3	
18"		149		4500	16.9	
20"		143	300	12	4000	16.6
22"		136			3500	16.3
24"		135			3000	16.1
10"	172	150			9	5500
12"	150	185		5000	12.1	
14"		181	200	9	4500	11.9
16"		176		4000	11.7	
18"		198		3500	19.3	
20"		191	300	12	3000	19.3
22"		186			2500	19
24"		182			2300	18.9

PIPE SIZE NPS "P"	H	ha	STEEL #		ALLOW. LOAD (kg)	WEIGHT (kg)
			B	I		
10"	200	223	150	9	5300	12.6
12"		224		5000	13.8	
14"		223	200	9	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		4700	16.3	
14"		281	200	9	4500	16.2
16"		278		4000	15.9	
18"		298		3500	25.3	
20"		291	300	12	3000	24.9
22"		288			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 A672 GR. B65, 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. B A671 GR. C60, CL22	A516 GR. 60

- OTHERS PART : A36

2. SHOE HEIGHT

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

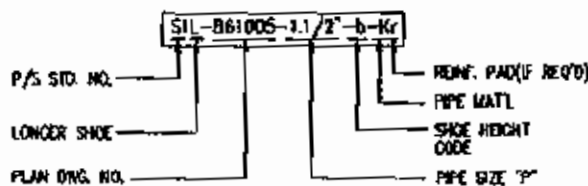
3. WHEN PIPE LONGITUDINAL EXPANSION EXCEEDS 300 mm, A LONGER SHOE WILL BE USED AND DESIGNATED BY ADDING AN "L" TO THE END OF SYMBOL.

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

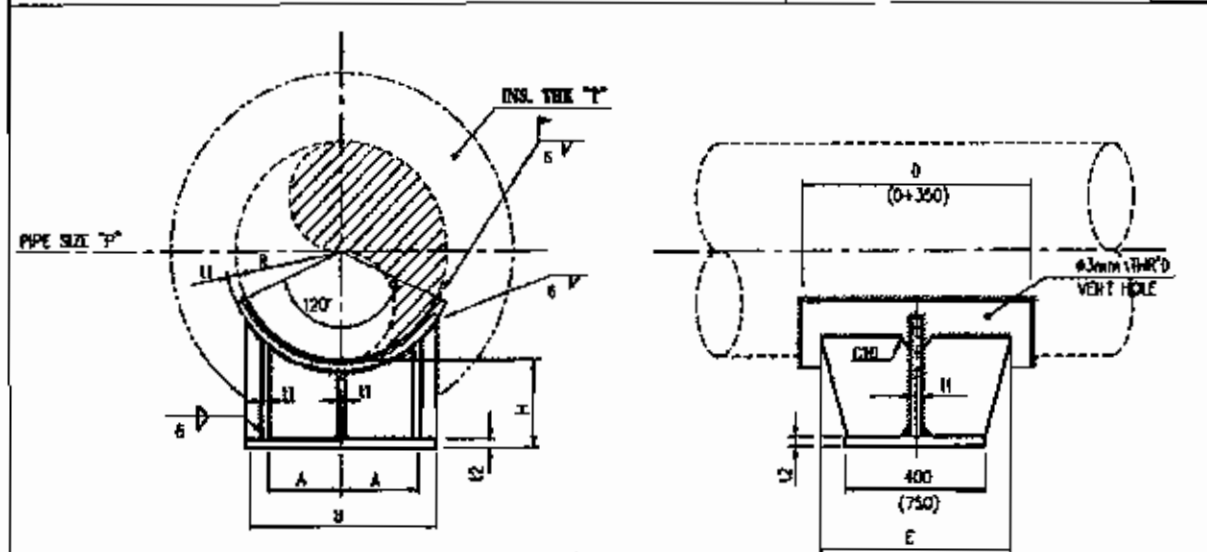
5. FOR LINES 20" & OVER CARBON STEEL PIPE AND THOSE WITH WALL THICKNESS LESS THAN STANDARD WEIGHT SHALL BE CHECKED TO DETERMINE THE NEED FOR REINFORCING PAD.

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

SYMBOL & CODING



ISO



26" & LARGER

SEE NOTE 3 FOR DIMENSIONS IN ()
UNIT (mm)

PIPE SIZE NPS "	B	A	H	E	INS. THK	D	R	I1	I2	WEIGHT (kg)				ALLOWABLE LOAD (kg)			
										H=100	H=150	H=200	H=250	H=100	H=150	H=200	H=250
26"	500	200		450	550	330	9	12	81	87	74	80					
28"	530	215		450	550	356	9	12	85	71	76	84					
30"	580	240		450	550	381	9	12	70	77	83	90					
32"	610	255		450	550	407	9	12	74	88	87	94					
34"	660	280		450	550	432	9	12	79	86	93	100					
36"	690	295	H=100	490	550	457	9	12	83	90	97	104	17,000	15,000	14,000	13,000	
40"	760	330	H=150	500	600	508	9	12	96	104	111	119					
42"	800	355	H=200	500	600	533	9	12	102	109	117	125					
44"	840	370	H=250	500	600	559	9	12	106	114	121	129					
48"	920	410		500	600	610	9	12	115	124	132	140					
52"	1000	450		500	600	660	12	16	166	177	189	200					
54"	1040	470		500	600	686	12	16	172	184	195	207					
60"	1150	525		550	650	762	12	16	200	213	225	238	19,300	18,100	17,000	16,100	
66"	1270	585		550	650	838	12	16	221	234	247	260					
72"	1390	645		550	650	914	12	16	243	256	270	283					
80"	1540	720		550	650	1016	12	16	270	284	298	312					

NOTE

1. MATERIAL

- PND. SAME AS RUN PIPE OR MAT'L TABLE.

CODE	RUN PIPE	PARTS DIRECTLY WELDED TO PIPE
K	A306 GR.B A307 GR. B05, CL.22 API 5L GR.B API 5L GR. 2S2 API 5L GR. 2S5 API 5L GR. 370	A283 GR.C
X	A312 TP316L	A240-TP316L
L	A333 GR.B A671 GR.CC60, CL.22	A516 GR. 60

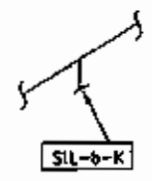
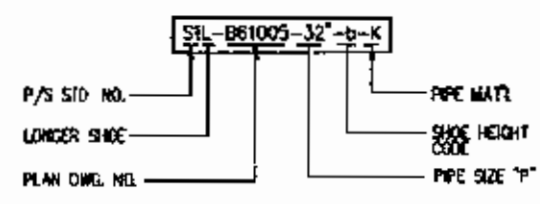
- OTHER PARTS : A36

2. SHOE HEIGHT

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

3. WHEN PIPE LONGITUDINAL EXPANSION EXCEEDS 150 mm, A LONGER SHOE WILL BE USED AND DESIGNATED AN "L" TO THE END OF SYMBOL.

SYMBOL & CODING

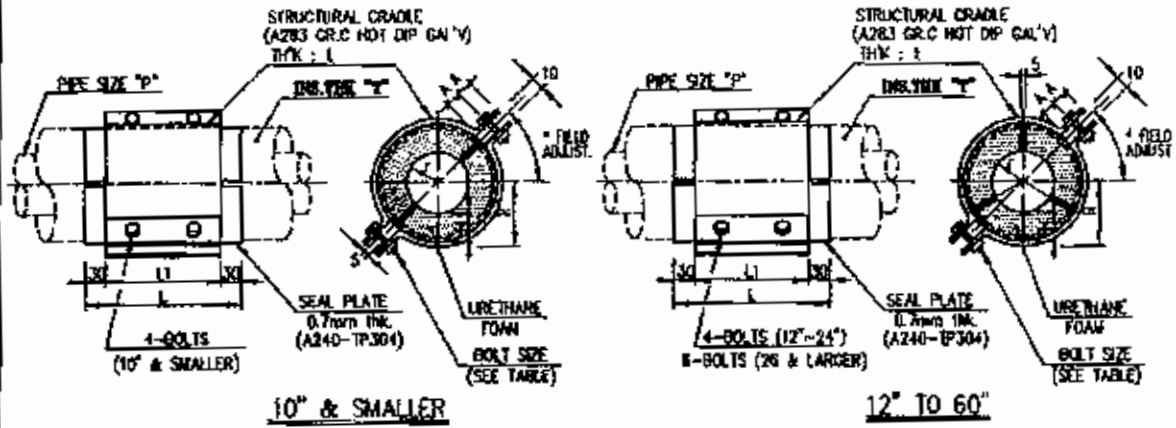


ISO

PIPING SUPPORT STANDARD DWG. ST-A4-1104

CRADLE S-4
(FOR COOL INSULATED PIPE, RESTING TYPE)

REV 07

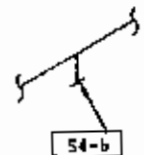
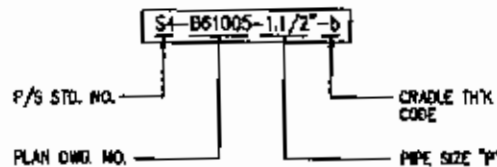


UNIT (mm)												UNIT (mm)															
COLD INSULATION (BY T)												COLD INSULATION (BY T)															
CRADLE R/YK												CRADLE R/YK															
SHOE HEIGHT CODE												SHOE HEIGHT CODE															
PIPE SIZE	r	L	L1	a	b	c	d	e	f	g	h	PIPE SIZE	r	L	L1	a	b	c	d	e	f	g	h				
1/2"	21	310	250	65	115	185	-	-	-	-	-	4	12750	18	307	354	420	380	329	359	409	459	509	559	5	20260	30
3/4"	14	310	250	67	117	167	-	-	-	-	-	4	12750	18	24	305	420	380	367	411	461	511	561	611	6	20260	30
1"	17	340	280	71	121	171	-	-	-	-	-	4	12750	18	26	371	420	380	386	436	486	536	586	636	6	20260	30
1-1/2"	26	330	280	76	126	176	226	-	-	-	-	4	12750	18	28	356	420	380	412	462	512	562	612	662	6	20260	30
2"	31	370	310	84	134	184	234	-	-	-	-	4	12750	18	30	381	420	380	437	487	537	587	637	687	5	20260	30
2-1/2"	37	370	310	92	142	192	242	-	-	-	-	5	12750	18	32	407	420	380	463	513	563	613	663	713	6	20260	30
3"	45	420	360	100	160	210	260	-	-	-	-	5	12750	18	34	432	420	380	488	538	588	638	688	738	6	20260	30
4"	59	420	360	112	162	212	262	-	-	-	-	5	12750	18	36	458	420	380	513	563	613	663	713	763	6	20260	30
6"	85	420	360	130	180	230	280	-	-	-	-	5	12750	18	40	508	420	380	564	614	664	714	764	814	8	20260	30
8"	110	420	360	145	215	265	315	365	-	-	-	5	16260	25	42	534	420	380	589	639	689	739	789	839	6	20260	30
10"	157	420	360	192	242	292	342	392	-	-	-	5	16260	25	44	559	520	460	618	668	718	768	818	868	9	24270	40
12"	182	420	360	217	267	317	367	417	-	-	-	5	20260	30	48	610	520	460	669	719	769	819	869	919	9	24270	40
14"	178	420	360	233	283	333	383	433	-	-	-	5	20260	30	50	661	520	460	722	772	822	872	922	972	12	24270	40
16"	204	420	360	258	308	358	408	458	-	-	-	5	20260	30	54	666	520	460	740	796	840	896	940	996	12	24270	40
18"	229	420	360	294	334	384	434	484	-	-	-	5	20260	30	56	711	520	460	773	823	873	923	973	1023	12	24270	40
															60	782	520	460	824	874	924	974	1024	1074	12	24270	40

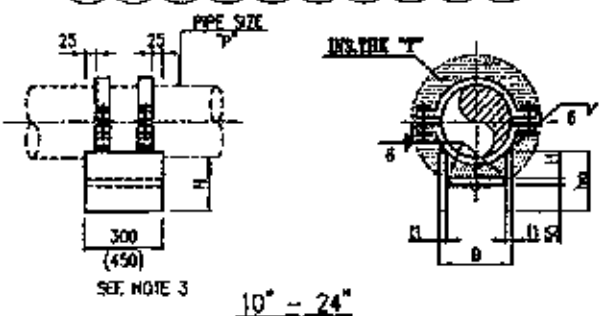
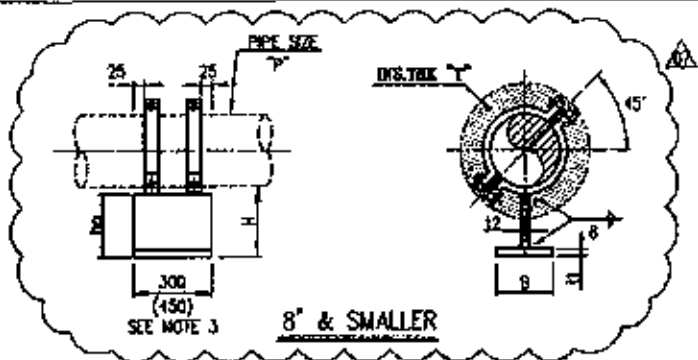
NOTE

- T. MATERIAL
- URETHANE FOAM : SEE DWG. NO. ST-A4-1022
- BOLT/NUT : A307 CREB / A563 GRA GALVANIZED

SYMBOL & CODING



ISO



UNIT (mm)

PIPE SIZE	H	ho	STEEL R	ALLOW. LOAD (kg)	WEIGHT (kg)
			B II		
2"	100	94	100	900	5.4
3"		94	9		6.8
4"		94			10.3
6"		88			18.3
8"		118		20.9	

PIPE SIZE	H	ho	STEEL R	ALLOW. LOAD (kg)	WEIGHT (kg)
			B II		
2"	150	144	100	1500	6.5
3"		144	9		8
4"		144			11.4
6"		138			19.4
8"		168		22	

PIPE SIZE	H	ho	STEEL R	ALLOW. LOAD (kg)	WEIGHT (kg)
			B II		
2"	200	194	100	2000	8.6
3"		194	9		9
4"		194			12.4
6"		188			20.4
8"		218		23	

UNIT (mm)

PIPE SIZE MPS T ¹	H	ho	STEEL R	ALLOW. LOAD (kg)	WEIGHT (kg)
			B II		
10"	100	107	150	7400	38.4
12"		110	9		43.4
14"		104			80.9
16"		108	12		65.3
18"		130			77.5
20"		121			119.4
22"		116			118.5
24"		113	123.3		
10"	150	156	150	6300	40.5
12"		169	9		45.9
14"		162			83.3
16"		157	12		67.7
18"		179			80.3
20"		169			113.1
22"		164			118.6
24"		161	126		

UNIT (mm)

PIPE SIZE MPS T ¹	H	ho	STEEL R	ALLOW. LOAD (kg)	WEIGHT (kg)
			B II		
10"	200	207	150	5300	42.6
12"		235	9		47.6
14"		220			65.1
16"		214	12		69.6
18"		210			83.2
20"		204			118
22"		201			122.5
24"		199	129		
10"	250	257	150	4500	44.7
12"		269	9		50.1
14"		249			67.8
16"		248	12		71.9
18"		275			85.9
20"		267			118.7
22"		263			125.2
24"		260	131.6		

NOTE

1. MATERIAL

- CLAMP, BOLT/NUT

CODE	TEMP.	CLAMP	BOLT & NUT
K	~350°C	A283 GR.C	A307 ORB/A563 GRA GALVANIZED
L	~420°C	A515 GR.80	A193 B7/A191 2H

- SHOE : A36

2. SHOE HEIGHT

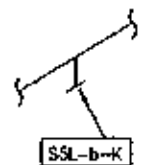
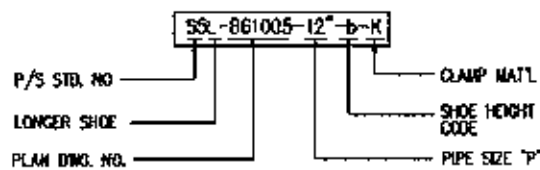
H	INS. THK	CODE	H	INS. THK	CODE
100	UP TO 75	b	200	126 TO 175	d
150	76 TO 125	c	250	176 TO 225	e

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.

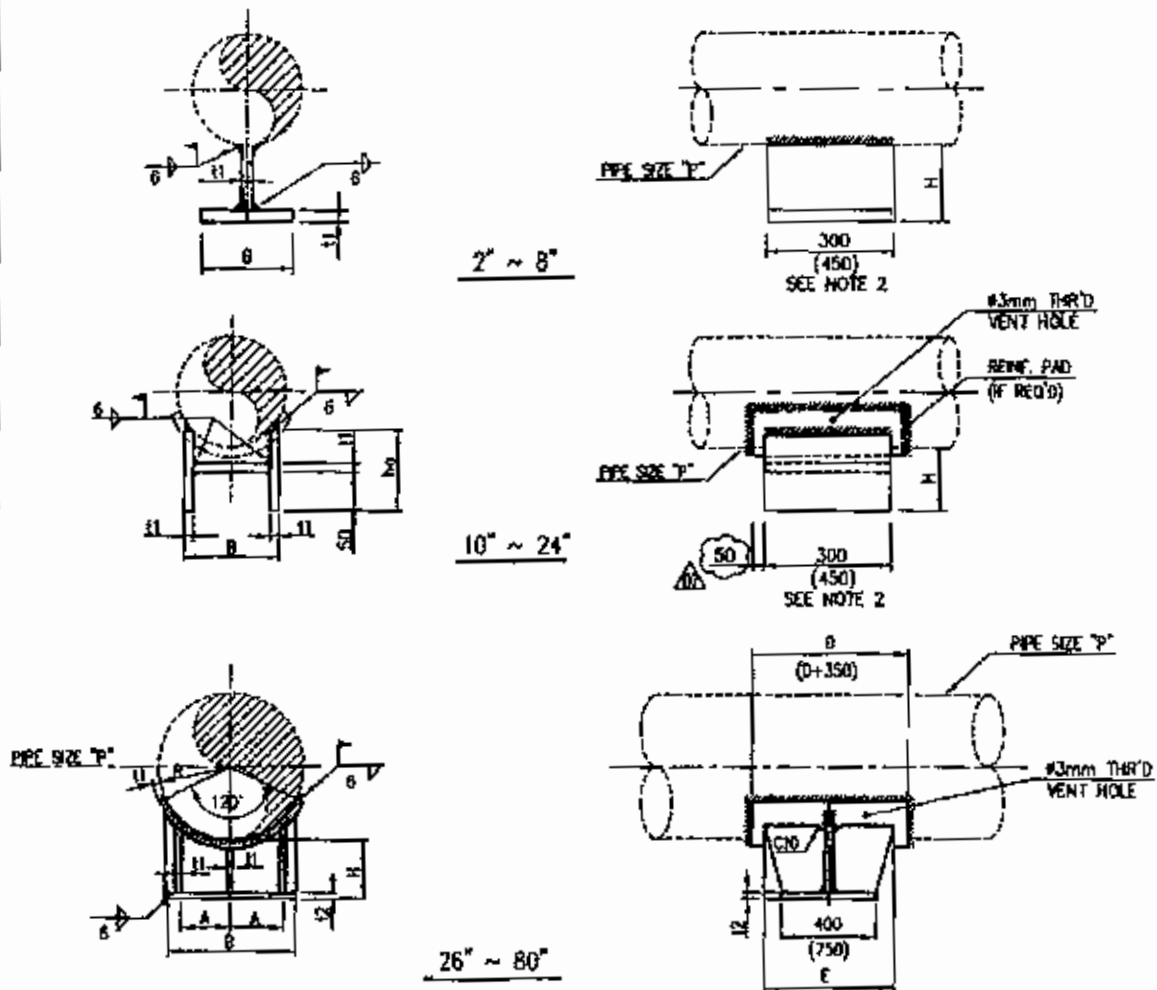
4. SEE DWG. NO. ST-A4-10146 FOR THE DETAIL OF CLAMP.

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

SYMBOL & CODING



PIPING SUPPORT STANDARD DWG.	ST-A4-1107	SHOE S-6 (FOR BARE AND SLOPED LINE)	REV D7
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NOTE

1. MATERIAL

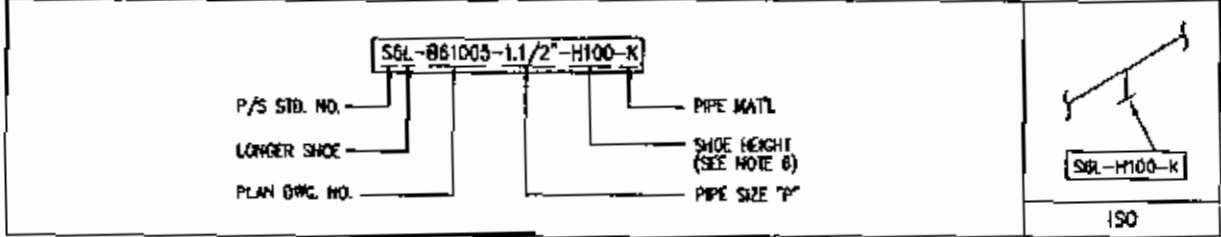
- PARTS DIRECTLY WELDED TO PIPE : SAME AS RUN PIPE OR MAT'L TABLE.

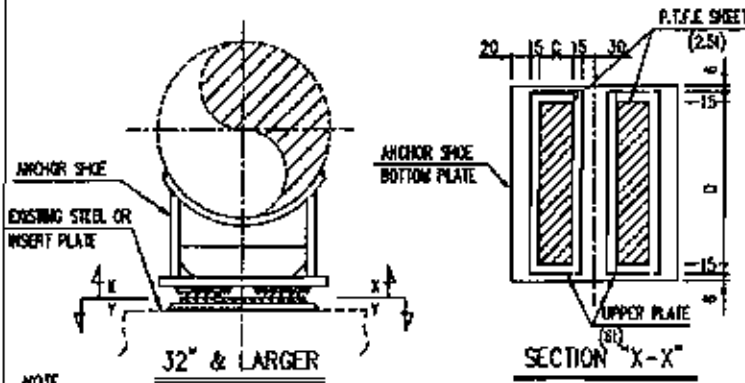
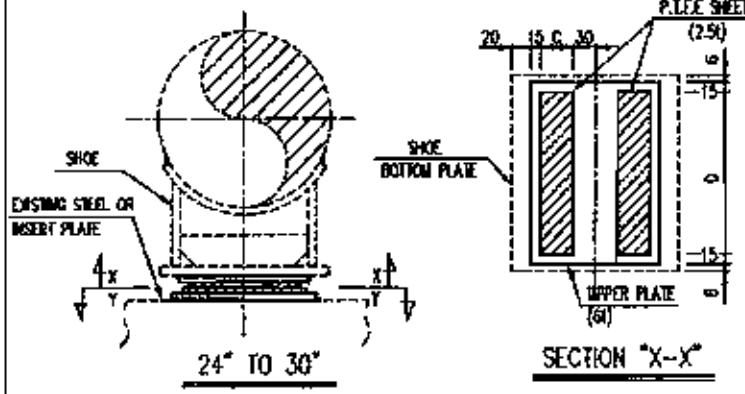
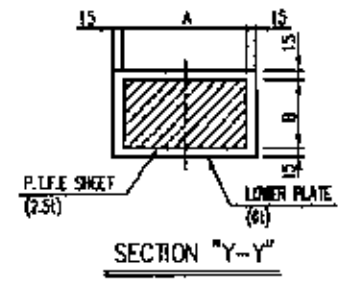
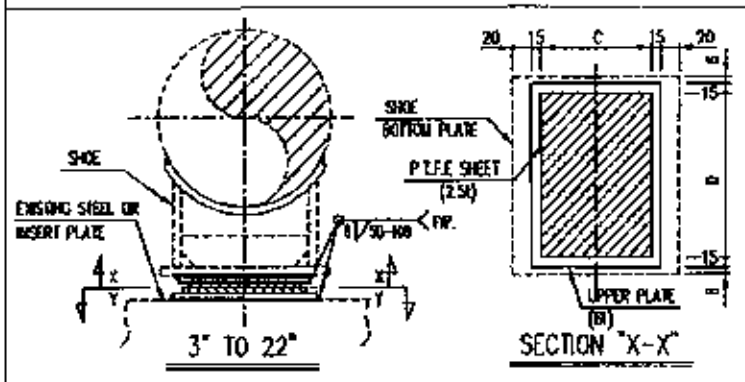
CODE	RUN PIPE	PARTS DIRECTLY WELDED TO PIPE
K	A106 GR.B A672 GR. 065, CL.22 API 5L GR.B API 5L GR. X52 API 5L GR. X65 API 5L GR. X70	A283 GR.C
X	A362 TP316L	A240-GR.316L
L	A333 GR.8 A671 GR.CC80, CL.22	A516 GR.60

- OTHERS PART : A36

2. WHEN PIPE LONGITUDINAL EXPANSION EXCEEDS 100mm, A LONGER SHOE WILL BE USED AND DESIGNATED BY ADDING AN "L" TO THE END OF SYMBOL.
3. SEE DWG. NO. ST-A4-1106 FOR THE DETAIL OF SHOE.
4. REINF. PADS ARE REQUIRED FOR 10" & LARGER STAINLESS STEEL PIPE.
5. FOR LINES 20" THRU 24" ARE CARBON STEEL AND THOSE WITH WALL THICKNESS LESS THAN STANDARD HEIGHT SHALL BE CHECKED TO DETERMINE THE NEED FOR REINFORCING PAD.
6. SHOE HEIGHT CODE CAN BE USED ADJUSTABLE VALUE.

SYMBOL & CODING





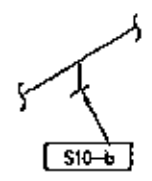
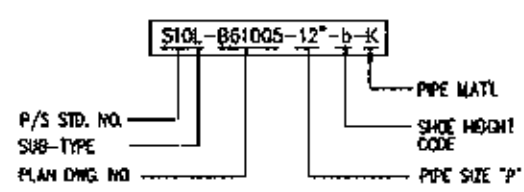
UNIT (mm)

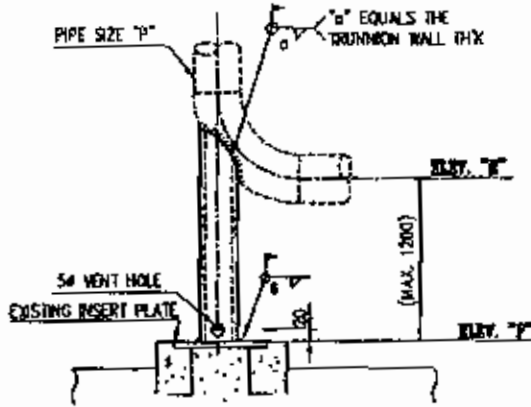
PIPE SIZE NPS "P"	A	B	C	D	D'	WEIGHT (Kg)
3"	100	70	80	358	558	3.3
4"	100	70	80	358	558	3.3
6"	100	70	80	358	558	3.5
8"	100	70	80	358	558	3.5
10"	100	70	80	358	708	3.5
12"	150	70	130	358	708	4.6
14"	150	70	130	358	708	4.6
16"	250	70	230	358	708	5.1
18"	250	70	230	358	708	7.0
20"	250	70	230	358	708	7.0
24"	350	70	135	358	708	9.4
26"	450	70	185	358	708	11.7
28"	480	70	200	358	708	12.4
30"	530	100	225	358	708	14.4
32"	580	100	225	358	708	15.1
34"	610	100	250	358	708	16.4
36"	640	100	265	358	708	17.1
40"	710	100	300	358	708	18.9
42"	780	100	325	358	708	20.1

D' IS LONGITUDINAL LENGTH OF BOTTOM PIPE PAD WHEN LONG TYPE SHOE IS USED.

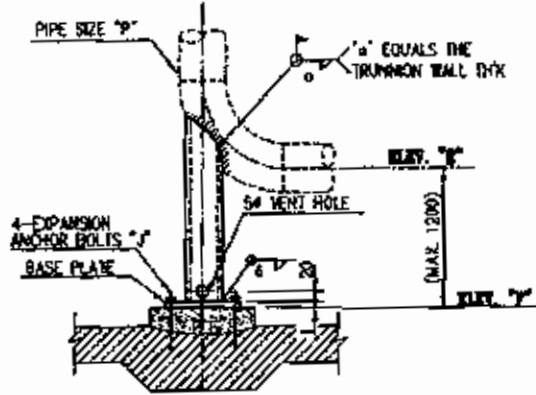
- NOTE
1. MATERIAL
 - UPPER & LOWER PLATE : A283 OR L OR EQ.
 - SLIDING PAD : VIRGIN PIPE FOR GENERAL USE (BEARING PRESSURE >70 kg/cm²), SUB TYPE = L
GLASS FILLED PIPE FOR HEAVY DUTY (BEARING PRESSURE >140 kg/cm²), SUB TYPE = H
 2. PIPE PAD SHALL BE BONDED TO THE BACKING PLATE USING A HOT SETTING EPOXY RESIN ADHESIVE.
 3. PIPE OPERATING TEMPERATURE SHALL NOT EXCEED 200°C.
 4. SEE DWG NO ST-A4-1101 FOR THE DETAIL OF SHOE.

SYMBOL & CODING

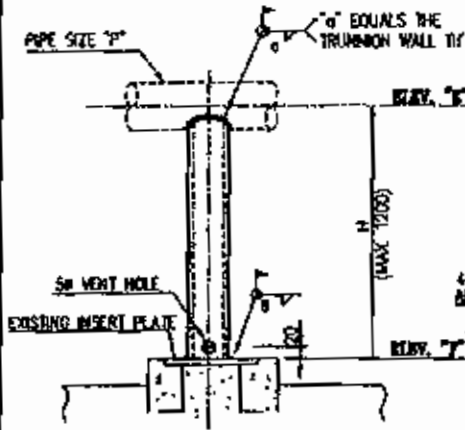




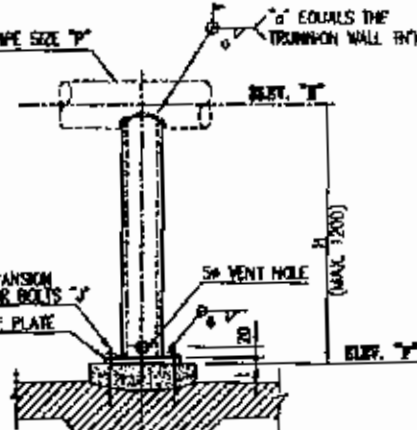
TYPE-7 (ON FOUNDATION)



TYPE-7 (ON PAVING)



TYPE-8 (ON FOUNDATION)



TYPE-8 (ON PAVING)

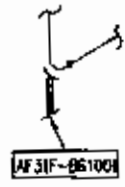
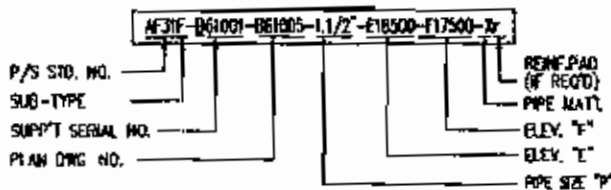
PIPE SIZE NPS "P"	SUPPORT PIPE	ALLOW LOAD(kg)
1-1/2"	1"	SEE DWG NO ST-A4-0004 (4 OF 5) (5 OF 5) FOR MAXIMUM ALLOWABLE LOADS
2"	1-1/2"	
3"	2"	
4"	2"	
6"	4"	
8"	4"	
10"	6"	
12"	6"	
14"	8"	
16"	10"	
18"	10"	
20"	12"	
24"	12"	
26"	14"	
28"	14"	
30"	16"	
32"	16"	
34"	18"	
36"	18"	
40"	20"	
42"	20"	

NOTE:
1. MATERIAL
- FOR SUPPORT PIPE : SAME AS RUN PIPE OR MAT'L TABLE.

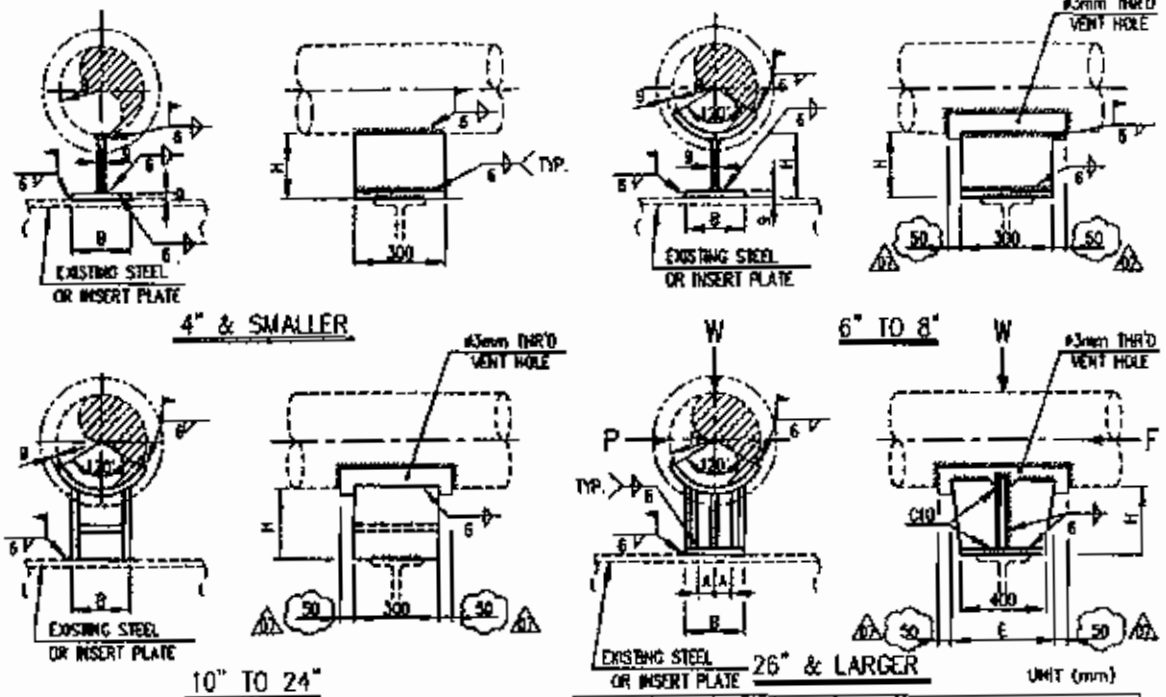
CODE	RUN PIPE	SUPPORT PIPE
X	A106 GR.B A672 GR. 805, CL.22 API 5L GR.B API 5L GR. 252 API 5L GR. 360 API 5L GR. 370	A106 GR.B
X	A312 TP304L	A312 TP316L
L	A333 GR.6 A671 GR.C060 CL.22	A333 GR.6

- SEE DWG. NO. ST-A4-1031 FOR TYPE-P & T FOR THE DETAIL OF BASE PLATE AND EXPANSION ANCHOR BOLT(DPLA)
- SEE DWG. NO. ST-A4-0004 (4 OF 5) (5 OF 5) FOR APPLICATION OF REINFORCING PAD AND TRUNNION ALLOWABLE LOADS

SYMBOL & CODING



150



NOTE

1. MATERIAL
- PAD : SAME AS RUN PIPE OR MATL. TABLE.

CODE	RUN PIPE	LAG PLATE
K	A106 GR.B	A203 GR.C
	A572 GR. 60S, CL.22	
	API 5L GR.B	
	API 5L GR. X52	
	API 5L GR. 36S	
	API 5L GR. X70	
X	A312 TP316L	A240-TP316L
L	A333 Gr.6	A516 GR 60
	A671 GR.CC80 CL22	

- OTHER PARTS : A36

2. SHOE HEIGHT

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

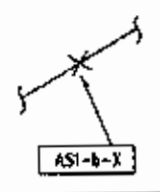
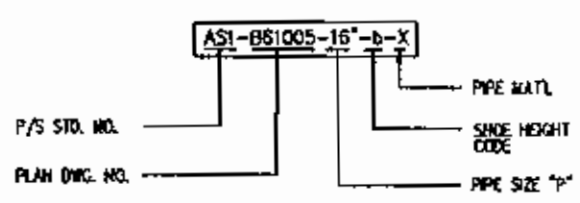
3. SEE DWG. NO. ST-A4-0003 FOR THE APPLICATION OF ALLOWABLE LOAD.

4. SEE DWG. NO. ST-A4-1101 (S-1) FOR THE DETAIL OF SHOE.

UNIT (mm)

PIPE SIZE	B	A	E	R	ALLOW. LOAD (kg)			
					H=100	H=150	H=200	H=250
1"-2"	100	-	-	31				
2-1/2"	100	-	-	37				
3"	150	-	-	45				
4"	150	-	-	58				
6"	150	-	-	85				
8"	150	-	-	110				
10"	150	-	-	137				
12"	200	-	-	162				
14"	200	-	-	178				
16"	200	-	-	204				SEE DWG. NO.
18"	300	-	-	229				ST-A4-1107 (BS-7)
20"	300	-	-	254				FOR ALLOWABLE LOADS
22"	300	-	-	280				
24"	400	-	-	305				
26"	500	200	450	330				
28"	530	215	450	356				
30"	580	240	450	381				
32"	610	255	450	407				
34"	660	280	450	432				
36"	690	295	450	458				
40"	780	330	500	508				
42"	810	355	500	534				

SYMBOL & CODING

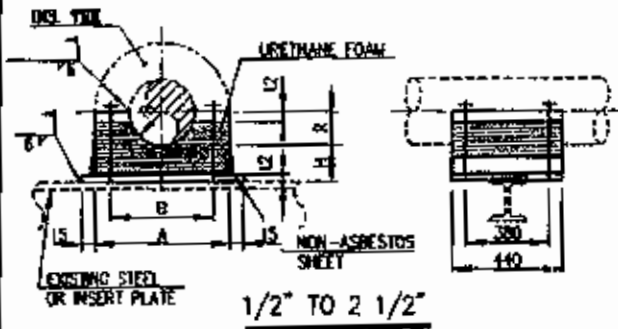


ISO

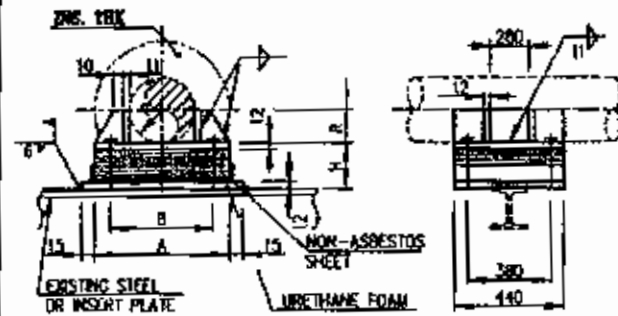
PIPING SUPPORT STANDARD DWG. ST-A4-1124

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

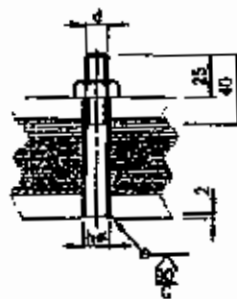
REV
07



1/2" TO 2 1/2"



3" TO 60"



METAL FOR BOLT/NUT

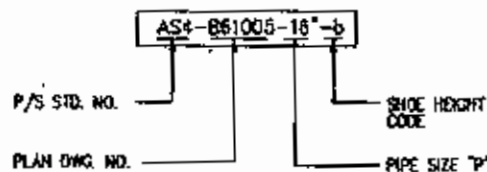
NOM. PIPE SIZE	A	B	R	b4	t1	t2	BOLT/NUT (d, LNC)	GR1 (mm)	
								ALLOW. LOAD (kg)	WEIGHT (kg)
1/2"	100	65	11	11	4.5	6	3/8"	200	4.9
3/4"	110	70	14	11	4.5	6	3/8"	650	5.4
1"	115	75	17	11	4.5	6	3/8"	650	5.6
1-1/2"	130	90	25	11	4.5	6	3/8"	650	6.1
2"	140	100	31	11	4.5	6	3/8"	650	6.5
2-1/2"	160	120	37	11	4.5	6	3/8"	650	7.1
3"	190	140	45	14	4.5	6	1/2"	1370	12.7
4"	210	165	58	14	4.5	6	1/2"	1800	14.3
6"	270	215	85	14	4.5	6	1/2"	2500	18.3
8"	320	265	110	14	6	9	1/2"	2500	32.5
10"	370	315	137	14	6	9	1/2"	4000	36.1
12"	425	370	162	14	6	9	1/2"	3800	43.3
14"	480	405	178	14	6	9	1/2"	3800	48.7
16"	530	455	204	14	6	9	1/2"	3600	53.8
18"	570	505	229	14	6	9	1/2"	3600	58.8
20"	630	555	254	14	6	9	1/2"	3800	64.3
22"	680	610	280	14	6	9	1/2"	3500	68.8
24"	740	660	305	14	6	9	1/2"	3500	75.4
26"	810	725	330	18	9	12	5/8"	3300	109.5
28"	860	775	356	18	9	12	5/8"	3300	117.1
30"	940	815	381	18	9	12	5/8"	3100	125.3
32"	970	880	407	18	9	12	5/8"	3100	131.2
34"	1020	930	432	18	9	12	5/8"	3000	138.7
36"	1070	980	458	18	9	12	5/8"	3000	146.1
40"	1180	1090	508	18	9	12	5/8"	3400	160.9
42"	1220	1150	534	22	9	12	3/4"	3400	168.7
44"	1295	1200	559	22	9	12	3/4"	3800	177.4
48"	1380	1250	610	22	9	12	3/4"	3800	191.4
52"	1470	1300	661	22	9	12	3/4"	3800	204.1
54"	1560	1455	686	22	9	12	3/4"	3600	215.4
60"	1720	1605	762	22	9	12	3/4"	3600	236.8

NOTE

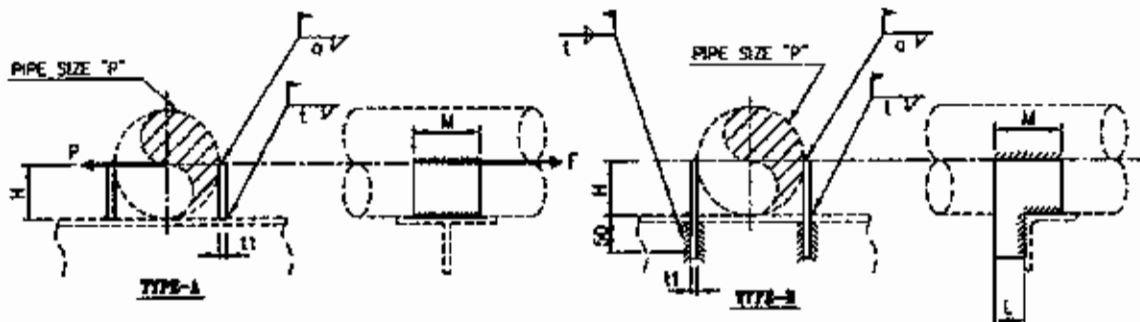
- MATERIAL
 - URETHANE FOAM : SEE DWG. NO. ST-A4-1022
 - PARTS DIRECTLY WELDED TO PIPE : A240-TP316L
 - BOLT/NUT : A320 08/A194 GR.4
 - PLATE : A516 GR. 60
 - OTHER PARTS : A36

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

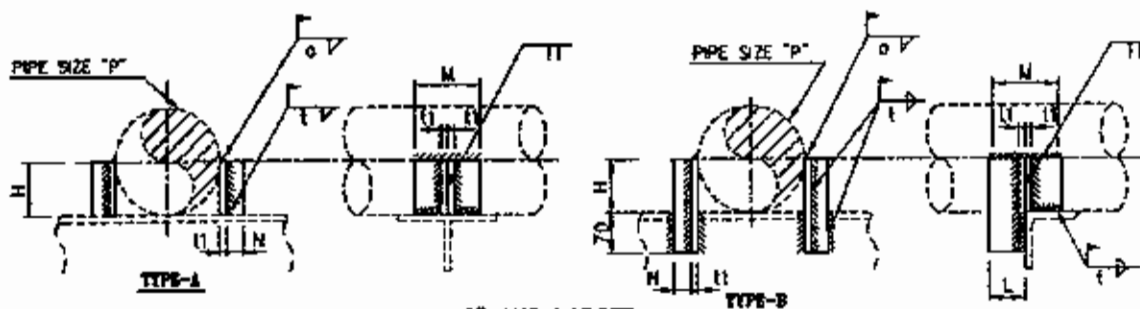
SYMBOL & CODING



ISO



4" AND SMALLER

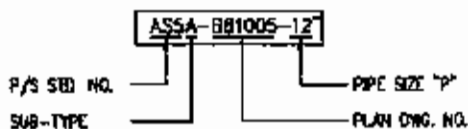


6" AND LARGER

NOTE
1. MATERIAL
- PLATE : ASSA GR.60

PIPE SIZE NPS "P"	DIMENSIONS								WEIGHT (Kg)	ALLOW LOAD (Kg)	
	M	N	L1	a	L	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	6	17	35	0.3	2250	1900	
1-1/2"	75	-	9	9	6	25	35	0.3	2250	1450	
2"	75	-	9	9	6	31	35	0.6	2250	1200	
2-1/2"	100	-	9	9	6	37	50	0.8	2250	1200	
3"	100	-	9	9	6	45	50	0.8	3000	1500	
4"	100	-	9	9	6	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	

SYMBOL & CODING

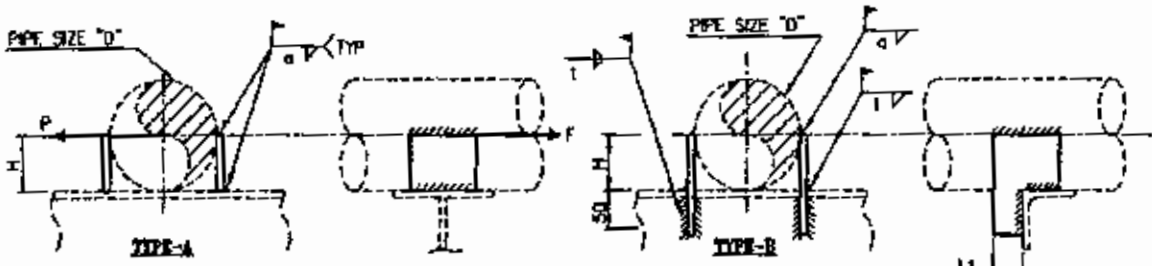


ISO

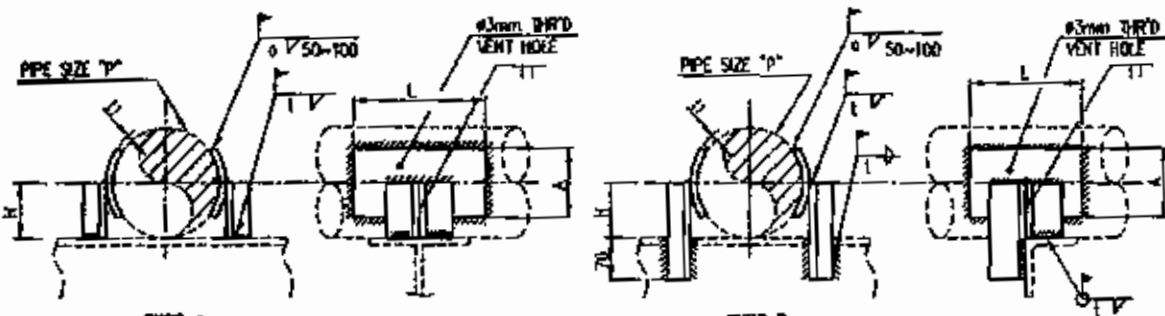
PIPING SUPPORT STANDARD DWG. ST-A4-1127

ANCHOR AS-7
(FOR S.S. BARE PIPE)

REV.
07



4" & SMALLER



6" & LARGER

NOTE

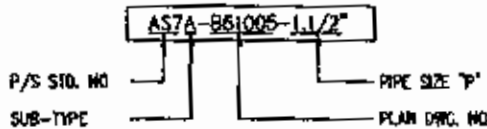
1. MATERIAL
 - ANGLE : A36
 - FB : A240 TP316L
 - REINF. PAD : SAME AS MATERIAL

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

PIPE SIZE NPS "D"	MEMBER	DIMENSIONS							ALLOW LOAD (kg)		WEIGHT (kg)
		a	t	3l	H	A	L	L1	Pmax	Fmax	
1/2"	FB 75 X 9	9	6	-	11	-	-	35	2250	2250	0.6
3/4"	FB 75 X 9	9	6	-	14	-	-	35	2250	2200	0.7
1"	FB 75 X 9	9	6	-	17	-	-	35	2250	1900	0.7
1-1/2"	FB 75 X 9	9	6	-	25	-	-	35	2250	1450	0.8
2"	FB 75 X 9	9	6	-	31	-	-	35	2250	1200	0.9
2-1/2"	FB 100 X 9	9	6	-	39	-	-	50	2250	1200	1.3
3"	FB 100 X 9	9	6	-	45	-	-	50	3000	1500	1.4
4"	FB 100 X 9	9	6	-	58	-	-	50	3000	1200	1.5
6"	2"A7	9	6	6	83	100	200	-	3150	1670	3.2
8"	2"A7	9	6	6	109	100	200	-	3150	1300	3.8
10"	2"A7	9	6	6	134	100	200	-	3150	1020	4.3

UNIT (mm)

SYMBOL & CODING



AS7A

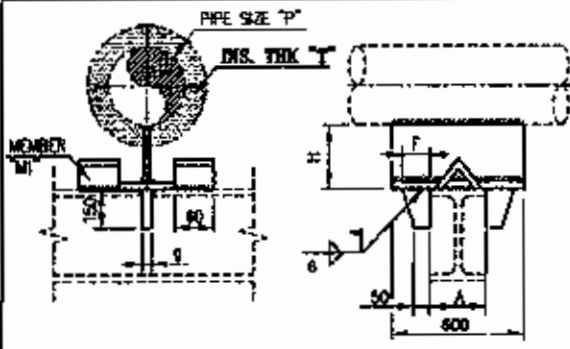
ISO

PIPING SUPPORT STANDARD DWG.

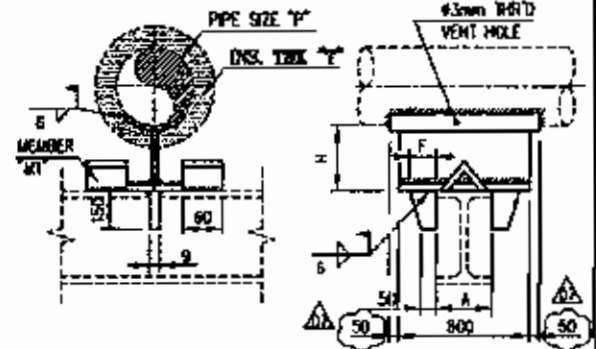
ST-A4-1157

3-WAY STOP DS-7
(FOR HOT INSULATED PIPE SHOE TYPE)

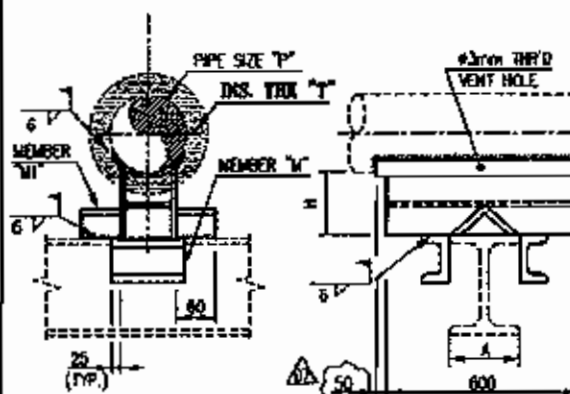
REV
07



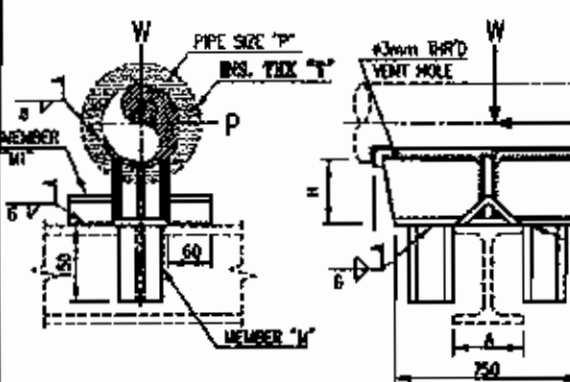
4" & SMALLER



6" TO 8"



10" TO 18"



20" & LARGER

UNIT (mm)

PIPE SIZE	F	T	MEMBER M	MEMBER MT	ALLOWABLE LOADS FOR EACH SHOE HEIGHT (kg)					
					H=100			H=150		
					Wmax	Fmax	Pmax	Wmax	Fmax	Pmax
2"	100	9	-	A6	630	1230	200	690	620	130
3"	100	9	-	A5	900	1230	200	630	630	150
4"	100	9	-	A6	1400	1230	260	1000	830	240
6"	100	9	-	A6	2100	1230	530	1400	830	360
8"	100	9	-	A6	3000	1230	1000	2700	830	360
10"-12"	-	-	C15	A7	17800	5400	1700	14100	1500	1700
14"-18"	-	-	C20	A7	17800	8300	1700	14600	2000	1700
20"-40"	-	-	H30	A7	18000	7900	1700	15200	6700	1700

PIPE SIZE	F	T	MEMBER M	MEMBER MT	ALLOWABLE LOADS FOR EACH SHOE HEIGHT (kg)					
					H=200			H=250		
					Wmax	Fmax	Pmax	Wmax	Fmax	Pmax
3"	106	9	-	A6	480	630	110	360	500	90
4"	106	9	-	A6	780	830	180	600	500	120
6"	100	9	-	A6	1100	630	270	900	500	220
8"	106	9	-	A6	2100	630	580	1700	500	490
10"-12"	-	-	C15	A7	12000	3500	1700	10000	7800	1700
14"-18"	-	-	C20	A7	12500	5700	1700	10900	4800	1700
20"-40"	-	-	H20	A7	13000	5800	1700	11400	5100	1700

NOTE

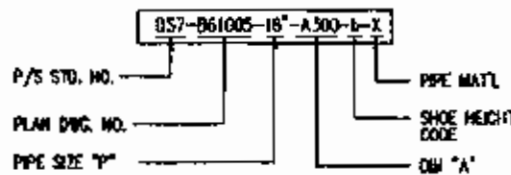
1. MATERIAL
- PLATE & SHAPE STEEL : A36
- PAD : SAME AS RUN PIPE OR WATL TABLE.

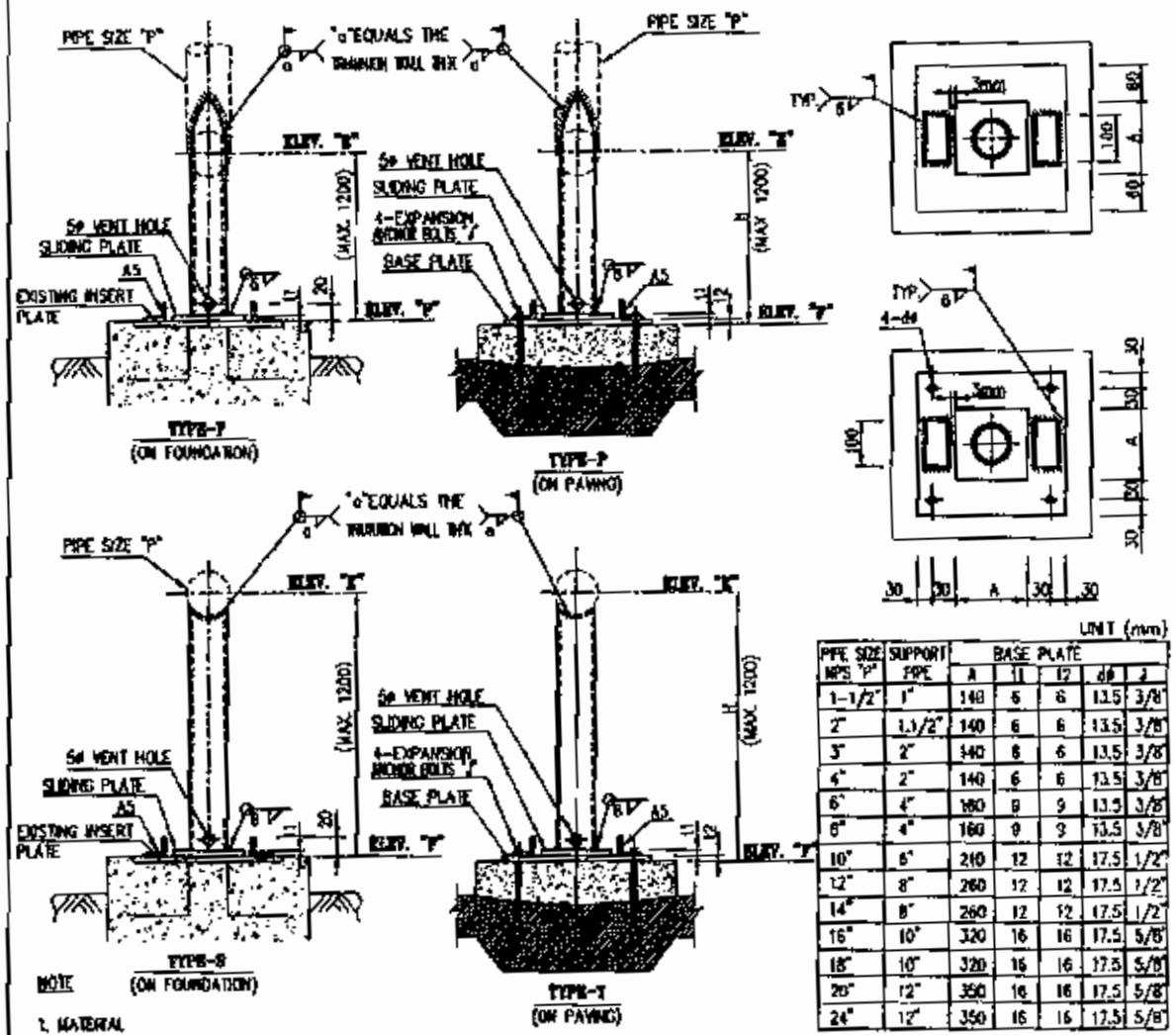
CODE	RUN PIPE	LDG PLATE
K	A105 GR.B A672 GR. B65, CL.22 API 5L GR.B API 5L GR. X52 API 5L GR. X65 API 5L GR. X70	A283 GR.C
X	A312 TP316L	A240-TP.316L
L	A333 Gr.8 A671 GR.CC80 CL.22	A516 GR. 60

2. SEE DWG. NO. ST-A4-1101 FOR THE DETAIL OF SHOE.
3. SEE DWG. NO. ST-A4-0001 FOR THE SIZE OF SHAPE STEEL.
4. SHOE HEIGHT

H	INS. THK "T"	CODE
100	UP TO 75	b
150	76 TO 125	c
200	126 TO 175	d
250	176 & OVER	e

SYMBOL & CODING





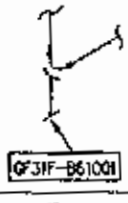
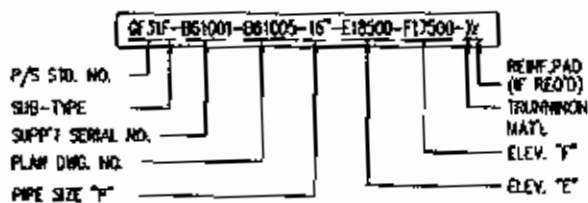
NOTE
1. MATERIAL

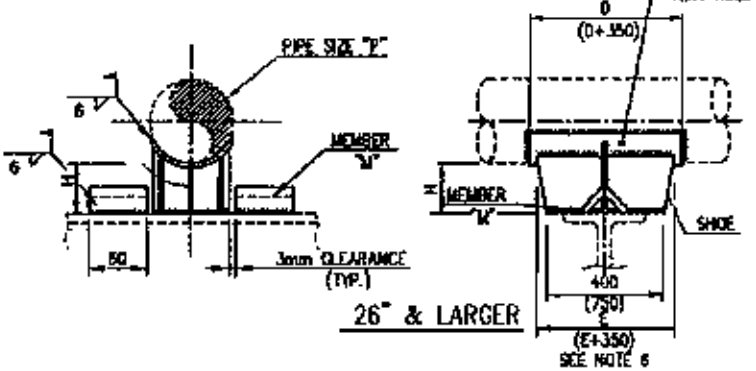
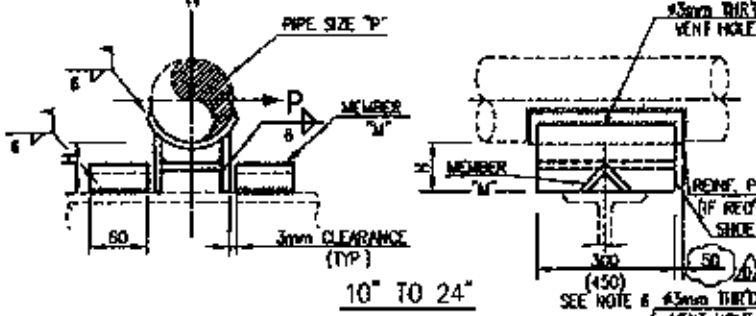
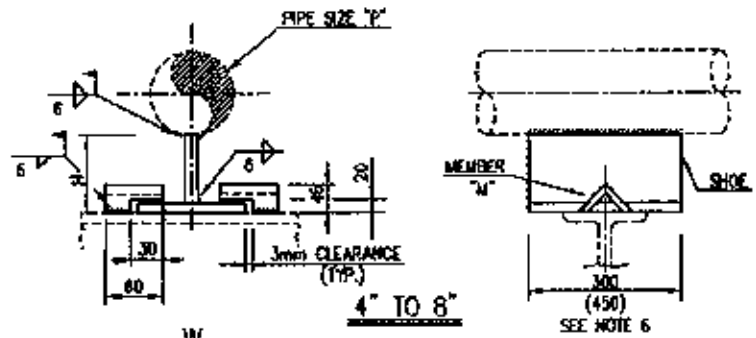
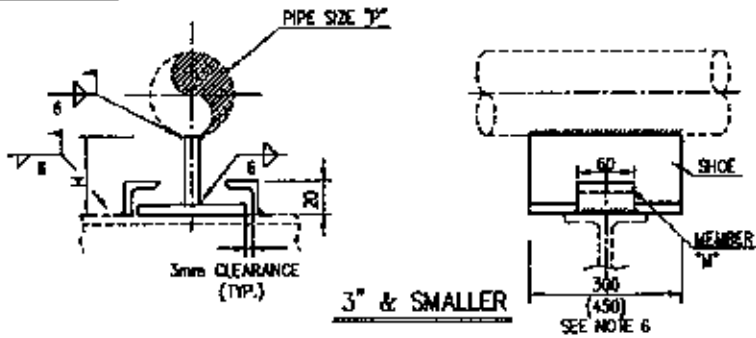
- FOR SUPPORT PIPE : SAME AS RUN PIPE OR MATL. TABLE.
- OTHERS : A36

CODE	RUN PIPE	SUPPORT PIPE
K	A106 GR.B A872 GR. BBS, CL.22 API 5L GR.B API 5L GR. X52 API 5L GR. X65 API 5L GR. X70	A106 GR.B
X	A312 TP316L	A312 TP316L
L	A333 GR.6 A871 GR.OC80 CL.22	A333 GR.6

- SEE DWG. NO. ST-A4-1032 FOR THE DETAIL OF EXPANSION ANCHOR BOLT (OPLR) OF TYPE-P & T
- SEE DWG. NO. ST-A4-0004 FOR APPLICATION OF REINFORCING PAD AND TRUNNION ALLOWABLE LOADS.
- FOR CRITICAL LINES, GAP 3mm WILL BE PROVIDED IF SO NOTED ON RELEVANT STRESS ANALYSIS DATA INPUT ; UNLESS OTHERWISE NO GAP IS ALLOWED FOR SUCH LINES AND ON RESPECTIVE ISOMETRICS THIS EXCEPTION TO BE NOTED, TOO.

SYMBOL & CODING





NOTE

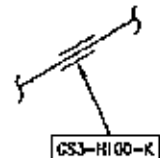
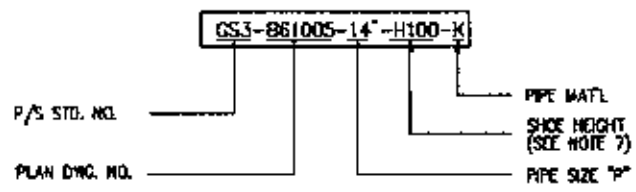
1. MATERIAL
 - PAD & PARTS DIRECTLY WELDED TO PIPE. SAME AS RUN PIPE OR MAT'L TABLE.
 - OTHER PARTS : A36
2. SEE DWG. NO. ST-A4-1107 FOR THE DETAIL OF SHOES.
3. REINF. PADS ARE REQUIRED FOR 10" & LARGER STAINLESS STEEL PIPE.
4. FOR LINES 20" THRU 24" SIZE CARBON STEEL PIPE AND THOSE WITH WALL THICKNESS LESS THAN STANDARD WEIGHT SHALL BE CHECKED TO DETERMINE THE NEED FOR REINFORCING PADS.
5. WHEN PIPE LONGITUDINAL EXPANSION EXCEEDS 100mm, A LONGER SHOE WILL BE USED AND DESIGNATED BY ADDING AN "L" TO THE END OF SYMBOL.
6. FOR CRITICAL LINES, GAP 3mm WILL BE PROVIDED IF SO NOTED ON RELEVANT STRESS ANALYSIS DATA INPUT; UNLESS OTHERWISE NO GAP IS ALLOWED FOR SUCH LINES AND ON RESPECTIVE ISOMETRICS THIS EXCEPTION TO BE NOTED, TOO.
7. SHOE HEIGHT CODE CAN BE USED ADJUSTABLE VALUE

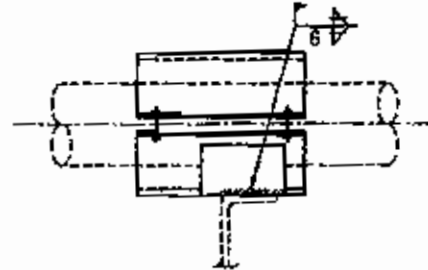
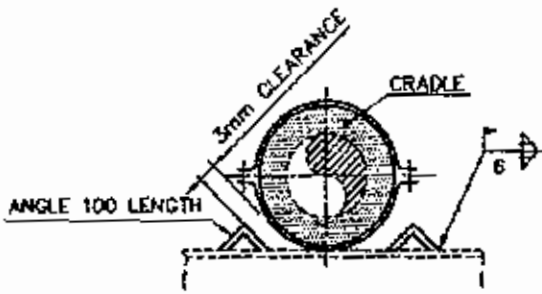
UNIT (mm)

PIPE SIZE	MEMBER M	ALLOWABLE LOADS (Kg)			
		H=100		H=150	
		Wmax	Pmax	Wmax	Pmax
2"-2-1/2"	A5	325	190	300	90
3"	A5	500	150	400	120
4"-8"	A8	900	200	875	150
10"-24"	A7	2700	1700	1000	830
26"-40"	A7	8650	1700	7950	1700

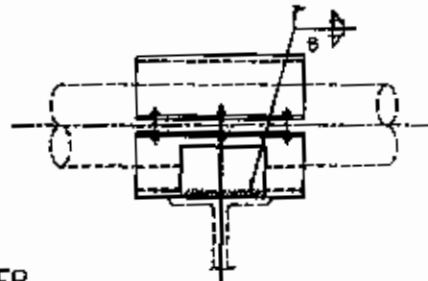
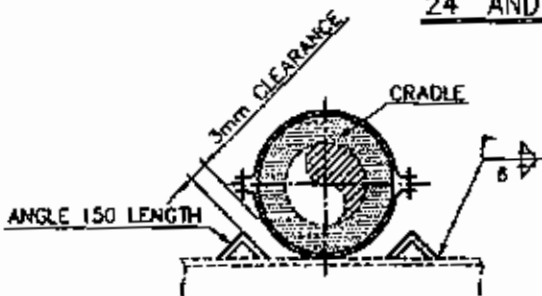
PIPE SIZE	MEMBER M	ALLOWABLE LOADS (Kg)			
		H=200		H=250	
		Wmax	Pmax	Wmax	Pmax
2"-2-1/2"	A5	-	-	-	-
3"	A5	-	-	-	-
4"-8"	A8	-	-	-	-
10"-24"	A7	-	-	-	-
26"-40"	A7	7400	1700	5900	1700

SYMBOL & CODING





24" AND SMALLER



26" AND LARGER

CRADLE; SEE DEG. NO. ST-A4-1104

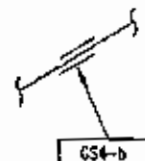
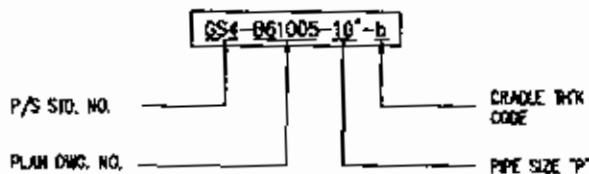
PIPE SIZE	ANGLE (FOR GUIDE)	REMARKS
1/2" ~ 6"	A50 x 50 x 6	
8" ~ 12"	A75 x 75 x 9	
14" ~ 24"	A90 x 90 x	
26" ~ 32"	A100 x 100	
34" ~ 42"	A100 x 100	
44" ~ 60"	A100 x 100	

CRADLE TH'K CODE	INSULATION TH'K
a=50	25 ~ 50
b=100	51 ~ 100
c=150	101 ~ 150
d=200	151 ~ 200
e=250	201 ~ 250
f=300	251 ~ 300

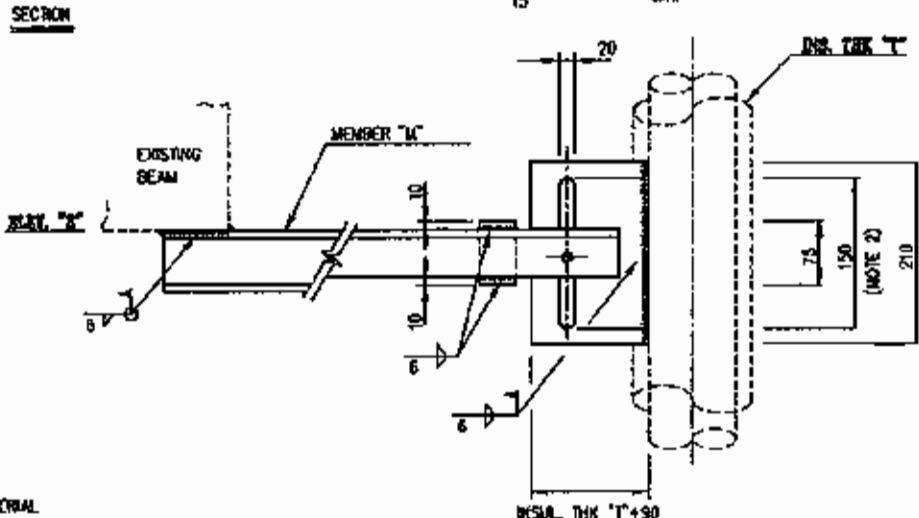
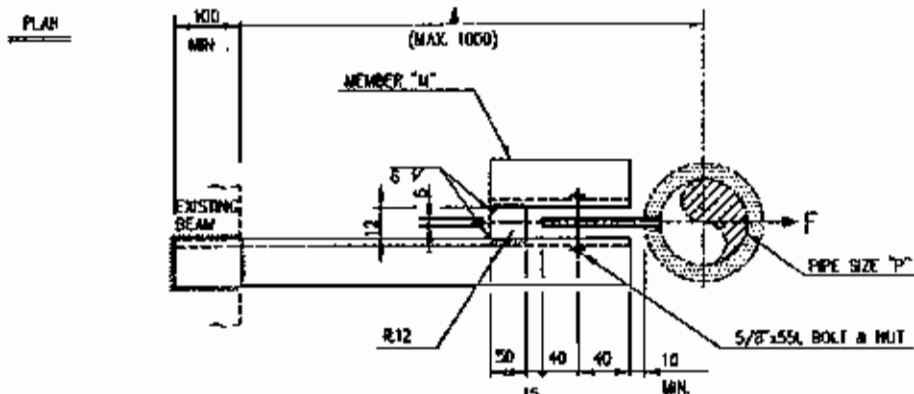
NOTE

1. FOR CRITICAL LINES, GAP 3mm WILL BE PROVIDED IF SO NOTED ON RELEVANT STRESS ANALYSIS DATA INPUT ; UNLESS OTHERWISE NO GAP IS ALLOWED FOR SUCH LINES AND ON RESPECTIVE ISOMETRICS THIS EXCEPTION TO BE NOTED, TOO.

SYMBOL & CODING



ISO



NOTE

1. MATERIAL

- LUG PLATE : SAME AS RUN PIPE OR MATL. TABLE.

CODE	RUN PIPE	LUG PLATE
K	A106 GR.B	A283 GR.C
	A672 GR. 685, CL.22	
	API 5L GR.B	
	API 5L GR. X52	
	API 5L GR. X65	
	API 5L GR. X70	
X	A312 TP316L	A240-TP316L
L	A333 Gr.6	A516 GR. 60
	A671 GR.6080 CL.22	

- SHAPE STEEL : A36
- BOLT/NUT : A307 GR.B / A563 GRA

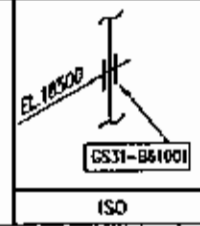
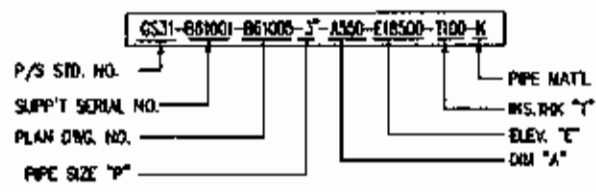
2. MAX. ALLOWED MOVEMENT : ±75MM
1. SEE DWG. NO. ST-A4-0001 FOR THE SIZE OF SHAPE STEEL.

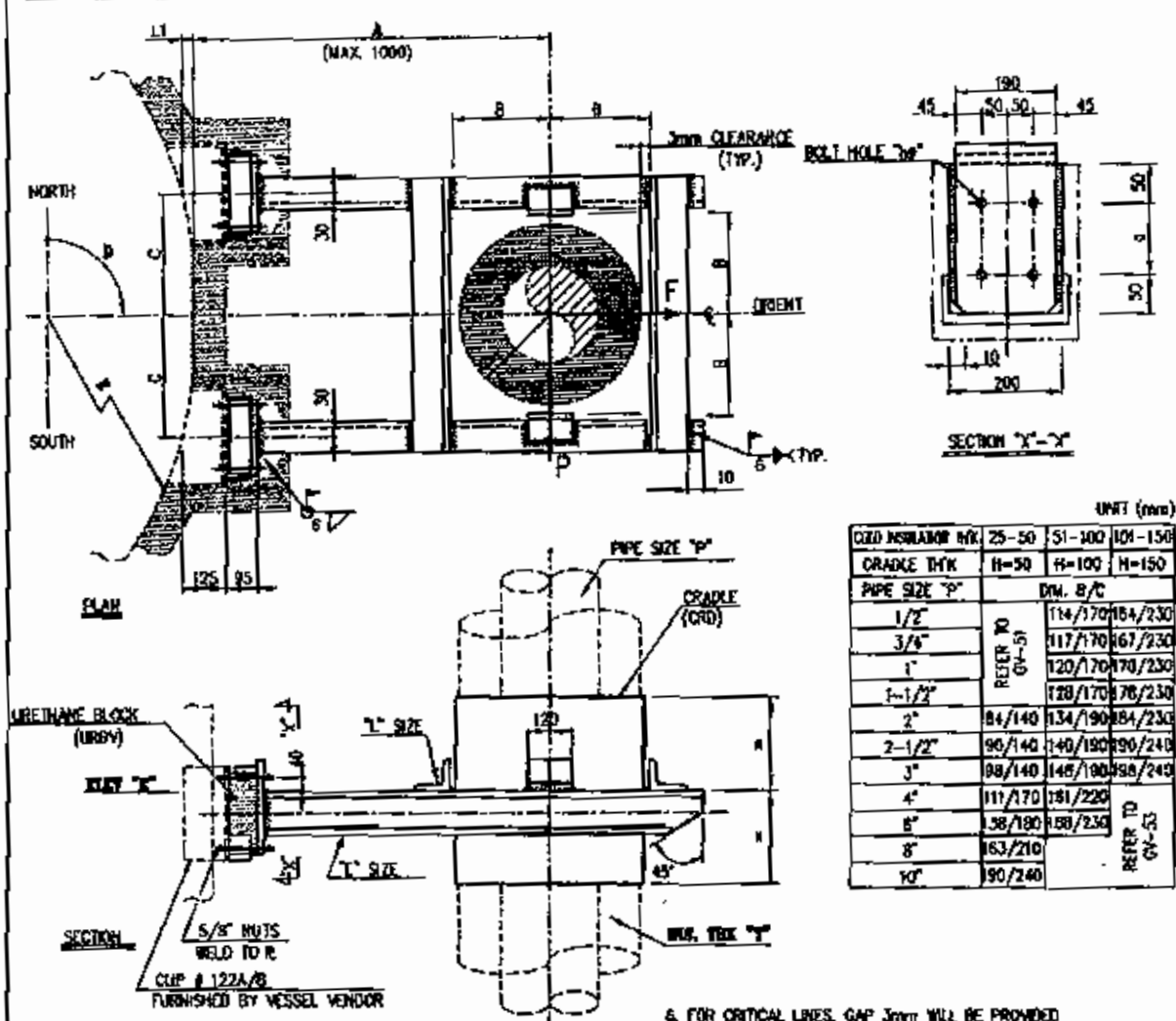
4" & SMALLER

UNIT (mm)

PIPE SIZE NPS "P"	A ≤ 500		500 < A ≤ 1000	
	MEMBER "M"	ALLOWLOAD F(Kg)	MEMBER "M"	ALLOWLOAD F(Kg)
3/4"	A5	550	A5	450
1"	A5	550	A6	850
1-1/2"	A6	850	A7	1450
2"	A8	850	A7	1450
3"	A6	850	A7	1450
4"	A10	2400	C10	1900

SYMBOL & CODING





UNIT (mm)

CRACKLE INSTRUMENT N°	25-50	51-100	101-150
CRACKLE THK	H=50	H=100	H=150
PIPE SIZE "P"	DIM. B/C		
1/2"	REFER TO GV-51	114/170	164/230
3/4"		117/170	167/230
1"		120/170	170/230
1-1/2"		128/170	176/230
2"		134/190	184/230
2-1/2"	140/190	190/240	
3"	148/190	198/240	
4"	111/170	181/220	
6"	138/190	190/230	
8"	163/210		
10"	190/240		

REFER TO GV-51

NOTE: $r=76$ TO $r=200$

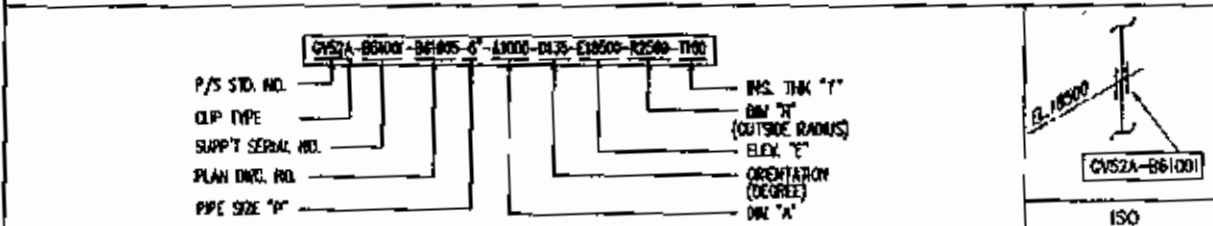
- MATERIAL - SHAPE STEEL : A36
- $DIM L1 = R - \sqrt{R^2 - C^2}$
- SEE DWG. NO. ST-A4-1019 FOR THE DETAIL OF CRACKLE.
- SEE DWG. NO. ST-A4-1021 FOR THE DETAIL OF URETHANE BLOCK ASSEMBLY.
- SEE DWG. NO. ST-A4-0001 FOR THE SIZE OF SHAPE STEEL.

- FOR CRITICAL LINES, GAP 3mm WILL BE PROVIDED IF SO NOTED ON RELEVANT STRESS ANALYSIS DATA INPUT; UNLESS OTHERWISE NO GAP IS ALLOWED FOR SUCH LINES AND ON RESPECTIVE ISOMETRICS THIS EXCEPTION TO BE NOTED, TOO.
- SEE DETAIL DWG ST-A4-2004 FOR CLIP DETAILS.

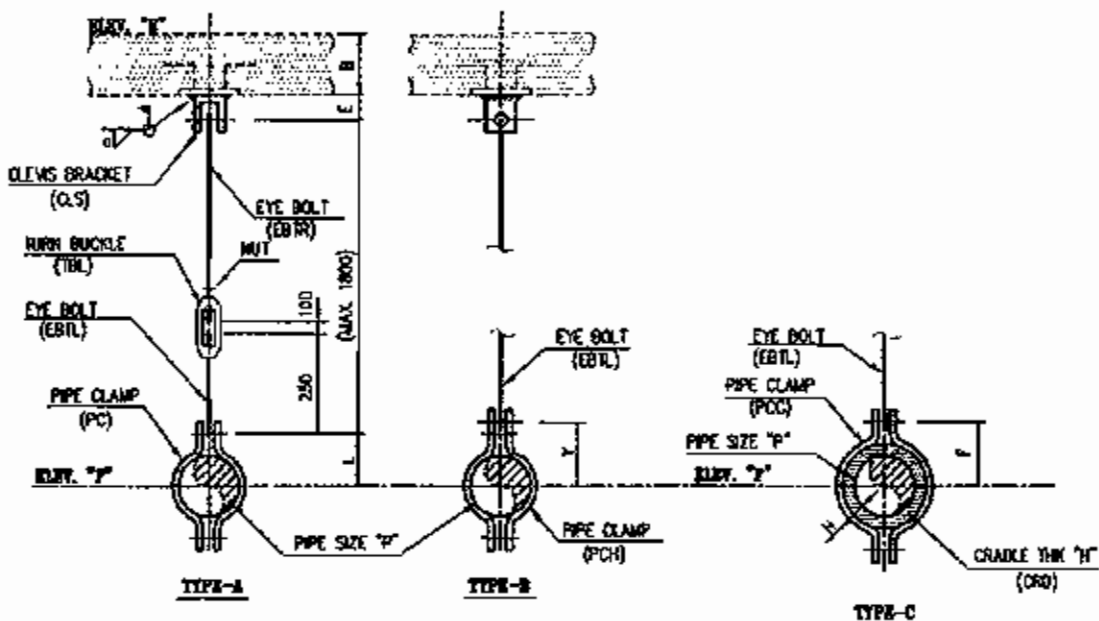
UNIT (mm)

CLIP TYPE	CLIP MARK	h#	a	T" SIZE	t" SIZE	A ≤ 500		500 < A ≤ 1000	
						Pmax (kg)	Fmax (kg)	Pmax (kg)	Fmax (kg)
A	122A	18	180	C40	A5	170	270	110	260
B	122B	18	230	C15	A6	380	490	270	480

SYMBOL & CODING



ISO



PIPE SIZE NPS "P"	ROD SIZE (inch)	E	F	Y	L	g	ALLOWLOAD (Kg)
1/2"	3/8"	50	SEE ST-A4-1018 (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"	90		260	140	6	1230
8"	1"	75		300	165	6	2750
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
18"	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

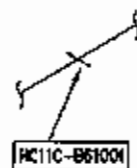
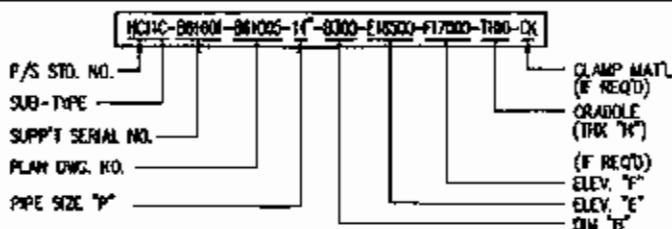
1. MATERIAL
- CLAMP, BOLT/NUT

CODE	TEMP.	CLAMP	BOLT & NUT
K	-350°C	A283 GR.C	A307 GR.B GALV./A563 GR.A-GALV.)
L	-420°C	A516 GR.60	A193 GR.B7/A194 2H

- OTHER PARTS : A36

2. SEE Dwg. NO. ST-A4-1008/1008/1010/1011/1013 FOR THE DETAIL OF HANGER ASSEMBLY.
3. SEE Dwg. NO. ST-A4-1019 FOR CRADLE(CRD) BRK "Y"

SYMBOL & CODING

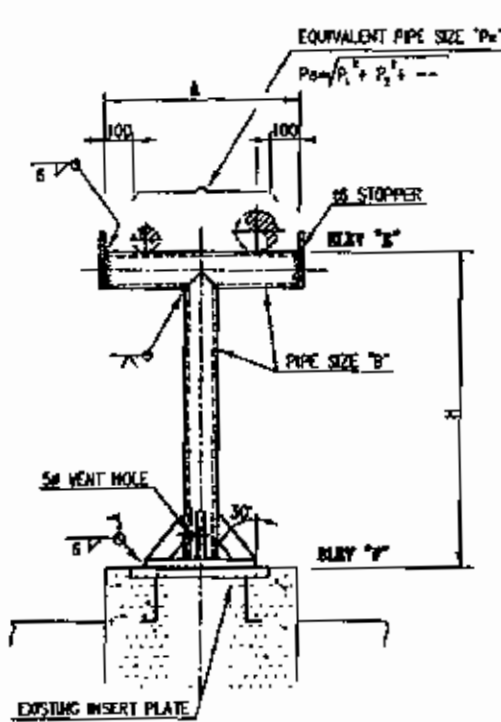


PIPING SUPPORT STANDARD DWG.

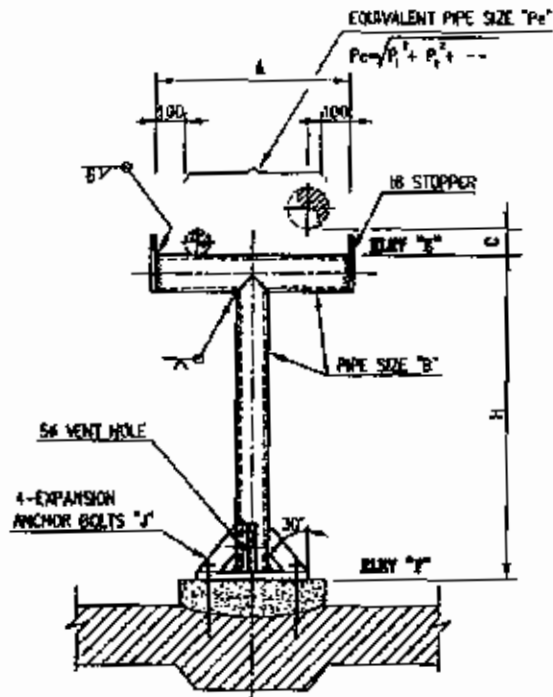
ST-A4-1276

RESTING RF-9
(T-TYPE FOR HEAVY DUTY)

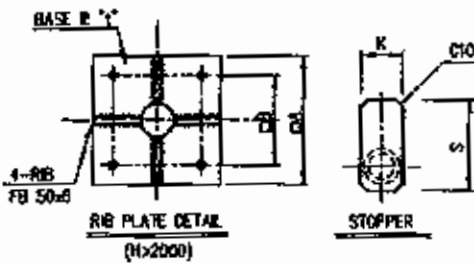
REV.
D7



TYPE-F
(ON FOUNDATION)



TYPE-P
(ON PAVMENT)

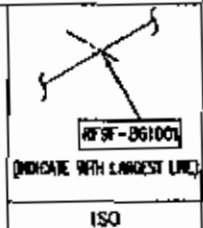
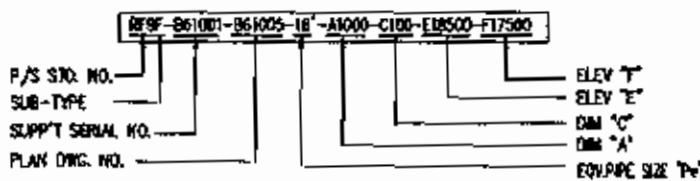


UNIT (mm)										
EQUIVALENT PIPE SIZE "Pe"	PIPE SIZE "B"	A (MAX.)	H (MAX.)	K	S	αA	αB	J	τ	ALLOW LOAD (Kg)
2"	2"	1000	1000	80	150	180	130	5/8"	9	200
3"	2"		1500			180	130	5/8"	9	160
4"	3"		2000	135	240	230	170	5/8"	9	410
6"	4"		2500			230	170	3/4"	16	740
8"	6"			240	350	330	270	3/4"	16	800
10"	6"					330	270	3/4"	16	800
12"	8"					330	270	3/4"	20	1500
14"	10"			340	450	430	350	3/4"	20	3400
16"	10"					430	390	3/4"	20	3400

NOTE

- SEE DWG. NO. ST-A4-1031 FOR THE DETAIL OF EXPANSION ANCHOR BOLT AND BASE PLATE(BPLA)
- FOR THE TYPE-P, USE ONLY FOR Hmax=1000.

SYMBOL & CODING



محصولات جوشکاری آما

۱ - الکترودهای جوشکاری دستی آما

Rutile Electrodes

الکترودهای روتیلی

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	23AK
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	180D
الکتروود روتیلی با پوشش ضخیم برای جوشکاری ورقهای ضخیم و کارهای نسبتاً سنگین صنعتی و اسکلت‌های فلزی. Thick covered electrode for welding of thick plate and structural steels			E 7014	1008A
الکتروود روتیلی با مقدار سیلیسیم کم مناسب برای بازسازی و تعمیر وان‌های گالوانیزه. Rutile electrode containing low Si is particularly suited for repair of galvanizing bath		E 4343R R(B)7	E 6013	1531
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	2000
برای جوشکاری فولادهای ساختمانی، کشتی سازی در حالت افقی، تخت و سربالا. Suitable for structural, shipbuilding steels in horizontal and flat, vertical up positions.	E 512 RR22	E 5122 RR6	E 6013	2000A
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	MK14
الکتروود روتیلی - سلولزی مناسب برای جوش سرازیر در لوله کشی های گاز خانگی، 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	P. L

Electrodes with High Metal Recovery

الکترودهای با جایگزینی زیاد

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	1118 K
الکتروود فلایی با راندهمان 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	1617 K

Basic Electrodes

الکترودهای قلیایی

خصوصیات و موارد کاربرد Characteristics & Applications	ISO 2560	DIN 8529	AWS/ASME SFA5.1	کد شناسایی آما AMA Trade Name
الکترودهای 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			E 7016	1007F
الکترودهای قلیایی برای جوشکاری معازن تحت فشار و فولادهای پر کربن با حدود ۱۱۵٪ جابجایی. Basic electrode for high pressure vessels and high carbon steels with 115% metal recovery.	E 515 B20	ESY4276 MnB	E 7018-1	1177 F
الکترودهای قلیایی برای جوشکاری معازن 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.	E 515 B1 10 20H	E 5154 B10	E 7018	1230 F
الکترودهای قلیایی با پایداری قوس خوب برای جوشکاری معازن 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.		E 5154 B10	E 7018	1232 F
الکترودهای قلیایی دور روپوشه با جاذبه شدن سرباره خوب و پایداری قوس عالی در جوشکاری شیار باریک. Double coated basic electrode with good slag removal and very good arc stability in narrow gap welding.		E 5154 B10	E 7018	1280 M

Cellulosic Electrodes

الکترودهای سلولزی

خصوصیات و موارد کاربرد Characteristics & Applications	ISO 2560	DIN 1913	AWS/ASME SFA5.1,5.5	کد شناسایی آما AMA Trade Name
الکترودهای سلولزی با نفوذ بالا برای پاس ریشه در تمام حالت مخصوصاً حالت سرازیر این الکترودها بویژه برای جوشکاری لوله ها و مخازن مناسب می باشد. (جابجایی 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%)	E 433 C19	E 4332 C4	E 6010	1045P
الکترودهای 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.			E 6010	1047P
الکترودهای 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.			E 7010 G	1048P
الکترودهای 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.			E 8010 G	1049P
الکترودهای سلولزی مولیبدن دار که مشابه الکترودهای E 6010 بوده ولی استحکام مکانیکی بالاتری دارد. Cellulosic electrode containing Mo similar to E 6010 but has more mechanical strength.			E 7010-A1	1707NP

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

خصوصیات و موارد کاربرد Characteristics & Applications	ISO 3581	DIN 8556	AWS/ASME SFA 5.4	کد شناسایی آما AMA Trade Name
برای جوشکاری اتصالی فولادهای مارتنزیتی - فریتی با ۱۲ تا ۱۴٪ کروم، ایجاد لایه 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.	E 131 B20 +	E 131 B20 +	E 410-15	1071 R

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 می‌رود . 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 L R23	E 2312 L R23	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 می‌باشد . 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 روکش کاری استفاده می‌شود . فلز جوش آن تا دمای ۱۰۰۰ °C پوسته نپزند و مقاوم به ترک نیز می‌باشد بطوریکه برای جوشکاری فولادهای بد جوش نیز به کار می‌رود . 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 سرپاره 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 منگنزی 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
الکتروود 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
الکتروود 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
الکتروود قلیایی مناسب برای فولادهای استحکام بالای 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
الکتروود 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
الکتروود قلیایی کم کربن با فلز جوش عاری از ترک و ماچرمنگی بسیار خوب. Low carbon basic electrode with crack free and very good tough weld metal.			E 7018C2L	1414 N
الکتروود 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
الکتروود قلیایی کم هیدروژن برای اتصالات مورد جوشکاری ماچرمنگی 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
الکتروود 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
الکتروود 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
الکتروود قلیایی با خواص مکانیکی عالی که جوش آن مقاوم به ترک بوده و از چقرمنگی خوبی برخوردار می باشد. Basic electrode with excellent mechanical properties for producing crack free and tough weld metal.			E9018M	1428 NC
الکتروود 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
الکتروود قلیایی با استحکام بالا و چقرمنگی 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
الکتروود قلیایی که جوش آن چقرمنگی 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
الکتروود قلیایی مولیبدن دار مقاوم به ترک که برای جوشکاری مخازن و دیگها تا دمای کاری ۵۰۰°C مناسب می باشد. Basic electrode of crack resistant used in the construction of pressure vessels, boilers subjected up to 500°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
الکتروود قلیایی برای جوشکاری دیگ ها و مخازن تحت فشار تا دمای کاری ۶۰۰°C. Basic electrode for welding of boilers, pressure vessels subjected to operating temperatures up to 600°C		E CrMo 5B20+	E 502-15	1366 N2
الکتروود قلیایی برای جوشکاری فولادهای مقاوم به خزش مورد استفاده در توربین های آبی تا دمای کاری ۵۷۰°C. Basic electrode for welding of creep resistant steels used in the construction of water turbin subjected to oprating temperatures up to 570°C.			E 8018-G	1379 4VN
الکتروود قلیایی کم هیدروژن برای جوشکاری فولادهای مقاوم به خزش مورد استفاده در مخازن تحت فشار و دیگ های کاری تا ۵۷۰°C. Basic type low hydrogen electrode for welding of creep resistant steels used in the construction of pressure vessels, boilers subjected up to 570°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
الکتروود قلیایی کم کربن که برای جوشکاری فولادهای مقاوم به خزش و مخازن تحت فشار بالا تا دمای کاری ۵۰۰°C. Low carbon basic electrode for welding of creep resistant steels and high pressure vessels up to 500°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
الکتروود 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
الکتروود 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
الکتروود 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 برنده ابزارهایی مثل صفحه تراش، تیغه فرز، مته خزانه، 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 ۱۵% جایگزینی برای روکشی سخت. Basic coated electrode with 160% metal recovery for surfacing deposit.		E 10UM-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 teeth.		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 8 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 وشکسته 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 & Cutting

الکتروود برش و شیارزنی

برای برش، سوراخ کردن و شیارزنی فولادهای معمولی، زنگ نزن، پرمنگنز، 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 اتسالی 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 لوله. 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 دیگر 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 318	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
الکتروود 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	AMA MC 10
الکتروود 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) SGR 1 M21Y4643	(A-5.20) E 71T-1	AMA FC 14
الکتروود 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	AMA FC 20
الکتروود 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	AMA FC 14HD
الکتروود 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	AMA FC 31
الکتروود 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		AMA MC 56
الکتروود 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	AMA MC 141
الکتروود 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	AMA MC 142

AMA

آما

۳- پودرها و وسیم جوش های زیر پودری

Fluxes and wires for submerged arc welding:

پودرها و وسیم جوش های زیر پودری برای:

- * General structural steels
- * Fine grain structural steels
- * فولادهای مقاوم به سرما و پیری
- * فولادهای عمومی ساختمانی
- * Heat resistant steels
- * Cryogenic steels
- * فولادهای مقاوم به حرارت
- * Non ageing steels
- * فولادهای دانه ریز

FLUX		پودر	وسیم 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 وسیم جوش آما AMA Trade Name
B MS 189 AC 8 SKM	A MS 189 AC	AMA- OP 155	AMA OE-S1
پودر منگنز- سیلیکاتی مخصوص جوشکاری سرعت های بالا ترجیحاً برای جوشکاری ورق های نازک. Manganese-Silicate type flux for high Speed welding preferably used for welding thin Plates.			AMA OE-S2
			AMA OE-S2 Mo
			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. Manganese - Silicate type flux for welding large diameter pipes and thin walled Spiral pipes at high speed welding.			AMA OE-S2
			AMA OE-S2Mo
			AMA OE-S1
B CS 177 AC 10M	A CS 177 AC	AMA- OP 119	AMA OE-S2
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. 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
			AMA OE-S1
B CS 198 AC 12M	A CS 198 AC	AMA- OP 143	AMA OE-S2
پودر کلسیم - سیلیکاتی مخصوص جوشکاری فولادهای ساختمانی، مخازن تحت فشار و لوله سازی با فرایند دوسیمه، پشت سر هم و چند سیمه در سرعت های بالا و همچنین فرایند جوشکاری دو طرفه در یک پاس. 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
			AMA OE-S1
			AMA OE-S2
B AR 188 AC 10 SKM	A AR 188 AC	AMA- OP 181	AMA OE-S2 Mo
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. 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 Cr Mo1
			AMA OE-S1
			AMA OE-S2
B AR 188 AC 10 SKM	A AR 188 AC	AMA- OP 185	AMA OE-S2 Mo
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. 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 Cr Mo1
			AMA OE-S1
			AMA OE-S2
B AR 197 AC 10 SKM	A AR 197 AC	AMA UNIVERSAL	AMA OE-S2 Mo
پودر آلومینات - روتیلی مخصوص جوشکاری فولادهای ساختمانی، مخازن تحت فشار و لوله سازی که برای فرایند جوشکاری پشت سر هم، دو سیمه و چند سیمه در سرعت های بالا مناسب است. 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 Cr Mo1
			AMA OE-S1
			AMA OE-S2
B AB 187 AC 10M	A AB 167 AC	AMA- OP 123	AMA OE-S1
پودر آلومینات - قلیایی 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. 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
			AMA OE-S2 Mo
			AMA OE-S1

SA AB 167 AC H5	AMA- OP 132	AMA OE-S1
پودر آلومینات - قلیایی برای ساخت لوله های نفت و گاز بصورت جوشکاری خطی و لوله های اسپیرال با فرایند جوشکاری پشت سرهم و چند سیمه (تا پنج سیم) در سرعت های بالا.		AMA OE-S2
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-S2 Mo
		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 سرهم 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
B FB 153 DC 8 HP5 A FB 153 DCHP5	AMA- OP 41 TT	AMA OE-SD3
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-S2 Mo
Fluoride - basic type flux for welding high tensile fine grain steels and creep resistant steels with very tough weld metal		AMA OE-S2 Cr Mo1
		AMA OE-S1 Cr Mo2
		AMA OE-Ni38R
		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-SD3
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 سرهم و چند سیمه مناسب می باشد.		AMA OE-S2 Mo
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-S3 Mo
		AMA OE-S2 Cr Mo1
		AMA OE-S1 Cr Mo2
		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 سرهم 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 اوستنییتی

FLUX		پودر	WIRE recommended to be combined with flux	سیم جوش توصیه شده جهت مصرف به همراه پودر
استاندارد DIN 32522	استاندارد EN 769	کدشناسایی پودر های آما AMA Trade Name	کد مواد Material No	AMA Trade Name کدشناسایی سیم جوش های آما
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
		پودر فلوراید - قلیایی مخصوص با کربن خیلی کم برای جوشکاری فولادهای زنگ نزن اوستنییتی و مقاوم به حرارت.	1.4430	AMA OE - 191 23 nc
		Fluoride - basic type flux of extra low carbon quality for welding austenitic stainless and heat resistant steels.	1.4576	AMA OE - 191 23 Nb

	1.4316	AMA OE - 199 nc
B FB 655456 AC 8MHP5 A FB 255 AC	1.4551	AMA OE - 199 Nb
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
Fluoride - basic type flux for welding austenitic Stainless and heat resistant steels.	1.4829	AMA OE - 2212
	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
AMA Trade Name	کد شناسایی مفتولهای آما	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 غلتکهای 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 سایبی 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.

کلید 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 گلگاه مهم فرایند تولید عملیات بالانس گیری انجام میگیرد. در حال حاضر کارخانه سنگ شرکت صنعتی آما با بهره گیری از مهندسی و متخصصین 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 و 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 سایبی 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	8500

Grinding Stainless Steel سنگهای خشن سایبی 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 سایبی 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 سایبی 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

