Allegheny Ludlum
An Allegheny Technologies Company

Technical Data BLUE SHEET

Allegheny Ludlum Corporation ◆ Pittsburgh, PA

Allegheny Ludlum Stainless Steel

Type 301

(UNS Designation S30100)

GENERAL PROPERTIES

Allegheny Ludlum Type 301 (S30100) is an austenitic stainless steel with a nominal composition of 17 percent chromium and 7 percent nickel. The high strengths of this grade of steel in the six available conditions or tempers, its resistance to atmosphere corrosion and its bright, attractive surface make it an excellent choice for decorative structural applications.

Automobile molding and trim, wheel covers, conveyor belts, kitchen equipment, roof drainage systems, hose clamps, springs, truck and trailer bodies, railway and subway cars are some of the major applications for this versatile grade. By varying the chemical composition within the limits set by the ASTM specifications and by temper rolling, a broad range of magnetic and mechanical properties can be obtained for a variety of applications.

Type 301 is available as cold rolled strip, sheets, and plates.

CHEMICAL COMPOSITION

Represented by ASTM A240 and A666

Element	Percent by Weight Maximum Unless Range is Specified
Carbon	0.15 maximum
Manganese	2.00 maximum
Phosphorus	0.045 maximum
Sulfur	0.030 maximum
Silicon	0.75 maximum
Chromium	16.00-18.00
Nickel	6.00-8.00
Nitrogen	0.10 maximum

RESISTANCE TO CORROSION

Type 301 is resistant to a variety of corrosive media. However, the corrosion properties are not as good as the 18-8 chromium-nickel steels. Its susceptibility to carbide precipitation during welding restricts its use in many applications in favor of Types 304 or 304L.

RESISTANCE TO OXIDATION

Type 301 possesses good resistance to oxidation at temperatures up to 1550°F (840°C). At 1600°F (871°C), Type 301 exhibits an oxidation weight gain of 10mg/cm^2 in 1,000 hours. Therefore, this stainless steel is not suggested for use at 1600°F or above. As the rate of oxidation is greatly affected by the atmosphere to which the metal is exposed by the heating and cooling cycle, and by the structural design, no data can be presented which will apply to all service conditions.

PHYSICAL PROPERTIES

The values reported below are representative for average composition in the annealed condition.

Melting Range	2550-2590°F (1399-1421°C)
Density	0.29 lb/in^3 (8.03g/cm^3)
Specific Gravity	8.03
Modulus of Elasticity in Tension	28 x 10^6 psi (193 GPa) *

* In the cold worked condition, the modulus is lowered.

Data shown are typical, and should not be construed as maximum or minimum values for specification or for final design. Data on any particular piece of material may vary from those shown herein.

Linear Coefficient of Thermal Expansion

Temperature Range		Coefficients	
°C	°F	cm/cm/°C	in/in/°F
20-100	62-212	16.6×10^{-6}	9.2×10^{-6}
20-300	68-572	17.6×10^{-6}	9.8×10^{-6}
20-500	68-932	18.6×10^{-6}	10.3×10^{-6}
20-700	68-1292	19.5×10^{-6}	10.8×10^{-6}
20-871	68-1600	19.8×10^{-6}	11.0×10^{-6}

Since the expansion coefficient is higher than that of many other metals and alloys, this characteristic should be considered in the design of equipment involving Type 301 and other materials of construction.

Thermal Conductivity

Temperature Range		W/m-K	Btu/ft²/hr/°F/ft
°C	°F		
20-100	68-212	16.3	9.4
20-500	68-932	21.4	12.4

Specific Heat

°C	°F	J/kg °K	Btu/lb/°F
0-100	32-212	500	0.12

Magnetic Permeability

Properly annealed Type 301 is completely austenitic and magnetic permeability is 1.02 maximum at 200H. Cold working promotes the formation of martensite and the magnetic permeability is increased. The amount of martensite formed depends on the amount of cold rolling, temperature of cold rolling, and composition. Figure 1 shows the increase in magnetic permeability with cold rolling at room temperature. The composition of the steels used in these determinations are:

Steel	C	Mn	Si	Cr	Ni	N
A	0.12	1.57	0.56	17.51	7.52	0.043
B	0.10	0.67	0.33	17.19	7.20	0.035

Electrical Resistivity

°C	°F	Microhm-cm	Microhm-in.
20	68	72	28.3
100	212	78	30.7
200	392	86	33.8
400	752	100	39.4
600	1112	111	43.7
800	1472	121	47.6
900	1652	126	49.6

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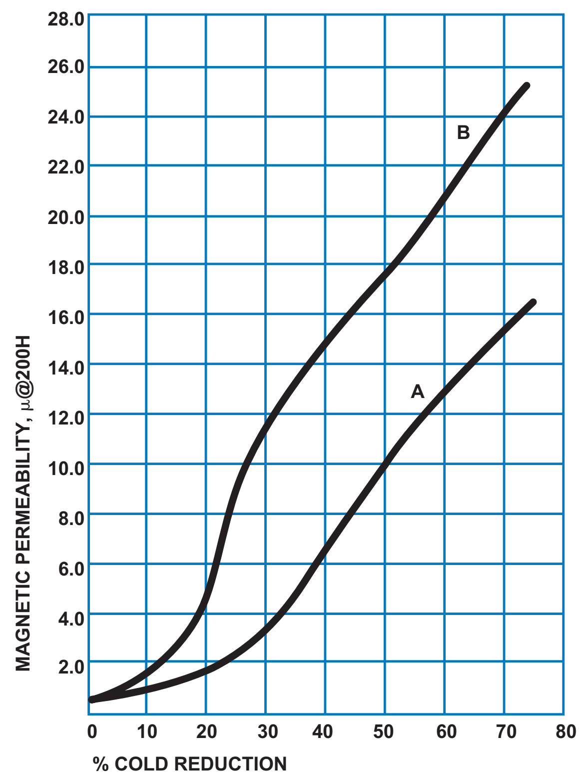
Figure 1 - Magnetic Permeability



MECHANICAL PROPERTIES

Type 301 is used in the annealed and cold-rolled conditions. In the work-hardened condition, Type 301 develops higher tensile strength than the other stable austenitic grades. Minimum properties for plate, sheet and strip per ASTM A240 and A666 follow.

Minimum Room Temperature Mechanical Properties, ASTM A240 and A666 Specifications

Condition	Tensile Strength, Min. Ksi	(MPa)	0.2% Yield Strength, Min. Ksi	(MPa)	Elong. In 2" (50mm) %, Min.
Annealed	75	(515)	30	(205)	40
1/4 Hard	125	(862)	75	(517)	25
1/2 Hard	150	(1,034)	110	(758)	18*
3/4 Hard	175	(1,207)	125	(931)	12*
Full Hard	185	(1,276)	140	(965)	9*

*Value shown for thickness greater than 0.015 in. (.038mm).

The properties can be controlled to a certain extent by proper balance of chemical composition. Figure 2 shows the effect of cold rolling on the tensile properties of a representative Type 301 composition. Figure 3 shows stress-strain curves and yield strength of annealed and 1/4 hard Type 301. Cold rolled Type 301 shows slightly anistropic properties in the direction of cold rolling (longitudinal) and at right angles to this direction (transverse). The difference becomes quite pronounced in compression. A more isotropic material can be produced by a stress relieving heat treatment in the 700 to 1000°F (371-538°C) temperature range for a period of five minutes to five hours. Use of lower temperature and shorter times minimizes carbide precipitation. The table to the right illustrates the as-rolled and stress-relieved mechanical properties of Type 301 in tension and compression.

		Tension							
		Longitudinal				Transverse			
		.2% Y.S.		Elastic Modulus		0.2% Y.S.		Elastic Modulus	
Temper	Condition	Ksi	(MPa)	10^6psi	(GPa)	Ksi	(MPa)	10^6psi	(GPa)
Annealed	As annealed	36	(248)	31.0	(214)	36	(248)	30.6	(211)
1/4 Hard	As rolled	80	(552)	28.0	(193)	84	(579)	28.6	(197)
	Stress relieved	77	(531)	28.7	(198)	79	(545)	27.0	(186)
1/2 Hard	As rolled	122	(841)	26.8	(185)	123	(848)	28.1	(194)
	Stress relieved	128	(883)	27.9	(192)	130	(896)	28.6	(197)
3/4 Hard	As rolled	142	(979)	25.8	(178)	145	(1,000)	27.5	(190)
	Stress relieved	155	(1,069)	27.3	(188)	155	(1,069)	28.8	(199)
Full Hard	As rolled	160	(1,103)	25.2	(174)	163	(1,124)	28.4	(196)
	Stress relieved	175	(1,207)	28.4	(196)	181	(1,248)	30.5	(210)
		Compression							
Annealed	As annealed	38	(262)	30.6	(211)	38	(262)	30.3	(209)
1/4 Hard	As rolled	50	(345)	28.2	(194)	91	(627)	28.2	(194)
	Stress relieved	73	(503)	28.8	(199)	84	(579)	30.6	(211)
1/2 Hard	As rolled	90	(621)	27.5	(190)	142	(979)	27.5	(190)
	Stress relieved	111	(765)	29.2	(201)	144	(993)	29.8	(205)
3/4 Hard	As rolled	100	(690)	26.5	(183)	170	(1,172)	27.9	(192)
	Stress relieved	133	(917)	27.5	(190)	176	(1,213)	29.5	(203)
Full Hard	As rolled	115	(793)	24.6	(170)	191	(1,317)	29.4	(203)
	Stress relieved	169	(1,165)	27.7	(191)	209	(1,441)	29.6	(204)

Figure 2 - Cold Rolled Properties

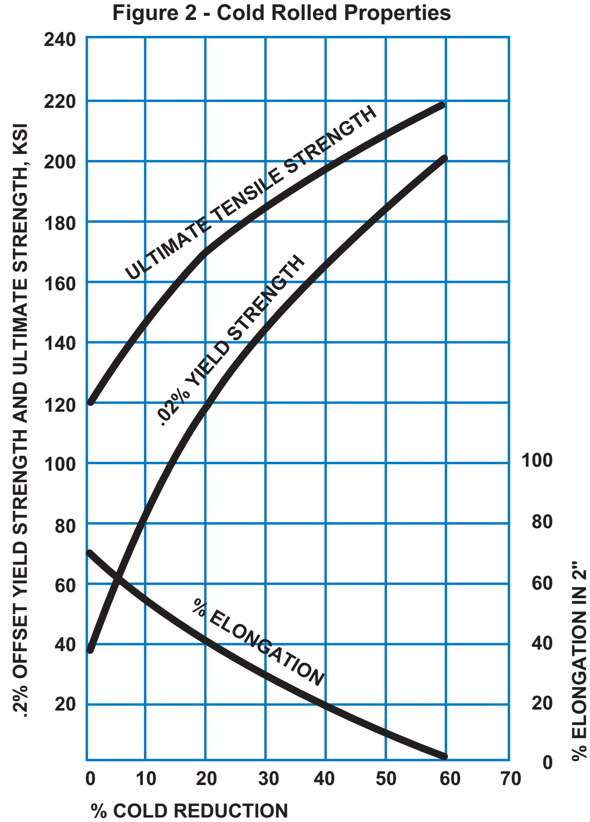
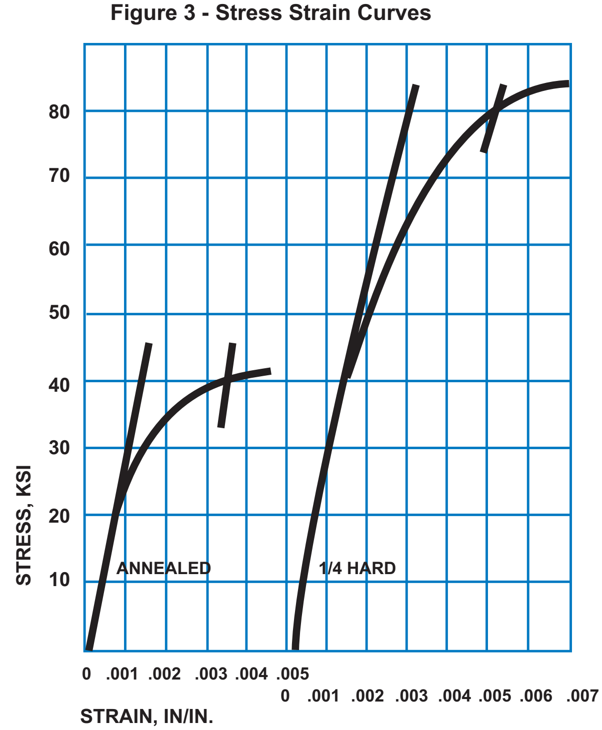


Figure 3 - Stress Strain Curves



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Typical Elevated Temperature Tensile Properties

Temperature °F (°C)	Tensile Strength, Ksi (MPa) Annealed	1/8 Hard	1/2 Hard	Yield Strength, 0.2% Offset, Ksi (MPa) Annealed	1/8 Hard	1/2 Hard	% Elongation in 2" (50mm) Annealed	1/8 Hard	1/2 Hard
Room Temp.	105.0 (724)	129.0 (889)	165.0 (1138)	40.0 (276)	73.0 (503)	112.0 (772)	55.0	43.5	28.5
400 (204)	80.0 (552)	90.6 (625)	127.0 (876)	22.0 (152)	61.5 (424)	106.0 (731)	46.0	23.0	9.0
600 (316)	70.4 (485)	86.2 (594)	122.7 (846)	19.4 (134)	59.8 (412)	95.2 (656)	40.0	20.0	6.5
800 (427)	67.2 (463)	81.7 (563)	116.9 (806)	19.5 (134)	54.7 (377)	85.5 (590)	39.0	17.5	7.0
1000 (538)	58.2 (401)	69.4 (479)	78.0 (538)	18.3 (126)	51.2 (353)	67.3 (464)	34.0	16.5	7.0
1200 (649)	40.9 (282)	51.0 (352)	57.5 (396)	15.4 (106)	40.0 (276)	48.0 (331)	36.0	20.0	10.0
1400 (760)	29.6 (204)	36.0 (248)	35.0 (241)	14.4 (99.3)	27.0 (186)	31.0 (214)	30.0	17.0	10.0
1600 (871)	15.8 (109)	19.4 (134)	16.4 (113)	9.5 (65.5)	15.4 (106)	13.9 (95.8)	29.0	15.0	12.5

Typical Low Temperature Tensile Properties

Condition	Test Temperature °F	(°C)	Yield Strength 0.2% Offset Ksi	(MPa)	Ultimate Tensile Strength Ksi	(MPa)	% Elongation in 2" (50 mm)	Notched to Unnotched Tensile Strength Ratio
Annealed	78	(25)	40	(276)	105	(724)	60	–
	32	(0)	43	(297)	155	(1,069)	53	–
	-40	(-40)	48	(331)	180	(1,241)	42	–
	-80	(-62)	50	(345)	195	(1,351)	40	–
	-320	(-196)	75	(517)	275	(1,896)	30	–
1/4 Hard	78	(25)	95	(655)	150	(1,034)	54	–
	32	(0)	98	(676)	170	(1,172)	46	–
	-40	(-40)	101	(696)	188	(1,296)	38	–
	-80	(-62)	105	(724)	205	(1,413)	37	–
	-320	(-196)	116	(800)	290	(1,999)	25	–
3/4 Hard	78	(25)	171	(1,179)	190	(1,310)	17	1.05
	-100	(-73)	154	(1,062)	224	(1,544)	19	0.96
	-320	(-196)	193	(1,331)	290	(1,999)	20	0.90
	-423	(-253)	–	–	317	(2,186)	14	0.92
Full Hard*	78	(25)	183	(1,262)	205	(1,413)	6	1.01
	-320	(-196)	215	(1,482)	302	(2,082)	20	0.90
	-423	(-253)	250	(1,724)	340	(2,344)	15	0.87

Typical short time high temperature tensile properties of Type 301 in the annealed and cold-rolled state are shown in the table above.

The high temperature short-time tensile properties can be used for design purposes only up to 700 or 800°F. Above this temperature, design is based on creep and stress-rupture data. There is no significant difference in the creep strength of Type 301 and the other 18-8 grades and the data given for these grades can also be used for Type 301. Stress-rupture and creep-strength curves are shown in Figures 4 and 5.

Typical low temperature properties for Type 301 are given above.

Hardness

Typical hardness values for annealed and cold-rolled Type 301 are given in the following table:

Temper	Brinell Hardness	Rockwell Hardness
Annealed	165	85 Rb
1/4 Hard	255	25 Rc
1/2 Hard	297	32 Rc
3/4 Hard	342	37 Rc
Full Hard	382	41 Rc

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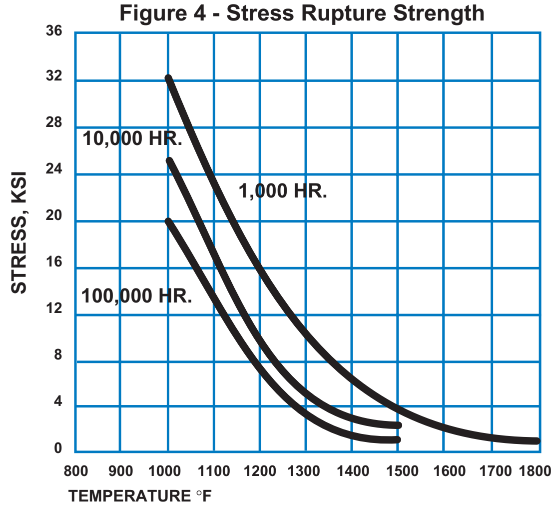
* Extra-full Hard, a proprietary temper harder and less ductile than A666 Full Hard Temper

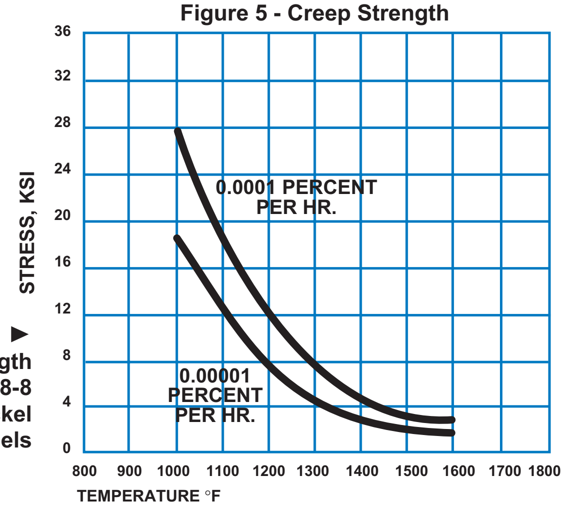
Figure 4 - Stress Rupture Strength



◄ Stress Rupture Strength Annealed 18-8 Chromium-Nickel Steels

► Creep Strength Annealed 18-8 Chromium-Nickel Steels

Figure 5 - Creep Strength



Impact Resistance

Annealed austenitic stainless steels exhibit high resistance to impact even at low temperatures. This property, in combination with strength and fabricability, has led to their use in cryogenic applications. Typical impact properties for Type 301 are shown below.

Temperature		Charpy V-Notch Energy Absorbed	
°F	°C	Foot-pounds	Joules
75	23	110	150
-100	-73	110	150
-320	-196	110	150

Fatigue Strength

The endurance limit of annealed Type 301 is 30-45 percent of the tensile strength. Cold rolling increases the endurance limit as compared with annealed material. Stress relieving increases the endurance limit of cold rolled material.

Typical endurance limits for Type 301 are shown in the following table:

Condition	Endurance Limit	
	Ksi	MPa
Annealed	35	(241)
1/4 Hard	44	(303)
1/2 Hard	55	(379)
Full Hard	80	(552)

HEAT TREATMENT

Forging Treatment

Initial: 2000-2200°F (1093-1204°C)
Finishing: 1700°F (927°C)

Annealing Temperature

1850-2050°F (1010-1121°C)

The primary purposes of annealing are to remove the stresses, recrystallize the structure if the material has been previously cold worked, and to take the carbides into solution. Rapid cooling through the carbide precipitation range is necessary to keep the carbides into solution. For thin sections, air cooling is sufficient for this purpose while heavier sections have to be water quenched.

Structure

When properly annealed, Type 301 is austenitic. It is possible that small quantities of delta ferrite are present. Cold rolling promotes the formation of martensite and exposure in the 800-1500°F (427-816°C) range results in grain boundary carbide precipitation.

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