Austral Wright Metals
at the cutting edge

Austral Bronze Crane Copper Limited
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**PRODUCT DATA SHEET**

# Naval Brass, uninhibited

UNS C46400

**Copper Alloys**

**Naval Brass** is a 60:40 copper zinc alloy to which about 1% of tin has been added to improve the corrosion resistance, particularly to dezincification. The alloy is a two phase alpha-beta brass, hence has reasonably high strength with lower ductility than the single phase 70:30 or alpha brass. It is used for structural applications and for forgings, especially where contact with sea water is likely to induce corrosion. The mechanical properties are almost indistinguishable from those of 60:40 brass C28000, although the tin addition tends to give slightly higher strength.

C46400 can be readily hot worked, and can also be cold worked, but not as easily as the single phase alpha brasses.

## Chemical Composition (% maximum, unless shown as range or minimum)

| | Copper | Iron | Lead | Tin | Zinc |
|---|---|---|---|---|---|
| Min./Max. | 59.0 - 62.0 | 0.10 | 0.20 | 0.50 – 1.0 | Remainder |
| Nominal | 60.0 | - | - | 0.7 | 39.2 |

Note: Copper + Sum of Named Elements, 99.6% minimum.

## Applicable Specifications

| Product | Specifications | |
|---|---|---|
| Bar | AMS 4611, 4612 | ASTM B21 |
| | FEDERAL QQ-B-639 | SAE J461, J463 |
| Bar, Forging | ASTM B124 | |
| Bolts | ASTM F468 | |
| Forgings, Die | ASTM B283 | |
| Nuts | ASTM F467 | |
| Plate | FEDERAL QQ-B-639 | |
| Plate, Clad | ASTM B432 | |
| Plate, Condenser Tube | ASME SB171 | ASTM B171 |
| Rod | AMS 4611, 4612 | ASTM B21 |
| | SAE J461, J463 | |
| Rod, Forging | ASTM B124 | |
| Screws | ASTM F468 | |
| Shapes | ASTM B21 | |
| Shapes, Forging | ASTM B124 | |
| Sheet | FEDERAL QQ-B-639 | |
| Strip | FEDERAL QQ-B-639 | SAE J461, J463 |
| Studs | ASTM F468 | |
| Wire, Metallizing | MILITARY MIL-W-6712 | |

## Common Fabrication Processes

Blanking, Drawing, Forming and Bending, Heading and Upsetting, Hot Forging and Pressing, Hot Heading and Upsetting, Shearing

## Fabrication Properties

| Technique | Suitability | Technique | Suitability |
|---|---|---|---|
| Capacity for Being Cold Worked | Fair | Oxyacetylene Welding | Good |
| Capacity for Being Hot Formed | Excellent | Gas Shielded Arc Welding | Fair |
| Forgeability Rating | 90% * | Coated Metal Arc Welding | Not Recommended |
| Machinability Rating | 30% ** | Spot Weld | Good |
| Soldering | Excellent | Seam Weld | Fair |
| Brazing | Excellent | Butt Weld | Good |

* of C37700 (forging brass)
** of C36000 (free cutting brass)

## Typical Mechanical Properties (room temperature, 20°C)

| Temper | Section Size | Cold Work | Temperature | Tensile Strength | Yield Strength (0.5% extension under load) | Elongation | Rockwell Hardness | | | | Vickers Hardness | Shear Strength |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mm. | % | °C | MPa | MPa | % | B | C | F | 30T | 0.5 | MPa |
| **Flat Products** | | | | | | | | | | | | |
| H01 | 1 | 0 | 20 | 483 | 400 | 17 | 75 | - | - | 68 | 138 | 296 |
| M20 | 25.4 | 0 | 20 | 379 | 172 | 50 | 55 | - | - | 55 | 99 | 276 |
| O50 | 1 | 0 | 20 | 427 | 207 | 40 | 60 | - | - | 57 | 107 | 283 |
| O50 | 6.35 | 0 | 20 | 414 | 193 | 45 | 58 | - | - | 56 | 104 | 283 |
| O60 | 6.35 | 0 | 20 | 400 | 172 | 49 | 56 | - | - | 55 | 100 | 276 |
| **Rod** | | | | | | | | | | | | |
| H01 | 6.35 | 10 | 20 | 483 | 331 | 25 | 80 | - | - | - | 150 | 296 |
| H01 | 25.4 | 8 | 20 | 476 | 317 | 27 | 78 | - | - | - | 146 | 296 |
| H01 | 51 | 8 | 20 | 462 | 276 | 35 | 75 | - | - | - | 138 | 296 |
| H02 | 6.35 | 20 | 20 | 552 | 393 | 20 | 85 | - | - | - | 164 | 310 |
| H02 | 25.4 | 20 | 20 | 517 | 365 | 20 | 82 | - | - | - | 156 | 303 |
| O50 | 6.35 | 0 | 20 | 434 | 207 | 40 | 60 | - | - | - | 107 | 290 |
| O50 | 25.4 | 0 | 20 | 434 | 207 | 40 | 60 | - | - | - | 107 | 290 |
| O50 | 51 | 0 | 20 | 427 | 193 | 43 | 60 | - | - | - | 107 | 290 |
| O60 | 6.35 | 0 | 20 | 400 | 186 | 45 | 56 | - | - | - | 100 | 276 |
| O60 | 25.4 | 0 | 20 | 393 | 172 | 47 | 55 | - | - | - | 99 | 276 |
| O60 | 51 | 0 | 20 | 386 | 172 | 47 | 55 | - | - | - | 99 | 276 |
| **Tube** | | | | | | | | | | | | |
| H80 | 0.0 | 35 | 20 | 607 | 455 | 18 | 95 | - | - | - | 200 | - |

## Tempers Most Commonly Used

| Flat Products | |
|---|---|
| BAR, DRAWN | H01, H02, O50, O60 |
| BAR, ROLLED | H01, O50, O60 |
| PLATE | H02, M20, O60 |
| STRIP, ROLLED | H01, O50 |

| Other Products | |
|---|---|
| ROD | H01, H02, M30, O50, O60 |
| SHAPES | H01, M30 |
| TUBE | H58, H80 |

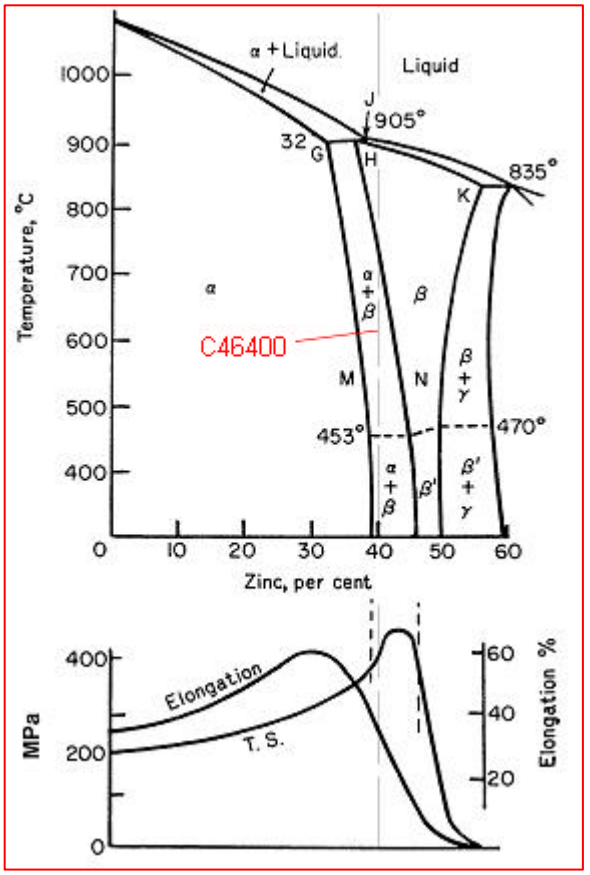
## Physical Properties

| | US Customary | Metric |
|---|---|---|
| Melting Point – Liquidus | 1650°F | 899°C |
| Melting Point – Solidus | 1630°F | 888°C |
| Density | 0.304 lb/in$^3$ at 68°F | 8.41 gm/cm$^3$ @ 20°C |
| Specific Gravity | 8.41 | 8.41 |
| Electrical Resistivity | 39.9 ohms-cmil/ft @ 68°F | 6.63 microhm-cm @ 20°C |
| Electrical Conductivity | 26 %IACS @ 68°F | 0.152 MegaSiemens/cm @ 20°C |
| Thermal Conductivity | 67.0 Btu · ft/(hr · ft2 · °F) at 68°F | 116.0 W/m · °K at 20°C |
| Coefficient of Thermal Expansion | 11.8 ·10$^{-6}$ per °F (68-572°F) | 21.2 ·10$^{-6}$ per °C (20-300°C) |
| Specific Heat Capacity | 0.09 Btu/lb/°F at 68°F | 377.1 J/kg · °K at 293°K |
| Modulus of Elasticity in Tension | 15,000 ksi | 103,400 MPa |
| Modulus of Rigidity | 5,600 ksi | 38,610 MPa |

## Typical Uses

| Industry | Uses |
|---|---|
| Builders Hardware | Lock Pins |
| Electrical | Precision Shipboard Equipment |
| Fasteners | Nuts, Rivets, Bolts |
| Industrial | Hub Cones, Balls, Aircraft Turn buckle Barrels, Valve Stems, Condenser Plates, Dies, Golf Ball Production, Pressure Vessels, Bearings, Bushings, Bearings, Heat Exchanger Tube, Welding Rod, Structural Uses |
| Marine | Decorative Fittings, Propeller Shafts, Turn buckles, Shafting, Marine Hardware, Propeller Shafts |
| Ordnance | Missile Components |
| Other | Baffle Plates and Flanges |
| Plumbing | Fittings |

## Phase Diagram & Mechanical Properties of the Brasses



## Corrosion Resistance

C46400 has good corrosion resistance to weathering and good resistance to many waters. It was developed to resist the dezincification in sea water which may be encountered with plain 60:40 brass, C28000.

Low-copper alloys, such as naval brass appear to form thin, adherent surface films of corrosion products which are moderately protective.

C46400 should not be used in contact with ammonia, ammonia compounds or amines, as it may suffer stress corrosion cracking. It may also suffer stress corrosion cracking in atmospheric exposures.

Please consult Austral Wright Metals for advice on your specific application.

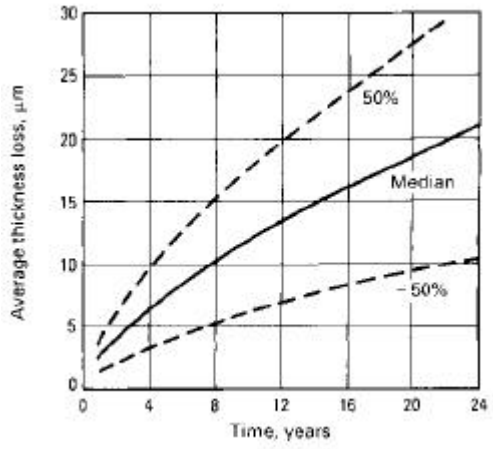
## Marine Atmospheric Exposures

Copper alloys are often specified for marine atmospheric exposures because of the attractive and protective patina they form during the exposure by mild surface corrosion. The corrosion rate slows during the exposure.

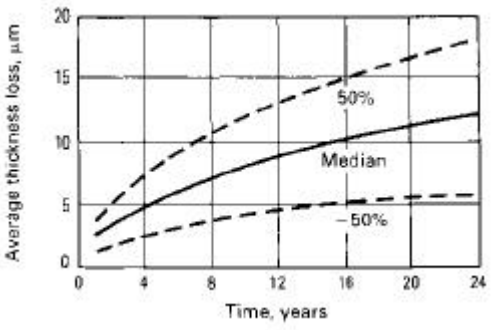
Naval brass generally darkens to a deep chocolate brown colour. It is not expected to form the green patina often seen on alloys richer in copper, especially on material mounted vertically.

Differences between the corrosion rates of various alloys do exist, but they are usually less than the differences caused by the environment. Copper alloys can be classed into a group that corrodes at a moderate rate (high copper alloys, silicon bronze, tin bronze) and a group that corrodes at a slower rate (brass, aluminium bronze, nickel silver, copper nickel).

The average metal thickness loss, d, of the former group approximates to $d = 0.1\ t^{2/3}$, and of the latter group to $d = 0.1\ t^{1/3}$, where t is the exposure time.




Moderate corrosion rate group
(high copper alloys, silicon bronze, tin bronze)




Low corrosion rate group
(brass, aluminium brass, nickel silver, copper nickel)

The surface can be artificially bronzed to produce by the patina, please contact Austral Wright Metals for details. Both artificial and naturally patinated surfaces will continue to darken unless washed hot soapy water, rinsed, dried and treated with lemon oil, boiled linseed oil or castor oil. The surface will take on a mild lustre.

This sequence of washing and oiling should be repeated at about yearly intervals to maintain the metal in good condition.