IS 2790 (1999): Guidelines for Manufacture of 23, 22, 21, 18, 14 and 9 Carat Gold Alloys [MTD 10: Precious Metals]

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IS 2790 : 1999
(Superseding IS 3541)
(Reaffirmed 2003)

भारतीय मानक

23, 22, 21, 18, 14 एवं 9 कैरट स्वर्ण मिश्रधातुओं के उत्पादन के लिए मार्गदर्शिका

(दूसरा पुनरीक्षण)

Indian Standard

GUIDELINES FOR MANUFACTURE OF 23, 22, 21, 18, 14 and 9 CARAT GOLD ALLOYS

(Second Revision)

ICS 39.060

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

December 1999

Price Group 2

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Precious Metals Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was earlier published in 1964 and revised in 1981. In this revision the provisions of IS 3541 : 1981 'Code of practice for manufacture of 23.3 and lower carat gold alloys (*first revision*)' have been incorporated by way of merger with a view to have a single, complete and user friendly standard. The earlier seven tables indicating typical compositions of the various types of gold alloys have also been rationalized in to three tables for easy understanding of the user. After publication of this standard IS 3541 shall stand withdrawn. The provisions of this standard have also been aligned with IS 1417 : 1999 'Gold and gold alloys, jewellery/artefacts — Fineness and marking — Specification (*third revision*)'.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical value (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

GUIDELINES FOR MANUFACTURE OF 23, 22, 21, 18, 14 and 9 CARAT GOLD ALLOYS

(Second Revision)

1 SCOPE

This standard covers guidelines for manufacture of 23, 22, 21, 18, 14 and 9 carat gold in the form of ingot, bar, plate, sheet, rod, wire and granules.

2 REFERENCES

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

IS No.	*Title*
191 (Part 6) : 1980	Copper : Part 6 Fire refined high conductivity copper (FRHC) (*third revision*)
209 : 1992	Zinc ingot (*fourth revision*)
1417 : 1999	Gold and gold alloys, jewellery/ artefacts — Fineness and marking — Specification (*third revision*)
1418 : 1999	Assaying of gold in gold bullion, gold alloys and gold jewellery — Cupellation (fire assay) method (*second revision*)
2112 : 1981	Grades of silver and silver alloys (*first revision*)
2782 : 1964	Primary nickel
3096 : 1965	Fine grade palladium

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Assaying

It is the chemical process of determining the gold content of the sample expressed in parts per thousand (‰).

3.2 Bar

A regular shaped ingot, narrow in width when compared to its length and made by casting in a metal or graphite mould.

3.3 Carat

Carat is one-twentyfourth (1/24th) part by weight of the metallic element gold.

3.4 Fineness

The ratio between the mass of gold content and the total mass expressed in parts per thousand (‰).

3.5 Ingot

A solid casting of convenient shape and weight.

3.6 Plate/Sheet

Material in flat form obtained by rolling and of uniform width and thickness.

3.7 Rod/Wire

Material usually in rounded form with uniform cross-section throughout. It may also be square, rectangular or in other cross-sectional form in special cases.

4 PURITY OF METALS

4.1 Gold

Gold used in the preparation of the alloys shall be standard or fine gold conforming to IS 1417.

4.2 Alloying Elements

For the purpose of alloying, the following metals conforming to grades as indicated against each shall be used:

Metal	*Grade*	*Indian Standard, Ref to*
Silver	999/1 000	IS 2112
Copper	FRHC Grade	IS 191(Part 6)
Nickel	99.90% (Grade I)	IS 2782
Zinc	Zn 99.95%	IS 209
Palladium	Pd 99.9%	IS 3096

4.2.3 Some typical compositions of the alloys including those specified in IS 1417 have been given in Annex A.

4.2.4 Rich alloys of gold with silver and copper of known composition may also be employed.

4.2.5 When preparing alloys that have to conform to a standard gold content, allowance shall be made for

the varying gold content, in the metal used. The following example will illustrate the point. Depending on the purity and caratage of gold, the parts of this gold required to produce a particular carat alloy may be calculated from the following formula:

$$\frac{a \times b}{c}$$

where

a = carat required,
b = 24 parts of carat, and
c = caratage of gold alloy to be converted.

For example, for converting 22 carat gold to 14 carat gold, we require, 15.27 parts of 22 carat gold and 8.73 parts of base alloy, such as copper-silver alloy.

5 REQUIREMENTS

5.1 Forms

Gold of 23, 22, 21, 18, 14 and 9 carat shall be in the form of ingot, bar, plate, sheet, rod, wire and granules. Details of shape and size shall be subject to agreement between the purchaser and the seller.

5.2 Standards for Assaying

The actual gold content of the forms stipulated in **5.1** shall be of fineness as specified in IS 1417 when assayed in accordance with IS 1418.

6 ACCESSORIES FOR MELTING

6.1 Accessories such as crucibles, furnace, mould, mould dressing, etc are usually required for the preparation of gold alloy.

6.2 The furnace should be capable of attaining a temperature of about 200°C above the temperature at which the alloy will melt completely.

7 MELTING AND CASTING

7.1 Weigh accurately gold and alloying elements. Place copper, which should preferably be in the form of grains, at the bottom of the crucible and then add silver, preferably in the form of grains. Finally, add gold and cover with a layer of lump charcoal, sufficiently thick to prevent oxidation followed by borax. When using zinc as an alloying element, let the alloy in the crucible melt and introduce zinc in the molten metal under the layer of charcoal in the crucible.

7.1.1 When the entire mass is in liquid state stir thoroughly with red hot graphite stirrer, quickly withdraw the curcible from the furnace and pour the contents into a suitable mould previously warmed and dressed with oil. If the ingot is large, it will be necessary to slow down the pouring rate towards the end of casting so as to prevent shrinkage and promote better feeding of the casting. In all cases, the temperature of final pouring should be controlled so that it is about 50°C above the temperature at which the alloy will melt completely.

7.1.2 In most cases and particularly when the composition has nickel or zinc in it, it is easier and better to manufacture the alloy in two stages, first by preparing an alloy of the base metals and then by mixing the proper proportion of this alloy with gold or an alloy of gold. When using nickel and zinc, it is better to prepare an alloy of copper, nickel and zinc or copper and zinc and to mix the requisite proportions of it with an alloy of gold and silver.

7.1.2.1 A typical illustration for manufacturing 14 carat gold is as follows:

a) Take pure copper 8 parts and pure silver 2 parts and melt them in a crucible under a layer of charcoal. After thoroughly mixing the molten alloy with a hot iron rod, pour the melt into a hot cast iron horizontal mould.
b) Take 14 parts of pure gold in a crucible placed in a furnace. Depending on the purity of the gold taken, calculate the weight of copper-silver alloy required to produce 14 carat gold alloy as given in **4.2.5**.
c) Add the alloy to the crucible and heat. When the gold and the alloy are at the fusion point, add pure vegetable charcoal on the surface of the melt to prevent the alloy from oxidation. Then follow the procedure given in **7.1.1**.

NOTE — It is advisable to granulate the entire mass, remelt the granules and cast into ingots to ensure homogeneity.

8 HEAT TREATMENT OF GOLD ALLOYS

8.1 Annealing

As general rule, when proper attention has been given to the melting and casting, a cast ingot may be reduced to one half in original thickness without any annealing. This reduction is to be effected in several passes, the actual opening of each pass varying with the alloy.

8.1.1 *Condition*

The conditions necessary for successful annealing are:

a) Annealing temperature,
b) Duration of annealing, and
c) Annealing atmosphere.

8.1.1.1 *Annealing temperature*

A suitable annealing temperature for the majority of gold alloys (excluding white gold) lies in the region

of 550°C- 650°C. The exact temperature, suitable for annealing any particular alloy may only be ascertained by practice.

8.1.1.2 *Duration of annealing*

The duration of annealing will depend on the size of the ingot. As a general rule, alloy should be removed as soon as they are uniformly heated to the annealing temperature and should not be allowed to soak for more than a minute or two.

Yellow gold requires a slightly higher temperature and slightly longer annealing time than red gold which contains larger proportion of copper than of silver.

8.1.1.3 *Annealing atmosphere*

Annealing has always to be carried out under non-oxidising conditions to prevent oxidation of the base metals present in the alloys. For ideal results, a muffle furnace equipped with pyrometer and heated by gas or electrically and with attachment for maintaining non-oxidising atmosphere is the best equipment.

The working jeweller will seldom have a muffle furnace or pyrometer available and he will have to take recourse to the blow-pipe annealing generally used for small articles in the course of manufacture. The article is thinly coated with a mixture of boric acid and methylated spirit and dried. It is next placed on a charcoal block and heated as far as possible to the time and temperature combination. Some oxidation is inevitable and particularly with large pieces annealing may not be expected to be perfectly uniform.

8.2 Quenching

Quenching is an essential operation after annealing of the carat alloys.

8.2.1 Quenching should be performed generally from a temperature of 400°C for the carat alloys. Visual estimation of the correct temperature is difficult and experience and judgment of the craftsman are the only guides in the absence of any equipment for measurement of temperature.

8.2.2 It is advantageous to quench the alloy in dilute sulphuric acid of about 5 to 10 percent strength.

9 MARKING

9.1 The gold ingot, bar, plate and sheet may be suitably marked in a prominent position with their fineness, the mass and the name of manufacturer or his trade-mark and the date of manufacture. In case of rod/ wire and granules the containers duly sealed shall be marked in a prominent position with their fineness, the mass and the name of the manufacturer or his trade-mark and the date of manufacture.

ANNEX A

(*Clause* 4.2.3)

TYPICAL COMPOSITION

A-1 The typical compositions of 23, 22, 21, 18, 14 and 9 carat yellow, red and white gold alloys are given in Tables 1 to 3 for information.

Table 1 Typical Compositions of Yellow Gold Alloys
(*Clause* A-1)

Grades in Carat	Metals, Percent by Mass			
	Au	Ag	Cu	Zn
23	96.00	4.00	—	—
	96.00	2.00	2.00	—
	96.00	—	4.00	—
22	91.66	8.34	—	—
	91.66	6.20	2.14	—
	91.66	4.10	4.24	—
	91.66	2.00	6.34	—
	91.66	—	8.34	—
21	87.50	12.50	—	—
	87.50	10.00	2.50	—
18	75.00	16.00	9.00	—
	75.00	12.50	12.50	—
	75.00	11.00	14.00	—
	75.00	9.50	15.50	—
14	58.50	17.50	24.00	—
	58.50	15.00	26.50	—
	58.50	12.50	29.00	—
9	37.50	17.50	42.00	3.00
	37.50	11.00	51.50	—
	37.50	10.50	45.00	7.00

Table 2 Typical Compositions of Red Gold Alloys
(*Clause* A-1)

Grade in Carat	Metals, Percent by Mass				
	Au	Ag	Cu	Ni	Zn
21	87.50	2.50	10.00	—	—
	87.50	—	12.50	—	—
18	75.00	4.00	21.00	—	—
	75.00	2.50	22.50	—	—
	75.00	—	25.00	—	—
14	58.50	7.50	34.00	—	—
	58.50	6.00	35.50	—	—
	58.50	5.20	36.30	—	—
9	37.50	7.50	55.00	—	—
	37.50	—	61.00	—	1.50
	37.50	5.00	57.50	—	—

Table 3 Typical Compositions of White Gold Alloys
(*Clause* A-1)

Grades in Carat	Metals, Percent by Mass					
	Au	Ag	Cu	Ni	Zn	Pa
18	75.00	15.00	—	—	—	10.00
	75.00	8.00	—	—	—	17.00
	75.00	—	5.00	5.00	—	15.00
	75.00	11.00	3.10	5.90	—	5.00
	75.00	—	5.50	14.50	5.00	—
14	58.50	—	18.00	17.50	6.00	—
	58.50	—	16.50	16.50	8.50	—
	58.50	31.50	—	10.00	—	—
	58.50	21.50	5.00	—	—	15.00
	58.50	18.00	6.50	2.00	1.00	14.00
9	37.50	—	27.60	17.50	17.40	—
	37.50	—	40.00	10.70	11.80	—

NOTES

1 The alloys shall be free from Pb, Bi, As, Hg, Se, Te and Pt group metals etc.

2 Composition of gold alloys given above are indicative and not exhaustive. The base metal contents may vary to get desired colour and other physical characteristics but gold content shall however not go below the minimum fineness as specified for the respective grades.

Bureau of Indian Standards

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Review of Indian Standards

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