**SOLVED PROBLEMS TO MATERIALS PROBLEMS**

Special Metals is a world leader in the development and production of nickel-based and other high-performance alloys with high-temperature strength, corrosion-resistance and other critical properties, used in virtually every industry, worldwide. We produce the largest range of nickel alloys and product forms available from any one manufacturer anywhere. We have production facilities in the USA and Europe, sales offices in North America, Europe and Australia, and distributors around the world. This publication is an introduction to the markets we serve and to the alloy products available from Special Metals.

**GENERAL INDUSTRIES**

**AEROSPACE ENGINEERING**
The first of the Nimonic® alloys made the prototype jet engines of the early 1940s a practical reality. Today, the superalloys of the Inconel®, Nimonic®, Incoloy® and Udiment® series are used for their hot strength in civil and military engines—from combustors, through power turbines, to exhaust systems. The Nimonic® alloys are used for tooling in the production of composites. Our alloys are specified for applications in commercial jets, supersonic military aircraft, helicopters and space exploration programs.

**AUTOMOTIVE ENGINEERING**
New engine ratings and pollution control requirements are creating new applications for the Incoloy®, Inconel®, Nimonic® and other high-nickel alloys in exhaust systems, valves, ignition equipment, sensors, electrical and electronic switchgear and safety devices.

**THE CHEMICAL & PROCESS INDUSTRIES**

**NIMONIC**
Wrought nickel and the alloys of the Incoloy®, Inconel®, Nimonic® and Monel® series are used for their corrosion-resistance in process applications from vessels, piping and heat-exchangers, to pumps and valves.

**MARINE ENGINEERING**
This is one of the longest established applications for nickel alloys; Monel® was first registered as a trademark in 1906. Today our products are used for their resistance to seawater corrosion in marine and submarine applications, on land and offshore platforms as well as in power and process plants, using seawater as a coolant.

**POLLUTION CONTROL & WASTE PROCESSING**
Helping meet new standards for clean-up and conservation, our products are used in power utilities and municipal and hazardous waste management systems, calling for the highest known performance from metallic materials working in aggressively corrosive environments. Applications include stack linings, scrubbers, boiler tubing and heat-exchangers.

**THERMAL PROCESSING & HEAT TREATMENT**

With high-temperature strength and resistance to corrosion by furnace atmospheres, Incoloy®, Inconel® and Nimonic® alloys are used for furnace components such as radiant tubes, muffles, reheat, belts and hearths, and for the jigs and carriers that support the work through the heat-treatment processes. Incotherm™ alloy seamless tubing is used for thermocouples.

**WELDING**
Our Welding Products Company produces a range of coated electrodes, filler metals and flux-cored filler wires, weldstrip and fluxes for joining nickel alloys, high-performance steels, dissimilar metals and cast irons. Welding Products Company’s trademarks include Inco-Weld®, IncoFlux® and Ni-Rod®.

**ENERGY INDUSTRY**

Special Metals supplies critical alloys to the energy industry as a member of PCC Energy Group, a collection of companies that leverages the top names in the industry to push what’s possible with metals for demanding energy applications.

**OIL & GAS**
On land and offshore, the Inconel®, Incoloy® and Monel® alloys are used for applications ranging from downhole tubulars and tools through well-head hardware and processing equipment to flare booms. Some of these alloys are particularly useful for wells where sour gas and oil products at high-temperatures could create major operating problems.

**PETROCHEMICAL PROCESSING**
The Incoloy® and Inconel® high-temperature corrosion-resistant alloys are used for vessels, reactors, heat-exchangers, pyrolysis tubing, pigtail, headers and transfer piping. In this largely continuous process industry, the predictably reliable performance of these alloys is a major benefit to plant designers and operators.

**POWER GENERATION**
From superalloys for land-based gas turbines, to feedwater and superheater tubing in coal and gas-fired utilities, to nuclear engineering, the Inconel®, Incoloy®, Nimonic®, Monel® and Udiment® alloys are used for their corrosion-resistance and high-temperature strength. And we have alloy and welding products used for solar and nuclear power generation.
**CORROSION-RESISTANT ALLOYS**

Other alloy compositions and product forms may be available. Inquire for details.

**Nickel 200** (UNS N02200, W.Nr. 2.4000/2.4068)  
(Ni 99.8, C 0.04)  
Commercially pure wrought nickel with good mechanical properties and corrosion-resistance. Used for chemical and process plant such as caustic soda and synthetic fiber production as well as for food handling.

**Nickel 201** (UNS N02201, W.Nr. 2.4068)  
(Ni 99.8, C 0.02 MAX)  
Similar to Nickel 200 but with the carbon content controlled to prevent intergranular embrittlement at service temperatures above 600°F (315°C). Used for chemical and process plant applications.

**Duranickel® Alloy 301** (UNS N03301)  
(Ni 94.0, Al 4.5, Ti 0.5)  
An age-hardenable nickel grade combining the corrosion-resistance of Nickel 200 with greater strength and hardness. Used for extrusion dies in the plastics industry and in the chemical and process industries.

**Monel® Alloy 400** (UNS N04400/404, W.Nr. 2.4360/2.4366)  
(Ni 65.1, Cu 32.0, Fe 1.6, Mn 1.1)  
A Ni-Cu alloy with high strength and excellent resistance to a range of media including seawater, hydrofluoric and sulfuric acids, and alkalies. Used in marine and offshore engineering, salt production and chemical and hydrocarbon processing.

**Monel® Alloy R-405** (UNS N04405)  
(Ni 65.0, Cu 32.5, Fe 1.2, Mn 1.1, S 0.04)  
Similar to Monel alloy 400 but with controlled sulfur to improve machinability characteristics.

**Monel® Alloy K-500** (UNS N05500, W.Nr. 2.4375)  
(Ni 64.7, Cu 30.2, Al 2.7, Fe 1.0, Ti 0.6)  
Similar to Monel alloy 400 but age-hardenable for improved strength and hardness. Used for pump shafts, oil well tools, doctor blades, springs, fasteners and marine propeller shafts.

**Inconel® Alloy 600** (UNS N06600, W.Nr. 2.4816)  
(Ni 76.0, Cr 15.0, Fe 8.0)  
A Ni-Cr-Fe alloy with high-temperature strength and oxidation-resistance, and resistance to stress corrosion cracking and caustic corrosion. Used in chemical, petrochemical and thermal processing as well as commercial and military nuclear power generation.

**Inconel® Alloy 602** (UNS N06602, W.Nr. 2.4802)  
(Ni 59.0, Cr 20.5, Mo 24.2, Fe 2.3, W 3.2)  
An Ni-Cr-Mo alloy with corrosion resistance in a wide range of reducing and oxidizing media, and resistance to localized corrosion and stress-corrosion cracking.

**Inconel® Alloy 625** (UNS N06625, W.Nr. 2.4856)  
(Ni 61.0, Cr 21.5, Mo 9.0, Nb 3.6, Fe 2.5)  
An Ni-Cr-Mo alloy with resistance to severely corrosive environments, particularly to pitting, crevice corrosion and high-temperature oxidation, and with high strength from cryogenic temperatures up to 1500°F (815°C). Used in aerospace engineering, gas turbines, chemical processing, oil and gas extraction, pollution control, and marine and nuclear engineering.

**Inconel® Alloy 625 Super®** (UNS N06626)  
(Ni 61.0, Cr 21.5, Mo 9.0, Nb 3.6, Fe 2.5)  
Similar to Inconel alloy 625 but with composition and processing controlled for optimum resistance to mechanical and thermal fatigue up to 1200°F (650°C).
**A GUIDE TO AQUEOUS CORROSION-RESISTANCE**

All alloys listed are resistant to chloride cracking.

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**HEAT-RESISTANT ALLOYS**

Other alloy compositions and product forms may be available. Inquire for details.

**INCOLOY® ALLOY 330 (UNS N08330, W.N.: 1.4303)**
- (Fe 44.0, Ni 35.5, Cr 18.5, Si 3.1)
- An alloy with good resistance to oxidation and carburization, for thermal processing and heat treatment applications.

**INCOLOY® ALLOY 800 (UNS N08800, W.N.: 1.4876)**
- (Fe 46.0, Ni 32.5, Cr 21.0, C 0.05)
- An alloy with high strength and corrosion-resistance used for applications in chemical and petrochemical processing, and for the sheathing of electric heating elements.

**INCOLOY® ALLOY 800H (UNS N08810, W.N.: 1.4958 & 1.4876)**
- (Fe 46.0, Ni 32.5, Cr 21.0, Al+Ti 0.9-1.2, C 0.08)
- Similar to INCOLOY alloy 800 but with improved creep and stress-rupture properties for applications above 1200°F (650°C). Resistant to high-temperature oxidation, carburization and nitridation, it is widely used in petrochemical and thermal processing.

**INCOLOY® ALLOY 800HT® (UNS N08811, W.N.: 1.4959 & 1.4876)**
- (Fe 46.0, Ni 32.5, Cr 21.0, Al+Ti 0.85-1.2, C 0.08)
- Similar to INCOLOY alloy 800H but with even more precisely controlled composition and higher ASME allowable design stresses.

**INCOLOY® ALLOY 803 (UNS S35045)**
- (Fe 37.0, Ni 35.0, Cr 25.0, Al+Ti 0.3-1.2, C 0.08)
- An Fe-Ni-Cr heat-resistant alloy with improved resistance to oxidation, carburization and sulfidation due to its content of chromium. Alloy 803 is typically used in refining, petrochemical and thermal processing applications and as internally finned tubes for ethylene pyrolysis.

**INCONEL® ALLOY 600 (UNS N06600, W.N.: 2.4816)**
- (Ni 76.0, Cr 15.0, Fe 8.0)
- A Ni-Cr-Fe alloy with good high-temperature strength and oxidation-resistance, and resistance to stress-corrosion cracking and caustic corrosion. Used for chemical and petrochemical processing, heat treatment applications, and in nuclear and automobile engineering.

**INCONEL® ALLOY 625 (UNS N06625, W.N.: 2.4851)**
- (Ni 60.5, Cr 23.0, Fe 14.4, Al 1.4)
- A nickel-chromium-iron alloy with an addition of aluminum for enhanced resistance to oxidation and other forms of high-temperature corrosion. It also has high mechanical properties at elevated temperatures. Alloy 625 products are used for industrial furnaces, heat-treating equipment and refining, petrochemical and other process equipment.

**INCONEL® ALLOY 625 (UNS N06625, W.N.: 2.4851)**
- (Ni 60.5, Cr 23.0, Fe 14.4, Al 1.4)
- A nickel-chromium-iron alloy with an addition of aluminum for enhanced resistance to oxidation and other forms of high-temperature corrosion. It also has high mechanical properties at elevated temperatures. Alloy 625 products are used for industrial furnaces, heat-treating equipment and refining, petrochemical and other process equipment.

**INCOLOY® ALLOY 617 (UNS N06817, W.N.: 2.4863)**
- (Ni 52.0, Cr 21.0, Cu 12.5, Mo 9.5, Fe 1.5, Al 1.2)
- An alloy with an exceptional combination of high-temperature strength, stability and oxidation-resistance. Also resistant to carburizing gases, it is used in petrochemical and thermal processing, nitric acid production and gas turbine engineering.
HEAT-RESISTANT ALLOYS

Other alloy compositions and product forms may be available. Inquire for details.

INCONEL® ALLOY 625 (UNS N06625, W. Nr. 2.4856)
(Ni 61.0, Cr 21.5, Mo 9.0, Nb 3.6, Fe 2.5)
A Ni-Cr-Mo alloy with resistance to a range of severely corrosive environments, particularly to pitting, crevice corrosion and high-temperature oxidation, and with high strength from cryogenic temperatures up to 1500°F (815°C). Used in aerospace engineering, gas turbines, chemical processing, oil and gas extraction, pollution control and marine and nuclear engineering.

INCONEL® ALLOY 625LCF® (UNS N06626)
(Ni 61.0, Cr 21.5, Mo 9.0, Nb 3.6, Fe 2.5)
Similar to INCONEL alloy 625 but with composition and processing controlled for optimum resistance to mechanical and thermal fatigue at up to 1200°F (650°C).

INCONEL® ALLOY 690 (UNS N06690, W. Nr. 2.4642)
(Ni 61.5, Cr 29.0, Fe 9.0)
An alloy with excellent resistance to high-temperature corrosion in applications such as nuclear steam generators, coal gasification and sulfuric, nitric and nitric/hydrofluoric acid processing.

INCONEL® ALLOY HX (UNS N06002, W. Nr. 2.4665)
(Ni 47.0, Cr 22.0, Fe 18.0, Mo 9.0, Co 1.5, W 0.6, C 0.1)
An alloy with an excellent balance of strength, fabricability and oxidation-resistance at up to 2000°F (1100°C). Used for aircraft, marine and land-based gas turbine engine combustors and other fabricated components, and in thermal processing and nuclear engineering.

A GUIDE TO HIGH-TEMPERATURE CHARACTERISTICS

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HIGH-PERFORMANCE & SPECIAL PURPOSE ALLOYS

Other alloy compositions and product forms may be available such as specific information on high-temperature mechanical, creep- and stress- rupture properties under different heat-treatment conditions and information on high-temperature corrosion-resistance alloys. Visit www.specialmetals.com for more information.

INCONEL® ALLOY 706 (UNS N07066)
(Ni 41.5, Fe 37.0, Cr 18.0, Nb 2.9, Ti 1.8, Al 0.2)
A superalloy for gas turbine applications, particularly for shafts, discs and spacers of land-based gas turbines for power generation.

INCONEL® ALLOY 718 (UNS N07718, W. Nr. 2.4668)
(Ni 54.0, Fe 18.5, Cr 18.0, Nb 5.0, Mo 3.0, Ti 1.0)
An age-hardenable alloy combining high strength up to 1300°F (700°C) with corrosion-resistance and excellent weldability. Used in aerospace, gas turbines, oil and gas extraction and nuclear engineering.

INCONEL® ALLOY 718SP™ (UNS N07719)
(Ni 73.0, Cr 15.5, Fe 7.0, Ti 2.5, Nb 1.0, Al 0.7)
A development of INCONEL alloy 718 with composition and processing controlled to create a high-strength, nickel-base superalloy with exceptional fatigue-resistance and amenable to superplastic forming.

INCONEL® ALLOY X-750 (UNS N07750, W. Nr. 2.4669)
(Ni 73.0, Cr 15.5, Fe 7.0, Ti 2.5, Nb 1.0, Al 0.7)
An age-hardenable Ni-Cr-Fe alloy with high tensile and creep-rupture properties up to 1300°F (700°C). Applications include gas turbine engineering, tooling, fasteners and springs.

INCONEL® ALLOY 783 (UNS R30783)
(Co 34.0, Ni 28.5, Fe 26.0, Al 5.4, Nb 3.0, Cr 3.0, Ti 1.4, Si 0.9)
A Co-base superalloy with a low and constant coefficient of thermal expansion, good oxidation- and impact-resistance, and metallurgical stability. Used for gas turbine engine casings, rings and seals.

INCONEL® ALLOY 925 (UNS N19903)
(Fc-43.0, Ni 38.0, Co 15.0, Nb 3.0, Ti 1.1, Al 0.1)
An age-hardenable alloy with a low and constant coefficient of thermal expansion up to 800°F (426°C) and its high strength, constant modulus of elasticity and resistance to thermal shock from cryogenic temperatures up to 1300°F (700°C). Applications include gas turbine casings, shrouds, vanes and shafts.

INCONEL® ALLOY 982 (UNS N19905, W. Nr. 2.4682)
(Fc-43.0, Ni 38.0, Co 13.0, Nb 4.7, Ti 1.5, Si 0.4, Al 0.03)
Similar to INCONEL alloy 980 but with improved notch-rupture and tensile properties at high temperatures and improved processing characteristics. Used for gas turbine calings, shrouds, vanes and shafts.

INCONEL® ALLOY A-286 (UNS S66286, W. Nr. 1.4980)
(Fc-55.5, Ni 25.5, Co 15.0, Ti 2.1, Mo 1.25)
An age-hardenable alloy with good strength and oxidation-resistance up to 1300°F (700°C). Applications include aircraft construction, automotive components and gas turbine engineering.

Udimet® ALLOY 883 (UNS R30188)
(Co 38.0, Ni 20.0, Cr 22.0, W 14.0, Fe 3.0, Mo 1.25)
A high-strength, thermally stable, oxidation- and sulphidation-resistant, cobalt-base superalloys used for gas turbine combustors and other key components.
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.