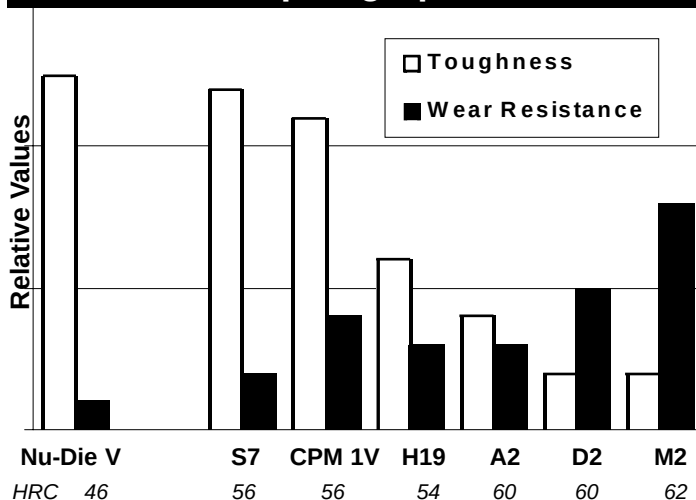


CRUCIBLE

Nu-Die® V (AISI H13) has been the most popular, and perhaps the most versatile hot work tool steel available for many years. It provides a good balance of toughness, heat check resistance and temper resistance, along with moderate wear resistance. It is air hardenable and is used in most applications in the heat treated condition at HRC 44-52. The normal tempering temperatures for Nu-Die V are quite high (>1000°F, 540°C), allowing it to retain its heat treated hardness and strength while in service at elevated temperatures. Nu-Die V may be used for tool temperatures up to about 1000°F (540°C) with brief exposures up to 1100°F (595°C), making it ideal for forging dies, hot extrusion tooling, and die casting dies. Crucible offers two premium versions, Nu-Die XL and Nu-Die ESR, for applications requiring critical polishability, improved heat check resistance and better transverse toughness.

Tool Steel Comparagraph



Typical Applications

Extrusion Tooling	Forging Dies
Die Casting Dies	Die Inserts
Bolsters	Dummy Blocks
Shot Sleeves/Plungers	Mandrels
Core Pins	Ejector Pins

Note: These are some typical applications. Your specific application should not be undertaken without independent study and evaluation for suitability.

Crucible...

The Tool Steel Pros®

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DATA SHEET

Nu-Die® V (AISI H13)

Issue #13

Carbon	0.40%
Silicon	1.00%
Chromium	5.20%
Molybdenum	1.30%
Vanadium	0.95%

Physical Properties

Elastic Modulus	30 X 10 ⁶ psi	(207 GPa)
Density	0.280 lbs./in ³	(7.75 g/cm ³)
Thermal Conductivity		
	BTU/hr-ft-°F	W/m-°K cal/cm-s-°C
at 200° F (95° C)	15	26.0 0.062
at 600° F (315° C)	16	27.7 0.066
Coefficient of Thermal Expansion		
	in/in/°F	mm/mm/°C
70-200° F (20-95° C)	6.1 X10 ⁻⁶	(11.0 X10 ⁻⁶)
70-400° F (20-205° C)	6.4 X10 ⁻⁶	(11.5 X10 ⁻⁶)
70-800° F (20-425° C)	6.8 X10 ⁻⁶	(12.2 X10 ⁻⁶)
70-1000° F (20-540° C)	7.0 X10 ⁻⁶	(12.6 X10 ⁻⁶)
70-1200° F (20-650° C)	7.3 X10 ⁻⁶	(13.1 X10 ⁻⁶)

Mechanical Properties

The practice of pre-heating Nu-Die V tooling prior to elevated temperature service will greatly improve its toughness as shown by the following high temperature Charpy V-Notch test data:

Effect of Elevated Temperature on Impact Toughness:

Austenitized 1850°F (1010°C) Air Cool. Double tempered to hardness indicated, i.e. original HRC at Room Temperature. Charpy V-Notch specimens subsequently heated to test temperature as shown.

Original Hardness at R.T. HRC	Impact Toughness in ft-lbs. (J) Charpy V-Notch Test Temperature				
	R.T. (21°C)	500°F (260°C)	1000°F (540°C)	1050°F (565°C)	1100°F (595°C)
52	10 (14)	22 (30)	25 (34)	25 (34)	---
47	18 (24)	30 (41)	33 (45)	---	32 (43)
43	18 (24)	38 (51)	44 (60)	---	42 (57)

Machinability

The machinability of Nu-Die V in the annealed condition is about 70% of W1 tool steel.

Thermal Treatments

Annealing: Heat to 1600°F (870°C), hold 2 hours, slow cool 25°F (15°C) per hour to 1200°F (650°C) then air cool. OR heat to 1600°F (870°C), hold 2 hrs., cool to 1400°F (760°C) hold 6 hrs. then air cool.

Annealed Hardness: About BHN 192/235

Stress Relieving

Annealed Parts: Heat to 1200-1250°F (650-675°C), hold 2 hours, then cool in still air to room temperature.

Hardened Parts: Heat to 25-50°F (15-25°C) below the original tempering temperature, hold 2 hours, then cool in still air to room temperature.

Hardening

Critical Temperature: 1560°F (850°C)

Preheat: Heat to 1100-1250°F (595-675°C), equalize, then to 1450-1550°F (790-845°C), equalize.

Austenitize: 1825-1875°F (995-1025°C), Hold time at temperature 30-45 minutes. *Hardening from the high end of the range will provide better resistance to softening but with a slight decrease in toughness.*

Quench: Air or positive pressure quench (2 bar minimum), salt or interrupted oil to below 150°F (65°C)

A minimum quench rate of about 50°F (25°C) per minute from 1800°F (980°C) down to below 1200°F (650°C) is recommended to achieve maximum impact toughness.

Temper: 1000-1200°F (540-650°C). Temper Twice. Temper 2 hours minimum each time or at least 1 hour per inch (25mm) of thickness. Air cool to room temperature.

Dimensional Change: Average dimensional change for normally heat treated Nu-Die V is about +0.06% (= a growth of 0.0006 in/in) when tempered in the range 1000-1150°F (540-620°C). Variations in the heat treating process will affect actual results.

Surface Treatments

Nu-Die V may be nitrided or PVD coated. Because of its high tempering temperatures (>1000°F, >540°C), it will retain its hardness after such processes. As for most tool steels, higher temperature surface treatments, such as CVD, may result in dimensional distortion.

Service Center Locations

Location	Phone	Toll Free	FAX
Auburn, MA	508-832-5353	800-365-1101	508-832-2217
Charlotte, NC	704-372-3073	800-365-1160	704-342-0985
Chicago, IL	630-378-0093	800-365-1151	630-378-1965
Cincinnati, OH	513-771-1310	800-365-1163	513-771-0119
Cleveland, OH	330-562-3131	800-365-1132	330-562-7818
Columbus, OH	614-262-4959	800-365-1131	614-262-7850
Dallas, TX	817-649-2800	800-365-1168	817-633-8142
Detroit, MI	248-528-0332	800-365-1133	248-528-1977
Grand Rapids, MI	616-554-9699	800-365-1137	616-554-9328
Huntsville, AL	256-772-0201	800-365-1161	256-772-3361
Indianapolis, IN	317-638-4501	800-365-1146	317-634-7375
Los Angeles, CA	714-632-1131	800-365-1179	714-632-1181

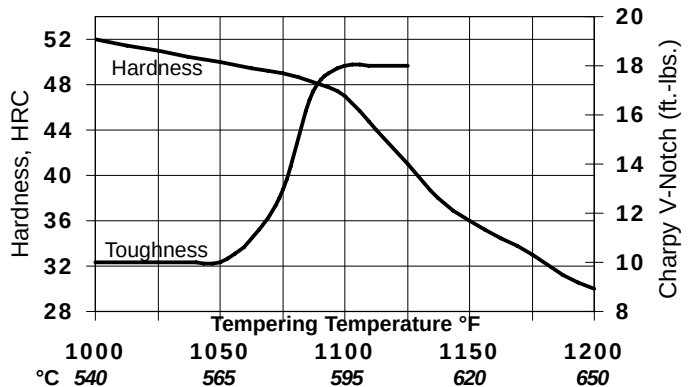


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Heat Treat Response

Hardness and Impact Toughness Data

Austenitized 1850°F (1010°C) Air Cool, Double Tempered			
Tempering Temperature	HRC	Charpy V-Notch(*) Ft. lbs.	Joules
1000°F (540°C)	51-53	10	14
1050°F (565°C)	49-51	10	14
1100°F (595°C)	46-48	18	24
1125°F (605°C)	40-42	18	24
1150°F (620°C)	35-37	---	---
1200°F (650°C)	28-32	---	---



(*) Longitudinal Toughness Measurements

Welding

Use H13, H11 or other hot work tool steel filler material.

Annealed Material: Preheat 800-1000°F (425-540°C). Maintain the temperature of the workpiece above 700°F (370°C) during welding. Reanneal after welding or temper at 1400°F (760°C) for 6 hours.

Hardened Material: Preheat 800-1000°F (425-540°C). Maintain the temperature of the workpiece above 700°F (370°C) during welding. Cool to hand warm, below 150°F (65°C), after welding. Retemper at 25-50°F (15-25°C) below original tempering temperature or 1000°F (540°C) minimum.

Note: Properties shown throughout this data sheet are typical values. Normal variations in chemistry, size and heat treat conditions may cause deviations from these values. For additional data or metallurgical engineering assistance, consult your local Crucible Service Center.

Location	Phone	Toll Free	FAX
Meadville, PA	814-337-8804	800-365-0530	814-337-8808
Milwaukee, WI	262-781-6710	800-242-0948	262-781-6743
Minneapolis, MN	612-331-6320	800-365-1153	612-331-4137
St. Louis, MO	636-272-7220	877-201-4049	636-978-9559
Canada			
Wallaceburg, ONT	519-627-2245	800-265-5293	519-627-2247
			Toll Free 888-701-4287
Mexico (SISA)			
Monterrey, N.L.	52-81-8351-7220		52-81-8351-2981
Naucalpan, E de M	52-55-5576-4011		52-55-5360-1865

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