

# Inconel Wire Spring



## Inconel® alloy X750

UNS N07750 W.Nr 2.4669

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### Applications

Springs operating from cryogenic temperatures up to 1300°F (704°C), fasteners and components requiring resistance to high temperature and corrosive environments.

### Description

Inconel® X750 is a precipitation hardenable Nickel-Chromium alloy with high strength at temperatures up to 1300°F (704°C) and oxidation resistance up to 1800°F (982°C). Inconel® X750 offers excellent resistance to relaxation and as a result it is widely used for springs operating at elevated temperatures.

### Key Features

Good creep rupture strength at high temperatures Not as strong as Nimonic 90 Very good at cryogenic temperatures Age hardenable High temperature dynamic applications

### Industries Supplied

Oil & Gas Extraction and Processing, Nuclear, Aerospace, Power Generation and Automotive

### Nominal Composition

Ni: 70.0 min Cr: 14.0 - 17.0 Fe: 5.0 - 9.0 Ti: 2.25 - 2.75 Al: 0.40 - 1.0 Cb (Nb): 0.70 - 1.20 Mn: 1.0 Si: 0.50 max C: 0.08 max S: 0.01 max Cu: 0.5 max

### Physical Properties

**Density:** 0.299 lb/in<sup>3</sup>, (8.28 g/cm<sup>3</sup>)

**Modulus of Elasticity (E):** At 70°F (20°C): 31.0 x 10<sup>6</sup> psi (214 GPa) At 1000°F (538°C): 26.7 x 10<sup>6</sup> psi (184 GPa)

**Modulus of Rigidity (G):** At 70°F (20°C): 12.0 x 10<sup>6</sup> psi (82.7 GPa)

**Coefficient of Expansion:** 7.8  $\mu\text{in/in}\cdot^\circ\text{F}$  (70°F to 1000°F) 14.5  $\mu\text{m/m}\cdot^\circ\text{C}$  (20°C to 538°C)

**Electrical Resistivity:** 20.1  $\mu\Omega\cdot\text{in}$ , (122  $\mu\Omega\cdot\text{cm}$ )

**Thermal Conductivity:** 83 Btu-in/ft<sup>2</sup>hr-°F, (12.0 W/m-K)

### Applicable Specifications

**Wire & Bar:** AMS 5698, AMS 5699, AMS 5778, NACE MR0175 (ISO 15156-3), ASTM B637, AMS 5667, AMS 5668, AMS 5670

### Typical Mechanical Properties – Spring Applications

- **Annealed**
  - **Heat Treatment:** 2000 - 2200°F (1093 - 1204°C)
  - **Tensile Strength:** 130 ksi max; (896 MPa) max
- **No.1 Temper**
  - **Heat Treatment:** As supplied condition.
  - **Tensile Strength:** 130 – 165 ksi; (896 – 1138 MPa)
- **No.1 Temper + Aged**
- **Heat Treatment:** After spring coiling. Age: 1350°F (732°C) for 16 hours.
- **Tensile Strength:** 165 - 220 ksi (1138 - 1517 MPa)
  - **Suggested Operating Conditions:** Optimum resistance to relaxation at temperatures up to 1000°F (538°C) with moderate or low stresses.
- **Spring Temper**
  - **Heat Treatment:** As supplied condition.
  - **Tensile Strength:** 160 - 220 ksi; (1103 - 1517 MPa)
- **Spring Temper + Aged**
  - **Heat Treatment:** After spring coiling. Age: 1200°F (649°C) for 4 hours.
  - **Tensile Strength:** 180 - 250 ksi; (1241-1793 MPa)
  - **Suggested Operating Conditions:** Optimum stress and low relaxation at temperatures up to 700°F (371°C)
- **Spring Temper + Solution + Aged (3 Step Heat treatment)**
  - **Heat Treatment:** After spring coiling. Solution Heat Treat: 2100°F (1149°C) for 2 hours and air cool. Age Harden at 1550°F (843°C) for 24 hours and air cool. Reheat to 1300°F(704°C) for 20 hours and air cool.
  - **Tensile Strength:** 145 - 190 ksi; (1000-1310 MPa)
  - **Suggested Operating Conditions:** Optimum resistance to relaxation at temperatures in the range 1000 – 1300°F (538 – 704°C).

### Inconel® alloy 718

UNS N07718 W.Nr 2.4668

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### Applications

Springs, valves, and aircraft and land-based turbine engines.

### Description

Inconel® 718 is an age-hardenable Nickel-Chromium-Columbium (Niobium)-Molybdenum alloy with high strength, corrosion-resistance, and good fabrication characteristics. Inconel® 718 has high tensile, yield, and creep-rupture properties at high temperatures and can operate at cryogenic temperatures up to 1200°F (650°C).

## Key Features

Good creep rupture strength at high temperatures

Higher strength than Inconel X-750 Better mechanical properties at lower temperatures than Nimonic 90 & Inconel X-750 Age hardenable High temperature dynamic applications.

## Industries Supplied

Oil & Gas Extraction, Nuclear, Aerospace, Defense and Automotive.

## Nominal Composition

Ni: 50.0 - 55.0 Cr: 17.0 - 21.0 Cb (Nb): 4.75 - 5.5 Mo: 2.8 - 3.3 Ti: 0.65 - 1.15 Fe: balance Co: 1.0 max Al: 0.2 - 0.8 Mn: 0.35 max Si: 0.35 max Cu: 0.3 max

## Physical Properties

**Density:** 0.296 lb/in<sup>3</sup>, (8.19 g/cm<sup>3</sup>)

**Modulus of Elasticity (E):** At 70°F (20°C): 29.0 x 10<sup>3</sup> ksi (200 GPa)

**Modulus of Rigidity (G):** At 70°F (20°C): 11.6 x 10<sup>3</sup> ksi (80 GPa)

**Coefficient of Expansion:** 7.7 μin/in.-°F (70°F to 600°F) 13.9 μm/m-°C (20°C to 300°C)

**Electrical Resistivity:** 47.5 μΩ.in, (121 μΩ.cm)

**Thermal Conductivity:** 79 Btu-in/ft<sup>2</sup>hr-°F, (11.4 W/m-K)

## Applicable Specifications

**Wire & Bar:** AMS 5662, AMS 5663, AMS 5664, AMS 5832, AMS 5962, ASME SB-637, ASTM B637, AWS A5.14, NACE MR0175 (ISO 15156-3).

## Typical Mechanical Properties – Spring Applications

- **Annealed**
  - **Heat Treatment:** 1800°F (980°C)
  - **Tensile Strength:** 115 - 145 ksi; (790-1000 MPa)
  - **Suggested Operating Conditions:** -330°F to 1200°F (-200°C to 650°C)
- **Spring Temper**
  - **Tensile Strength:** 190 – 220 ksi; (1310 – 1515 MPa)
  - **Suggested Operating Conditions:** -330°F to 1200°F (-200°C to 650°C)
  - **Spring Temper + Aged**
  - **Heat Treatment:** After spring coiling. Age: 1325°F (720°C) for 8 hours, furnace cool to 1150°F and hold for a total aging time of 18 hours.

- **Tensile Strength:** 220 ksi minimum; (1515 MPa)
  - **Suggested Operating Conditions:** -330°F to 1200°F (-200°C to 650°C)