

# NAS600 (UNS N06600)

## Heat-Resistant Nickel Alloy

NAS600 (NCF600, UNS N06600) is a nickel-chromium alloy that provides excellent resistance to oxidation at high temperatures. Nippon Yakin supplies this product in plate, sheet, and strip forms.

### Grade/Standard

Nippon Yakin Grade	JIS G 4902	ASTM B168	EN 10095
NAS600	NCF600	UNS N06600	2.4816

### Chemical Composition

	C	Si	Mn	P	S	Ni	Cr	Cu	Al	Ti	Fe
Specification (NCF600)	≤0.15	≤0.50	≤1.00	≤0.030	≤0.015	≥72.00	14.00~17.00	≤0.50	—	—	6.00~10.00
Specification (UNS N06600)	≤0.15	≤0.5	≤1.0	—	≤0.015	≥72.0	14.0~17.0	≤0.5	—	—	6.0~10.0
Specification (EN 2.4816)	0.05~0.10	≤0.50	≤1.00	≤0.020	≤0.015	≥72.00	14.00~17.00	≤0.50	≤0.30	≤0.30	6.00~10.00

### Physical Properties

Density	[g/cm <sup>3</sup> ]	8.51
Specific heat	[J/kg · K]	444
Electrical resistivity	[μΩ · cm]	103
Thermal conductivity	[W/m · K]	15.0
Average coefficient of thermal expansion [10 <sup>-6</sup> /°C]	25~ 93°C	13.3
	25~316°C	14.2
	25~538°C	15.1
	25~760°C	16.0
	25~982°C	16.7
Young's modulus	[MPa]	21.4 × 10 <sup>4</sup>
Curie point	[°C]	-124
Magnetism		None
Melting range	[°C]	1370~1410

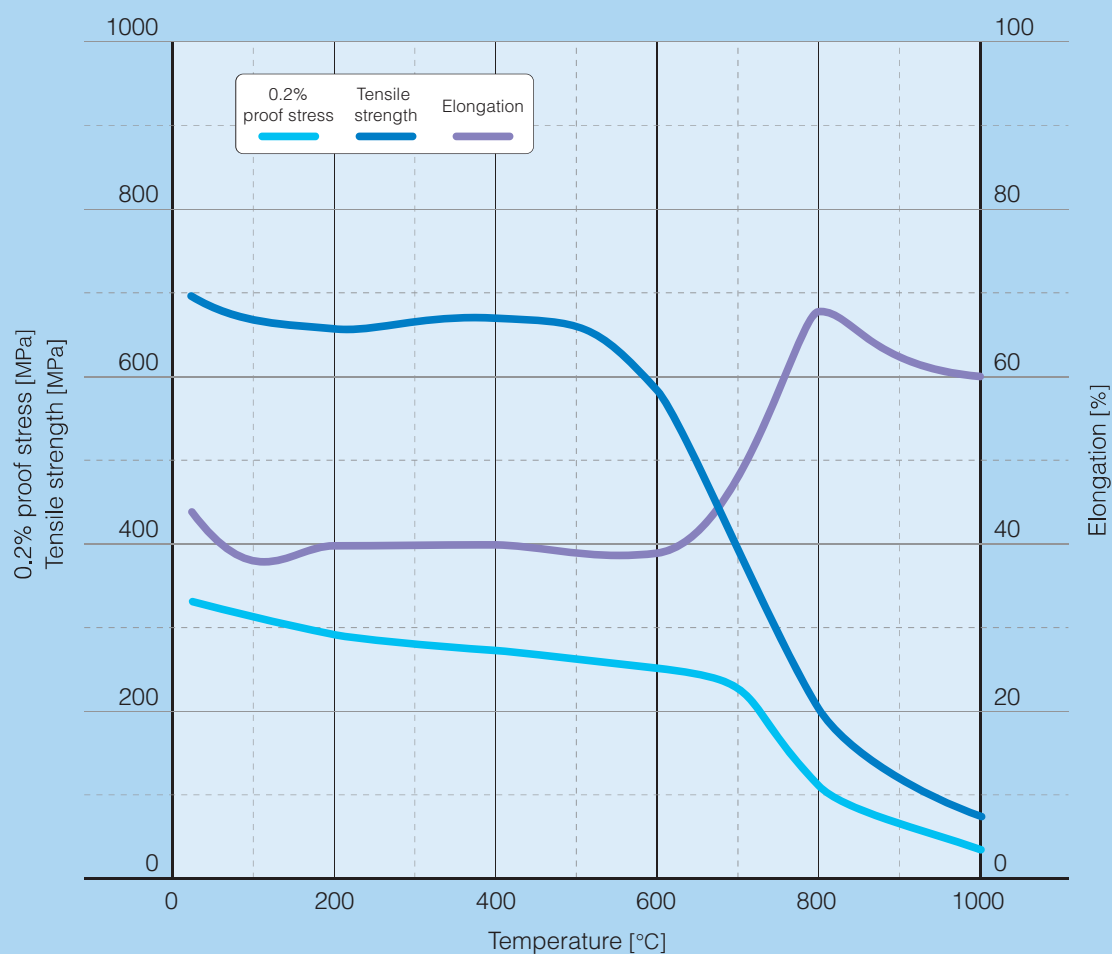
## Mechanical Properties

### Mechanical Properties at Room Temperature

		0.2% proof stress [MPa]	Tensile strength [MPa]	Elongation [%]	Hardness	
					[HV]	[HBW]
Specification (NCF600)		$\geq 245$	$\geq 550$	$\geq 30$	$\leq 182$	$\leq 179$
Specification (UNS N06600)		$\geq 240$	$\geq 550$	$\geq 30$	—	—
Specification (EN 2.4816)		$\geq 240$	500~850	$\geq 30$	—	$\leq 200$
Example	Hot-rolled plate	321	677	42	—	171
	Cold-rolled sheet	337	704	40	—	84 (HRBW)

## High Temperature Strength

Results of high-temperature tensile test



## Creep Properties

Heat treatment	Temperature [°C]	Creep rupture strength [MPa]		
		10hr	100hr	1000hr
Annealing (Cold-rolled sheet)	538	511	345	234
	649	234	158	100
	760	89	58	38
	871	52	33	21

## Corrosion Resistance

The composition of NAS600 provides corrosion resistance in a remarkably large number of corrosive environments. The addition of chromium content provides superior corrosion resistance in acidic environments over pure nickel. Furthermore, the high nickel content maintains the corrosion resistance in a reducing state and exhibits superior corrosion resistance to alkaline solutions. Another feature of this product is the high level of resistance against stress corrosion cracking.

## Comparison of Alloys in Stress Corrosion Cracking Test

Test condition: U-shaped test piece in boiling MgCl<sub>2</sub> aqueous solution for 300hr

Alloy	Main chemical composition (wt %)	45% (154°C)	42% (142°C)	40% (138°C)	38% (134°C)	35% (126°C)	30% (115°C)	25% (110°C)	20% (108°C)
Type 304	18Cr-8Ni	×	×	×	×	×	×	×	×
Type 316L	17Cr-12Ni-2Mo	×	×	×	×	×	×	×	○
NAS64	25Cr-6Ni-3.3Mo-0.16N	×	×	×	×	×	×	○	○
NAS185N	20Cr-18Ni-6Mo-0.8Cu-0.2N	×	×	×	×	○	○	○	○
NAS254N	23Cr-25Ni-5.5Mo-0.2N	×	×	×	○	○	○	○	○
NAS255NM	20Cr-25Ni-6Mo-1Cu-0.2N	×	×	×	○	○	○	○	○
NAS354N	23Cr-35Ni-7.5Mo-0.2N	×	○	○	○	○	○	○	○
<b>NAS600</b>	<b>Ni-17Cr</b>	○	○	○	○	○	○	○	○
NASNW276	Ni-15Cr-16Mo-4W-5Fe	○	○	○	○	○	○	○	○
NASNW22	Ni-21Cr-13Mo-3W-4Fe	○	○	○	○	○	○	○	○

○: No cracking    ×: Cracking present

**Workability**

Hot working is relatively easy with NAS600. For hot working, temperature should be between 1000 and 1180°C, although light work may be done at temperature as low as 850°C. The range between 650 and 850°C should be avoided as cracking may occur. Cold workability is easier than austenitic stainless steels, similar to Monel.

**Weldability**

As with standard austenitic stainless steels, NAS600 may be welded using techniques such as TIG, MIG, and shield metal arc welding. For edge preparation, mechanical cutting is desirable. Wide U- and V-groove angles should be used. Care should be taken to ensure its welding portion is clean as NAS600 is sensitive to surface contamination.

**Heat Treatment**

The following heat treatment may be used:

Annealing: 800~1150°C; Air or water cooling

Care should be taken at temperatures exceeding 1050°C as there is a strong tendency for the crystal grains to become coarse.

**Machinability**

As a high-nickel alloy, NAS600 is not as machinable as an austenitic stainless steel. A high-speed steel cutting tool may be used, though a sintered carbide tool is recommended. Also, the feed speed should be somewhat reduced, aiming for deep cutting. The recommended lathe feed speeds are as follows:

High-speed steel tool: 1050~1350mm/min

Sintered carbide tool: 3000~5250mm/min

After machine work, lubricants should be completely removed before welding or heat treating.

**Properties at High Temperatures**

Exhibiting particularly superior oxidation resistance at high temperatures, NAS600 can be used in air as well as other environments continuously for long periods of time. Because it has excellent resistance to nitrogen, hydrogen and carburization, NAS600 can be used in heat treatment furnaces. Care is needed with wet chlorine and bromide, however, as they will cause damage.

The maximum temperatures that NAS600 may be used in different environments are as follows:

Long-term continuous use in air oxidizing environment: 1100°C

Reducing environment of H<sub>2</sub> or CO not containing sulfur: 1150°C

Oxidizing sulfur environment (in air containing sulfurous acid): 815°C

Reducing environment containing hydrogen sulfide: 535°C

Hydrogen chloride: 540°C

Chlorine gas: 510°C

**Applications**

Heat treatment fixtures, Muffle furnace, Chemical plants.

**For more information, please contact:**

Nippon Yakin Kogyo Co., Ltd.

Material Solutions Sales Department

San-Ei Bldg., 5-8, 1-chome Kyobashi, Chuo-ku,

Tokyo 104-8365 Japan

TEL: +81-3-3273-4649 FAX: +81-3-3273-4642

URL: <https://www.nyk.co.jp/en/>

**Note regarding the handling of property data:**

The technical information contained in this product guide is representative values obtained in property tests and other items used to explain the performance of the product. With the exception of items specifically mentioned as provisions of a "Standard," the contents do not represent guaranteed upper limit or lower limit values. The respective data given on this technical information are typical examples and may be different in some cases from the data obtained from the actual product. No responsibility shall, therefore, be assumed for damages arising from using the technical information data. This information is also subject to change in the future without notice. To obtain the most recent information, please contact Nippon Yakin. No part of this document may be copied or reproduced in any form without the consent of Nippon Yakin.