



STAINLESS STEEL UNIVERSITY

PENN STAINLESS PRODUCTS, INC.



Overview & Objectives

You will Understand:

What makes
Stainless
Stain'less'

The Stainless
Family Tree

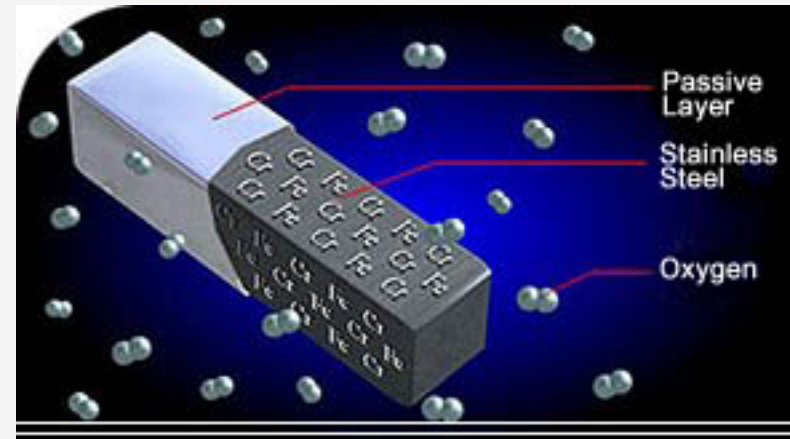
Workhorses –
304/L & 316/L

Specifications
(Flat Rolled,
Long Product)

Part 1: What Makes Stainless Stain'less'?

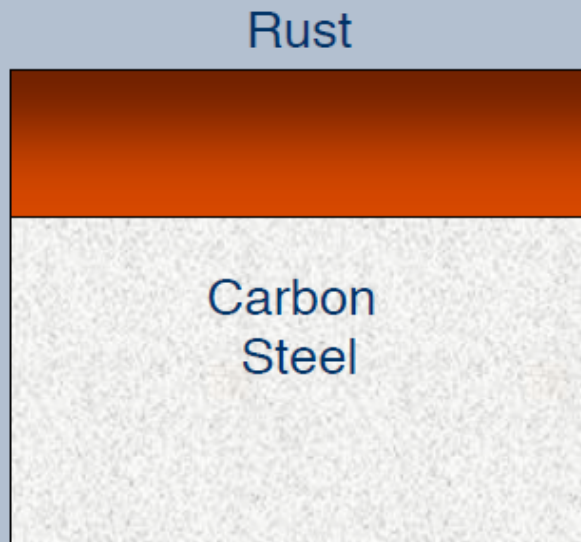
Stainless steel is the name given to a group of corrosion resistant and high temperature steels. Their remarkable resistance to corrosion is due to a chromium-rich oxide film which forms on the surface.

- When ordinary carbon steel is exposed to rain water, for example, it corrodes forming a brown iron oxide, commonly called rust, on the surface. This is not protective and eventually the entire piece of steel will corrode and be converted to rust.
- But when enough chromium (more than about 10%) is added to ordinary steel, the oxide on the surface is transformed - it is very thin, virtually invisible and protective in a wide range of corrosive media.
- This is what we call stainless steel and there are several different types, and many different grades.



Part 1: What Makes Stainless Stain'less'?

Stainless steel is iron plus at least 11% chromium. If enough chromium is added, a protective passive film will form.

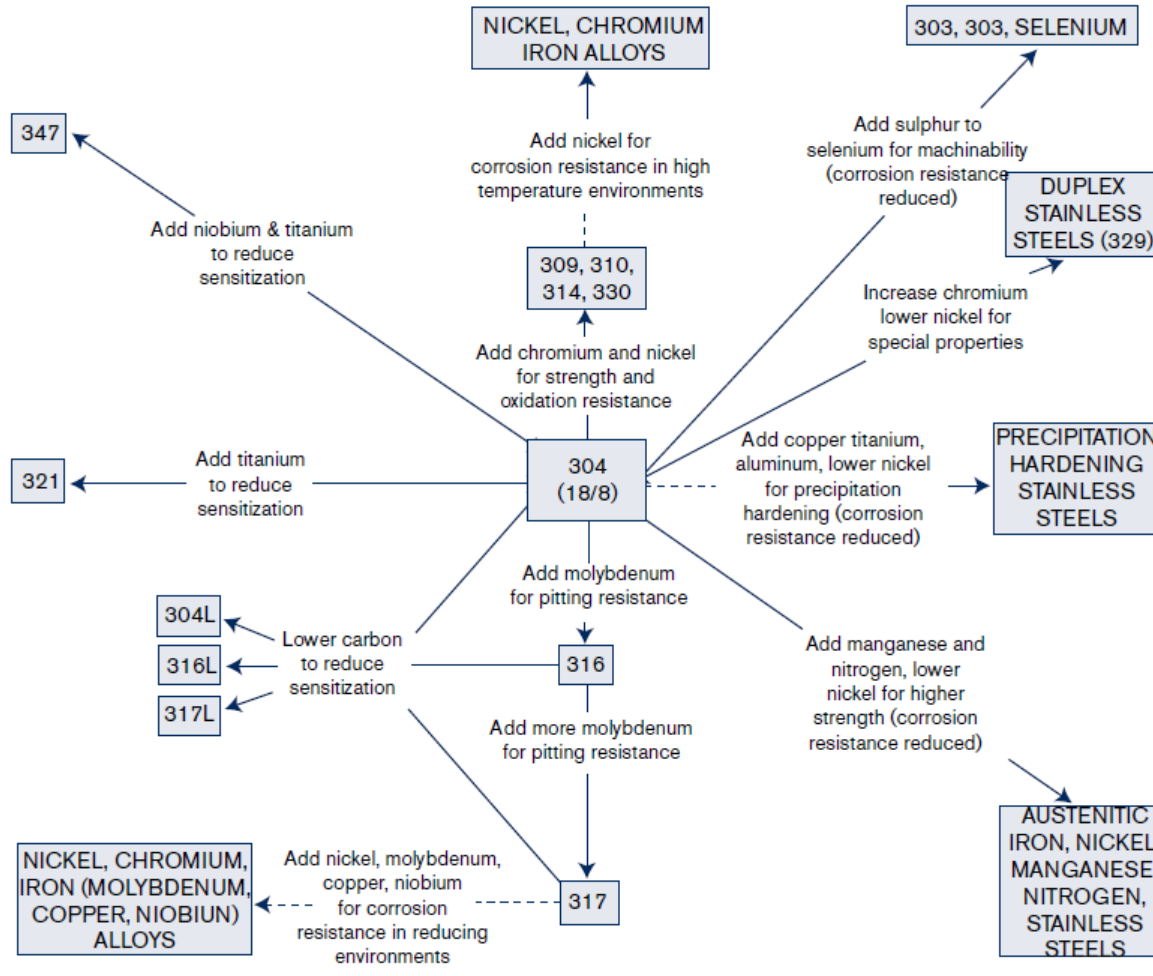


< 11% Chromium



> 11% Chromium

Part 2: The Stainless Family Tree – It Starts with 18/8 - 304



Part 2: The Stainless Family Tree

- **Austenitic Stainless Steels**

- Most Common in the market place
- Non Magnetic – Easy to recognize
- Highly Formable & Weldable
- Application: From cryogenics to red-hot jet engines or furnaces
- 16% to 25% chromium
- Typically contain nickel – leads to price variability
- Austenitic Stainless Steels work-harden
- Not heat treated

Why does 304 bar seem to have a magnetic pull?

Part 2: The Stainless Family Tree

- **Martensitic Stainless Steels**

- Magnetic
- Higher strength at room temp than austenitic and ferritic stainless steels.
- Applications: appliances, architectural, machinery components, automotive
- Martensitic stainless steels generally contain between 12 and 17% chromium
- Can be heat treated
- Common Martensitic Stainless steels are 410, 416, 420, 440C



Part 2: The Stainless Family Tree

- **Ferritic Stainless Steels**

- Magnetic
- Applications: appliances, architectural, machinery components, automotive
- Minimum of 10.5% chromium
- Typically contain very little nickel – price stability
- Not heat treated
- Common Ferritic Stainless steels are 409, 430, 439, 410S

Be careful when ordering 410 or 410S

Part 2: The Stainless Family Tree

410 Stainless Chemistry (Martensitic Characteristics – Can Be Heat Treated)

	C	Mn	Si	P	S	Cr	Ni
410	0.15 max	1.00 max	1.00 max	0.04 max	0.03 max	min: 11.5 max: 13.5	0.50 max

410S Stainless Chemistry (Ferritic Characteristics – No heat treating)

	C	Mn	Si	P	S	Cr	Ni
410S	0.08 max	1.00 max	1.00 max	0.04 max	0.03 max	min: 11.5 max: 14.5	0.60 max

Be careful when ordering 410 or 410S & Story about 405

PENN STAINLESS PRODUCTS, INC.



Part 2: The Stainless Family Tree

- **Duplex Stainless Steels**

- Have two-phase microstructure – combines austenitic and ferritic
- Produces about twice the strength of austenitic or ferritic grades
- Applications: Chemical tanks, building materials
- Contains between 20% - 27% chromium
- Contains nickel – 2% to 7% typically – Offers some price stability
- Can be challenging to weld / form
- Common Duplex Grades 2205, 2304, 2101 (Lean Duplex)



Part 2: The Stainless Family Tree

- **Precipitation Hardening (PH Stainless Grades)**
 - “Act” Austenitic in the annealed state AND “Act” martensitic when heat treated
 - Applications: Gears, turbine blades, molding components
 - Contain both nickel and chromium
 - Can be welded, but difficult to form
 - 17-4PH & 15-5PH



Part 3: Austenitic Workhorses: 304/L and 316/L

- The majority of stainless steels contain nickel (Ni), which is added for a number of reasons but particularly to change the crystal structure from ferrite to austenite.
- Austenitic stainless steels are ductile, tough and, most importantly, easy to form and weld. These steels are not magnetic in the annealed condition.
- The most common example is Type 304 (S30400) or "18/8" - the most widely used stainless steel in the world. The lower carbon version, Type 304L (S30403) is always preferred in more corrosive environments where welding is involved.
- There are numerous applications for this grade, ranging from domestic kitchen sinks and building facades to commercial food processing equipment and chemical plant piping.



Part 3: Austenitic Workhorses: 304/L and 316/L

- Molybdenum (Mo) is added to some stainless steels to increase their corrosion resistance, particularly in marine and acidic environments. It increases an alloy's pitting and crevice corrosion resistance. These corrosion forms are caused by the common and highly aggressive chloride ion (Cl^-), which is present in salts, such as sea salt and table salt.
- When 2-3% molybdenum is added to Type 304 or 304L, we create Type 316 (S31600) or 316L (S31603) stainless steel. They are sometimes referred to as the marine grades of stainless steel, since they are widely used for items such as boat fittings.
- They are also known as the acid resistant grades, since they have better corrosion resistance in some acids such as sulfuric acid. But their range of applications is wide, from building facades in aggressive atmospheres to piping onboard chemical tankers.



Part 3: Austenitic Workhorses: 304/L and 316/L

- 316/316L: In 99.99% of cases, grade 316/316L is always dual certified for sheet, plate, long products, tubular items, and structurals.
- 304/304L: In 99.99% of cases bar products and structural sections are dual certified to 304/304L
 - Exception: In cold rolled sheet products in particular, (28 ga – 7ga) 304 and 304L are separate products.
 - Exception: Plate mill plate
 - Exception: Watch Chinese tubular products – Not all items are dual certified to 304/304L.



Part 3: Austenitic Workhorses: 304/L and 316/L

Comparison of 304 & 304/L Chemistry & Mechanicals (Austenitic Characteristics)

CHEMICAL PROPERTIES

	C	Mn	Si	P	S	Cr	Ni	N
304	0.07 max	2.0 max	0.75 max	0.045 max	0.03 max	min: 18.0 max: 20.0	min: 8.0 max: 10.5	–
304L	0.030 max	2.0 max	0.75 max	0.045 max	0.03 max	min: 18.0 max: 20.0	min: 8.0 max: 12.0	0.10 max

MECHANICAL PROPERTIES

Grade	Tensile Strength ksi (min)	Yield Strength 0.2% ksi (min)	Elongation %	Hardness Brinell (max)	Hardness Rockwell B (max)
304	75	30	40	201	92
304L	70	25	40	201	92

Part 3: Austenitic Workhorses: 304/L and 316/L

What is so important about the “L” or no “L” in 304 series stainless?

- The “L” is the Low Carbon version of 304.
- The lower carbon “L grade” improves the weldability
- The lower carbon “L” grade” improves the corrosion properties of the stainless around the weld areas.
 - This is important! High temperatures generated by welding process impact the grain structure of the material that reduces the general corrosion properties at the weld area. The lower carbon content in 304/L mitigates the loss of corrosion properties around the weld.

When customers require the “L” grade, specify “L” on your quotes and orders. If you ask your favorite stainless steel service center for 304, you will likely NOT receive 304/304L for sheet or some plate product.

Part 3: Austenitic Workhorses: 304/L and 316/L

	304L		316L		
	Cr	Ni	Cr	Ni	Mo
ASTM A240	18-20	8-10.5	16-18	10-14	2-3
Pre 1965 heats	18.7	9.9	17.9	12.4	2.4
1992 Heats	18.3	9.0	16.3	10.2	2.1
Change	0.4	-0.9	-1.6	-2.2	-0.3
2004 Heats	18.3	8.2	16.6	10.2	2.1

The mills took out all the fat!

Part 4: Overview of Stainless Steel Specifications

Governing organizations develop specifications that standardize the chemical, mechanical, manufacture, and order processing of stainless steels. These organizations include:

- American Society for Testing and Materials (ASTM) www.astm.org
- American Society of Mechanical Engineers (ASME) www.asme.org
- American National Standards Institute (ANSI) www.ansi.org
- Society of Automotive Engineers (SAE) www.sae.org
 - AMS specifications – Aerospace
- National Association of Corrosion Engineers (NACE) www.naceweb.com

We will focus on ASTM specifications and tolerances.

Part 4: Overview of Stainless Steel Specifications

Flat Rolled ASTM Specifications (ASTM A480): General Requirements – Lists other flat rolled related specifications, Including ASTM A 240

1. Scope*

1.1 This specification² covers a group of general requirements that, unless otherwise specified in the purchase order or in an individual specification, shall apply to rolled steel plate, sheet, and strip, under each of the following specifications issued by ASTM: Specifications A 167, A 176, A 240/A 240M, A 263, A 264, A 265, A 666, A 693, A 793, and A 895.

1.2 In the case of conflict between a requirement of a product specification and a requirement of this specification, the product specification shall prevail. In the case of conflict between a requirement of the product specification or a requirement of this specification and a more stringent requirement of the purchase order, the purchase order shall prevail. The purchase order requirements shall not take precedence if they, in any way, violate the requirements of the product specification or this specification; for example, by waiving a test requirement or by making a test requirement less stringent.

1.3 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets, except that when A 480M is specified, Annex A3 shall apply for the dimensional tolerances and not the bracketed SI values in Annex A2. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.4 This specification and the applicable material specifications are expressed in both inch-pound and SI units. However, unless the order specifies the applicable “M” specification designation [SI units], the material shall be furnished in inch-pound units.

¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.17 on Flat-Rolled and Wrought Stainless Steel.

2. Referenced Documents

2.1 ASTM Standards:³

- A 167 Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- A 176 Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
- A 240/A 240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
- A 263 Specification for Stainless Chromium Steel-Clad Plate
- A 264 Specification for Stainless Chromium-Nickel Steel-Clad Plate
- A 265 Specification for Nickel and Nickel-Base Alloy-Clad Steel Plate
- A 342/A 342M Test Methods for Permeability of Feebly Magnetic Materials
- A 370 Test Methods and Definitions for Mechanical Testing of Steel Products
- A 666 Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- A 693 Specification for Precipitation-Hardening Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
- A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment
- A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- A 763 Practices for Detecting Susceptibility to Intergranular Attack in Ferritic Stainless Steels
- A 793 Specification for Rolled Floor Plate, Stainless Steel
- A 895 Specification for Free-Machining Stainless Steel Plate, Sheet, and Strip

General Specs – Sets definitions & terminology. Example: What is Strip?
Answer: under 3/16” thick & under 24” wide. Over 24” wide = sheet. Plate = 3/16” and over in thickness.

Part 4: Overview of Stainless Steel Specifications



**NORTH AMERICAN
STAINLESS**

METALLURGICAL TEST REPORT

6870 Highway 42 East
Ghent, KY 41045-9615
(502) 347-6000

Certificate: 394678 10 Mail To:
Customer: 0470 096 PENN STAINLESS PRODUCTS INC.
102 MCQUISTON DRIVE
JACKSON CENTER, PA 16133

Ship To:
PENN STAINLESS PRODUCTS INC.
102 MCQUISTON DRIVE
JACKSON CENTER, PA 16133

Date: 3/23/2018 Page: 1

Steel: 304/304L

Finish: HRAP

Corrosion: ASTM A262/15 A 180Bend-OK

Your Order: P031405

NAS Order: AN 0796444 15

PRODUCT DESCRIPTION:

STAINLESS STEEL PLATE, HRAP; UNS 30400/30403
ASTM A240/17, A480/16b, A666/15; ASME SA240/17, SA480/17, SA666/17
CHEM ONLY ON FOLLOWING ASTM: A276/17, A479/17, A484/16, A312/16
CHEM ONLY ON FOLLOWING ASME: SA312/13, SA479/13
AMS 5511H/5513J XMRK; MIL-S-5059D AMD3(X CRN MEAS); MIL-S-4043B
NACE MR0175/ISO 15156-3:2009 A, MR0103/07; QSS766D-A X MAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED
ASTMA240/99a, ASTMA480/99a, ASTMA262/98PR A
ASME Sect. II, 1995 Edition, 1996 & 1997 Addenda

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; RoHS 1 & 2 Compliant
Material is Free of Radioactive Contamination
Steel Making Process: EAF, AOD, & Cont. Casting
Product Mfg. by a Quality Mgt. Sys. in Conf. w/ISO 9001
Annealing Temp did not exceed 2100F
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant

Product ID #	Coil #	Thickness	Width	Weight	-----Length-----	Mark	Pieces
04739A FAA	* 04739A FAA	1.0000	48.0000	1,740	PLATE	120.00	25

Lab Accreditation Bureau, ISO/IEC 17025, Certificate# L2323

CHEMICAL ANALYSIS

HEAT	CM	C %	CR %	CU %	MN %	MO %	N %	NI %	P %	S %
739A	US	.0194	18.1520	.4110	1.8350	.3005	.0770	8.0550	.0345	.0014
SI %										
		.2435								

MECHANICAL PROPERTIES

Product ID #	Coil #	UTS	20C .2% YS	20C ELONG	% Hard	A 262 Pr A	R of A	
Product ID #	Coil #	KSI	KSI	%-2"	RB	Pr A	%	
04739A FAA	04739A FAA	FT	85.69	41.61	63.10	78.00	OK	65.15
		M103316		LA 48234				

NAS hereby certifies that the analysis on this certification is correct. Based upon the results and the accuracy of the test methods used, the material meets the specifications stated. These results relate only to the items tested and this report cannot be reproduced, except in its entirety, without the written approval of NAS.

Technical
Dept. Mgr.

KRIS LARK

3/23/2018

PENN STAINLESS PRODUCTS, INC.



Can MTRs
be
revised?
Depends

Specs

Heat

Part 4: Overview of Stainless Steel Specifications

Plate Thickness Tolerance for Coil Mill Plate (CMP) Per ASTM

Specified Thickness in.	Permitted Variations, in. Over and Under, Except as Indicated Otherwise for Specified Width (w) in.	
	Width ≤60	Width >60
>0.1875 to 0.250	-0.010; +0.020	-0.010; +0.020
>0.250 to 0.3125	-0.010; +0.022	-0.010; +0.022
>0.3125	-0.010; +0.030	-0.010; +0.030

As a general rule, plate produced from coil runs at or below the nominal plate thickness. If a min thickness is needed, communicate your requirements to the service center.

Thickness	Min	Max	Min %
.188	.178	.207	5%
.250	.240	.270	4%
.313	.303	.335	3%
.375	.365	.405	2.7%

CMP is continuously casted and rolled into large coils, then leveled by the service centers to produce “pattern sizes” such as 48 x 120

Part 4: Overview of Stainless Steel Specifications

Plate Mill Plate

Plate Thickness Tolerance for Plate Mill Plate (PMP) Per ASTM A240.

PMP Plate is manufactured from slab or billet, and plates are rolled to final thickness one at a time.

PMP tends to be rolled to final thicknesses that are at OR above the nominal thickness -

Minimum thickness may have value when machining, grinding or rolling pipe to ASTM A358

Services Centers (Penn Stainless) Can mic plates, but there are some limitations.

Gauge	LB/Sq. Ft.	LB/Sq In.	Gauge Tolerance	
			72" Wide	96" Wide
3/16	0.1875	8.579	+045° -010°	+050° -010°
7/32	0.2187	9.870		
1/4	0.2500	11.162		
5/16	0.3125	13.746		
3/8	0.3750	16.496	+055° -010°	+060° -010°
7/16	0.4375	19.080		
1/2	0.5000	21.633		
9/16	0.5625	24.247		
5/8	0.6250	26.831		
11/16	0.6875	29.415	+060° -010°	+065° -010°
3/4	0.7500	32.123		
13/16	0.8125	34.707		
7/8	0.8750	37.291		
15/16	0.9375	39.875		
1	1.0000	42.665		
1-1/8	1.1250	47.833	+070° -010°	+075 -010°
1-1/4	1.2500	53.001		
1-3/8	1.3750	58.169		
1-1/2	1.5000	63.337		



Part 4: Overview of Stainless Steel Specifications

Sheet Product – Cold Rolled – ASTM A 240

Sheet Thickness Tolerance Per ASTM A240. (Cold Rolled)

Cold Rolled Sheet like CMP, tends to run light or below the nominal specified thickness.

Aerospace applications take sheet thicknesses very seriously – minimum thicknesses often specified.

Services Centers (Penn Stainless) Can mic sheets, but there are some limitations.

ASTM TOLERANCES FOR STAINLESS STEEL SHEET

Sheet gauge to Thickness Conversion		Permitted Variations in Over and Under for specified width in Inches			
		Less than 40"	40" to Less Than 50"	50" to less than 84"	WT Per Sq/ft
7GA	0.1875"	0.007	0.007	0.0075	7.877
8GA	0.1650"	0.007	0.007	0.0075	6.981
10GA	0.1350"	0.007	0.007	0.007	5.670
11GA	0.1200"	0.007	0.007	0.007	5.040
12GA	0.1050"	0.005	0.005	0.006	4.410
13GA	0.0900"	0.004	0.004	0.005	3.780
14GA	0.0750"	0.004	0.004	0.0045	3.15
16GA	0.0600"	0.004	0.004	0.0045	2.52
18GA	0.0480"	0.003	0.003	0.004	2.016
20GA	0.0360"	0.0025	0.0025	0.003	1.512
22GA	0.0300"	0.002	0.002	XXXX	1.260
24GA	0.0240"	0.002	0.002	XXXX	1.008
26GA	0.0180"	0.0015	0.0015	XXXX	0.756
28GA	0.0150"	0.0015	0.0015	XXXX	0.6301
30GA	0.0120"	0.001	XXXX	XXXX	0.5000

Part 4: Overview of Stainless Steel Specifications

Sheet (2B) vs Plate HRAP

- Plate is Hot Rolled / Sheet is Cold Rolled – The finish are not the same

- 3/16" – vs 7 GA (.187)



Part 4: Overview of Stainless Steel Specifications

Bar Products (ASTM A276 & 484): Covers Round, Square, Hex, Rolled Flat (True Bar) and Shapes such as angle and channel

Standard Specification for Stainless Steel Bars and Shapes¹

This standard is issued under the fixed designation A 276; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope⁶

1.1 This specification covers hot-finished or cold-finished bars except bars for reforging (Note 1). It includes rounds, squares, and hexagons, and hot-rolled or extruded shapes, such as angles, tees, and channels in the more commonly used types of stainless steels. The free-machining types (Note 2) for general corrosion resistance and high-temperature service are covered in a separate specification.

Note 1—For bars for reforging, see Specification A 314.

Note 2—For free-machining stainless bars designed especially for optimum machinability, see Specification A 582/A 582M.

Note 3—There are standards covering high nickel, chromium, austenitic corrosion, and heat resisting alloy materials. These standards are under the jurisdiction of ASTM Subcommittee B02.07 and may be found in *Annual Book of ASTM Standards*, Vol. 02.04.

1.2 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards*:²

A 314 Specification for Stainless Steel Billets and Bars for Forging

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 484/A 484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings

A 582/A 582M Specification for Free-Machining Stainless Steel Bars

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

E 527 Practice for Numbering Metals and Alloys (UNS)

2.2 *SAE Document*:³

SAE J 1086 Recommended Practice for Numbering Metals and Alloys

3. Ordering Information

3.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Such requirements may include but are not limited to the following:

3.1.1 Quantity (weight or number of pieces),

3.1.2 Name of material: stainless steel,

3.1.3 Form (bars, angles, etc.),

3.1.4 Condition (Section 4.1),

3.1.5 Finish (Section 8 of Specification A 484/A 484M),

3.1.6 Surface preparation of shapes (Section 8 of Specification A 484/A 484M),

3.1.7 Applicable dimensions including size, thickness, width, and length,

1

3.1.8 Cross section (round, square, etc.),

3.1.9 Type or UNS designation (Table 1),

3.1.10 ASTM designation and date of issue, and

3.1.11 Whether bars are to be rolled as bars or cut from strip or plate.

3.1.12 Test for magnetic permeability when specified by customer purchase order when ordering Types 201 and 205.

3.1.13 Special requirements.

Note 4—A typical ordering description is as follows: 5000 lb (2268 kg) Stainless Steel Bars, Annealed and Centerless Ground, 1½ in. (38.10 mm) Round, 10 to 12 ft (3.05 to 3.66 m) in length, Type 304, ASTM Specification A 276 dated _____. End use: machined valve parts.

4. Manufacture

4.1 *Condition*:

4.1.1 Bars shall be furnished in one of the following conditions listed in the Mechanical Requirements table:

4.1.1.1 *Condition A*—Annealed

¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.17 on Flat-Rolled and Wrought Stainless Steel.

Current edition approved March 1, 2006. Published March 2006. Originally approved in 1944. Last previous edition approved in 2005 as A 276 – 05a.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

ASTM even provides guidelines on how a product should be ordered.

Areas of confusion related to purchasing are Hot Rolled vs Cold Finish product. Can impact start sizes, particularly on round bar.

Part 4: Overview of Stainless Steel Specifications

Cold Finish Tolerances for Round Bar

TOLERANCES

CF Tolerances	Plus	Minus
1/8" to 5/16"	0.001	0.001
5/16" to 1/2"	0.0015	0.0015
1/2" to 1"	0.002	0.002
1" to 1-1/2"	0.0025	0.0025
1-1/2" to 4"	0.003	0.003

Cold finished bar is typically stocked from 2-3/8" diameter or less by PSP. 2-1/2 and over is Rough Turned / Hot Finished. May vary from service center to service center.

Part 4: Overview of Stainless Steel Specifications

Rough Turned / Hot Rolled Tolerances for Round Bar

HF Tolerances	Plus	Minus
2" to 2-1/2"	1/32	0.000
2-1/2" to 3-1/2"	3/64	0.000
3-1/2" to 4-1/2"	1/16	0.000
4-1/4" to 5-1/2"	5/64	0.000
5-1/2" to 6-1/2"	1/8	0.000
6-1/2" to 8"	5/32	0.000
8" to 12"	3/16	0.000
12" to 15"	7/32	0.000
15" to 24"	1/4	0.000

CF bar is typically stocked as CF through to 2-3/8" Dia by PSP. Over 2-1/2" and is Rough Turned. May vary from service center to service center.

Cold Finished and Rough Turned inventory / tolerances overlap (1-1/2" – 4")

Part 4: Overview of Stainless Steel Specifications

True Bar Tolerances – Cold Finished

Width (inches)	Width Tolerance		Thickness Tolerances in Inches
	Up to 1/4 Inclusive	Over 1/4 Exclusive	
1/16 to 3/8 (incl)	+0.005 -0.005	+0.005 -0.005	+0.002 -0.002
over 3/8 to 1 (incl)	+0.004 -0.004	+0.004 -0.004	+0.002 -0.002
over 1 to 2 (incl)	+0.006 -0.006	+0.004 -0.004	+0.003 -0.003
over 2 to 3 (incl)	+0.008 -0.008	+0.004 -0.004	+0.004 -0.004
over 3 to 4 1/2	+0.010 -0.010	+0.005 -0.005	+0.005 -0.005

Most True Bar in 304/L, 316/L and 17-4PH is Hot Finished.

True Bar has lots of different names: Rectangle Bar, Rolled Bar, Flat Bar & True Bar. True Bar is hot rolled or extruded, and complies with ASTM A 479. It's EASY to confuse True Bar and S/E Flat Bar.

Part 4: Overview of Stainless Steel Specifications

True Bar Tolerances – Hot Finished

Width (inches)	Width Tolerance	Thickness Tolerances in Inches					
		1/8-1/2	Over 1/2 -1	Over 1-2	Over 2-4	Over 4-6	Over 6-8
to 1 (incl)	+0.015 -0.015	+0.008 -0.008	+0.010 -0.010				
over 1 to 2	+0.031 -0.031	+0.012 -0.012	+0.015 -0.015	+0.031 -0.031			
over 2 to 4	+0.062 -0.031	+0.015 -0.015	+0.020 -0.020	+0.031 -0.031	+0.062 -0.031		
over 4 to 6	+0.093 -0.062	+0.015 -0.015	+0.020 -0.020	+0.031 -0.031	+0.062 -0.031	+0.093 -0.062	
over 6 to 8	+0.125 -0.156	+0.016 -0.016	+0.025 -0.025	+0.031 -0.031	+0.062 -0.031	+0.093 -0.062	+0.125 -0.156
over 8-10	+0.156 -0.187	+0.020 -0.020	+0.031 -0.031	+0.031 -0.031	+0.062 -0.031	+0.093 -0.062	+0.125 -0.156

Most True Bar 303 is Cold Finished.

Most True Bar in 304/L, 316/L and 17-4PH is Hot Finished.

Part 4: Overview of Stainless Steel Specifications

Sheared & Edged Tolerances – Produced From Plate

WIDTH (INCHES)	WIDTH TOLERANCE	THICKNESS TOLERANCES IN INCHES				
		1/8	3/16	1/4	3/8	1/2
to 4 (incl)	+0.094 -0.031	+0.010 -0.010	+0.050 -0.010	+0.050 -0.010	+0.060 -0.010	+0.060 -0.010
over 4	+0.094 -0.094	+0.010 -0.010	+0.050 -0.010	+0.050 -0.010	+0.060 -0.010	+0.060 -0.010

Sheared & Edged Flat Bar is produced from a plate specification, and confirms to ASTM A240

There are multiple cross over sizes / inventory between True Bar and S/E flat bar.

Part 4: Overview of Stainless Steel Specifications

Angle Tolerances – ASTM A484. A276

- **Unequal leg angles** the longer leg determines the tolerance for the length of each leg
- **Length of Legs:** legs or flanges up to 6 inch, inclusive, the length tolerance shall not exceed plus or minus 1/8 inch. For angles having legs or flanges over 6 inch, the length tolerance shall not exceed plus 3/16" inch and minus 1/8" inch
- **Squareness** the tolerance for the right angle between the legs is plus or minus 2 % degrees.

IMPORTANT – There can be variation in Angle Leg Lengths, particularly from 1 manufacture to the next.



Part 4: Overview of Stainless Steel Specifications

Polishing – Items to Consider

- Polished Material – Does not always match precisely from 1 batch to the next.
- For larger jobs, its best to get a sample approved.
- On bar products, its important to specify if S/E or True Bar is required for the start material

IMPORTANT – There can be variation in Angle Leg Lengths, particularly from 1 manufacture to the next.



Part 5: Market Overview

Market Update

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STAINLESS STEEL UNIVERSITY

PENN STAINLESS PRODUCTS, INC.

