



## Nitronic® 33 Stainless Steel (UNS S24000, XM29)

Electralloy's Nitronic® 33 Stainless Steel is a low nickel, Nitrogen strengthened austenitic stainless steel that combines high yield strength with excellent toughness and ductility. Its magnetic permeability remains very low even after severe cold working, and at very low temperatures. Nitronic® 33 also exhibits good resistance to galling and wear, superior to Type 304 stainless steel.

### CHEMICAL COMPOSITION (Nominal Analysis, weight percent)

Carbon ( <i>max.</i> ).....	0.08	Silicon ( <i>max.</i> ).....	0.75
Manganese.....	11.50/14.50	Chromium.....	17.00-19.00
Phosphorus ( <i>max.</i> ).....	0.060	Nickel.....	2.30/3.70
Sulfur ( <i>max.</i> ).....	0.010	Nitrogen.....	0.20/0.40
Iron.....	Balance		

### TYPICAL APPLICATIONS

Electralloy's Nitronic® 33 exhibits increased yield strength at very low temperature, without great loss of ductility and toughness as compared to type 304. Along with low magnetic permeability at these temperatures; these properties make in an excellent candidate for cryogenic service applications such as tanks, flanges, valves, etc. Low magnetic permeability also allows for applications in conduit shielding, MRI support structures, and other electronic services. Resistance to weak acids, similar to 304, and slightly better stress corrosion cracking resistance than 304, make Nitronic® 33 a good choice for corrosion resistant rebar, and in heat exchangers, pressure vessels, piping and the like. Nitronic® 33 is used in aerospace gas turbine engine mounts and retaining rings; and has been used in gas turbine compressor blades. Nitronic® 33 is approved by ASME Boiler and Pressure Vessel Committee for use in welded tubes.

Electralloy's Nitronic® 33 Stainless Steel is supplied in ingot, forging billet, bar and plate to meet the requirements of the following specifications, and more...

**ASTM A240, ASTM A249, ASTM A276, ASTM A312, ASTM A314, ASTM A479, ASTM 480,  
ASTM A580, ASTM A688, ASTM A813, ASTM A814, ASTM A943**

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## PHYSICAL PROPERTIES

Magnetic Permeability: (Annealed Bar)			
77°F (25°C)	—	~1.0017	
-126°F (-88°C)	—	~1.0023	
-320°F (-196°C)	—	~1.0017	
Typical Magnetic Permeability @ RT:			
0% cold work	—	1.0014	
20% cold work	—	1.0015	
40% cold work	—	1.0015	
70% cold work	—	1.0009	
Density: 0.280 lb/in. <sup>3</sup> (7.755 gm/cm <sup>3</sup> )			
Specific Heat: (32 to 212°F) 0.12 Btu/lb°F			
Coefficient of Thermal Expansion: (Annealed Material)			
Temperature °F	Temperature °C	10 <sup>-6</sup> in/in./°F	um/m/°C
70 to 200	21 to 93	8.93	16.1
70 to 600	21 to 316	9.68	17.4
70 to 1200	21 to 649	10.84	19.5
Thermal Conductivity:			
Temperature °F	Temperature °C	BTU/ft <sup>2</sup> /in. <sup>2</sup> /hr	W/m <sup>2</sup> K
212	100	110	15.9
392	200	120	17.3
752	400	141	20.4
Electrical Resistivity:			
Temperature		Resistivity	
°F	°C	microhm-cm	
75	24	70	
212	100	80	
752	400	100	

### WORKABILITY

Nitronic® 33 may be formed by the same methods used with other austenitic stainless steels. However the alloy is stronger and requires more power for forming or forging. In-process annealing may be done at 1900°F to 2000°F.

### HEAT TREATMENT

Annealing is done at 1900°F to 2000°F followed by rapid cooling. Nitronic® 33 cannot be hardened by heat treatment.

## MECHANICAL PROPERTIES

Minimum Acceptable Room Temperature Tensile:					
	UTS		YS		EI
	ksi	MPa	ksi	MPa	%
Annealed Bar	100	689	55	379	30
Typical Cryogenic and Short-Time Elevated Temperature Tensile Properties:					
-320°F (-196°C)	229	1579	176	1217	20
-100°F (-73°C)	166	1145	104	717	60
75°F (24°C)	117	807	72	496	49
200°F (93°C)	106	731	59	407	50
400°F (204°C)	93	641	45	310	44
1000°F (538°C)	74	510	32	221	39
Typical Charpy V-Notch Toughness:					230 ft-lbs 307 joules
(Annealed Bar)					

## CORROSION RESISTANCE

Electralloy's Nitronic® 33 alloy provides resistance to mild acids and pitting media similar to type 304 stainless, but may be less resistant than type 304 in more severe environments.

Resistance to stress corrosion cracking at low stress levels exceeds type 304. Nitronic® 33 is particularly resistant to polythionic acids in both the annealed condition and after sensitizing at 1250°F for one hour.

## MACHINABILITY

Nitronic® 33 is machined to same methods as other austenitic stainless steels, and like those alloys, also work hardens during machining. This requires rigid tooling, heavy feeds and slower speeds.

## WELDABILITY

Nitronic® 33 is readily weldable in all forms, with or without filler metal. Alloy may be welded by all the following methods: (1) Gas Metal Arc; (2) Gas Tungsten Arc; (3) Submerged Arc.

## WEAR and GALLING RESISTANCE

Nitronic® 33 exhibits excellent resistance to wear in sliding metal to metal contact; superior to type 410 stainless steel, 17-4 precipitation hardening stainless steel, or type 304. If galling persists Electralloy's Nitronic® 60 should be considered.

## MAGNETIC PERMEABILITY

Nitronic® 33 is characterized by low magnetic permeability even after severe cold working and at cryogenic temperatures. Nitronic® 33 exhibits a cusp at ~126°F (-88°C), a phenomenon which also occurs for Nitronic® 40 and 50, that is dependent upon temperature but not field strength.