CLIFFS

301
STAINLESS STEEL

- **Aircraft Structural Parts**
- **Automotive Trim**
- **Cooking Utensils**
- **Roof Drainage**
- **Subway Cars**

TYPE 301 is an austenitic, chromium-nickel stainless steel. This alloy is non-magnetic in the annealed condition, but magnetic when cold worked. Within the scope of the ASTM Type 301 specification, chemical composition and processing modifications can result in a wide range of engineered material properties targeted at specific applications. Type 301 is available in the annealed, as well as a variety of temper-rolled conditions.

High strength and excellent corrosion resistance make Type 301 useful for a wide variety of applications. Typical uses include aircraft structural parts, trailer bodies, diaphragms, utensils, architectural and automotive trim, automobile wheel covers, roof drainage products, tablewear, storm door frames, conveyor belts, sinks, subway cars and appliances.

Product Description

Type 301 is an austenitic chromium-nickel stainless steel that provides high strength and good ductility when cold worked. It is a modification of Type 304 in which the chromium and nickel contents are lowered to increase the cold work-hardening range. This permits higher tensile strengths to be achieved by rolling with a lower loss of ductility than with Type 304.

The grade is essentially non-magnetic when annealed. However, when the grade is cold worked, it becomes more magnetic than other standard austenitic stainless steels.

Composition		(wt %)
Carbon	(C)	0.15 max.
Manganese	(Mn)	2.00 max
Phosphorus	(P)	0.045 max.
Sulfur	(S)	0.030 max.
Silicon	(Si)	0.75 max.
Chromium	(Cr)	16.0 – 18.0
Nickel	(Ni)	6.00 – 8.00
Nitrogen	(N)	0.10 max.
Iron	(Fe)	Balance

AVAILABLE FORMS

Cleveland-Cliffs produces Type 301 in thicknesses from 0.01 – 0.187 in. (0.25 – 4.75 mm) and widths up to 60 in. (1524 mm). For other thicknesses and widths, contact your Cleveland-Cliffs sales representative.

Mechanical Properties

TABLE 1 – TYPICAL ROOM TEMPERATURE MECHANICAL PROPERTIES

Condition	UTS, ksi. (MPa)	0.2% YS, ksi. (MPa)	Elongation % in 2 in. (50.8 mm)	Rockwell Hardness, B
Annealed	120 (827)	45 (310)	60	86

TABLE 2 – COLD-WORKED PROPERTIES

Condition	UTS, ksi. (MPa) min.*	0.2% YS, ksi. (MPa) min.*	Elongation % in 2 in. (50.8 mm)		Rockwell Hardness, C
			<0.015 in.	≥0.015 in.	
1/4-hard	125 (862)	75 (517)	25	25	25
1/2-hard	150 (1034)	110 (758)	18	18	32
3/4-hard	175 (1207)	135 (931)	12	12	37
Full-hard	185 (1276)	140 (965)	9	9	41

**Minimum - standard practice is to produce to either minimum tensile strength, minimum yield strength or minimum hardness, but not to combinations of these properties.*

TABLE 3 – FULL-HARD SHEET ELEVATED TEMPERATURE MECHANICAL PROPERTIES

Temperature, °F (°C)	UTS, ksi. (MPa)	0.2% YS, ksi. (MPa)	Elongation % in 2 in. (50.8 mm)
Room	185 (1276)	151 (1041)	9.0
200 (93)	174 (1200)	145 (1000)	7.0
400 (204)	168 (1158)	140 (965)	4.5
600 (316)	156 (1076)	130 (896)	6.0
800 (427)	145 (1000)	119 (820)	6.0

TABLE 4 – LOW TEMPERATURE MECHANICAL PROPERTIES

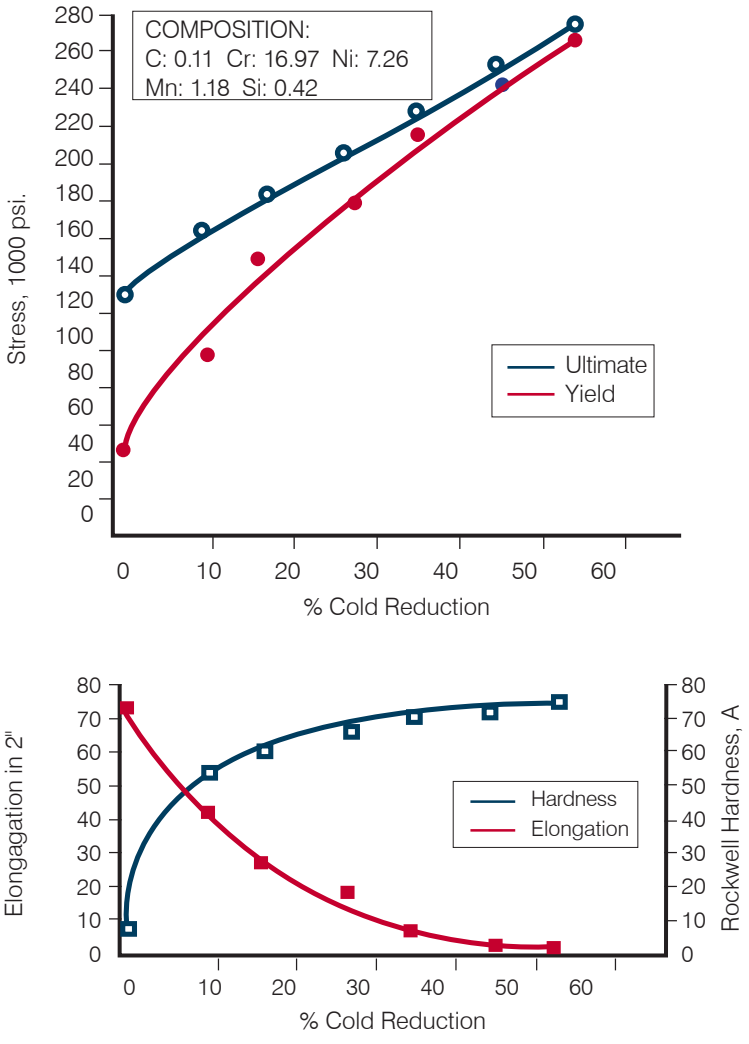
Condition	Temperature, °F (°C)	UTS, ksi. (MPa)	0.2% YS, ksi. (MPa)	Elongation % in 2 in. (50.8 mm)
Annealed	-320 (-196)	275 (1896)	75 (517)	30
	-80 (-62)	195 (1344)	50 (345)	40
	-40 (-40)	180 (1241)	48 (331)	42
	32 (0)	155 (1069)	43 (296)	53
	70 (21)	110 (758)	40 (276)	60
Half-hard	-320 (-196)	290 (1999)	115 (793)	25
	-80 (-62)	205 (1413)	105 (724)	37
	-40 (-40)	188 (1296)	101 (696)	38
	32 (0)	170 (1172)	98 (676)	46
	70 (21)	150 (1034)	110 (758)	48

Mechanical Properties

TABLE 5 – IMPACT ENERGY

Temperature, °F (°C)	Izod V-Notch, ft. •lbs (J)
-320 (-196)	114 (155)
-80 (-62)	112 (151)
-40 (-40)	110 (149)
32 (0)	108 (146)
70 (21)	102 (138)

FIGURE 1 – EFFECT OF COLD WORK ON TENSILE PROPERTIES



Properties

PHYSICAL PROPERTIES

Cleveland-Cliffs produces Type 301 in thicknesses from 0.01 – 0.187 in. (0.25 – 4.75 mm) and widths up to 60 in. (1524 mm). For other thicknesses and widths, contact your Cleveland-Cliffs sales representative.

Density, lbs/in.^{3} (g/cm^3)	0.283 (7.81)
Electrical Resistivity, $\mu\Omega$•in. ($\mu\Omega$•cm)	27.0 (68.5)
Thermal Conductivity, BTU/hr./ft./°F W/(m•K)	
212 °F (100 °C)	9.4 (16.2)
932 °F (500 °C	12.4 (21.4)
Coefficient of Thermal Expansion, in./in./°F (μm/m/K)	
32 – 212 °F (0 – 100 °C)	8.7 x 10^{-6} (15.7)
32 – 600 °F (0 – 315 °C)	9.7 x 10^{-6} (17.5)
32 – 1000 °F (0 – 538 °C)	10.2 x 10^{-6} (18.4)
32 – 1200 °F (0 – 649 °C)	10.5 x 10^{-6} (18.9)
32 – 1600 °F (0 – 871 °C	11.3 x 10^{-6} (20.3)
Modulus of Elasticity, ksi. (MPa)	28.6 x 10^3 (197 x 10^3)
Magnetic Permeability, (H/m at 200 Oersteds)	Annealed 1.02
Specific Heat, BTU/lbs./°F (kJ/kg/K)	
32 – 212 °F (0 – 100 °C	0.12 (0.50)
Melting Range, °F (°C	2550 – 2650 (1399 –1454)

CORROSION RESISTANCE

Type 301 exhibits corrosion resistance comparable to Types 302 and 304 in most mild service conditions. Resistance to food service requirements and atmospheric corrosion is excellent. Stress cracking resistance is similar to Type 304. The optimal corrosion resistance is obtained in the cold- worked then annealed condition. When Type 301 is heated or cooled slowly through a temperature range of 800 – 1600 °F (427 – 871 °C) without subsequent annealing, it may undergo carbide precipitation that may result in intergranular corrosion.

OXIDATION RESISTANCE

The maximum temperature to which Type 301 can be exposed continuously without appreciable scaling is about 1600 °F (871 °C). For intermittent exposure, the maximum exposure temperature is about 1450 °F (788 °C).

HEAT TREATMENT

Type 301 is non-hardenable by heat treatment.

Annealing: Heat to 1900 – 2050 °F (1038 – 1121 °C), then water quench.

Stress Relief Annealing: Heat to 500 – 900 °F (260 – 482 °C), then air cool.

COLD-WORKING

High hardness and strength for structural applications are achieved through cold working. In addition to the annealed condition 110 ksi. (758 MPa) minimum tensile strength, Type 301 strip is normally produced in various cold-rolled tempers up to full-hard 185 ksi. (1276 MPa) minimum tensile strength.

FORMABILITY

Type 301 can be readily formed and drawn. Due to its high work-hardening rate, intermediate annealing may be necessary for severe drawing and forming operations. Type 301 may not be suitable in certain severe forming applications where multiple forming operations are required.

SPECIFICATIONS

Type 301 is covered by the following specifications:

- ASTM A240
- ASTM A666

CLIFFS

301 STAINLESS STEEL

WELDABILITY

The austenitic class of stainless steels is generally considered to be weldable by the common fusion and resistance techniques. Special consideration is required to avoid weld "hot cracking" by assuring formation of ferrite in the weld deposit. This particular alloy is generally considered to have similar weldability than the most common alloy of this stainless class, Type 304L. A major difference is the high chrome content for this alloy, which can cause the weld heat-affected-zones to be susceptible to intergranular corrosion in certain environments. When a weld filler is needed, AWS E/ER 308 is most often specified. Type 301 is well known in reference literature, and more information can be obtained in the following ways:

1. ANSI/AWS A5.9, A5.22 and A5.4 (filler metals, minimum UTS and elongation).
2. "Welding of Stainless Steels and Other Joining Methods," SSINA, (800:982-0355).
3. ANSI/AWS B2.1.009:2002 (GTAW 300's @ 0.50 in. – 0.14 in.).
4. ANSI/AWS B2.1-8-024:2001 (GTAW 300's @ 0.125 in. – 1.5 in.).
5. ANSI/AWS B2.1-8-013:2002 (SMAW 300's @ 0.050 in. – 0.14 in.).
6. ANSI/AWS B2.1-8-025:2001 (SMAW 300's @ 0.125 in. – 1.5 in.).
7. ANSI/AWS B2.1-8-005:2002 (GMAW 300's @ 0.050 in. – 0.14 in.).

About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, Cliffs also is the largest manufacturer of iron ore pellets in North America. The Company is vertically integrated from mined raw materials and direct reduced iron to primary steelmaking and downstream finishing, stamping, tooling, and tubing. The Company serves a diverse range of markets due to its comprehensive offering of flat-rolled steel products and is the largest steel supplier to the automotive industry in North America. Headquartered in Cleveland, Ohio, Cleveland-Cliffs employs approximately 25,000 people across its mining, steel and downstream manufacturing operations in the United States and Canada.

CLIFFS

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