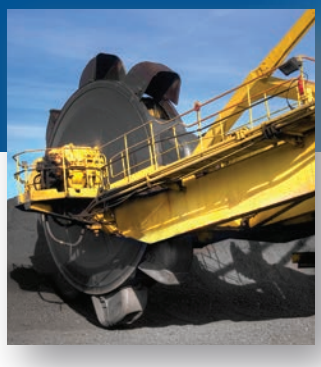
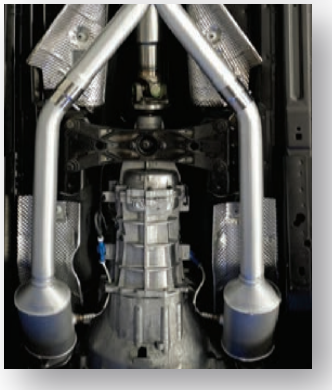
CLIFFS

409 Ni

STAINLESS STEEL





- **Bus Frames**
- **Dryer Components**
- **Intermodel Containers**
- **Rail Cars**
- **Trailers**

CLEVELAND-CLIFFS 409 Ni is an ideal material for applications requiring weldability and toughness superior to standard Type 409 in gauges greater than 0.120 in. (3.05 mm). Transportation applications include automotive exhaust flanges, hopper car bodies and discharge chutes, intermodal containers, trailers, bus frames, and dump truck bed liners. Under wet, sliding conditions, such as encountered in coal-handling equipment, Cleveland-Cliffs 409 Ni is a more cost-effective solution to carbon and abrasion-resistant (AR) steel due to the corrosion component of the wear process. Potential coal-handling applications include chutes, hoppers, bunkers, flooring, perforated plate for sizing, flight conveyor wear liners, vibrating screen pans, blending bin feeders, paddle mixers, screw feeders, fuel bins and dryer components. Additional applications include noise suppression barriers, slurry pipelines, heat shields, cyclones, silos, belt scraper blades, screens and tanks.

Product Description

Cleveland-Cliffs 409 Ni is a nominal 11% chromium (Cr) stainless steel, micro-alloyed with titanium (Ti), manganese (Mn) and nickel (Ni), that provides excellent weldability, toughness and fabricating characteristics in sections over 0.120 in. (3.05 mm). This is a cost effective alternative to mild and low-alloy steels, providing superior corrosion and/or oxidation resistance.

The fine grain structure of Cleveland-Cliffs 409 Ni promotes toughness in welds and ease of fabricating in thicknesses greater than 0.120 in. (3.05 mm).

Under wet sliding conditions, such as encountered in coal-handling equipment, Cleveland-Cliffs 409 Ni is a more cost-effective solution to carbon and AR steels, due to the corrosion component of the wear process.

The high-temperature strength and oxidation of this material are superior to carbon steel. The recommended maximum service temperature is 1350 °F (730 °C).

Composition		(wt %)
Carbon	(C)	0.03 max.
Manganese	(Mn)	1.00 max.
Phosphorus	(P)	0.04 max.
Sulfur	(S)	0.03 max.
Silicon	(Si)	1.0 max.
Chromium	(Cr)	10.5 – 11.7
Nickel	(Ni)	0.50 – 1.0
Titanium	(Ti)	6(C+N) min., 0.75 max.
Nitrogen	(N)	0.03 max.
Iron	(Fe)	Balance

AVAILABLE FORMS

Cleveland-Cliffs produces 409 Ni in hot-rolled annealed and pickle coil in thicknesses from 0.157 – 0.500 in. (4.0 – 12.7 mm) max. and widths from 48 in. (1219 mm). For other thicknesses and widths, contact your Cleveland-Cliffs sales representative.

The values shown in this bulletin were established in U.S. customary units. The metric equivalents of U.S. customary units shown may be approximate.

DENSITY

Density, lbs/in^3. (g/cm^3)	0.278 (7.70)

Mechanical Properties

TABLE 1 – TYPICAL MECHANICAL PROPERTIES

UTS, ksi. (MPa)	0.2% YS, ksi. (MPa)	Elongation % in 2” (50.8 mm)	Rockwell Hardness, B
69 (476)	55 (379)	30	82

Cleveland-Cliffs 409 Ni offers much higher design strength than standard Type 409 as noted by the mechanical properties indicated in Table 2.

TABLE 2 – MINIMUM PROPERTIES ACCEPTABLE FOR MATERIAL SPECIFICATION*

	UTS, ksi. (MPa)	0.2% YS, ksi. (MPa)	Elongation % in 2 in. (50.8 mm)
409 Ni	60 (415)	40 (276)	20
Type 409 (per ASTM A240)	55 (380)	25 (205)	20

**Annealed sheet, strip and plate.*

Table 3 highlights the energy output for Cleveland-Cliffs 409 Ni at different temperatures and thickness. Type 409 has less than 10 ft.•lbs (12J) output at the same temperatures. Cleveland-Cliffs 409 Ni is less prone to brittle failure than Type 409 during fabrication and service in sections greater than 0.0120 in. (3.05 mm).

TABLE 3 – IMPACT STRENGTH*

Specimen Orientation	Temperature, °F (°C)	Energy ft.•lbs. (J)	W/A, in.•lbs./in². (mm•N/mm²)
Longitudinal	32 (0)	136 (152)	13405 (2346)
Transverse	32 (0)	109 (122)	10722 (1876)
Longitudinal	-25 (-32)	86 (96)	8422 (1474)
Transverse	-25 (-32)	65 (73)	6422 (1124)
Longitudinal	-50 (-46)	58 (65)	5750 (1006)
Transverse	-50 (-46)	53 (59)	5200 (910)

**0.375 in. (9.5 mm) plate*

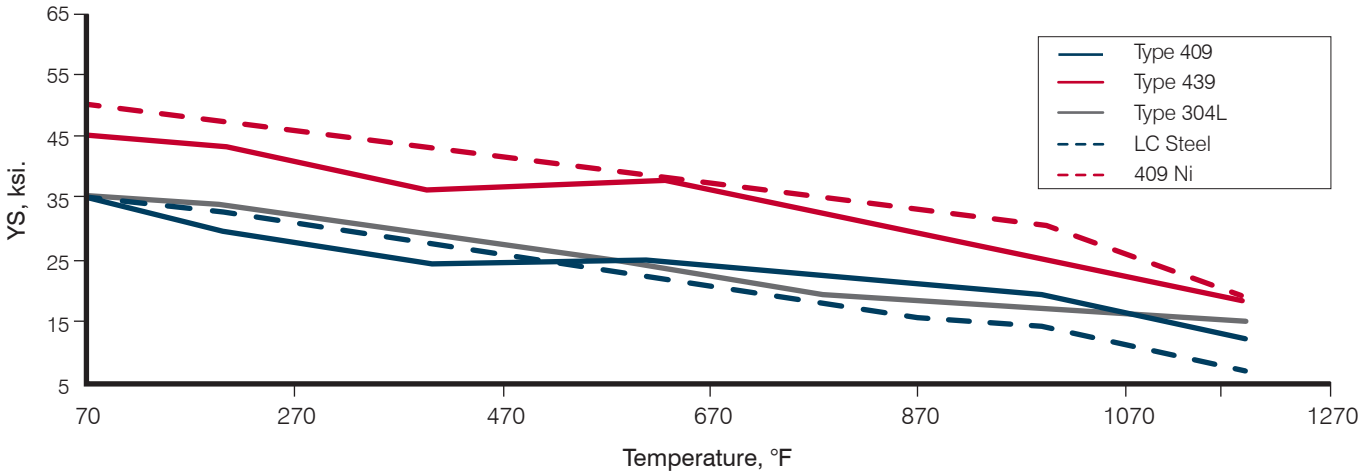
Mechanical Properties

TABLE 4 – WEIGHT CHANGE AFTER 1600 – 1700 °F (871 –927 °C) EXPOSURE*

Alloy	288 Cycles	480 Cycles	750 Cycles	958 Cycles
Type 430	63.6	Destroyed	—	—
Type 442	4.7	7.5	9.4	9.4
Type 446	2.0	2.4	1.2	0.3
Type 309	1.7	-30.0	-153.0	-210.0
18 SR® SS	1.9	2.7	3.4	3.8

**mg/in². – 15 minutes heating – 15 minutes cooling*

FIGURE 1 – ELEVATED TEMPERATURE STRENGTH



409 Ni STAINLESS STEEL

CORROSION RESISTANCE

The overall corrosion resistance of Cleveland-Cliffs 409 Ni is similar to that of standard Type 409. In many environments, Cleveland-Cliffs 409 Ni provides a superior improvement in corrosion resistance compared to mild steel. Cleveland-Cliffs 409 Ni will provide moderate resistance to atmospheric and neutral chloride corrosion. However, it is not recommended for applications where surface appearance is critical, as it is prone to localized pitting corrosion. In the as-welded condition, this material may be susceptible to sensitization, which can lead to preferential grain boundary attack in the heat affected zone. Like most 11 – 14% chromium alloys, in highly acidic environments this grade can undergo uniform corrosive attack that will result in high corrosion rates. Caution should be exercised when considering this alloy in environments of such extreme conditions.

CORROSIVE WEAR

Many components are subject to the combined detrimental effects of moisture and sliding wear. Materials handling equipment in such industries as coal, pulp and paper, and minerals are particularly prone to this problem. The data in Tables 5 and 6 show that Cleveland-Cliffs 409 Ni is an effective alternative to abrasion resistant and mild steels in these environments.

WELDABILITY

Cleveland-Cliffs 409 Ni is weldable by common fusion and resistance welding processes. The alloy is generally considered to have better weldability in heavy sections than the most common alloy of the stainless class, Type 409. A major difference is the high nickel and manganese contents for this alloy which help in the development of a finer grain heat affected zone (HAZ) and weld metal structures that benefits toughness in heavy sections. Higher heat-input processes, such as gas tungsten arc welding (GTAW), will produce grain coarsening in the weld HAZ with ferrite grain boundaries fringed with untempered martensite. The low carbon level in the grade restricts hardness increase, however, and good toughness is retained. The use of a low heat input weld procedure will minimize grain coarsening and reduce the tendency for brittle weld fracture. When a weld filler is needed, Cleveland-Cliffs 18 Cr-Cb™ Stainless Steel (No AWS Class) and EC439Nb wires may be specified. Filler wires ER309L, EC309L, and E309LT0-3 may be used where thermal cycling at temperatures >1000 °F is not expected.

FORMABILITY

Because of its superior toughness and finer grain structure, Cleveland-Cliffs 409 Ni has proven to be more readily formable in heavy sections compared to Type 409.

TABLE 5 – CORROSIVE WEAR OF CLEVELAND-CLIFFS 409 Ni

Laboratory Test	Relative Wear*		
	409 Ni RB 82	NITRONIC® 30 SS RB92	AR500 RC 48
Ball MIll – pea sized gravel plus sea water	1.0	0.6	4.6
Ball Mill – pea sized gravel plus Ni-Cu mine water	1.0	0.5	3.0
Ball Mill – pea sized gravel plus Ni-Cu mine water	1.0	0.5	3.6
Ball Mill – pea sized gravel plus coal mine water	1.0	0.8	2.4

**The lower the value, the more corrosion/wear resistant the alloy.*

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TABLE 6 – MATERIAL COMPARATOR

Alloy	Formability	Weldability	Impact Resistance	Corrosive Wear (CW)	Alloy Cost Factor	Life Cycle Cost Factor (CW x ACF)
AR 500	Very Poor	Very Poor	Poor	4.5	1.0	4.5
Cleveland-Cliffs 409 Ni	Good	Good	Good	3.1	1.16	3.6
Type 304	Excellent	Excellent	Excellent	1.6	1.49	2.4
NITRONIC® 30 SS	Excellent	Excellent	Excellent	1.0 (Best)	1.42	1.4
Mild Steel	Excellent	Excellent	Good	10.0 (est.)	0.50	5.0

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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