DATA SHEET

LATROBE SPECIALTY STEEL COMPANY
Latrobe, PA 15650-0031 USA

Issue 1

CRUSADER™ High Speed Steel
ASTM M3-2

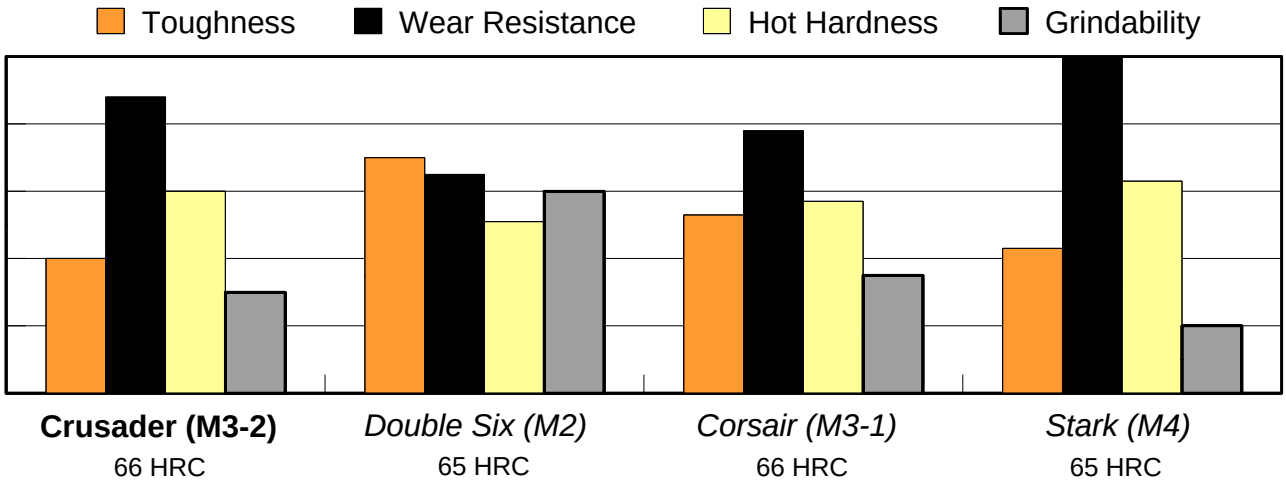
Typical Composition

C	Mn	Si	Cr	W	Mo	V
1.20	0.25	0.30	4.10	6.00	5.00	3.00

CRUSADER (M3-2) is a high speed steel with an outstanding balance of red hardness, edge toughness and wear resistance. The additional carbon and vanadium provide superior resistance to abrasion and edge breakdown, which makes Crusader a superb tool material for form tools and roll turning. Increased tool life will also be experienced in the machining of heat-treated sections, castings and similar hard materials.

Typical applications for Crusader high speed steel include form tools, spade drills, milling cutters and broaches.

Relative Properties



Physical Properties

Density: 0.295 lb/in^3 (8166 kg/m^3)
Specific Gravity: 8.17
Modulus of Elasticity: 30x10^6 psi (207 GPa)

Machinability: 35-40% of a 1% carbon steel

Temperature, °F	in/in °Fx10^{-6}	Temperature, °C	mm/mm °Cx10^{-6}
70 - 200	5.77	21 - 93	10.39
70 - 400	6.18	21 - 204	11.12
70 - 600	6.43	21 - 316	11.57
70 - 800	6.69	21 - 427	12.04
70 - 1000	6.89	21 - 358	12.40

Coefficient of Thermal Expansion: (at 65-66HRC)

CRUSADER™
HEAT TREATING INSTRUCTIONS

(See Tech-Topics Bulletin 102 for a more thorough explanation of heat treating.)

HARDENING:

Critical Temperatures:
Ac1: 1535°F (835°C)

Preheating: To minimize distortion and stresses in large or complex tools use a double preheat. Heat at a rate not exceeding 400°F per hour (222°C per hour) to 1100°F (593°C) equalize, then heat to 1450-1550°F (788-843°C). For normal tools, use only the second temperature range as a single preheating treatment.

Austenitizing (High Heat): Heat rapidly from the preheat.

Furnace: 2200-2250°F (1204-1232°C)
Salt: 2175-2225°F (1191-1218°C)

Quenching: Pressurized gas, warm oil, or salt.

For pressurized gas, a rapid quench rate to below 1000°F (538°C) is critical to obtain the desired properties.

For oil, quench until black, about 900°F (482°C), then cool in still air to 150 -125°F (66-51°C).

For salt maintained at 1000-1100°F (538-593°C), equalize, then cool in still air to 150 -125°F (66-51°C).

For large tools: remove from the salt quench when the tool reaches approximately 1500°F (816°C), quench in oil until black, about 900°F (482°C), then air cool to 150 -125°F (66-51°C).

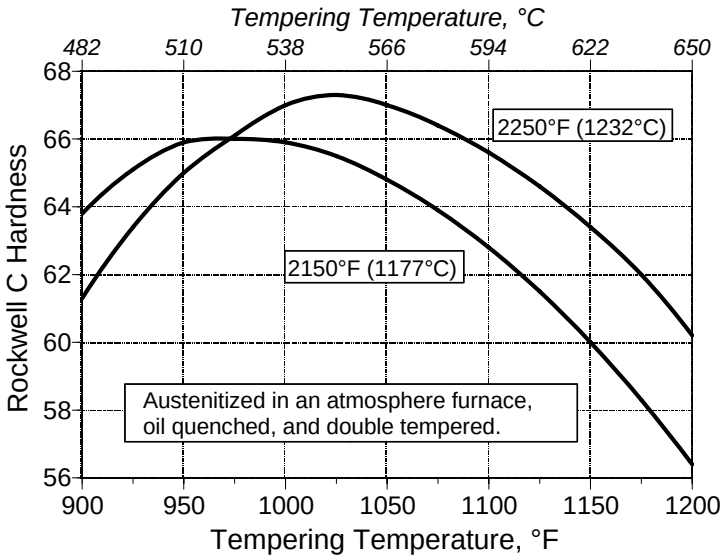
Tempering: *Temper immediately after quenching*. Typical tempering range is 1020-1050°F (549-566°C). Hold at temperature for 2 hours, then air cool to ambient temperature. Double tempering is required, triple tempering is recommended

ANNEALING: Annealing must be performed after hot working and before rehardening.

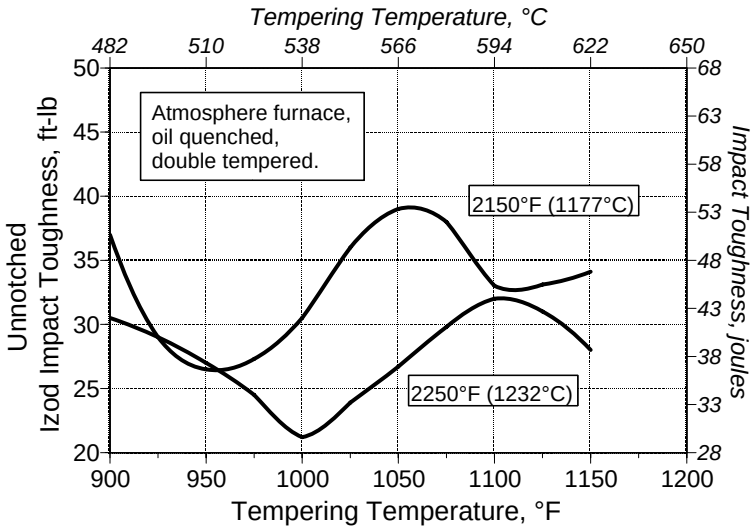
Heat at a rate not exceeding 400°F per hour (222°C per hour) to 1550-1575°F (843-857°C), and hold at temperature for 1 hour per inch (25.4 mm) of thickness, 2 hours minimum. Then cool slowly with the furnace at a rate not exceeding 50°F per hour (28°C per hour) to 1000°F (538°C). Continue cooling to ambient temperature in the furnace or in air. The resultant hardness should be 255 HBW or lower.

HEAT TREATMENT RESPONSE

As Oil Quenched from	HRC
2100°F (1149°C)	64.5
2150°F (1177°C)	66.0
2175°F (1191°C)	66.5
2200°F (1204°C)	66.0
2250°F (1232°C)	65.0



IMPACT TOUGHNESS



The data presented herein are typical values, and do not warrant suitability for any specific application or use of this material. Normal variations in the chemical composition, the size of the product, and heat treatment parameters may result in different values for the various physical and mechanical properties.

LATROBE SPECIALTY STEEL COMPANY

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