Precision engineered tubing for industry

- Stainless Steel
- Nickel Alloys
- Titanium

make the connection

RathGibson

Table of Contents

Overview

Make the Connection

The RathGibson Group of Companies manufactures the finest quality Precision Engineered Tubing for Industry. Materials include Stainless Steel, Nickel Alloys and Titanium. Our tubing is available in PRECISION WELDED STRAIGHT LENGTHS AND COIL, WELDED & DRAWN, and SEAMLESS.

We will meet the challenge of your most demanding requirements. We achieve this through a customer-focused philosophy that is shared by every RathGibson employee.

Our technical leadership drives our continuous improvement of production techniques and a quality system to meet every requirement.

Our unique capabilities include electropolishing, encapsulation of wire and fiber optics in coils and the ability to manufacture coiled tubing up to 80,000 feet.

RathGibson will continue to grow thanks to customers who appreciate our product diversification, world-class service, and our commitment to quality.

At RathGibson, we MAKE THE CONNECTION.

Available Tubing Size Ranges

Outside Diameter:
From 1/16" (1.59 mm) to 8" (203.2 mm)

Wall Thickness:
From 0.010" (0.25 mm) to 0.225" (5.7 mm)

Straight Lengths:
Up to 90 feet (27 m)

Coil Sizes:
Up to 80,000 feet (24 km)

Worldwide Locations

RathGibson has three manufacturing facilities in the United States: Janesville, Wisconsin; North Branch, New Jersey; and Clarksville, Arkansas. Our six sales offices are strategically situated throughout the world. In the United States, RathGibson has sales offices in Janesville, Wisconsin, and North Branch, New Jersey. Additional RathGibson sales offices are located in Shanghai, China; Manama, Bahrain; Knoxfield, Australia; and Seoul, Korea.

GTC®
GREENVILLE TUBE COMPANY

When projects demand high quality tubing and quick turnaround, companies can also turn to Greenville Tube. In fact, Greenville Tube has become the industry leader for projects whose deadlines demand fast delivery. As a member of the RathGibson family of companies, Greenville Tube's production expertise, as well as their commitment to customer service, elevate RathGibson into the next level of technologically advanced tubing and pipe manufacturing.

Using stainless steel and nickel alloys, Greenville Tube manufactures seamless, welded & drawn, and welded tubing in Clarksville, Arkansas to be shipped to installations throughout the world.

RathGibson has been a power-house in the Oil and Gas industries for decades. Here are some of the many reasons why our clients trust us time and time again.

- Products – RathGibson straight length and coil tubing is cost effective, while maintaining high strength and corrosion resistant characteristics
- Delivery – On-time delivery performance means that you will receive what you want when you want it
- Lengths – Coils are available up to 80,000 feet (24 km) in length
- Specific Process Plans – for downhole and umbilical customers
- Advanced Quality Program – with multiple non-destructive testing capabilities

Oil and Gas

Applications

- Downhole Control Line
- Downhole Chemical Injection Lines
- Encapsulated Wire and Fiber Optics
- Subsea Umbilical Tubing
- Offshore Topside Applications
- Panel Board Instrumentation Tubing

Products

- 304L
- 316L
- 825
- 625
- Duplex 2205
- Lean Duplex Alloys
- Zinc Clad Clean Duplex
- Zinc Rod

Products available in welded, welded & drawn, and seamless

Companies throughout the world rely on RathGibson for more than our outstanding tubing products. They trust our technical expertise and superior service, as well. From the moment you contact a RathGibson representative, you become more than a client – you become a member of the RathGibson family. Make the connection and experience the RathGibson difference.

Chemical/ Petrochemical/ Power Generation

Applications:

Heat Exchangers

Steam Condensers

Feedwater Heaters

Products:

304L

316L

Lean Duplex Alloys

Duplex 2205

Super Duplex 2507®

Super Duplex Zeron® 100

Titanium, Grade 2

20

C276

C22®

625

825

904L

6-Moly

Products available in welded, welded & drawn, and seamless

At RathGibson, we know the importance of surface finish in high purity applications. For years, we have carefully followed industry and governmental regulations in order to bring our clients the ultra high purity quality tubing for which RathGibson has been known and trusted in installations around the world. No matter what your requirements, RathGibson has the tubing to fit your most demanding needs.

Beverage/ Food/Dairy/ Pharmaceutical/ BioPharmaceutical

Beverage Products

304L

316L

Available as bright annealed mill finished straight lengths up to 40 ft. and coil lengths up to 15,000 ft. for the beverage industries.

Food / Dairy Products

TP304L

TP316L

Available mechanically polished to 20 µ-in Ra (0.5 µm) ID maximum and 30 µ-in Ra (0.8 µm) OD maximum surface roughness exceeding ASTM A270-S2 and 3A® specifications.

Pharmaceutical / BioPharmaceutical High Purity Products

304L

316L

Available as 100% bore-scoped and mechanically polished to 20 µ-in Ra (0.5 µm) ID maximum and 30 µ-in Ra (0.8 µm) OD maximum surface roughness exceeding ASTM A270-S2 and the stringent ASME BPE SFT1 standard.

Pharmaceutical / BioPharmaceutical Ultra High Purity Products

True 10™

True 15™

Available in RathGibson's proprietary electropolishing processes for minimal ID surface anomalies producing surface finishes to 10 µ-in Ra (0.25 µm) or 15 µ-in Ra (0.4 µm) ID maximum and 30 µ-in Ra (0.8 µm) OD maximum exceeding ASTM A270-S2 and ASME BPE SFT4 specifications. Ultra high purity products are cleaned in acertified ISO 14644-1 Class 5 cleanroom with 99.9999% pure electronics grade nitrogen purge, plastic capped ends, heat-sealed 6-mil poly sleeves and wood boxed for shipment.

RathGibson is proud to be the supplier of choice to countless companies in a variety of industries. We have achieved this distinction because of our unique customer response philosophy that allows us to react to present needs while anticipating future requirements.

From manufacturing all the way through to the delivery of final product, RathGibson is there to make certain of your total satisfaction.

RathGibson and Greenville Tube products are also available through select, recognized distributors.

Make the Connection!

General Commercial

Applications

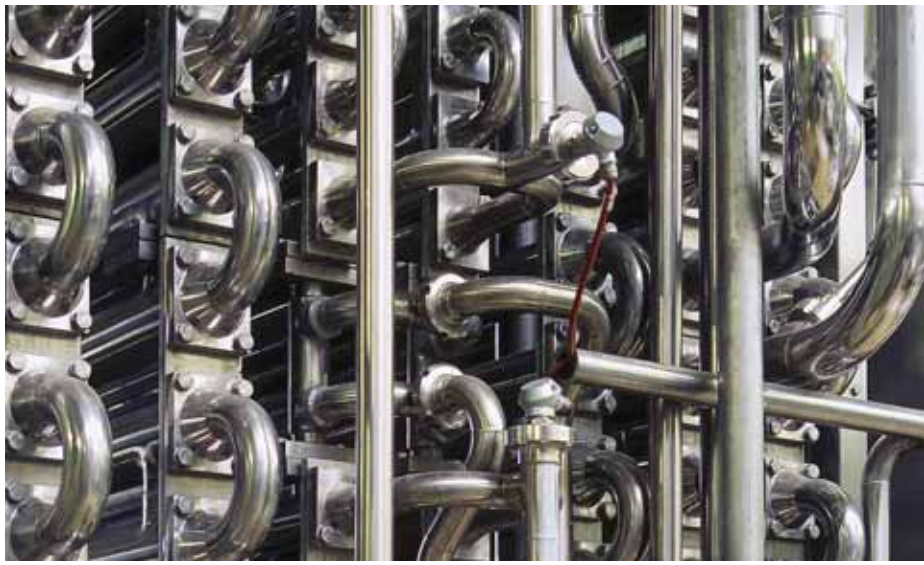
Instrumentation

Mechanical

Specialty Automotive

Pulp and Paper

Desalination



Products

Stainless Steel Alloys

Nickel Alloys

Duplex 2205

Super Duplex 2507®

Super Duplex Zeron® 100

Lean Duplex Alloys

Products available in welded, welded & drawn, and seamless

Products by Alloy

If your company needs tubing and piping, you can rely on RathGibson. Thanks to our specially engineered manufacturing procedures, we are able to easily and effectively respond to our customers' requirements, no matter how stringent they may be. Innovations in welding, bright annealing, and other processes allow us to continually expand the range of product solutions. RathGibson engineers closely follow each phase of production and testing to ensure PRECISION WELDED STRAIGHT LENGTHS AND COIL, WELDED & DRAWN, and SEAMLESS tubing and piping of superior performance.

STAINLESS STEEL

- 304, 304L, 304H
- 316, 316L
- 317, 317L
- 309S, 309H
- 310S, 310H
- 321, 321H
- 347, 347H

DUPLEX STAINLESS STEEL

- Duplex 2205
- Lean Duplex Nitronic 19D®
- Super Duplex 2507®
- Super Duplex Zeron® 100
- Lean Duplex 2003™
- Lean Duplex 2101®
- Lean Duplex 2304

NICKEL

- 20
- 200/201
- C-276
- 400
- 600
- C22®
- 625
- 686
- 59

SUPER AUSTENITIC STAINLESS STEEL

- 6-Moly
  - AL-6XN®
  - 254-SMO®
  - 25-6MO®
- 825
- 904L
- 27-7 MO®
- 800/800H/800HT®

FERRITIC / SUPER FERRITIC

- AL 29-4C®
- E-Brite®
- 439
- 444
- 18SR

When you choose RathGibson as your tube and pipe supplier, you have entered into a partnership with a world-class organization. All of us at RathGibson are committed to providing the highest quality products and services in the industry. Our goal is to cost effectively meet and exceed your most demanding requirements.

TITANIUM

Grade 2

TYPES

Precision Welded Straight Lengths and Coil, Welded & Drawn, and Seamless

FINISHES

Full-finished and bright annealed

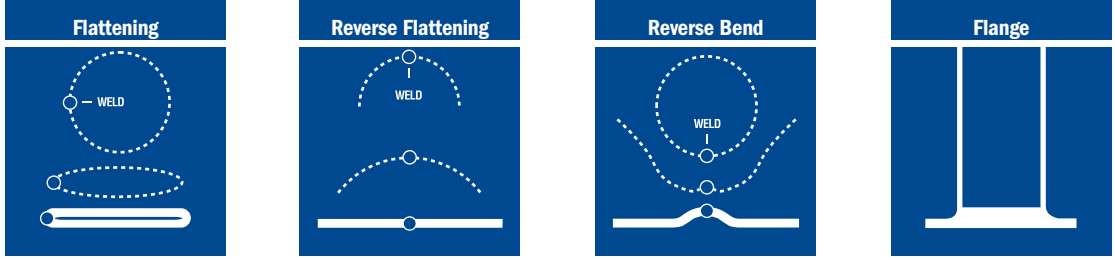
Full-finished and polished

TEMPERS

Hard drawn

Fully annealed

Dead soft

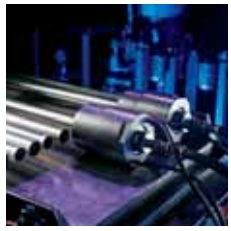


Quality

Above are some of the destructive test procedures routinely performed at RathGibson to ensure quality control and compliance to specifications.

When you choose RathGibson to be your tube and pipe supplier, you have chosen excellence. Our dedication to total customer satisfaction is the driving force behind our comprehensive quality control program. Every step of order fulfillment, from sales to manufacturing and delivery is regulated by RathGibson's own standards to maintain high levels of consistency. Quality is ensured via detailed checklists, strict monitoring, and physical inspection criteria.

All RathGibson tubing and piping are subject to internal test criteria that can meet or exceed ASTM, ASME, DIN, ECN, ISO and other industry specifications, as well as individual customer requirements. Rigorous testing is performed on raw materials in order to assure compliance to our specifications prior to processing. RathGibson has developed and maintained relationships with world-class suppliers of raw materials.

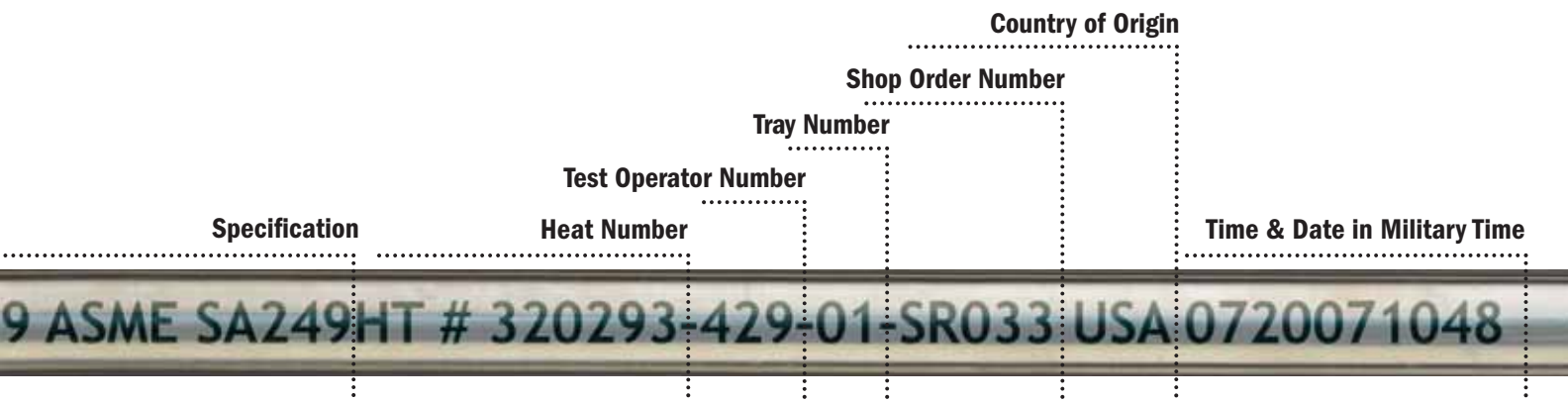


Manufacturer	Size/Type
RATHGIBSON	WLD 3/4 X .049 TP316/TP316L ASTM A249/A26

Quality Tests Performed by RathGibson

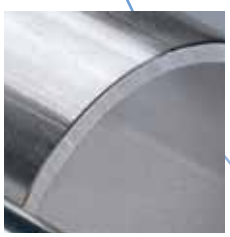
Test		Type	Typical Specifications	Products	Who's performing the testing?	Minimum Sampling*	Description
Strength	Tensile	Destructive	A370, E8	Standard	RathGibson	Heat-Lot Order	Finds the maximum amount of force required to pull the product to its failure point.
	Burst		—	Standard on coils	RathGibson	Heat-Lot Order	Ascertains the maximum amount of internal pressure a product is able to withstand before reaching its failure point.
Hardness	Rockwell	Destructive	E18, A370	Standard	RathGibson	Heat-Lot Order	An indentor is applied to a sample under a minor and then a major load. The difference in depth of penetration determines the placement of the material in relation to the Rockwell scale.
	Micro		E92	Optional	RathGibson	Heat-Lot Order	Calculated from the length of the impression made after a precision diamond indenter is applied into the material at a certain load.
Soundness	Eddy Current	NDE	E309	Standard	RathGibson	100%	An encircling coil that the tubing is passing through is energized inducing eddy currents in the tubing. The presence of any discontinuities in the entire circumference of the tubular product will alter the normal flow of currents and this change is detected.
	Ultrasonic Testing	NDE	E213	Optional	RathGibson and/or Independent Lab	100%	As a transducer is passed over the pipe or tube, it releases pulse-waves. Imperfections are detected by analyzing the returning waves.
	X-Ray	NDE	—	Optional	RathGibson and/or Independent Lab	100%	Especially useful in weld inspections.
Leak & Strength	Hydrostatic	NDE	A1016	Optional	RathGibson	100%	The inside of a tube or pipe is pressurized by a nearly incompressible liquid, and then examined for leaks or permanent shape changes.
Leak	Air Under Water	NDE	A1016, A1046	Optional	RathGibson	100%	Air is injected and then the tube/pipe placed underwater for visual leak detection.
	Pressure Decay	NDE	A1046	Optional	RathGibson	100%	Air is injected and the air pressure within the pipe/tube is measured over time.
Bend Testing	Reverse Bend	Destructive	A370	Standard	RathGibson	1500' or Heat-lot Order	Ductility, the physical property of sustaining large irreversible deformations without fracturing of the tube/pipe and/or the weld, is measured.
	Flattening	Destructive	A370	Standard	RathGibson		
	Reverse Flattening	Destructive	A370	Standard	RathGibson		
	Flange	Destructive	A370	Standard	RathGibson		
Dimensional	OD, Wall, Straightness	NDE	—	Standard	RathGibson	1500'	All these tests ascertain the integrity of any welds and the verification of wall thickness throughout the length of pipe.
Metallurgical	Grain Size	Destructive	E112	Optional	RathGibson	Heat-lot Order	Grain Size is derived from a digital image analysis of the metal surface. It is generally considered that strength and toughness are found with fine-grained steels, while coarse-grained steels are considered to have better machinability.
	Sensitization	Destructive	A262/A or E	Optional	RathGibson	Heat-lot Order	Sensitization involves the microstructural analysis of the product to see how it may respond to intergranular corrosion and stress corrosion cracking (SCC).
	Corrosion	Destructive	Alloy Dependent	Optional	RathGibson	Heat-lot Order	RathGibson's Technical Services group will recommend which of the dozen different corrosion tests will be appropriate based upon alloy, application, and possible failure modes.
	Phase balance or intermetallic	Destructive	E562, E1245	Optional	RathGibson	Heat-lot Order	Microscopic examinations from the weld cap to weld root to check for non-metallic or third phase precipitates.
	Metallographic	Destructive	—	Optional	RathGibson	Heat-lot Order	Mounted cross sections are magnified to determine condition, quality, structure, strength, corrosion, wear, and effectiveness of any treatments.

NDE = Non-Destructive Examination
*Additional strength, hardness, and destructive bend sampling is taken based on heat treatment lots or process changes.

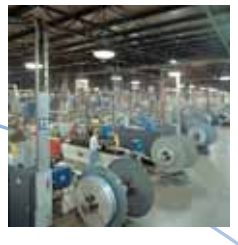


(ABOVE) Line marking is an important key to maintaining quality control and traceability.
Complete product description, specifications, manufacturing and testing information are included.

Product Information



Products	Sizes	
	OD	**Wall**
Welded Austenitic Steel Boiler, Super Heater, Heat-Exchangers & Condenser Tubes Specifications: ASTM-A249, ASME-SA249, ASTM-A688, ASME-SA688	3/16" (4.76 mm) to 4" (101.6 mm) *metric sizes available*	0.020" (0.51 mm) to 0.220" (5.59 mm)
Welded Austenitic Steel Boiler, Super Heater, Heat-Exchangers & Condenser Tubes Specifications: ASTM-A789 and ASME-SA789	3/16" (4.76 mm) to 4" (101.6 mm) *metric sizes available*	0.020" (0.51 mm) to 0.220" (5.59 mm)
Welded Heat Exchangers & Condensers Specifications: ASTM-A789 and ASME-SA789	0.5" (12.7 mm) to 4" (101.6 mm) *metric sizes available*	0.020" (0.51 mm) to 0.150" (3.81 mm)
Pressure & Corrosion Tubing Meets or exceeds requirements for welded Specifications: ASTM-A269, ASTM-A1016, and ASTM-A632	1/16" (1.59 mm) to 4" (101.6 mm) *metric sizes available*	0.010" (0.25 mm) to 0.220" (5.59 mm)
Pressure & Corrosion Tubing Meets or exceeds requirements for welded Specification: ASTM-A789	1/16" (1.59 mm) to 4" (101.6 mm) *metric sizes available*	0.010" (0.25 mm) to 0.220" (5.59 mm)
Pressure & Corrosion Tubing Meets or exceeds requirements for welded Specifications: ASTM-B704, ASME-SB704, ASTM-B705, ASME-SB705	1/16" (1.59 mm) to 4" (101.6 mm) *metric sizes available*	0.010" (0.25 mm) to 0.220" (5.59 mm)


	Grades	Standard Tolerances		
Lengths and/or coils		**OD**	**Wall**	**Lengths**
Random or cut lengths up to 90' (27.4 m) **Coils to 1-1/2" OD***	304/304L/304H 316/316L 317/317L	Under 1" (25.4 mm) ±0.004" (0.10 mm) 1" (25.4 mm) to 1-1/2" (38.1 mm) ±0.006" (0.15 mm) >1-1/2" (38.1 mm) to 2" (50.8 mm) ±0.008" (0.20 mm) >2" (50.8 mm) to 2-1/2" (63.5 mm) ±0.010" (0.25 mm) >2-1/2" (63.5 mm) to 3" (76.2 mm) ±0.012" (0.30 mm) 3" (76.2 mm) to 4" (101.6 mm) ±0.015" (0.38 mm)	±10%	Randoms up to +2" (50.8 mm) Cuts +1/8" (3 mm) -0" **Coils to 80,000' (24,384 m)**
Random or cut lengths up to 68' (20.7 m) **Coils to 1-1/2" OD***	Duplex 2205	<1-1/2" (38.1 mm) ±0.005" (0.13 mm) 1-1/2" (38.1 mm) to 3" (76.2 mm) ±0.010" (0.25 mm) 3-1/2" (88.9 mm) to 4" (101.6 mm) ±0.015" (0.38 mm)	±10%	Randoms up to +2" (50.8 mm) Cuts +1/8" (3 mm) -0" **Coils to 80,000' (24,384 m)**
Cut lengths to 60' (18.3 m)	Lean Duplex 2003™ Lean Duplex 2101® Lean Duplex 2304	< 0.50" (12.7 mm) +/-0.005" (0.13 mm) 0.50" (12.7 mm) to <1.50" (38.1 mm) +/-0.005" (0.13 mm) 1.50" (38.1 mm) to <3.50" (88.9 mm) +/-0.010" (0.25 mm) >3.50" (88.9 mm) to 4.00" (101.6 mm) +/-0.015" (0.38 mm)	+/-15% +/-10%	+1/8" (3 mm)/-0"
Random or cut lengths up to 90' (27.4 m) **Coils to 1-1/2" OD***	304/304L/304H 316/316L 317/317L	<1-1/2" (38.1 mm) ±0.005" (0.13 mm) 1-1/2" (38.1 mm) to 3" (76.2 mm) ±0.010" (0.25 mm) 3-1/2" (88.9 mm) to 4" (101.6 mm) ±0.015" (0.38 mm)	±10%	Randoms up to +2" (50.8 mm) Cuts +1/8" (3 mm) -0" **Coils to 80,000' (24,384 m)**
Random or cut lengths up to 40' (12.2 m) **Coils to 1-1/2" OD***	Super Duplex 2507®	<1-1/2" (38.1 mm) ±0.005" (0.13 mm) 1-1/2" (38.1 mm) to 3" (76.2 mm) ±0.010" (0.25 mm) 3-1/2" (88.9 mm) to 4" (101.6 mm) ±0.015" (0.38 mm)	±10%	Randoms up to +2" (50.8 mm) Cuts +1/8" (3 mm) -0" **Coils to 80,000' (24,384 m)**
Random or cut lengths up to 40' (12.9 m) **Coils to 1-1/2" OD***	625 825	<5/8" (15.9 mm) ±0.005" (0.127 mm) 5/8" to 1-1/2" ±0.007" >1-1/2" (38.1 mm) to 3" (76.2 mm) ±0.010" (0.25 mm) >3" (76.2 mm) to 4" (101.6 mm) ±0.015" (0.38 mm)	±15% ±12.5%	Randoms up to +2" (50.8 mm) Cuts +1/8" (3 mm) -0" **Coils to 80,000' (24,384 m)**

* Coiled tubing OD capabilities to increase to 3" (72.6 mm) in 2008

Product Information

Products	Sizes	
	OD	**Wall**
Beverage Tubing	1/4"(6.35 mm) 5/16" (7.94 mm) 3/8" (9.53 mm) 1/2" (12.7 mm) *metric sizes available*	0.020" (0.51 mm) to 0.028" (0.71 mm)
Instrumentation Tubing Specifications: ASTM-A269 and ASTM-A632	1/16" (1.59 mm) to 1/2" (12.7 mm) *metric sizes available*	0.010" (0.25 mm) to 0.065" (1.65 mm)
Food/Dairy Tubing **Pharmaceutical/BioPharmaceutical Tubing** **High Purity Tubing** **Ultra High Purity Tubing**	1/2" (12.7 mm) to 8" (203.2 mm)	0.049" (1.24 mm) to 0.109" (2.77 mm)
Subsea Umbilical Tubing Specifications: ASTM-A789 and ASTM-A790	3/8" (9.53 mm) to 1-1/2" (38.1 mm)	0.039" (0.99 mm) to 0.125" (3.18 mm)
Grade 2 Titanium Specifications: ASTM-B338 and ASME-SB338; Condenser and Chemical Process Applications	1/2" (12.7 mm) through 1" (25.4 mm)	0.020" (0.51 mm) through 0.083" (2.11 mm)

	Grades	Standard Tolerances		
Lengths		**OD**	**Wall**	**Lengths**
Random or cut lengths up to 40' (12.2 m)	304/304L/304H/ 316L	±0.005" (0.13 mm)	±10%	Randoms up to +2" (50.8 mm) Cuts +1/8" (3 mm) -0" **Coils to 15,000' (4,572 m)**
Random or cut lengths up to 40' (12.2 m)	304/304L/304H 316/316L 317/317L	±0.005" (0.13 mm)	±10%	Randoms up to +2" (50.8 mm) Cuts +1/8" (3 mm) -0"
20' (6.1 m) stock lengths. Other lengths available upon request.	304/304L/ 316/316L	1/2" (12.7 mm) ± 0.005" (0.13 mm)	±10%	+1/8" (3 mm) -0"
		3/4" (19.1 mm) ± 0.005" (0.13 mm)	±10%	+1/8" (3 mm) -0"
		1" (25.4 mm) ± 0.005" (0.13 mm)	±10%	+1/8" (3 mm) -0"
		1-1/2" (38.1 mm) ± 0.008" (0.20 mm)	±10%	+1/8" (3 mm) -0"
		2" (50.8 mm) ± 0.008" (0.20 mm)	±10%	+1/8" (3 mm) -0"
		2-1/2" (63.5 mm) ± 0.010" (0.25 mm)	±10%	+1/8" (3 mm) -0"
		3" (76.2 mm) ± 0.010" (0.25 mm)	±10%	+1/8" (3 mm) -0"
		4" (101.6 mm) ± 0.015" (0.38 mm)	±10%	+1/8" (3 mm) -0"
		6" (152.4 mm) ± 0.030" (0.76 mm)	±10%	+1" (25.4 mm) -0"
		8" (203.2 mm) +0.061" (1.55 mm), -0.031" (0.79 mm)	±10%	+1" (25.4 mm) -0"
Cut lengths to 60' (18.3 m) **Coils to 1-1/2" OD***	Lean Duplex Nitronic 19D® Super Duplex 2507® Lean Duplex 2003™ Lean Duplex 2101®	±0.005" (0.127 mm)	±10%	**Coils to 80,000' (24,384 m)**
Cut lengths to 60' (18.3 m)	Titanium Grade 2	Under 1" (25.4 mm) ±0.004" (0.10 mm) 1" (25.4 mm) to 1-1/2" (38.1 mm) ±0.005" (0.13 mm)	±10%	Randoms up to 2" (50.8 mm) Cuts +1/8" (3 mm) -0"

* Coiled tubing OD capabilities to increase to 3" (72.6 mm) in 2008

Tube Weight for Austenitic Stainless Steels in Pounds Per Foot

	Wall Thickness (inches and gauges)												
Tube OD (in.)	**0.008**	**0.010**	**0.012**	**0.020**	**0.028**	**0.035**	**0.049**	**0.065**	**0.083**	**0.109**	**0.120**	**0.134**	**0.140**
	33	**31**	**30**	**25**	**22**	**20**	**18**	**16**	**14**	**12**	**11**	**10**	**—**
0.063	0.0047	0.0057	0.0066	0.0092	0.0106	–	–	–	–	–	–	–	–
0.094	0.0074	0.0090	0.0106	0.0160	0.0199	0.0223	–	–	–	–	–	–	–
0.125	0.0100	0.0123	0.0146	0.0226	0.0293	0.0339	–	–	–	–	–	–	–
0.156	0.0127	0.0157	0.0186	0.0293	0.0386	0.0457	0.0565	0.0638	–	–	–	–	–
0.188	0.0155	0.0191	0.0228	0.0362	0.0482	0.0577	0.0734	0.0862	–	–	–	–	–
0.250	0.0208	0.0258	0.0308	0.0496	0.0670	0.0812	0.1062	0.1296	0.1494	–	–	–	–
0.313	0.0263	0.0326	0.0390	0.0632	0.0860	0.1049	0.1395	0.1738	0.2058	–	–	–	–
0.375	0.0316	0.0393	0.0469	0.0765	0.1048	0.1283	0.1722	0.2172	0.2613	–	–	–	–
0.438	0.0370	0.0461	0.0551	0.0901	0.1238	0.1520	0.2055	0.2614	0.3176	–	–	–	–
0.500	0.0424	0.0528	0.0631	0.1035	0.142	0.175	0.238	0.305	0.373	–	–	–	–
0.540	–	–	–	–	–	–	0.259	0.333	0.409	0.506	0.543	–	–
0.563	0.0478	0.0596	0.0712	0.1170	0.161	0.199	0.272	0.349	0.429	–	–	–	–
0.625	0.0532	0.0662	0.0793	0.1304	0.180	0.223	0.304	0.392	0.485	–	–	–	–
0.675	–	–	–	–	–	–	0.331	0.427	0.530	0.665	0.718	–	–
0.750	0.0639	0.0797	0.0955	0.1574	0.218	0.270	0.370	0.480	0.597	0.753	–	–	–
0.840	–	–	–	–	–	–	0.418	0.543	0.677	0.859	0.931	1.020	1.056
0.875	–	–	–	0.1843	0.256	0.317	0.436	0.568	0.709	0.900	0.977	–	–
1.000	–	–	–	0.2113	0.293	0.364	0.502	0.655	0.820	1.04	1.13	–	–
1.050	–	–	–	–	–	–	0.529	0.690	0.865	1.106	1.203	1.323	1.373
1.125	–	–	–	0.2382	0.331	0.411	0.568	0.743	0.932	1.19	1.30	–	–
1.250	–	–	–	0.2652	0.369	0.458	0.634	0.830	1.04	1.34	1.46	–	–
1.315	–	–	–	–	–	–	0.669	0.876	1.10	1.42	1.55	1.71	1.77
1.375	–	–	–	0.2921	0.407	0.506	0.700	0.918	1.15	1.48	1.62	–	–
1.500	–	–	–	0.3191	0.444	0.553	0.766	1.00	1.26	1.63	1.78	1.97	2.05
1.625	–	–	–	–	–	0.600	0.832	1.09	1.38	1.78	1.94	2.15	2.24
1.660	–	–	–	–	–	–	0.851	1.12	1.41	1.82	1.99	2.20	2.29
1.750	–	–	–	–	–	0.647	0.899	1.18	1.49	1.92	2.10	2.33	2.43
2.000	–	–	–	–	–	0.741	1.03	1.35	1.71	2.22	2.43	2.69	2.80
2.125	–	–	–	–	–	0.789	1.09	1.44	1.82	2.36	2.59	2.87	2.99
2.250	–	–	–	–	–	0.836	1.16	1.53	1.932	2.51	2.75	3.05	3.18
2.375	–	–	–	–	–	0.883	1.22	1.61	2.05	2.66	2.91	3.23	3.37
2.500	–	–	–	–	–	0.930	1.29	1.70	2.16	2.80	3.07	3.41	3.59
2.625	–	–	–	–	–	–	1.36	1.79	2.27	2.95	3.24	3.59	3.75
2.750	–	–	–	–	–	–	1.427	1.88	2.38	3.10	3.40	3.77	3.93
2.875	–	–	–	–	–	–	1.49	1.96	2.49	3.25	3.56	3.95	4.12
3.000	–	–	–	–	–	–	1.55	2.05	2.61	3.39	3.72	4.14	4.31
3.500	–	–	–	–	–	–	–	2.40	3.05	3.98	4.37	4.86	5.07
4.000	–	–	–	–	–	–	–	2.75	3.5	4.57	5.10	5.58	5.82
6.000	–	–	–	–	–	–	–	–	5.29	6.92	7.61	8.47	8.84

The formulas used to calculate the weights shown is:
Pounds per foot = 10.78 (D-t) t

Where: D = Outside diameter, inches
t = Wall Thickness, inches

OVERALL SIZE RANGE
1/16" (1.59 mm) to 8" (203.2 mm) OD,
33 to 9 gauge Schedules 5 – 40
Metric sizes also available.
Stock Lengths = 20 feet (6.1 m). Others available.

Weight Conversion Factors

To determine weights of tubing made of other alloys, multiply weight per foot shown in the Pipe Size Range and Tube Size Range tables by the applicable conversion factor shown below.

UNS	Common	Factor
S30403	Alloy 304L	1.00
N02200	Nickel 200	1.130
N04400	Alloy 400	1.119
N06022	Alloy C22®	1.091
N06059	Alloy 59	1.091
N06600	Alloy 600	1.067
N06625	Alloy 625	1.070
N06686	Alloy 686	1.105
N08020	Alloy 20	1.025
N08367/N08926/ S31254	6MO	1.021
N08800	Alloy 800	1.018
N08825	Alloy 825	1.028
N08904	Alloy 904L	1.007
N10276	Alloy C276	1.126
R50400	Grade 2 Titanium	0.572
S20100	Alloy 201	0.996
S30908	Alloy 309	1.018
S31008	Alloy 310	1.018
S31803/S32205	Duplex 2205	1.000
S32001	Lean Duplex Nitranic 19-D®	0.979
S32003	Lean Duplex 2003™	0.979
S32100	Alloy 321	1.039
S32750	Super Duplex 2507®	1.000
S34700	Alloy 347	1.011
S34800	Alloy 348	1.014
S43035	Ferritic 439	0.975
S4400	Ferritic 444 (18-2)	0.982
S44627	Super Ferritic E-Brite®	0.982
S44735	Super Ferritic AL 29-4C®	0.972

General Alloy Specifications

ASTM	ASME
A450	SA450
A999	SA999
A1016	SA1016
B751	SB751
B775	SB775
B829	SB829

Product Alloy Specifications

ASTM	ASME
A213	SA213
A249	SA249
A268	SA268
A269	–
A312	SA312
A511	–
A530	SA530
A554	–
A632	–
A688	SA688
A789	SA789
A790	SA790
B161	SB161
B163	SB163
B165	SB165
B167	SB167
B338	SB338
B407	SB407
B423	SB423
B444	SB444
B468	SB468
B514	SB514
B515	SB515
B516	SB516
B517	SB517
B619	SB619
B626	SB626
B673	SB673
B674	SB674
B675	SB675
B676	SB676
B677	SB677
B704	SB704
B705	SB705
B725	–
B730	–

Pipe Weight Per Foot (304 normalized) and Size Range

		Pipe Schedules				
NPS inches	**OD inches**	**5**	**10**	**40**	**80**	**160**
1/8	0.405	–	0.189 @ 0.049"	*0.249 @ 0.068"	*0.319 @ 0.095"	–
1/4	0.540	–	0.334 @ 0.065"	*0.430 @ 0.088"	*0.542 @ 0.119"	–
3/8	0.675	–	0.429 @ 0.065"	*0.575 @ 0.091"	*0.748 @ 0.126"	–
1/2	0.840	0.545 @ 0.065"	0.680 @ 0.083"	*0.862 @ 0.109"	*1.10 @ 0.147"	*1.32 @ 0.187"
3/4	1.050	0.693 @ 0.065"	0.868 @ 0.083"	1.15 @ 0.113"	*1.52 @ 0.157"	*1.96 @ 0.218"
1	1.315	0.879 @ 0.065"	1.42 @ 0.109"	1.70 @ 0.133"	*2.20 @ 0.179"	*2.88 @ 0.250"
1-1/4	1.660	1.12 @ 0.065"	1.83 @ 0.109"	2.30 @ 0.140"	3.04 @ 0.191"	–
1-1/2	1.900	1.29 @ 0.065"	2.11 @ 0.109"	2.57 @ 0.145"	3.68 @ 0.200"	–
2	2.375	1.63 @ 0.065"	2.67 @ 0.109"	3.7 @ 0.154"	5.09 @ 0.218"	–
2-1/2	2.875	1.98 @ 0.083"	3.58 @ 0.120"	5.87 @ 0.203"	–	–
3	3.500	3.07 @ 0.083"	4.39 @ 0.120"	8.01 @ 0.226"	–	–
3-1/2	4.000	3.52 @ 0.083"	5.04 @ 0.120"	9.23 @ 0.226"	–	–

Stock Lengths: 20 or 21 feet depending on alloys. Other lengths available.
Weight (lbs/ft) = 10.78 (D-t) t
Where: D = Outside diameter, inch
t = Minimum Wall Thickness, inch

* Welded & Drawn or Seamless only size.

Titanium Tubing in Pounds Per Foot – Grade 2

	BWG/Avg.Wall									
Tube OD inches	**25**	**24**	**23**	**22**	**20**	**18**	**17**	**16**	**15**	**14**
	0.020	**0.022**	**0.025**	**0.028**	**0.035**	**0.049**	**0.058**	**0.065**	**0.072**	**0.083**
1/2 (0.500)	0.0590	0.0646	0.0730	0.0812	0.1000	0.1358	0.1575	0.1737	0.1894	0.2127
5/8 (0.625)	0.0744	0.0815	0.0955	0.1027	0.1269	0.1734	0.2020	0.2237	0.2447	0.2764
3/4 (0.750)	0.0897	0.0984	0.1140	0.1242	0.1538	0.2110	0.2466	0.2736	0.3000	0.3402
7/8 (0.875)	0.1051	0.1153	0.1306	0.1457	0.1807	0.2487	0.2911	0.3235	0.3553	0.4039
1 (1.000)	0.1204	0.1322	0.1498	0.1672	0.2075	0.2864	0.3357	0.3735	0.4106	0.4677
1-1/8 (1.125)	0.1358	0.1491	0.1690	0.1887	0.2344	0.3240	0.3802	0.4234	0.4659	0.5315
1-1/4 (1.250)	0.1512	0.1660	0.1882	0.2103	0.2613	0.3616	0.42418	0.4733	0.5212	0.5952
1-3/8 (1.375)	0.1665	0.1829	0.2074	0.2318	0.2882	0.3993	0.1693	0.5232	0.5765	0.6590
1-1/2 (1.500)	0.1819	0.1998	0.2260	0.2533	0.3151	0.4369	0.5139	0.5732	0.6318	0.7227

For weight of minimum wall tube: Multiply the above weight by 1.1
The formula used to calculate the weights in the above table is:
Pounds per foot = 6.145 (D-t) t
Where: D = Outside diameter, inches
t = Wall Thickness, inches

Physical Properties of Alloys in the Annealed Condition at -20°F to +100°F

Alloys	UNS Designation	Specification	Tensile Strength (min.)		
			psi	MPa	ksi
304	S30400	A249 A312	75,000	(515)	75
304L	S30403	A270 A312	70,000	(485)	70
304H	S30409	A249 A312	75,000	(515)	75
316	S31600	A249 A312	75,000	(515)	75
316L	S31603	A270 A312	70,000	(485)	70
316H	S31609	–	–	–	–
316LN	S31653	A249 A312	–	–	75
317	S31700	A249 A312	75,000	(515)	75
317L	S31703	A249 A312	75,000	(515)	75
309S	S30908	A249 A312	75,000	(515)	75
309H	S30909	–	75,000	(515)	–
310S	S31008	A249 A312	75,000	(515)	75
310H	S31009	A249 A312	75,000	(515)	75
321	S32100	–	75,000	(515)	–
321H	S32109	–	75,000	(515)	–
347	S34700	A249 A312	75,000	(515)	75
347H	S34709	–	75,000	(515)	–
Duplex 2205	S32205	A789 A790	95,000	(655)	95
Duplex 2205	S31803	A789 A790	90,000	(620)	95
Lean Duplex Nitronic 19D®	S32001	A789 A790	90,000	(620)	90
Super Duplex 2507®	S32950	A789 A790	–	–	100
Super Duplex 2507®	S32750	A789 A790	116,000	(800)	116
Lean Duplex 2003™	S32003	A789 A790	90,000	(620)	95
Lean Duplex 2101®	S32101	A789 A790	94,000	(650)	101
Lean Duplex 2304 OD = 1" & under	S32304	A789 A790	100,000	(690)	100†
Lean Duplex 2304 OD > 1"	S32304	A789 A790	87,000	(600)	101
Super Duplex Zeron® 100	S32760	A789 A790	–	–	109
20	N08020	B464 B468	80,000	(551)	80

see page 28 for footnotes

Yield Strength 0.2% Offset (min.)			Elongation in 2 inches (min.)	Grain Size Requirement	Max Hardness	Modulus of Elasticity ($x10^6$ psi)	Mean Coefficient of Thermal Expansion IN./IN./°F x 10^{-6})	Thermal Conductivity (BTU-in/ft²-h-°F)
psi	MPa	ksi	%					
30,000	(205)	30	35	–	90 Rb	28.0	9.2	116
25,000	(170)	25	35	–	90 Rb	28.0	9.2	116
30,000	(205)	30	35	7 or coarser	90 Rb	28.0	9.2	116
30,000	(205)	30	35	–	90 Rb	28.0	9.2	116
25,000	(170)	25	–	–	90 Rb	28.0	9.2	116
–	–	–	–	7 or coarser	–	–	–	–
–	–	30	35	–	90 Rb	–	9.2	116
30,000	(205)	30	35	–	90 Rb	28.0	9.2	116
30,000	(205)	30	35	–	90 Rb	28.0	9.2	116
30,000	(205)	30	35	–	90 Rb	29.0	9.2	116
30,000	(205)	–	35	6 or coarser	–	29.0	9.2	–
30,000	(205)	30	35	–	90 Rb	29.0	9.2	116
30,000	(205)	30	35	6 or coarser	90 Rb	29.0	9.2	116
30,000	(205)	–	35	–	–	29.0	9.2	–
30,000	(205)	–	35	7 or coarser	–	29.0	9.2	–
30,000	(205)	30	35	–	90 Rb	28.0	9.2	116
30,000	(205)	–	35	7 or coarser	–	28.0	9.2	–
70,000	(485)	70	30	–	28 Rc 30.5† Rc	27.5	7.6	180
65,000	(450)	70	30	–	28 Rc 30.5† Rc	27.5	7.6	180
65,000	(450)	65	25	–	30 Rc	–	7.6	180
–	–	70	20	–	30.5 Rc	–	–	–
80,000	(550)	80	15	–	32 Rc	27.5	7.2	98
65,000	(450)	70	30	–	28 Rc	27.5	7.2	120
65,000	(450)	77	30	–	30 Rc	27.5	7.6	180
65,000	(450)	58†	30	–	28 Rc 30.5† Rc	27.5	7.6	180
58,000	(400)	58†	30	–	28 Rc 30.5† Rc	27.5	7.6	180
–	–	80	25	–	31 Rc	–	7.5	156
35,000	(241)	35	30	–	–	28.0	8.3	148

Table continued on next page

Physical Properties of Alloys in the Annealed Condition at -20°F to +100°F *continued*

Alloys	UNS Designation	Specification	Tensile Strength (min.)		
			psi	MPa	ksi
200	N02200	B725 B730	55,000‡	(380)‡	55
201	N02201	B725 B730	50,000	(345)	50
C-276	N10276	B619 B626	100,000	(690)	100
400	N04400	B725 B730	70,000‡	(480)‡	70
600	N06600	B516 B517	80,000	(550)	80
C22®	N06022	B619 B626	100,000	(690)	100
625 GR 1 (Annealed)	N06625	B704 B705	120,000	(827)	120
625 GR 2 (Solution Annealed)	N06625	B704 B705	100,000	(690)	100
686	N06686	B619 B626	100,000	(690)	100
59	N06059	B619 B626	100,000	(690)	100
AL-6XN®	N08367	B675	100,000	(690)	100
254-SMO®	S31254	A249 A312	98,000	(675)	98
25-6MO®	N08926	A249 A312	94,000	(650)	94
25-6MO®	N08926	B673 B674	–	–	94
825	N08825	B704 B705	85,000	(586)	85
904L	N08904	A249 A312	71,000	(490)	71
904L	N08904	B673 B674	71,000	(490)	71
27-7MO®	S31277	–	112,000	(770)	–
800	N08800	B514 B515	75,000	(520)	75
800H	N08810	B514 B515	65,000	(450)	65
800HT®	N08811	B514 B515	65,000	(450)	65
AL 29-4C®	S44735	A268	75,000	(515)	75
E-Brite®	S44627	A268	65,000	(450)	65
439	S43035	A268	60,000	(415)	60
444	S44400	A268	60,000	(415)	60
446	S44660	A268	–	–	85
Titanium	R50400	B338	50,000	(345)	50

‡Annealed Condition
†OD over 1.0" TS>87, YS>58, no hardness requirement 1.0" OD and under
*for 0.049" average wall
Hardness values adjusted to comply with MR-0175
% Requires Hydrogen testing on each Tensile sample

Yield Strength 0.2% Offset (min.)			Elongation in 2 inches (min.)	Grain Size Requirement	Max Hardness	Modulus of Elasticity ($x10^6$ psi)	Mean Coefficient of Thermal Expansion IN./IN./°F x 10^{-6})	Thermal Conductivity (BTU-in/ft^2-h-°F)
psi	MPa	ksi	%					
15,000‡	(105)‡	15	35‡	–	–	30.0	7.4	533
12,000	(80)	12	35‡	–	–	30.0	7.4	533
41,000	(283)	41	40	–	–	29.8	6.8	67.9
28,000‡	(195)‡	28	35‡	–	–	26.0	7.7	168
35,000	(240)	35	30	–	–	30.0	6.9	103
45,000	(310)	45	45	–	–	30.3	6.7	118
60,000	(414)	60	30	–	–	30.0	7.1	68
40,000	(276)	40	30	–	–	30.0	7.1	68
45,000	(310)	45	45	–	–	30.0	6.7	118
45,000	(310)	45	45	–	–	30.5	6.7	118
45,000	(310)	45	30	–	–	28.3	8.5	116
45,000	(310)	45	40	–	96 Rb	28.0	8.5	90
43,000	(295)	43	35	–	100 Rb	28.1	8.5	116
–	–	43	35	–	–	–	8.5	116
35,000	(240)	35	30	–	–	28.0	7.7	77
31,000	(215)	31	35	–	90 Rb	28.0	8.5	79
31,000	(215)	31	35	–	–	–	8.5	79
52,000	(360)	–	35	–	–	27.7	8.3	69.8
30,000	(205)	30	30	–	–	–	7.9	80
25,000	(170)	25	30	5 & coarser	–	–	7.9	80
25,000	(170)	25	30	5 & coarser	–	–	7.9	80
60,000	(415)	60	10*	–	100 Rb	28.0	5.2	119
40,000	(275)	65	12*	–	95 Rb	29.0	5.2	116
30,000	(205)	30	20	–	90 Rb	29.0	5.6	168
40,000	(275)	40	12*	–	100 Rb	–	7.7	186
–	–	65	12*	–	25 Rc	–	5.2	119
40,000-65,000	(276-448)	40-65	20	–	–	16.0	5.1	144

Estimated Internal Burst Pressure For Types 304 & 316 Stainless Steel Tubing at Ambient Temperature

OD		Wall		Gauge	Burst Pressure
(in)	(mm)	(in)	(mm)		(psi)
1/8 (0.125)	3.2	0.020	0.51	25	24,000
		0.028	0.71	22	33,600
		0.035	0.89	20	42,000
3/16 (0.188)	4.8	0.020	0.51	25	16,000
		0.028	0.71	22	22,400
		0.035	0.89	20	28,000
1/4 (0.250)	6.4	0.020	0.51	25	12,000
		0.028	0.71	22	16,800
		0.035	0.89	20	21,000
		0.049	1.25	18	29,400
		0.065	1.65	16	39,000
		0.083	2.11	14	49,800
5/16 (0.313)	7.9	0.020	0.51	25	9,600
		0.028	0.71	22	13,440
		0.035	0.89	20	16,800
		0.049	1.25	18	23,520
		0.065	1.65	16	31,200
		0.083	2.11	14	39,840
3/8 (0.375)	9.5	0.020	0.51	25	8,000
		0.028	0.71	22	11,200
		0.035	0.89	20	14,000
		0.049	1.25	18	19,600
		0.065	1.65	16	26,000
		0.083	2.11	14	33,200
1/2 (0.500)	12.7	0.020	0.51	25	6,000
		0.028	0.71	22	8,400
		0.035	0.89	20	10,500
		0.049	1.25	18	14,700
		0.065	1.65	16	19,500
		0.083	2.11	14	24,900
		0.095	2.41	13	28,500
5/8 (0.625)	15.9	0.020	0.51	25	4,800
		0.028	0.71	22	6,720
		0.035	0.89	20	8,400
		0.049	1.25	18	11,760
		0.065	1.65	16	15,600
		0.083	2.11	14	19,920
		0.095	2.41	13	22,800

Barlow's Formula

The ASTM tubing specifications do not include any recommended service pressure or any elevated temperature pressure requirements. However, throughout the tubing and pipe industry, Barlow's Formula is commonly used to estimate the theoretical internal burst pressure of the tubing.

Simply stated, Barlow's Formula is:
$P = 2St/OD$

Where:

P = Burst Pressure, psi

S = Tensile Strength of material, psi (75,000 psi for types 304 & 316)

t = Wall thickness, inches

OD = Outside diameter, inches

OD		Wall		Gauge	Burst Pressure
(in)	(mm)	(in)	(mm)		(psi)
3/4 (0.750)	19.1	0.020	0.51	25	4,000
		0.028	0.71	22	5,600
		0.035	0.89	20	7,000
		0.049	1.25	18	9,800
		0.065	1.65	16	13,000
		0.083	2.11	14	16,600
		0.095	2.41	13	19,000
		0.109	2.77	12	21,800
7/8 (0.875)	22.2	0.020	0.51	25	3,429
		0.028	0.71	22	4,800
		0.035	0.89	20	6,000
		0.049	1.25	18	8,400
		0.065	1.65	16	11,143
		0.083	2.11	14	14,229
		0.095	2.41	13	16,286
		0.109	2.77	12	18,686
1 (1.000)	25.4	0.020	0.51	25	3,000
		0.028	0.71	22	4,200
		0.035	0.89	20	5,250
		0.049	1.25	18	7,350
		0.065	1.65	16	9,750
		0.083	2.11	14	12,450
		0.095	2.41	13	14,250
		0.109	2.77	12	16,350
		0.120	3.05	11	18,000
1-1/8 (1.125)	28.6	0.028	0.71	22	3,733
		0.035	0.89	20	4,667
		0.049	1.25	18	6,533
		0.065	1.65	16	8,667
		0.083	2.11	14	11,067
		0.095	2.41	13	12,667
		0.109	2.77	12	14,533
		0.120	3.05	11	16,000
1-1/4 (1.250)	31.8	0.028	0.71	22	3,360
		0.035	0.89	20	4,200
		0.049	1.25	18	5,880
		0.065	1.65	16	7,800
		0.083	2.11	14	9,960
		0.095	2.41	13	11,400
		0.109	2.77	12	13,080
		0.120	3.05	11	14,400

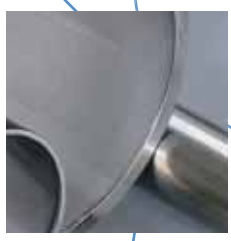


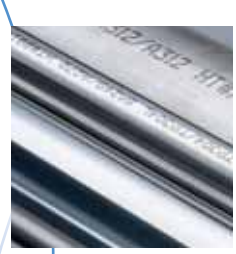
Table continued on next page

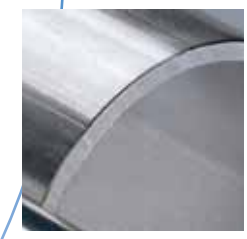
Estimated Internal Burst Pressure For Types 304 & 316 Stainless Steel Tubing

OD		Wall		Gauge	Burst Pressure
(in)	(mm)	(in)	(mm)		(psi)
1-3/8 (1.375)	34.9	0.035	0.89	20	3,818
		0.049	1.25	18	5,345
		0.065	1.65	16	7,091
		0.083	2.11	14	9,055
		0.095	2.41	13	10,364
		0.109	2.77	12	11,891
		0.120	3.05	11	13,091
1-1/2 (1.500)	38.1	0.035	0.89	20	3,500
		0.049	1.25	18	4,900
		0.065	1.65	16	6,500
		0.083	2.11	14	8,300
		0.095	2.41	13	9,500
		0.109	2.77	12	10,900
		0.120	3.05	11	12,000
1-5/8 (1.625)	41.3	0.035	0.89	20	3,229
		0.049	1.25	18	4,520
		0.065	1.65	16	5,996
		0.083	2.11	14	7,657
		0.095	2.41	13	8,764
		0.109	2.77	12	10,055
		0.120	3.05	11	11,070
1-3/4 (1.750)	44.5	0.035	0.89	20	3,000
		0.049	1.25	18	4,200
		0.065	1.65	16	5,571
		0.083	2.11	14	7,114
		0.095	2.41	13	8,143
		0.109	2.77	12	9,343
		0.120	3.05	11	10,286
2 (2.000)	50.8	0.035	0.89	20	2,625
		0.049	1.25	18	3,675
		0.065	1.65	16	4,875
		0.083	2.11	14	6,225
		0.095	2.41	13	7,125
		0.109	2.77	12	8,175
		0.120	3.05	11	9,000
2-1/8 (2.125)	54.0	0.049	1.25	18	3,459
		0.065	1.65	16	4,588
		0.083	2.11	14	5,859
		0.095	2.41	13	6,706
		0.109	2.77	12	7,694
		0.120	3.05	11	8,471

at Ambient Temperature *continued*

OD		Wall		Gauge	Burst Pressure
(in)	(mm)	(in)	(mm)		(psi)
2-1/4 (2.250)	57.2	0.049	1.25	18	3,267
		0.065	1.65	16	4,333
		0.083	2.11	14	5,533
		0.095	2.41	13	6,333
		0.109	2.77	12	7,267
		0.120	3.05	11	8,000
2-1/2 (2.500)	63.5	0.049	1.25	18	2,940
		0.065	1.65	16	3,900
		0.083	2.11	14	4,980
		0.095	2.41	13	5,700
		0.109	2.77	12	6,540
		0.120	3.05	11	7,200
2-5/8 (2.625)	66.7	0.049	1.25	18	2,800
		0.065	1.65	16	3,714
		0.083	2.11	14	4,743
		0.095	2.41	13	5,429
		0.109	2.77	12	6,229
		0.120	3.05	11	6,857
2-3/4 (2.750)	69.9	0.049	1.25	18	2,673
		0.065	1.65	16	3,545
		0.083	2.11	14	4,527
		0.095	2.41	13	5,182
		0.109	2.77	12	5,945
		0.120	3.05	11	6,545
3 (3.000)	76.2	0.049	1.25	18	2,450
		0.065	1.65	16	3,250
		0.083	2.11	14	4,150
		0.095	2.41	13	4,750
		0.109	2.77	12	5,450
		0.120	3.05	11	6,000
3-1/2 (3.500)	88.9	0.065	1.65	16	2,786
		0.083	2.11	14	3,557
		0.095	2.41	13	4,071
		0.109	2.77	12	4,671
		0.120	3.05	11	5,143
4 (4.000)	101.6	0.065	1.65	16	2,438
		0.083	2.11	14	3,113
		0.095	2.41	13	3,563
		0.109	2.77	12	4,088
		0.120	3.05	11	4,500





Composition (%) of Stainless Steel Alloys

Grade	304	304L	304H	316	316L	317	317L
UNS Designation	S30400	S30403	S30409	S31600	S31603	S31700	S31703
Carbon (C) Max.	0.08	0.030*	0.04–0.10	0.08	0.030*	0.08	0.035*
Manganese (Mn) Max.	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Phosphorous (P) Max.	0.045	0.045	0.045	0.045	0.045	0.04	0.04
Sulphur (S) Max.	0.030	0.030	0.030	0.030	0.030	0.03	0.03
Silicon (Si) Max.	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Chromium (Cr)	18.0–20.0	18.0–20.0	18.0–20.0	16.0–18.0	16.0–18.0	18.0–20.0	18.0–20.0
Nickel (Ni)	8.0–11.0	8.0–12.0	8.0–11.0	10.0–14.0	10.0–14.0	11.0–14.0	11.0–15.0
Molybdenum (Mo)	–	–	–	2.0–3.0	2.0–3.0	3.0–4.0	3.0–4.0
Nitrogen (N)	–	–	–	–	–	–	–
Iron (Fe)	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.
Other Elements	–	–	–	–	–	–	–

* Maximum carbon content of 0.04% acceptable for drawn tubes

309S	309H	310S	310H	321	321H	347	347H
S30908	S30909	S31008	S31009	S32100	S32109	S34700	S34709
0.08	0.04–0.10	0.08	0.04–0.10	0.08	0.04–0.10	0.08	0.04–0.10
2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
0.045	0.045	0.045	0.045	0.04	0.04	0.04	0.04
0.030	0.030	0.030	0.030	0.03	0.03	0.03	0.03
1.00	1.00	1.00	1.00	0.75	0.75	0.75	0.75
22.0–24.0	22.0–24.0	24.0–26.0	24.0–26.0	17.0–20.0	17.0–20.0	17.0–20.0	17.0–20.0
12.0–15.0	12.0–15.0	19.0–22.0	19.0–22.0	9.0–12.0	9.0–12.0	9.0–13.0	9.0–13.0
–	–	–	–	–	–	–	–
–	–	–	–	0.1 Max.	0.1 Max.	–	–
Bal.	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.
–	–	–	–	Ti = 5(C) to 0.70%	Ti = 4(C) to 0.60%	Cb+Ta = 10 x C–1.0	Cb+Ta = 8 x C–1.0

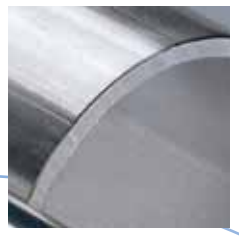
Composition (%) of Duplex Stainless Steel Alloys

Grade	Duplex 2205	Lean Duplex Nitronic 19D®*
UNS Designation	S31808/S32205†	S32001
Carbon (C) Max.	0.030	0.030
Manganese (Mn) Max.	2.00	4.0–6.0
Phosphorous (P) Max.	0.030	0.040
Sulphur (S) Max.	0.020	0.030
Silicon (Si) Max.	1.00	1.00
Chromium (Cr)	22.0–23.0	19.5–21.5
Nickel (Ni)	4.5–6.5	1.0–3.0
Molybdenum (Mo)	3.0–3.5	0.60
Nitrogen (N)	0.14–0.20	0.05–0.17
Iron (Fe)	Bal.	Bal.
Copper (Cu)	–	–
Other Elements	n/a	n/a

* Zinc Clad for Subsea Umbilical Tubing
† S32205 is the more restrictive chemistry and is shown
‡ % Cr + 3.3% Mo + 16% N



	Lean Duplex 2003™	Lean Duplex 2101®	Lean Duplex 2304	Super Duplex 2507®	Super Duplex Zeron® 100
	S32003	S32101	S32304	S32750	S32760
	0.030	0.040	0.030	0.030	0.05
	2.00	4.0–6.0	2.50	1.20	1.00
	0.030	0.040	0.040	0.035	0.030
	0.020	0.030	0.040	0.020	0.010
	1.00	1.00	1.00	0.80	1.00
	19.5–22.5	21.0–22.0	21.5–24.5	24.0–26.0	24.0–26.0
	3.00–4.00	1.35–1.70	3.00–5.50	6.0–8.0	6.0–8.0
	1.50–2.00	0.10–0.80	0.05–0.60	3.0–5.0	3.0–4.0
	0.14–0.20	0.20–0.25	0.50–0.20	0.24–0.32	0.20–0.30
	Bal.	–	Bal.	Bal.	Bal.
	–	0.10–0.80 Max.	0.50–0.60 Max.	0.50	0.50–1.00
	–	–	–	–	W 0.50–1.00, 40 min ‡

Composition (%) of Nickel Alloys, Titanium Alloys

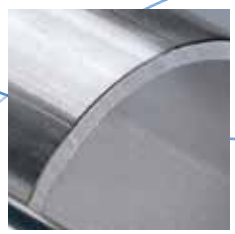
Grade	20	200	201
UNS Designation	N08020	N02200	N02201
Nickel (Ni)	32.0–38.0	99.0 Min. (Plus Cobalt)	99.0 Min. (Plus Cobalt)
Chromium (Cr)	19.00–21.00	–	–
Iron (Fe)	Bal.	0.40 Max.	–
Molybdenum (Mo)	2.00–3.00	–	–
Titanium (Ti) Max.	–	–	–
Aluminum (Al) Max.	–	–	–
Cobalt (Co) Max.	–	–	–
Tungsten (W)	–	–	–
Vanadium (V) Max.	–	–	–
Copper (Cu) Max.	3.00–4.00	0.25	0.25
Manganese (Mn) Max.	2.00	0.35	0.35
Niobium (Nb) plus Tantalum	8xC–1.00	–	–
Carbon (C) Max.	0.07	0.15	0.02
Nitrogen (N) Max.	–	–	–
Silicon (Si) Max.	1.00	0.35	0.35
Sulphur (S) Max.	0.035	0.01	0.01
Phosphorous (P) Max.	0.045	–	–
Other Elements	–	–	–

C-276	400	600	C22®	625	686	59	Titanium Grade 2
N10276	N04400	N06600	N06022	N06625	N06686	N06059	R50400
Bal.	63.0 Min. (Plus Cobalt)	72.0 Min. (Plus Cobalt)	Bal.	58.0 Min. (Plus Cobalt)	Bal.	Bal.	–
14.5–16.5	–	14.0–17.0	20.0–22.5	20.0–23.0	19.0–23.0	22.0–24.0	–
4.0–7.0	2.5 Max.	6.0-10.0	2.0–6.0	5.0 Max.	5.0 Max.	1.50	0.30 Max.
15.0–17.0	–	–	12.5–14.5	8.0–10.0	15.0–17.0	15.0–16.5	–
–	–	–	–	0.40	0.02–0.25	–	Bal.
–	–	–	–	0.40	–	0.1–0.4	–
2.5	–	–	2.5	1.0	–	0.3	–
3.0–4.5	–	–	2.5–3.5	–	3.0–4.40	–	–
0.35	–	–	0.35	–	–	–	–
-	28.0–34.0	0.5	–	0.75	–	0.50	–
1.0	2.00	1.0	0.5	0.50	0.75	0.5	–
–	–	–	–	3.15–4.15	–	–	–
0.010	0.3	0.15	0.015	0.10	0.010	0.010	0.08
–	–	–	–	–	–	–	0.03 Max.
0.08	0.5	0.5	0.08	0.5	0.08	0.010	–
0.03	0.024	0.015	0.02	0.015	0.02	0.010	–
0.04	–	–	0.02	0.015	0.04	0.015	–
–	–	–	–	–	–	–	H=0.015 O=0.25 Max.

Composition (%) of Super Austenitics, Super Ferritics/Ferritics

Grade	AL-6XN®	254-SMO®	25-6MO®	825	904L
UNS Designation	N08367	S31254	N08926	N08825	N08904
Nickel (Ni)	23.5–25.5	17.5–18.5	24.0–26.0	38.0–46.0	23.0–28.0
Chromium (Cr)	20.0–22.0	19.5–20.5	19.0–21.0	19.5–23.5	19.0–23.0
Iron (Fe)	Bal.	Bal.	Bal.	22.0 Min.	Bal.
Molybdenum (Mo)	6.00–7.00	6.0 - 6.5	6.0–7.0	2.5–3.5	4.0–5.0
Titanium (Ti) Max.	–	–	–	0.6–1.2	–
Aluminum (Al) Max.	–	–	–	0.2	–
Cobalt (Co) Max.	–	–	–	–	–
Tungsten (W)	–	–	–	–	–
Vanadium (V) Max.	–	–	–	–	–
Copper (Cu) Max.	0.75	0.50 - 1.00	0.50–1.50	1.5–3.0	1.00–2.00
Manganese (Mn) Max.	2.00	1.00	2.00	1.0	2.00
Niobium (Nb) plus Tantalum	–	–	–	–	–
Carbon (C) Max.	0.030	0.020	0.020	0.05	0.020
Nitrogen (N) Max.	0.18–0.25	0.18 - 0.25	0.15–0.25	–	0.10
Silicon (Si) Max.	1.00	0.80	0.5	0.5	1.00
Sulphur (S) Max.	0.030	0.010	0.010	0.03	0.035
Phosphorous (P) Max.	0.040	0.030	0.03	–	0.045
Other Elements	–	–	–	–	–

*N08811 Al + Ti 0.85 – 1.20
**(Ti + Ch) 0.20 – 1.00, & 6 (C+N) min
‡0.015 Max. for OD<0.500" and for T<0.049"
†Nickel & Copper



27-7MO®	800	800H	800HT®	AL 29-4C®	E-Brite®	439	444
S31277	N08800	N08810	N08811	S44735	S44627	S43035	S44400
26.0 – 28.0	30.0–35.0	30.0–35.0	30.0–35.0	1.00	0.5†	0.50	1.00
20.5 – 23.0	19.0–23.0	19.0–23.0	19.0–23.0	28.00–30.00	25.0–27.5	17.0–19.0	17.5–19.5
Bal.	39.5 Min.	39.5 Min.	39.5 Min.	Bal.	Bal.	Bal.	Bal.
6.50 - 8.00	–	–	–	3.60–4.20	0.75–1.50	0	1.75–2.50
–	0.15–0.60	0.15–0.60	0.15–0.60*	**	–	0.20 + 4x (C+N) Min. to 1.10 Max.	0.20 + 4x (C+N) Min. to 0.80 Max.
–	0.15–0.60	0.15–0.60	0.15–0.60*	–	–	0.15	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
0.50 - 1.50	0.75	0.75	0.75	–	0.2	–	–
3.00	1.5	1.5	1.5	1.00	0.40	1.00	1.00
–	–	–	–	**	0.05–0.20	–	–
0.020	0.10	0.05–0.10	0.06–0.10	0.030	0.01†‡	0.07	0.025
0.30 - 0.40	–	–	–	0.045	0.015	0.04	0.035
0.50	1.00	1.00	1.00	1.00	0.40	1.00	1.00
0.010	0.015	0.015	0.1015	0.030	0.02	0.030	0.030
0.030	–	–	–	0.040	0.02	0.040	0.040
–	–	–	–	–	–	–	–

Glossary

ANNEALING
The controlled process of heating and cooling a metal to achieve a reduction in hardness, remove stress, and to homogenize the material.

ASM (American Society for Materials International)
A professional society of Material Scientists and Engineers dedicated to the collection and distribution of information about materials and manufacturing processes.

ASME (American Society of Mechanical Engineers)
An organization of engineers dedicated to the preparation of design code requirements, and material and testing standards. Adopts, sometimes with minor changes, specifications prepared by ASTM. The adopted specifications are those approved for use under the ASME Boiler and Pressure Code and are published by ASME in Section II of the ASME Code. The ASME specifications have the letter "S" preceding the "A" or the "B", of the ASTM specifications. The "SA" series are for iron base materials, while the "SB" series are for other materials such as nickel base, copper, etc.

ASTM (American Society for Testing and Materials)
A body of industry professionals involved in writing universally accepted steel material and test specifications and standards. The "A" series of material specifications are for iron base materials, while the "B" series are for other materials such as nickel base, copper, etc.

AUSTENITE
A non-magnetic metallurgical phase having a face-centered cubic crystalline structure. Except for steel compositions having at least 6% nickel, austenite is typically only present at temperatures above 1333°F (723°C).

AUSTENITIC
These grades of stainless steels (300 Series plus some 200) have chromium (roughly 18% to 30%) and nickel (roughly 6% to 20%) as their major alloying additions. They have excellent ductility and formability at all temperatures, excellent corrosion resistance, and good weldability. In the annealed condition they are nonmagnetic. Some have the ability to be hardened by cold rolling as a final step. These grades are usually non-magnetic and are used for applications requiring good general corrosion resistance such as food processing, chemical processing, kitchen utensils, pots and pans, brewery tanks, sinks, wheel covers and hypodermic needles.

BEND TEST
A test for determining relative soundness and ductility of a metal to be formed. The specimen is bent over a specified diameter through a specified angle. In welded tubing the weld is of primary interest.

BRIGHT ANNEALING
A heat treat process performed in a carefully controlled furnace atmosphere resulting in a clean, smooth, scale free metal surface. During typical annealing, the heated steel combines with oxygen in the air to form an oxide layer on the steel's surface. In bright annealing, the steel is heated in a furnace filled with gases, such as hydrogen or nitrogen, or in a vacuum, to prevent oxide scale formation. The material comes out of the bright anneal furnace with the same surface as it had when it went into the furnace. The process eliminates the need for the old fashioned acid bath pickling operations.

BURST PRESSURE
The internal pressure that will cause a piece of tubing to fail by exceeding the plastic limit and tensile strength of the material from which the tube is fabricated.

COLD SINKING
The process of pulling a tube through a carbide die to reduce the diameter of the tube. Small tubes with very high thickness-to-diameter ratios are commonly produced this way in long lengths. The sinking of the tube is done at room temperature (i.e.: "Cold").

CONCENTRICITY
Used to describe tubing where the center of its inside diameter is consistent with the center of its outside diameter resulting in no variation of wall thickness. By virtue of the fact that welded tubing is fabricated from precision rolled flat stock, concentricity is inherent with a roll-formed, welded tube.

DEBURRING
Removal of a small ridge of metal formed by upset during a machining or cutting operation.

DUPLEX STAINLESS STEELS
Stainless Steels exhibiting both austenitic and ferritic phases and characteristics.

DESTRUCTIVE TESTING
Any of the mechanical tests performed on an expendable sample of tubing to check physical properties. These tests include: tensile, yield, elongation, hardness, flare, flattening, bend and burst.

ECCENTRICITY
Opposite of concentricity, resulting in variations of wall thickness.

EDDY CURRENT TESTING
A nondestructive testing procedure which is a continuous process performed on the tubular products during fabrication and in final inspection. It is by nature an electrical test that utilizes fluctuations in magnetic field strength to check tubing (against a calibrated standard) for possible defects such as holes, cracks, gouges, etc. on both inside and outside surfaces of the tube. All eddy current testing at RathGibson is done in accordance with ASTM-E 426.

ELECTROPOLISHING
An electrochemical method of surface finish enhancement in which the metal to be polished is exposed to a suitable electrolyte, typically an acid solution, while a carefully controlled current is passed between the object and a cathode. The object to be polished is the anode, and polishing is accomplished through the uniform removal of surface metal that goes into solution. Surface finish roughness of less than 0.000,010-inch (10 micro-inch) is attainable.

FERRITE
A metallurgical phase of iron having a body-centered cubic crystalline structure. It is soft, magnetic, and less susceptible to certain corrosion cracking than austenite.

FERRITE NUMBER
A calculated value indicating the relative ability of a particular chemical composition of steel to form ferrite upon solidification from the molten state. The higher the ferrite number the higher the percent of ferrite formed. Several different ferrite number formulas have been developed and should not be interchanged.

FERRITIC STAINLESS STEEL
A magnetic grade of stainless steel having a microstructure consisting of ferrite, including some of the 200 and 400 series stainless steels. Hardness can be increased slightly by cold work, but not by heat treatment. At lower temperatures ductility and formability is significantly less than that of austenitic grades. As the only major alloying element is chromium (10 to 30% depending on specific grade), these steels are relatively inexpensive to produce and are common in automotive exhaust and ornamental applications.

GAS TUNGSTEN ARC WELDING (GTAW)
An arc welding process that uses an arc between a tungsten electrode (nonconsumable) and the weld pool (base metal of strip). A high quality full fusion weld is achieved. The process can be performed with or without the addition of filler material. The GTAW process is also commonly referred to as Tungsten Inert Gas (TIG) welding.

HARDNESS
Resistance to deformation or indentation. Materials with little resistance are called soft; and those with high resistance are called hard. Finer grained structures are harder than larger grained structures. Measured in steel by scientific instruments as follows:

Brinell machine for sizes over 1/2" in diameter or thickness. Based on measurement of the diameter of the indentation of a standard size ball under a standard applied load.

Rockwell machine for sizes under 1/2" in diameter or thickness. Based on a measurement of the depth of penetration of a standard indentor under a standard applied load.

"B" scale - for soft materials such as brass, stainless steel (1/8" ball @ 100Kg load)

"T" scale - for very thin (<0.040" thick) soft materials that normally use the "B" scale (1/16" ball @ 15, 30 or 45 Kg load)

"C" scale - for harder materials such as high strength steel, tool steel, duplex stainless steel, martensitic and precipitation hardening stainless steel (diamond @ 150 Kg load)

"N" scale - for very thin (<0.040") harder materials that normally use the "C" scale (diamond @ 15, 30 or 45 Kg load)

The interest in hardness is because hardness correlates well with strength; with harder materials being stronger.

HEAT
A lot of steel produced by a furnace with one chemical composition. Steel melting is a batch process and each batch is a heat. Also known as a melt of steel. In austenitic stainless steels a heat is typically about 200,000 pounds of material, and will yield approximately 8 coils of 25,000 pounds each. Nickel base materials are typically melted in heats of 10,000 to 50,000 pounds, yielding 2 to 5 coils of 5,000 to 25,000 pounds each.

HEAT NUMBER
An identifying number assigned to the product of one melting (e.g.: 721299).

HUEY TEST
A corrosion test for evaluating intergranular corrosion resistance by boiling in refluxed 65% nitric acid for five consecutive 48-hour periods, each period starting with fresh acid. The weight of metal lost is converted into loss in ipy (inches per year) or ipm (inches per month). ASTM-A262 Practice C.

HYDROSTATIC TESTING
A nondestructive test procedure that checks for holes, cracks or porosity. Tubing is pressurized internally with water to a high pressure, but does not exceed material yield strength.

ID
Inside diameter of a tubular product. It is also known as the opening or bore of a tube or pipe.

INTERGRANULAR CORROSION
Corrosion that occurs at the grain boundaries in austenitic stainless steels that have been heated to and held at temperatures between 850° F and 1450° F. Slow cooling through this range can also result in sensitization to intergranular corrosion. Usually caused by precipitation of chrome carbides.

ISO (International Organization for Standardization)
Prepares specifications. Both Canada and the U.S.A. are ISO members and participate in the ISO specification development.

LASER BEAM WELDING (LBW)
A fusion joining process that produces coalescence of materials with the heat obtained from a concentrated beam of coherent, monochromatic light impinging on the joint to be welded. Generally an autogenous weld with no
filler metal added.

LINE MARKING
A continuous strip of information that is printed with an inert ink along the longitudinal surface of the tube after final inspection. This data includes ASTM spec number, material identification, size and wall thickness, as well as a heat number identity. Full traceability is possible with any line marked product.

MEAN COEFFICIENT OF THERMAL EXPANSION
This is the amount that a material will 'grow' in size when subjected to a temperature rise. It is measured in inches/inch/°F. This number multiplied by the length of the tubing (in inches) and by the temperature rise (in °F) indicates how much the tube length will expand (in inches). If the temperature decreases, the tube will shrink by a similar amount.

MODULUS OF ELASTICITY
A ratio of stress to strain. Used in engineering calculations to determine rigidity and deflections. The higher the number, the more rigid the item will be for a given load. The units are in pounds per square inch (psi).

NiDI
Abbreviation for the Nickel Development Institute. A group of engineering professionals dedicated to the distribution of information regarding the selection and application of nickel alloyed materials.

NONDESTRUCTIVE TESTING
See "Eddy Current Testing" or "Hydrostatic Testing".

OD
Outside diameter of a tubular product.

ORBITAL WELD
A circumferential, full fusion butt or girth weld used to join together two lengths of tubing. It is a GTAW welding process similar in nature to the longitudinal weld seam of a welded tubular product.

OVALITY
A quantitative measurement of how 'round' a tube is by comparing width to height. Limits are specified on the appropriate ASTM specification of a product.

OXIDATION
An electro-chemical reaction in which oxygen attacks a metal surface to form a metallic oxide, such as rust or the protective layer on stainless steel.

PASSIVATION
A protective layer of oxides on the surface of a metal, which resists corrosion. This passive oxide layer is the chief reason why stainless steels have such good corrosion resistant properties. It is a natural phenomenon, but can be accelerated by special passivating solutions that can be applied to tubular products by an optional process.

PROFILOMETER
An instrument that quantitatively measures surface roughness and reports height and/or depth of surface ridges.

psi
Common engineering abbreviation for pounds per square inch. A measurement of stress in a material.

RECRYSTALLIZATION
(1) Formation of a new, strain-free grain structure from that existing in cold worked metal, usually accomplished by heating (solution annealing of austenitic stainless steels). (2) The change from one crystal structure to another, as occurs when heating or cooling through a critical temperature. As in the change of an as-welded dendritic structure to an equi-axed grain structure, similar to that of the parent material.

REFLECTIVITY
A measure of the optical properties or "brightness" of a metallic surface expressed in terms of the percentage of the impinging illumination that is reflected back from that surface.

ROUGHNESS AVERAGE (Ra)
An expression of measured surface roughness or texture, typically, of a polished or machined metal surface. The arithmetic average value of the departure (peaks and valleys) of a surface profile from the center-line throughout the sampling length, generally expressed in micro-inch (0.000,001-inch) or micro-meter (or micron) (0.0003937-inch) units.

SCHEDULE, PIPE
A means of indicating the wall thickness of pipe sizes, as set forth in ASME B36.1 and ASTM A530 and B775. Commonly available pipe schedules are Schedules 5, 10, 20, 40, and 80. The actual wall thickness of a schedule number varies with the nominal pipe size or diameter (e.g.: 0.5" Sch 40 = 0.109" while 2" Sch 40 = 0.154"). A higher number schedule indicates a thicker wall for a particular pipe diameter.

SEAMLESS TUBING
Tubular product that is made by piercing or hot extrusion to form the tube hollows. Further reduction of the tube hollows is accomplished by cold drawing or tube reducing to the final finish and size. Initial steel billet or ingot is cast.

SPRINGBACK
The tendency of a material deformed under load to return to its original shape when the load is removed, like a rubber band returning to its unstretched condition when an applied load is released. Springback occurs in the elastic deformation regime, or at loads less than the yield strength of the material.

STAINLESS STEEL
The broad classification of iron-based alloys (50% minimum iron) containing at least 10% chromium that are known for their excellent corrosion and heat resistance. Other elements are also added to form alloys for special purposes,
in addition to the corrosion resistance imparted by chromium. Some of these elements are: nickel for increased corrosion resistance, ductility and workability; molybdenum for increased corrosion resistance, particularly resistance to pitting, increased creep strength and high temperature strength; columbium and titanium for stabilization; sulfur and selenium for improved machinability.

STRESS-CORROSION CRACKING
Catastrophic failure by generally transgranular cracking occurring in stainless steels and other metals. It is caused by combined action of a corrosive environment and stress, often without outward appearance of general corrosion attack.

TENSILE STRENGTH
A short form of "ultimate tensile strength". The maximum load per unit area that a material is capable of withstanding before it fails (pulls apart). Units are in psi.

TENSILE TESTING
A procedure used to determine the load at which a material will begin to plastically deform (the tensile yield strength) and ultimately at which it will break (the ultimate tensile strength). Resulting test values are a ratio of applied load (pounds) to cross-sectional area of the test sample (square inches) and are expressed in units of pounds per square inch (psi) or in metric units of megaPascals (MPa).

TIG (Tungsten Inert Gas)
A welding process that uses a non-consumable tungsten electrode to provide an electric arc to melt a work piece. Inert gases are used to shield the arc and the weld puddle to prevent oxidation during cooling. Used for heat exchanger, condenser and sanitary tubing.

TUBING DIMENSIONS
OD Outside Diameter
ID Inside Diameter
Wall thickness or gauge
All tube dimensions are specific; pipe dimensions are nominal.
Specific – actual measurement in inches
Nominal – theoretical or stated value of a dimension

ULTIMATE TENSILE STRENGTH
The stress in pounds per square inch (psi) that causes the material to fracture.

ULTRASONIC TESTING
The scanning of material with an ultrasonic beam, during which reflections from faults in the material can be detected: a powerful nondestructive test method.

WELD DECAY TEST
A corrosion test developed for the black liquor industries (pulp/paper, sugar refining) to detect susceptibility of stainless steel weldments to attack by boiling hydrochloric acid cleaning solutions. Test results are reported as a ratio of the change in thickness of the weld to the change in thickness of the base material. A ratio of 1.0:1 indicates no difference between weld and base metal. A ratio of 1.25:1 indicates that the weld thickness changed by 25% more than the base material did.

WELDED TUBING
Tubular products which are roll formed and then joined continuously along a longitudinal seam by a material fusion process. The process employed at RathGibson is Gas Tungsten Arc Welding (GTAW). See "Gas Tungsten Arc Welding" and "Laser Beam Welding" (LBW).

YIELD STRENGTH
The load per unit area that a material can withstand before permanent deformation (nonelastic) occurs. It is conventionally determined by a 0.2% offset from the modulus slope on a stress/strain diagram. Units are in psi and referenced to 0.2% offset in most literature.

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