Chemseal Inc.
Integral Solutions

Hygienic Piping Design Guidelines

INDEX

INTRODUCTION (Scope)

This guideline has been developed to help you on systems design for food and beverage industrial manufacturing, no matter if is a new installation, replace an existing one, process upgrade or factory production increase.

We will try to make a check list of most common matters to assist you for the whole job from design going through installation work to finally arrive at the testing and inspection maters.

One of the main issues is strip your product as well as your production process and set which level of product quality are you looking for, or acceptable by your target market, once is defined the quality level is more easy identify all input variables to match compatibility with materials equipment and systems available at the process equipment market.

Other hand is important to take care what is the most suitable cleaning system for the production process is going to be design. The piping system shall be constructed to withstand CIP and SIP or any other cleaning system has being choose for the project.

Codes and Standards may apply

AWS; American Welding Society: www.aws.org
ASME: American Society of Mechanical Engineers www.asme.org
AISI: American Iron & Steel Institute www.steel.org
ISO: International Organization for Standardization www.iso.org
EN: European Standards www.cenelec.eu
DIN: German Institute for Standardization www.DIN.de/en
DS: Danish Standard Association: www.ds.dk
SIS: Swedish Standards Institute www.sis.se
ASSDA: Australian Stainless Steel Development Association www.assda.asn.au
NIDI: Nickel Institute www.nickel-institute.org
SSINA: Specialty Steel Industry of North America www.ssina.com
3-A Sanitary Standards: www.3-a.org
EHEDG: European Hygienic Engineering & Design Group www.ehedg.org
USFDA: Food and Drug Administration in the US: www.fda.gov
ISPEE: International Society of Pharmaceutical Engineers. www.ispe.org
BSSA: British Stainless Steel Association: www.bssa.org.uk/index.htm

GENERAL

On Sanitary processing plants the most important mater is the surface finishing; it has to compiles with many features to be enough smooth to do not retain any dirt or particles coming from the processing product. If this happens the system must be cleaned by CIP or SIP system.

Food equipment surfaces could be subdivided into two categories:

1. Food product contact surfaces.
2. Non-product contact surfaces.

Food product contact surface: is defined as a surface in "direct contact with food residue, or where food residue can drip, drain, diffuse, or be drawn". For sanitary design, all *food contact surfaces* should be: (IAFIS; IAFP; USPHS; DIC; USDA, 2002)

- smooth;
- impervious;
- free of cracks and crevices;
- nonporous;
- nonabsorbent;
- non-contaminating;
- inert;
- corrosion resistant;
- durable and maintenance free;
- nontoxic; and
- cleanable.

If the surface is coated with metal alloy or non-metal (e.g. ceramics, plastic, rubber) in any way, the final surface must meet the above requirements. 3A Standards require that such coatings maintain corrosion resistance, and be free of surface pitting, flaking, chipping, blistering, and distortion under conditions of intended use. Similarly, if any other modification or process is used at the fabrication process (e.g., welded, bonded, or soldered) it should be done using appropriate material and process to ensure the final surface meets the sanitary design criteria. (Folkmar Andersen & A/S, 2006)

Non-product contact surfaces: All the equipment parts (e.g., legs, supports, housings) which do not direct contact with product. (IAFIS; IAFP; USPHS; DIC; USDA, 2002) As contamination of *non-product contact surfaces* can cause indirect product contamination, these surfaces cannot be ignored with regard to sanitary design. All equipment located in the clean areas are periodically cleaned by wash-down or manually cleaned by wipe-down with harsh cleaning solutions. (ASME-BPE, 2014)

MATERIALS

A variety of materials used in the equipment fabrication for different food and beverage applications. Materials vary in their properties regarding to workability.

Process Compatibility: materials of construction shall be capable of withstanding the temperature, pressure and chemical corrosiveness ensure the purity and integrity of the product as well with cleaning solutions and or SIP conditions in case it has being specified for the project designer/user. (ASME-BPE, 2014)

Metals

Stainless steel is the most suitable metal for product contact surfaces in the food and beverage applications. The stainless steel alloy properties are related to chromium and nickel level. Corrosion resistance varies with chromium level, and structural strength will be proportional to nickel level. For welding purposes is better stainless low carbon content less than 0.03% carbon contents.

3A Standards also provide specifications regarding alloys and other coatings used in fabrication. Stainless steel properties may change with continued use, especially under conditions where the chromium oxide layer is altered (e.g. incompatible cleaners, abrasive cleaners, abrasive cleaning pads, or chlorine and related sanitizers). Therefore, it is recommended this surfaces be passivated (using nitric acid or other strong oxidizing agents) initially and on a regular frequency thereafter, to maintain a passive (non-reactive) oxide film on the surface. Passivation of stainless steel food contact surfaces is recommended after any surface repair, welding, polishing, or working.

- **Titanium** has excellent durability and corrosion resistance (especially in an acidic environment). However, its use is limited by high cost. Titanium is used in stainless steel alloys for food equipment used in the processing of food products with high acid and/or salt content (e.g., citrus juice, tomato products).
- **Platinum**, another excellent corrosion resistant material, would also be highly desirable, but, obviously, the cost of this rare material would prohibit its use.
- **Gold** has been approved as a food contact surface in certain 3-A Sanitary Standards. In some cases, gold is used for soldering optical sensors (e.g., fiber optics) into stainless steel fittings. Gold is desirable in these applications for its resistance to abrasion and compatibility with glass.

Other metals are limited by application as follows:

- **Copper** is primarily used for equipment used in the brewing industry, with some use for cheese vats in Swiss cheese manufacture, due to tradition. Care should be used with copper equipment when processing acid products, as copper residues can leach into the product.
- **Aluminum** is used in certain parts and components where lighter weight is desired. However, aluminum has poor corrosion resistance and can become pitted and cracked with continued use. Care should take when cleaning and sanitizing aluminum components as oxidizing chemicals can accelerate the pitting of the metal. In most food contact applications, aluminum must be coated with an acceptable material. Plastic coatings such as polytetrafluorethylene (PTFE or Teflon®) are common.
- **Carbon steel** and **cast iron** are only used for frying and cooking surfaces, and similar applications in food service.

- **Galvanized iron** should be avoided as a food contact surface because it is highly reactive with acids highly reactive with acids. (Folkmar Andersen & A/S, 2006)
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	Steel grade		C %	Cr %	NI %	Mo %	P %	S %	N %	Price index (relative scale)
Common stainless steel (austenitic)	AISI 304	min.		18.0	8.0	-				
		max.	0.08	20.0	10.5	-	0.045	0.030		
	AISI 304 L EN 1.4306	min.		18.0	8.0	-				
		max.	0.03	20.0	10.5	-	0.045	0.030		
	SS 2333	min.		17.0	8.0	-				100
		max.	0.05	19.0	11.0	-	0.045	0.030		
	EN 1.4301	min.		17.0	8.5	-				
		max.	0.07	19.0	10.5	-	0.045	0.030		
Acid-resistant stainless steel (austenitic steel containing molybdenum)	AISI 316	min.		16.0	10.0	2.0				
		max.	0.08	18.0	14.0	3.0	0.045	0.030		
	AISI 316 L EN 1.4404	min.		16.0	10.0	2.0				
		max.	0.03	18.0	14.0	3.0	0.045	0.030		
	SS 2347	min.		16.5	10.5	2.0				
		max.	0.05	18.5	14.0	2.5	0.045	0.030		
	SS 2343	min.		16.5	10.5	2.5				
		max.	0.05	18.5	14.0	3.0	0.045	0.030		130
	EN 1.4401	min.		16.5	10.5	2.0				
		max.	0.07	18.5	13.5	2.5	0.045	0.030		
	EN 1.4436	min.		16.5	11.0	2.5				
		max.	0.07	18.5	14.0	3.0	0.045	0.030		
	AISI 904 L		0.01	20.0	25.0	4.5	-	-		300
	AV 254 SMO		0.01	20.0	18.0	6.1				400
Duplex steel (austenitic-ferritic-steel)	SAF 2304	min.		22.0	4.0				0.10	
		max.	0.03	23.5	5.5					170
	SAF 2205 (EN 1.4462)	min.		21.0	4.5	2.5			0.14	
		max.	0.03	23.0	6.5	3.5				190
	SAF 2507	min.		24.0	6.0	3.0			0.30	
		max.	0.03	26.0	8.0	5.0				400

Non-metals

A variety of non-metal materials are used as food contact surfaces in specific applications of food equipment (e.g., probes, gaskets, membranes). These materials should meet the same sanitary design and cleanability requirements as metals when used in these applications as described in 3A Sanitary Standards and other standards. Non-metal surfaces, in general, lack the corrosion resistance and durability of metal surfaces, therefore, maintenance programs should include frequent examination for wear and deterioration under continued use, and replacement as appropriate.

Non-metal materials used in food contact surfaces include:

- **Plastics**, **rubber**, and **rubber-like** materials that should be food grade and should meet the requirements designated under 3A Sanitary Standards (18-03

and 20-20). Multi-use plastics, rubber, and rubber-like materials may also be considered as *indirect food additives* under FDA regulations.

- **Ceramics** are used primarily in membrane filtration systems. They may also be used in other limited applications if wear resistance is necessary.
- **Glass** may be used as a food contact surface. These applications are limited due to the potential for breakage. Specially formulated glass materials such as Pyrex® have proven successful. When glass is used, it must be durable, break resistant or heat resistant glass. Some applications where glass is used are light and sight openings into vessels and in very limited glass piping applications.
- **Paper** has been used over the years as a gasket material in piping systems designed for daily disassembly. Paper is considered a single use material.
- **Wood**, which is highly porous and difficult to clean, should be avoided as a food contact surface. Wood is restricted in food service applications by most regulatory agencies, with the exception of hardwood cutting boards and tight grain butcher blocks.

Surface Texture and/or Finish

If any surface is ground, polished, or textured in any way, it must be done so the final surface is smooth, durable, and free of cracks and crevices, and meets the other sanitary design requirements described above. 3A Sanitary Standards require that ground or polished stainless steel surfaces meet a No. 4 ground surface, and unpolished surfaces meet a No. 2B finish. The 3-A Sanitary Standards development group has recently adopted an industry recognized method for determining an acceptable food contact surface termed *roughness average* or *Ra value*. The Ra is determined using a sensitive instrument (termed a profilometer) which employs a diamond tipped stylus to measure peaks and valleys in a relatively smooth surface. (Folkmar Andersen & A/S, 2006)

PIPING DESIGN

Before we start with this matter is better understand certain definitions such as, cleanability and drainability

Cleanability: the ability to be cleaned, especially easily or without damage, regarding to piping surface:
All surfaces shall be cleanable. Surface imperfections (e.g., crevices, gouges, obvious pits) shall be eliminated whenever feasible.
All surfaces shall be accessible to the cleaning solutions and shall be accessible to establish and determine efficacy of the cleaning protocol.
The following provisions are applicable to tubing equipment or systems to be cleaned in place: Internal horizontal surfaces should be minimized. The equipment shall be

drainable and free of areas where liquid may be retained and where soil or contaminants could collect. The equipment shall be free of areas of low flow and velocity or impact where soil or contaminants could collect. (ASME-BPE, 2014)

Drainability: the system ability to be drainage, mainly by gravity. For sterility and cleaning, gravity is an effective way to facilitate drainage. To achieve gravity drainage, lines should be pitched to designated points at the specific slope.
For gravity-drained piping/tubing systems, the designer/user may define the system slope in accordance with one of the designations listed in table SD-2.4.3.1-1. (ASME-BPE, 2014)

Pipe work

Pipe material and roughness has to be specified at least according with the minimum requirements following international standards by type of industry.
• The inside surface should be passivated, pickled or electropolished. Special care should be taken when welding electropolished surfaces as a far better gas protection is required for welding of surfaces which have been made “shiny” – e.g. through grinding, electropolishing, etc.
• There must be no scratches, holes, porosity or other surface defects on the product side of the steel.
• Pipes must be delivered free of defects and clean on the inside as well as on the outside. The pipes must be plugged at the ends and wrapped.
• Fittings must be delivered flawless and clean on the outside as well as on the inside, and they must be wrapped.
• All pipes and fittings belonging to the same mounting operation should have identical pipe diameters and material thickness, i.e. be delivered in the same standard (DS, DIN, 3A, SMS or other). (Later a DIN pipe can, however, be welded onto a DS pipe. It only requires that the pipe with the smallest diameter be milled to the same diameter as the other pipe). (Folkmar Andersen & A/S, 2006)

Piping Layout

Process piping would be installed to meet with standards:
• Continuous slope for correct drainability-. Pipe layout must be design to reduce pressure loss as low as possible using few elbows, branch tees, etc.
• Dead pockets/blind ends are not allowed.
• To avoid undrainable pockets, for horizontal pipelines use eccentric reducers to change pipe diameter. For vertical pipes use of concentric reducer is

allowed. Change of pipe dimeter is not allowed without the use of proper sanitary reducers.
• For pipe expansion due temperature changes inserting a lyre or an expansion joint. Stainless steel expands by more than 1 mm per meter per 100°C heat increase.
For correct slope:
• Adequate spacing of supports to avoid liquids traps

Tubing

A tube, or tubing, is a long hollow cylinder used for moving fluids (liquids or gases). (Unknow, 2015)

Stainless steel tubing for the Brewery, Food, Dairy and Pharmaceutical Industries must be manufactured in 304L & 316L polished on the ID from 32u-in to 20u-in Ra; OD up to 30u-in Ra, Following standards like ASTM A-269; A-270, DIN 11850.

A-270 Sanitary Tubing Dimensional Tolerances
All dimensions in inches (mm)

Size OD	Wall`	Outside Diameter	Length	Wall
1/2" (12.7)	0.065" (1.65)/0.049" (1.25)	+/-0.005 (0.13)	+1/8" (3.18)	- 0 +/-10.0%
3/4" (19.1)	0.065" (1.65)/0.049" (1.25)	+/-0.005 (0.13)	+1/8" (3.18)	- 0 +/-10.0%
1" (25.4)	0.065" (1.65)/0.049" (1.25)	+/-0.005 (0.13)	+1/8" (3.18)	- 0 +/-10.0%
1-1/2" (38.1)	0.065" (1.65)/0.049" (1.25)	+/-0.008 (0.20)	+1/8" (3.18)	- 0 +/-10.0%
2" (50.8)	0.065" (1.65)/0.049" (1.25)	+/-0.008 (0.20)	+1/8" (3.18)	- 0 +/-10.0%
2-1/2" (63.5)	0.065" (1.65)	+/-0.010 (0.25)	+1/8" (3.18)	- 0 +/-10.0%
3" (76.2)	0.065" (1.65)	+/-0.010 (0.25)	+1/8" (3.18)	- 0 +/-10.0%
4" (101.6)	0.083" (2.11)	+/-0.015 (0.38)	+1/8" (3.18)	- 0 +/-10.0%
6" (152.4)	0.083" (2.11)/0.109" (2.77)	+/-0.030 (0.76)	+1" (25.4)	- 0 +/-10.0%
8" (203.2)	0.109" (2.77)	+0.061 (1.55) - 0.031 (0.79)	+1" (25.4)	- 0 +/-10.0%

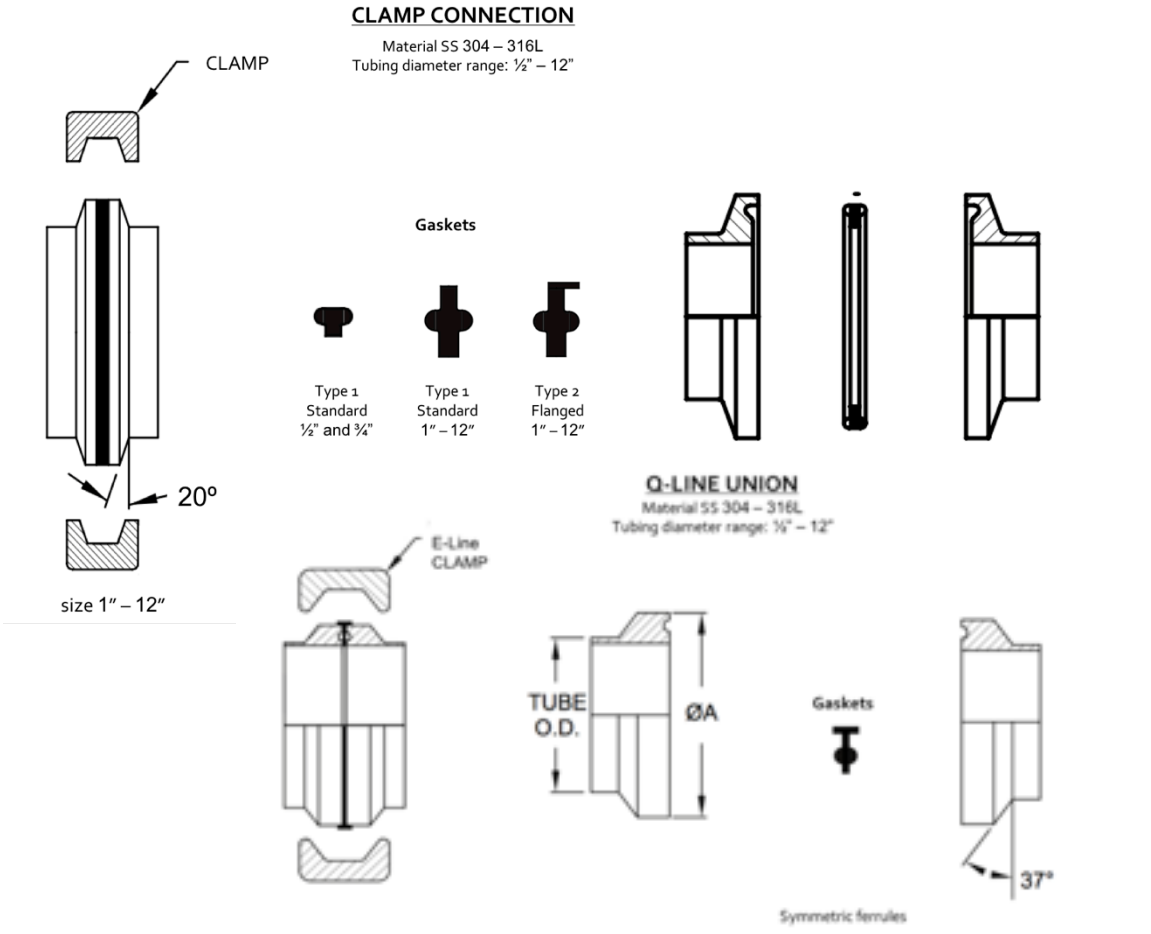
Hygienic Couplings

Food & Beverage; Pharmaceutical & Cosmetic Industry is very sensible to a process contamination due a piping sealing devices on their operational plants world-wide, becoming a management concern to keep the reasonably levels of product quality to get trust of their customers.

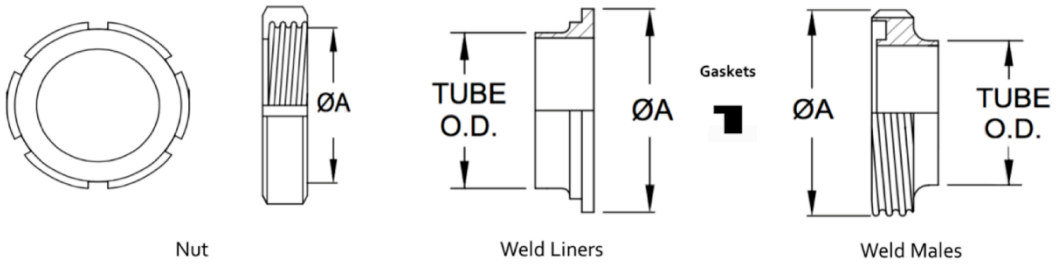
Areas of seal intrusion or recess are caused by overtightened gaskets creating a microbial trap at the clamp union. This cause a certain number of production problems:

- Drainability and cleanability of the system is being compromised
- Remaining product is held in the system creating a microbial trap
- Gasket Intrusion into the process stream creates damming and exposes the gasket to get into the product
- Seal failure is accelerated because increased contact area is in contact with aggressive CIP chemicals
- Risk of process contamination increases due to shearing of seal particulates.

The most common hygienic couplings or sanitary unions used at the food, beverage, cosmetic and Pharmaceutical industry as well, are listed below

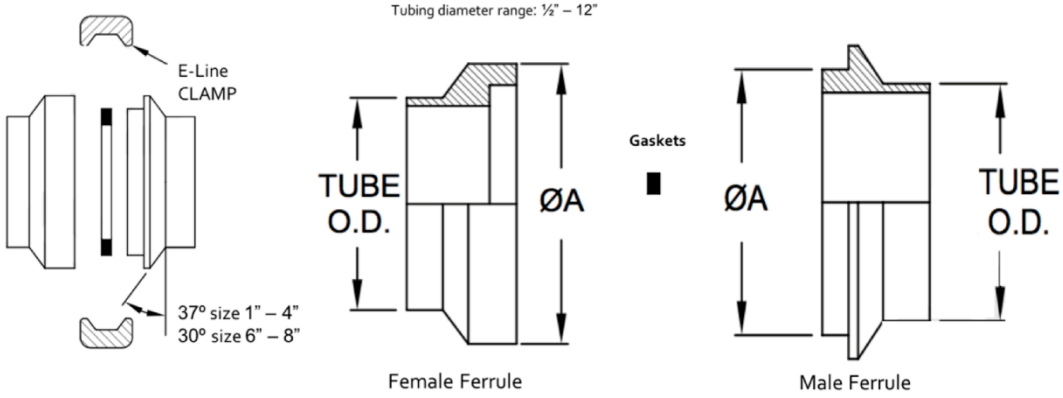


SMS UNION



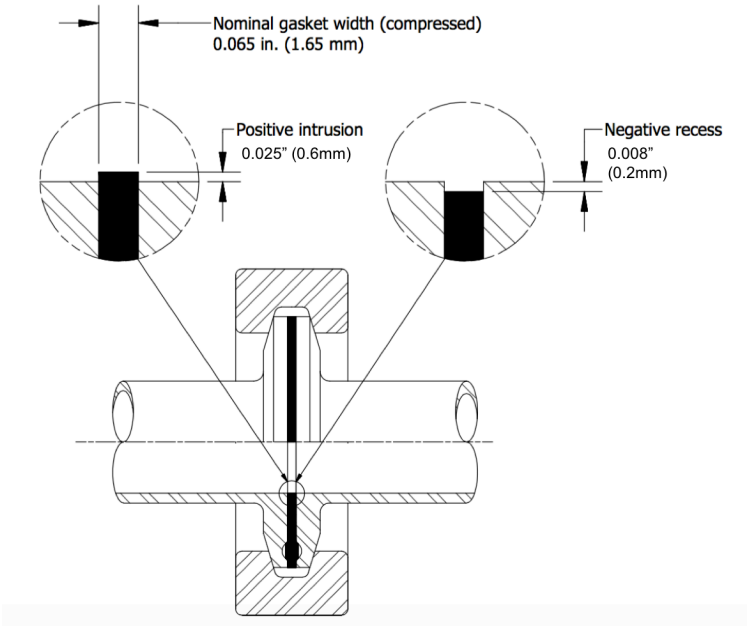
E-LINE UNION

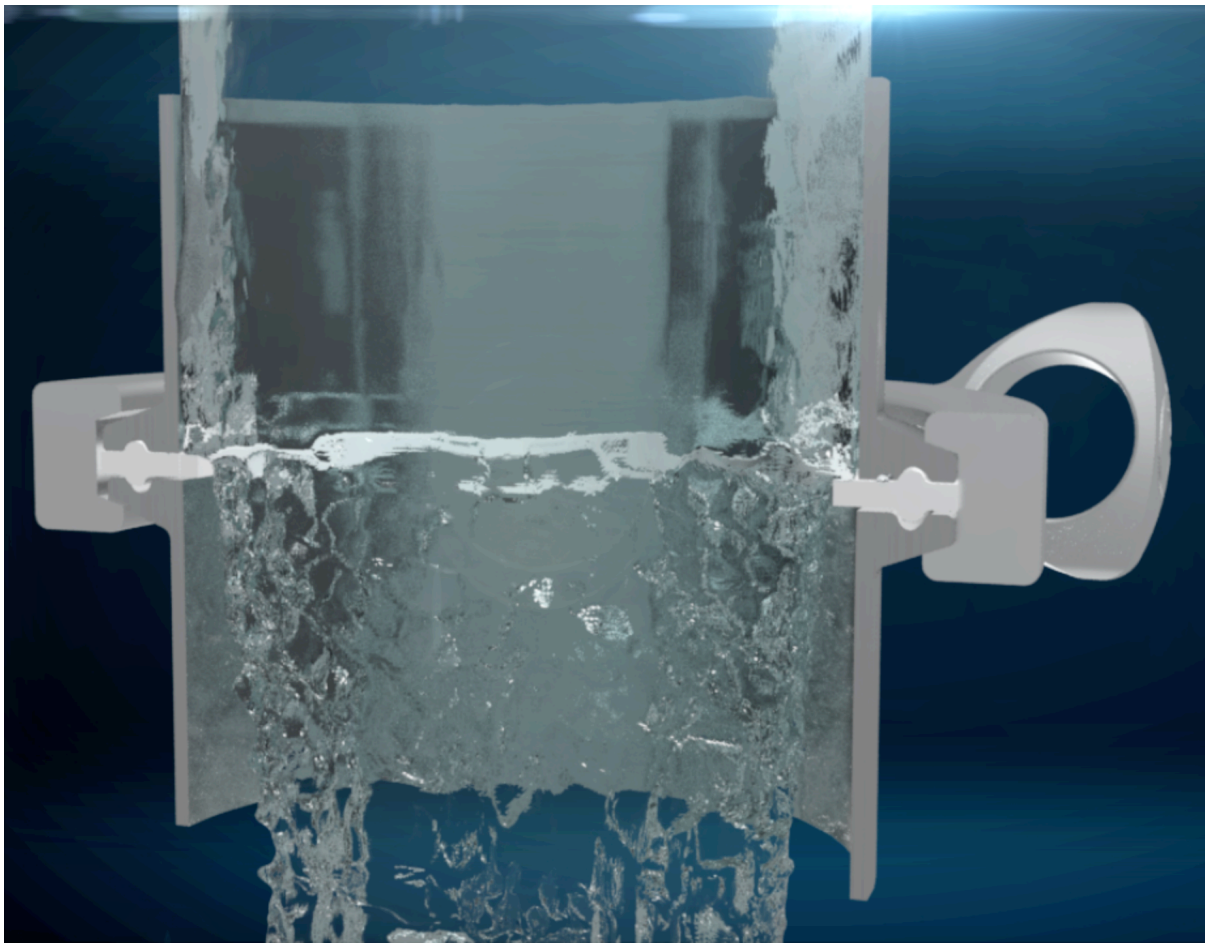
Material SS 304 – 316L
Tubing diameter range: ½" – 12"



One of the common sanitary unions in piping is the highly know as clamp union, thousand of this device are installed worldwide food and beverage processing plants The process to installing, maintaining, cleaning, and removing theses sanitary gasket is a critical aspect to avoid bacteria growth. Unfortunately, the clamp union design is susceptible to human handling. Depends on how much clamp is tightened results in either a recess or intrusion of the gasket, relative to the ferrule affecting the flow path. (IAFIS; IAFP; USPHS; DIC; USDA, 2002) (ASME-BPE, 2012)

ASME BPE-2012
Fig. SG-4.2-1 Typical Hygienic Clamp Union: Allowable Gasket intrusion

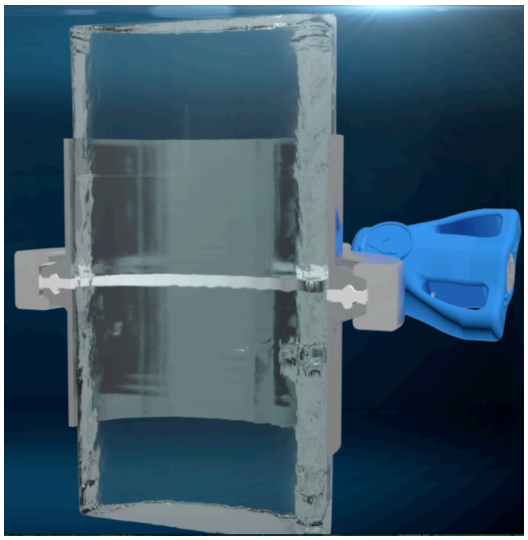




One solution to this issue is the new Clamp-Sense by Trynox™. This is a precision limit torque adjustable clamp has been engineered to consistently achieve intrusion levels of less than +0.025”/-0.008” into the flow path. This mitigates the possibility of cracking, gasket debris in the product stream or harmful bacteria growing in crevices that the CIP failed to adequately reach, as shown above

Some of the features of Clamp-Sense by Trynox are:

- ✓ Reduce the risk of gasket damage, preventing possibility of product contamination either by gasket cracking or by gasket intrusion on the flow path.
- ✓ Limit the clamp pressure through wingnut torque sensing the sealing pressure applied over the sanitary gasket.
- ✓ Lower maintenance costs.
- ✓ Easy removal and replacement.
- ✓ Match to all existing clamp gaskets and unions diameters.
- ✓ Keyless clamp fitting.
- ✓ Increase system cleanability
- ✓ Improve piping drainability
- ✓ Same weight than standard clamps



Sanitary Gaskets

Thousands of gaskets are used daily throughout food and beverage processing plants at every hygienic union. They are inserted between two flanges and connected using a Clamp and or threaded Nut. Biopharmaceutical processes usually require one or more Steam-In-Place (SIP) cycles per production batch. Depending on the requirements and the location in the process, the number of SIP exposures that a seal may be subjected to may be as high as 20 to 30 SIPs per production batch. In the Food and Beverage Industry, automated Clean-In-Place (CIP) operations are more commonplace today. One cleaning per production batch is typically required, and cleaning cycles usually consist of weak caustic acid and/or bleach solutions at elevated temperatures.

The information below has been prepared to help you in selecting the correct elastomer or perfluorocarbon utilized in high purity sanitary hygienic seals where critical pure water, process fluids (both ambient and hot), and SIP environments exist. The intention is to consider the different uses, applications and conditions to determine the most favorable hygienic seal material for each application.

Most common sanitary gaskets elastomer materials

Buna-N (NBR): Will handle most food, dairy, beverage and sanitary services. It is the backbone of the food and edibles processing industries, has excellent resistance to

compression set, tear and abrasion. It has good acid and milk alkali resistance and is good for vegetable oil service. Rated at -40° F to 225° F.

EPDM: Excellent for hot water and steam service up to 275°F. EPDM is very abrasion resistant and has excellent resistance to ozone, sunlight or weather and de-ionized water. EPDM also has good tensile strength and good resistance to mild acids, alkalis and alcohols. Rated at -55° F to 275° F (short term to 400° F).

Viton®: (FKM, FPM): material has excellent mechanical, chemical, heat and steam resistance. Viton® is particularly well suited for hot fatty oil products. Viton® is especially good for hard vacuum service because of its high molecular weight and low gas permeability. It has been used to -65°F in static seals - flexibility, 0°F to 400°F under continuous duty and will take 600°F for short periods of time. Rated at -2° F to 450° F (short term to 600° F).

Silicone: (VMQ): Known for its standard of purity and non-leaching characteristics. Its ability to withstand many chemical and combination of chemicals is the reason it is so popular with the pharmaceutical industry. Silicone has excellent low temperature flexibility - to -100°F in dry heat; 400°F is the maximum for continuous duty with 600°F possible for short periods of time. Rated at -80° F to 400° F (short term to 600° F).

Teflon® PTFE: The material of choice whenever low temperature flexibility or hygienic seal memory is not required (not recommended where large temperature variations occur frequently, leakage can occur). PTFE has almost no extractable, has a low absorption rate and excellent resistance to process fluids. It can remain in service for longer periods of time in both water and steam for continuous use, high pressure clamps are recommended to prevent leakage resulting from temperature variations.

A PTFE envelope hygienic seal with an FKM Fluoroelastomer inner core should be used if slight misalignment is observed. **ENVELOPE:** Almost universal chemical inertness. This gasket is a composite construction being a PTFE outer case, in contact with the media, and a FPM. Filler that provides elasticity. Temperature range from -20°F to 400°F.

Tuf-Steel®: A unique 50/50 blend of nonpigmented PTFE and 316L, water atomized and passivated, delivers leak-proof performance. Tuf-Steel is the choice for leak-proof, perfect surface performance and outstanding durability in SIP (steam in place) and WFI (water for injection) applications. Tuf-Steel is ideal for sanitary steam pipe connections in extreme temperatures ranging from -20°F to 500°F. The superior strength of Tuf-Steel eliminates cold flow and creep to prevent maintenance problems and system downtime.

KALREZ: Almost universal chemical inertness. Especially suitable for CIP, SIP and WFI systems. Temperature range -20°C to 260°C.

Sanitary Gaskets General Performance Properties

	Nitrite (Buna)	**Fluoro-Elastomer (Viton)**	**Platinum Cured Silicone Elastomer**	**Ethylene-Propylene Diene Monomer(EPDM)**	**PolyTetra Fluoro Ethylene(Teflon)**	**Tufsteel**
Letter Designation	U	SFY	PX	EPDM	G	GTS
Sanitary Gasket Color Code	RED	Yellow & White	Pink	Green	Remains White	Remains Grey
Max Temperature Intermittent	240Deg F	410Deg F	580Deg F	300Deg F	450Deg F	578Deg F
Max Temperature Continuous	210Deg F	380Deg F	490Deg F	260Deg F	400Deg F	526Deg F
Minimum Temperature	-65	-20	-85	-70	-350	-370
USP Class VI	No	Yes	Yes	Yes	Yes	Yes
Steam in Place Performance	Poor	Good	Good	Good	Good	Excellent
Acids, Dilute	Good	Excellent	Good	Good	Excellent	Excellent
Alkalies	Good	Good	Excellent	Excellent	Excellent	Excellent
Alcohol, Glycols	Excellent	Good	Excellent	Excellent	Excellent	Excellent
Animal Oils & Fats	Excellent	Excellent	Good	Fair	Excellent	Excellent
Soaps, Bleaches, Detergents	Fair/Good	Good	Fair	Excellent	Excellent	Excellent
Vegetable Oil	Excellent	Excellent	Excellent	Fair	Excellent	Excellent
Water	Good	Excellent	Good	Excellent	Excellent	Excellent

Note: This chart is intended to be used as a general guideline. Actual performance of our sanitary gaskets will vary with each application. Consult our staff if you have any questions regarding sanitary gasket performance in your application (RUBBERFAB TECHNOLOGIES GORUP, 2006)

Sanitary Fittings

One of the elements on the piping systems are fittings, let say elbows, branch tees & branch yees, concentric & eccentric reducers, etc.

Following a different international standards as DIN, ASME, ISO, SMS, 3A,

Fittings are made in different dimensional standards, metric or inches, take care pipe dimensions and thickness match with fittings you choose to avoid problems on the welding development.

Follow we will try to illustrate some of the most used fittings for hygienic piping systems:

90 Short Elbow

90 Elbow with straight ends

45 Short Elbow

Equal Tee

Reduced Short Tee

Concentric Reducer

Excentric Reducer

Sanitary Valves

Valves are process components that provide dynamic seals within the process. Is a device that regulates, directs or controls the flow of a fluid (gases, liquids, fluidized solids, or slurries) by opening, closing, or partially obstructing various passage ways. Valves are technically fittings, but are usually discussed as a separate category. In an open valve, fluid flows in a direction from higher pressure to lower pressure. They also provide seals between the process and the atmosphere. (ASME-BPE, 2014)

Diaphragm Valves:

Consists of a valve body with two or more ports, a diaphragm, and a "weir or saddle" or seat upon which the diaphragm closes the valve. The valve is constructed from either plastic or metal. (unknown, wikipedia: article Diaphragm valves, 2015) The diaphragm seal is a flexible membrane that forms a positive closure when it is compressed against the weir usually made by elastomeric material or PTFE filled with elastomeric like EPDM or VITON. (ASME-BPE, 2014)

Ball Valves:

This popular valve is a form of quarter-turn valve which uses a hollow, perforated and pivoting ball (called a "floating ball") to control flow through it. It is open when the ball's hole is in line with the flow and closed when it is pivoted 90-degrees by the valve handle. (unknown, wikipedia Article Ball Valves, 2105)

Butterfly Valve:

It is from a family of valves called quarter-turn valves. In operation, the valve is fully open or closed when the disc is rotated a quarter turn. The "butterfly" is a metal disc mounted on a rod. (unknown, wikipedia article butterfly valves, 2015) The seal creates a dynamic seal when the disc is rotated into the closed position the same seat also forms the primary stem seal to prevent seal through the stem journal. (ASME-BPE, 2014)

Relief valve:

The relief valve (RV) is a type of valve used to control or limit the pressure in a system or vessel which can build up for a process upset, instrument or equipment failure. Vacuum safety valves (or combined pressure/vacuum safety valves) are used to prevent a tank from collapsing while it is being emptied, or when cold rinse water is used after hot CIP (clean-in-place) or SIP (sterilization-in-place) procedures. When sizing a vacuum safety valve, the calculation method is not defined in any norm, particularly in the hot CIP / cold water scenario, but some manufacturers have developed sizing simulations. (Unknown, 2015)

Rising Stem Valves:

Poppet is used to close the flow against the seat, uses a dynamic seal on the stem and static seal are used between body components. There are many types, single and double seat, mix proof, also in many combinations,

shutoff, 3 ways or more ways, which in right combination form a clusters to operate big processing plants by remote control systems. (ASME-BPE, 2014)

Check Valves:

Non-return valve or one-way valve is a valve that normally allows fluid (liquid or gas) to flow through it in only one direction. The valve seat is closed either by mechanical means spring or by process fluid that the flow stream is blocked. (Unknown, Wikipedia Article Check Valves, 2015) The body cavity may be sealed by static seal. The seat can be sealed by o'ring seal. (ASME-BPE, 2014)

MATERIALS RECEIVING & INSPECTION

Material Reception

Check the following points carefully when the material arrives:

Material has been delivered in the agreed quality, and make sure mill certificates numbers match with heat numbers engrave on pipes and fittings.

Fittings and pipes are wrapped according with the specifications.

Longitudinal welding in pipes and fittings not show any discoloration on the inside.

Deep Material Inspection Analysis

Depend on the Installation requirements there is some additional analysis might be done Rx Gun Spectrometric material analysis you might get detailed metallic material composition except carbon content Roughness micro meters to verify inside and/or outside material roughness according with surface profiles.

Measure tools instruments to verify fittings and tubing dimensions.

After receiving inspection has finished would be a good practice make a report for the material traceabillity installation records, or simply to make any claim to the suppliers

Material Storage

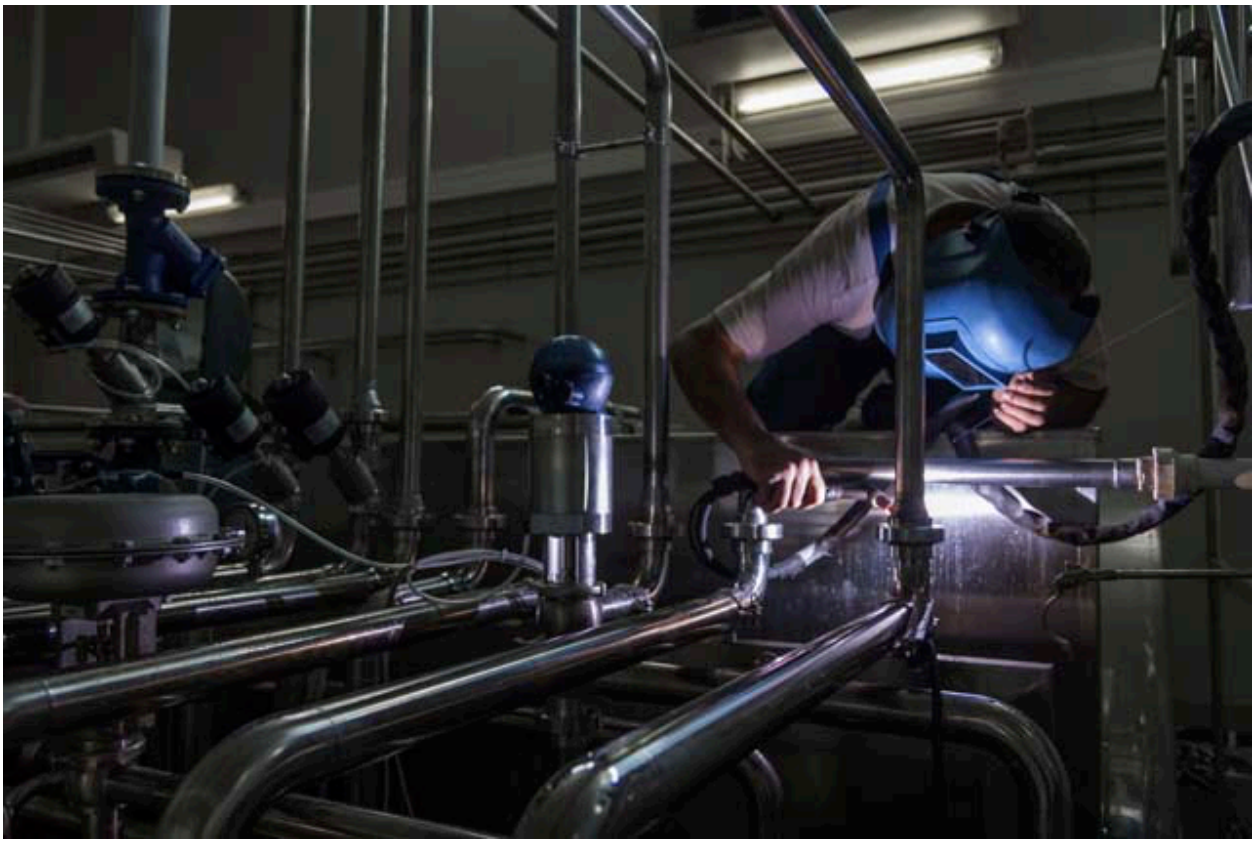
Once the receiving inspection has being completed, pipes and fittings must be resealed to avoid impurities and/or small insects come in to the pipe and fittings. All materials (Sheets, Pipes, Valves and Fittings) must be stored in a dry, dust free room (Folkmar Andersen & A/S, 2006)

WELDING

General

For every project must be defined a welding specification describing requirements for welding procedure, control and inspection of the finished job. If the delivered job ”fails” at the inspection, and/or does not meet the specified quality requirements, the inspection should be intensified beyond what was agreed. All defects found must be repaired.

Welding of product pipes must only be carried out by certified welders.



Welding Roughness

The normal roughness of a well-performed weld will be approx. 1.6 to 4 µm. The maximum roughness accepted on the product side is 6 µm.

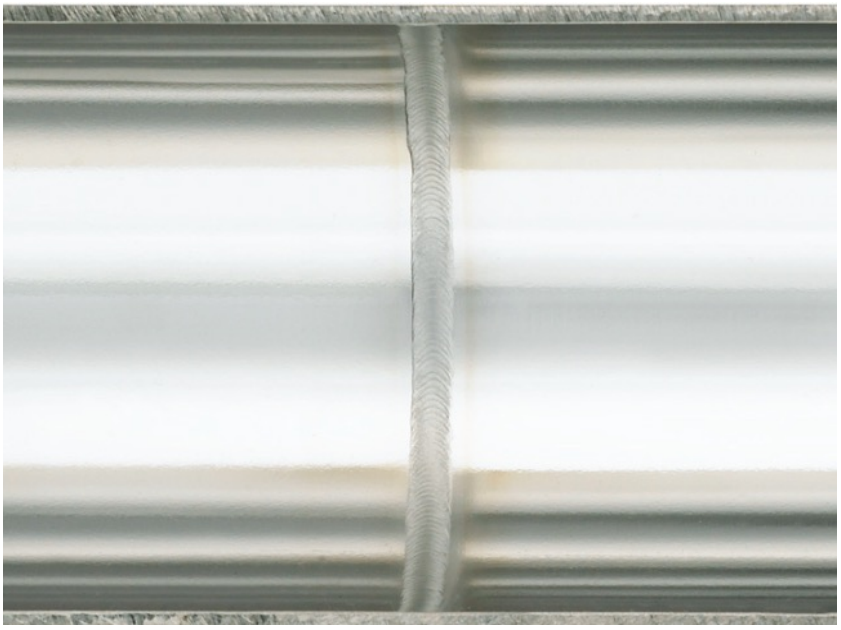
Shielding

During stainless steel welding, shielding gas must be used at all the times, both on the front and on the backside of the weld zone. The purpose of the shielding gas is to prevent the access of oxygen to the weld area.

Insufficient shielding will become in oxidation of the heat-affected weld zone. This will reduce stainless chemical properties.
Often, argon is used in the welding gun and as gas protection inside pipes.

Equipment required for welding

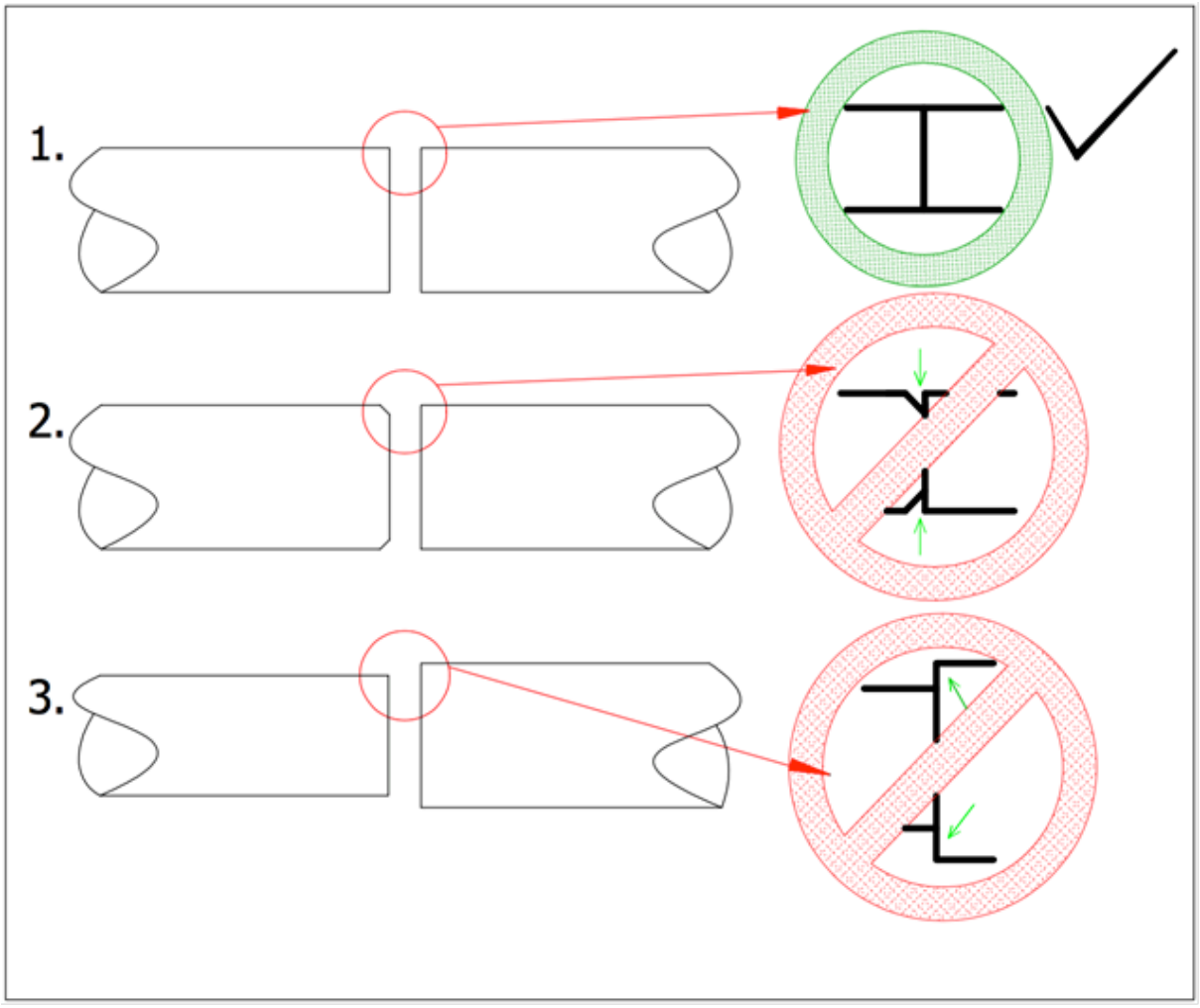
The following equipment is expected to be required:
• TIG welding unit with pulse box. (Manual and/or Orbital)



• Oxygen meter to check residual oxygen content at the shielding.
• Flow meter to control the inert gas supply. For welding gun and for pipe shielding
• Shielding gas Argon and Pickling paste to passivate stainless after welding procedure.
• Orbital pipe cutter. (Folkmar Andersen & A/S, 2006)

Welding Preparation

For piping installations, observe the following guidelines:
All pipe fitting materials (couplings, unions, valves, etc.) must be at the mounting side temperature to prevent condensation inside the pipes, which may cause welding defects
Joint design for hygienic tubing and fittings shall be square butt joints.
The tubing and fittings shall have ends prepared by machining or facing to provide a square ends.



The butt weld joints shall be properly cleaned within 1” (25mm) of the joint area on the inside and outside surfaces prior to welding.

Welding on tube will be done using orbital welding machine, except where the size or space will not permit In that case, manual welding can be performed.

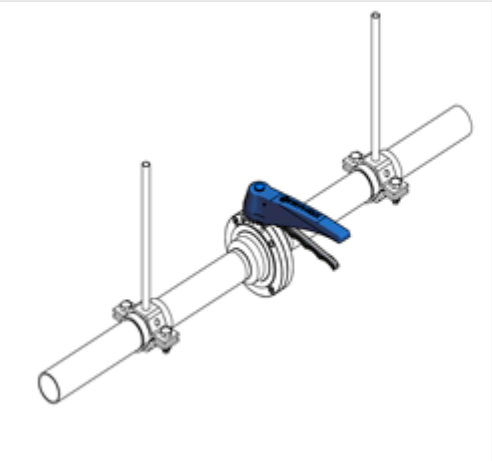
• Pipe ends must be free of burrs.
• Pipe ends to be welded must have identical inside and outside diameters. In case of any difference, the smallest pipe must be expanded to the big inside diameter.
• When using fit-up clamps for pipe ends, the contact face must be stainless.

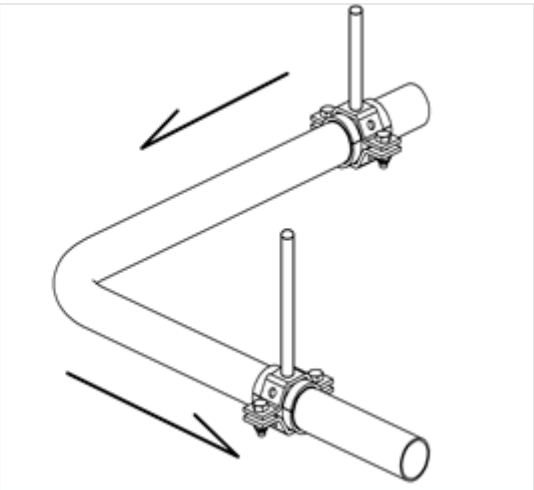
After Welding

• Weld piping systems must be inspected by endoscopy.
• The weld is pickled on the outside with pickling paste. When possible, it is also pickled on the inside. (Folkmar Andersen & A/S, 2006)

INSTALLATION

Proper Slope for correct Drainability
• Pipes must be mounted so as to be fully drainable (minimum incline of 0.29°).
• If the location prevents drainability problems, valves must be built in at all low points of the installation.





Minimum slope per ASME BPE Standard:
Table SD-2.4.3.1-1 Slope Designations for Gravity-Drained Lines

Slope Designation	Minimun slope in/ft	Minimun mm/m	Minimun Slope,%	Minimun Slope Deg.
GSD1	1/16	5	0.5	0.29
GSD2	1/8”/ft.	10	1.0	0.57
GSD3	1/4”/ft.	20	2.0	1.15
GSD0	Line	slope	not	required

Slope measurements should be taken with a calibrated digital level or protractor per ASME Bends, Branch tees and other fittings to guarantee correct drainability. (ASME-BPE, 2014)

Recommended Mounting Practices

Supports and hangers must be installed in close proximity to each change in direction of piping, with consideration of pipe movement due to thermal expansion and use of anchor and guide inserts to facilitate intended pipe movements.

Supports and hangers will be installed as close as possible to any concentrated loads, such as valves, instrumentation, and other process components. It may be necessary to install on both sides of certain loads to reduce deflection and ensure proper continuous slope for drainability.

• Anchoring systems should be designed to accommodate piping motion including thermal expansion. (Folkmar Andersen & A/S, 2006)

Spacing of Pipe Hangers

Hangers and/or supports shall be spaced as far apart as economically possible, with due consideration to assure that the sag of the pipe between supports is within limits that will permit drainage and also avoid excessive bending stresses from concentrated loads such as valves and in-line equipment.

Contractor shall use the maximum recommended spacing between pipe support specified below.

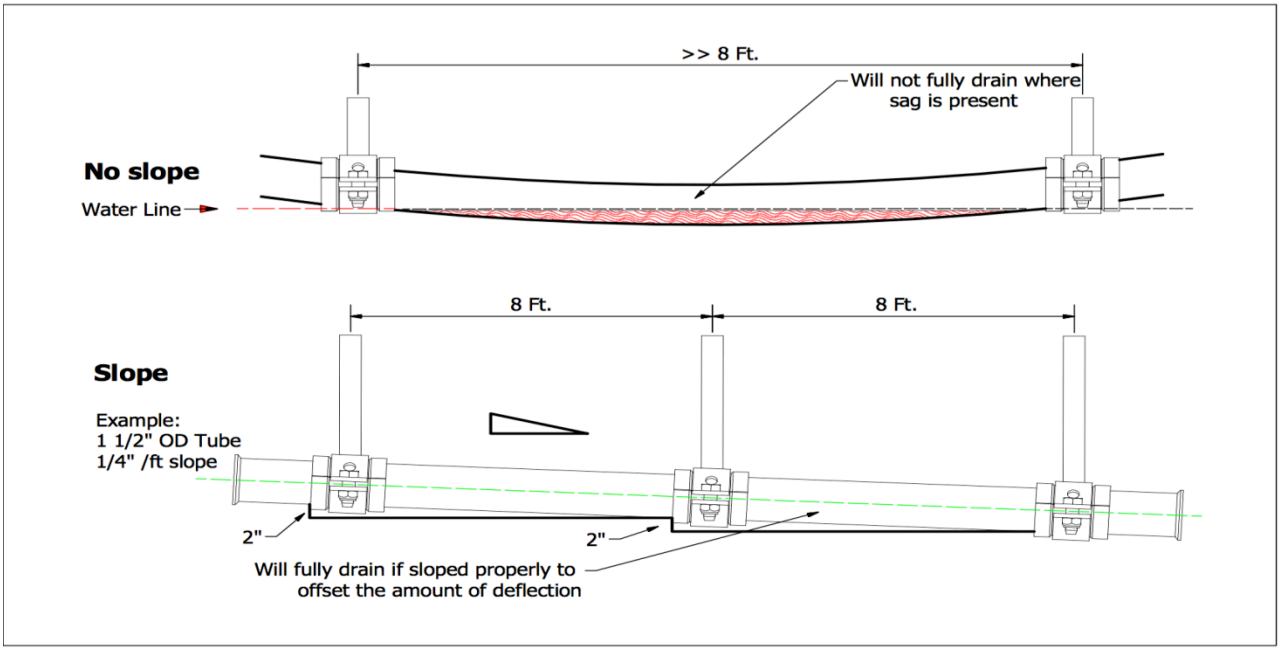
Additional hangers may be necessary to adequately support concentrated loads such as valves, flanges, or instruments.

STEEL **PIPE** HANGER SPACING:

PIPE SIZE (in)	MAXIMUN SPACING (ft)
1/2" & 3/4"	6
1" & 1-1/4"	8
1-1/2" & 2"	10
3"	12
4" -16"	16

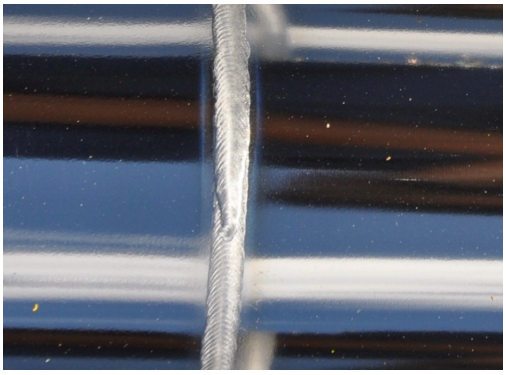
STAINLESS STEEL **SANITARY TUBING** HANGER SPACING

TUBING SIZE (in)	MAXIMUN SPACING (ft)
1/2" - 3/4"	6
1" - 1-1/2"	8
2" - 3"	10
4" - 6"	12



INSTALLATION INSPECTION

Welding Inspection

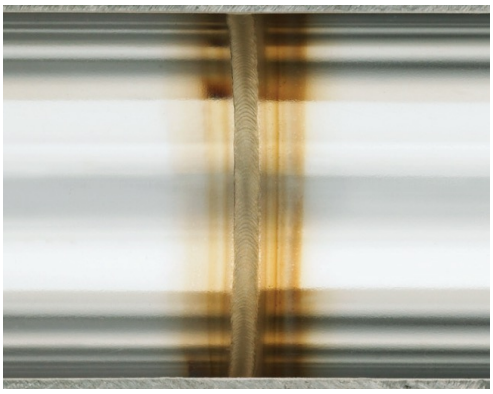


1.-Verify all welding test and reports approved by Quality Assurance team from welders who carry out welding operations during installation.

2.- A minimum of 5 per cent of all pipe welds must be endoscopied welds must subsequently be individually identifiable and recorded.

3.- If defects are detected, an extended endoscopy inspection is made on 10 of the welder's latest welds. If further defects are found, the welder in question must have his certificate renewed. Before the welder can perform welding operations on installations again, he must perform three supervised, error-free welds on setups selected by Quality Assurance Team.

4.- If defects are detected during 2.-, further endoscopy inspection must be carried out on 5 per cent of the other welds that were not referred to under 3.-.



5.- Endoscopy must be carried out regularly – weekly – and video copy hereof must be sent to Quality Assurance Team, as the inspections are performed.

6.- The customer reserves the right to carry out his own endoscopy to an extent chosen by him, and documented defects must be subject to the procedures in steps 2.-, 3.- and 4.-. (Folkmar Andersen & A/S, 2006)

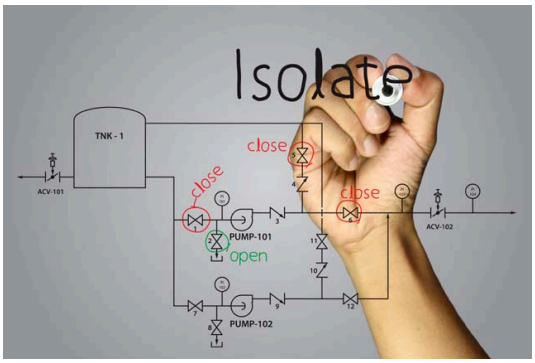
Pipe work Inspection

The layout of the mounted pipe runs is sensible and according to the project specifications.

the selected pipe dimensions, valves and other equipment are sensible to mounting requirements and guidelines have been observed.

If a plant inspection shows inside discolorations from welding, and there is no root defect in the welds, the discolorations can be removed by pickling.

The pickling procedure must ensure:
• Rubber gaskets, pumps mechanical seals and similar materials are not damaged
• pickling does not represent any kind of danger or hazard to persons and the environment
• No valves and measurement equipment is damaged
• The pickling procedure must be approved by the customer and his safety representative before it can be implemented! (Folkmar Andersen & A/S, 2006)



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Unknown*Wikipedia, Article Safety Valves*

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