

# 15 Cr-Cb<sup>®</sup> ULTRA FORM<sup>®</sup> STAINLESS STEEL



**Catalytic Converters**

**Exhaust Flanges**

**Exhaust Manifolds**

**Front Pipes**



Cleveland-Cliffs **15 Cr-Cb<sup>®</sup> ULTRA FORM<sup>®</sup>** Stainless Steel has been engineered to meet the challenges of the automotive exhaust industry, especially in the hot-end of the system where temperatures may exceed 1400 °F (760 °C). Exhaust flanges, exhaust manifolds, front pipes and catalytic converters are potential applications. These exhaust components require good room temperature formability, excellent high temperature oxidation resistance and hot strength.

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## Product Description

### PRODUCT FEATURES

Cleveland-Cliffs 15 Cr-Cb ULTRA FORM Stainless Steel is a low-carbon (C), low-nitrogen (N) ferritic grade of stainless steel with an intermediate 14.5% chromium (Cr) content. Alloying additions of titanium (Ti), niobium (Nb), silicon (Si) and manganese (Mn) provide excellent room temperature formability and impart superior hot strength and high temperature oxidation resistance when compared to Type 409, Type 439, Type 430, 11 Cr-Cb™ Stainless Steel and Type 436L. This grade's alloying additions, combined with Cleveland-Cliffs' proprietary ULTRA FORM processing technology, yield a fine, equiaxed grain structure that enhances room temperature formability and minimizes ridging.

Composition		(wt %)
Carbon	(C)	0.03 max.
Manganese	(Mn)	1.5 max.
Phosphorus	(P)	0.03 max.
Sulfur	(S)	0.02 max.
Silicon	(Si)	1.00 – 1.75
Chromium	(Cr)	14.0 – 15.25
Nickel	(Ni)	0.50 max.
Titanium + Niobium	(Ti + Nb)	0.20 + 8(C+N) min., (0.80 max.)
Nitrogen	(N)	0.03 max.

### AVAILABLE FORMS

Cleveland-Cliffs offers 15 Cr-Cb ULTRA FORM Stainless Steel in thicknesses from 0.015 – 0.100 in., (0.38 – 2.50 mm). Widths are available up to 48 in. (1219 mm). For other sizes, contact your Cleveland-Cliffs sales representative.

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## Mechanical Properties

TABLE 1 – TYPICAL ROOM TEMPERATURE MECHANICAL PROPERTIES ANNEALED CONDITION

UTS, ksi. (MPa)	0.2% YS, ksi. (MPa)	Elongation % in 2 in. (50.8 mm)	Rockwell Hardness, B
75 (517)	52 (359)	30	84

TABLE 2 – ELEVATED TEMPERATURE STRENGTH

Gauge, in. (mm)	Temperature, °F (°C)	UTS, ksi. (MPa)	0.2% YS, ksi. (MPa)
0.059 (1.5)	1100 (593)	52.1 (359)	23.8 (164)
—	1300 (704)	21.1 (146)	15.9 (110)
—	1500 (816)	6.7 (46)	5.0 (39)
—	1650 (899)	4.4 (30)	3.2 (22)

The high temperature strength and oxidation resistance of Cleveland-Cliffs 15 Cr-Cb ULTRA FORM Stainless Steel exceeds that of those exhaust grades typically used including Type 436, Type 444, Type 439, Type 409 and Cleveland-Cliffs 18 Cr-Cb™ Stainless Steel up to 1500 °F. Hot strength mechanical properties are shown in Figures 1 and 2 for yield strength and ultimate tensile strength, respectively.

FIGURE 1 – SHORT-TIME ELEVATED TEMPERATURE YIELD STRENGTH

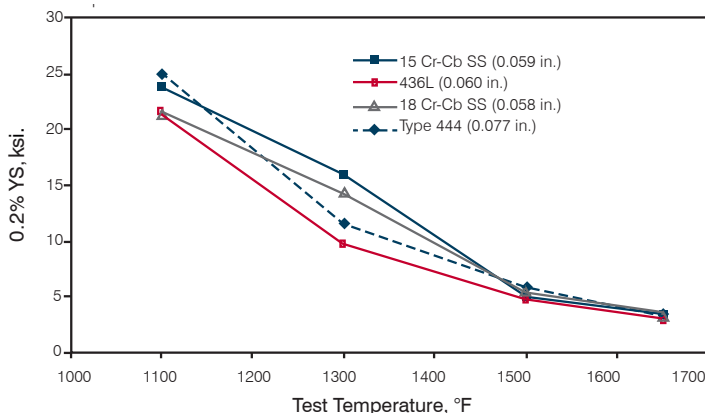
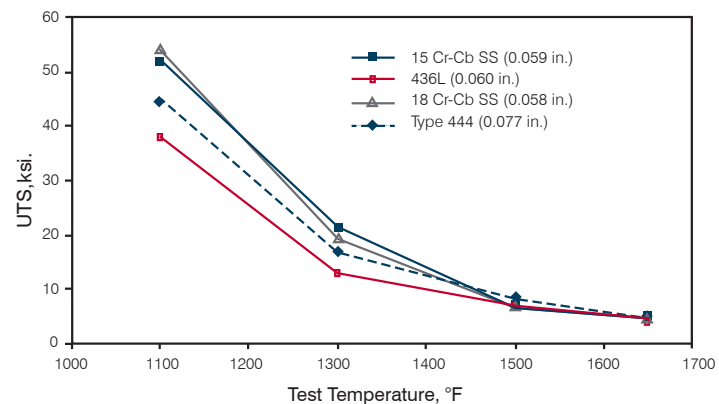


FIGURE 2 – SHORT-TIME ELEVATED TEMPERATURE ULTIMATE TENSILE STRENGTH



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## Properties

### CORROSION RESISTANCE

Cleveland-Cliffs 15 Cr-Cb ULTRA FORM Stainless Steel provides good wet corrosion resistance superior to Type 409 in moderately severe chloride and organic acid environments. Cleveland-Cliffs 15 Cr-Cb ULTRA FORM Stainless Steel also provides excellent resistance to corrosion in dilute sulfuric acid and in concentrated sodium hydroxide solutions.

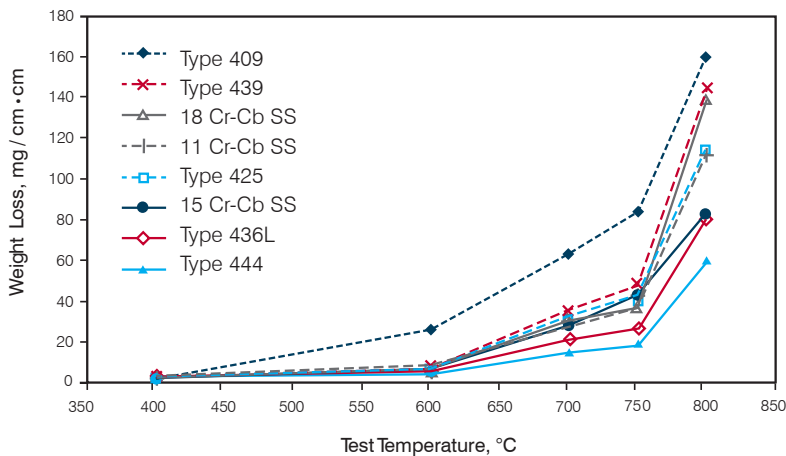
### HIGH TEMPERATURE OXIDATION

Cleveland-Cliffs 15 Cr-Cb ULTRA FORM Stainless Steel is resistant to high temperature oxide scaling as a result of additional high silicon alloying. This product is expected to be comparable to Cleveland-Cliffs 11 Cr-Cb Stainless Steel and Cleveland-Cliffs 18 Cr-Cb Stainless Steel and should provide better oxidation resistance than Type 409 and Type 439. This alloy is an attractive option for exhaust manifolds and other high temperature areas of the exhaust system.

### HIGH TEMPERATURE CYCLIC CORROSION

Cleveland-Cliffs 15 Cr-Cb ULTRA FORM Stainless Steel samples, along with other commonly used exhaust materials, were dipped in a 5% NaCl solution, and exposed to various temperatures for 2 hours. After 10 cycles, the scale loss was measured in mg/cm<sup>2</sup>. These values are presented in Figure 3, showing that the hot salt corrosion of Cleveland-Cliffs 15 Cr-Cb ULTRA FORM Stainless Steel is better than Type 409 and Type 439 and comparable to Type 425, Cleveland-Cliffs 11 Cr-Cb Stainless Steel and Cleveland-Cliffs 18 Cr-Cb Stainless Steel.

**FIGURE 3 – HOT SALT SCALE LOSS**



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## WELDABILITY

Cleveland-Cliffs 15 Cr-Cb ULTRA FORM Stainless Steel is generally considered to be weldable by the common fusion and resistance welding processes, including laser and high frequency induction tube welding. This grade is generally considered to have diminished weldability compared to the most common alloy of this stainless class, Type 409. Application of weld heat can cause grain growth and reduced toughness in the heat-affected zone. Use of a low heat input weld procedure, minimizing stress concentrations and warming parts slightly prior to forming will reduce the tendency for brittle weld fracture in subsequent processing. The balanced dual-stabilized (titanium and niobium) Cleveland-Cliffs 18 Cr-Cb Stainless Steel chemistry is not susceptible to the formation of continuous intergranular carbides that could lead to intergranular corrosion. When a matching weld filler is required, Cleveland-Cliffs 18 Cr-Cb Stainless Steel (No AWS Class) and EC439Nb wires are often recommended for light gauge high temperature (>1000 °F) service where thermal cycling is expected. The addition of hydrogen to weld shielding gases for increased welding speed is discouraged, as the ferritic stainless steels are subject to hydrogen embrittlement. More information on the welding of ferritic stainless steels may be obtained from the following sources:

1. ANSI/AWS A5.9, A5.22 and A5.4 (stainless welding electrode specifications).
2. "Welding of Stainless Steels and Other Joining Methods" SSINA, ([www.ssina.com](http://www.ssina.com)).

## 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.



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