



ASM Aerospace Specification Metals Inc.



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Haynes® 188 alloy, 20% cold reduction, 3.2 mm thick sheet, 1175°C for 5 minutes

**Subcategory:** Cobalt Base; Metal; Superalloy

**Key Words:** UNS R30188, AMS 5608, AMS 5772, AMS 5801

| Component | Wt. %       | Component | Wt. %       | Component | Wt. %     |
|-----------|-------------|-----------|-------------|-----------|-----------|
| B         | Max 0.015   | Fe        | Max 3       | Ni        | 20 - 24   |
| C         | 0.05 - 0.15 | La        | 0.02 - 0.12 | Si        | 0.2 - 0.5 |
| Co        | 42          | Mn        | Max 1.25    | W         | 13 - 15   |
| Cr        | 21 - 23     |           |             |           |           |

#### Material Notes:

Cobalt composition to balance. Excellent high temperature strength and very good resistance to oxidizing environments up to 1095°C for prolonged exposure, and excellent resistance to sulfate deposit hot corrosion. Readily fabricated and formed, excellent resistance to molten chloride salts, and good resistance to gaseous sulfidation. Applications include a variety of fabricated component applications in the aerospace industry, commercial gas turbine engines for combustion cans, transition ducts and afterburner components.

Data provided by the manufacturer, Haynes International, Inc.

| Physical Properties          | Metric           | English                  | Comments                            |
|------------------------------|------------------|--------------------------|-------------------------------------|
| Density                      | <u>8.98 g/cc</u> | 0.324 lb/in <sup>3</sup> | at RT.                              |
| <b>Mechanical Properties</b> |                  |                          |                                     |
| Hardness, Brinell            | 167              | 167                      | Converted from Rockwell B hardness. |
| Hardness, Knoop              | 185              | 185                      | Converted from Rockwell B hardness. |
| Hardness, Rockwell B         | 97.1             | 97.1                     |                                     |
| Hardness, Vickers            | 234              | 234                      | Converted from Rockwell B hardness. |
| Tensile Strength, Ultimate   | <u>975 MPa</u>   | 141000 psi               |                                     |
| Tensile Strength, Yield      | <u>445 MPa</u>   | 64500 psi                | at 0.2% offset                      |
| Elongation at Break          | <u>53.3 %</u>    | 53.3 %                   | in 51 mm                            |

|   |                |           |   |
|---|----------------|-----------|---|
| Modulus of Elasticity                         | <u>232 GPa</u> | 33600 ksi | RT  |
| Modulus of Elasticity at Elevated Temperature | <u>153 GPa</u> | 22200 ksi | 1000°C (1830°F)   |
| Modulus of Elasticity at Elevated Temperature | <u>161 GPa</u> | 23400 ksi | 900°C (1650°F)  |
| Modulus of Elasticity at Elevated Temperature | <u>169 GPa</u> | 24500 ksi | 800°C (1470°F)  |
| Modulus of Elasticity at Elevated Temperature | <u>176 GPa</u> | 25500 ksi | 700°C (1290°F)  |
| Modulus of Elasticity at Elevated Temperature | <u>184 GPa</u> | 26700 ksi | 600°C (1110°F)  |
| Modulus of Elasticity at Elevated Temperature | <u>193 GPa</u> | 28000 ksi | 500°C (930°F)   |
| Modulus of Elasticity at Elevated Temperature | <u>201 GPa</u> | 29200 ksi | 400°C (750°F)   |
| Modulus of Elasticity at Elevated Temperature | <u>209 GPa</u> | 30300 ksi | 300°C (570°F)   |
| Modulus of Elasticity at Elevated Temperature | <u>217 GPa</u> | 31500 ksi | 200°C (390°F)   |
| Modulus of Elasticity at Elevated Temperature | <u>225 GPa</u> | 32600 ksi | 100°C (212°F)   |
| Charpy Impact                                 | <u>194 J</u>   | 143 ft-lb | at 20°C, 158 J at -185°C, 162 J at -100°C, 159 J at 540°C, 145 J at 705°C, 194 J solution annealed, 31 J after 8000 hours at 650°C, 4 J after 8000 hours at 760°C, 12 J after 8000 hours at 870°C |

### Electrical Properties

|  |                         |                  |                 |
|--|-------------------------|------------------|-----------------|
| Electrical Resistivity                         | <u>0.000101 ohm-cm</u>  | 0.000101 ohm-cm  | RT              |
| Electrical Resistivity at Elevated Temperature | <u>0.000103 ohm-cm</u>  | 0.000103 ohm-cm  | 100°C (212°F)   |
| Electrical Resistivity at Elevated Temperature | <u>0.000105 ohm-cm</u>  | 0.000105 ohm-cm  | 200°C (390°F)   |
| Electrical Resistivity at Elevated Temperature | <u>0.0001077 ohm-cm</u> | 0.0001077 ohm-cm | 300°C (570°F)   |
| Electrical Resistivity at Elevated Temperature | <u>0.0001105 ohm-cm</u> | 0.0001105 ohm-cm | 400°C (750°F)   |
| Electrical Resistivity at Elevated Temperature | <u>0.0001127 ohm-cm</u> | 0.0001127 ohm-cm | 500°C (930°F)   |
| Electrical Resistivity at Elevated Temperature | <u>0.0001148 ohm-cm</u> | 0.0001148 ohm-cm | 600°C (1110°F)  |
| Electrical Resistivity at Elevated Temperature | <u>0.0001164 ohm-cm</u> | 0.0001164 ohm-cm | 700°C (1290°F)  |
| Electrical Resistivity at Elevated Temperature | <u>0.0001175 ohm-cm</u> | 0.0001175 ohm-cm | 800°C (1470°F)  |
| Electrical Resistivity at Elevated Temperature | <u>0.0001183 ohm-cm</u> | 0.0001183 ohm-cm | 900°C (1650°F)  |
| Electrical Resistivity at Elevated Temperature | <u>0.0001191 ohm-cm</u> | 0.0001191 ohm-cm | 1000°C (1830°F) |

### Thermal Properties

|                    |                     |                |                     |
|--------------------|---------------------|----------------|---------------------|
| CTE, linear 20°C   | <u>11.9 μm/m-°C</u> | 6.61 μin/in-°F | 25-100°C (77-212°F) |
| CTE, linear 250°C  | <u>12.6 μm/m-°C</u> | 7 μin/in-°F    | 25-200°C (77-390°F) |
| CTE, linear 500°C  | <u>13.2 μm/m-°C</u> | 7.33 μin/in-°F | 25-300°C            |
| CTE, linear 500°C  | <u>13.8 μm/m-°C</u> | 7.67 μin/in-°F | 25-400°C            |
| CTE, linear 500°C  | <u>14.5 μm/m-°C</u> | 8.06 μin/in-°F | 25-500°C            |
| CTE, linear 1000°C | <u>15.2 μm/m-°C</u> | 8.44 μin/in-°F | 25-600°C            |
| CTE, linear 1000°C | <u>15.8 μm/m-°C</u> | 8.78 μin/in-°F | 25-700°C            |

|  |  |  |                      |
|--|--|--|----------------------|
| CTE, linear 1000°C                             | <u>16.5 <math>\mu\text{m}/\text{m}\cdot^\circ\text{C}</math></u> | 9.17 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$ | 25-800°C             |
| CTE, linear 1000°C                             | <u>17.1 <math>\mu\text{m}/\text{m}\cdot^\circ\text{C}</math></u> | 9.5 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$  | 25-800°C (77-1470°F) |
| CTE, linear 1000°C                             | <u>17.9 <math>\mu\text{m}/\text{m}\cdot^\circ\text{C}</math></u> | 9.94 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$ | 25-1000°C            |
| Specific Heat Capacity                         | <u>0.403 J/g<math>\cdot^\circ\text{C}</math></u>                 | 0.0963 BTU/lb $\cdot^\circ\text{F}$              | RT                   |
| Specific Heat Capacity at Elevated Temperature | <u>0.423 J/g<math>\cdot^\circ\text{C}</math></u>                 | 0.101 BTU/lb $\cdot^\circ\text{F}$               | 100°C (212°F)        |
| Specific Heat Capacity at Elevated Temperature | <u>0.444 J/g<math>\cdot^\circ\text{C}</math></u>                 | 0.106 BTU/lb $\cdot^\circ\text{F}$               | 200°C (390°F)        |
| Specific Heat Capacity at Elevated Temperature | <u>0.465 J/g<math>\cdot^\circ\text{C}</math></u>                 | 0.111 BTU/lb $\cdot^\circ\text{F}$               | 300°C (570°F)        |
| Specific Heat Capacity at Elevated Temperature | <u>0.486 J/g<math>\cdot^\circ\text{C}</math></u>                 | 0.116 BTU/lb $\cdot^\circ\text{F}$               | 400°C (750°F)        |
| Specific Heat Capacity at Elevated Temperature | <u>0.502 J/g<math>\cdot^\circ\text{C}</math></u>                 | 0.12 BTU/lb $\cdot^\circ\text{F}$                | 500°C (930°F)        |
| Specific Heat Capacity at Elevated Temperature | <u>0.523 J/g<math>\cdot^\circ\text{C}</math></u>                 | 0.125 BTU/lb $\cdot^\circ\text{F}$               | 600°C (1110°F)       |
| Specific Heat Capacity at Elevated Temperature | <u>0.54 J/g<math>\cdot^\circ\text{C}</math></u>                  | 0.129 BTU/lb $\cdot^\circ\text{F}$               | 700°C (1290°F)       |
| Specific Heat Capacity at Elevated Temperature | <u>0.557 J/g<math>\cdot^\circ\text{C}</math></u>                 | 0.133 BTU/lb $\cdot^\circ\text{F}$               | 800°C (1470°F)       |
| Specific Heat Capacity at Elevated Temperature | <u>0.573 J/g<math>\cdot^\circ\text{C}</math></u>                 | 0.137 BTU/lb $\cdot^\circ\text{F}$               | 900°C (1650°F)       |
| Specific Heat Capacity at Elevated Temperature | <u>0.59 J/g<math>\cdot^\circ\text{C}</math></u>                  | 0.141 BTU/lb $\cdot^\circ\text{F}$               | 1000°C (1830°F)      |
| Thermal Conductivity                           | <u>10.4 W/m-K</u>  | 72.2 BTU-in/hr-ft $^2\cdot^\circ\text{F}$        | RT                   |
| Thermal Conductivity at Elevated Temperature   | <u>12.2 W/m-K</u>  | 84.7 BTU-in/hr-ft $^2\cdot^\circ\text{F}$        | 100°C (212°F)        |
| Thermal Conductivity at Elevated Temperature   | <u>14.3 W/m-K</u>  | 99.2 BTU-in/hr-ft $^2\cdot^\circ\text{F}$        | 200°C (390°F)        |
| Thermal Conductivity at Elevated Temperature   | <u>15.9 W/m-K</u>  | 110 BTU-in/hr-ft $^2\cdot^\circ\text{F}$         | 300°C (570°F)        |
| Thermal Conductivity at Elevated Temperature   | <u>17.5 W/m-K</u>  | 121 BTU-in/hr-ft $^2\cdot^\circ\text{F}$         | 400°C (750°F)        |
| Thermal Conductivity at Elevated Temperature   | <u>19.3 W/m-K</u>  | 134 BTU-in/hr-ft $^2\cdot^\circ\text{F}$         | 500°C (930°F)        |
| Thermal Conductivity at Elevated Temperature   | <u>21.1 W/m-K</u>  | 146 BTU-in/hr-ft $^2\cdot^\circ\text{F}$         | 600°C (1110°F)       |
| Thermal Conductivity at Elevated Temperature   | <u>23 W/m-K</u>  | 160 BTU-in/hr-ft $^2\cdot^\circ\text{F}$         | 700°C (1290°F)       |
| Thermal Conductivity at Elevated Temperature   | <u>24.8 W/m-K</u>  | 172 BTU-in/hr-ft $^2\cdot^\circ\text{F}$         | 800°C (1470°F)       |
| Thermal Conductivity at Elevated Temperature   | <u>25.5 W/m-K</u>  | 177 BTU-in/hr-ft $^2\cdot^\circ\text{F}$         | 900°C (1650°F)       |
| Thermal Conductivity at Elevated Temperature   | <u>27.6 W/m-K</u>  | 192 BTU-in/hr-ft $^2\cdot^\circ\text{F}$         | 1000°C (1830°F)      |
| Melting Point                                  | 1315 - 1410 °C   | 2400 - 2570 °F                                   |                      |
| Solidus  | <u>1315 °C</u>   | 2400 °F  |                      |
| Liquidus                                       | <u>1410 °C</u>   | 2570 °F  |                      |
| Maximum Service Temperature, Air               | <u>1095 °C</u>   | 2000 °F  |                      |

Some of the values displayed above may have been converted from their original units and/or rounded in order to display the information in a consistent format. Users requiring more precise data for scientific or engineering calculations can click on the property value to see the original value as well as raw conversions to equivalent units. We advise that you only use the original value or one of its raw conversions in your calculations to minimize rounding error.