The European Nickel Directive

How Do Changes Affect You?

The last revision of the European Nickel Directive was meant to address the concerns raised from the 2004 version. More stable artificial sweat solutions are used, which are likely more aggressive. The requirements are outlined in the table to the right.

This law went into effect April 2013. The results include an uncertainty factor where it is considered "non-conclusive." This still puts the burden on the manufacturer to prove it is compliant.

Jewelry Type	Ni release value µg/week/cm2)	Result
Intimate contact with skin	< 0.11	Compliant
	0.11 –0.35	Non-conclusive
	> 0.35	Non-compliant
Direct and prolonged contact with skin	< 0.28	Compliant
	0.28 –0.88	Non-conclusive
	> 0.88	Non-compliant

Note: The acceptable nickel release rates are much lower than in earlier standards.

History of the European Directive

Based on the pioneering work on allergy to nickel in 1991 by Dr. Carola Linden, a Swedish dermatologist, the first European Nickel Directive became a law and came into force June 1994 in all the European Community countries. The supporting test method on nickel release became a standard (EN 1811), which outlines the requirements of the Directive and pass the nickel release test conducted on jewelry products. The test measures the leaching rate of nickel when the jewelry article is immersed in an artificial sweat solution.

The 1994 European Directive established two basic nickel requirements for jewelry alloys:

1. It practically excludes the use of nickel in the alloys that come in intimate contact with parts of human body by restricting the nickel content to be less than 0.05% by weight. Earring posts, ear wire assemblies, and other body piercing jewelry articles fall under this restriction.
2. For jewelry articles that come into direct and prolonged contact with the skin, the test result should show the nickel release rate to be less than 0.5 microgram per square centimeter per week (0.5 µg/week/cm2). There is no restriction on the nickel content in the alloy used to make the jewelry articles.

Previous Revision of European Directive

The practical exclusion of nickel and numerous discrepancies of testing instances brought about the first revision of the Directive in 2004, which dealt only with nickel release rates and removed the restriction on the nickel content.

In spite of these improvements, the nickel release limits imposed by revisions of the standard have proved to be insufficient to avoid reactions in sensitized subjects. In addition, tests revealed that the artificial sweat degraded over the course of a week's testing, which made the nickel release result to be suspect.

To Raise Karat:
Find raising factor at intersection of karat on hand and karat wanted. Multiply the weight of your karat gold on hand by the raising factor. This gives you the weight of fine gold you must add to raise to the karat wanted.

RAISING FACTORS

Karat wanted	9½kt	10kt	13½kt	14kt	17½kt	18kt
Karat on hand						
0Kt	0.655172	0.714284	1.285714	1.399998	2.692299	3.00
9½Kt		0.035714	0.380953	0.450	1.23076	1.41666
10Kt			0.333335	0.400	1.153843	1.333336
13½Kt				0.4999	0.61538	0.750
14Kt					0.538459	.666667
17½Kt						0.83336

To Reduce Karat:
Find reducing factor at intersection of karat on hand and karat wanted. Multiply the weight of your karat gold on hand by the reducing factor. This gives you the weight of alloy gold you must add to reduce to the karat wanted.

REDUCING FACTORS

Karat wanted	18kt	17½kt	14kt	13½kt	10kt	9½kt
Karat on hand						
24Kt	0.333333	0.37143	0.714287	0.777778	1.400	1.526318
18Kt		0.028572	0.285715	0.333333	0.8000	0.894737
17½Kt			0.250	0.296295	0.7500	0.842105
14Kt				0.037036	0.4000	0.421054
13½Kt						0.052631

To lower the karat, use this formula:
A = The weight of alloy needed to lower the karat
W = The weight of the gold
K = Karat of the gold present
N = The needed karat

$$\frac{A = W\ (K–N)}{N} \quad \textbf{or} \quad A = (K – N) \times W \div N = A$$

Example: We want to change 7 dwt of 18kt to 14kt

$$\frac{A = 7\ (18–14)}{14} = \frac{7(4)}{14} = \frac{28}{14} = 2 \quad \textbf{or} \quad 18 – 14 \times 7 \div 14 = 2$$

(This formula works better for a calculator.)

To raise the karat, use this formula:
Amount of 24kt gold needed equals (final karat less beginning karat) times beginning weight divided by (24 less final karat)

Example 1: How much 24kt gold must be added to 15 grams of 12kt gold to raise it to 14kt gold?

$$\text{Amount of 24kt gold needed equals } \frac{(14 – 12) \times 15}{24 – 14} = 3 \text{ grams}$$

Example 2: How much gold is required to raise 10 grams of 14kt gold to 18kt gold?

$$\text{Amount of fine gold needed equals } \frac{(18 – 14) \times 10}{24 – 18} = 6.6 \text{ grams}$$

TROY WEIGHT

Used in weighing precious metals.

24 grains = 1 pennyweight (dwt)
20 dwt = 1 ounce Troy
12 ounces = 1 pound Troy
5,760 grains = 1 pound Troy
480 grains = 1 ounce Troy

1 kilogram = 2.68 pounds
1 kilogram = 32.15 ounce Troy
1 kilogram = 2.2046 pounds Avoir
1 kilogram = 35.2740 ounce Avoir
1 kilogram = 15,432 grains

Troy oz. = 1.0972 ounce Avoir

CARAT WEIGHT

Used in weighing precious and semi-precious stones. (The term karat refers to the quality of purity in gold.)

1 carat = 31/16 grains Troy
1 carat = .007 ounce Avoir
1 carat = ⅕ gram

The carat is further divided into points for simple measurement:
1 carat = 100 points
½ carat = 50 points
¼ carat = 25 points
⅛ carat = 12½ points

AVOIRDUPOIS WEIGHT

Used in weighing base metals.

16 drams (or drachms) = 1 ounce Avoir
16 ounces = 1 pound Avoir
16 ounces = 7,000 grams
28 pounds = 1 quarter English
4 quarters = 1 hundredweight (cwt.)
20 hundredweight = 1 ton Avoir

1 pound Avoir = 14.5833 ounce Troy
1 ounce Avoir = 0.914 ounce Troy
1 pound Avoir = 7,000 grains
1 ounce Avoir = 437.5 grains
1 pound Avoir = 0.4359 kilo.

GRAM WEIGHT

1 gram = 15.43 grains Troy
1.55 grams = 1 pennyweight (dwt)
31.104 grams = 1 ounce Troy
28.35 grams = 1 ounce Avoir

1 grain = 0.0648 grams
1 grain = 64.80 milligrams
1 milligram = .015432 grams
1 gram = .035274 Avoir ounce
1 gram = .032151 Troy ounce

To convert	-> To	Multiply by
Carats	-> dwt	0.12860
Carats	-> Grams	0.2
dwt	-> Carats	7.776
dwt	-> Grams	1.5552
dwt	-> Ounces (Troy)	0.05
Grams	-> Carats	5.0
Grams	-> dwt	0.64301
Inches	-> Millimeters	25.4
Kilograms	-> Ounces (Troy)	32.1507
Kilograms	-> dwt	0.643014
Millimeters	-> Inches	0.03937
Ounces (Av)	-> Ounces (Troy)	0.91146
Ounces (Av)	-> Grams	28.3495
Ounces (Troy)	-> Grams	31.1035
Ounces (Troy)	-> Ounces (Av)	1.0971
Pounds (Av)	-> Grams	453.592
Pounds (Av)	-> dwt	291.666
Pounds (Av)	-> Ounces (Troy)	14.583

WEIGHT CONVERSIONS FOR SIMILAR VOLUMES

If you have one (1) pennyweight of

	Sterling	10Y	14Y	18Y	14W	18W	Platinum	Pt 10Ir	Brass	Pewter	Lead	Wax
Sterling	1.00	0.90	0.79	0.67	0.82	0.71	0.49	0.48	1.23	1.43	0.91	10.36
10Y	1.11	1.00	0.89	0.74	0.92	0.79	0.54	0.54	1.36	1.60	1.02	11.60
14Y	1.27	1.13	1.00	0.84	1.03	0.89	0.61	0.61	1.54	1.80	1.15	13.08
18Y	1.49	1.34	1.19	1.00	1.23	1.06	0.73	0.72	1.84	2.15	1.38	15.60
14W	1.22	1.09	0.97	0.81	1.00	0.86	0.59	0.59	1.49	1.74	1.12	12.65
18W	1.41	1.26	1.12	0.94	1.16	1.00	0.68	0.68	1.72	2.02	1.29	14.65
Pt	2.04	1.85	1.64	1.38	1.70	1.46	1.00	1.00	2.52	2.95	1.89	21.45
Pt 10Ir	2.08	1.86	1.65	1.38	1.70	1.47	1.00	1.00	2.53	2.96	1.90	21.54
Brass	0.81	0.73	0.65	0.54	0.67	0.58	0.40	0.39	1.00	1.17	0.75	8.50
Pewter	0.70	0.63	0.56	0.47	0.57	0.50	0.34	0.34	0.86	1.00	0.64	7.27
Lead	1.09	0.98	0.87	0.73	0.90	0.77	0.53	0.53	1.33	1.56	1.00	11.34
Wax	0.10	0.09	0.08	0.06	0.08	0.07	0.05	0.05	0.12	0.14	0.09	1.00

Example: You have a two (2) pennyweight ring in 10K yellow, and you would like to know what it would weigh as 14K yellow.
Find 10 yellow across the top row and read down until you reach 14 yellow, then multiply your two (2) pennyweights by this number.
(2 dwt) x 1.13 Factor = 2.26 dwt as 14K Yellow

SHEET METAL WEIGHT PER SQUARE INCH BY B&S GAUGE

B&S Gauge	Fine Thickness Inches	Sterling Silver Ounces	Fine Silver Ounces	24K Yellow Gold dwt	10K Yellow Gold dwt	14K Yellow Gold dwt	18K Gold dwt	Platinum Ounces
8	0.128	0.7130	0.7140	26.20	15.70	17.70	21.10	1.450
10	0.102	0.5650	0.5580	20.80	12.40	14.00	16.70	1.150
12	0.081	0.4480	0.4430	16.50	9.85	11.10	13.30	.913
14	0.064	0.3560	0.3510	13.10	7.81	8.82	10.50	.724
16	0.051	0.2820	0.2780	10.40	6.21	7.70	8.35	.574
18	0.040	0.2240	0.2210	8.22	4.91	5.55	6.62	.455
19	0.036	0.1990	0.1960	7.32	4.38	4.94	5.89	.406
20	0.032	0.1770	0.1750	6.52	3.90	4.40	5.25	.361
22	0.025	0.1410	0.1390	5.17	3.09	3.49	4.16	.286
24	0.020	0.1120	0.1100	4.10	2.45	2.77	3.30	.227
26	0.016	0.0884	0.0873	3.25	1.94	2.19	2.62	.180
28	0.013	0.0701	0.0689	2.58	1.86	1.62	1.95	.143
30	0.010	0.0556	0.0549	2.04	1.17	1.38	1.60	.113

Technical Info

DETERMINING RING BLANK LENGTHS IN B&S GAUGE

Ring Finger Size (U.S.A.)	Diameter (mm)	Length (mm)	Metal Thickness in Millimeters 2mm	1.6mm	1.3mm	1.0mm	.80mm	.60mm	.50mm
1	12.44	39.09	45.29	44.09	43.09	42.09	41.49	40.89	40.59
1½	12.85	40.37	46.57	45.37	44.37	43.37	42.77	42.17	41.87
2	13.26	41.64	47.84	46.64	45.64	44.64	44.04	43.44	43.14
2½	13.66	42.92	49.12	47.92	46.92	45.92	45.32	44.72	44.42
3	14.07	44.20	50.40	49.20	48.20	47.20	46.60	46.00	45.70
3½	14.47	45.47	51.67	50.47	49.47	48.47	47.87	47.27	46.97
4	14.88	46.75	52.95	51.75	50.75	49.75	49.15	48.55	48.25
4½	15.29	48.03	54.23	53.03	52.03	51.03	50.43	49.83	49.53
5	15.69	49.30	55.50	54.30	53.30	52.30	51.70	51.10	50.80
5½	16.10	50.58	56.78	55.58	54.58	53.58	52.98	52.38	52.08
6	16.51	51.86	58.06	56.86	55.86	54.86	54.26	53.66	53.36
6½	16.91	53.13	59.33	58.13	57.13	56.13	55.53	54.93	54.63
7	17.32	54.41	60.61	59.41	58.41	57.41	56.81	56.21	55.91
7½	17.73	55.69	61.89	60.69	59.69	58.69	58.09	57.49	57.19
8	18.13	56.96	63.16	61.96	60.96	59.96	59.36	58.76	58.46
8½	18.54	58.24	64.44	63.24	62.24	61.24	60.64	60.04	59.74
9	18.95	59.52	65.72	64.52	63.52	62.52	61.92	61.32	61.02
9½	19.35	60.79	66.99	65.79	64.79	63.79	63.19	62.59	62.29
10	19.76	62.07	68.27	67.07	66.07	65.07	64.47	63.87	63.57
10½	20.16	63.35	69.55	68.35	67.35	66.35	65.75	65.15	64.85
11	20.57	64.63	70.83	69.63	68.63	67.63	67.03	66.43	66.13
11½	20.98	65.90	72.10	70.90	69.90	68.90	68.30	67.70	67.40
12	21.38	67.18	73.38	72.18	71.18	70.18	69.58	68.98	68.68
12½	21.79	68.46	74.66	73.46	72.46	71.46	70.86	70.26	69.96
13	22.20	69.73	75.93	74.73	73.73	72.73	72.13	71.53	71.23
13½	22.60	71.01	77.21	76.01	75.01	74.01	73.41	72.81	72.51
14	23.01	72.29	78.49	77.29	76.29	75.29	74.69	74.09	73.79
14½	23.42	73.56	79.76	78.56	77.56	76.56	75.96	75.36	75.06
15	23.82	74.84	81.04	79.84	78.84	77.84	77.24	76.64	76.34

** Add 0.5mm to these lengths if the ring band is wider than 4mm.*

AGE HARDENING OF GOLD ALLOYS

Gold alloys are most commonly hardened and strengthened by cold work, or deformation. Sometimes it is desirable or necessary to harden a gold alloy without deforming it. There are particular gold alloys that gain various degrees of hardness when subjected to a controlled sequence of temperature, time, and cooling rate. For example, the hardness of a certain 10K yellow gold alloy can be increased almost 50%, or 30 points on the RB scale by special, heat-treating steps. Many individuals refer to this group of alloys as heat-treatable alloys. It is more accurate and informative to refer to them as age-hardenable alloys. At this point, we will discuss three key issues:

1. Concept of age-hardening alloys
2. Choosing the correct alloys
3. Process parameters to achieve age hardening

METALLURGY OF AGE HARDENING

Two types of percipitation-hardening phenomena occur with age-hardenable gold alloys. They are precipitation hardening and order-disorder transformations. Both phenomena require heating the alloy through a sequence of designated temperatures for a determined period of time to facilitate the hardness increase. The critical process steps in precipitation hardening age:

- Annealing at sufficiently high temperatures, to ensure the material becomes saturated with alloying elements followed by quenching.
- "Aging" the material at a lower temperature for a sufficient length of time to create a favorable distribution of fine precipitates to cause maximum hardening and strengthening.

Precipitation hardening is a phenomenon where a second phase in the gold alloy forms and grows while the alloy is in the solid state. At a specific temperature, phase B is encouraged to precipitate at the grain boundaries and within the crystals of a solid phase. The result is a large number of microscopic particles within the alloy matrix. These precipitate particles make it difficult for dislocations to move through the alloy matrix during cold working, and increased stress levels are required to deform the alloy.

A second type of precipitation hardening occurs when the precipitate has a special relationship with the matrix in which it forms. In gold alloys, these special types of precipitates form during what are called order-disorder transformations. These transformations occur in alloys with Au/Cu atomic ratios of 1:1 and 3:1.

When these alloy systems are at high temperatures, the atoms are randomly distributed on the crystal lattice points, and the structure is considered to be "disordered." When cooled below a specific temperature, the atoms become regularly spaced with gold and copper atoms located on special sites in the gold FCC crystal lattice. This is called the "ordered" state of the alloy. The ordered structure creates an extra degree of stress and becomes strained and distorted. Sometimes these types of precipitates are called coherent precipitates because of their special relationship to the crystal lattice in which they reside. The lattice strain created by these participates is then called "coherent strain." This distortion makes it more difficult for dislocations to move through structure, and higher stresses are required to deform the alloy.

AGE HARDENING ALLOYS

To incorporate an age-hardening process, three steps require special attention. The first step is selection of a gold alloy that will age harden, the second step is conditioning the alloy structure, and the third is the actual heat-treatment process referred to as aging. Proper selection of a gold alloy will be discussed first.

In karat yellow golds with or without zinc, copper and silver are responsible for the age-hardening characteristics of a particular gold alloy. More specifically, it is the copper/silver ratio that determines whether a gold alloy will respond significantly to an age-hardening process. Additions of zinc will modify the (Au, Cu, Ag) system, and, as zinc levels are increased, the alloy's ability to age harden is somewhat reduced.

AGE HARDENING PROCESS PARAMETERS

Once it is determined that an alloy will respond to age hardening, the process steps required to achieve a maximum response must be followed. A second important issue is to assure that the alloy structure is in a condition that will yield a maximum increase in hardness. This maximum response can be assured by homogenizing the alloy with the heat treatment step. At this point, it is useful to discuss some differences in the production of cast vs. die struck or fabricated metal products. Solution annealing is often referred to as a homogenizing and is designed to blend any microsegregation that may be the result of nonuniform cooling of the alloy structure. If the alloy structure is not homogenous, the product will not evenly harden.

Homogenizing an alloy structure can be done either by annealing solution or by cold working. If the product will be left in the as-cast condition, such as investment-cast pieces, then solution annealing is required to homogenize the alloy structure prior to aging. Solutionizing is done by holding the product at an elevated temperature for a period of time followed by rapid cooling, such as quenching. The first cycle is typically called solutioning, and the second cycle is called aging and is the driving force behind the structural changes discussed below. Quenching from above a specific temperature is critical to avoid any microsegregation that may result from slow cooling. An oven is highly recommended for the solutionizing treatment due to better control of temperature and the length of time required for proper treatment. Cold work by itself will homogenize an alloy if the amount of cold work is significant. Therefore, sheet and wire products formed by cold working should be homogenous and should not require solution annealing prior to heat treatment to increase the hardness.

As mentioned earlier, as-cast structures should be solution annealed and quenched prior to age hardening to decrease segregation, which may be present due to uneven cooling. Temperatures and times recommended for solution annealing colored gold alloys are as follows:

18 karat colored gold	550-600° C	30 minutes
14 karat colored gold	650° C	30 minutes

The third and final stage of the process is the low-temperature treatment known as aging. Increasing the hardness of the alloy is dependent on both time and temperature. If the aging time is too short, maximum hardness will not be achieved. When the aging time is too long, a loss of hardness and strength could occur. If the temperature used for the aging step is too high, an increase in hardness will not occur. In fact, an article which may have been tempered due to cold work may start to anneal and loose harness. Temperatures and times recommended for aging colored gold alloys are as follows:

18 karat colored gold	280° C	60 minutes
14 karat colored gold	260-350° C	60 minutes

The information that has been presented is intended for use as a general guide for selection and aging of colored gold alloys. It is not intended for white gold alloys. When handled properly, these gold alloys can be beneficial for multiple applications. Some of the many applications follows:

1. Jewelry products can be hardened to help resist indentation during mass media finishing or service in the field.
2. Jewelry products, such as clips, that require using annealed stock for bending processes could be hardened afterward. Some examples of these products would be earring clutches, catches for jewelry, and money clips.
3. Thin wall gold products, such as hollow beads, charms, light weight rings, and thin wall tubing used for bracelets stock, can be hardened to help prevent distortion.
4. Wire products used for earring posts, stick pins, and hinge pins can be hardened after soldering operations.

ANNEALING COLD-WORKED STRUCTURES

The cold-worked state is a condition of higher internal energy than the undeformed metal. Although the cold-worked structure is mechanically stable, it is not thermodynamically stable. With increasing temperature, the cold-worked state becomes more and more unstable, and, eventually, the metal softens and reverts to a stress-free condition.

Annealing is a process that eliminates the stresses created during mechanical working or deformation of an alloy so that the material can be restored to maximum softness. In the metals industry, this involves heating a metal to an elevated temperature for a controlled length of time, followed by natural or forced cooling back to room temperature. Annealing is very important commercially because it restores ductility to a metal that has been severely cold worked. Therefore, by interposing annealing operations after severe deformation, it is possible to deform metal to a great extent.

It is important to realize both time, temperature, and cooling rate are important variables in controlling the outcome of an annealing process. In general, annealing should be completed in a time that is measured in minutes, not hours. We received a distress call from a person who destroyed a white gold piece by annealing it overnight in an attempt to make it really soft. Unfortunately, the gold alloy was severely damaged by trying to achieve the impossible. Metals can be softened to a certain point and no further, regardless of how long they are exposed to elevated temperatures.

The gold alloy data in the appendix contains many graphs for 14kt, 18kt, and 22kt yellow gold alloys that describe how hardness, strength, and ductility change with annealing conditions. To create these graphs, samples were annealed for a period of 30 minutes at increasing temperatures. This graphical information is worth some study. For example, the graphs demonstrate how hardness, strength, and ductility change drastically after 30 minutes of exposure to temperatures around 500-600°C. The graphs indicate that a 30-minute anneal at 800°C results in hardness values that are only slightly less than those achieved by annealing at 500-600°C for the same length of time.

This extra decrease in hardness is a result of grain growth. Large grains are undesirable in material that is cold formed because they will create “orange peel” texture, which is very difficult to polish and finish. Thus it is best to choose an optimum temperature for annealing where recrystallization occurs readily and grain growth occurs slowly.

THE METALLURGY OF ANNEALING

As stated earlier, the driving force for annealing is the elimination of the stored energy that accumulates in the piece during cold working (plastic deformation). About 5% of the energy used for plastic deformation is stored in the material while the remainder is converted into heat. In a practical sense, material cannot be rolled indefinitely. Annealing restores the ductility and reduces the strength a material had before cold working.

A cold-worked metal structure can pass through three stages during an annealing process. These three stages of annealing are (1) recovery, (2) recrystallization, and (3) grain growth. The most desirable metal properties are generally created in stage two, the recrystallization step. The grain-growth stage should generally be avoided because large grains are generally undesirable in a high-quality, metallurgical product.

FINISHING PROCEDURES

The density of platinum seems to make finishing somewhat more laborious. However, a fine, high polish is readily achieved by following regular polishing procedures and finishing sequences. Whenever possible, it is best to pre-finish components prior to assembly as solders are more easily polished than platinum and may be over-finished or dragged out of the seam otherwise. Always begin with the least aggressive abrasive that will accomplish the task, and remove all defects before moving to the next step. Use closely spaced abrasives as skipping a step to save time will ultimately require more time and result in a less attractive finish. It is essential to maintain a separate set of files, buffs, brushes, and compounds reserved exclusively for platinum to avoid contamination and achieve the ultimate platinum finish. The following sequence and materials are used to finish platinum products at Stuller and are available from our tools catalog:

1. Remove sprues using a 120 grit 3M® sanding belt or a #3 cut Grobet USA® file.
2. Hand burnish or tumble in stainless steel burnishing media to compact surface and fill minor pitting.
3. Remove surface blemishes with #5 and #6 cut Grobet USA® files.
4. Sand inside of ring with a 320 grit 3M® cartridge roll.
5. Sand inside of ring with a fine grit, gray silicone, inside-ring cylinder.
6. Deburr mounting with a 3M® light deburring wheel.
7. In areas inaccessible to a light deburring wheel, use a 180-grit, 7/8" knife-edged silicone wheel.
8. Repeat using a 220 grit, 7/8" knife-edged silicone wheel.
9. Use a ¾" medium bristle brush and Graystar polishing compound to polish prongs and other difficult-to-access areas.
10. Use a six-inch stitched yellow, treated muslin buff to smooth shank and other broad areas.
11. Polish inside of ring with a felt, inside-ring buff using Graystar compound.
12. Lap sides and angles with a 6"×½" Paramount split lap using Graystar compound.
13. Clean thoroughly using steam or ultrasonic.
14. Polish with a non-stitched, six-inch finex white muslin buff using green rouge.
15. Clean, then polish with a six-inch purple treated buff using bright white platinum polish.
16. Clean, then polish with a six-inch purple treated buff using carrot rouge.

COLORED KARAT GOLDS

The precious metal alloys can be grouped based on the color as follows:

GOLD-SILVER-COPPER-ZINC ALLOY SYSTEM	**Yellow, Pink, Red, Green Golds**
GOLD-COPPER-NICKEL ALLOY SYSTEM	**Nickel White Golds**
GOLD-SILVER-PALLADIUM ALLOY SYSTEM	**Palladium White Golds**

Apart from the major alloying elements, silicon, iridium, rhenium, ruthenium, and cobalt are added as deoxidizers or grain refiners.

EFFECTS OF ALLOYING ELEMENTS ON THE PROPERTIES OF KARAT GOLDS

Gold alloys consisting of a single solid solution or mixtures of solid solutions generally have lower melting ranges than pure gold. Adjusting the ratio of pure constituents produces a wide range of physical and mechanical properties compared with the pure metals. In general, the properties are enhanced due to alloying, and, for this reason, alloys are used rather than pure metals. The alloys can often be designed to have minor alloying elements that, when exceeded, could result in diminished properties for the gold alloy. On the other hand, malleability and ductility of gold alloys can be considerably reduced by even smaller quantities of contaminants or impurities, such as lead, antimony, or arsenic. In general, major alloying elements such as copper, silver, nickel, palladium, and zinc are added to gold to control color, hardness, workability, and castability of karated gold. Minor alloying elements, like silicon, boron, phosphorus, iridium, rhenium, and cobalt, are added to control grain size, deoxidation, and fluidity of karated gold.

GAUGE TO INCHES TO MILLIMETERS CONVERSION TABLE

B&S Gauge	Inch (Decimal)	Millimeter (mm)	Inch (Fraction)
1	0.289	7.348	–
2	0.258	6.543	–
–	0.250	6.350	1/4
–	0.234	5.953	15/64
3	0.229	5.827	–
–	0.219	5.556	7/32
4	0.204	5.189	–
–	0.203	5.154	11/64
–	0.188	4.762	3/16
5	0.182	4.621	–
–	0.172	4.366	11/64
6	0.162	4.115	–
–	0.156	3.969	5/32
7	0.144	3.664	–
–	0.141	3.572	9/64
8	0.128	3.263	–
–	0.125	3.175	1/8
9	0.114	2.906	–
–	0.109	2.778	7/64
10	0.102	2.588	–
–	0.094	2.381	3/32
11	0.091	2.304	–
12	0.081	2.052	–
–	0.078	1.984	5/64
13	0.072	1.828	–
14	0.064	1.628	–
–	0.063	1.588	1/16
15	0.057	1.449	–
16	0.051	1.291	–
–	0.047	1.191	3/64
17	0.045	1.149	–
18	0.040	1.024	–
19	0.036	0.912	–
20	0.032	0.812	–
–	0.031	0.795	1/32
21	0.028	0.723	–
22	0.025	0.644	–
23	0.023	0.573	–
24	0.020	0.511	–
25	0.018	0.455	–
26	0.016	0.405	–
–	0.016	0.396	1/64
27	0.014	0.360	–
28	0.013	0.321	–
29	0.011	0.286	–
30	0.010	0.255	–
31	0.009	0.226	–
32	0.008	0.200	–
33	0.007	0.180	–
34	0.006	0.160	–
35	0.006	0.142	–
36	0.005	0.130	–

TEMPERATURE CONVERSION TABLE

Conversion Formulas

°F = (9/5 x °C) + 32°

°C = 5/9 (°F - 32°)

°F	°C
600	316
620	327
640	338
660	349
680	360
700	371
720	382
740	393
760	404
780	416
800	427
820	438
840	449
860	460
880	471
900	482
920	493
1000	538
1020	549
1040	560
1060	571
1080	582
1100	593
1120	604
1140	616
1160	627
1180	638
1200	649
1220	660
1240	671
1260	682

°F	°C
1280	693
1300	704
1320	716
1400	760
1420	771
1440	782
1460	793
1480	804
1500	816
1520	827
1540	838
1560	849
1580	860
1600	871
1620	882
1640	893
1660	904
1680	916
1700	927
1720	938
1800	982
1820	993
1840	1004
1860	1016
1880	1027
1900	1038
1920	1049
1940	1060
1960	1071
1980	1082
2000	1093

COMPARATIVE HARDNESS SCALES

Rockwell Hardness Number			Brinell Hardness Number 10mm Ball		Gold Hardness Range				
					14K	14K	18K	18K	Pt 95
C	B	Vickers	3000Kgf	500Kgf	Y	W	Y	W	Ru 5
41	–	402	381	–					
40	–	392	371	–					
39	–	382	362	–					
38	(110)	372	353	–					
37	(109)	363	344	..					
36	(108.5)	354	336	–					
35	(108)	345	327	–		50% CW		50% CW	
34	(107.5)	336	319	–		50% CW		50% CW	
33	(107)	327	311	–		50% CW		50% CW	
32	(106.5)	318	301	–		50% CW		50% CW	
31	(106)	310	294	–		50% CW			
30	(105.5)	302	286	–		50% CW			
29	(104.5)	294	279	–		50% CW			
28	(104)	286	271	–					
27	(104)	279	264	–					
26	(103)	272	258	–					
25	(102)	266	253	–					
24	(101)	260	247	–	50% CW				
23	100	240	240	201	50% CW				
22	99	234	234	195	50% CW		50% CW	Annealed	
21	98	228	228	189	50% CW		50% CW	Annealed	
20	97	222	222	184			50% CW	Annealed	
(18)	96	216	216	179			50% CW	Annealed	
(16)	95	210	210	175					
–	94	205	205	171					
–	93	200	200	167					50% CW
–	92	195	195	163					50% CW
–	91	190	190	160					50% CW
–	90	185	185	157					
–	89	180	180	154					

Rockwell Hardness Number			Brinell Hardness Number 10mm Ball		Gold Hardness Range				
					14K	14K	18K	18K	Pt 95
C	B	Vickers	3000Kgf	500Kgf	Y	W	Y	W	Ru 5
–	88	176	176	151					
–	87	172	172	148					
–	86	169	169	145		Annealed			
–	85	165	165	142		Annealed			
–	84	162	162	140		Annealed			
–	83	159	159	137		Annealed			
–	82	156	156	135		Annealed			
–	81	153	153	133		Annealed			
–	80	150	150	130		Annealed			
–	79	147	147	128		Annealed			
–	78	144	144	126	Annealed	Annealed			
–	77	141	141	124	Annealed	Annealed			
–	76	139	139	122	Annealed	Annealed			
–	75	137	137	120	Annealed	Annealed	Annealed		
–	74	135	135	118	Annealed	Annealed	Annealed		
–	73	132	132	116	Annealed		Annealed		
–	72	130	130	114	Annealed		Annealed		
–	71	127	127	112	Annealed		Annealed		Annealed
–	70	125	125	110	Annealed		Annealed		Annealed
–	69	123	123	109	Annealed		Annealed		Annealed
–	68	121	121	107	Annealed		Annealed		
–	67	119	119	106					
–	66	117	117	104					
–	65	116	116	102					
–	64	114	114	101					
–	63	112	112	99					
–	62	110	110	98					
–	61	108	108	96					
–	60	107	107	95					
–	59	106	106	94					

Technical Info

HOW TO ORDER

STULLER.COM

Take advantage of quick and easy ordering and enjoy the following benefits:

- Check current pricing and availability on more than 200,000 products — 24/7, 365 days a year.
- Place orders quickly and accurately.
- Track shipments, view previous orders, and print any of your invoices.
- Use Schedule Order to add to your cart all day and submit your order automatically at your cutoff time.
- Live, text-based chat is available to assist you Monday through Friday, 9:00 a.m. to 6:00 p.m. Central.
- For **WEB ASSISTANCE**, call 877-619-2174.

Click *Create Account* at the top of **Stuller.com** to create your online account. We'll verify your information and send an email confirmation that your login/password is ready for use. Go to **Stuller.com**, click *Log In*, and enter it for full access to the site. Use the Quick Order feature on the home page when you know exactly what you want to order.

PHONE

U.S. and CANADA INTERNATIONAL
PHONE: 800-877-7777
PHONE: 337-262-7700

To ensure accuracy when placing orders for an item, be prepared to give the following information: account number, account name, your name, complete series number, karat, color, size, quantity, and conditional sale number (if applicable).

FAX

24/7 FAX: 800-444-474
24/7 FAX: 337-981-1655

GENERAL INFORMATION

In the continental U.S., orders placed before 5:00 p.m. (4:00 p.m. Pacific) will be shipped the same day. Canadian accounts must place orders by 3:00 p.m. local time for same-day shipping. International accounts must place orders by 2:00 p.m. Central for same-day shipping. Place orders toll-free by phone, fax, email **Sales@Stuller.com**, or on **Stuller.com**.

SHIPPING INFORMATION

Type of Item	Shipping
In Stock	Same day
Non-Stock	2-8 days
Clearance	Same day
Custom Orders	2-8 days

Custom orders include sizing, setting, engraving, special finishes, and monogram jewelry.

- Special orders may be available upon request.
- If an item is not in stock, we will back order and ship as separate order with postage.

PRICING INFORMATION

Prices are in U.S. dollars. Prices do not include taxes, shipping, or handling. **Actual pricing for items will be determined by the precious metal markets at the time the item ships.**

- Most prices listed are suggested retail at triple keystone with markets at $1,400 gold, $1,000 platinum, $1,300 palladium, and $18 sterling silver.
- Diamond pricing varies with market conditions and is subject to change without notice.
- Items priced at jeweler's cost are sold each, unless otherwise noted, and are subject to change without notice. Visit **Stuller.com** for our complete product selections, current pricing, and quantity price breaks.

CATALOG INFORMATION

Please consider these points when showing product from the catalog:

- All 14K white polished mountings are rhodium-plated.
- Rings are ladies' stock size 6 to 7, men's stock size 10 to 11, and youth stock size 3 to 5. Other sizes are available upon request for an additional charge.
- While we strive to show our jewelry at actual size, some variances may occur.

DELIVERY INFORMATION

Most items in this catalog are available for same-day shipping, next-day delivery. Ground delivery service is recommended for items that are too large or too heavy for next-day delivery to be cost effective. Your sales consultant will discuss alternative shipping options with you when you order. Freight and insurance are billed at the time of shipment.

- **Truck Shipments/UPS/FedEx**
  If you suspect any damage or shortage caused during transit, do not sign freight bill or receipt without making a notation on the freight bill. Retain all packing material and shipping cartons until the carrier has made an inspection. File a claim directly with the carrier within 15 days. Stuller CANNOT file a claim for you.
- **Hazardous Materials Shipping**
  The Department of Transportation (DOT) governs the labeling, packaging, and handling of certain materials. These standards increase costs from shipping companies for handling. Some of your packaging amounts may change. We continually update our shipping policies and try to minimize the DOT charges where possible. Material Safety Data Sheets are sent with all required items and contain important safety recommendations and emergency procedures. Additional copies are available by contacting Tools Customer Service. Keep on file for quick reference.

CANCELLATIONS AND RETURNS

Once an order has been submitted online, by telephone, or by fax, you will need to contact a sales associate to determine whether your order can be changed or canceled.

WHERE AND HOW TO RETURN

We want you to be happy with everything you purchase from us. If you are not satisfied and need to return merchandise, we will give you full credit, provided you follow these procedures (excludes special ordered, non-returnable items).

- Simply go to **Stuller.com/StartMyReturn** to create a return request. Once you've completed the request, the system will generate a unique barcode and merchandise return form for your convenience
  or
- Send the completed Merchandise Return Form or a copy of the original invoice with the returned items. Easily download a copy of our merchandise return form at **Stuller.com/Returns**. Please include the reason for return.

Return merchandise in its original condition and packaging, including envelopes, bags, and boxes. Merchandise should be securely packaged and insured. Stuller is not responsible for returns that are damaged in transit. Insure for full value and return to:

Stuller, Inc., Attn: Customer Returns
302 Rue Louis XIV, Lafayette, LA 70508

All returns must be shipped prepaid (no CODs).

Upon receiving your return, we will exchange, replace, or credit. You will receive credit in the same manner as you paid for the merchandise.

Stuller is not responsible for returns that are damaged in transit. Items with manufacturing defects may be returned for exchange. Items that were altered, cut, or manufactured to your specifications cannot be accepted for credit or exchange. Be aware that normal shipping charges do apply to the exchange order.

Refused, undeliverable, or merchandise returned that was not purchased from Stuller will be charged for the shipping costs of returning it to you.

Thank you for adhering to these policies. If you have any questions concerning the return of merchandise or credit for the return of merchandise, please contact our Customer Service Department at **800-877-7777** or **Info@Stuller.com**. Or view **Stuller.com/Returns** for further assistance and forms.

CONTEMPORARY METALS RETURN POLICY

Stuller's standard return policy applies to its contemporary metals product, including tungsten, titanium, cobalt, ceramic, and stainless steel bands. Stuller will accept for return or exchange contemporary metals product that is received with defect or any Tungsten or Ceramic band that becomes scratched or discolored. All returns and exchanges require proof of purchase, and exchanges will be processed for the applicable fee listed below. Bands with engraving that are submitted for exchange are subject to an additional engraving fee.

LIFETIME SIZING POLICY

Stuller offers a lifetime size exchange service on its contemporary metal products. Applicable fees are listed below. Stuller will exchange your band for the same ring or, at its discretion, a ring of similar style and/or value. Bands with engraving that are submitted for exchange are subject to an additional engraving fee.

Be aware that normal shipping charges do apply to the exchange order.

Product Category	Applicable Fees
Basic contemporary metals	$20
With diamonds 0.05 CT or under	$20
With silver inlay or overlay	$20
With diamonds 0.06 CT or over	$25
With gold inlay or overlay	$35

PRODUCT REVIEW/CONDITIONAL SALE (PRCS)

Finished jewelry is available to qualified accounts for your customer's review (limits may apply). Conditional sale merchandise is available for review for 15 calendar days of PRCS ship date. If not returned within the 15 calendar days, merchandise will be invoiced. If returned after invoiced, a 15% restocking fee will be applied.

Note: Days are calendar days.

Stuller Diamonds™ and **Stuller Gemstones**™: Available for your customer's review for five days of PRCS date.

To return, follow these procedures:

1. Include a copy of the conditional sale document or invoice, and use the original packaging for the merchandise.
2. Use the enclosed prepaid air bill to return items within 15 calendar days for finished jewelry/five calendar days for diamonds and gemstones.
3. Call FedEx or UPS to request pick up.

Terms and conditions subject to change.