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introduction

Founded in 1984, Electrolux is a world leader in the manufacture of precision drawn round wire, flat wire and shaped wire in a comprehensive range of High Performance Nickel alloys. It is a privately owned company with all shares held by the employees of the company, a situation that creates interest, loyalty and commitment. Today, Electrolux is a highly developed modern company that has become well respected within the wire industry. Electrolux manufactures to exacting specifications and demands for a wide variety of applications, including precision springs and components for use in gas turbines, oil, chemical and process plant, aerospace and nuclear industries, mechanical seals and medical implants. Electrolux combines the commitment of its staff with the efficiency of its operation to provide a service that is second to none. The motivation and innovation of the management team together with the skill and dedication of the workforce ensure that each and every requirement of your order is met rapidly and to the highest quality. The following pages are intended to help buyers, designers and engineers who wish to use these High Performance alloys. We hope that the information is useful and welcome any comments on how to improve the presentation. Electrolux has offices all over the world.

For details of your local office please visit: **www.electrolux.mk**

FRIHRD

www.electrolux.com.mk
1984

services

- We **MANUFACTURE** round and shaped wire
- Produced to **YOUR SPECIFICATION**
- Sizes from **20mm** (.787") - **0.025mm** (.001")
- Order quantities from **As low as a few metres/feet**
- Typical **LEAD TIME** of 2 weeks
- **EMERGENCY** manufacturing service (EMS)
- **RE-DRAW** facility for **FREE ISSUE STOCK**

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products, custom made

WE MANUFACTURE

- Round and shaped wire, produced on machinery specifically designed to precisely suit Electrolux's requirements
- Wire produced to your specification!
- With a typical lead time of 2 weeks
- And hold up to 80 tons of material in stock at any one time

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SMALL QUANTITIES

- order quantities from as low as 1kg (2lbs)
- manufactured to customer specification
- emergency manufacturing service available (EMS)

to customer specification

SIZE RANGE

- **wire diameters:**
  from 20mm (0.787")
  to 0.025mm (0.001")
- **rolled products:**
  width from 8mm (0.300")
  to 0.13mm (0.005")
  thickness from 4mm (0.160")
  to 0.025mm (0.001")
- **straight lengths:**
  from 3m (10')
  to 3mm (0.125")

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COMPLETE SERVICE

- all our staff are trained to be able to answer your enquiry personally
- fast delivery
- skilled workforce. Average experience of more than 15 years

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FRINKO

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Inconel 600*

W.NR 2.4816
UNS N06600
AWS 010

* Trade name of Special Metals Group of Companies

A Nickel-Chromium alloy with good resistance to oxidation and corrosion at high temperatures.

Applications include:
furnace components, chemical and food processing and nuclear engineering.

APPROXIMATE CHEMICAL COMPOSITION

Ni	72% min
Cr	14 - 17%
Fe	6 - 10%

DENSITY	**8.47** g/cm³	**0.306** lb/in³
MELTING POINT	**1413**°C	**2575**°F
COEFFICIENT OF EXPANSION	**13.3** µm/m•°C (20-100°C)	**7.4x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**75.6** kN/mm²	**10965** ksi
MODULUS OF ELASTICITY	**206** kN/mm²	**29878** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **460°C (860°F)** for **1** hour and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**600 - 750** N/mm²	**87 - 109** ksi	**-200°** to **+330°C**	**-330°** to **+625°F**
Spring Temper	**900 - 1250** N/mm²	**131 - 181** ksi	**-200°** to **+330°C**	**-330°** to **+625°F**
			Note: in both cases slight magnetism may occur below -120°C	Note: in both cases slight magnetism may occur below -184°F

STANDARDS

BS 3075 & 3076 NA 14 **AMS 5687** **ASTM B166**

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Inconel 601•

W.NR 2.4851
UNS N06601
AWS 011
• Trade name of Special Metals Group of Companies

A Nickel-Chromium alloy with an addition of aluminium to give outstanding resistance to oxidation and other forms of high temperature corrosion. It also has high mechanical properties at elevated temperatures.

Applications include:
petrochemical processing, industrial furnaces, gas turbine components and for heat treating equipment such as baskets, muffles and retorts.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	58 - 63%
Cr	21 - 25%
Fe	BAL
Al	1.0 - 1.7%

DENSITY	**8.11** g/cm³	**0.293** lb/in³
MELTING POINT	**1411** °C	**2571** °F
COEFFICIENT OF EXPANSION	**13.75** µm/m • °C (20-100°C)	**7.6x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**81.2** kN/mm²	**11777** ksi
MODULUS OF ELASTICITY	**206.5** kN/mm²	**29951** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **480 - 870°C (900 - 1600°F)** for **1** hour and air cool. (temperature depends on composition and amount of cold work)

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**700 - 900** N/mm²	**102 - 131** ksi	**-200** to **+340°C** (for lightly stressed applications)	**-330** to **+645°F**
Spring Temper	**1200 -1450** N/mm²	**174 - 210** ksi	**-200** to **+340°C** (for lightly stressed applications)	**-330** to **+645°F**

STANDARDS

ASTM B166

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Inconel 625*

W.NR 2.4856
UNS N06625
AWS 012

* Trade name of Special Metals Group of Companies

A Nickel-Chromium-Molybdenum alloy with excellent corrosion resistance in a wide range of corrosive media, being especially resistant to pitting and crevice corrosion. It is a favourable choice for sea water applications.

Applications include:
marine and aerospace industries, chemical processing, nuclear reactors and pollution control equipment.

APPROXIMATE CHEMICAL COMPOSITION

Ni	58% min
Cr	20 - 23%
Mo	8 - 10%
Nb+Ta	3.15 - 4.15%
Fe	5% max

DENSITY	**8.44** g/cm³	**0.305** lb/in³
MELTING POINT	**1350**°C	**2460**°F
COEFFICIENT OF EXPANSION	**12.8** µm/m•°C (20-100°C)	**7.1x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**79** kN/mm²	**11458** ksi
MODULUS OF ELASTICITY	**205.8** kN/mm²	**29849** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **260 - 370**°C (**500 - 700**°F) for **30 - 60** minutes and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**800 - 1000** N/mm²	**116 - 145** ksi	**-200°** to **+340**°C	**-330°** to **+645**°F
Spring Temper	**1300 - 1600** N/mm²	**189 - 232** ksi	up to **+200**°C	up to **+395**°F

STANDARDS

BS 3076 NA 21 **ASTM B446** **AMS 5666**

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Inconel 718•

W.NR 2.4668
UNS N07718
AWS 013

• Trade name of Special Metals Group of Companies

A Nickel-Chromium alloy being precipitation hardenable and having high creep-rupture strength at high temperatures to about 700°C (1290°F). It has higher strength than Inconel X-750 and better mechanical properties at lower temperatures than Nimonic 90 and Inconel X-750.

Applications include:
gas turbines, rocket motors, space craft, nuclear reactors and pumps.

APPROXIMATE CHEMICAL COMPOSITION

Ni+Co	50 - 55%
Cr	17 - 21%
Fe	BAL
Nb+Ta	4.75 - 5.5%
Mo	2.8 - 3.3%
Ti	0.65 - 1.15%
Al	0.2 - 0.8%

DENSITY	**8.19** g/cm³	**0.296** lb/in³
MELTING POINT	**1336**°C	**2437**°F
COEFFICIENT OF EXPANSION	**13.0** µm/m•°C (20-100°C)	**7.2x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**77.2** kN/mm²	**11197** ksi
MODULUS OF ELASTICITY	**204.9** kN/mm²	**29719** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
No.1 Spring Temper/Spring Temper	1. Solution Anneal at **980°C (1800°F)** for **1** hour and air cool and 2. Age harden at **720°C (1330°F)** for **8** hours and furnace cool to **620°C (1150°F)** and hold at **620°C (1150°F)** for a total age hardening time of **18** hours and air cool.
No.1 Spring Temper/Spring Temper (NACE MR0175)	1. **1010°C (1870°F) 2** hours and air cool. and 2. **790°C (1455°F) 6** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**800 - 1000** N/mm²	**116 - 145** ksi	–	–
No.1 Spring Temper	**1000 - 1200** N/mm²	**145 - 175** ksi	–	–
No.1Spring Temper + Annealed + Aged	**1250 - 1450** N/mm²	**181 - 210** ksi	**-200** to **+550°C**	**-330** to **+1020°F**
Spring Temper	**1300 - 1500** N/mm²	**189 - 218** ksi	–	–
Spring Temper + Annealed + Aged	**1250 - 1450** N/mm²	**181 - 210** ksi	**-200** to **+550°C**	**-330** to **+1020°F**

STANDARDS

AMS 5663 **AMS 5832** **AMS 5962** **AMS 5662** **ASTM B637**

Inconel X-750*

W.NR 2.4669
UNS N07750
AWS 014

* Trade name of Special Metals Group of Companies

A Nickel-Chromium alloy made precipitation hardenable by additions of Aluminium and Titanium, having creep-rupture strength at high temperatures to about 700°C (1290°F).
It is widely used for high temperature conditions but is not as strong as Nimonic 90.

Applications include:
nuclear reactors, gas turbines, rocket engines, pressure vessels and aircraft structures.

APPROXIMATE CHEMICAL COMPOSITION	
Ni+Co	70% min
Cr	14 - 17%
Fe	5 - 9%
Ti	2.25 - 2.75%
Al	0.4 - 1.0%
Nb+Ta	0.7 - 1.2%

DENSITY		**8.28** g/cm³	**0.299** lb/in³
MELTING POINT		**1430**°C	**2600**°F
COEFFICIENT OF EXPANSION		**12.6** µm/m•°C (20-100°C)	**7.0x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY		**75.8** kN/mm²	**10994** ksi
MODULUS OF ELASTICITY	*	**218.0** kN/mm²	**31619** ksi
	**	**212.4** kN/mm²	**30806** ksi
	***	**213.7** kN/mm²	**30995** ksi

* Spring Temper + Aged **Spring Temper + 3 Part Heat Treated *** No.1 Spring Temper + Aged

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Spring Temper	Age harden at **650°C (1200°F)** for **4** hours and air cool.
Spring Temper	**3 Part Heat Treatment:** *1. Solution Anneal at **1150°C (2100°F)** for **2** hours and air cool 2. and Stabilise at **843°C (1550°F)** for **24** hours and air cool 3. and Age harden at **704°C (1300°F)** for **20** hours and air cool.
No.1 Spring temper	Age harden at **730°C (1350°F)** for **16** hours and air cool.

*for diameters below 1.00mm contact AWI technical department.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**800 - 1000** N/mm²	**116 - 145** ksi	–	–
Spring Temper	**1100 - 1500** N/mm²	**159 - 217** ksi	–	–
Spring Temper + Aged	**1350 - 1750** N/mm²	**196 - 254** ksi	**-200°** up to **370°C**	**-330°** up to **700°F**
Spring Temper + 3 Part heat treated	**1100 - 1250** N/mm²	**159 - 181** ksi	**-200°** up to **550°C**	**-330°** up to **1020°F**
No.1 Spring Temper	**900 - 1150** N/mm²	**130 - 167** ksi	–	–
No.1 Spring Temper + Aged	**1300 - 1450** N/mm²	**188 - 210** ksi	**-200°** up to **550°C**	**-330°** up to **1020°F**

STANDARDS

AMS 5667 | **AMS 5699** (Spring temper) | **AMS 5698** (No.1 SpringTemper) | **ASTM B637** | **BS HR 505**

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Incoloy 800•

W.NR 1.4875
UNS N08800
AWS 020

• Trade name of Special Metals Group of Companies

This Nickel-Iron-Chromium alloy has good strength and excellent resistance to oxidation and carburisation in high temperature atmospheres.
Incoloy 800 also resists corrosion in many aqueous environments.

Applications include:
process piping, heat exchangers, carburising equipment and heating element sheathing.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	30 - 35%
Fe	39.5% min
Cr	19 - 23%
C	0.1% max
Al	0.15 - 0.6%
Ti	0.15 - 0.6%

DENSITY	**7.94** g/cm³	**0.287** lb/in³
MELTING POINT	**1385**°C	**2525**°F
COEFFICIENT OF EXPANSION	**14.4** µm/m • °C (20-100°C)	**7.9x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**78.9** kN/mm²	**11444** ksi
MODULUS OF ELASTICITY	**196.5** kN/mm²	**28500** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **450 - 470**°C (**840 - 880**°F) for **30 - 60** minutes and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**600 - 800** N/mm²	**87 - 116** ksi	**-200** to **+815**°C (for lightly stressed applications)	**-330** to **+1500**°F
Spring Temper	**800 - 1100** N/mm²	**116 - 159** ksi	**-200** to **+815**°C (for lightly stressed applications)	**-330** to **+1500**°F

STANDARDS

BS 3075 & 3076 NA 15

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Incoloy 800HT•

W.NR 1.4958
W.NR 1.4959
UNS N08811
AWS 021
• Trade name of Special Metals Group of Companies

This Nickel-Chromium-Iron alloy has the same basic composition as Incoloy 800, but has significantly higher creep rupture strength, resultant from the close control of the carbon, aluminium and titanium contents. It has good strength and excellent resistance to oxidation and carburisation in high temperature atmospheres. It also resists corrosion in many aqueous environments.

Applications include:

chemical and petrochemical processing, industrial furnaces and heat treating equipment.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	30 - 35%
Fe	39.5% min
Cr	19 - 23%
C	0.06 - 0.1%
Al	0.15 - 0.6%
Ti	0.15 - 0.6%
Al+Ti	0.85 - 1.2%

DENSITY	**7.94** g/cm³	**0.287** lb/in³
MELTING POINT	**1385**°C	**2525**°F
COEFFICIENT OF EXPANSION	**14.4** µm/m • °C (20-100°C)	**7.9x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**78.9** kN/mm²	**11444** ksi
MODULUS OF ELASTICITY	**196.5** kN/mm²	**28500** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **450 - 470**°C **(840 - 880**°F) for **30 - 60** minutes and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**600 - 800** N/mm²	**87 - 116** ksi	**-200°** to **+1100**°C (for lightly stressed applications)	**-330°** to **+2010**°F
Spring Temper	**800 - 1100** N/mm²	**116 - 159** ksi	**-200°** to **+1100**°C (for lightly stressed applications)	**-330°** to **+2010**°F

STANDARDS

BS 3076 NA 15H

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Incoloy 825*

W.NR 2.4858
UNS N08825
AWS 022

* Trade name of Special Metals Group of Companies

Incoloy 825 is a Nickel-Iron-Chromium alloy with additions of Molybdenum and Copper. It has excellent resistance to both reducing and oxidising acids, to stress-corrosion cracking and to localised pitting and crevice corrosion. It is also especially resistant to sulphuric and phosphoric acids.

Applications include:
chemical processing, nuclear fuel reprocessing, acid production and pickling equipment.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	38 - 46%
Fe	22% min
Cr	19.5 - 23.5%
Mo	2.5 - 3.5%
Cu	1.5 - 3%
Ti	0.6 - 1.2%

DENSITY	**8.14** g/cm³	**0.294** lb/in³
MELTING POINT	**1400**°C	**2550**°F
COEFFICIENT OF EXPANSION	**14.0** µm/m•°C (20-100°C)	**7.8x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**75.9** kN/mm²	**11009** ksi
MODULUS OF ELASTICITY	**196** kN/mm²	**28428** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **450 - 470°C (840 - 880°F)** for **30 - 60** minutes and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**600 - 800** N/mm²	**87 - 116** ksi	**-100** to **+250°C**	**-145** to **+480°F**
Spring Temper	**800 - 1100** N/mm²	**116 - 159** ksi	**-100** to **+250°C**	**-145** to **+480°F**

STANDARDS	
BS 3076 NA 16	**ASTM B425**

Incoloy A-286 *

W.NR 1.4944
W.NR 1.4980
UNS S66286
AWS 023

* Trade name of Special Metals Group of Companies

This age hardenable, Iron-Nickel-Chromium alloy is designed for applications requiring high strength and good corrosion resistance at temperatures up to 700°C (1290°F).

Applications include:
jet engines, super chargers, after burner parts and fasteners.

APPROXIMATE CHEMICAL COMPOSITION	
Fe	56.5%
Ni	25.5%
Cr	15%
Ti	2.1%
Mo	1.25%

DENSITY	**7.94** g/cm³	**0.287** lb/in³
MELTING POINT	**1430**°C	**2600**°F
COEFFICIENT OF EXPANSION	**16.4** µm/m • °C (20-100°C)	**9.1x10**⁻⁶ in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**71.5** kN/mm²	**10370** ksi
MODULUS OF ELASTICITY	**205** kN/mm²	**29733** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Age Hardened at **705 - 760°C (1300 - 1400°F)** for **16** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**600 - 750** N/mm²	**87 - 109** ksi	**-200** to **+400°C**	**-330** to **+750°F**
Annealed + Aged	**1100 - 1300** N/mm²	**159 - 188** ksi	**-200** to **+400°C**	**-330** to **+750°F**
Spring Temper	**1050 - 1250** N/mm²	**152 - 181** ksi	**-200** to **+400°C**	**-330** to **+750°F**
Spring Temper + Aged	**1300 - 1500** N/mm²	**188 - 218** ksi	**-200** to **+400°C**	**-330** to **+750°F**

STANDARDS

AMS 5731 **AMS 5734** **AMS 5737** **AMS 5853** **BS HR 650** **BS HR 52**

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Nimonic 90*

W.NR 2.4632
W.NR 2.4969
UNS N07090
AWS 030
* Trade name of Special Metals Group of Companies

A Nickel-Chromium-Cobalt alloy being precipitation hardenable, having high stress-rupture strength and creep resistance at high temperatures up to about 950°C (1740°F). It is widely used and a well proven alloy in high temperature conditions.

Applications include:
aerospace industry, high temperature springs and various thermal processing.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	54%
Cr	18 - 21%
Co	15 - 21%
Ti	2 - 3%
Al	1 - 2%

DENSITY		**8.18** g/cm³	**0.296** lb/in³
MELTING POINT		**1370**°C	**2500**°F
COEFFICIENT OF EXPANSION		**12.7** µm/m•°C (20-100°C)	**7.1x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY		**82.5** kN/mm²	**11966** ksi
MODULUS OF ELASTICITY	*	**213** kN/mm²	**30894** ksi
	**	**227 / 240** kN/mm²	**32924 / 34810** ksi

* Solution Annealed + Aged **Spring Temper and Aged

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Solution Annealed	Age Harden at **750°C (1380°F)** for **4** hours and air cool.
Spring Temper	Age Harden at **650°C (1200°F)** for **4** hours and air cool.
Spring Temper	Age Harden at **600°C (1110°F)** for **16** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Solution Annealed	**800 - 1000** N/mm²	**116 - 145** ksi	–	–
Solution Annealed + aged	**1300 - 1400** N/mm²	**189 - 203** ksi	up to **550°C**	up to **1020°F**
Spring Temper	**1300 - 1500** N/mm²	**189 - 218** ksi	–	–
Spring Temper + aged	**1500 - 1800** N/mm²	**218 - 261** ksi	up to **350°C**	up to **660°F**

STANDARDS

BS HR 501 (Spring temper)	**BS HR 502** (Solution Annealed)	**BS HR 503**	**BS 3075 NA19**	**AMS 5829**	**NCK20TA**

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Nimonic 80A•

W.NR 2.4952
W.NR 2.4631
UNS N07080
AWS 031
• Trade name of Special Metals Group of Companies

Nimonic 80A is a Nickel-Chromium alloy which is precipitation hardenable. It has largely been superseded by Nimonic 90 and Inconel X-750, but because of the low Cobalt content, it is still specified for nuclear applications.

Applications include:
gas turbine components, nuclear industry and fasteners.

APPROXIMATE CHEMICAL COMPOSITION

Cr	18 - 21%
Ti	1.8 - 2.7%
Al	1.0 - 1.80%
Co	2% max
Ni	BAL

DENSITY	**8.19** g/cm³	**0.296** lb/in³
MELTING POINT	**1365**°C	**2490**°F
COEFFICIENT OF EXPANSION	**12.7** µm/m•°C (20-100°C)	**7.1x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**85** kN/mm²	**12328** ksi
MODULUS OF ELASTICITY	**222** kN/mm²	**32199** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Solution Annealed	Age Harden at **700°C (1290°F)** for **16** hours and air cool.
Spring Temper	Age Harden at **600°C (1110°F)** for **16** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Solution Annealed	**800 - 1000** N/mm²	**116 - 145** ksi	–	–
Solution Annealed + Aged	**1200 - 1400** N/mm²	**174 - 203** ksi	up to **550°C**	up to **1020°F**
Spring Temper	**1300 - 1500** N/mm²	**189 - 218** ksi	–	–
Spring Temper + Aged	**1500 - 1800** N/mm²	**218 - 261** ksi	up to **350°C**	up to **660°F**

STANDARDS

BS HR 601 | **BS 3076 NA 20** | **ASTM B637**

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Nimonic 75*

W.NR 2.4951
W.NR 2.4630
UNS N06075
AWS 032

* Trade name of Special Metals Group of Companies

Nimonic 75 is a Nickel-Chromium alloy with good corrosion and heat resistance.

Applications include:
aerospace fasteners.

APPROXIMATE CHEMICAL COMPOSITION

Ni	80% min
Cr	19.5%

DENSITY	**8.37** g/cm³	**0.302** lb/in³
MELTING POINT	**1380**°C	**2520**°F
COEFFICIENT OF EXPANSION	**11.0** µm/m • °C (20-100°C)	**6.1x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**75.6** kN/mm²	**10965** ksi
MODULUS OF ELASTICITY	**206** kN/mm²	**29878** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **450 - 470**°C (**840 - 880**°F) for **30 - 60** minutes and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Solution Annealed	**700 - 800** N/mm²	**102 - 116** ksi	**-200** to **+1100**°C (for lightly stressed applications)	**-330** to **+2010**°F
Cold Drawn	**1200 - 1500** N/mm²	**174 - 218** ksi	**-200** to **+1100**°C (for lightly stressed applications)	**-330** to **+2010**°F

STANDARDS

BS HR 5 **BS HR 504**

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Monel 400®

W.NR 2.4360
W.NR 2.4361
UNS N04400
AWS 040
® Trade name of Special Metals Group of Companies

A Nickel-Copper alloy with high strength and excellent corrosion resistance in a range of acidic and alkaline environments and especially suitable for reducing conditions. It also has good ductility and thermal conductivity.

Applications include:
marine engineering, chemical and hydro-carbon processing equipment, heat exchangers, valves and pumps.

APPROXIMATE CHEMICAL COMPOSITION

Ni	63%
Cu	28 -34%
Fe	2.5% max
Mn	2% max

DENSITY	**8.8** g/cm³	**0.318** lb/in³
MELTING POINT	**1350**°C	**2460**°F
COEFFICIENT OF EXPANSION	**13.9** µm/m • °C (20-100°C)	**7.7x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**65.3** kN/mm²	**9471** ksi
MODULUS OF ELASTICITY	**173** kN/mm²	**25092** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **300 - 320**°C (**570 - 610**°F) for **30 - 60** minutes and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**400 - 600** N/mm²	**58 - 87** ksi	**-200** to **+230**°C	**-330** to **+445**°F
Spring Temper	**850 - 1050** N/mm²	**123 - 152** ksi	**-200** to **+230**°C	**-330** to **+445**°F

STANDARDS

BS 3075 & 3076 NA 13 | **DTD 204B** | **ASTM B164**

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Monel K-500*

W.NR 2.4375
UNS N05500
AWS 041

* Trade name of Special Metals Group of Companies

This Nickel-Copper alloy is precipitation hardenable, due to the additions of Aluminium and Titanium. It combines the corrosion resistance of Monel 400 but gives the added advantage of extra strength and hardness (as a result of its age hardening ability).

Applications include:
pump shafts, fasteners, marine propeller shafts, oil well tools, instruments and springs.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	63% min
Cu	30%
Fe	2% max
Al	2.3 - 3.15%
Ti	0.35 - 0.85%

DENSITY	**8.44** g/cm³	**0.305** lb/in³
MELTING POINT	**1350**°C	**2460**°F
COEFFICIENT OF EXPANSION	**13.7** µm/m•°C (20-100°C)	**7.6x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**66** kN/mm²	**9573** ksi
MODULUS OF ELASTICITY	**179** kN/mm²	**25962** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed	Age harden at **580 - 590°C (1075 - 1095°F)** for **8 - 10** hours and air cool.*
Spring Temper	Age harden at **530 - 550°C (985 - 1020°F)** for **4 - 6** hours and furnace cool to **450°C (840°F)** at a rate of **8 -15°C (45-60°F)** per hour and air cool.*
Spring Temper	Age harden at **530 - 540°C (985-1005°F)** for **4 - 6** hours and air cool.*

* heat treating Monel K-500 in free air can have a detrimental effect on its corrosion resistant properties.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**650 - 850** N/mm²	**94 - 123** ksi	**-100** to **+260**°C	**-150** to **+500**°F
Annealed + Aged	**950 - 1050** N/mm²	**138 - 167** ksi	**-100** to **+260**°C	**-150** to **+500**°F
Spring Temper	**1000 - 1300** N/mm²	**145 - 189** ksi	**-110** to **+260**°C	**-150** to **+500**°F
Spring Temper + Aged	**1200 - 1500** N/mm²	**174 - 218** ksi	**-100** to **+260**°C	**-150** to **+500**°F

STANDARDS

BS 3075 & 3076 NA 18

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Hastelloy B-2▲

W.NR 2.4617
UNS N10665
AWS 050

▲ Trade name of Haynes International

Hastelloy B-2 is a Nickel base wrought alloy with excellent resistance to hydrochloric acid at all concentrations and temperatures. B-2 also withstands hydrogen chloride, sulphuric, hydrofluoric, acetic and reagent grade phosphoric acids. This alloy also has excellent resistance to stress corrosion cracking and to knife line and heat affected zone attack.

Applications include:
chemical processing
(not recommended in the presence of ferric or cupric salts)

APPROXIMATE CHEMICAL COMPOSITION	
Ni	69%
Mo	28%
Fe	2% max
Cr	1% max
Co	1% max

DENSITY	**9.22** g/cm³	**0.333** lb/in³
MELTING POINT	**1370**°C	**2500**°F
COEFFICIENT OF EXPANSION	**10.3** µm/m • °C (20-100°C)	**5.7x10**⁻⁶ in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**84** kN/mm²	**12183** ksi
MODULUS OF ELASTICITY	**217** kN/mm²	**31474** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **400 - 450°C (750 - 840°F)** for **2** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**900 - 1100** N/mm²	**131 - 159** ksi	**-200° to +400°C**	**-330° to +750°F**
Spring Temper	**1400 - 1900** N/mm²	**203 - 276** ksi	**-200° to +400°C**	**-330° to +750°F**

STANDARDS

ASTM B335 **ASTM B619**

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Hastelloy B-3▲

W.NR 2.4600
UNS N10675
AWS 051

▲ Trade name of Haynes International

This Nickel-Molybdenum alloy gives excellent resistance to hydrochloric acid at all concentrations and temperatures. It also withstands sulphuric, acetic, formic and phosphoric acids and other non oxidizing media. B-3 also has excellent resistance to pitting corrosion and to stress-corrosion cracking.

Applications include:
chemical processing
(not recommended in the presence of ferric or cupric salts)

APPROXIMATE CHEMICAL COMPOSITION	
Ni	65% min
Mo	28.5%
Cr	1.5%
Fe	1.5%
Co	3% max
W	3% max
Mn	3% max

DENSITY	**9.22** g/cm³	**0.333** lb/in³
MELTING POINT	**1418**°C	**2585**°F
COEFFICIENT OF EXPANSION	**10.6** µm/m • °C (20-100°C)	**5.7x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**83** kN/mm²	**12038** ksi
MODULUS OF ELASTICITY	**216** kN/mm²	**31329** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **400 - 450°C (750 - 840°F)** for **2** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**1000 - 1200** N/mm²	**145 - 174** ksi	**-200** to **+400°C**	**-330** to **+750°F**
Spring Temper	**1600 - 2000** N/mm²	**232 - 290** ksi	**-200** to **+400°C**	**-330** to **+750°F**

STANDARDS

ASTM B335 **ASTM B619**

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Hastelloy C-4 ▲

W.NR 2.4610
UNS N06455
AWS 052

▲ Trade name of Haynes International

This Nickel-Chromium-Molybdenum alloy tolerates high temperatures and gives a design freedom in areas where weld geometry makes excessive heat build-up unavoidable. Resistance to general and localised corrosion and stress corrosion cracking is generally similar to Hastelloy C-276.

Applications include:
chemical processing.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	65%
Cr	16%
Mo	16%
Fe	3% max
Co	2% max

DENSITY	**8.64** g/cm³	**0.312** lb/in³
MELTING POINT	**1399**°C	**2550**°F
COEFFICIENT OF EXPANSION	**10.8** µm/m • °C (20-100°C)	**6.0x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**81.2** kN/mm²	**11777** ksi
MODULUS OF ELASTICITY	**212.4** kN/mm²	**30807** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **400 - 450°C (750 - 840°F)** for **2** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**800 - 1100** N/mm²	**116 - 159** ksi	**-200** to **+400°C**	**-330** to **+750°F**
Spring Temper	**1300 - 1500** N/mm²	**189 - 218** ksi	**-200** to **+400°C**	**-330** to **+750°F**

STANDARDS

ASTM B574 **ASTM B619**

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Hastelloy C-22 ▲

W.NR 2.4602
UNS N06022
AWS 053

▲ Trade name of Haynes International

A Nickel-Chromium-Molybdenum alloy with better overall corrosion resistance and versatility than any other NiCrMo available. It has excellent resistance to localised corrosion and to a variety of mixed industrial chemicals.

Applications include:
chlorination systems, nuclear fuel reprocessing and pickling systems.

APPROXIMATE CHEMICAL COMPOSITION

Ni	56%
Cr	22%
Mo	13%
Co	2.5% max
W	3%
Fe	3%

DENSITY	**8.69** g/cm³	**0.314** lb/in³
MELTING POINT	**1399**°C	**2550**°F
COEFFICIENT OF EXPANSION	**12.4** µm/m•°C (20-100°C)	**6.9x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**78.6** kN/mm²	**11400** ksi
MODULUS OF ELASTICITY	**205.5** kN/mm²	**29806** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **400 - 450°C (750 - 840°F)** for **2** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**800 - 1100** N/mm²	**116 - 159** ksi	**-200** to **+400°C**	**-330** to **+750°F**
Spring Temper	**1400 - 1700** N/mm²	**203 - 247** ksi	**-200** to **+400°C**	**-330** to **+750°F**

STANDARDS

ASTM B619 **ASTM B574**

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Hastelloy C-276▲

W.NR 2.4819
UNS N10276
AWS 054

▲ Trade name of Haynes International

This Nickel-Molybdenum-Chromium alloy with the addition of Tungsten, has excellent corrosion resistance in a wide range of corrosive media and is especially resistant to pitting and crevice corrosion.

Applications include:
pollution control, chemical processing, waste treatment, marine engineering, pulp and paper production.

APPROXIMATE CHEMICAL COMPOSITION

Ni	55%
Mo	15 - 17%
Cr	14.5 - 16.5%
Fe	4 - 7%
W	3 - 4.5%

DENSITY	**8.89** g/cm³	**0.321** lb/in³
MELTING POINT	**1370**°C	**2500**°F
COEFFICIENT OF EXPANSION	**11.2** µm/m • °C (20-100°C)	**6.2x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**78.6** kN/mm²	**11400** ksi
MODULUS OF ELASTICITY	**205.5** kN/mm²	**29806** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **400 - 450**°C (**750 - 840**°F) for **2** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**850 - 1050** N/mm²	**123 - 152** ksi	**-200** to **+400**°C	**-330** to **+750**°F
Spring Temper	**1300 - 1600** N/mm²	**189 - 232** ksi	**-200** to **+400**°C	**-330** to **+750**°F

STANDARDS

ASTM B619 **ASTM B574**

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Hastelloy C-2000 ▲

W.NR 2.4675
UNS N06200
AWS 055

▲ Trade name of Haynes International

This alloy was developed to broaden the application range of one alloy. With the addition of Copper to the Nickel-Chromium-Molybdenum system, Hastelloy C-2000 is resistant to an extensive range of corrosive chemicals, including sulphuric, hydrochloric and hydrofluoric acids. The combination of Molybdenum and Copper provide excellent corrosion resistance to reducing media, while the high Chromium content gives good oxidising resistance.

Applications include:
chemical processing.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	59%
Cr	23%
Mo	16%
Cu	1.6%

DENSITY	**8.5** g/cm³	**0.307** lb/in³
MELTING POINT	**1399**°C	**2550**°F
COEFFICIENT OF EXPANSION	**12.4** µm/m•°C (20-100°C)	**6.9x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**79** kN/mm²	**11458** ksi
MODULUS OF ELASTICITY	**206** kN/mm²	**29878** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **400 - 450°C (750 - 840°F)** for **2** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**700 - 1000** N/mm²	**102 - 145** ksi	**-200** to **+400°C**	**-330** to **+750°F**
Spring Temper	**1300 - 1600** N/mm²	**189 - 232** ksi	**-200** to **+400°C**	**-330** to **+750°F**

STANDARDS

ASTM B619 **ASTM B574**

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Hastelloy G-30▲

W.NR 2.4603
UNS N06030
AWS 056

▲ Trade name of Haynes International

G-30 is a high Nickel based alloy which shows superior corrosion resistance over most other Nickel and Iron based alloys in phosphoric acids as well as many complex environments containing highly oxidising acids such as nitric, hydrofluoric and sulphuric acids.

Applications include:
nuclear fuel reprocessing, nuclear waste processing, pickling operations and petrochemical processing.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	43%
Cr	28 -31.5%
Fe	13 - 17%
Mo	4 - 6%
Co	5% max
W	1.5 - 4%

DENSITY	**8.22** g/cm³	**0.297** lb/in³
MELTING POINT	**1399**°C	**2550**°F
COEFFICIENT OF EXPANSION	**12.8** µm/m • °C (20-100°C)	**7.1x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**77.6** kN/mm²	**11255** ksi
MODULUS OF ELASTICITY	**202** kN/mm²	**29298** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **400 - 450**°C (**750 - 840**°F) for **2** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**650 - 900** N/mm²	**94 - 131** ksi	**-200** to **+400**°C	**-330** to **+750**°F
Spring Temper	**1000 - 1500** N/mm²	**145 - 218** ksi	**-200** to **+400**°C	**-330** to **+750**°F

STANDARDS

ASTM B619

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Hastelloy X ▲

W.NR 2.4665
UNS N06002
AWS 057

▲ Trade name of Haynes International

Hastelloy X is a Nickel-Chromium-Iron-Molybdenum alloy with an exceptional combination of oxidation resistance, ease of fabrication and high temperature strength. It has also been found to be exceptionally resistant to stress corrosion cracking in petrochemical applications.

Applications include:
gas turbine engine components, industrial furnace applications, chemical processing and petrochemical industry.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	47%
Cr	22%
Fe	18%
Mo	9%
Co	1.5%

DENSITY	**8.22** g/cm³	**0.297** lb/in³
MELTING POINT	**1355**°C	**2470**°F
COEFFICIENT OF EXPANSION	**13.9** µm/m•°C (20-100°C)	**7.7x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**77.6** kN/mm²	**11255** ksi
MODULUS OF ELASTICITY	**205** kN/mm²	**29733** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **400 - 450**°C (**750 - 840**°F) for **2** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**850 - 1050** N/mm²	**123 - 152** ksi	**-200** to **+400**°C	**-330** to **+750**°F
Spring Temper	**1350 - 1550** N/mm²	**196 - 225** ksi	**-200** to **+400**°C	**-330** to **+750**°F

STANDARDS

AMS 5798 **ASTM B619**

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Haynes 25 ▲

W.NR 2.4964
UNS R30605
AWS 060

▲ Trade name of Haynes International

Haynes 25 is a Cobalt-Nickel-Chromium-Tungsten alloy that combines excellent high temperature strength with good resistance to oxidising environments up to 980°C (1795°F) for long exposures. It also has excellent resistance to sulphidation.

Applications include:
parts in gas turbine engines and bearings.

APPROXIMATE CHEMICAL COMPOSITION	
Co	51% max
Cr	20%
W	15%
Ni	10%
Fe	3% max
Mn	1.5%

DENSITY	**9.13** g/cm³	**0.330** lb/in³
MELTING POINT	**1410**°C	**2570**°F
COEFFICIENT OF EXPANSION	**12.3** µm/m • °C (20-100°C)	**6.8x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**98** kN/mm²	**14214** ksi
MODULUS OF ELASTICITY	**225** kN/mm²	**32634** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **400 - 450**°C **(750 - 840**°F**)** for **2** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**950 - 1100** N/mm²	**138 - 159** ksi	**-200**°C to **+900**°C (for lightly stressed applications)	**-330**°F to **+1650**°F
Spring Temper	**1400 - 1800** N/mm²	**203 - 261** ksi	**-200**°C to **+900**°C (for lightly stressed applications)	**-330**°F to **+1650**°F

STANDARDS

AMS 5796 **ASTM F90**

Haynes 214▲

W.NR 2.4646
UNS N07214
AWS 061

▲ Trade name of Haynes International

Haynes 214 is a Nickel-Chromium-Aluminium-Iron alloy which is principally intended for use at temperatures of 955°C (1750°F) and above. It exhibits resistance to oxidation that far exceeds virtually all conventional heat resistant wrought alloys at these temperatures.

Applications include:

mesh belts, trays and fixtures for the firing of pottery and china and the heat treatment of electronic devices and technical grade ceramics.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	75%
Cr	16%
Al	4.5%
Fe	3%
Mn	0.5% max

DENSITY	**8.05** g/cm³	**0.291** lb/in³
MELTING POINT	**1400**°C	**2550**°F
COEFFICIENT OF EXPANSION	**13.3** µm/m•°C (20-100°C)	**7.4x10**⁻⁶ in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**84** kN/mm²	**12183** ksi
MODULUS OF ELASTICITY	**217** kN/mm²	**31474** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **400 - 450°C (750 - 840°F)** for **2** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**900 - 1050** N/mm²	**131 - 152** ksi	**-200** to **+1100**°C	**-330** to **+2010**°F (for lightly stressed applications)
Spring Temper	**1300 - 1700** N/mm²	**189 - 247** ksi	**-200** to **+1100**°C	**-330** to **+2010**°F (for lightly stressed applications)

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Nickel 200 *

W.NR 2.4060
W.NR 2.4066
UNS N02200
AWS 070

* Trade name of Special Metals Group of Companies

Nickel 200 is commercially pure and has good mechanical properties and excellent corrosion resistance to alkalis i.e. Sodium hydroxide. It also has good electrical, thermal and magneto-strictive properties.

Applications include:
food and synthetic fibre processing, heat exchangers, chemical and electrical industries.

APPROXIMATE CHEMICAL COMPOSITION

Ni 99% min
(Typically 99.6% Nickel)

DENSITY	**8.89** g/cm³	**0.321** lb/in³
MELTING POINT	**1446**°C	**2635**°F
COEFFICIENT OF EXPANSION	**13.3** µm/m•°C (20-100°C)	**7.4x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**81** kN/mm²	**11748** ksi
MODULUS OF ELASTICITY	**204** kN/mm²	**29588** ksi

ELECTRICAL RESISTIVITY

9.6 µΩ•cm	**58** ohm•circ mil/ft

THERMAL CONDUCTIVITY

70.2 W/m•°C	**487** btu•in/ft²•h•°F

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE
Annealed	**400 - 500** N/mm²	**58 - 73** ksi	Tensile strength and elongation drop significantly at temperatures above 315°C (600°F). Service temperature is dependent on environment, load and size range.
Hard Drawn	**700 - 900** N/mm²	**102 - 131** ksi	

STANDARDS

BS 3075 & 3076 NA11 **ASTM B160** **ASTM B162**

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Nickel 201•

W.NR 2.4061
W.NR 2.4068
UNS N02201
AWS 071

• Trade name of Special Metals Group of Companies

A commercially pure Nickel (typically 99.6% Nickel), Nickel 201 is essentially the same as Nickel 200, but with a lower Carbon content to prevent embrittlement by inter granular carbon at temperatures over 315°C (600°F). Lower carbon content also reduces hardness.

Applications include:
food and synthetic fibre processing, heat exchangers, chemical and electrical industries.

APPROXIMATE CHEMICAL COMPOSITION

Ni	99% min
C	0.02% max

DENSITY	8.89 g/cm³	0.321 lb/in³
MELTING POINT	1446°C	2635°F
COEFFICIENT OF EXPANSION	13.1 µm/m•°C (20-100°C)	7.3x10⁻⁶ in/in•°F (70-212°F)
MODULUS OF RIGIDITY	82 kN/mm²	11893 ksi
MODULUS OF ELASTICITY	207 kN/mm²	30000 ksi

ELECTRICAL RESISTIVITY	
8.5 µΩ•cm	51 ohm•circ mil/ft

THERMAL CONDUCTIVITY	
79.3 W/m•°C	550 btu•in/ft²•h•°F

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE
Annealed	400 - 500 N/mm²	58 - 73 ksi	Tensile strength and elongation drop significantly at temperatures above 315°C (600°F). Service temperature is dependent on environment, load and size range.
Hard Drawn	700 - 900 N/mm²	102 - 131 ksi	

STANDARDS		
BS 3076 NA12	ASTM B160	ASTM B162

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Nickel 205 •

W.NR 2.4061
UNS N02205
AWS 072

• Trade name of Special Metals Group of Companies

Nickel 205 is similar to Nickel 200, but has compositional adjustments to enhance its performance in electrical and electronic applications.

Applications include:
anodes and grids of electronic valves, lead wires, transistor housings and magneto-strictive transducers.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	99% min
Mg	0.01 - 0.08%
Ti	0.01 - 0.05%

DENSITY	**8.89** g/cm³	**0.321** lb/in³
MELTING POINT	**1446**°C	**2635**°F
COEFFICIENT OF EXPANSION	**13.3** µm/m•°C (20-100°C)	**7.4x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**82** kN/mm²	**11893** ksi
MODULUS OF ELASTICITY	**207** kN/mm²	**30000** ksi

ELECTRICAL RESISTIVITY	
9.5 µΩ•cm	**57** ohm•circ mil/ft

THERMAL CONDUCTIVITY	
75 W/m•°C	**520** btu•in/ft²•h•°F

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE
Annealed	**400 - 500** N/mm²	**58 - 73** ksi	Tensile strength and elongation drop significantly at temperatures above 315°C (600°F). Service temperature is dependent on environment, load and size range.
Hard drawn	**700 - 900** N/mm²	**102 - 131** ksi	

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Nickel 212 •

W.NR 2.4110
AWS 073

• Trade name of Special Metals Group of Companies

Nickel strengthened with an addition of Manganese.

Applications include:
electrical lead wires, supporting components in lamps and cathode ray tubes, electrodes in glow-discharge lamps and sparking contacts.

APPROXIMATE CHEMICAL COMPOSITION

Ni	97% min
Mn	1.5 - 2.5%

DENSITY	**8.86** g/cm³	**0.320** lb/in³
MELTING POINT	**1446**°C	**2635**°F
COEFFICIENT OF EXPANSION	**12.9** µm/m•°C (20-100°C)	**7.2x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**78** kN/mm²	**11313** ksi
MODULUS OF ELASTICITY	**196** kN/mm²	**28400** ksi

ELECTRICAL RESISTIVITY

10.9 µΩ•cm	**66** ohm•circ mil/ft

THERMAL CONDUCTIVITY

44 W/m•°C	**305** btu•in/ft²•h•°F

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE
Annealed	**450 - 550** N/mm²	**65 - 80** ksi	Tensile strength and elongation drop significantly at temperatures above 315°C (600°F). Service temperature is dependent on environment, load and size range.
Hard Drawn	**750 - 950** N/mm²	**109 - 138** ksi	

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Nickel 270•

W.NR 2.4050
UNS N02270
AWS 074

• Trade name of Special Metals Group of Companies

A high purity grade of nickel that is made by powder metallurgy.

Applications include:
electrical resistance thermometers and various other electrical and electronic applications.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	99.9% min

DENSITY	8.89 g/cm³	0.321 lb/in³
MELTING POINT	1454°C	2650°F
COEFFICIENT OF EXPANSION	13.3 µm/m•°C (20-100°C)	7.4x10⁻⁶ in/in•°F (70-212°F)
MODULUS OF RIGIDITY	82 kN/mm²	11893 ksi
MODULUS OF ELASTICITY	207 kN/mm²	30000 ksi

ELECTRICAL RESISTIVITY	
7.5 µΩ•cm	45 ohm•circ mil/ft

THERMAL CONDUCTIVITY	
86 W/m•°C	595 btu•in/ft²•h•°F

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE
Annealed	300 - 450 N/mm²	44 - 65 ksi	Tensile strength and elongation drop significantly at temperatures above 315°C (600°F). Service temperature is dependent on environment, load and size range.
Hard Drawn	600 - 800 N/mm²	87 - 116 ksi	

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Ni-Span-C Alloy 902 •

UNS N09902
AWS 080

• Trade name of Special Metals Group of Companies

A precipitation hardenable Nickel-Iron-Chromium alloy having outstanding controllable thermoelastic coefficient characteristics and excellent strength and oxidation resistance in high temperature atmospheres. The alloy can be processed to have a constant modulus of elasticity at temperatures ranging from -45°C to +65°C (-50 to +150°F).

Applications include:
springs in precise applications, such as watches and weighing machines

APPROXIMATE CHEMICAL COMPOSITION	
Ni	41 - 43.5%
Cr	4.9 - 5.75%
Ti	2.2 - 2.75%
Fe	48%

DENSITY	**8.05** g/cm³	**0.291** lb/in³
MELTING POINT	**1480**°C	**2700**°F
COEFFICIENT OF EXPANSION	**7.6** µm/m•°C (20-100°C)	**4.2x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**62 - 69** kN/mm²	**8993 - 10008** ksi
MODULUS OF ELASTICITY	**165 - 200** kN/mm²	**23932 - 29008** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Spring Temper	
For good all round properties:	Age harden at **650°C (1200°F)** for **2** hours and air cool.
For maximum stability:	Stress equalise at **400°C (750°F)** for **2** hours and air cool and age harden at **650°C (1200°F)** for **2** hours and air cool.
For min. hysterisis & low thermo elastic coefficient:	Stress equalise at **400°C (750°F)** for **2** hours and air cool.

(Very high precision applications will require each batch to be pilot tested to determine the specific heat treatment necessary to produce the required thermo elastic coefficient).

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**450 - 650** N/mm²	**65 - 94** ksi	**-45** to **+65°C** (for constant modulus applications)	**-50** to **+150°F**
Spring Temper	**900 - 1100** N/mm²	**131 - 159** ksi	**-45** to **+65°C** (for constant modulus applications)	**-50** to **+150°F**
Spring Temper+ Aged	**1300 - 1500** N/mm²	**189 - 218** ksi	**-45** to **+65°C** (for constant modulus applications)	**-50** to **+150°F**

STANDARDS

AMS 5225

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Nilo 36 *

W.NR 1.3912
UNS K93600
UNS K93601
AWS 090

* Trade name of Special Metals Group of Companies

A Nickel-Iron, low expansion alloy containing 36% Nickel. It maintains near constant dimensions over the range of normal atmospheric temperatures and has a low coefficient of expansion from cryogenic temperatures to about 500°C (930°F). Nilo 36 also retains good strength and toughness at cryogenic temperatures.

Applications include:
standards of length, thermostat rods, laser components, tanks and piping for the storage and transportation of liquefied gasses.

APPROXIMATE CHEMICAL COMPOSITION

Ni	35 - 38%
Fe	BAL

DENSITY	**8.11** g/cm³	**0.293** lb/in³
MELTING POINT	**1430**°C	**2610**°F
INFLECTION POINT	**220**°C	**430**°F
THERMAL CONDUCTIVITY	**10.0** W/m•°C	**69.3** btu•in/ft²•h•°F
COEFFICIENT OF EXPANSION	**1.5** µm/m•°C (20-100°C) **2.6** µm/m•°C (20-200°C)	**0.83x10⁻⁶** in/in•°F (70-212°F) **1.4x10⁻⁶** in/in•°F (70-392°F)

HEAT TREATMENT (AFTER FORMING)

The Nilo alloys are usually used in the annealed condition (residual cold work distorts the coefficients of thermal expansion).
Anneal at **850 - 1000°C (1560 - 1830°F)**

For highest dimensional stability, heat treat as follows:
Anneal at **830°C (1525°F)** for **30** minutes and water quench,
Re-heat to **300°C (570°F)** for **1** hour and water quench.
Finally re-heat to **100°C (212°F)** for **48** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**450 - 550** N/mm²	**65 - 80** ksi	up to **500°C**	up to **930°F**
Hard Drawn	**700 - 900** N/mm²	**102 - 131** ksi	up to **500°C**	up to **930°F**

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Nilo 42 •

W.NR 1.3917
UNS K94100
AWS 091

• Trade name of Special Metals Group of Companies

A Nickel-Iron, low expansion alloy containing 42% Nickel. It has a low and nominally constant coefficient of thermal expansion from room temperature to about 300°C (570°F).

Applications include:
semiconductor lead frames, thermostat rods, various glass to metal seals.

APPROXIMATE CHEMICAL COMPOSITION

Ni	42%
Fe	BAL

DENSITY	**8.11** g/cm³	**0.293** lb/in³
MELTING POINT	**1435**°C	**2615**°F
INFLECTION POINT	**370**°C	**700**°F
THERMAL CONDUCTIVITY	**10.5** W/m•°C	**72.8** btu•in/ft²•h•°F
COEFFICIENT OF EXPANSION	**5.3** µm/m•°C (20-100°C) **4.5 - 6.5** µm/m•°C (20-300°C)	**2.9x10⁻⁶** in/in•°F (70-212°F) **2.5 - 3.6x10⁻⁶** in/in•°F (70-572°F)

HEAT TREATMENT (AFTER FORMING)

The Nilo alloys are usually used in the annealed condition (residual cold work distorts the coefficients of thermal expansion).

Anneal at **850 - 1000°C (1560 - 1830°F)**

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**450 - 550** N/mm²	**65 - 80** ksi	up to **300°C**	up to **570°F**
Hard Drawn	**700 - 900** N/mm²	**102 - 131** ksi	up to **300°C**	up to **570°F**

STANDARDS

ASTM F30

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Nilo 48•

W.NR 1.3922
W.NR 1.3926
W.NR 1.3927
UNS K94800
AWS 092

• Trade name of Special Metals Group of Companies

A Nickel-Iron, controlled expansion alloy containing 48% Nickel. Its coefficient of thermal expansion was designed to match that of soft lead and soda-lime glasses. This alloy also has a high inflection point.

Applications include:
industrial thermostats that operate at temperatures up to 450°C (840°F) and various glass to metal seals.

APPROXIMATE CHEMICAL COMPOSITION

Ni	48%
Fe	BAL

DENSITY	**8.2** g/cm³	**0.296** lb/in³
MELTING POINT	**1450**°C	**2640**°F
INFLECTION POINT	**460**°C	**860**°F
THERMAL CONDUCTIVITY	**16.7** W/m•°C	**116** btu•in/ft²•h•°F
COEFFICIENT OF EXPANSION	**8.5** µm/m•°C (20-100°C) **8.3 - 9.3** µm/m•°C (20-400°C)	**4.7x10⁻⁶** in/in•°F (70-212°F) **4.6 - 5.2x10⁻⁶** in/in•°F (70-572°F)

HEAT TREATMENT (AFTER FORMING)

The Nilo alloys are usually used in the annealed condition (residual cold work distorts the coefficients of thermal expansion).

Anneal at **850 - 1000°C (1560 - 1830°F)**

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**450 - 550** N/mm²	**65 - 80** ksi	up to **450**°C	up to **840**°F
Hard Drawn	**700 - 900** N/mm²	**102 - 131** ksi	up to **450**°C	up to **840**°F

STANDARDS

ASTM F30

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Nilo 52 •

W.NR 2.4478
UNS N14052
AWS 093

• Trade name of Special Metals Group of Companies

Nilo 52 was designed for use with a variety of soft glasses.
It is known for its almost constant coefficient of thermal expansion up to approx. 565°C (1050°F).

Applications include:
various glass to metal sealing applications with soft glass and ceramics.

APPROXIMATE CHEMICAL COMPOSITION

Ni	52%
Fe	BAL

DENSITY	8.3 g/cm³	0.300 lb/in³
MELTING POINT	1450°C	2640°F
INFLECTION POINT	500°C	930°F
THERMAL CONDUCTIVITY	17 W/m•°C	118 btu•in/ft²•h•°F
COEFFICIENT OF EXPANSION	10.3 µm/m•°C (20-100°C)	5.7x10⁻⁶ in/in•°F (70-212°F)

HEAT TREATMENT (AFTER FORMING)

The Nilo alloys are usually used in the annealed condition (residual cold work distorts the coefficients of thermal expansion).

Anneal at **850 - 1000°C (1560 - 1830°F)**

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	450 - 550 N/mm²	65 - 80 ksi	up to 450°C	up to 840°F
Hard Drawn	700 - 900 N/mm²	102 - 131 ksi	up to 450°C	up to 840°F

STANDARDS

ASTM F30

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Nilo K •

W.NR 1.3981
UNS K94610
AWS 094

• Trade name of Special Metals Group of Companies

A Nickel-Iron-Cobalt, controlled expansion alloy containing 29% Nickel. Its coefficient of expansion (which decreases with rising temperature to the inflection point), matches the expansion rate of borosilicate glasses and alumina ceramics.

Applications include:

glass to metal seals in applications requiring high reliability or resistance to thermal shock, ie. high power transmitting valves.

APPROXIMATE CHEMICAL COMPOSITION

Ni	29%
Fe	53%
Co	17%

DENSITY	**8.16** g/cm³	**0.295** lb/in³
MELTING POINT	**1450**°C	**2640**°F
INFLECTION POINT	**450**°C	**840**°F
THERMAL CONDUCTIVITY	**16.7** W/m•°C	**116** btu•in/ft²•h•°F
COEFFICIENT OF EXPANSION	**6.0** µm/m•°C (20-100°C) **4.6 - 5.2** µm/m•°C (20-400°C)	**3.3x10⁻⁶** in/in•°F (70-212°F) **2.6 - 2.9x10⁻⁶** in/in•°F (70-752°F)

HEAT TREATMENT (AFTER FORMING)

The Nilo alloys are usually used in the annealed condition (residual cold work distorts the coefficients of thermal expansion).

Anneal at **850 - 1000°C (1560 - 1830°F)**

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**450 - 550** N/mm²	**65 - 80** ksi	up to **400°C**	up to **750°F**
Hard Drawn	**700 - 900** N/mm²	**102 - 131** ksi	up to **400°C**	up to **750°F**

STANDARDS

ASTM F15

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Phynox†

W.NR 2.4711
UNS R30003
AWS 100

† Trade name of Imphy Ugine Precision

This Cobalt-Chromium-Nickel alloy gives a combination of high strength, ductility and good mechanical properties and is age hardenable. Phynox also has excellent fatigue life, corrosion resistance in numerous environments and is non-magnetic.

Applications include:
use where a high resistance to corrosion and / or low relaxation at temperatures up to 380°C (715°F) are required. Also for springs, seal components, medical devices, components for watches, aerospace, petro-chemical and marine engineering applications.

APPROXIMATE CHEMICAL COMPOSITION	
Co	39 - 41%
Cr	19 -21%
Ni	14 - 16%
Mo	6 - 8%
Fe	BAL

DENSITY	**8.3** g/cm³	**0.300** lb/in³
MELTING POINT	**1427**°C	**2600**°F
COEFFICIENT OF EXPANSION	**12.5** µm/m • °C (20-100°C)	**7.0x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**77** kN/mm²	**11168** ksi
MODULUS OF ELASTICITY	**203.4** kN/mm²	**29501** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed	Phynox cannot be age hardened in the annealed condition.
Spring Temper	Age harden at **520°C (970°F)** for **5** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**800 - 1000** N/mm²	**116 - 145** ksi	**-185** to **+450°C**	**-300** to **+840°F**
Spring Temper	**1400 - 1900** N/mm²	**203 - 276** ksi	**-185** to **+450°C**	**-300** to **+840°F**
Spring Temper + Aged	**1900 - 2200** N/mm²	**276 - 319** ksi	**-185** to **+450°C**	**-300** to **+840°F**

STANDARDS

AMS 5833 **ISO 5832** **AMS 5834**

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MP35N *

UNS R30035
AWS 110

* Trade name of SPS Technologies

MP35N is an age hardenable Nickel-Cobalt base alloy that has a unique combination of properties - ultra high strength, toughness, ductility and outstanding corrosion resistance. MP35N resists corrosion in hydrogen sulphide, salt water and other chloride solutions. It also has excellent resistance to crevice and stress corrosion cracking in sea water and other hostile environments.

Applications include:

where a high combination of strength, high modulus values and good corrosion resistance are required. Also medical devices and marine engineering applications.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	35%
Co	35%
Cr	20%
Mo	10%

DENSITY	**8.43** g/cm³	**0.304** lb/in³
MELTING POINT	**1440**°C	**2625**°F
COEFFICIENT OF EXPANSION	**12.8** µm/m•°C (20-100°C)	**7.1x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**80.7** kN/mm²	**11705** ksi
MODULUS OF ELASTICITY	**234** kN/mm²	**33939** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed	MP35N cannot be age hardened in the annealed condition.
Spring Temper	Age harden at **650°C (1200°F)** for **4** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**800 - 1000** N/mm²	**116 - 145** ksi	**-200** to **+315**°C	**-330** to **+600**°F
Spring Temper	**1400 - 1900** N/mm²	**203 - 276** ksi	**-200** to **+315**°C	**-330** to **+600**°F
Spring Temper + Aged	**1900 - 2200** N/mm²	**276 - 319** ksi	**-200** to **+315**°C	**-330** to **+600**°F

STANDARDS

AMS 5844

Rene 41*

W.NR 2.4973
UNS N07041
AWS 120

* Trade name of General Electric Inc.

Rene 41 is an age hardenable nickel base alloy that has very high strength at elevated temperatures, particularly within the range of 650 - 980°C (1200 - 1800°F). Required mechanical properties can be tailored by selection of various combinations of cold work and/or heat treatments. Rene 41 also has good oxidation resistance.

Applications include:
after burner parts, turbine castings, bolts and other fasteners.

APPROXIMATE CHEMICAL COMPOSITION

Cr	18 -20%
Co	12%
Mo	9- 10.5%
Ti	3.0 - 3.3%
Al	1.4 -1.6%
Ni	BAL

DENSITY	**8.25** g/cm³	**0.298** lb/in³
MELTING POINT	**1345**°C	**2450**°F
COEFFICIENT OF EXPANSION	**13.6** µm/m•°C (20-100°C)	**7.41x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**83.2** kN/mm²	**12067** ksi
MODULUS OF ELASTICITY	**218** kN/mm²	**31619** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed	Age harden at **760°C (1400°F)** for **16** hours and air cool.
Spring Temper	1. Solution anneal at **1065°C (1950°F)** for **4** hours and air cool 2. + Age at **760°C (1400°F)** for **16** hours and air cool.
Spring Temper	Age harden at **760°C (1400°F)** for **16** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**800 - 1100** N/mm²	**116 - 159** ksi	up to **+550°C**	up to **+1020°F**
Annealed + Aged	**1350 - 1550** N/mm²	**196 - 225** ksi	up to **+550°C**	up to **+1020°F**
Spring Temper	**1400 - 1800** N/mm²	**203 - 261** ksi	up to **+550°C**	up to **+1020°F**
Spring Temper + Aged	**1600 - 2000** N/mm²	**232 - 290** ksi	up to **+550°C**	up to **+1020°F**

STANDARDS

AMS 5545 **AMS 5800**

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Alloy 20 CB 3

W.NR 2.4660
UNS N08020
AWS 130

Alloy 20 CB 3 is an austenitic stainless steel with excellent resistance to hot sulphuric acid and many other aggressive environments that would readily attack stainless steel 316. This alloy exhibits superior resistance to stress-corrosion cracking in boiling 20 to 40% sulphuric acid.

Applications include:
chemical and allied industries, and in the processing of synthetic rubber, high-octane gasoline, solvents, pharmaceuticals, and agrichemicals.

APPROXIMATE CHEMICAL COMPOSITION

Ni	32 - 38%
Cr	19 - 21%
Cu	3 - 4%
Mo	2 - 3%
Fe	BAL
C	0.07% max

DENSITY	**8.08** g/cm³	**0.292** lb/in³
MELTING POINT	**1425**°C	**2600**°F
COEFFICIENT OF EXPANSION	**14.69** µm/m • °C (20-100°C)	**8.16x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	**73.6** kN/mm²	**10675** ksi
MODULUS OF ELASTICITY	**193** kN/mm²	**27993** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **250 - 530°C (480 - 990°F)** for **1** hour and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**600 - 900** N/mm²	**87 - 131** ksi	**-200** to **+300°C**	**-330** to **+570°F**
Spring Temper	**1200 - 1800** N/mm²	**174 - 261** ksi	**-200** to **+300°C**	**-330** to **+570°F**

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Beryllium Copper CB 101

UNS C17200
AWS 140

This age hardenable copper alloy combines a range of properties suited to meet the exacting requirements of many automotive, electronic and aerospace industries.

Applications include:
automotive and aerospace industries

APPROXIMATE CHEMICAL COMPOSITION	
Cu	BAL
Be	1.7 - 1.9%
Ni+Co	0.05 - 0.40%

DENSITY	**8.25** g/cm³	**0.298** lb/in³
MELTING POINT	**980**°C	**1800**°F
COEFFICIENT OF EXPANSION	**17.8** µm/m • °C (20-100°C)	**9.9x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	—	—
MODULUS OF ELASTICITY	**123** kN/mm²	**17840** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed	Age Hardened at **315 - 320°C (600- 610°F)** for **3** hours and air cool.
Hard Drawn	Age Hardened at **315 - 320°C (600- 610°F)** for **2** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**400 - 600** N/mm²	**58 - 87** ksi	up to **200°C**	up to **390°F**
Annealed + Aged	**800 - 1200** N/mm²	**116 - 174** ksi	up to **200°C**	up to **390°F**
Spring Temper	**800 - 1200** N/mm²	**116 - 174** ksi	up to **200°C**	up to **390°F**
Spring Temper + Aged	**1200 - 1600** N/mm²	**174 - 232** ksi	up to **200°C**	up to **390°F**

STANDARDS

BS 2873

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Waspaloy+

W.NR 2.4654
UNS N07001
AWS 170

+ Trade name of united Technologies Corporation

This age hardenable nickel base super alloy has very good strength in temperatures up to about 980°C (1800°F). It's strength is generally comparable to that of Rene 41 and is generally superior to that of Alloy 718 at temperatures exceeding 650 - 705°C (1200 - 1300°F).

Applications include:
gas turbine engine parts, aerospace components, springs and fasteners.

APPROXIMATE CHEMICAL COMPOSITION	
Ni	BAL
Co	13.5%
Fe	2% max
Cr	19%
Mo	4.3%
Al	1.5%
Ti	3%

DENSITY	**8.16** g/cm³	**0.295** lb/in³
MELTING POINT	**1330**°C	**2425**°F
COEFFICIENT OF EXPANSION	**12.2** µm/m•°C (21-93°C)	**6.8x10⁻⁶** in/in•°F (70-200°F)
MODULUS OF RIGIDITY	—	—
MODULUS OF ELASTICITY	**211** kN/mm²	**30600** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Solution Annealed	Stabilize at **843°C (1550°F)** for **4** hours and air cool. and Age harden at **760°C (1400°F)** for **16** hours and air cool.
Spring Temper	Anneal at **1050°C (1920°F)** for **4** hours and air cool. and Stabilize at **843°C (1550°F)** for **24** hours and air cool. and Age harden at **760°C (1400°F)** for **16** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Solution Annealed	**800 - 1100** N/mm²	**116 - 159** ksi	up to **+550°C** Depending on spring design and operating conditions	up to **+1020°F** Depending on spring design and operating conditions
Solution Annealed + Aged	**1300 - 1500** N/mm²	**189 - 218** ks		
Spring Temper	**1300 - 1600** N/mm²	**189 - 232** ksi		
Spring Temper + Annealed and Aged	**1300 - 1500** N/mm²	**189 - 218** ksi		

STANDARDS

AMS 5544 **AMS 5708** **AMS 5828**

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Titanium Grade 5

W.NR 3.7164
W.NR 3.7165
AWS 151

Titanium Grade 5 has good tensile properties at ambient temperature and a useful creep resistance up to 300°C (570°F). Resistance to fatigue and crack propagation is excellent. Like most titanium alloys, Grade 5 has outstanding resistance to corrosion in most natural and many industrial process environments. The ability to age harden this alloy makes it a good choice for such applications as springs and fasteners.

Applications include:
aerospace, surgical implants, jewellery, chemical, springs, bolts and various other fasteners.

APPROXIMATE CHEMICAL COMPOSITION	
Ti	BAL
Al	5.5 - 6.75%
V	3.5 - 4.5%
H	0.015% max

DENSITY	**4.42** g/cm³	**0.16** lb/in³
MELTING POINT	**1650**°C	**3000**°F
COEFFICIENT OF EXPANSION	**9.0** µm/m • °C (20-100°C)	**5.0x10⁻⁶** in/in • °F (70-212°F)
MODULUS OF RIGIDITY	—	—
MODULUS OF ELASTICITY	**105 - 120** kN/mm²	**15230 - 17405** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **250 - 650°C (482 - 1200°F)** for **30** minutes to **4** hours and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**950 - 1100** N/mm²	**138 -159** ksi	**-200** to **+400°C**	**-330** to **+750°F**
Spring Temper	**1100 - 1400** N/mm²	**159 - 203** ksi	**-200** to **+400°C**	**-330** to **+750°F**

STANDARDS

ASTM B348

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Stainless Steel 302

W.NR 1.4310
UNS S30200
AWS 160

Stainless Steel 302 has good mechanical properties and corrosion resistance.

Applications include:
springs, wire gauze and wire cloth.

APPROXIMATE CHEMICAL COMPOSITION

Cr	17 - 19%
Ni	8 - 10%
Fe	BAL

DENSITY	**8.0** g/cm³	**0.289** lb/in³
MELTING POINT	**1420**°C	**2590**°F
COEFFICIENT OF EXPANSION	**17.6** µm/m•°C (20-100°C)	**9.8x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**70.3** kN/mm²	**10196** ksi
MODULUS OF ELASTICITY	**187.5** kN/mm²	**27195** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **250°C (480°F)** for **1** hour and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**600 - 800** N/mm²	**87 - 116** ksi	**-200** to **+300°C**	**-330** to **+570°F**
Spring Temper	**1300 - 2200** N/mm²	**189 - 319** ksi	**-200** to **+300°C**	**-330** to **+570°F**

STANDARDS

BS 970	**BS 1554**	**BS 2056**	**ASTM A313**

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Stainless Steel 304

W.NR 1.4301
W.NR 1.4303
W.NR 1.4306
UNS S30400
AWS 161

Stainless Steel 304, like 302, has good mechanical properties and corrosion resistance.

Applications include:
springs, wire gauze and wire cloth.

APPROXIMATE CHEMICAL COMPOSITION

Cr	17 - 19%
Ni	8 - 11%
Fe	BAL

DENSITY	**8.0** g/cm³	**0.289** lb/in³
MELTING POINT	**1454**°C	**2650**°F
COEFFICIENT OF EXPANSION	**18.2** µm/m•°C (20-100°C)	**10.1x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**70.3** kN/mm²	**10196** ksi
MODULUS OF ELASTICITY	**187.5** kN/mm²	**27195** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **250°C (480°F)** for **1** hour and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**600 - 800** N/mm²	**87 - 116** ksi	**-200** to **+300°C**	**-330** to **+570°F**
Spring Temper	**1300 - 2200** N/mm²	**189 - 319** ksi	**-200** to **+300°C**	**-330** to **+570°F**

STANDARDS

BS 970	**BS 1554**	**BS 2056**	**ASTM A313**

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Stainless Steel 316

W.NR 1.4401
W.NR 1.4404
UNS S31600
AWS 162

Stainless Steel 316 has slightly better corrosion resistance than 302 and 304. It also has better non-magnetic properties.

Applications include:
more suited to Marine, Food and Medical application than 302 and 304.

APPROXIMATE CHEMICAL COMPOSITION	
Cr	16.5 - 18.5%
Ni	10.5 - 13.5%
Fe	BAL
Mo	2.0 - 2.5%

DENSITY	**8.0** g/cm³	**0.289** lb/in³
MELTING POINT	**1398**°C	**2555**°F
COEFFICIENT OF EXPANSION	**17.5** µm/m•°C (20-100°C)	**9.7x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**70.3** kN/mm²	**10196** ksi
MODULUS OF ELASTICITY	**187.5** kN/mm²	**27195** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **250°C (480°F)** for **1** hour and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**600 - 800** N/mm²	**87 - 116** ksi	**-200** to **+300°C**	**-330** to **+570°F**
Spring Temper	**1300 - 2200** N/mm²	**189 - 319** ksi	**-200** to **+300°C**	**-330** to **+570°F**

STANDARDS

BS 970 **BS 1554** **BS 2056** **ASTM A313**

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Stainless Steel 316LVM

W.NR 1.4441
UNS S31673
AWS 163

Regarded as 'Medical Grade', this stainless steel 316 is vacuum melted to achieve the extremely high levels of purity and 'cleanliness' required for surgical implants. It has excellent resistance in physiological environments, to general and intergranular corrosion, to pitting and crevice corrosion.

Applications include:
medical implants and high precision electronics.

APPROXIMATE CHEMICAL COMPOSITION	
Cr	17 -19%
Ni	13 - 15%
Mn	2% max
Mo	2.25 - 3.5%
Fe	BAL

DENSITY	**8.0** g/cm³	**0.289** lb/in³
MELTING POINT	**1500**°C	**2730**°F
COEFFICIENT OF EXPANSION	**16.5** µm/m•°C (20-100°C)	**9.2x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**70.3** kN/mm²	**10196** ksi
MODULUS OF ELASTICITY	**187.5** kN/mm²	**27195** ksi

CONDITION OF SUPPLY	HEAT TREATMENT (AFTER FORMING)
Annealed/Spring Temper	Stress relieve at **250°C (480°F)** for **1** hour and air cool.

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**600 - 800** N/mm²	**87 - 116** ksi	**-200** to **+300°C**	**-330** to **+570°F**
Spring Temper	**1300 - 2200** N/mm²	**189 - 319** ksi	**-200** to **+300°C**	**-330** to **+570°F**

STANDARDS

BS 7252 Pt1 COMPOSITION D **ASTM F138**

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Stainless Steel DTD 189A

AWS 164

This grade of stainless steel is widely used in the aerospace industry.

Applications include:
locking wire and other types of fasteners.

APPROXIMATE CHEMICAL COMPOSITION

Cr	17 - 20%
Ni	7 - 10%
Ni + Cr	25% min
Fe	BAL

DENSITY	**8.0** g/cm³	**0.289** lb/in³
MELTING POINT	**1398**°C	**2550**°F
COEFFICIENT OF EXPANSION	**17.5** µm/m•°C (20-100°C)	**9.7x10⁻⁶** in/in•°F (70-212°F)
MODULUS OF RIGIDITY	**70.3** kN/mm²	**10196** ksi
MODULUS OF ELASTICITY	**187.5** kN/mm²	**27195** ksi

CONDITION	APPROX TENSILE STRENGTH		APPROX SERVICE TEMPERATURE	
Annealed	**600 - 800** N/mm²	**87 - 116** ksi	**-200** to **+300**°C	**-330** to **+570**°F

STANDARDS

DTD 189A

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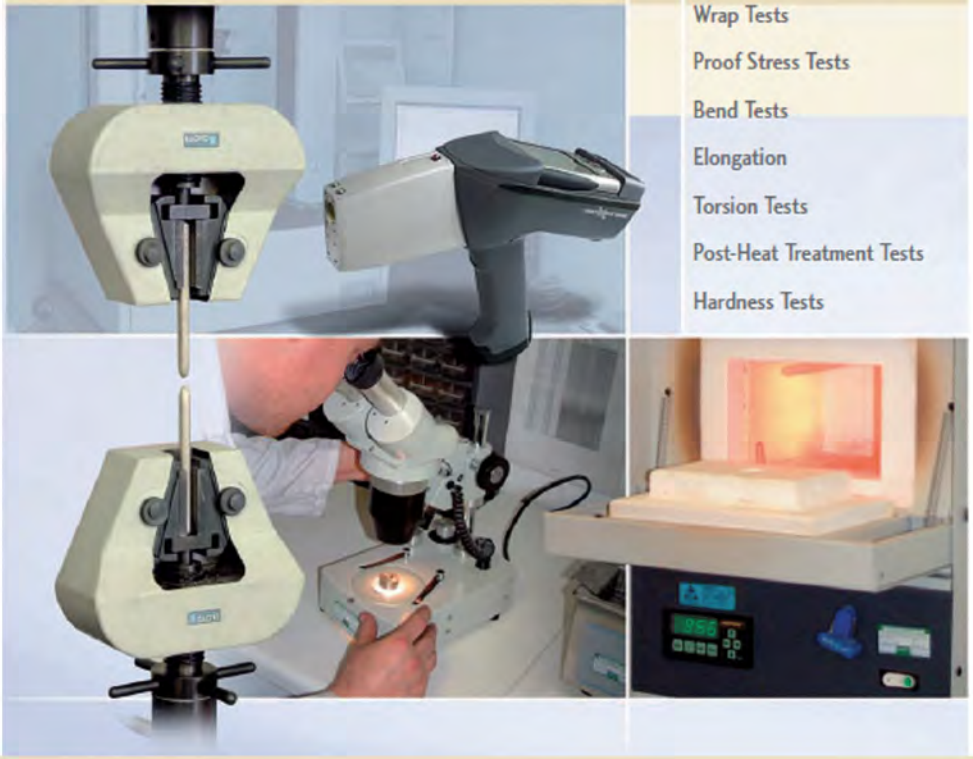
Testing

- Positive Material Identification
- Tensile Strength Tests
- Wrap Tests
- Proof Stress Tests
- Bend Tests
- Elongation
- Torsion Tests
- Post-Heat Treatment Tests
- Hardness Tests



Tolerances

inches			ALLOY WIRE STANDARD TOLERANCES		mm
WIREØ	up to but excluding...	TOLERANCE	WIREØ	up to but excluding...	TOLERANCE
0.001"	0.002"	+/- .0002"	0.0254mm	0.0508mm	+/- 0.0051mm
0.002"	0.0148"	+/- .0003"	0.0508mm	0.376mm	+/- 0.0076mm
0.0148"	0.032"	+/- .0004"	0.376mm	0.813mm	+/- 0.0100mm
0.032"	0.048"	+/- .0005"	0.813mm	1.22mm	+/- 0.0127mm
0.048"	0.080"	+/- .0006"	1.22mm	2.03mm	+/- 0.0152mm
0.080"	0.128"	+/- .0008"	2.03mm	3.25mm	+/- 0.0203mm
0.128"	0.176"	+/- .0010"	3.25mm	4.47mm	+/- 0.0254mm
0.176"	0.232"	+/- .0015"	4.47mm	5.89mm	+/- 0.0381mm
0.232"	0.315"	+/- .0025"	5.89mm	8.00mm	+/- 0.0635mm
0.315"	0.395"	+/- .0030"	8.00mm	10.0mm	+/- 0.0760mm
0.395"	0.470"	+/- .0040"	10.0mm	12.0mm	+/- 0.1000mm
0.470"	0.787"	+/- .0050"	12.0mm	20.0mm	+/- 0.1270mm

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Packaging

Coil Diameter		Wire Diameter		Weight Range		
1000mm	40"	6mm - 20mm	0.236" - 0.787"	up to 100 kgs	up to 200 pounds	COIL
600mm	24"	1.6mm - 6mm	0.063" - 0.236"	up to 100 kgs	up to 200 pounds	
300mm	12"	0.6mm - 1.6mm	0.024" - 0.063"	up to 50 kgs	up to 100 pounds	
200mm	8"	0.3mm - 0.6mm	0.012" - 0.024"	up to 20 kgs	up to 50 pounds	
Din 250		0.25mm - 2.0mm	0.010" - 0.080"	up to 20 kgs	up to 50 pounds	SPOOLS
Din 200		0.25mm - 1.00mm	0.010" - 0.040"	0.up to 10 kgs	up to 25 pounds	
Din 160		0.25mm - 1.00mm	0.010" - 0.040"	up to 7 kgs	up to 15 pounds	
Din 125		0.25mm - 1.00mm	0.010" - 0.040"	up to 3 kgs	up to 7 pounds	
Din 100		0.15mm - 0.30mm	0.006" - 0.012"	up to 1.5 kgs	up to 3 pounds	
Din 80		0.05mm - 0.20mm	0.002" - 0.008"	up to 0.80 kgs	up to 1.5 pounds	
Din 50		0.025mm - 0.05mm	0.001" - 0.002"	up to 0.10 kgs	up to 0.25 pounds	

Quality

Electrolux has held ISO 9000 certification since 1991. This quality approval is essential to our company as it offers the assurance that our products are made to the highest standards. As a rule we supply Certificates with all shipments and, as well as normal chemical analyses, we can offer full mechanical test results. We are able to provide the mechanical tests listed using our in-house testing equipment. In addition, we have examination facilities that allow visual inspection up to 400x, linked to computer software that can produce digital or photographic images. We also have equipment that enables preparation and examination of cross sections of wire. This is useful when looking for problems such as inclusions or seams in wire. All incoming material is visually inspected before processing begins and all our production is checked during processing and at the completion stage for size, properties, chemical analysis and appearance. Most of our work is produced to individual customer specifications that involve producing and proving trials prior to production. All material used by Alloy Wire International is fully certified and traceable back to the primary source. We are able to offer our test facilities on a sub-contract basis and, although not NAMAS certified, our equipment is regularly calibrated and certified by our fully competent staff.