LEVERAGING A NETWORK OF EXPERTISE

The properties of our specialty metal offerings are unmatched, but as part of Precision Castparts Corporation (PCC), Special Metals can leverage the capabilities of leaders in metal to offer an unparalleled range of alloy components and products to diverse industries worldwide.

To supply the critical needs of the energy industry, Special Metals operates as a member of PCC Energy Group—a collection of the top names in the industry, assembled to push what’s possible with metals for energy applications, including oil and gas, processing and refining, and power generation.

MANUFACTURING

Alloying processes: Electric arc, air induction and vacuum induction melting

Mechanical alloying: Used for a few of our most specialized alloys

Refining facilities: AOD and vacuum refining, vacuum arc and electroslag remelting

Hot working: Forging, hot rolling and extrusion

Cold working: Rolling, drawing and pilgering

DISTRIBUTION

Our products are available directly from Special Metals and through a network of distributors that stock our alloys and products in most of the industrialized world.

QUALITY STANDARDS

All of our operations maintain IS0 9001-certified quality management standards to produce alloy compositions and forms that meet nationally and internationally recognized standards or customers’ own specifications.

MANUFACTURING LOCATIONS

- New Hartford, New York
- Huntington, West Virginia
- Newton, North Carolina
- Hereford, United Kingdom
- Elkhart, Indiana
- Perth, Australia
- Albury, New South Wales

ADDITIONAL INFORMATION

Comprehensive product data sheets and bulletins on Special Metals High-Performance Alloys are available on our website, www.specialmetals.com. Technical and commercial inquiries may be entered on the website as well.

TRADEMARKS OF THE SPECIAL METALS CORPORATION GROUP OF COMPANIES

- BRIGHTRAY
- DURANICKEL
- FERRY
- INCOFLUX
- INCOLoy
- INCONEL
- INCOtest
- INCOtherM
- INCO-WELD
- KOTHERM
- MONEl
- NIO
- NIMONIC
- NI-ROD
- RESISTOHM
- UDIMET
- 27-7MO
- 625LCF
- 718SPF
- 725NDUR
- 740H
- 800HT
- 945
- 945X

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### Nickel 200

Commercially pure (99.6%) wrought nickel with good mechanical properties and resistance to a range of corrosive media. Good thermal, electrical, and magnetostrictive properties. Used for a variety of processing equipment, particularly to maintain product purity in handling foods, synthetic fibers and alkalies.

**Major Specifications**

Pipe, tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon and wire.

**Limiting Mechanical Composition, %**

<table>
<thead>
<tr>
<th>Element</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe</td>
<td>0.01 max.</td>
</tr>
<tr>
<td>Cu</td>
<td>0.25 max.</td>
</tr>
<tr>
<td>Fe</td>
<td>0.10 max.</td>
</tr>
<tr>
<td>N</td>
<td>0.003 max.</td>
</tr>
<tr>
<td>S</td>
<td>0.001 max.</td>
</tr>
</tbody>
</table>

**Physical Constants and Thermal Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, lb/ft³</td>
<td>0.291</td>
</tr>
<tr>
<td>Melting Range, °F</td>
<td>2615 - 2635</td>
</tr>
<tr>
<td>Specific Heat, BTU/lb °F</td>
<td>1245</td>
</tr>
<tr>
<td>Curie Temperature, °F</td>
<td>1060</td>
</tr>
<tr>
<td>Permeability, 70 – 200°F</td>
<td>2550 – 2620</td>
</tr>
<tr>
<td>Thermal Conductivity, W/m · °C</td>
<td>55.0</td>
</tr>
<tr>
<td>Electrical Resistivity, Ω · m</td>
<td>0.65</td>
</tr>
</tbody>
</table>

**Typical Mechanical Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength (Annealed), ksi</td>
<td>30.5</td>
</tr>
<tr>
<td>Yield Strength (0.2% Offset), ksi</td>
<td>11.0</td>
</tr>
<tr>
<td>Elongation, %</td>
<td>50.0</td>
</tr>
</tbody>
</table>

---

### Nickel 201

Commercially pure (99.6%) wrought nickel essentially the same as Nickel 200 but with a lower carbon content to prevent embrittlement by intergranular carbon at temperatures over 600°F (315°C). Lower carbon content also reduces hardness, making Nickel 201 particularly suitable for cold-formed items.

**Major Specifications**

Pipe, tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon and wire.

**Limiting Mechanical Composition, %**

<table>
<thead>
<tr>
<th>Element</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe</td>
<td>0.01 max.</td>
</tr>
<tr>
<td>Cu</td>
<td>0.25 max.</td>
</tr>
<tr>
<td>Fe</td>
<td>0.10 max.</td>
</tr>
<tr>
<td>N</td>
<td>0.003 max.</td>
</tr>
<tr>
<td>S</td>
<td>0.001 max.</td>
</tr>
</tbody>
</table>

**Physical Constants and Thermal Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, lb/ft³</td>
<td>0.321</td>
</tr>
<tr>
<td>Melting Range, °F</td>
<td>2615 - 2635</td>
</tr>
<tr>
<td>Specific Heat, BTU/lb °F</td>
<td>1245</td>
</tr>
<tr>
<td>Curie Temperature, °F</td>
<td>1060</td>
</tr>
<tr>
<td>Permeability, 70 – 200°F</td>
<td>2550 – 2620</td>
</tr>
<tr>
<td>Thermal Conductivity, W/m · °C</td>
<td>55.0</td>
</tr>
<tr>
<td>Electrical Resistivity, Ω · m</td>
<td>0.65</td>
</tr>
</tbody>
</table>

**Typical Mechanical Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength (Annealed), ksi</td>
<td>30.5</td>
</tr>
<tr>
<td>Yield Strength (0.2% Offset), ksi</td>
<td>11.0</td>
</tr>
<tr>
<td>Elongation, %</td>
<td>50.0</td>
</tr>
</tbody>
</table>

---

### Nickel 270

A high-purity grade of nickel made by powder metallurgy. It has a low base hardness and high ductility. Its extreme purity is useful for components of hydrogen thyristors. It is also used for electrical resistance thermometers.

**Major Specifications**

Strip, round bar and wire.

**Typical Mechanical Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength, ksi</td>
<td>31.5</td>
</tr>
<tr>
<td>Yield Strength (0.2% Offset), ksi</td>
<td>16.0</td>
</tr>
<tr>
<td>Elongation, %</td>
<td>110.0</td>
</tr>
</tbody>
</table>

---

### Duralnickel Alloy 301

An age-hardened alloy that combines the excellent corrosion resistance characteristics of Nickel 200 with the added advantages of greater strength and hardness. The alloy is used for springs requiring high electrical conductivity, parts of equipment requiring good thermal conductivity and magnetostrictive units, which are operated under stress conditions in which the fatigue strength of Nickel 200 is inadequate.

**Typical Mechanical Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength, ksi</td>
<td>50.0</td>
</tr>
<tr>
<td>Yield Strength (0.2% Offset), ksi</td>
<td>10.0</td>
</tr>
<tr>
<td>Elongation, %</td>
<td>50.0</td>
</tr>
</tbody>
</table>

---

### Typical usage range

- **Typical use**: Ranges for typical usage are indicated in the figure.
# MONEL ALLOY 400

A nickel-copper alloy with high strength and excellent corrosion resistance in a range of media, including sea water, hydrofluoric acid, sulfuric acid and alkalies. Used for marine engineering, chemical and hydrocarbon processing equipment, valves, pumps, shafts, fittings, fasteners and heat exchangers.

### PHYSICAL CONSTANTS

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>8.44 g/cm³</td>
</tr>
<tr>
<td>Tensile Strength, ksi</td>
<td>21.80</td>
</tr>
<tr>
<td>Yield Strength, ksi</td>
<td>8.80</td>
</tr>
<tr>
<td>Elongation, %</td>
<td>30.7</td>
</tr>
<tr>
<td>Stress, MPa</td>
<td>240</td>
</tr>
<tr>
<td>Density, Ib/in³</td>
<td>28.0 – 34.0</td>
</tr>
<tr>
<td>Coefficient of Expansion</td>
<td>0.615 x 10⁻⁶/°C</td>
</tr>
<tr>
<td>Thermal Conductivity, μm/W/°C</td>
<td>0.350</td>
</tr>
<tr>
<td>Electrical Resistivity, Ωm</td>
<td>0.510</td>
</tr>
<tr>
<td>Electrical Resistivity, µΩm</td>
<td>0.615</td>
</tr>
</tbody>
</table>

### SPECIFICATIONS

- **UNS N04400**
- **BS 3072 – 3076 (NA13)**
- **ADHE SB-187, SB-189, SB-366, SB-564, SB-715, SB-743**
- **ASTM B 187**
- **UNS N04400**
- **DIN 17743, 17750 – 17754**
- **Plus Co.**

### Typical usage range

- Pipe, tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon and wire.
- Pipe, tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon and wire.
- Pipe, tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon and wire.

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# MONEL ALLOY R-405

The free-machining version of MONEL alloy 400. A controlled amount of sulfur is added to the alloy to provide sulfide inclusions that act as chip breakers during machining. Other characteristics are essentially the same as those of MONEL alloy 400. Used for meter and valve parts, fasteners and on-site-machining products.

### PHYSICAL CONSTANTS

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>8.44 g/cm³</td>
</tr>
<tr>
<td>Tensile Strength, ksi</td>
<td>21.80</td>
</tr>
<tr>
<td>Yield Strength, ksi</td>
<td>8.80</td>
</tr>
<tr>
<td>Elongation, %</td>
<td>30.7</td>
</tr>
<tr>
<td>Stress, MPa</td>
<td>240</td>
</tr>
<tr>
<td>Density, Ib/in³</td>
<td>28.0 – 34.0</td>
</tr>
<tr>
<td>Coefficient of Expansion</td>
<td>0.615 x 10⁻⁶/°C</td>
</tr>
<tr>
<td>Thermal Conductivity, μm/W/°C</td>
<td>0.350</td>
</tr>
<tr>
<td>Electrical Resistivity, Ωm</td>
<td>0.510</td>
</tr>
<tr>
<td>Electrical Resistivity, µΩm</td>
<td>0.615</td>
</tr>
</tbody>
</table>

### SPECIFICATIONS

- **UNS N04405**
- **BS 3072 – 3076 (NA13)**
- **ASTM B 187**
- **UNS N04405**
- **ML, N 824**

### Typical usage range

- Round bar, hexagon and wire.

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# MONEL ALLOY K-500

A precipitation-hardenable nickel-copper alloy that combines the corrosion resistance of MONEL alloy 400 with greater strength and hardness. It also has low permeability and is nonmagnetic to temperatures as low as -150°F (-101°C). Used for pump shafts, oil-well tools and instruments, doctor blades and scrapers, springs, valve trim, fasteners and marine propeller shafts.

### PHYSICAL CONSTANTS

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>8.44 g/cm³</td>
</tr>
<tr>
<td>Tensile Strength, ksi</td>
<td>21.80</td>
</tr>
<tr>
<td>Yield Strength, ksi</td>
<td>8.80</td>
</tr>
<tr>
<td>Elongation, %</td>
<td>30.7</td>
</tr>
<tr>
<td>Stress, MPa</td>
<td>240</td>
</tr>
<tr>
<td>Density, Ib/in³</td>
<td>28.0 – 34.0</td>
</tr>
<tr>
<td>Coefficient of Expansion</td>
<td>0.615 x 10⁻⁶/°C</td>
</tr>
<tr>
<td>Thermal Conductivity, μm/W/°C</td>
<td>0.350</td>
</tr>
<tr>
<td>Electrical Resistivity, Ωm</td>
<td>0.510</td>
</tr>
<tr>
<td>Electrical Resistivity, µΩm</td>
<td>0.615</td>
</tr>
</tbody>
</table>

### SPECIFICATIONS

- **UNS N05500**
- **BS 3072 – 3076 (NA13)**
- **ASTM B 187**
- **UNS N05500**
- **Werkstoff Nr. 2.4375**
- **ASME Code Case 1192, Werkstoff Nr. 2.4375**

### Typical usage range

- Pipe, tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon and wire.

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## ALLOY HANDBOOK 2021

- **MONEL ALLOY 400**
- **MONEL ALLOY R-405**
- **MONEL ALLOY K-500**

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### INCONEL ALLOY 600

A nickel-chromium alloy with good oxidation resistance at high temperatures and resistance to chloride-ion stress-corrosion cracking, corrosion by high-purity water and caustic solutions. Used for furnace components, chemical and food processing, nuclear engineering and spark-arc welding.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>8.47 g/cm³</td>
</tr>
<tr>
<td>Melting Range, °F</td>
<td>2107 – 2575</td>
</tr>
<tr>
<td>Specific Heat, Btu/lb °F</td>
<td>0.015 max.</td>
</tr>
<tr>
<td>Curie Temperature, °F</td>
<td>192</td>
</tr>
<tr>
<td>Permeability at 200° Denitted</td>
<td>1.22</td>
</tr>
<tr>
<td>Permeability at 200° Denitted [15.9 kA/m]</td>
<td>1.06</td>
</tr>
<tr>
<td>Electrical Conductivity, Btu/lb °F</td>
<td>1.19</td>
</tr>
<tr>
<td>Electrical Resistivity, ohm·cm/mil ft</td>
<td>3.03</td>
</tr>
</tbody>
</table>

#### Typical Mechanical Properties

<table>
<thead>
<tr>
<th>(Annealed)</th>
<th>Tensile Strength, ksi</th>
<th>Yield Strength (0.2% Offset), ksi</th>
<th>Elongation, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>95</td>
<td>655</td>
<td>45</td>
</tr>
</tbody>
</table>

#### Limiting Chemical Composition, %

- Ni: 65.0 – 68.0
- Fe: 0.05 – 0.15
- Si: 0.5 max.
- C: 0.15 max.
- Mn: 1.5 max.
- Cu: 0.015 max.
- Al: 1.0 max.
- Ti: 1.0 max.
- Mo: 0.015 max.
- Nb: 0.05 max.
- Cr: 0.015 max.
- Co: 0.5 max.
- W: 0.015 max.

### INCONEL ALLOY 601

A nickel-chromium alloy with an addition of aluminum for outstanding resistance to oxidation and other forms of high-temperature corrosion. It also has high mechanical properties at elevated temperatures. Used for industrial furnaces, heat-treating equipment such as baskets, muffles, and retorts; petrochemical and other process equipment; and gas-turbine components.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>0.293 g/cm³</td>
</tr>
<tr>
<td>Melting Range, °F</td>
<td>2980 – 3271</td>
</tr>
<tr>
<td>Specific Heat, Btu/lb °F</td>
<td>0.015 max.</td>
</tr>
<tr>
<td>Curie Temperature, °F</td>
<td>448</td>
</tr>
<tr>
<td>Permeability at 200° Denitted</td>
<td>1.22</td>
</tr>
<tr>
<td>Permeability at 200° Denitted [15.9 kA/m]</td>
<td>1.06</td>
</tr>
<tr>
<td>Electrical Conductivity, Btu/lb °F</td>
<td>0.19</td>
</tr>
<tr>
<td>Electrical Resistivity, ohm·cm/mil ft</td>
<td>0.293</td>
</tr>
</tbody>
</table>

#### Typical Mechanical Properties

<table>
<thead>
<tr>
<th>(Solution Annealed)</th>
<th>Tensile Strength (1000h)</th>
<th>Yield Strength (1000h)</th>
<th>Elongation (1000h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200°F / 650°C</td>
<td>950</td>
<td>615</td>
<td>17</td>
</tr>
<tr>
<td>1400°F / 760°C</td>
<td>91</td>
<td>56</td>
<td>14</td>
</tr>
<tr>
<td>1600°F / 870°C</td>
<td>91</td>
<td>54</td>
<td>14</td>
</tr>
<tr>
<td>1800°F / 980°C</td>
<td>91</td>
<td>52</td>
<td>14</td>
</tr>
</tbody>
</table>

#### Limiting Chemical Composition, %

- Ni: 68.0 – 71.0
- Fe: 0.05 – 0.15
- Si: 0.5 max.
- C: 0.15 max.
- Mn: 1.5 max.
- Cu: 0.015 max.
- Al: 0.1 – 1.5
- Ti: 0.08 max.
- Mo: 0.015 max.
- Nb: 0.05 max.
- Cr: 0.015 max.
- Co: 0.5 max.
- W: 0.015 max.

### INCONEL ALLOY 617

A nickel-chromium-cobalt-molybdenum alloy with an exceptional combination of metallurgical stability, strength, and oxidation resistance at high temperatures. Resistance to oxidation is enhanced by an aluminum addition. The alloy also resists a wide range of corrosive environments and is especially resistant to pitting and crevice corrosion. Used in chemical processing, aerospace and marine engineering, pollution-control equipment and nuclear reactors.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>0.303 g/cm³</td>
</tr>
<tr>
<td>Melting Range, °F</td>
<td>3200 – 3500</td>
</tr>
<tr>
<td>Specific Heat, Btu/lb °F</td>
<td>0.015 max.</td>
</tr>
<tr>
<td>Curie Temperature, °F</td>
<td>420</td>
</tr>
<tr>
<td>Permeability at 200° Denitted</td>
<td>1.30</td>
</tr>
<tr>
<td>Permeability at 200° Denitted [15.9 kA/m]</td>
<td>1.06</td>
</tr>
<tr>
<td>Electrical Conductivity, Btu/lb °F</td>
<td>1.09</td>
</tr>
<tr>
<td>Electrical Resistivity, ohm·cm/mil ft</td>
<td>0.79</td>
</tr>
</tbody>
</table>

#### Typical Mechanical Properties

<table>
<thead>
<tr>
<th>(Solution Annealed)</th>
<th>Tensile Strength (1000h)</th>
<th>Yield Strength (1000h)</th>
<th>Elongation (1000h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200°F / 650°C</td>
<td>1000</td>
<td>650</td>
<td>17</td>
</tr>
<tr>
<td>1400°F / 760°C</td>
<td>91</td>
<td>56</td>
<td>14</td>
</tr>
<tr>
<td>1600°F / 870°C</td>
<td>91</td>
<td>54</td>
<td>14</td>
</tr>
<tr>
<td>1800°F / 980°C</td>
<td>91</td>
<td>52</td>
<td>14</td>
</tr>
</tbody>
</table>

#### Limiting Chemical Composition, %

- Ni: 68.0 – 71.0
- Fe: 0.05 – 0.15
- Si: 0.5 max.
- C: 0.15 max.
- Mn: 1.5 max.
- Cu: 0.015 max.
- Al: 0.1 – 1.5
- Ti: 0.08 max.
- Mo: 0.015 max.
- Nb: 0.05 max.
- Cr: 0.015 max.
- Co: 0.5 max.
- W: 0.015 max.

### INCONEL ALLOY 625

A nickel-chromium-molybdenum alloy with an addition of niobium that acts with the molybdenum to stiffen the alloy’s matrix and thereby provide high strength without a strengthening heat treatment. The alloy resists a wide range of severely corrosive environments and is especially resistant to pitting and crevice corrosion. Used in chemical processing, aerospace and marine engineering, pollution-control equipment and nuclear reactors.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>0.305 g/cm³</td>
</tr>
<tr>
<td>Melting Range, °F</td>
<td>3200 – 3500</td>
</tr>
<tr>
<td>Specific Heat, Btu/lb °F</td>
<td>0.015 max.</td>
</tr>
<tr>
<td>Curie Temperature, °F</td>
<td>420</td>
</tr>
<tr>
<td>Permeability at 200° Denitted</td>
<td>1.30</td>
</tr>
<tr>
<td>Permeability at 200° Denitted [15.9 kA/m]</td>
<td>1.06</td>
</tr>
<tr>
<td>Electrical Conductivity, Btu/lb °F</td>
<td>1.09</td>
</tr>
<tr>
<td>Electrical Resistivity, ohm·cm/mil ft</td>
<td>0.79</td>
</tr>
</tbody>
</table>

#### Typical Mechanical Properties

<table>
<thead>
<tr>
<th>(Solution Annealed)</th>
<th>Tensile Strength (1000h)</th>
<th>Yield Strength (1000h)</th>
<th>Elongation (1000h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200°F / 650°C</td>
<td>1000</td>
<td>650</td>
<td>17</td>
</tr>
<tr>
<td>1400°F / 760°C</td>
<td>91</td>
<td>56</td>
<td>14</td>
</tr>
<tr>
<td>1600°F / 870°C</td>
<td>91</td>
<td>54</td>
<td>14</td>
</tr>
<tr>
<td>1800°F / 980°C</td>
<td>91</td>
<td>52</td>
<td>14</td>
</tr>
</tbody>
</table>

#### Limiting Chemical Composition, %

- Ni: 68.0 – 71.0
- Fe: 0.05 – 0.15
- Si: 0.5 max.
- C: 0.15 max.
- Mn: 1.5 max.
- Cu: 0.015 max.
- Al: 0.1 – 1.5
- Ti: 0.08 max.
- Mo: 0.015 max.
- Nb: 0.05 max.
- Cr: 0.015 max.
- Co: 0.5 max.
- W: 0.015 max.
### INCONEL ALLOY 625LCF

A nickel-chromium-molybdenum alloy that was developed as a fatigue-resistant bellow-quality version of INCONEL alloy 625. Alloying, melting and processing of this alloy are specially designed and controlled to provide a sheet product with optimum resistance to low-cycle and thermal fatigue at temperatures up to 1000°F (538°C). Used in Aircraft exhaust and automotive flexible coupling bellows and expansion joints in various types of process or transport piping.

### INCONEL ALLOY 686

An alloy designed for outstanding corrosion-resistance in a wide range of severe environments. The alloy is used in the most severe environments encountered in chemical processing, pollution control, pulp and paper production, and treatment of industrial and municipal wastes. Chemical processing uses include heat exchangers, reaction vessels, evaporators and transfer piping. Air pollution control applications are stack liners, ducts, dampers, scrubbers, stack-gas reheaters, fans and housings.

### INCONEL ALLOY 690

INCONEL alloy 690 is a high-chromium nickel alloy with excellent resistance to many corrosive aqueous media and high-temperature atmospheres. The alloy’s high chromium content gives it excellent resistance to aqueous corrosion by oxidizing acids (especially nitric acid) and salts, and to sulfidation at high-temperature. In addition to its corrosion resistance, alloy 690 has high strength, good metallurgical stability and favorable fabrication characteristics.

### STANDARD PRODUCT FORMS

<table>
<thead>
<tr>
<th>INCONEL ALLOY 625LCF</th>
<th>INCONEL ALLOY 686</th>
<th>INCONEL ALLOY 690</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Form</strong></td>
<td><strong>Major</strong></td>
<td><strong>Major</strong></td>
</tr>
<tr>
<td>Sheet and strip</td>
<td>SAE AMS 5879</td>
<td>UNS N06690</td>
</tr>
<tr>
<td>ADI Code Case 272</td>
<td>ASME SB-443</td>
<td>ASTM B 166 - 166</td>
</tr>
<tr>
<td>W.N.: 2.4856</td>
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<td>38402</td>
</tr>
<tr>
<td>BS 3307 (NA 21)</td>
<td></td>
<td>ASTM B 166 - 166</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B 584, B 829</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM Code Cases</td>
</tr>
</tbody>
</table>

### LIMITING CHEMICAL COMPOSITION, %

<table>
<thead>
<tr>
<th><strong>Type</strong></th>
<th><strong>Ni</strong></th>
<th><strong>Fe</strong></th>
<th><strong>Mo</strong></th>
<th><strong>Cu</strong></th>
<th><strong>Fe</strong></th>
<th><strong>Si</strong></th>
<th><strong>Nb</strong></th>
<th><strong>C</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annealed</td>
<td>58.0</td>
<td>5.0</td>
<td>20.0</td>
<td>0.7</td>
<td>0.1</td>
<td>0.3</td>
<td>1.0</td>
<td>0.05</td>
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### PHYSICAL CONSTANTS AND THERMAL PROPERTIES

<table>
<thead>
<tr>
<th><strong>Property</strong></th>
<th><strong>Value</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, lb/in³</td>
<td>0.305 g/cm³</td>
</tr>
<tr>
<td>Melting Range, °F</td>
<td>2950 - 2960 °C</td>
</tr>
<tr>
<td>Specific Heat, Brufet-F°</td>
<td>0.0983 J/g°C</td>
</tr>
<tr>
<td>Curie Temperature, °F</td>
<td>500 °C</td>
</tr>
<tr>
<td>Permeability at 200 Oersted</td>
<td>1.0006</td>
</tr>
<tr>
<td>Coefficient of Expansion, 70 - 200°F</td>
<td>1.093 x 10⁻⁶ in/in</td>
</tr>
<tr>
<td>Thermal Conductivity, Btu/h • ft • °F</td>
<td>0.88 W/m • °C</td>
</tr>
<tr>
<td>Electrical Resistivity, ohm-cm/m²</td>
<td>7.76 X 10⁻⁶ Ω-m</td>
</tr>
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</table>

### TYPICAL MECHANICAL PROPERTIES

<table>
<thead>
<tr>
<th><strong>Property</strong></th>
<th><strong>Value</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength, ksi</td>
<td>110 MPa</td>
</tr>
<tr>
<td>YS, 0.2% Offset</td>
<td>55 MPa</td>
</tr>
<tr>
<td>EL, %</td>
<td>50</td>
</tr>
</tbody>
</table>

### STANDARD PRODUCT FORMS

<table>
<thead>
<tr>
<th><strong>Product Form</strong></th>
<th><strong>Major</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe, tube, plate, round bar</td>
<td>SAE AMS 5879</td>
</tr>
<tr>
<td>UNS N06690</td>
<td>ASTM B 166 - 166</td>
</tr>
<tr>
<td>ASME SB-443</td>
<td>B 584, B 829</td>
</tr>
<tr>
<td>ADI Code Case 272</td>
<td>ASTM B 166 - 166</td>
</tr>
</tbody>
</table>

### LIMITING CHEMICAL COMPOSITION, %

<table>
<thead>
<tr>
<th><strong>Type</strong></th>
<th><strong>Ni</strong></th>
<th><strong>Fe</strong></th>
<th><strong>Mo</strong></th>
<th><strong>Cu</strong></th>
<th><strong>Fe</strong></th>
<th><strong>Si</strong></th>
<th><strong>Nb</strong></th>
<th><strong>C</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annealed</td>
<td>58.0</td>
<td>5.0</td>
<td>20.0</td>
<td>0.7</td>
<td>0.1</td>
<td>0.3</td>
<td>1.0</td>
<td>0.05</td>
</tr>
</tbody>
</table>

### PHYSICAL CONSTANTS AND THERMAL PROPERTIES

<table>
<thead>
<tr>
<th><strong>Property</strong></th>
<th><strong>Value</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, lb/in³</td>
<td>0.315 g/cm³</td>
</tr>
<tr>
<td>Melting Range, °F</td>
<td>2950 - 2960 °C</td>
</tr>
<tr>
<td>Specific Heat, Brufet-F°</td>
<td>0.0899 J/g°C</td>
</tr>
<tr>
<td>Permeability at 200 Oersted</td>
<td>1.001</td>
</tr>
<tr>
<td>Coefficient of Expansion, 70 - 200°F</td>
<td>1.093 x 10⁻⁶ in/in</td>
</tr>
<tr>
<td>Thermal Conductivity, Btu/h • ft • °F</td>
<td>0.88 W/m • °C</td>
</tr>
<tr>
<td>Electrical Resistivity, ohm-cm/m²</td>
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</tr>
</tbody>
</table>

### TYPICAL MECHANICAL PROPERTIES

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<thead>
<tr>
<th><strong>Property</strong></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength, ksi</td>
<td>110 MPa</td>
</tr>
<tr>
<td>YS, 0.2% Offset</td>
<td>55 MPa</td>
</tr>
<tr>
<td>EL, %</td>
<td>50</td>
</tr>
</tbody>
</table>

*Typical usage range*
**INCONEL ALLOY 706**

INCONEL alloy 706 is a precipitation-hardenable nickel–iron–chromium–aluminum alloy that provides high mechanical strength in combination with good fabricability. The properties of the alloy are similar to those of INCONEL alloy 718 (N07718) except that alloy 706 is more readily fabricated, particularly by machining. Primary uses of the alloy are aerospace and land-based gas turbine parts and components, requiring resistance to creep, and stress rupture up to 1300°F (700°C). INCONEL alloy 718SPF is a special version designed for plastic forming.

**Phys Prop**
- Tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon, wire and extruded section.

**TYPICAL MECHANICAL PROPERTIES**
- **Room temperature**
  - Hardness: 150 HV, 7010 HRC
  - Yield Strength: 670 MPa (98 ksi)
  - Tensile Strength: 930 MPa (135 ksi)
  - Elongation: 23%

**STANDARD PRODUCT FORMS**
- UNS N07706
- SAE AMS 5605, 5606, 5701 – 5703

**PHYSICAL CONSTANTS AND THERMAL PROPERTIES**
- Density: 7.77 gm/cm³
- Thermal Conductivity: 16 W/m°C
- Coefficient of Expansion: 15.0 µm/m°C

**LIMITING CHEMICAL COMPOSITION, %**
- C: 0.03
- Mn: 1.0
- Si: 0.30
- Mo: 5.0

**TYPICAL MECHANICAL PROPERTIES**
- **Room temperature**
  - Hardness: 150 HV, 7010 HRC
  - Yield Strength: 670 MPa (98 ksi)
  - Tensile Strength: 930 MPa (135 ksi)
  - Elongation: 23%

---

**INCONEL ALLOY 718 & 718SPF**

INCONEL alloy 718 is a precipitation-hardenable nickel–chromium–molybdenum–niobium alloy that is highly resistant to corrosion and is age hardenable for extremely high strength. The properties of the alloy are excellent for post-weld cracking. The alloy has excellent creep-rupture properties up to 1300°F (700°C). Used in gas turbines, rocket motors, spacecraft, nuclear reactors, pumps and other hard-to-machine applications. INCONEL alloy 718SPF is a special version designed for plastic forming.

**Phys Prop**
- Tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon, wire and extruded section.

**TYPICAL MECHANICAL PROPERTIES**
- **Room temperature**
  - Hardness: 150 HV, 7010 HRC
  - Yield Strength: 670 MPa (98 ksi)
  - Tensile Strength: 930 MPa (135 ksi)
  - Elongation: 23%

**STANDARD PRODUCT FORMS**
- UNS N07718, N07719
- ASTM B 671
- ASME SB-671, SB-672
- DIN 17741, 17740, 17742
- DIN 17751
- SAE AMS 5501, 5502, 5503
- 2401, 2402, 2405
- 5307, 5602, 5603, 5604
- 2502, 2602, 2631, 2666
- 5924, 5925, 5967
- ISO 2080, 9732 – 9725

---

**INCONEL ALLOY 725**

A nickel–chromium–molybdenum–niobium alloy that is highly resistant to corrosion and is age hardenable for extremely high strength. The properties of this alloy are developed by heat treatment to achieve high ductility and toughness. The alloy is resistant to hydrogen embrittlement and stress-corrosion cracking. Used for high-strength fasteners in marine applications.

**Phys Prop**
- Tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon, wire and extruded section.

**TYPICAL MECHANICAL PROPERTIES**
- **Room temperature**
  - Hardness: 150 HV, 7010 HRC
  - Yield Strength: 670 MPa (98 ksi)
  - Tensile Strength: 930 MPa (135 ksi)
  - Elongation: 23%

**STANDARD PRODUCT FORMS**
- UNS N07725
- SAE AMS 5606

---

**INCONEL ALLOY 740H**

A nickel–chromium–cobalt superalloy age hardened by the precipitation of a gamma prime phase. Alloy 740H exhibits excellent high temperature strength in the age-hardened condition up to 1500°F (815°C). With its high contents of chromium and cobalt, alloy 740H offers excellent resistance to oxidation, carburization and sulfidation at elevated temperatures. Alloy 740H is targeted for use as advanced power production boiler tubes.

**Phys Prop**
- Tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon, wire and extruded section.

**TYPICAL MECHANICAL PROPERTIES**
- **Room temperature**
  - Hardness: 150 HV, 7010 HRC
  - Yield Strength: 670 MPa (98 ksi)
  - Tensile Strength: 930 MPa (135 ksi)
  - Elongation: 23%
### INCONEL ALLOY X-750

A nickel-chromium alloy similar to INCONEL alloy 600 but made precipitation hardenable by additions of aluminium and titanium. It has good resistance to corrosion and oxidation along with high tensile and creep-rupture properties at temperatures to 1300°F (700°C).

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rupture Strength (Precipitation Hardened)</td>
<td>2150°F / 1177°C, 120 ksi / 830 MPa</td>
</tr>
<tr>
<td>Young’s Modulus</td>
<td>160,000 ksi / 1110 GPa</td>
</tr>
<tr>
<td>Tensile Strength, 0.2% Offset</td>
<td>260 ksi / 1790 MPa</td>
</tr>
<tr>
<td>Yield Strength, 0.2% Offset</td>
<td>135 ksi / 930 MPa</td>
</tr>
</tbody>
</table>

### INCONEL ALLOY 751

A nickel-chromium alloy similar to INCONEL alloy X-750 but with increased aluminum content for higher precipitation hardening. This alloy was designed for use as exhaust valves in internal-combustion engines. In that application, the alloy offers high strength at operating temperatures, high heat hardness for wear resistance, and corrosion resistance in hot exhaust gases containing lead oxide, sulfur, bromine, and chlorine.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rupture Strength (Precipitation Hardened)</td>
<td>2150°F / 1177°C, 120 ksi / 830 MPa</td>
</tr>
<tr>
<td>Young’s Modulus</td>
<td>160,000 ksi / 1110 GPa</td>
</tr>
<tr>
<td>Tensile Strength, 0.2% Offset</td>
<td>260 ksi / 1790 MPa</td>
</tr>
<tr>
<td>Yield Strength, 0.2% Offset</td>
<td>135 ksi / 930 MPa</td>
</tr>
</tbody>
</table>

### INCONEL ALLOY 783

An oxidation-resistant low coefficient of thermal expansion [low CTE] superalloy developed for gas turbine applications. The alloy is strengthened by a precipitation-hardening heat treatment made possible by additions of niobium and aluminum. In addition, the aluminum content provides excellent resistance to oxidation at high temperatures. The alloy’s density is 5% less than those of superalloys such as INCONEL alloy 718.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rupture Strength (Precipitation Hardened)</td>
<td>2150°F / 1177°C, 120 ksi / 830 MPa</td>
</tr>
<tr>
<td>Young’s Modulus</td>
<td>160,000 ksi / 1110 GPa</td>
</tr>
<tr>
<td>Tensile Strength, 0.2% Offset</td>
<td>260 ksi / 1790 MPa</td>
</tr>
<tr>
<td>Yield Strength, 0.2% Offset</td>
<td>135 ksi / 930 MPa</td>
</tr>
</tbody>
</table>

### INCONEL ALLOY 782

An oxidation-resistant superalloy for gas turbine and steam turbine components. The low expansion enables closer control of clearances and tolerances for greater power output and fuel efficiency.
INCONEL ALLOY C-276

A nickel-molybdenum-chromium alloy with an addition of tungsten having excellent corrosion resistance in a wide range of severe environments. The high molybdenum content makes the alloy especially resistant to pitting and crevice corrosion. The low carbon content minimizes carbide precipitation during welding to maintain corrosion resistance in as-welded structures. Used in pollution central, chemical processing, pulp and paper production and waste treatment.

Pipe and tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon and wire.

**STANDARD PRODUCT FORMS**

**MAJOR SPECIFICATIONS**

**LIMITING CHEMICAL COMPOSITION, %**

**PHYSICAL CONSTANTS AND THERMAL PROPERTIES**

**TYPICAL MECHANICAL PROPERTIES**

**Typical usage range**

---

INCONEL ALLOY G-3

A nickel-chromium-iron alloy with additions of molybdenum and copper. It has good weldability and resistance to intergranular corrosion in the welded condition. The low carbon content helps prevent sensitization and consequent intergranular corrosion of weld heat-affected zones. Used for fly-gas scrubbers and for handling phosphoric and sulfuric acids.

Pipe and tube.

**STANDARD PRODUCT FORMS**

**MAJOR SPECIFICATIONS**

**LIMITING CHEMICAL COMPOSITION, %**

**PHYSICAL CONSTANTS AND THERMAL PROPERTIES**

**TYPICAL MECHANICAL PROPERTIES**

**Typical usage range**

---

INCONEL ALLOY HX (SOLUTION ANNEALED)

A nickel-chromium-iron-molybdenum alloy with outstanding strength and oxidation resistance at temperatures to 2200°F (1200°C). Matrix softening provided by the molybdenum content results in high strength in a solid-solution alloy having good fabrication characteristics. Used in gas turbines, industrial furnaces, heat-treating equipment and nuclear engineering.

**STANDARD PRODUCT FORMS**

**MAJOR SPECIFICATIONS**

**LIMITING CHEMICAL COMPOSITION, %**

**PHYSICAL CONSTANTS AND THERMAL PROPERTIES**

**TYPICAL MECHANICAL PROPERTIES**

**Solution Annealed**

Rupture Strength (100,000h) ksi MPa
1400°F 760°C 10.0 690
1500°F 815°C 10.0 690
1600°F 870°C 8.0 550
1700°F 980°C 3.8 260
1800°F 1000°C 2.0 130

**Typical usage range**

---

INCONEL ALLOY NOG250

A carbide strengthened nickel-chromium-tungsten alloy with an exceptional combination of strength, stability and resistance to exsolution corrosion at very high temperatures. Alloy NOG250 offers particularly good resistance to oxidation at temperatures greater than 1800°F (980°C). It also offers good resistance to carburization and nitridation. Potential applications for this alloy include equipment and components for land-based gas turbines, thermal and petrochemical processing, heat treating, and air refining.

**STANDARD PRODUCT FORMS**

**MAJOR SPECIFICATIONS**

**LIMITING CHEMICAL COMPOSITION, %**

**PHYSICAL CONSTANTS AND THERMAL PROPERTIES**

**TYPICAL MECHANICAL PROPERTIES**

**Typical usage range**

---
INCONEL ALLOY 800

**A nickel-chromium alloy with good strength and excellent resistance to oxidation and creep in severe thermal environments.**

Pipe, tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon and wire.

**UNI 36880**
**BS 3072 – 3074 (N451)**
**ASTM B 163 – 24 (B 861, B 460, A 460, B 871, B 875, B 829)
**UNS N08800**
**EN 10088-3**

+ **Typical usage range**

---

INCONEL ALLOY BOO H & BOOHT

**A nickel-iron-chromium alloy that has the same basic composition as INCOLOY alloy 800 but with an exceptional level of high-temperature strength.**

Pipe, tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon and wire.

**UNI 36880**
**BS 3072 – 3074 (N451)**
**ASTM B 163 – 24 (B 861, B 460, A 460, B 871, B 875, B 829)**
**UNS N08811**
**EN 10088-3**

+ **Typical usage range**

---

INCOLOY ALLOY 803

**Designed for use in petrochemical, chemical and thermal processing applications, the alloy provides an exceptionally high level of high-temperature strength. It also resists corrosion by reducing and oxidizing acids, stress-corrosion cracking and localized attack such as pitting and crevice corrosion.**

Pipe, tube, sheet, strip, plate, round bar, flat bar, forging stock, ID finned tube and wire.

**UNI 36885**
**ASTM A 182, A 213, A 240, A 480**
**UNS N08810, N08811**
**EN 10088-3**

+ **Typical usage range**

---

INCOLOY ALLOY 825

**A nickel-chromium alloy with additions of molybdenum and copper. It has excellent resistance to both reducing and oxidizing acids, stress-corrosion cracking and localized attack such as pitting and crevice corrosion.**

Pipe, tube, sheet, strip, plate, round bar, flat bar, forging stock, hexagon and wire.

**UNI 36885**
**BS 3072 – 3074, 3076 (N461)**
**ASTM B 163 – 265, B 870, B 871, B 875, B 710, B 711, B 715, B 829**
**UNS N08825**

+ **Typical usage range**

---

**STANDARD PRODUCT FORMS**

**MAJOR SPECIFICATIONS**

**Limiting Chemical Composition, %**

<table>
<thead>
<tr>
<th>Element</th>
<th>Typical Range</th>
<th>Max</th>
<th>Min</th>
<th>Typical Range</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.05 – 0.10</td>
<td>0.10</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si</td>
<td>0.05 – 0.20</td>
<td>0.15</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mn</td>
<td>0.50 – 1.20</td>
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<td>0.50</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cu</td>
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<td>0.30</td>
<td>0.15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PHYSICAL CONSTANTS AND THERMAL PROPERTIES**

<table>
<thead>
<tr>
<th>Property</th>
<th>Density, bN/m³ (g/cm³)</th>
<th>7.8 (14.0)</th>
<th>9.4 (17.1)</th>
<th>3.8 (6.8)</th>
<th>5.0 (9.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melting Range, °C</td>
<td>1400 – 1420</td>
<td>1420 – 1440</td>
<td>1440 – 1460</td>
<td>1460 – 1480</td>
<td>1480 – 1500</td>
</tr>
<tr>
<td>Specific Heat, J/g°C</td>
<td>9.48 (17.1)</td>
<td>9.5 (17.1)</td>
<td>9.6 (17.6)</td>
<td>9.7 (18.0)</td>
<td>9.8 (18.4)</td>
</tr>
<tr>
<td>Thermal Conductivity, W/m°C</td>
<td>45.0 (9.8)</td>
<td>45.0 (9.8)</td>
<td>45.0 (9.8)</td>
<td>45.0 (9.8)</td>
<td>45.0 (9.8)</td>
</tr>
</tbody>
</table>

**TYPICAL MECHANICAL PROPERTIES**

<table>
<thead>
<tr>
<th>Property</th>
<th>Yield Strength (0.2% Offset), ksi</th>
<th>Elongation, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annealed</td>
<td>60 – 65</td>
<td>30 – 35</td>
</tr>
</tbody>
</table>

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**INCOLOY**

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**ALLOY HANDBOOK**

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Yield Strength, ksi | 100
Elongation, % | 45

---
INCOLOY ALLOY 864

A new high-performance and cost-effective alloy specifically developed for automotive exhaust system flexible couplings. Potentially useful for exhaust gas recirculation tubes and other fabricated exhaust system components.

Sheet and strip.

INCOLOY ALLOY 865

INCOLOY alloy 865 (UNS S355115) is an economical, high-performance corrosion-resistant alloy. Developed from the technology of INCOLOY alloy 864, it improved strength, ductility and fatigue resistance at reduced cost. The alloy was designed for automotive applications such as flexible couplings and exhaust gas recirculation (EGR) components. However, with its excellent combination of strength and corrosion resistance, alloy 865 may be evaluated for chemical processing and marine applications.

Sheet and strip.

INCOLOY ALLOY 903

A nickel-iron-cobalt alloy with additions of niobium, titanium and aluminum for precipitation hardening. The alloy combines high strength with a low and constant coefficient of thermal expansion at temperatures to about 800°F (430°C). It also has a constant modulus of elasticity and is highly resistant to thermal fatigue and thermal shock. Used in gas turbines for rings and casings.

INCOLOY ALLOY 907

A nickel-iron-cobalt alloy with additions of niobium and titanium for precipitation hardening. It has the low coefficient of expansion and high strength of INCOLOY alloy 903 but with improved notch-rupture properties at elevated temperatures. Used for components of gas turbines including seals, shafts and casings.

**INCOLOY ALLOY 864**

**STANDARD FORMS**

UNS S35535

**MAJOR SPECIFICATIONS**

Ni: 30.0 – 38.0 Mo: 4.0 – 8.0 Mn: 0.01 Fe: Remainder C: 0.08 max S: 0.015 max Cr: 20.0 – 25.0 Si: 0.6 – 1.0 Ti: 0.4 – 1.0

**PHYSICAL CONSTANTS AND THERMAL PROPERTIES**

Density, lb/in³: 0.290

Density, g/cm³: 8.02

Melting Range, °C: 2484 – 2539

Curie Temperature, °F: 1353 – 1393

Permeability at 200 Derksen [15.9 kA/m]: 1.000

Coefficient of Expansion, 10⁻⁶ in/in-°F [µm/m-°C]: 70 - 200°F (21 - 93°C): 0.15 (11.7) 70 - 800°F (21 - 427°C): 0.85 (11.8) 70 - 1200°F (21 - 649°C): 9.21 (16.4)

Thermal Conductivity, Btu/h-ft²-°F: 78.1

Young’s Modulus: 17.7 x 10¹¹ psi

Electrical Resistivity, ohm-circ mil-ft: 0.085

GPA: 195

Room temperature, as annealed

**TYPICAL MECHANICAL PROPERTIES**

(Annealed)

Tensile Strength, ksi: 94.1

MPa: 641

Yield Strength (0.2% Offset), ksi: 64.8

MPa: 440

Elongation, %: 276

Annealed

Tensile Strength, ksi: 110

Yield Strength (0.2% Offset), ksi: 75.8

Elongation, %: 372

Reduction of Area, %: 50

Hardness: .08 HRB

**FATIGUE PROPERTIES AT 1000°F (540°C) LONGITUDINAL STRAIN CONTROLLED**

INCOLOY ALLOY 864 (SOLUTION ANNEALED)

Annealed

**INCOLOY ALLOY 865**

**STANDARD FORMS**

UNS S35511

**MAJOR SPECIFICATIONS**

Ni: 10.0 – 22.0 Mo: 0.20 – 0.30 P: 0.045 max Cr: 20.0 – 25.0 Mn: 1.0 max S: 0.015 max Mo: 1.50 – 2.50 C: 0.000 max

**PHYSICAL CONSTANTS AND THERMAL PROPERTIES**

Density, lb/in³: 0.276

Density, g/cm³: 7.64

Melting Range, °C: 2484 – 2535

Curie Temperature, °F: 1352 – 1390

Permeability at 200 Derksen [15.9 kA/m]: 1.000

Electrical Resistivity, ohm-circ mil-ft: 55.3

µm/m: 0.92

Young’s Modulus: 18.7 x 10¹¹ psi

GPA: 195

**TYPICAL MECHANICAL PROPERTIES**

(Annealed)

Tensile Strength, ksi: 75.8

Yield Strength (0.2% Offset), ksi: 54.4

Elongation, %: 50

Reduction of Area, %: 40

Hardness: .08 HRB

**FATIGUE PROPERTIES AT 1000°F (540°C) LONGITUDINAL STRAIN CONTROLLED**

INCOLOY ALLOY 865 (SOLUTION ANNEALED)

Annealed

**INCOLOY ALLOY 903**

**STANDARD FORMS**

UNS N09903

**MAJOR SPECIFICATIONS**

Ni: 36.0 – 40.0 Co: 13.0 – 17.0 Ti: 1.00 – 1.85 Fe: Remainder

**PHYSICAL CONSTANTS AND THERMAL PROPERTIES**

Density, lb/in³: 0.298

Density, g/cm³: 8.25

Melting Range, °C: 2405 – 2539

Curie Temperature, °F: 1351 – 1393

Specific Heat, Btu/lb-°F: 0.105

MELTING RANGE, °F: 1100°F / 595°C

Young’s Modulus: 17.7 x 10¹¹ psi

GPA: 195

**TYPICAL MECHANICAL PROPERTIES**

(Precipitation Hardened)

Tensile Strength, ksi: 110

Yield Strength (0.2% Offset), ksi: 75.8

Elongation, %: 372

Reduction of Area, %: 50

Hardness: .08 HRB

**FATIGUE PROPERTIES AT 1000°F (540°C) LONGITUDINAL STRAIN CONTROLLED**

INCOLOY ALLOY 903 (PRECIPITATION HARDENED)

Precipitation Hardened

**INCOLOY ALLOY 907**

**STANDARD FORMS**

UNS N09907

**MAJOR SPECIFICATIONS**

Ni: 35.0 – 40.0 Nb: 4.3 – 5.9 Al: 0.2 max Fe: Remainder

**PHYSICAL CONSTANTS AND THERMAL PROPERTIES**

Density, lb/in³: 0.301

Density, g/cm³: 8.33

Melting Range, °C: 2484 – 2535

Curie Temperature, °F: 1355 – 1400

Specific Heat, Btu/lb-°F: 0.103

MELTING RANGE, °F: 1100°F / 595°C

Young’s Modulus: 17.7 x 10¹¹ psi

GPA: 195

**TYPICAL MECHANICAL PROPERTIES**

(Precipitation Hardened)

Tensile Strength, ksi: 100

Yield Strength (0.2% Offset), ksi: 75.8

Elongation, %: 14

Reduction of Area, %: 40

Hardness: .08 HRB

**FATIGUE PROPERTIES AT 1000°F (540°C) LONGITUDINAL STRAIN CONTROLLED**

INCOLOY ALLOY 907 (PRECIPITATION HARDENED)

Precipitation Hardened
INCOLOY ALLOY 909

A nickel–iron–cobalt alloy with a silicon addition containing niobium and titanium for precipitation hardening. It is similar to INCOLOY alloys 903 and 907 because it has low thermal expansion and high strength. However, the silicon addition results in improved notch–rupture and tensile properties with less-restrictive processing and significantly shorter heat treatments. Used for gas-turbine casings, struts, vanes and shafts.

TYPICAL MECHANICAL AND THERMAL PROPERTIES

<table>
<thead>
<tr>
<th>Composition, %</th>
<th>Specifications</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ni ... 35.0 – 40.0</td>
<td>Nb ... 2.5 – 3.5</td>
<td>Al ... 0.15 max.</td>
</tr>
<tr>
<td>Fe ... Remainder</td>
<td>Cu ... 3.5 – 3.9</td>
<td>C ... 0.05 max.</td>
</tr>
<tr>
<td>Cr ... 12.0 - 14.0</td>
<td>Cu ... 3.5 - 3.9</td>
<td>Ni ... 0.25 - 0.5</td>
</tr>
</tbody>
</table>

STANDARD PRODUCT FORMS

| Round bar, forging stock and hot-rolled profile. | INCOLOY ALLOY 909 |

INCOLOY ALLOY 925

A precipitation–hardenable nickel–iron–chromium alloy with additions of molybdenum and copper. It combines the high strength of a precipitation–hardenable alloy with the excellent corrosion resistance of INCOLOY alloy 925. The alloy has outstanding resistance to general corrosion, pitting, crevice corrosion and stress-corrosion cracking in many aqueous environments, including those containing sulfides and chlorides. Used for surface and down-hole hardware in sour gas wells and for oil–production equipment.

TYPICAL MECHANICAL AND THERMAL PROPERTIES

<table>
<thead>
<tr>
<th>Composition, %</th>
<th>Specifications</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ni ... 42.0 – 46.0</td>
<td>Mo ... 2.5 – 3.5</td>
<td>Al ... 0.1 – 0.5</td>
</tr>
<tr>
<td>Fe ... Remainder</td>
<td>Cu ... 3.5 – 3.9</td>
<td>C ... 0.03 max.</td>
</tr>
<tr>
<td>Cr ... 19.5 – 22.5</td>
<td>Cu ... 3.5 – 3.9</td>
<td>Ni ... 0.25 – 0.5</td>
</tr>
</tbody>
</table>

INCOLOY ALLOY 945

INCOLOY alloy 945 (UNS N09945) is a corrosion-resistant, high strength, age hardenable nickel–iron–chromium alloy. Its nickel content provides resistance to stress corrosion cracking. Its combination of nickel, molybdenum and copper gives it outstanding resistance to attack by reducing media, while its high chromium content provides resistance to oxidizing environments. Molybdenum and niobium provide resistance to localized attack such as pitting and crevice corrosion. Nickel, titanium and aluminum react upon heat treatment to precipitate gamma prime. The general usage range is 1800°F (982°C) and 2900°F (1590°C). Both alloys are approved to NACE MR0175 Level VI and Level VI-1500°F. Thus, alloys 945 and 945X find applications in corrosive sour oil and gas environments containing hydrogen sulfide, free-sulfur, carbon dioxide, chlorides and other aggressive corrodents.

TYPICAL MECHANICAL PROPERTIES

<table>
<thead>
<tr>
<th>Composition, %</th>
<th>Specifications</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ni ... 45.0 – 55.0</td>
<td>Nb ... 2.5 – 4.5</td>
<td>Mo ... 1.0 max.</td>
</tr>
<tr>
<td>Fe ... 18.5 – 23.0</td>
<td>Cr ... 6.0 max.</td>
<td>Si ... 0.5 max.</td>
</tr>
<tr>
<td>Cu ... 0.005 – 0.035</td>
<td>Al ... 0.01 – 0.03</td>
<td>P ... 0.03 max.</td>
</tr>
<tr>
<td>Cr ... 19.5 – 22.5</td>
<td>Cu ... 0.005 – 0.035</td>
<td>Si ... 0.03 max.</td>
</tr>
<tr>
<td>Ni ... 15 – 30</td>
<td>Cu ... 15 – 30</td>
<td>Ni ... 15 – 30</td>
</tr>
</tbody>
</table>

STANDARD PRODUCT FORMS

| Bar, forging stock, tubes. | INCOLOY ALLOY 945 |

INCOLOY ALLOY 945X

INCOLOY alloy 945X (UNS N09945X) offers enhanced strength over that of INCOLOY alloy 945. With increased levels of hardeners in the alloy composition, alloy 945X exhibits a minimum yield strength of 140 ksi. With this higher strength, alloy 945X is especially well suited for high strength field equipment as both bar and mechanical tube products. The corrosion resistance of INCOLOY alloy 945X is comparable to that of INCOLOY alloy 945. Both alloys are approved to NACE MR0175 Level VII and Level VI-1500°F. Thus, alloys 945 and 945X find applications in corrosive sour oil and gas environments containing hydrogen sulfide, free-sulfur, carbon dioxide, chlorides and other aggressive corrodents.

TYPICAL MECHANICAL PROPERTIES

<table>
<thead>
<tr>
<th>Composition, %</th>
<th>Specifications</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ni ... 45.0 – 55.0</td>
<td>Nb ... 2.5 – 4.5</td>
<td>Mo ... 1.0 max.</td>
</tr>
<tr>
<td>Fe ... 18.5 – 23.0</td>
<td>Cr ... 6.0 max.</td>
<td>Si ... 0.5 max.</td>
</tr>
<tr>
<td>Cu ... 0.005 – 0.035</td>
<td>Al ... 0.01 – 0.03</td>
<td>P ... 0.03 max.</td>
</tr>
<tr>
<td>Cr ... 19.5 – 22.5</td>
<td>Cu ... 0.005 – 0.035</td>
<td>Si ... 0.03 max.</td>
</tr>
<tr>
<td>Ni ... 15 – 30</td>
<td>Cu ... 15 – 30</td>
<td>Ni ... 15 – 30</td>
</tr>
</tbody>
</table>

INCOLOY ALLOY 945X

INCOLOY alloy 945X (UNS N09945X) offers enhanced strength over that of INCOLOY alloy 945. With increased levels of hardeners in the alloy composition, alloy 945X exhibits a minimum yield strength of 140 ksi. With this higher strength, alloy 945X is especially well suited for high strength field equipment as both bar and mechanical tube products. The corrosion resistance of INCOLOY alloy 945X is comparable to that of INCOLOY alloy 945. Both alloys are approved to NACE MR0175 Level VII and Level VI-1500°F. Thus, alloys 945 and 945X find applications in corrosive sour oil and gas environments containing hydrogen sulfide, free-sulfur, carbon dioxide, chlorides and other aggressive corrodents.

TYPICAL MECHANICAL PROPERTIES

<table>
<thead>
<tr>
<th>Composition, %</th>
<th>Specifications</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ni ... 45.0 – 55.0</td>
<td>Nb ... 2.5 – 4.5</td>
<td>Mo ... 1.0 max.</td>
</tr>
<tr>
<td>Fe ... 18.5 – 23.0</td>
<td>Cr ... 6.0 max.</td>
<td>Si ... 0.5 max.</td>
</tr>
<tr>
<td>Cu ... 0.005 – 0.035</td>
<td>Al ... 0.01 – 0.03</td>
<td>P ... 0.03 max.</td>
</tr>
<tr>
<td>Cr ... 19.5 – 22.5</td>
<td>Cu ... 0.005 – 0.035</td>
<td>Si ... 0.03 max.</td>
</tr>
<tr>
<td>Ni ... 15 – 30</td>
<td>Cu ... 15 – 30</td>
<td>Ni ... 15 – 30</td>
</tr>
</tbody>
</table>
INCOLOY ALLOY 20

A nickel-iron-chromium alloy with additions of cobalt, copper and molybdenum. It also contains nickelium for stabilization against sensitization and resultant intergranular corrosion. The alloy has excellent resistance to general corrosion, pitting and crevice corrosion in chemicals containing chlorides and sulfuric, phosphoric and nitric acids. Used for tanks, piping, heat exchangers, pumps, valves and other process equipment.

INCOLOY ALLOY 28

INCOLOY alloy 28 (UNS NO8028) is a highly corrosion-resistant austenitic alloy offering resistance to chloride stress corrosion cracking and excellent resistance to pitting and crevice corrosion. It is also useful in highly oxidizing environments.

STANDARD PRODUCT FORMS

Pipe, tube, sheet, strip, plate, round bar, flat bar, forging, stock, hexagon and wire.

MAJOR SPECIFICATIONS

UNS N08028

ASTM B 688, B 780, B 829

Workshop No. 1-961

NACE MR-01-75

LIMITING CHEMICAL COMPOSITION, %

Ni ... 30.0 - 34.0 Fe ... Balance S ... 0.030 max. Cr ... 26.0 - 28.0 Mn ... 2.50 max. Si ... 1.00 max. Mo ... 3.0 - 4.0 Cu ... 0.030 max. Cu ... 0.016 - 0.14 P ... 0.030 max.

PHYSICAL CONSTANTS AND THERMAL PROPERTIES

Density, lb/in³ / g/cm³ 0.292 / 3.94

Specific Heat, Btu/lb °F (J/kg °C) 8.08 / 3.94

Coefficient of Expansion, °F / 10°F (µm/°C) 0.012 / 1.25

Thermal Conductivity, Btu/h ft °F (W/m K) 0.85 / 0.48

Electrical Resistivity, ohm-cm (mΩ-m) 12.3 / 0.1

Typical mechanical properties

(Typical usage range)

Tensile Strength, ksi 100 Yield Strength (0.2% Offset), ksi 62.0 Elongation, % 20

(Annealed)

Tensile Strength, ksi 130 Yield Strength (0.2% Offset), ksi 82.0 Elongation, % 75

(Cold Worked)

Tensile Strength, ksi 130 Yield Strength (0.2% Offset), ksi 85.0 Elongation, % 75

Young’s Modulus, 10 hint (GPa) 29.0 / 200

Electrical Resistivity, ohm-cm (mΩ-m) 1.08

Warm temperature, as annealed

INCOLOY ALLOY 330

A nickel-iron-chromium alloy with an addition of silicon for enhanced oxidation resistance. It has good strength at high temperatures and excellent resistance to carburizing and oxidizing atmospheres. The alloy’s austenitic microstructure remains stable during long time exposure to high temperatures. Used in industrial heating for furnace muffles, retorts, conveyor systems and heat-treating baskets and fixtures.

STANDARD PRODUCT FORMS

Pipe, tube, sheet, strip, plate, round bar, forging, stock, hexagon, wire and rod.

MAJOR SPECIFICATIONS

UNS N08367, N08366

ASTM B 366, B 511, B 512, B 835, B 856, B 942, B 710, B 735, B 739, B 829

Workshop No. 1-981

NACE MR-01-75

LIMITING CHEMICAL COMPOSITION, %

Ni ... 34.0 - 37.0 Si ... 0.75 - 1.50 P ... 0.30 max. Fe ... Balance Mo ... 1.50 max. Si ... 0.30 max. Cr ... 17.0 - 20.0 Mn ... 2.0 max.

PHYSICAL CONSTANTS AND THERMAL PROPERTIES

Density, lb/in³ / g/cm³ 0.292 / 3.94

Specific Heat, Btu/lb °F (J/kg °C) 8.08 / 3.94

Coefficient of Expansion, °F / 10°F (µm/°C) 0.012 / 1.25

Thermal Conductivity, Btu/h ft °F (W/m K) 0.85 / 0.48

Electrical Resistivity, ohm-cm (mΩ-m) 12.3 / 0.1

Typical mechanical properties

(Annealed)

Rupture Strength (1000h), ksi 240 Yield Strength (0.2% Offset), ksi 110 Elongation, % 60

(Typical usage range)

(Annealed)

Tensile Strength, ksi 100 Yield Strength (0.2% Offset), ksi 60 Elongation, % 40

(Annealed)

Tensile Strength, ksi 100 Yield Strength (0.2% Offset), ksi 60 Elongation, % 40

0.02 max.

INCOLOY ALLOY 25-6MO

A super-austenitic containing 6% molybdenum and offering excellent corrosion-resistance to neutral and acidic environments. It is resistant to chloride containing chlorides or other halides, such as what is found in air pollution control and flue gas desulfurization systems. The molybdenum and nitrogen content provide resistance to pitting and crevice corrosion, while copper enhances resistance to sulfuric acid. The alloy is especially suited for service in high-chloride environments such as brackish water, seawater, caustic chlorides and pulp mill bleach systems.

STANDARD PRODUCT FORMS

Pipe, tube, sheet, strip, plate, round bar, forging, stock and wire.

MAJOR SPECIFICATIONS

UNS N08835, N08836, N08834

ASTM A 242, A 480, B 366

Workshop No. 1-987

NACE MR-01-75

LIMITING CHEMICAL COMPOSITION, %

Ni ... 24.0 - 26.0 Cu ... 0.5 - 1.5 P ... 0.03 max. Fe ... Balance Mo ... 0.05 max. Si ... 0.30 max. Cr ... 19.0 - 21.0 Mn ... 2.0 max.

PHYSICAL CONSTANTS AND THERMAL PROPERTIES

Density, lb/in³ / g/cm³ 0.292 / 3.94

Specific Heat, Btu/lb °F (J/kg °C) 8.08 / 3.94

Coefficient of Expansion, °F / 10°F (µm/°C) 0.012 / 1.25

Thermal Conductivity, Btu/h ft °F (W/m K) 0.85 / 0.48

Electrical Resistivity, ohm-cm (mΩ-m) 12.3 / 0.1

Typical mechanical properties

(Annealed)

Rupture Strength (1000h), ksi 240 Yield Strength (0.2% Offset), ksi 110 Elongation, % 60

(Annealed)

Typical usage range

Typical usage range

INCOLOY
INCOLOY alloy A-286

An alloy that is precipitation hardenable for high mechanical properties. The alloy maintains good strength and oxidation resistance at temperatures up to about 1300°F (700°C). The alloy’s high strength and excellent fabrication characteristics make it useful for various components of aircraft and industrial gas turbines. Applications include blades, vanes, tail cones, afterburners, spinners and fasteners. This alloy is also used for automotive applications.

INCOLOY® alloy 890 (UNS N08890) is the latest addition to the INCOLOY® alloy family of high-temperature resistant alloys. Alloy 890 joins existing INCOLOY® products in offering high strength along with excellent resistance to oxidation, carburization and sulfidation at temperatures up to 2500°F (1370°C). Alloy 890 offers the high chromium content of alloy 803 along with improved properties from additions of molybdenum, silicon and niobium. The primary application for alloy 890 is tubes for ethylene pyrolysis furnaces.

INCOLOY™ alloy 890 (UNS N08890) is the latest addition to the INCOLOY™ alloy family of heat-resistant alloys. Alloy 890 joins existing INCOLOY™ products in offering high strength along with excellent resistance to oxidation, carburization and sulfidation at temperatures up to 2500°F (1370°C). Alloy 890 offers the high chromium content of alloy 803 along with improved properties from additions of molybdenum, silicon and niobium. The primary application for alloy 890 is tubes for ethylene pyrolysis furnaces.
A nickel-chromium alloy similar to NIMONIC alloy 75 but made precipitation hardenable by additions of aluminum and titanium. The alloy has good corrosion and oxidation resistance and high tensile and creep-rupture properties at temperatures to 1500°F (815°C). Used for gas-turbine components [blades, rings and discs], bolts, tube supports in nuclear steam generators, die-casting inserts and cores, and exhaust valves in internal-combustion engines.

**Typical mechanical properties**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Rupture Strength (1000h)</th>
<th>ksi</th>
<th>MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Annealed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1100°F / 649°C</td>
<td>1200°F / 650°C</td>
<td>20</td>
<td>140</td>
</tr>
<tr>
<td>1200°F / 650°C</td>
<td>1300°F / 705°C</td>
<td>24</td>
<td>165</td>
</tr>
<tr>
<td>1300°F / 705°C</td>
<td>1400°F / 760°C</td>
<td>31</td>
<td>217</td>
</tr>
<tr>
<td>1400°F / 760°C</td>
<td>1500°F / 815°C</td>
<td>20</td>
<td>140</td>
</tr>
<tr>
<td>(Precipitation Hardened)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1100°F / 649°C</td>
<td>1200°F / 650°C</td>
<td>20</td>
<td>140</td>
</tr>
<tr>
<td>1200°F / 650°C</td>
<td>1300°F / 705°C</td>
<td>24</td>
<td>165</td>
</tr>
<tr>
<td>1300°F / 705°C</td>
<td>1400°F / 760°C</td>
<td>31</td>
<td>217</td>
</tr>
<tr>
<td>1400°F / 760°C</td>
<td>1500°F / 815°C</td>
<td>20</td>
<td>140</td>
</tr>
</tbody>
</table>

### Properties

- **Density**: 0.296 g/cm³
- **Electrical Resistivity**: 0.309 Ω-m
- **Young’s Modulus**: 36.5 MPa
- **Coefficient of Expansion**: 68 - 212°F: 0.0002°F⁻¹
- **Coefficient of Permeability**: 0.0006
- **Coefficient of Thermal Conductivity**: 81.1 W/m-K
- **Coefficient of Thermal Expansion**: 11.7 10⁻⁶°C⁻¹
- **Electrical Resistivity**: 7.46 × 10⁻⁵ Ω-m

### Typical usage range

- **Rupture Strength (1000h)**: 110°F / 60°C
- **Young’s Modulus**: 20 - 1000 MPa
- **Electrical Resistivity**: 7.46 × 10⁻⁵ Ω-m
- **Coefficient of Thermal Expansion**: 11.7 10⁻⁶°C⁻¹

**Limiting chemical composition, %**

- Ni: 65 - 70
- Mo: 10 - 12
- C: 0.05 - 0.15
- Cu: 2.5 - 3.0
- Fe: 1.0 - 2.0
- Mn: 0.1 - 0.2
- Si: 0.1 - 0.2
- Al: 1.0 - 2.0
- Ti: 2.0 - 3.0
- Zr: 0.1 - 0.15
- Cr: 0.1 - 0.2

**Standard product forms**

- UNS N07080
- DIN 17760
- Alloys 2401, 2402, 2403, 2404, 2405
- HR201, HR401, HR601
- Wrought forging stock and plate.

**Major specifications**

- HR201, HR401, HR601
- UNS N06075
- DIN 17742, 17750 – 17752
- HR601
- ASTM B 827
- AISI 305-37

**Thermal constants and properties**

- **Density**: 0.296 g/cm³
- **Electrical Resistivity**: Ω-m
- **Young’s Modulus**: 36.5 MPA
- **Coefficient of Expansion**: 68 - 212°F: 10⁻⁶°F⁻¹
- **Coefficient of Permeability**: 0.0006
- **Coefficient of Thermal Conductivity**: 81.1 W/m-K
- **Coefficient of Thermal Expansion**: 11.7 10⁻⁶°C⁻¹
- **Electrical Resistivity**: 7.46 × 10⁻⁵ Ω-m
- 20 - 1000 MPa

**Typical usage range**

- Rupture Strength (1000h): 110°F / 60°C
- Young’s Modulus: 20 - 1000 MPa
- Electrical Resistivity: 7.46 × 10⁻⁵ Ω-m
- Coefficient of Thermal Expansion: 11.7 10⁻⁶°C⁻¹
- Typical usage range
### NIMONIC ALLOY 105

A precipitation-hardenable nickel-cobalt-chromium alloy with an addition of molybdenum for solid-solution strengthening. The relatively high aluminum content enhances both strength (through greater precipitation hardening) and oxidation resistance. The alloy has high creep-rupture properties at temperatures to about 1740°F (950°C). Used in gas turbine blades for discs and shafts.

**Standard Product Forms**
- BS-M48
- AECMA Pr EN 2179 - 2181
- Werkstoff Nr. 2.4814

**Limiting Chemical Composition, %**
- Ni.....Remainder
- Al.....4.5 - 4.9
- Mn.....1.0 max.
- Cr.....18.0 – 20.0
- C.....0.12 max
- S.....0.010 max.
- Mo.....4.5 - 5.5
- Cu.....0.3 max
- Zr.....0.15 max.
- Ti.....0.9 - 1.5
- Fe.....1.0 max.

**Physical Constants and Thermal Properties**
- Density, lb/ft³
- Melting Range, °F
- Specific Heat, Btu/lb
- Thermal Conductivity, Btu/h ft °F
- Electrical Resistivity, ohm-cm

**Typical Mechanical Properties**
- (Precipitation Hardened)
  - Rupture Strength (1000h), ksl/ft²
  - Temperature, °F

**Typical Usage Range**

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### NIMONIC ALLOY 115

A precipitation-hardenable nickel-chromium-cobalt alloy with an addition of molybdenum for solid-solution strengthening. It is similar to NIMONIC alloy 105 but has higher levels of aluminum and titanium for increased strengthening by precipitation hardening. The alloy has high strength and creep resistance at temperatures to about 1850°F (1010°C). Used for turbine blades in aircraft gas turbines.

**Standard Product Forms**
- BS-M48
- AECMA Pr EN 2196, 2197
- Werkstoff Nr. 2.4636

**Limiting Chemical Composition, %**
- Ni.....Remainder
- Al.....4.5 - 5.5
- Mn.....1.0 max.
- Cr.....14.0 – 16.0
- C.....0.12 – 0.2
- S.....0.015 max.
- Mo.....3.0 – 5.0
- Cu.....0.2 max
- Zr.....0.15 max.
- Ti.....3.5 – 4.5
- Fe.....1.0 max.

**Physical Constants and Thermal Properties**
- Density, lb/ft³
- Melting Range, °F
- Specific Heat, Btu/lb
- Thermal Conductivity, Btu/h ft °F
- Electrical Resistivity, ohm-cm

**Typical Mechanical Properties**
- (Precipitation Hardened)
  - Rupture Strength (1000h), ksl/ft²
  - Temperature, °F

**Typical Usage Range**

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### NIMONIC ALLOY 263

A precipitation-hardenable nickel-chromium-cobalt alloy with an addition of molybdenum for solid-solution strengthening. It has high strength and corrosion resistance along with good formability and high-temperature ductility in welded structures. The alloy is especially suitable for sheet applications. Used in gas turbines for rings, casings and various sheet fabrications.

**Standard Product Forms**
- UNS N07263
- AECMA Pr EN
- Werkstoff Nr. 2.4601

**Limiting Chemical Composition, %**
- Ni.....Remainder
- Al.....6.0 max
- Mn.....0.007 max.
- Cr.....19.0 – 21.0
- Ti.....0.5 – 1.0
- Co.....2.1 – 2.6
- Cu.....0.05 max.
- Mo.....5.0 – 6.1
- Si.....0.40 max.
- Fe.....0.7 max.

**Physical Constants and Thermal Properties**
- Density, lb/ft³
- Melting Range, °F
- Specific Heat, Btu/lb
- Thermal Conductivity, Btu/h ft °F
- Electrical Resistivity, ohm-cm

**Typical Mechanical Properties**
- (Precipitation Hardened)
  - Rupture Strength (1000h), ksl/ft²
  - Temperature, °F

**Typical Usage Range**

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### NIMONIC ALLOY 901

A nickel-iron-chromium alloy containing titanium and aluminum for precipitation hardening and molybdenum for solid-solution strengthening. The alloy has high yield-strength and creep resistance at temperature to about 1110°F (600°C). A substantial iron content enables the alloy to be contorted to high strength with good forging characteristics. Used in gas turbines for discs and shafts.

**Standard Product Forms**
- UNS N09901
- AECMA Pr EN
- Werkstoff Nr. 2.4602

**Limiting Chemical Composition, %**
- Ni.....Remainder
- Fe.....85.0 – 85.5
- Mn.....0.35 max
- Mo.....0.5 max
- Cr.....10.0 – 11.0
- Co.....0.1 max
- Cu.....1.0 max
- Al.....0.5 – 0.6
- Ti.....0.007 max

**Physical Constants and Thermal Properties**
- Density, lb/ft³
- Melting Range, °F
- Specific Heat, Btu/lb
- Thermal Conductivity, Btu/h ft °F
- Electrical Resistivity, ohm-cm

**Typical Mechanical Properties**
- (Precipitation Hardened)
  - Rupture Strength (1000h), ksl/ft²
  - Temperature, °F

**Typical Usage Range**
**NIMONIC ALLOY PE11**

A nickel-iron-chromium alloy precipitation hardened by titanium and aluminum and solid-solution strengthened by an addition of molybdenum. It was developed as a high-strength sheet alloy for use at temperatures to 1000°F (550°C). The high iron content provides good workability and also relatively high tensile ductility, especially after welding. Used for components of gas turbines.

**NIMONIC ALLOY PE16**

A precipitation-hardenable nickel-iron-chromium alloy with an addition of molybdenum for solid-solution strengthening. It has good strength and oxidation resistance at temperatures to about 1380°F (750°C). The alloy is designed to provide a precipitation-hardened material having excellent hot-working, cold-working and welding characteristics. Used for gas-turbine components and nuclear reactors.

**NIMONIC ALLOY PK35**

A nickel-iron-chromium-cobalt alloy that is precipitation hardenable and also contains a relatively high (7%) level of molybdenum for solid-solution strengthening. It has an exceptional combination of high-temperature strength, creep resistance and ductility when welded. The alloy is especially suitable for welded sheet structures. Used in gas turbines for flame tubes and other components.

**NIMONIC ALLOY MP35N**

NIMONIC alloy MP35N is a multi-phase, cobalt-base alloy offering a unique combination of ultra-high strength, toughness and corrosion resistance. Common applications are fasteners, springs and high strength components for marine, oil and gas, and chemical processing services.
### NILO ALLOY 36

A nickel-iron-cobalt controlled-expansion alloy containing 29% nickel. Its coefficient of expansion in applications requiring high reliability or resistance to thermal shock. Examples include: high-power transmitting valves, transistor leads and headers, integrated-circuit lead frames and photography flash bulbs.

#### MAJOR SPECIFICATIONS

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<th>Fe</th>
<th>Co</th>
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#### PHYSICAL CONSTANTS AND THERMAL PROPERTIES

- **Density**: 8.11 g/cm³
- **Electrical Resistivity**: 5.24 µΩ·m

#### TYPICAL MECHANICAL PROPERTIES

- **Annealed**
  - Tensile Strength: 310 MPa
  - Yield Strength: 220 MPa
  - Elongation: 40%

- **Annealed**
  - Tensile Strength: 290 MPa
  - Yield Strength: 200 MPa
  - Elongation: 35%

### NILO ALLOY 42

A nickel-iron controlled-expansion alloy containing 62% nickel. It has a low and nominally constant coefficient of thermal expansion from room temperature to about 570°F (300°C). Used for semiconductor lead frames in integrated circuits, bi-metal thermostat strip, thermostat rods, for ceramic-to-metal seals with alumina ceramics and various glass-to-metal seals such as: the core of copper-clad wire for sealing in glass envelopes of electric bulbs, radio valves, television tubes and fluorescent lights.

#### MAJOR SPECIFICATIONS

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<tr>
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#### PHYSICAL CONSTANTS AND THERMAL PROPERTIES

- **Density**: 8.08 g/cm³
- **Electrical Resistivity**: 4.06 µΩ·m

#### TYPICAL MECHANICAL PROPERTIES

- **Annealed**
  - Tensile Strength: 300 MPa
  - Yield Strength: 210 MPa
  - Elongation: 40%

- **Annealed**
  - Tensile Strength: 280 MPa
  - Yield Strength: 190 MPa
  - Elongation: 35%

### NILO ALLOY 48

A nickel-iron-cobalt controlled-expansion alloy containing 68% nickel. Its coefficient of thermal expansion is designed to match that of soft lead and soda-lime glasses. The alloy also has a high inflection point. Used for glass-to-metal seals in radio valves and incandescent electric light bulbs and for industrial thermostats that operate at temperatures up to 810°F (450°C).

#### MAJOR SPECIFICATIONS

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#### PHYSICAL CONSTANTS AND THERMAL PROPERTIES

- **Density**: 8.00 g/cm³
- **Electrical Resistivity**: 3.00 µΩ·m

#### TYPICAL MECHANICAL PROPERTIES

- **Annealed**
  - Tensile Strength: 290 MPa
  - Yield Strength: 190 MPa
  - Elongation: 40%
**FERRY ALLOY**

A copper–nickel alloy used mainly for its electrical properties. It has medium-range electrical resistivity and a very low temperature coefficient of resistance (TCR). The low TCR makes the alloy useful for wire-wound precision resistors having operating temperatures up to 750°F (400°C). A reproducible electromotive force against copper makes the alloy suitable for thermocouples and thermocouple compensating leads.

**NI-Span-C Alloy 902**

A nickel–iron–chromium alloy made precipitation hardenable by additions of aluminum and titanium. The titanium content also helps provide a constant modulus of elasticity at temperatures from -50 to 150°F (-45 to 65°C). Used for precision springs, mechanical resonators and other precision elastic components.

**WASPALLOY**

Waspalloy is a nickel-base, age-hardenable superalloy with excellent high-temperature strength and good oxidation resistance to 1300°F (700°C). The high chromium level coupled with small additions of lanthanum produce an extremely tenacious and protective scale. The alloy also has good sulfidation resistance and excellent metallurgical stability displayed by its ductility after prolonged exposure to elevated temperatures. Fabricability and weldability combine to make the alloy useful in typical gas turbine applications such as combustors, flame holders, liners and transition ducts.

**UDIMET ALLOY 188**

A cobalt-base alloy with excellent high temperature strength and good oxidation resistance to 1300°F (700°C). The high chromium level coupled with small additions of lanthanum produce an extremely tenacious and protective scale. The alloy also has good sulfidation resistance and excellent metallurgical stability displayed by its ductility after prolonged exposure to elevated temperatures. Fabricability and weldability combine to make the alloy useful in typical gas turbine applications such as combustors, flame holders, liners and transition ducts.
FORGING BILLET AND BAR

- Forging bar.
- Forging billet, bar, sheet, plate and wire.

UDIMET ALLOY L-605

- A cobalt-base superalloy with good formability, high strength to 1500°F (816°C) and oxidation resistance to 2000°F (1093°C).
- Has good sulfidation resistance and resistance to wear and galling. The alloy is used in industrial furnace kilns.

UDIMET ALLOY 250

- A precipitation hardenable nickel-base superalloy with an exceptional combination of high temperature mechanical properties, corrosion resistance and forgeability characteristics.
- Developed for use in the 1400–1700°F (760–927°C) temperature range, the alloy has excellent structural stability and unusually good fabricability.
- Primarily applied is blading for aircraft and land-based gas turbines.

UDIMET ALLOY 720

- A nickel-base alloy solid solution strengthened with tungsten and molybdenum and precipitation hardened with titanium and aluminum.
- The alloy combines high strength with metallurgical stability, as demonstrated by excellent impact strength retention after long exposures at elevated temperatures.
- Good oxidation and corrosion resistance combined with high strength make the alloy useful in gas turbine blades and disc applications.

OTHER ALLOYS

PHYSICAL CONSTANTS

- Composition, %
- Limiting Chemical Standard

STANDARD PRODUCT FORMS

MAJOR SPECIFICATIONS

LIMITING CHEMICAL COMPOSITION, %

PHYSICAL CONSTANTS AND THERMAL PROPERTIES

TYPICAL MECHANICAL PROPERTIES

UDIMET ALLOY D-979

- An iron-nickel alloy designed for turbine blade and disc applications at temperatures up to 1200–1400°F (649–760°C). Hardened by a complex precipitation of intermetallic phases, the alloy combines corrosion resistance with excellent tensile and stress rupture strength.
### UDIMET ALLOY R41

A precipitation hardenable nickel-chromium alloy containing significant amounts of cobalt and molybdenum, along with lesser amounts of aluminum and titanium. It exhibits extremely high room and elevated temperature mechanical properties. Excellent corrosion resistance and fabricability have led to wide usage in critical aircraft engine components such as nozzle partitions, turbine blades and wheels, combustion chamber liners and structural hardware.

### INCOTHERM ALLOY TD

A nickel-chromium-molybdenum alloy that was originally developed for thermocouple sheathing where high temperature corrosion resistance and strength are required without the use of elements that may cause thermocouple degradation over time, the alloy has now been identified for uses in other high temperature and heat-treating applications. This product has been tailored to provide improved oxidation resistance over stainless steels and higher nickel alloys at temperatures up to 1200°F (650°C) and possibly beyond. The alloy’s additions improve oxide scale adhesion and reduce the rate of mass change, allowing the alloy to show significant improvements over alloys currently being used in heat treating applications. INCOTHERM alloy TD has excellent resistance to nitridation up to 2000°F (1090°C). Lacking the alloying elements that form nitrides such as Nb or Al, the product exhibits freedom from microstructural degradation in nitrogen-based atmospheres. Because of this excellent resistance to nitridation, the alloy is being evaluated for use in powder metallurgy sintering furnace belts and other thermal processing applications as well as thermocouple sheathing.

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**UDIMET ALLOY R41**

**INCOTHERM ALLOY TD**

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**Typical Mechanical Properties**

**Mechanical Properties INCOHERM alloy TD**

**Selected Conversion Factors for U.S. Customary SI Metric Units**

**Conversion Factors for Units of Measure**

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**Conversion Factors for Units of Measure**

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**Conversion Factors for Units of Measure**

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**Conversion Factors for Units of Measure**

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**Conversion Factors for Units of Measure**

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**Conversion Factors for Units of Measure**
MAJOR USES

INCONEL alloys 718 and X-750.
MONEL alloy 450; weldable grades of 70/30, 80/20, and 90/10 copper-nickel alloys.

INCONEL alloy HX.
MIL-E-21562 TYPE

MONEL alloy 400 to itself, to low-alloy and carbon steels, to copper and copper-nickel alloys; surfacing of steels.

High deposition rate flux for strip overlays with INCONEL weldstrips 82 and 625.
30% Cr for GMAW & GTAW welding of 690 and for overlays on steel; INCONEL alloys 600 and 601; surfacing of steels.

INCONEL alloys 625 and 601; pit-resistant alloys; dissimilar combinations of steels and nickel alloys; surfacing of steels.

INCONEL Welding Electrode 110
INCONEL alloys 825 and 801; pit-resistant alloys; dissimilar combinations of steels and nickel alloys; surfacing of steels.

INCOFLUX NT100

Ni-Rod FM 82 Welding Electrode

Inconel 625, 601, and 600; acid-resistant stainless steels; 9% nickel steel.

For SMAW of INCONEL weldstrips 82 and 625 and other NiCrMo alloys; excellent pitting and crevice corrosion resistance & resistance to mixed acids. Also for low NOx boiler tube overlay.

Maximum resistance to pitting, crevice corrosion & mixed acids; excellent for overlay, welding of clad steels and providing overmatching corrosion-resistant welds for all types of NiCrMo alloys and super duplex stainless steels.

ENiCrFe-2

Weld strip; excellent for overlay, welding of clad steels and providing overmatching corrosion-resistant welds for all types of NiCrMo alloys and super duplex stainless steels.

ENiCrMo-3

INCOFLUX SAS1

ENi-1

ENiCrMo-14

FOR highest bond strength arc-spray build ups and bond coats, for bonding and protective coatings.

INCOFLUX Spray Spray 301STW

Corrosion-resistant arc-spray coatings used for pulp and paper and other industry applications.

INCONEL Thermal Spray 727STW

Most sulfurization-resistant arc-spray product, used extensively in black liquor recovery boilers.

INCOFLUX 727STW

Ni-Rod FM 82 Welding Electrode

For SMAW with MONEL FM 60 and butt welding and overlaying of cast iron with Ni-Rod PC 55.

FOR SAW with FM 82, 625, 51, CF36, CF42, Ni-Rod FM 99 and 4% for limited thickness butt welds and overlays.

Neutral SAW flux for overlays with FM 82, 625, 61 and Ni-Rod FM 64 and 99; also used with FM CF36 and CF42.

Neutral SAW flux for overlaying with MONEL FM 60 and 67.

SAW flux for butt welding and overlaying with PNs C-276, 620, and 626/CTP.

High-deposition rate flux for strip overlays with INCONEL weldstrips 82, 625, and INCO-WELD weldstrip 626CTP with ESS processes.

For electroslag strip welding overlay (ESSW) with INCONEL 52 and 52M Weldstrips.

For electroslag strip welding overlay (ESSW) with INCONEL 82, 625 and 626 Weldstrips, and INCO-WELD C-276.

For electroslag strip welding overlay (ESSW) with INCONEL 82, 625, and INCO-WELD C-276 and BICOPT.

High deposition rate flux for strip overlays with INCONEL weldstrips 82 and 625.

For submerged arc strip welding overlay (DSSW) with INCONEL 52 and 52M Weldstrips.

MONEL Weldstrip 60

Weldstrip for producing MONEL 400 type overlays at high-deposition rates with the electroslag surfacing (ESS) and submerged arc strip (SAS) processes.

Weldstrip for producing nickel overlays at high-deposition rates with ESS and SAS processes.

Weldstrip for high-deposition rate overlays of INCONEL alloy 625 type using ESS and SAS processes.

NLD CF36 Filler Metal

For GMAW & GTAW of INNAR and similar low expansion alloys; deposits crack-free welds that are closely matching in 1/4" to INNAR.

Similar to NLD CF36, but is intended for 42% nickel low-expansion alloys.

Ni-Rod 441HT Filler Metal

For GMAW & GTAW of high temperature ductile irons to each other and to stainless steels.

Ni-Rod FC44 Welded Wire

For FCAW of all types of cast iron with T5A-05 C02, especially suited to ductile iron welding for maximum strength and ductility of welds.

Ni-Rod 441HT Welded Wire

For flat position (1G) FCAW welding of 625 and lower alloyed NiCrMo materials such as super austenitics, high-phosphorus irons.

Ni-Rod 441HT Welding Electrode

For all position FCAW welding of INCONEL 600 and similar alloys; also for dissimilar joints involving stainless steels, CrMo steels and carbon steels.

Ni-Rod 441HT Welding Electrode

Inconel 625, 601, and 600; acid-resistant stainless steels; 9% nickel steel.

For GMAW, GTAW & SAW of all types of cast irons; best machinability in first layer or two layer overlays; not recommended for more than two layers.

NLD CF36 Filler Metal

MONEL alloys 400, R-405, and K-500; surfacing of steel.

INCOLOY alloys 800 and 800HT; dissimilar combinations of steels and nickel alloys.

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A CENTURY OF ALLOY INNOVATION

For over 100 years, Special Metals has been a world leader in the invention and production of highly engineered nickel alloys for demanding applications. In fact, Special Metals has invented over 80 percent of the nickel alloys in the market today—offering the industry’s widest range of nickel alloys, cobalt alloys and product forms. As part of Precision Castparts Corporation (PCC), Special Metals can leverage the capabilities of other leaders in metal to offer an unmatched range of alloy components and products.