



# SLOVENSKI STANDARD

## SIST ISO 6207:1997

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### Nevarjena cev iz niklja in nikljevih zlitin

Seamless nickel and nickel alloy tube

Tubes sans soudure en nickel et alliages de nickel

Ta slovenski standard je istoveten z: **ISO 6207:1992**

[SIST ISO 6207:1997](https://standards.iteh.ai/catalog/standards/sist/e564ab52-84f4-4410-8c24-19f54b136be5/sist-iso-6207-1997)

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#### **ICS:**

23.040.15	Cevi iz neželeznih kovin	Non-ferrous metal pipes
77.150.40	Nikljevi in kromovi izdelki	Nickel and chromium products

**SIST ISO 6207:1997**

**en**

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# INTERNATIONAL STANDARD

**ISO  
6207**

First edition  
1992-07-15

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## Seamless nickel and nickel alloy tube

*Tubes sans soudure en nickel et alliages de nickel*

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Reference number  
ISO 6207:1992(E)

## ISO 6207:1992(E)

**Foreword**

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 6207 was prepared by Technical Committee ISO/TC 155, *Nickel and nickel alloys*, Sub-Committee SC 2, *Wrought and cast nickel and nickel alloys*.

Annex A of this International Standard is for information only.

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# Seamless nickel and nickel alloy tube

## 1 Scope

1.1 This International Standard specifies requirements for round seamless nickel and nickel alloy tube for general purposes as well as for condenser and heat-exchanger applications in the following size ranges.

### 1.1.1 Tube for general purposes

Cold worked: outside diameter 4 mm to 240 mm

Hot worked: outside diameter 38 mm to 240 mm

### 1.1.2 Tube for condenser and heat-exchanger applications

Cold worked: maximum outside diameter 80 mm with wall thickness up to and including 5 mm.

1.2 Dimensional requirements and limiting bend radii are also specified for U-bent heat-exchanger tubes of outside diameter up to and including 26 mm.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

1) To be published.

ISO/R 204:1961, *Non-interrupted creep testing of steel at elevated temperatures.*

ISO 6372-1:1989, *Nickel and nickel alloys — Terms and definitions — Part 1: Materials.*

ISO 6372-3:1989, *Nickel and nickel alloys — Terms and definitions — Part 3: Wrought products and castings.*

ISO 6507-1:1982, *Metallic materials — Hardness test — Vickers test — Part 1: HV 5 to HV 100.*

ISO 6508:1986, *Metallic materials — Hardness test — Rockwell test (scales A - B - C - D - E - F - G - H - K).*

ISO 6892:1984, *Metallic materials — Tensile testing.*

ISO/TR 7003:1990, *Unified format for the designation of metals.*

ISO 8493:1986, *Metallic materials — Tube — Drift expanding test.*

ISO/TR 9721:—<sup>1)</sup>, *Nickel and nickel alloys — Code of designation based on chemical symbols (To be published as an ISO/TR type 2).*

ISO 9722:1992, *Nickel and nickel alloys — Composition and forms of wrought products.*

ASTM E 112:1988, *Standard methods for determining the average grain size.*

## 3 Definitions

For the purposes of this International Standard, the definitions for nickel and nickel alloys in ISO 6372-1 and for tube in ISO 6372-3 apply.

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**3.1 mean diameter:** The average of the maximum and minimum diameters as determined at any cross-section.

**3.2 heat:** The product of a furnace melt or a number of melts that are mixed prior to casting.

**3.3 thick-wall tube:** Tube with a specified wall thickness which is greater than 3 % of the specified outside diameter.

**3.4 thin-wall tube:** Tube with a specified wall thickness which is 3 % or less of the specified outside diameter.

**3.5 lot:** Tubes of the same cross-sectional dimensions from the same heat, heat treated together or sequentially heat treated in a continuous furnace, but in no case for longer than 16 h of production. When tubes cannot be identified by heat, a lot shall consist of not more than 250 kg of material in the same heat-treated condition and size.

## 4 Alloy identification

For the purposes of this International Standard, the principles for alloy identification in ISO/TR 7003 and ISO/TR 9721 apply.

## 5 Ordering information

Orders for tubes according to this International Standard shall include the following information.

**5.1 The number of this International Standard.**

**5.2 A specification of whether the tube is for general purposes or for condensers or heat exchangers.**

**5.3 Quantity (mass, number of pieces, or total length).**

**5.4 Alloy identification (see table 1).**

NOTE 1 For alloy identification either the number or the description may be used.

**5.5 Alloy temper (see table 2).**

**5.6 Dimensions: outside diameter and nominal wall thickness or outside diameter and minimum wall thickness.**

**5.7 Optional requirements:**

a) ends other than plain-cut and deburred;

b) straightness (see 6.1.7.5);

c) annealed ends for stress-relieved condenser and heat-exchanger tube (see 6.2.3);

d) samples for product analysis (see 7.1.2);

e) determination of 1 % proof stress ( $R_{p1,0}$ ) (see 9.2);

f) pressure test other than standard (see 9.7.2 or 9.8);

g) non-destructive testing (see 9.9);

h) individual tube marking (see 10.2);

i) purchaser or third party inspection (see clause 11);

j) declaration of conformity (see clause 12).

## 5.8 Additional information for U-bent tubes.

**5.8.1** Specify if tubes are to be U-bent (see limitations in 6.2.2 to 6.2.5).

**5.8.2** Specify if U-bent areas are to be subsequently stress relieved.

**5.8.3** Specify size of radii and length of U-bent tube legs (see 6.2.5.4 and table 6).

**5.8.4** Specify if proof of conformance of wall thickness in U-bent area is required (see 6.2.5.3).

**5.8.5** Specify if hydrostatic testing is to be applied after bending (see 9.7.4).

## 6 Requirements

Tubes shall meet the following requirements.

### 6.1 Tubes for general purposes

#### 6.1.1 Composition

Heat analysis shall meet the composition limits specified in table 1.

The composition limits do not preclude the possible presence of other elements that are not specified. If the purchaser's requirements necessitate limits for any other element that is not specified, these shall be agreed upon between the purchaser and the supplier. The percentage content of elements shown as "remainder" shall be calculated by difference from 100 %.

### 6.1.2 Tensile properties

Tubes shall have the tensile properties specified in table 2.

### 6.1.3 Hydrostatic pressure test

Any tube exhibiting leaks during hydrostatic testing shall be deemed not to comply with this International Standard.

### 6.1.4 Grain size

Alloys NW8810/FeNi32Cr21AlTi-HC and NW8811/FeNi32Cr21AlTi-HT shall have an average grain diameter of ASTM 5 or coarser (average diameter 0,06 mm or greater).

### 6.1.5 Creep requirements

Alloy NW7263/NiCo20Cr20Mo5Ti2Al shall meet the creep requirements specified in table 2, footnote 2). (For sampling for creep testing, see 7.3).

### 6.1.6 Surface quality

All tubes shall be clean and free from detrimental surface imperfections.

NOTE 2 Where appropriate, the acceptance criteria should be agreed upon by the purchaser and the supplier.

### 6.1.7 Dimensional tolerances

#### 6.1.7.1 Cold-worked tube

The wall thickness and outside diameter shall not differ at any point from that specified by more than the tolerance given in table 3, except that

- a) for thick-wall tube (see 3.3) of outside diameter over 115 mm, the mean diameter shall not exceed the tolerance specified in table 3 and individual measurements shall not exceed twice the tolerance specified in table 3.
- b) for thin-wall tube (see 3.4), the mean diameter shall not exceed the tolerance specified in table 3 and individual measurements shall not exceed the tolerance specified in table 3 with the values increased by 0,5 % of the nominal outside diameter.

NOTE 3 Tolerances for wall thickness are given in table 3 for both "nominal" and "minimum" wall requirements. The appropriate column should be referred to, depending upon the product specified.

#### 6.1.7.2 Hot-worked tube

For all tubes, the wall thickness and outside diameter shall not differ at any point from that specified

by more than the tolerance given in table 4, except that for tubes of outside diameter over 125 mm, the mean diameter shall not exceed the tolerance specified in table 4, and individual measurements shall not exceed twice the tolerance specified in table 4.

When the minimum wall thickness is specified, the thickness tolerance on the specified minimum wall thickness shall be  $^{+28,5}_{0}$  %.

For tubes supplied with machined outside or inside surfaces, the tolerances on the machined surface shall be

$^{+0,8}_{0}$  mm for the outside diameter;

$^{0}_{-1,6}$  mm for the inside diameter.

### 6.1.7.3 Concentricity

For cold-worked tube and hot-worked tube, the permissible variations in individual measurements of wall thickness in 6.1.7.1 and 6.1.7.2 include concentricity.

#### 6.1.7.4 Length

Tube ordered according to a specified length shall not differ from that length by more than the appropriate tolerance given in table 5.

#### 6.1.7.5 Straightness

Tubes shall be free from kinks.

NOTE 4 Where appropriate, the acceptance criteria should be agreed upon by the purchaser and the supplier.

## 6.2 Tubes for condensers and heat-exchangers

In addition to the requirements of 6.1, tubes for condensers and heat-exchangers shall meet the following requirements.

### 6.2.1 Materials

The requirements given in 6.2.2 to 6.2.5.5 apply only to the following materials in their appropriate heat-treated conditions (see table 2):

NW2200/Ni99,0  
 NW2201/Ni,99,0-LC  
 NW6600/NiCr15Fe8  
 NW6690/NiCr29Fe9  
 NW6625/NiCr22Mo9Nb  
 NW4400/NiCu30  
 NW8825/NiFe30Cr21Mo3  
 NW8800/FeNi32Cr21AlTi  
 NW8810/FeNi32Cr21AlTi-HC  
 NW8811/FeNi32Cr21AlTi-HT

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**6.2.2 Tube size and bending radii limitations for U-bent tubes** (see table 6)**6.2.3 Hardness of annealed ends of stress-relieved tubes**

When stress-relieved condenser or heat-exchanger tubes are furnished with annealed ends, the Rockwell or Vickers hardness of the ends after annealing shall not exceed the values specified in table 7.

**6.2.4 Drift expanding**

The tube shall be expanded without rupture until the outside diameter has been increased by 30 %.

**6.2.5 Tolerances for U-bent tubes****6.2.5.1 Leg spacing**

The leg spacing, measured between the points of tangency of the bend to the legs, shall not vary from the value:  $(2r - \text{specified tube outside diameter})$  by more than the amounts shown in table 8, where  $r$  is the specified centreline bend radius.

**6.2.5.2 Diameter of the tube in U-bent section**

Neither the major nor minor outside diameter of the tube, at any one cross-section included within the points of tangency of the bend, shall deviate from the nominal diameter prior to bending by more than 10 %.

**6.2.5.3 Wall thickness of tube in U-bent section**

The wall thickness of the tube at the apex of the U-bent section shall be not less than the value determined by the following equation:

$$\delta_t = \delta(2r)/(2r + D)$$

where

- $\delta_t$  is the thickness after bending, in millimetres;
- $\delta$  is the minimum permissible thickness of tube wall prior to bending, in millimetres;
- $r$  is the centreline bend radius, in millimetres;
- $D$  is the nominal outside diameter of the tube, in millimetres.

When specified by the purchaser, proof of conformance to this requirement shall be obtained by bending a tube specimen, representative of the material offered, to the scheduled radius of bend, cutting the

tube at the apex of the bend, measuring the wall thickness at the cross-section of this apex and comparing the measured value with the calculated value of  $\delta_t$ .

**6.2.5.4 Length of U-bent tube legs**

The length of the tube legs, measured from the point of tangency of the bend to the end of the tube leg, shall be within the tolerance specified in table 9.

The difference in the length of the tube legs shall be not greater than 4 mm.

**6.2.5.5 Squareness of ends**

The end of any tube shall not depart from square by more than the amounts shown in table 10.

**7 Sampling****7.1 Chemical analysis**

**7.1.1** Representative heat analysis samples shall be taken during pouring or subsequent processing.

**7.1.2** Product analysis samples shall be taken from the finished product.

**7.2 Tensile testing**

**7.2.1** Unless otherwise indicated in table 2, tensile test specimens shall be taken from material in the final heat-treated condition, and tested in the longitudinal direction.

**7.2.2** In the case of stress-relieved tubes furnished with annealed ends, the tensile test specimen shall be taken from tubes in the stress-relieved condition prior to annealing.

**7.3 Creep testing**

Creep test specimens may be taken from the finished product of alloy NW7263/ NiCo20Cr20Mo5Ti2Al, or at an intermediate stage of processing, and shall be tested in the longitudinal direction.

**8 Number of tests****8.1 Chemical analysis**

One test per heat.

**8.2 Tensile test**

One test per lot.



### 8.3 Creep test

One test per lot.

### 8.4 Drift expanding test

A drift expanding test shall be performed on one end of each mill length of condenser and heat exchanger tube.

### 8.5 Pressure test

Each tube or finished mill length of condenser and heat exchanger tube.

### 8.6 Hardness test

3 % of each lot of stress-relieved tubes with annealed ends.

### 8.7 Grain size determination

One test per lot.

## 9 Test procedures

### 9.1 Chemical analysis

9.1.1 The method of chemical analysis shall be at the option of the supplier, however in cases of dispute the method specified in the relevant International Standard shall be used.

If no International Standard exists, an analytical method that can be calibrated to a reference standard agreed upon by the purchaser and the supplier shall be used.

9.1.2 For a list of ISO analytical standards, see annex A.

### 9.2 Tensile testing

Testing shall be carried out in accordance with ISO 6892.

The offset method shall be used for the determination of proof stress. An offset of 0,2 % ( $R_{p0,2}$ ) shall be standard. However, a 1 % proof stress ( $R_{p1,0}$ ) shall be determined and reported for information when requested by the purchaser. Determination of proof stress is not required for tubes with wall thickness less than 0,5 mm.

### 9.3 Creep testing

Testing shall be carried out in accordance with ISO/R 204, except that only the final total plastic strain need be reported.

### 9.4 Hardness testing

#### 9.4.1 Vickers hardness

Testing shall be carried out in accordance with ISO 6507.

#### 9.4.2 Rockwell hardness

Testing shall be carried out in accordance with ISO 6508.

### 9.5 Drift expanding test

Testing shall be carried out in accordance with ISO 8493. It shall consist of flaring a test piece with an expanding tool having an included angle of 60° until the specified outside diameter has been increased by 30 %.

### 9.6 Grain size determination

A transverse sample representative of the full wall thickness shall be examined in accordance with ASTM E 112.

### 9.7 Hydrostatic test (also see 9.9.2)

9.7.1 Tubes with outside diameters of 4 mm and over and tubes with wall thicknesses of 0,4 mm and over shall be subjected to an internal hydrostatic pressure of 70 bar<sup>2)</sup> (gauge) by the manufacturer, provided that the fibre stress calculated in accordance with the following equation does not exceed the allowable fibre stress. The test pressure shall be held for a minimum of 20 s.

The hydrostatic test pressure  $p$ , in bar, is given by the formula

$$p = \frac{20R_F \delta_{\min}}{D}$$

where

$R_F$  is the allowable fibre stress, in newtons per square millimetre, for material in the temper furnished as shown in table 2;

$\delta_{\min}$  is the minimum wall thickness, in millimetres, equal to the nominal wall thickness minus the permissible "minus" wall tolerance (see table 3) or the minimum wall thickness, as applicable;

2) 1 bar = 10<sup>5</sup> Pa.