

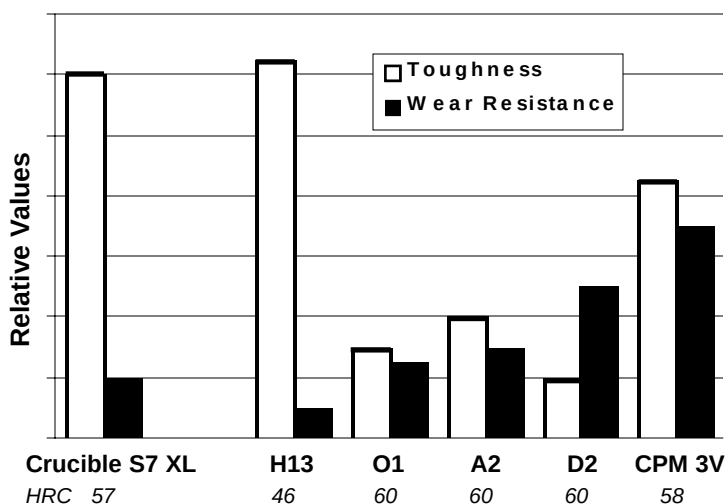
# CRUCIBLE

Crucible S7XL is a double refined, high purity grade of S7. The remelt operation produces a cleaner steel with a more uniform microstructure, offering the following advantages over conventional S7:

- Better Consistency in Wire EDM Cutting
- Higher Polishability for Critical Finish Plastic Molds
- More Uniform Texturing for Plastic Molds
- Higher Transverse Impact Toughness (Across the Grain)

Crucible S7 XL can be used in any application where AISI S7 is used.

## Tool Steel Comparagraph



## Typical Applications

Critically Polished Plastic Molds  
Highly Textured Plastic Molds  
Wire EDM'd Punches and Dies  
Tablet Compression Dies  
Heavy Impact Stamping and Cold Forming Tooling  
Zinc Die Casting Dies

*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®

## DATA SHEET

### Crucible S7 XL (Premium AISI S7)

Issue #2

|            |       |
|------------|-------|
| Carbon     | 0.55% |
| Manganese  | 0.70% |
| Silicon    | 0.35% |
| Chromium   | 3.25% |
| Molybdenum | 1.40% |
| Vanadium   | 0.25% |

### Physical Properties

|                      |                            |                                        |
|----------------------|----------------------------|----------------------------------------|
| Elastic Modulus      | 30 X 10 <sup>6</sup> psi   | (207 GPa)                              |
| Density              | 0.283 lbs./in <sup>3</sup> | (7.83 g/cm <sup>3</sup> )              |
| Thermal Conductivity |                            |                                        |
| at 200° F (95° C)    | BTU/hr-ft-°F<br>16.5       | W/m-°K<br>28.5<br>cal/cm-s-°C<br>0.068 |

### Coefficient of Thermal Expansion

|                        |                       |                           |
|------------------------|-----------------------|---------------------------|
|                        | in/in/°F              | mm/mm/°C                  |
| 70-400° F (20-205° C)  | 7.0 X10 <sup>-6</sup> | (12.6 X10 <sup>-6</sup> ) |
| 70-750° F (20-400° C)  | 7.3 X10 <sup>-6</sup> | (13.1 X10 <sup>-6</sup> ) |
| 70-1000° F (20-540° C) | 7.6 X10 <sup>-6</sup> | (13.7 X10 <sup>-6</sup> ) |

### Mechanical Properties

|        | Heat Treatment <sup>(1)</sup><br>Austenitizing<br>Temperature | HRC | Impact<br>Toughness <sup>(2)</sup><br>ft.-lb. (J) | Wear<br>Resistance <sup>(3)</sup><br>Adhesive |
|--------|---------------------------------------------------------------|-----|---------------------------------------------------|-----------------------------------------------|
| S7 XL  | 1750°F (955°C)                                                | 57  | 125 (169)                                         | 1                                             |
| H13    | 1850°F (1010°C)                                               | 45  | 175* (237*)                                       | ---                                           |
| O1     | 1475°F (800°C)                                                | 60  | 30 (41)                                           | ---                                           |
| A2     | 1750°F (955°C)                                                | 60  | 40 (53)                                           | 2-3                                           |
| D2     | 1850°F (1010°C)                                               | 60  | 21 (28)                                           | 3-4                                           |
| CPM 3V | 1950°F (1065°C)                                               | 60  | 70 (95)                                           | 7                                             |

(1) Heat Treatment: Austenitized as indicated and tempered to hardness.

(2) Charpy C-Notch Impact Test

(3) Crossed cylinder adhesive wear test (higher number = better wear resistance)

\*H13 Impact Toughness estimated from Charpy V-Notch data

### Machinability

The machinability of Crucible S7 XL as annealed is about 75% of W1 tool steel.

### Surface Treatments

Crucible S7 XL can be given standard surface treatments such as nitriding, chromium plating or nickel plating if desired. However, S7 XL is not usually nitrided because heat treatment prior to nitriding should include tempering at a temperature above the nitriding process temperature, and this typically results in lower than normal hardness.

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## Thermal Treatments

**Critical Temperature:** 1470°F (800°C)

**Annealing:** Heat to 1550°F (845°C), hold 2 hours, slow cool 50°F (30°C) per hour to 1000°F (540°C) then air cool. OR heat to 1550°F (845°C), hold 2 hrs., cool to 1400°F (760°C) hold 4 hrs. then air cool.

**Annealed Hardness:** About BHN187/220

### Stress Relieving

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

**Hardened Parts:** Heat to 25-50°F (15-30°C) below the original tempering temperature, hold 2 hours, then cool in still air.

### Hardening

**Preheat:** Heat to 1350-1400°F (730-760°C), equalize.

**Austenitize:** 1725-1750°F (940-955°C), Hold time at temperature 30-45 minutes.

**Quench:** Air, positive pressure quench (2 bar minimum) or interrupted oil to below 150°F (65°C) Sections >3" may require interrupted oil quench. Oil quench to 1000-1100°F (540-595°C), then air cool to handwarm.

**Temper:** 400-1000°F (205-540°C).

Temper 2 hours minimum or at least 1 hour per inch (25mm) of thickness. Double Tempering is recommended. Cool to room temperature in between tempers.

**Size Change:** +0.001in/in (0.10%) when air cooled from 1725-1750°F (940/955°C) and tempered at 400°F (205°C).

*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.*

### 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 |

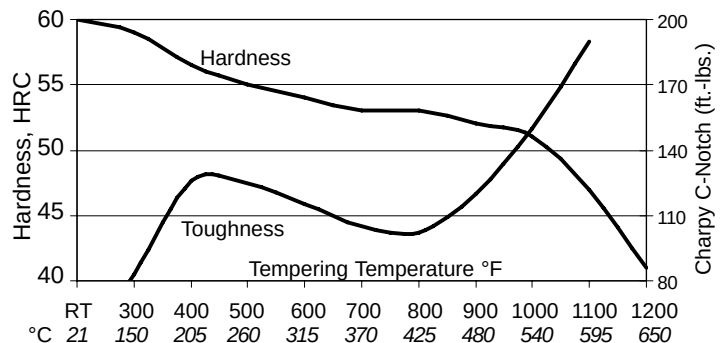
## Heat Treat Response

### Hardness and Impact Toughness Data

*Austenitized 1725°F (940°C) Air Cool*

| Tempering Temperature | HRC   | Charpy C-Notch Ft. lbs. | Joules |
|-----------------------|-------|-------------------------|--------|
| As Air Quenched       | 59-61 | 46                      | 62     |
| 400°F (205°C)         | 55-58 | 126                     | 171    |
| 500°F (260°C)         | 54-56 | 125                     | 169    |
| 600°F (315°C)         | 53-55 | 115                     | 156    |
| 700°F (370°C)         | 52-54 | 105                     | 142    |
| 800°F (420°C)         | 52-54 | 102                     | 138    |
| 900°F (480°C)         | 51-53 | 120                     | 163    |
| 1000°F (540°C)        | 50-52 | 150                     | 203    |
| 1100°F (595°C)        | 46-48 | 190                     | 257    |
| 1200°F (650°C)        | 40-42 | ---                     | ---    |
| 1300°F (705°C)        | 33-35 | ---                     | ---    |

*Results may vary with hardening method and section size. Vacuum or atmosphere cooling may result in up to 1-2 HRC points lower.*



### Welding

Use S7 filler material. Alternatively, hot work tool steel filler or 4140 or 4150 filler may be used for small repairs or welds away from the working surface of the tool.

**Annealed Material:** Preheat 400-600°F (205-315°C), maintain the temperature of the workpiece above 400°F (205°C) during welding. After welding, reanneal or temper at 1400°F (760°C) for 6 hours.

**Hardened Material:** Preheat 25-50°F (15-30°C) below original tempering temperature or 350°F (175°C) minimum. Maintain the workpiece above 350°F (175°C) during welding. Cool to 150°F (65°C) after welding. Temper 25-50°F (15-30°C) below original tempering temperature.



A Division of Crucible Materials Corporation

### CRUCIBLE SERVICE CENTERS DIVISIONAL HEADQUARTERS:

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