CARPENTER TECHNOLOGY

DATASHEET

# 17-4 SELECT™

*Applicable specifications: ASME SA564, ASTM A564, ASTM F899 (when fully aged)*
*Associated identifiers: AISI 630, UNS S17400*

## Type analysis

*Single figures are nominal except where noted.*

| | | | | | |
|---|---|---|---|---|---|
| **Iron** | Balance | **Chromium** | 15.00–17.50 % | **Copper** | 3.00–5.00 % |
| **Nickel** | 3.00–5.00 % | **Manganese** | Max 1.00 % | **Silicon** | Max 1.00 % |
| **Columbium + Tantalum** | 0.15–0.45 % | **Cobalt** | < 0.1 % | **Carbon** | Max 0.070 % |
| **Phosphorus** | Max 0.040 % | **Sulfur** | Max 0.030% | | |

## Forms manufactured

| |
|---|
| **Bar-Rounds** |

## Description

17-4 Select controlled residual stress alloy is Carpenter Technology's latest advancement in enhanced machinability Custom 630 (17-4) stainless steel. This proprietary production process combines the alloy benefits our customers have come to expect with our Project 70+ blend, but now with purposefully controlled residual stress fields to generate predictability during their machining operations.

Customers report that Custom 630 Project 70+ offers significantly improved machinability characteristics over conventional stainless Type 17Cr-4Ni. This includes up to 15% and higher machining speeds with improved finishes and longer tool life, with some reports in excess of 40% tool life improvement. With 17-4 Select, the controlled residual stress variant, customers have further improved their reliability in complex, tight-tolerance production parts to meet the most demanding of expectations. In some cases, this has shifted the reliability of part acceptability by 50%.

**Key Properties:**

- Predictable stress relaxation bar-to-bar
- High strength and hardness
- Excellent corrosion resistance
- Good fabricating characteristics

**Markets:**

- All

**Applications:**

- Medical instrumentation and surgical tooling
- Aircraft and missile fittings
- Tight-tolerance, complex parts in various industries where Custom 630 (17-4) has been used



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## Corrosion resistance

17-4 Select has withstood corrosive attack better than any of the 400 series hardenable stainless steels, and, in most corrodents, its corrosion resistance closely approaches that of stainless Types 302 and 304.

Good resistance to stress-corrosion cracking is gained by hardening at temperatures of 1025°F (552°C) and higher. The alloy also withstands erosion-corrosion well due to the combination of good corrosion resistance and high hardness.

For optimum corrosion resistance, surfaces must be free of scale, lubricants, foreign particles, and coatings applied for drawing and heading. After fabrication of parts, cleaning and/or passivation should be considered.

*IMPORTANT NOTE:*
*The following 4-level rating scale (Excellent, Good, Moderate, Restricted) is intended for comparative purposes only. Corrosion testing is recommended. Factors that affect corrosion resistance include temperature, concentration, pH, impurities, aeration, velocity, crevices, deposits, metallurgical condition, stress, surface finish, and dissimilar metal contact.*

| | | | |
|---|---|---|---|
| **Nitric Acid** | Good | **Sulfuric Acid** | Restricted |
| **Phosphoric Acid** | Restricted | **Acetic Acid** | Moderate |
| **Sodium Hydroxide** | Moderate | **Salt Spray (NaCl)** | Good |
| **Sea Water** | Restricted | **Sour Oil/Gas** | Restricted |
| **Humidity** | Excellent | | |

**COMPARATIVE CORROSION RATES – MILS PER YEAR**

| CORRODENTS | TYPE 410 | | TYPE 431 | | CUSTOM 630 PROJECT 70+[3] | | |
|---|---|---|---|---|---|---|---|
| | HARDENED AND TEMPERED 300°F (150°C) | HARDENED AND TEMPERED 1200°F (650°C) | HARDENED AND TEMPERED 500°F (260°C) | HARDENED AND TEMPERED 1200°F (650°C) | H 900 | H 1025 | H 1150 |
| 5 w/o $H_2SO_4$ at 75°F (24°C) | 1732[1] | 1218 | 1402[1] | 2325[1] | 2 | 3 | 14[1] |
| 20 w/o $HNO_3$ at 200°F (93°C) | 8 | 59[2] | 3 | 3 | 2 | 2 | 2 |
| 50 w/o Acetic Acid Boiling | 266[1] | 1627 | 43[1] | 54 | 3 | 3 | 4 |

*Corrosion rates for one 48-hour period.*
*[1] Several or all of subsequent 48-hour test periods showed nil rates.*
*[2] Rates increased to 200 mpy by 3rd 48-hour test period.*
*[3] Similar performance expected for 17-4 Select, but remains untested.*

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## Physical properties

| PROPERTY | Condition / At or From | English Units | Metric Units |
|---|---|---|---|
| SPECIFIC GRAVITY | Condition H 900 | 7.80 | 7.80 |
| | Condition H 1075 | 7.81 | 7.81 |
| | Condition H 1150 | 7.82 | 7.82 |
| DENSITY | Condition H 900 | 0.2820 lb/in$^3$ | 7800 kg/m$^3$ |
| | Condition H 1075 | 0.2820 lb/in$^3$ | 7810 kg/m$^3$ |
| | Condition H 1150 | 0.2830 lb/in$^3$ | 7820 kg/m$^3$ |
| MEAN SPECIFIC HEAT | 32 to 212°F (0 to 100°C) Condition H 900 | 0.1000 Btu/lb/°F | 419 J/kg·K |
| MEAN COEFFICIENT OF THERMAL EXPANSION (CTE) | -100 to 70°F (-73 to 21°C) Condition H 900 | 5.80 x 10$^{-6}$ in/in/°F | 10.4 x 10$^{-6}$ length/length/K |
| | 70 to 200°F (21 to 93°C) Condition H 900 | 6.00 x 10$^{-6}$ in/in/°F | 10.8 x 10$^{-6}$ length/length/K |
| | 70 to 400°F (21 to 204°C) Condition H 900 | 6.10 x 10$^{-6}$ in/in/°F | 11.0 x 10$^{-6}$ length/length/K |
| | 70 to 600°F (21 to 316°C) Condition H 900 | 6.30 x 10$^{-6}$ in/in/°F | 11.3 x 10$^{-6}$ length/length/K |
| | 70 to 800°F (21 to 427°C) Condition H 900 | 6.50 x 10$^{-6}$ in/in/°F | 11.7 x 10$^{-6}$ length/length/K |
| | 70 to 200°F (21 to 93°C) Condition H 1075 | 6.30 x 10$^{-6}$ in/in/°F | 11.3 x 10$^{-6}$ length/length/K |
| | 70 to 400°F (21 to 204°C) Condition H 1075 | 6.50 x 10$^{-6}$ in/in/°F | 11.7 x 10$^{-6}$ length/length/K |
| | 70 to 600°F (21 to 316°C) Condition H 1075 | 6.60 x 10$^{-6}$ in/in/°F | 11.9 x 10$^{-6}$ length/length/K |
| | 70 to 800°F (21 to 427°C) Condition H 1075 | 6.80 x 10$^{-6}$ in/in/°F | 12.2 x 10$^{-6}$ length/length/K |
| | -100 to 70°F (-73 to 21°C) Condition H 1150 | 6.10 x 10$^{-6}$ in/in/°F | 11.0 x 10$^{-6}$ length/length/K |
| | 70 to 200°F (21 to 93°C) Condition H 1150 | 6.60 x 10$^{-6}$ in/in/°F | 11.9 x 10$^{-6}$ length/length/K |
| | 70 to 400°F (21 to 204°C) Condition H 1150 | 6.90 x 10$^{-6}$ in/in/°F | 12.4 x 10$^{-6}$ length/length/K |
| | 70 to 600°F (21 to 316°C) Condition H 1150 | 7.10 x 10$^{-6}$ in/in/°F | 12.8 x 10$^{-6}$ length/length/K |
| | 70 to 800°F (21 to 427°C) Condition H 1150 | 7.20 x 10$^{-6}$ in/in/°F | 13.0 x 10$^{-6}$ length/length/K |
| THERMAL CONDUCTIVITY | 300°F (149°C) Condition H 900 | 124.0 Btu-in/hr/ft$^2$/°F | 17.9 W/m·K |
| | 500°F (260°C) Condition H 900 | 135.0 Btu-in/hr/ft$^2$/°F | 19.5 W/m·K |
| | 860°F (460°C) Condition H 900 | 156.0 Btu-in/hr/ft$^2$/°F | 22.5 W/m·K |
| | 900°F (482°C) Condition H 900 | 157.0 Btu-in/hr/ft$^2$/°F | 22.6 W/m·K |

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## Physical properties, continued

| PROPERTY | At or From | English Units | Metric Units |
|---|---|---|---|
| POISSON'S RATIO | Condition H 900 | 0.272 | 0.272 |
| | Condition H 1075 | 0.272 | 0.272 |
| | Condition H 1150 | 0.272 | 0.272 |
| MODULUS OF ELASTICITY (E) | 73°F, Condition H 900 | 28.5 x $10^3$ ksi | — |
| ELECTRICAL RESISTIVITY (RT) | 73°F, Condition H 900 | 463 ohm-cir-mil/ft | 770 microhm·mm |
| MODULUS OF RIGIDITY (G) | 73°F, Condition H 900 | 11.2 x 103 ksi | — |
| | 73°F, Condition H 1075 | 10.0 x 103 ksi | — |
| | 73°F, Condition H 1150 | 10.0 x 103 ksi | — |

## Typical mechanical properties

**AT ROOM TEMPERATURE**

| CONDITION, ANNEALED + COLD FINISHED | 0.2% YIELD STRENGTH | | ULTIMATE TENSILE STRENGTH | | ELONGATION IN 2 IN (50.8 MM) | REDUCTION OF AREA |
|---|---|---|---|---|---|---|
| | ksi | MPa | ksi | MPa | % | % |
| H 900 | 183 | 1262 | 198 | 1365 | 15 | 52 |
| H 1025 | 162 | 1117 | 168 | 1158 | 16 | 58 |
| H 1075 | 148 | 1020 | 164 | 1131 | 17 | 59 |
| H 1150 | 126 | 869 | 144 | 993 | 20 | 60 |
| H 1150M | 87 | 600 | 123 | 848 | 22 | 66 |

**AT ROOM TEMPERATURE**

| CONDITION | HARDNESS | |
|---|---|---|
| | HRC | BRINELL |
| A | 36 | 352 |
| H 900 | 44 | 420 |
| H 1025 | 38 | 352 |
| H 1075 | 36 | 341 |
| H 1150 | 33 | 311 |
| H 1150M | 29 | 293 |

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## Heat treatment

17-4 Select is aged by heating solution annealed and cold-finished material to a temperature between 900°F (482°C) and 1150°F (621°C) for 1 to 4 hours, depending on the temperature, then air cooling. The specific aging temperature chosen depends on the desired properties.

| | |
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| **Solution treatment** | Solution annealing 17-4 Select controlled residual stress material will destroy the precision stress fields of this product. It is not recommended to solution anneal this material. |
| **Deformation (size change) in hardening** | The precipitation hardening of 17-4 Select is accomplished with a slight dimensional change.<br>• The amount of contraction in hardening solution-treated (Condition A) material to Condition H 900 is about 0.0004 to 0.0006 in./in. (m/m).<br>• Condition A material when hardened to Condition H 1150 will contract approximately 0.0009 to 0.0012 in./in. (m/m). |
| **Age** | Condition H 900 (precipitation or age-hardened): Heat solution-treated material at 900°F (482°C) for 1 hour and air cool.<br>Condition H 925, H 1025, H 1075, H 1100, and H 1150: Heat solution-treated material at specified temperature ±15°F (±8°C) for 4 hours and air cool.<br>Condition H 1150M: Heat solution-treated material at 1400°F(760°C) ±15°F (±8°C) for 2 hours, air cool; then treat at 1150°F (621°C) ±15°F (±8°C) for 4 hours and air cool. |

## Workability

| | |
|---|---|
| **Cold working** | 17-4 Select can be cold worked to a limited degree. Due to the proximity of its initial yield strength to its ultimate tensile strength, satisfactory cold working requires precise knowledge of material condition and process parameters. Cold working capability is maximized in the H1150M and H1150D conditions. |
| **Machinability** | 17-4 Select controlled residual stress alloy is designed to have additional, but more consistent residual stress in the material. This allows stress relaxation to occur in a more predictable way, reducing material deflection during your machining operations. It is still recommended to machine in a manner to minimize excessive localized strain hardening, utilizing sharp tooling and properly balanced cutting depths. |

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## Typical feeds and speeds

The feeds and speeds in the following charts are conservative recommendations for initial setup. Higher feeds and speeds may be attainable depending on machining environment.

**TURNING — SINGLE-POINT AND BOX TOOLS**

| CONDITION | DEPTH OF CUT, IN | HIGH-SPEED TOOLS | | | CARBIDE TOOLS | | | |
|---|---|---|---|---|---|---|---|---|
| | | SPEED, FPM | FEED, IPR | TOOL MATERIAL | SPEED, FPM UNCOATED | SPEED, FPM COATED | FEED, IPR | TOOL MATERIAL |
| Solution Treated | .150 | 90 | .015 | M-48, T-15 | 375 | 475 | .015 | C-6 |
| | .025 | 105 | .007 | | 425 | 560 | .007 | C-7 |
| Double-Aged to H 1150M | .150 | 90 | .015 | M-48, T-15 | 375 | 475 | .015 | C-6 |
| | .025 | 105 | .007 | | 425 | 560 | .007 | C-7 |
| Aged to H 1075, H 1100, H 1150 | .150 | 70 | .015 | M-48, T-15 | 325 | 425 | .015 | C-6 |
| | .025 | 85 | .007 | | 375 | 475 | .007 | C-7 |
| Aged to H 1025 | .150 | 85 | .015 | M-48, T-15 | 300 | 375 | .010 | C-6 |
| | .025 | 80 | .007 | | 350 | 425 | .005 | C-7 |
| Aged to H 900, H 925 | .150 | 40 | .010 | M-48, T-15 | 210 | 275 | .010 | C-6 |
| | .025 | 55 | .005 | | 250 | 310 | .005 | C-7 |

**TURNING — CUT-OFF AND FORM TOOLS**

| CONDITION | SPEED, FPM | FEED, IPR | | | | | | | TOOL MATERIAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | CUT-OFF TOOL WIDTH, IN | | | | FORM TOOL WIDTH, IN | | | HIGH-SPEED TOOLS | CARBIDE TOOLS |
| | | 1/16 | 1/8 | 1/4 | 1/2 | 1 | 1-1/2 | 2 | | |
| Solution Treated | 75 | .001 | .0015 | .002 | .0015 | .001 | .001 | .0005 | M-48, T-15 | — |
| | 225 | .003 | .003 | .004 | .003 | .002 | .002 | .002 | — | C-6 |
| Double-Aged to H 1150M | 100 | .0015 | .002 | .0025 | .002 | .0015 | .001 | .001 | M-48, T-15 | — |
| | 250 | .003 | .003 | .0045 | .003 | .002 | .002 | .002 | — | C-6 |
| Aged to H 1075, H 1100, H 1150 | 85 | .001 | .0015 | .002 | .0015 | .001 | .001 | .0005 | M-48, T-15 | — |
| | 225 | .003 | .003 | .0045 | .003 | .002 | .002 | .002 | — | C-6 |
| Aged to H 1025 | 45 | .001 | .001 | .0015 | .0015 | .001 | .001 | .0005 | M-48, T-15 | — |
| | 150 | .003 | .003 | .0045 | .003 | .002 | .002 | .002 | — | C-6 |
| Aged to H 900, H 925 | 35 | .001 | .001 | .0015 | .0015 | .001 | .001 | .0005 | M-48, T-15 | — |
| | 125 | .0025 | .0025 | .004 | .0025 | .0015 | .0015 | .0015 | — | C-6 |

**ROUGH REAMING**

| CONDITION | HIGH-SPEED TOOLS | | CARBIDE TOOLS | | FEED, IPR, REAMER DIAMETER, IN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | SPEED, FPM | TOOL MATERIAL | SPEED, FPM | TOOL MATERIAL | 1/8 | 1/4 | 1/2 | 1 | 1-1/2 | 2 |
| Annealed + Cold Finished | 70 | M-48, T-15 | 200 | C-7 | .003 | .005 | .008 | .011 | .015 | .018 |
| Double-Aged | 75 | M-48, T-15 | 210 | C-2 | .003 | .005 | .008 | .011 | .015 | .018 |
| Aged | 55 | M-48, T-15 | 160 | C-2 | .003 | .005 | .008 | .011 | .015 | .018 |
| Aged to H 1025 | 45 | M-48, T-15 | 135 | C-2 | .003 | .004 | .006 | .010 | .013 | .018 |
| Aged to H 900, H 925 | 40 | M-48, T-15 | 110 | C-2 | .001 | .001 | .001 | .001 | .001 | .001 |

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## DRILLING — HIGH-SPEED TOOLS

| CONDITION | SPEED, FPM | FEED, IPR — NOMINAL HOLE DIAMETER, IN | | | | | | | | TOOL MATERIAL |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1/16 | 1/8 | 1/4 | 1/2 | 3/4 | 1 | 1-1/2 | 2 | |
| Annealed + Cold Finished | 55 | .001 | .002 | .004 | .007 | .008 | .010 | .012 | .015 | M-42 |
| Double-Aged | 65 | .001 | .002 | .004 | .007 | .009 | .011 | .013 | .016 | M-42 |
| Aged | 50 | — | .002 | .004 | .007 | .008 | .010 | .012 | .015 | M-42 |
| Aged to H 1025 | 40 | — | .002 | .004 | .006 | .008 | .009 | .011 | .012 | M-42 |
| Aged to H 900, H 925 | 30 | — | .001 | .002 | .003 | .004 | .004 | .004 | .004 | M-42 |

## BROACHING — HIGH-SPEED TOOLS

| CONDITION | SPEED, FPM | CHIP LOAD, IN PER TOOTH | TOOL MATERIAL |
|---|---|---|---|
| Annealed + Cold Finished | 12 | .002 | M-48, T-15 |
| Double-Aged | 15 | .002 | M-48, T-15 |
| Aged | 10 | .002 | M-48, T-15 |
| Aged to H 1025 | 10 | .002 | M-48, T-15 |
| Aged to H 900, H 925 | 10 | .002 | M-48, T-15 |

## TAPPING — HIGH-SPEED TOOLS

| CONDITION | SPEED, FPM | TOOL MATERIAL |
|---|---|---|
| Annealed + Cold Finished | 15–28 | M-7, M-10 |
| Double-Aged | 17–32 | M-7, M-10 |
| Aged | 15–28 | M-7, M-10 |
| Aged to H 1025 | 15–22 | M-7, M-10 |
| Aged to H 900, H 925 | 7–17 | M-7, M-10 Nitrided |

## DIE THREADING — HIGH-SPEED TOOLS

| CONDITION | SPEED, FPM | | | | TOOL MATERIAL |
|---|---|---|---|---|---|
| | 7 OR LESS, TPI | 8 TO 15, TPI | 16 TO 24, TPI | 25 AND UP, TPI | |
| Annealed + Cold Finished | 7–13 | 10–18 | 12–25 | 18–30 | M-2, M-7, M-10 |
| Aged | 5–10 | 8–12 | 10–15 | 12–18 | M-42, T-15 |

## MILLING — END PERIPHERAL

| CONDITION | DEPTH OF CUT, IN | HIGH-SPEED TOOLS | | | | | | CARBIDE TOOLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SPEED, FPM | FEED, IN PER TOOTH — CUTTER DIAMETER, IN | | | | TOOL MATERIAL | SPEED, FPM | FEED, IPT — CUTTER DIAMETER, IN PER TOOTH | | | | TOOL MATERIAL |
| | | | 1/4 | 1/2 | 3/4 | 1-2 | | | 1/4 | 1/2 | 3/4 | 1-2 | |
| Annealed + Cold Finished | .050 | 90 | .001 | .002 | .003 | .004 | M-48, T-15 | 280 | .001 | .002 | .004 | .006 | C-2 |
| Double-Aged | .050 | 95 | .001 | .002 | .003 | .004 | M-48, T-15 | 290 | .001 | .002 | .004 | .006 | C-2 |
| Aged | .050 | 85 | .001 | .002 | .003 | .004 | M-48, T-15 | 275 | .001 | .002 | .004 | .006 | C-2 |
| Aged to H 1025 | .050 | 70 | .0005 | .001 | .002 | .003 | M-48, T-15 | 200 | .001 | .002 | .003 | .004 | C-2 |
| Aged to H 900, H 925 | .050 | 65 | .0005 | .001 | .002 | .003 | M-48, T-15 | 100 | .001 | .002 | .003 | .004 | C-2 |

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## Additional machinability notes

The use of tool coatings is highly suggested, especially when machining in the aged hardened condition. TiCN and TiAlN are two suggestions. See your tool supplier for more information.

Figures used for all metal removal operations covered are starting points. On certain work, the nature of the part may require adjustment of speeds and feeds. Each job has to be developed for best production results with optimum tool life. Speeds or feeds should be increased or decreased in small steps.

| | |
|---|---|
| **Weldability** | It is not recommended to weld 17-4 Select controlled residual stress alloy, as the welded region could not be age-treated without solution anneal. Solution annealing would remove the precision stress fields of this product. |

## Other information

| | |
|---|---|
| **Descaling (cleaning)** | Descaling following forging and annealing can be accomplished by acid cleaning or grit blasting. The acid treatment consists of 2 minutes in 50% by volume muriatic acid at 180°F (82°C), followed by 4 minutes in a mixture 15% by volume nitric acid, plus 3% by volume hydrofluoric acid at room temperature. Water rinse and desmut in 20% by volume nitric acid at room temperature. Repeat cleaning procedure as necessary but decrease the times by 50% (i.e., 1 and 2 minutes, respectively).<br><br>The heat tint from aging can be removed by polishing, vapor blasting, or pickling 4 to 6 minutes in a mixture of 15% by volume nitric acid, plus 3% by volume hydrofluoric acid, followed by a water rinse. Repeat the acid cleaning procedure if necessary, but decrease the time by 2 to 3 minutes. Desmut in 20% by volume nitric acid at room temperature.<br><br>After acid cleaning, back 1 to 3 hours at 300/350°F (149/177°C) to remove hydrogen. |
| **High temperature exposure** | 17-4 Select shows excellent resistance to oxidation up to approximately 1100°F (539°C).<br><br>Long-term exposure to elevated temperatures can result in reduced toughness in precipitation hardenable stainless steels. The reduction in toughness can be minimized in some cases by using higher aging temperatures. Short exposures to elevated temperatures can be considered, provided the maximum temperature is at least 50°F (28°C) less than the aging temperature. |

**For additional information, please contact your nearest sales office:**
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