INTERNATIONAL STANDARD

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Brazing — Filler metals

Brasage fort — Métaux d'apport

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17672 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*.

Requests for official interpretations of any aspect of this International Standard should be directed to the Secretariat of ISO/TC 44/WG 3 via your national standards body, a complete listing which can be found at http://www.iso.org/.

Brazing — Filler metals

1 Scope

This International Standard specifies the compositional ranges of a series of filler metals used for brazing. The filler metals are divided into seven classes, related to their composition, but not necessarily to the major element present.

NOTE 1 For the major element(s) present, see Annex A.

In the case of composite products, such as flux-coated rods, pastes or plastics tapes, this International Standard covers only the filler metal that forms part of such products. The melting temperatures given in the tables are only approximate, as they necessarily vary within the compositional range of the filler metal. Therefore, they are given only for information. Technical delivery conditions are given for brazing filler metals and products containing brazing filler metals with other constituents such as flux and/or binders.

NOTE 2 For some applications, e.g. precious metal jewellery, aerospace and dental, filler metals other than those included in this International Standard are often used and these are covered by other International Standards to which reference can be made.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3677:1992, *Filler metal for soft soldering, brazing and braze welding — Designation*

ISO 80000-1:2009, *Quantities and units — Part 1: General*

3 Composition

The filler metal shall have a composition in accordance with Tables 5 to 13 for the particular type, except as modified for special vacuum requirements (see Clause 4 and Table 1).

For the purposes of determining compliance with composition limits, any value obtained from the analysis shall be rounded to the same number of decimal places as used in this International Standard in expressing the specified limit. The following rules shall be used for rounding.

a) When the figure immediately after the last figure to be retained is less than five, then the last figure to be retained shall be kept unchanged.

b) When the figure immediately after the last figure to be retained is either

   1) greater than five, or

   2) equal to five and followed by at least one figure other than zero,

   the last figure to be retained shall be increased by one.

c) When the figure immediately after the last figure to be retained is equal to five, and followed by zeros only, then the last figure to be retained shall be left unchanged if even, and increased by one if odd. For the purposes of determining compliance with the requirements of this International Standard, the actual test values obtained shall be subjected to the rounding-off instructions given in ISO 80000-1:2009, Annex B.

NOTE The chemical analysis is of the bulk material, but the material can be composed of discrete powders with different individual compositions or multiple layers of roll-clad foils where each layer can have a different individual composition.

4 Special vacuum requirement

In a few instances, which are most likely to apply to Ag 272, Pd 287, Pd 387, Pd 388, Pd 481, Pd 483, Pd 484, Pd 587, Pd 647 and Au 295, Au 375, Au 625, Au 752, Au 801 and Au 827, lower impurity limits can be required for brazing in vacuum or service in vacuum and these limits shall be as given in Table 1.

Filler metals complying with Table 1 shall have the letter V added as a suffix to the codification plus the digit 1 or 2 to indicate the grade.

NOTE Grade 1 is intended for the most demanding duties, Grade 2 for less demanding.

Table 1 — Impurity limits for special vacuum requirements

Impurity	**Limit** (% by mass max.)	
	Grade 1	Grade 2
C[a]	0,005	0,005
Cd	0,001	0,002
P	0,002	0,002[b]
Pb	0,002	0,002
Zn	0,001	0,002
Mn[c]	0,001	0,002
In[c]	0,002	0,003
All other elements where vapour pressure at 500 °C is $> 1{,}3 \times 10^{-5}$ Pa[d]	0,001	0,002

[a] For filler metal Ag 272 (see Table 6), lower levels may be available by agreement between the purchaser and the supplier.

[b] For filler metal Ag 272, 0,02 % maximum.

[c] Except where otherwise specified in Tables 5 to 13.

[d] Examples of such elements are Ca, Cs, K, Li, Mg, Na, Rb, S, Sb, Se, Sr, Te and Tl. For such elements (including Cd, Pb and Zn), the total is limited to 0,010 %.

5 Chemical analysis

Chemical analyses shall be carried out by any suitable method, but it should be noted that in the case of many brazing alloys, the use of reference standards may be essential, as agreed between the purchaser and the supplier. Analysis is only required to be carried out routinely for those elements for which specific limits are shown. If, however, the presence of other elements is suspected or in the course of routine analysis is indicated to be in excess of the limits laid down for unnamed elements, or would bring the total of impurities above the specified limit, further analyses shall be carried out for such elements.

6 Designation

The filler metal shall be designated by the description “filler metal”, the number of this International Standard, i.e. ISO 17672, and a code. Details of the two options for the code system used are given in Annex A.

As an example, the designations of an aluminium filler metal containing 11 % to 13 % Si, in accordance with this International Standard, can be made in one of the following ways:

EXAMPLE 1 Filler metal ISO 17672-Al 112

where

“Filler metal” is the description;

“ISO 17672” is the number of this International Standard;

“Al 112” is the short code given in Tables 5 to 13.

EXAMPLE 2 Filler metal ISO 17672-B-Al88Si-575/585

where

“Filler metal” is the description;

“ISO 17672” is the number of this International Standard;

“B” denotes brazing;

“Al88Si-575/585” is the code in accordance with ISO 3677.

7 Technical delivery conditions

7.1 Types of product

The form of the material shall be agreed between the purchaser and the manufacturer/supplier at the time of placing the order.

NOTE Brazing filler metals are available as rod, wire, foil (or preforms made from them) or powder, although not all filler metals are necessarily available in every type of product. They are also available as a constituent of brazing pastes or, particularly in the case of aluminium brazing filler metals, clad onto one or both sides of an alloy sheet. Rods can be completely or partially coated with flux.

7.2 Dimensions

7.2.1 General

Dimensions and tolerances for foils (see 7.2.2), rods (see 7.2.3) and, to a lesser extent, wires (see 7.2.4) are defined. For other forms and dimensions not listed in the respective tables, the purchaser and the manufacturer/supplier shall agree on the dimensions and tolerances at the time of placing the order.

7.2.2 Foils

The tolerances for thickness, width and camber are given in Tables 2, 3 and 4.

Table 2 — Thickness tolerance for foils

Thickness nominal size mm		Limits of thickness related to width (nominal size) mm
over	to	over 1 mm
—	0,05	± 10 %
0,05	0,1	± 0,005
0,1	0,2	± 0,010
0,2	0,3	± 0,015
0,3	0,4	± 0,018
0,4	0,5	± 0,020
0,5	0,8	± 0,025
0,8	1,2	± 0,030
1,2	2,0	± 0,035

Table 3 — Width tolerance for foils

Thickness nominal size mm		Limits of width related to width (nominal size) mm		
over	to	to 50 mm	over 50 mm to 100 mm	Over 100 mm
—	0,1	$^{+2}_{0}$	$^{+3}_{0}$	$^{+4}_{0}$
0,1	1,0	$^{+2}_{0}$	$^{+3}_{0}$	$^{+4}_{0}$
1,0	2,0	$^{+3}_{0}$	$^{+4}_{0}$	$^{+5}_{0}$

Table 4 — Camber tolerance for foils

Thickness nominal size mm		Max. camber for width nominal size mm/m				
over	to	3 mm to 10 mm	over 10 mm to 15 mm	over 15 mm to 30 mm	over 30 mm to 50 mm	over 50 mm
—	0,5	10	7	4	3	3
0,5	2,0	15	10	6	4	4

7.2.3 Rods

For rods, the preferred diameters are 1 mm, 1,5 mm, 2 mm, 2,5 mm, 3 mm and 5 mm and the preferred lengths are 500 mm and 1 000 mm. The tolerance on diameter shall be ± 3 % for drawn rods and ± 0,3 mm for other fabrication processes. The tolerance on length shall be ± 5 mm.

7.2.4 Wires

For wires, there are no preferred diameters and the tolerance on diameter shall be ± 3 %.

7.3 Condition

The surface of brazing filler metals shall be free from contamination which could adversely affect brazing. With flux-coated rods, the coating shall firmly adhere to the rod and shall not break off during proper handling and usage. Welds, when present, shall have been made so as not to interfere with uniform, uninterrupted feeding of filler metal on automatic and semiautomatic brazing.

7.4 Marking

Since in many cases the marking of brazing filler metals themselves is impracticable, reliance shall be placed on the marking of packets. The outside of each smallest unit package shall be clearly marked with the following information:

a) the designation in accordance with Clause 6;

b) the name of the manufacturer/supplier;

c) the trade name (if any);

d) the quantity of material and, if applicable, the dimensions;

e) the supplier's batch number;

f) health and safety warnings (as required by national regulations).

7.5 Packaging

Brazing filler metals or products containing them shall be packed to provide sufficient safeguard against damage and deterioration during transportation and storage.

7.6 Product certificates

If certificates (like those specified in ISO 14344) of conformity and/or analysis are required, the purchaser and the manufacturer/supplier shall agree on the details at the time of placing the order.

8 Metal hazards

Although not directly relevant to the requirements of this International Standard, any national requirements for limiting exposure to metal hazards, e.g. fume, should be observed. This is particularly important when using brazing filler metals containing cadmium as an alloying element.

Table 5 — Class Al: aluminium and magnesium brazing filler metals

Code	Composition, % by mass												Melting temperature (approximate)	
	Si	Fe	Cu	Mn	Mg	Zn	Cd	Pb	Others	Non-defined elements		Al		
										Each	Total		Solidus	Liquidus
	min./max.	max.	min./max.	max.	min./max.	max.	max.	max.	min./max.	max.	max.		°C	°C
Al-Si alloys														
Al 105	4,5/6,0	0,6	—/0,30	0,15	—/0,20	0,10	0,010	0,025	Ti: —/0,15	0,05	0,15	Remainder	575	630
Al 107	6,8/8,2	0,8	—/0,25	0,10	—/—	0,20	0,010	0,025	—/—	0,05	0,15	Remainder	575	615
Al 110	9,0/11,0	0,8	—/0,30	0,05	—/0,05	0,10	0,010	0,025	Ti: —/0,20	0,05	0,15	Remainder	575	590
Al 112	11,0/13,0	0,8	—/0,30	0,15	—/0,10	0,20	0,010	0,025	—/—	0,05	0,15	Remainder	575	585
Al-Si-Cu alloys														
Al 210	9,3/10,7	0,8	3,3/4,7	0,15	—/0,15	0,20	0,010	0,025	Cr: —/0,15	0,05	0,15	Remainder	520	585
Al-Si-Mg alloys														
Al 310	9,0/10,5	0,8	—/0,25	0,10	1,0/2,0	0,20	0,010	0,025	—/—	0,05	0,15	Remainder	555	590
Al 311	9,0/10,5	0,8	—/0,25	0,10	1,0/2,0	0,20	0,010	0,025	Bi: 0,02/0,20	0,05	0,15	Remainder	555	590
Al 315	9,5/11,0	0,8	—/0,25	0,10	0,20/1,0	0,20	0,010	0,025	—/—	0,05	0,15	Remainder	559	591
Al 317	11,0/13,0	0,8	—/0,25	0,10	0,10/0,50	0,20	0,010	0,025	—/—	0,05	0,15	Remainder	562	582
Al 319	10,5/13,0	0,8	—/0,25	0,10	1,0/2,0	0,20	0,010	0,025	—/—	0,05	0,15	Remainder	559	579
Al-Si-Zn alloys														
Al 410	9,0/11,0	0,8	—/0,3	0,05	—/0,05	0,50/3,0	0,010	0,025	—/—	0,05	0,15	Remainder	576	588
Al 415	10,5/13,0	0,8	—/0,25	0,10	—/—	0,50/3,0	0,010	0,025	—/—	0,05	0,15	Remainder	576	609
Mg alloys														
Mg 001	0,05	0,005	0,05	0,15/1,5	Remainder	1,7/2,3	0,010	0,025	Be: 0,0002/0,0008 Ni: —/0,005	0,05	0,30	8,3/9,7	443	599

Table 6 — Class Ag: silver brazing filler metals

Code	Composition, % by mass								Melting temperature (approximate)	
	Ag min./max.	Cu min./max.	Zn min./max.	Cd min./max.	Sn min./max.	Si min./max.	Ni min./max.	Mn min./max.	Solidus °C	Liquidus °C
Ag-Cu-Zn-Sn alloys										
Ag 125	24,0/26,0	39,0/41,0	31,0/35,0	—/0,010	1,5/2,5	—/0,05	—/—	—/—	680	760
Ag 130	29,0/31,0	35,0/37,0	30,0/34,0	—/0,010	1,5/2,5	—/0,05	—/—	—/—	665	755
Ag 134	33,0/35,0	35,0/37,0	25,5/29,5	—/0,010	2,0/3,0	—/0,05	—/—	—/—	630	730
Ag 138	37,0/39,0	31,0/33,0	26,0/30,0	—/0,010	1,5/2,5	—/0,05	—/—	—/—	650	720
Ag 140	39,0/41,0	29,0/31,0	26,0/30,0	—/0,010	1,5/2,5	—/0,05	—/—	—/—	650	710
Ag 145	44,0/46,0	26,0/28,0	23,5/27,5	—/0,010	2,0/3,0	—/0,05	—/—	—/—	640	680
Ag 155	54,0/56,0	20,0/22,0	20,0/24,0	—/0,010	1,5/2,5	—/0,05	—/—	—/—	630	660
Ag 156	55,0/57,0	21,0/23,0	15,0/19,0	—/0,010	4,5/5,5	—/0,05	—/—	—/—	620	655
Ag 160	59,0/61,0	29,0/31,0	—/—	—/0,010	9,5/10,5	—/0,05	—/—	—/—	600	730
Ag-Cu-Zn alloys										
Ag 205	4,0/6,0	54,0/56,0	38,0/42,0	—/0,010	—/—	0,05/0,25	—/—	—/—	820	870
Ag 212	11,0/13,0	47,0/49,0	38,0/42,0	—/0,010	—/—	0,05/0,25	—/—	—/—	800	830
Ag 225	24,0/26,0	39,0/41,0	33,0/37,0	—/0,010	—/—	—/0,05	—/—	—/—	700	790
Ag 230	29,0/31,0	37,0/39,0	30,0/34,0	—/0,010	—/—	—/0,05	—/—	—/—	680	765
Ag 235	34,0/36,0	31,0/33,0	31,0/35,0	—/0,010	—/—	—/0,05	—/—	—/—	685	755
Ag 244	43,0/45,0	29,0/31,0	24,0/28,0	—/0,010	—/—	—/0,05	—/—	—/—	675	735
Ag 245	44,0/46,0	29,0/31,0	23,0/27,0	—/0,010	—/—	—/0,05	—/—	—/—	665	745
Ag 250	49,0/51,0	33,0/35,0	14,0/18,0	—/0,010	—/—	—/0,05	—/—	—/—	690	775
Ag 265	64,0/66,0	19,0/21,0	13,0/17,0	—/0,010	—/—	—/0,05	—/—	—/—	670	720
Ag 270	69,0/71,0	19,0/21,0	8,0/12,0	—/0,010	—/—	—/0,05	—/—	—/—	690	740
Ag 272[a]	71,0/73,0	27,0/29,0	—/—	—/0,010	—/—	—/0,05	—/—	—/—	780	780
Ag-Cu-Zn-Cd alloys										
Ag 326	24,0/26,0	29,0/31,0	25,5/29,5	16,5/18,5	—/—	—/0,05	—/—	—/—	605	720
Ag 330	29,0/31,0	27,0/29,0	19,0/23,0	19,0/23,0	—/—	—/0,05	—/—	—/—	600	690
Ag 335	34,0/36,0	25,0/27,0	19,0/23,0	17,0/19,0	—/—	—/0,05	—/—	—/—	605	700
Ag 340	39,0/41,0	18,0/20,0	19,0/23,0	18,0/22,0	—/—	—/0,05	—/—	—/—	595	630
Ag 345	44,0/46,0	14,0/16,0	14,0/18,0	23,0/25,0	—/—	—/0,05	—/—	—/—	605	620
Ag 350	49,0/51,0	14,5/16,5	14,5/18,5	17,0/19,0	—/—	—/0,05	—/—	—/—	625	635
Ag 351	49,0/51,0	14,5/16,5	13,5/17,5	15,0/17,0	—/—	—/0,05	2,5/3,5	—/—	635	655

Table 6 (*continued*)

Code	Composition, % by mass								Melting temperature (approximate)	
	Ag min./max.	Cu min./max.	Zn min./max.	Cd min./max.	Sn min./max.	Si min./max.	Ni min./max.	Mn min./max.	Solidus °C	Liquidus °C
Ag-Cu-Zn-Ni-Mn alloys										
Ag 425	24,0/26,0	37,0/39,0	31,0/35,0	—/0,010	—/—	—/0,05	1,5/2,5	1,5/2,5	705	800
Ag 427	26,0/28,0	37,0/39,0	18,0/22,0	—/0,010	—/—	—/0,05	5,0/6,0	8,5/10,5	680	830
Ag 440	39,0/41,0	29,0/31,0	26,0/30,0	—/0,010	—/—	—/0,05	1,5/2,5	—/—	670	780
Ag 449	48,0/50,0	15,0/17,0	21,0/25,0	—/0,010	—/—	—/0,05	4,0/5,0	7,0/8,0	680	705
Ag 450	49,0/51,0	19,0/21,0	26,0/30,0	—/0,010	—/—	—/0,05	1,5/2,5	—/—	660	705
Ag 454	53,0/55,0	37,5/42,5	4,0/6,0	—/0,010	—/—	—/0,05	0,5/1,5	—/—	720	855
Ag 456	55,0/57,0	41,0/43,0	—/—	—/0,010	—/—	—/0,05	1,5/2,5	—/—	770	895
Ag 463	62,0/64,0	27,5/29,5	—/—	—/0,010	5,0/7,0	—/0,05	2,0/3,0	—/—	690	800
Ag 485	84,0/86,0	—/—	—/—	—/0,010	—/—	—/0,05	—/—	14,0/16,0	960	970

NOTE Maximum impurity limits applicable to all types are (% by mass) Al 0,001, Bi 0,030, P 0,008, Pb 0,025; total of all impurities = 0,15; total of all impurities for Ag 427, Ag 449 and Ag 485 = 0,30.

[a] For special vacuum applications, see Table 1.

Table 7 — Class CuP: copper-phosphorus brazing filler metals

Code	Composition, % by mass				Melting temperature (approximate)		Indicative minimum brazing temperature[a]
	Cu	P	Ag	Other	Solidus	Liquidus	
		min./max.	min./max.	min./max.	°C	°C	°C
CuP alloys							
CuP 178	Remainder	4,8/5,3	—/—	—/—	710	925	790
CuP 179	Remainder	5,9/6,5	—/—	—/—	710	890	760
CuP 180	Remainder	6,6/7,4	—/—	—/—	710	820	730
CuP 181	Remainder	7,0/7,5	—/—	—/—	710	793	730
CuP 182	Remainder	7,5/8,1	—/—	—/—	710	770	720
Ag-CuP alloys							
CuP 279	Remainder	5,9/6,7	1,5/2,5	—/—	645	825	740
CuP 280	Remainder	6,8/7,2	1,8/2,2	—/—	643	788	740
CuP 281	Remainder	5,8/6,2	4,8/5,2	—/—	645	815	710
CuP 282	Remainder	6,5/7,0	4,8/5,2	—/—	643	771	710
CuP 283	Remainder	7,0/7,5	5,8/6,2	—/—	643	813	720
CuP 283a	Remainder	7,0/7,5	5,8/6,2	Ni 0,05/0,15	643	813	720
CuP 284	Remainder	4,8/5,2	14,5/15,5	—/—	645	800	700
CuP 285	Remainder	6,0/6,7	17,2/18,0	—/—	643	666	670
CuP 286	Remainder	6,6/7,5	17,0/19,0	—/—	645	645	650
CuSn-Si-Sb alloys							
CuP 385	Remainder	6,0/7,0	—/—	Sn 6,0/7,0 Si 0,01/0,4	635	675	645
CuP 386	Remainder	6,4/7,2	—/—	Sn 6,5/7,5	650	700	700
CuP 389	Remainder	5,6/6,4	—/—	Sb 1,8/2,2	690	825	740

NOTE 1 Maximum impurity limits applicable to all types are (% by mass) Al 0,01, Bi 0,030, Cd 0,010, Pb 0,025, Zn 0,05, Zn + Cd 0,05; total of all impurities = 0,25.

NOTE 2 These filler metals should never be used on ferrous metals, nickel alloys or copper alloys containing nickel.

[a] Unlike the majority of filler metals in this International Standard, which only flow satisfactorily at, around or above the liquidus, most copper phosphorus filler metals are sufficiently fluid for brazing at a temperature significantly below the liquidus.

Table 8 — Class Cu: copper brazing filler metals — High Cu alloys

Code	Composition, % by mass									Melting temperature (approximate)	
	Cu (including Ag)	Sn	Ag	Ni	P	Bi	Al	Cu_2O	Total impurity limits (see note)	Solidus	Liquidus
	min.	min./max.	min./max.	min./max.	min./max.	min./max.	max.	max.	max.	°C	°C
Copper-cuprous oxide											
Cu 087	86,50	—/—	—/—	—/—	—/—	—/—	—	Remainder	0,50	1 085	1 085
Cu 099	99,00	—/—	—/—	—/—	—/—	—/—	—	Remainder	0,30 (excluding O)	1 085	1 085
Copper (99,9 min.)											
Cu 102	99,95	—/—	—/—	—/—	—/—	—/—	—	—	0,03 (excluding Ag)	1 085	1 085
Cu 110	99,90	—/—	—/—	—/—	—/—	—/—	—	—	0,04 (excluding O and Ag)	1 085	1 085
Cu 141	99,90	—/—	—/—	—/—	—/0,075	—/—	0,01	—	0,060 (excluding Ag, As and Ni)	1 085	1 085
Cu-Ag alloy											
Cu 188	Remainder	—/—	0,8/1,2	—/—	—/—	—/0,1	—	—	0,3 (including Bi 0,1 max.)	1 070	1 080
Cu-Ni alloy											
Cu 186	Remainder	—/—	—/—	2,5/3,5	—/—	0,02/0,05	—	—	0,15 (excluding Ag)	1 085	1 100
Cu-Sn alloys											
Cu 922	Remainder	5,5/7,0	—/—	—/—	0,01/0,40	—/—	—	—	Al 0,005	910	1 040
Cu 925	Remainder	11,0/13,0	—/—	—/—	0,01/0,40	—/—	—	—	Zn 0,05, others 0,1; total 0,4	825	990

NOTE Maximum impurity limit applicable to all types are (% by mass) Cd 0,010 and Pb 0,025.

Table 9 — Class Cu: copper brazing filler metals — Cu-Zn alloys

Code	Composition, % by mass							Melting temperature (approximate)	
	Cu min./max.	Zn	Sn min./max.	Si min./max.	Mn min./max.	Ni min./max.	Fe min./max.	Solidus °C	Liquidus °C
Cu 470	57,0/61,0	Remainder	0,2/0,5	—/—	—/—	—/—	—/—	875	895
Cu 470a	58,5/61,5	Remainder	—/—	0,2/0,4	—/—	—/—	—/—	875	895
Cu 471	56,0/60,0	Remainder	0,2/0,5	0,15/0,2	0,05/0,25	—/—	—/—	870	900
Cu 670	58,5/61,5	Remainder	—/0,2	0,15/0,4	0,05/0,25	—/—	—/—	870	900
Cu 680	56,0/60,0	Remainder	0,8/1,1	0,1/0,2	0,2/0,5	0,2/0,8	—/—	870	890
Cu 681	56,0/60,0	Remainder	0,8/1,1	0,04/0,2	0,01/0,50	0,2/0,8	0,2/1,2	870	890
Cu 773	46,0/50,0	Remainder	—/—	0,15/0,2	—/—	9,0/11,0	—/—	890	920

NOTE Maximum impurity limits applicable to all types are (% by mass) Al 0,01, As 0,01, Bi 0,01, Cd 0,010, Fe 0,25, Pb 0,025, Sb 0,01; total impurities (excluding Fe) 0,2.

Table 10 — Class Cu: copper brazing filler metals — Cu special alloys

Code	**Composition**, % by mass										**Melting temperature** (approximate)	
ISO	Cu	Al	Fe	Mn	Ni	P	Si	Sn	Zn	Total impurities	Solidus °C	Liquidus °C
Cu-Si-Mn alloys												
Cu 511	Remainder	max. 0,01	max. 0,03	0,1/0,4	max. 0,1	max. 0,015	0,1/0,4	0,5/1,0	—	max. 0,1	1 020	1 050
Cu 521	Remainder	max. 0,01	max. 0,1	0,5/1,5	—	max. 0,02	1,5/2,0	0,1/0,3	max. 0,2	max. 0,5	1 030	1 050
Cu 541	Remainder	max. 0,05	max. 0,2	0,7/1,3	—	max. 0,05	2,7/3,2	—	max. 0,4	max. 0,5	980	1 035
Cu-Al alloys												
Cu 551	Remainder	4,5/5,5	max. 0,5	0,1/1,0	1,0/2,5	—	max. 0,1	—	max. 0,2	max. 0,5	1 040	1 075
Cu 561	Remainder	7,0/9,0	max. 0,5	max. 0,5	max. 0,5	—	max. 0,2	max.0,1	max. 0,2	max. 0,2	1 030	1 040
Cu 565	Remainder	8,5/11,5	0,5/1,5	—	—	—	max. 0,1	—	max. 0,02	max. 0,5	1 030	1 040
Cu-Mn-Ni alloys												
Cu 571	Remainder	7,0/8,5	2,0/4,0	11,0/14,0	1,5/3,0	—	max. 0,1	—	max. 0,15	max. 0,5	945	985
Cu 595	Remainder	max. 0,5	max. 0,5	11,0/14,0	1,5/5,0	—	max. 0,1	max. 1,0	max. 1,0	max. 0,5	965	1 000
NOTE Maximum impurity limits applicable to all types are (% by mass) Cd 0,010 and Pb 0,025.												

Table 11 — Classes Ni: nickel (and cobalt brazing) filler metals

Code	Composition, % by mass													Melting temperature (approximate)	
	Ni min./max.	Co max.	Cr min./max.	Si min./max.	B min./max.	Fe min./max.	C min./max.	P min./max.	W min./max.	Cu min./max.	Mn min./max.	Mo min./max.	Nb min./max.	Solidus °C	Liquidus °C
Ni-Cr-B alloys															
Ni 600	Rem.	0,10	13,0/15,0	4,0/5,0	2,75/3,50	4,0/5,0	0,60/0,90	—/0,02	—/—	—/—	—/—	—/—	—/—	980	1 060
Ni 610	Rem.	0,10	13,0/15,0	4,0/5,0	2,75/3,50	4,0/5,0	—/0,06	—/0,02	—/—	—/—	—/—	—/—	—/—	980	1 070
Ni 612	Rem.	0,10	13,5/16,5	—/—	3,25/4,0	—/1,5	—/0,06	—/0,02	—/—	—/—	—/—	—/—	—/—	1 055	1 055
Ni 620	Rem.	0,10	6,0/8,0	4,0/5,0	2,75/3,50	2,5/3,5	—/0,06	—/0,02	—/—	—/—	—/—	—/—	—/—	970	1 000
Ni-Si-B alloys															
Ni 630	Rem.	0,10	—/—	4,0/5,0	2,75/3,50	—/0,5	—/0,06	—/0,02	—/—	—/—	—/—	—/—	—/—	980	1 040
Ni 631	Rem.	0,10	—/—	3,0/4,0	1,50/2,20	—/1,5	—/0,06	—/0,02	—/—	—/—	—/—	—/—	—/—	980	1 070
Ni-Cr-Si alloys															
Ni 650	Rem.	0,10	18,5/19,5	9,75/10,50	—/0,03	—/—	—/0,06	—/0,02	—/—	—/—	—/—	—/—	—/—	1 080	1 135
Ni 655	Rem.	0,10	21,0/23,0	6,0/7,0	—/0,01	—/—	—/0,16	3,5/4,5	—/—	—/—	—/—	—/—	—/—	960	1 079
Ni 660	Rem.	0,10	18,5/19,5	7,0/7,5	1,0/1,5	—/0,5	—/0,10	—/0,02	—/—	—/—	—/—	—/—	—/—	1 065	1 150
Ni 661	Rem.	1,0	14,5/15,5	7,0/7,5	1,1/1,6	—/1,0	—/0,06	—/0,02	—/—	—/—	—/—	—/—	—/—	1 030	1 125
Ni-W-Cr alloys															
Ni 670	Rem.	0,10	10,0/13,0	3,0/4,0	2,0/3,0	2,5/4,5	0,40/0,55	—/0,02	15,0/17,0	—/—	—/—	—/—	—/—	970	1 105
Ni 671	Rem.	0,10	9,0/11,75	3,35/4,25	2,2/3,1	2,5/4,0	0,30/0,50	—/0,02	11,5/12,75	—/—	—/—	—/—	—/—	970	1 095
Ni-P alloys															
Ni 700	Rem.	0,10	—/—	—/—	—/—	—/—	—/0,06	10,0/12,0	—/—	—/—	—/—	—/—	—/—	875	875
Ni 710	Rem.	0,10	13,0/15,0	—/0,10	—/0,02	—/0,2	—/0,06	9,7/10,5	—/—	—/—	—/0,04	—/—	—/—	890	890
Ni 720	Rem.	0,10	24,0/26,0	—/0,10	—/0,02	—/0,2	—/0,06	9,0/11,0	—/—	—/—	—/—	—/—	—/—	880	950
Ni-Mn-Si-Cu alloys															
Ni 800	Rem.	0,10	—/—	6,0/8,0	—/—	—/—	—/0,06	—/0,02	—/—	4,0/5,0	21,5/24,5	—/—	—/—	980	1 010
Ni-Cr-B-Si-Cu-Mo-Nb alloys															
Ni 810	Rem.	0,10	7,0/9,0	3,8/4,8	2,75/3,50	—/0,4	—/0,06	—/0,02	—/—	2,0/3,0	—/—	1,5/2,5	1,5/2,5	970	1 080
Co-Ni-Si-W alloys															
Co 900	16,0/18,0	Rem.	18,0/20,0	7,5/8,5	0,70/0,90	—/1,0	0,35/0,45	—/0,02	3,5/4,5	—/—	—/—	—/—	—/—	1 120	1 150
Maximum impurity limits applicable to all types are (% by mass) Al 0,05, Cd 0,010, Pb 0,025, S 0,02, Se 0,005, Ti 0,05, Zr 0,05; if elements other than those given in this table or this note are found to be present, the amount of these elements shall be determined; the total of such other elements shall not exceed 0,50 %.															

Table 12 — Class Pd: palladium bearing brazing filler metals

Code	Composition, % by mass						Melting temperature (approximate)	
	Ag min./max.	Cu min./max.	Pd min./max.	Mn min./max.	Ni min./max.	Co min./max.	Solidus °C	Liquidus °C
Pd 287[a]	67,0/69,0	26,0/27,0	4,5/5,5	—/—	—/—	—/—	805	810
Pd 288[a]	94,5/95,5	—/—	4,5/5,5	—/—	—/—	—/—	970	1 010
Pd 387[a]	57,0/59,0	31,0/32,0	9,5/10,5	—/—	—/—	—/—	825	850
Pd 388[a]	67,0/68,0	22,0/23,0	9,5/10,5	—/—	—/—	—/—	830	860
Pd 481[a]	64,5/65,5	19,5/20,5	14,5/15,5	—/—	—/—	—/—	850	900
Pd 483[a]	—/—	81,5/82,5	17,5/18,5	—/—	—/—	—/—	1 080	1 090
Pd 484[a]	51,5/52,5	27,5/28,5	19,5/20,5	—/—	—/—	—/—	875	900
Pd 485[a]	74,5/75,5	—/—	19,5/20,5	4,5/5,5	—/—	—/—	1 000	1 120
Pd 496[a]	—/—	—/—	20,5/21,5	30,5/31,5	47,0/49,0	—/—	1 120	1 120
Pd 587[a]	53,0/55,0	20,5/21,5	24,5/25,5	—/—	—/—	—/—	900	950
Pd 597[a]	73,0/75,0	—/—	32,/—33,5	2,5/3,5	—/—	—/—	1 180	1 200
Pd 647[a]	—/—	—/—	59,5/60,5	—/—	39,5/40,5	—/—	1 235	1 235
Pd 657[a]	—/—	—/—	64,0/66,0	—/—	—/0,06	34,0/36,0	1 235	1 252

NOTE 1 For Pd 287, Pd 288, Pd 387, Pd 388, Pd 481, Pd 483, Pd 484, Pd 587 and Pd 657, maximum impurity limits applicable are (% by mass) Al 0,0010, P 0,008, Ti 0,002, Zr 0,002; total of all impurities = 0,15.

NOTE 2 For Pd 485 and Pd 597, maximum impurity limits are (% by mass) Al 0,010, Ti 0,01, Zr 0,01; total of all impurities = 0,30.

[a] For special vacuum applications, see Table 1.

Table 13 — Class Au: gold bearing brazing filler metals

Code	Composition, % by mass						Melting temperature (approximate)	
	Au min./max.	Cu min./max.	Ni min./max.	Pd min./max.	Ag min./max.	Others min./max.	Solidus °C	Liquidus °C
Au 295 [a]	29,5/30,5	69,5/70,5	—/—	—/—	—/—	—/—	995	1 020
Au 300	29,5/30,5	—/—	35,5/36,5	33,5/34,5	—/—	—/—	1 135	1 165
Au 351	34,5/35,5	61,0/63,0	2,5/3,5	—/—	—/—	—/—	975	1 030
Au 354	34,5/35,5	64,5/65,5	—/—	—/—	—/—	—/—	990	1 010
Au 375 [a]	37,0/38,0	62,0/63,0	—/—	—/—	—/—	—/—	980	1 000
Au 503	49,5/50,5	49,5/50,5	—/—	—/—	—/—	—/—	955	970
Au 507	49,5/50,5	—/—	24,5/25,5	24,0/26,0	—/—	Co —/0,06	1 100	1 120
Au 625 [a]	62,0/63,0	37,0/38,0	—/—	—/—	—/—	—/—	930	940
Au 700	69,5/70,5	—/—	21,5/22,5	7,5/8,5	—/—	—/—	1 005	1 045
Au 752 [a]	74,5/75,5	—/—	24,5/25,5	—/—	—/—	—/—	950	990
Au 755	74,5/75,5	11,5/13,5	—/—	—/—	12,0/13,0	—/—	880	895
Au 800	79,5/80,5	19,5/20,5	—/—	—/—	—/—	—/—	890	890
Au 801 [a]	79,5/80,5	18,5/19,5	—/—	—/—	—/—	Fe 0,5/1,5	905	910
Au 827 [a]	81,5/82,5	—/—	17,5/18,5	—/—	—/—	—/—	950	950
Au 927	91,0/93,0	—/—	—/—	7,0/9,0	—/—	—/—	1 200	1 240

NOTE Maximum impurity limits applicable to all types are (% by mass) Al 0,0010, Cd 0,010, P 0,008, Pb 0,025, Ti 0,002, Zr 0,002; total of all impurities = 0,15.

[a] For special vacuum applications, see Table 1.

Annex A
(normative)

Codification

Two systems for the codification of filler metals are used in this International Standard. For the purposes of identifying a filler metal complying with this International Standard, e.g. in other International Standards, in orders, in brazing procedures or on drawings, any of these systems can be used.

The first system divides the filler metals into seven classes. The class to which a filler metal is assigned is based in most cases on the major element present but in some instances, it has been decided by the similarity of the filler metal to others in the same class.

The seven classes are as follows:

a) Al: filler metals containing aluminium as the major element;

b) Ag: filler metals containing silver as a significant addition, even if not the major element;

c) CuP: filler metals containing copper as the major element with an addition of phosphorus;

d) Cu: filler metals containing copper as the major element, not elsewhere classified;

e) Ni: filler metals containing nickel as the major element; one is based on cobalt;

f) Pd: filler metals containing palladium, in any amount;

g) Au: filler metals containing gold, in any amount.

The code for each filler metal consists of the two letters for the class followed by three digits.

The second system is that given in ISO 3677. However, this system can assign the same code to filler metals which differ only slightly in chemical composition but significantly in behaviour.

The relationship between these two systems and the former systems is given in Table A.1.

Table A.1 — Codification systems

ISO	UNS number	ISO 3677	AWS	EN 1044	JIS
Aluminium brazing filler metals					
Al 105	A94109	B-Al95Si-575/630		AL 101	
Al 107	A94343	B-Al92Si-575/615	BAlSi-2	AL 102	BA4343
Al 110	A94045	B-Al90Si-575/590	BAlSi-5	AL 103	BA4045
Al 112	A94047	B-Al88Si-575/585	BAlSi-4	AL 104	BA4047
Al 210	A94145	B-Al86SiCu-520/585	BAlSi-3	AL 201	BA4145
Al 310	A94004	B-Al89SiMg-555/590	BAlSi-7	AL 301	BA4004
Al 311	A94104	B-Al89SiMg(Bi)-555/590	BAlSi-11	AL 302	BA4104
Al 315		B-Al90Si-559/591			BA4005
Al 317	A94147	B-Al88SiMg-562/582	BAlSi-9		
Al 319		B-Al89SiMg-559/579			BA4N04
Al 410		B-Al87SiZn-576/588			BA4N45
Al 415		B-Al85SiZn-576/609			BA4N43
Mg 001		B-Mg88AlZnMn-443/599	BMg-1		
Silver brazing filler metals					
Ag 125	P07125	B-Cu40ZnAgSn-680/760	BAg-37	AG 108	
Ag 130	P07130	B-Cu36ZnAgSn-665/755		AG 107	
Ag 134	P07130	B-Cu36AgZnSn-630/730		AG 106	BAg-7B
Ag 138	P07380	B-Ag38CuZnSn-650/720	BAg-34		BAg-34
Ag 140	P07401	B-Ag40CuZnSn-650/710	BAg-28	AG 105	BAg-28
Ag 145	P07145	B-Ag45CuZnSn-640/680	BAg-36	AG 104	BAg-7A
Ag 155	P07155	B-Ag55ZnCuSn-630/660		AG 103	
Ag 156	P07563	B-Ag56CuZnSn-620/655	BAg-7	AG 102	BAg-7
Ag 160	P07600	B-Ag60CuSn-600/730	BAg-18	AG 402	BAg-18
Ag 205	P07205	B-Cu55ZnAg(Si)-820/870		AG 208	
Ag 212	P07212	B-Cu48ZnAg(Si)-800/830		AG 207	
Ag 225	P07254	B-Cu40ZnAg-700/790		AG 205	BAg-20A
Ag 230	P07301	B-Cu38ZnAg-680/765	BAg-20	AG 204	BAg-20
Ag 235	P07351	B-Ag35CuZn-685/775	BAg-35		BAg-35
Ag 244	P07453	B-Ag44CuZn-675/735		AG 203	
Ag 245	P07453	BAg-45CuZn-665/745	BAg-5		BAg-5
Ag 250	P07503	B-Ag50CuZn-690/775	BAg-6		BAg-6
Ag 265	P07650	B-Ag65CuZn-670/720	BAg-9		BAg-9
Ag 270	P07700	B-Ag70CuZn-690/740	BAg-10		BAg-10
Ag 272	P07720	B-Ag72Cu-780	BAg-8	AG 401	BAg-8

Table A.1 (*continued*)

ISO	UNS number	ISO 3677	AWS	EN 1044	JIS
Silver brazing filler metals					
Ag 326	P07252	B-Cu30ZnAgCd-605/765	BAg-33	AG 307	
Ag 330	P07300	B-Ag30CuCdZn-600/690		AG 306	
Ag 335	P07350	B-Ag35CuZnCd-610/700	BAg-2	AG 305	BAg-2
Ag 340	P07340	B-Ag40ZnCdCu-595/630		AG 304	
Ag 345	P07450	B-Ag45CdZnCu-605/620	BAg-1	AG 302	BAg-1
Ag 350	P07500	B-Ag50CdZnCu-620/640	BAg-1a	AG 301	BAg-1A
Ag 351	P07501	B-Ag50CdZnCuNi-635/655	BAg-3	AG 351	
Ag 425	P07250	B-Cu38ZnAgNiMn-705/800	BAg-26		BAg-26
Ag 427	P07427	B-Cu38AgZnMnNi-680/830		AG 503	
Ag 440	P07440	B-Ag40CuZnNi-670/780	BAg-4		BAg-4
Ag 449	P07490	B-Ag49ZnCuMnNi-680/705	BAg-22	AG 502	BAg-22
Ag 450	P07505	B-Ag50CuZnNi-660/705	BAg-24		BAg-24
Ag 454	P07540	B-Ag54CuZnNi-720/855	BAg-13		BAg-13
Ag 456	P07560	B-Ag56CuNi-770/895	BAg-13a		BAg-13A
Ag 463	P07630	B-Ag63CuSn-690/800	BAg-21		BAg-21
Ag 485	P07850	B-Ag85Mn-960/970	BAg-23	AG 501	BAg-23
Copper-phosphorus brazing filler metals					
CuP 178	C55178	B-Cu95P-710/925			BCuP-1
CuP 179	C55179	B-Cu94P-710/890		CP 203	
CuP 180	C55182	B-Cu93P-710/820		CP 202	BCuP-2
CuP 181	C55181	B-Cu93P-710/793	BCuP-2		
CuP 182	C55181	B-Cu92P-710/770		CP 201	
CuP 279	C55279	B-Cu92PAg-645/825		CP 105	
CuP 280	C55280	B-Cu91PAg-643/788	BCuP-6		BCuP-6
CuP 281	C55281	B-Cu89PAg-645/815	BCuP-3	CP 104	
CuP 282	C55282	B-Cu88PAg-643/771	BCuP-7		BCuP-7
CuP 283	C55283	B-Cu87PAg-643/813	BCuP-4		BCuP-4
CuP 283a				CP 103	
CuP 284	C55284	B-Cu80AgP-645/800	BCuP-5	CP 102	BCuP-5
CuP 285	C55385	B-Cu76AgP-643/666	BCuP-8		
CuP 286	C55385	B-Cu75AgP-645		CP 101	BCuP-8
CuP 385	C55385	B-Cu87PSnSi-635/675	BCuP-9		BCuP-9
CuP 386	C55385	B-Cu86SnP-650/700		CP 302	
CuP 389	C55389	B-Cu92PSb-690/825		CP 301	

Table A.1 (*continued*)

ISO	UNS number	ISO 3677	AWS	EN 1044	JIS
Copper brazing filler metals					
Cu 087		B-Cu87-1085	BCu-2		BCu-2
Cu 099		B-Cu99-1085	BCu-1a	CU 103	BCu-1A
Cu 102	C10200	B-Cu100-1085	BCu-3	CU 102	
Cu 110	C14180	B-Cu100-1085	BCu-1b	CU 101	BCu-1
Cu 141	C11000	B-Cu100(P)-1085	BCu-1	CU 104	
Cu 186	C18601	B-Cu97Ni(B)-1085/1100		CU 105	
Cu 188	C18803	B-Cu99(Ag)-1070/1080		CU 106	
Cu 922	C92201	B-Cu94Sn(P)-910/1040		CU 201	
Cu 925	C92501	B-Cu88Sn(P)-825/990		CU 202	
Cu 470	C47000	B-Cu60Zn(Sn)(Si)-875/895	RBCuZn-A	CU 302	BCu-6
Cu 470a		B-Cu60Zn(Si)-875/895		CU 301	BCu-5
Cu 471	C47100	B-Cu60Zn(Sn)(Si)(Mn)-870/900	RBCuZn-C	CU 304	
Cu 680	C68000	B-Cu60Zn(Si)(Mn)-870/900		CU 303	
Cu 681	C68100	B-Cu59Zn(Sn)(Ni)(Mn)(Si)-870/890	RBCuZn-B	CU 306	
Cu 773	C77300	B-Cu48ZnNi(Si)-890/920	RBCuZn-D	CU 305	BCu-8
Cu 511		B-Cu98SnMnSi-1020/1050			
Cu 521		B-Cu97SiMn-1030/1050			
Cu 541		B-Cu96SiMn-980/1035			
Cu 551		B-Cu92AlNiMn-1040/1075			
Cu 561		B-Cu92Al-1030/1040			
Cu 565		B-Cu89AlFe-1030/1040			
Cu 571		B-Cu74MnAlFeNi-945/985			
Cu 595		B-Cu84MnNi-965/1000			

Table A.1 (*continued*)

ISO	UNS number	ISO 3677	AWS	EN 1044	JIS
Nickel and cobalt brazing filler materials					
Ni 610	N99610	B-Ni74CrFeSiB-980/1070	BNi-1a	NI 1A1	BNi-1A
Ni 612	N99612	B-Ni81CrB-1055	BNi-9	NI 109	BNi-9
Ni 620	N99620	B-Ni82CrSiBFe-970/1000	BNi-2	NI 102	BNi-2
Ni 630	N99630	B-Ni92SiB-980/1040	BNi-3	NI 103	BNi-3
Ni 631	N99640	B-Ni95SiB-980/1070	BNi-4	NI 104	BNi-4
Ni 650	N99650	B-Ni71CrSi-1080/1135	BNi-5	NI 105	BNi-5
Ni 655		B-Ni68CrSiP-960/1079			
Ni 660	N99651	B-Ni73CrSiB-1065/1150	BNi-5a		BNi-5A
Ni 661	N99652	B-Ni77CrSiBFe-1030/1125	BNi-5b		BNi-5B
Ni 670	N99622	B-Ni63WCrFeSiB-970/1105	BNi-10	NI 110	BNi-10
Ni 671	N99624	B-Ni67WCrSiFeB-970/1095	BNi-11	NI 111	BNi-11
Ni 700	N99700	B-Ni89P-875	BNi-6	NI 106	BNi-6
Ni 710	N99710	B-Ni76CrP-890	BNi-7	NI 107	BNi-7
Ni 720	N99720	B-Ni65CrP-880/950	BNi-12	NI 112	BNi-12
Ni 800	N99800	B-Ni66MnSiCu-980/1010	BNi-8	NI 108	BNi-8
Ni 810	N99810	B-Ni78CrSiBCuMoNb-970/1080	BNi-13		BNi-13
Co 900	R39001	B-Co51CrNiSiW(B)-1120/1150	BCo-1	CO 101	BCo-1
Palladium bearing brazing filler metals					
Pd 287	P07287	B-Ag68CuPd-805/810	BVAg-30	PD 106	BPd-1
Pd 288	P07288	B-Ag95Pd-970/1010		PD 204	BPd-7
Pd 387	P07387	B-Ag58CuPd-825/850	BVAg-31	PD 105	BPd-2
Pd 388	P07388	B-Ag68CuPd-830/860		PD 104	BPd-3
Pd 481	P07481	B-Ag65CuPd-850/900		PD 103	BPd-4
Pd 483	P07483	B-Cu82Pd-1080/1090		PD 203	BPd-8
Pd 484	P07484	B-Ag52CuPd-875/900		PD 102	BPd-5
Pd 485	P07485	B-Ag75PdMn-1000/1120		PD 202	BPd-9
Pd 496	P07496	B-Ni48MnPd-1120			BPd-11
Pd 587	P07587	B-Ag54PdCu-900/950	BVAg-32	PD 101	BPd-6
Pd 597	P07597	B-Ag74PdMn-1180/1200			BPd-10
Pd 647	P07647	B-Pd60Ni-1235		PD 201	BPd-14
Pd 657	P07657	BPd65Co-1235/1252	BPVPd-1	PD 301	

Table A.1 (*continued*)

ISO	UNS number	ISO 3677	AWS	EN 1044	JIS
Gold bearing brazing filler metals					
Au 295	P00295	B-Cu70Au-995/1020		AU 104	BAu-1A
Au 300	P00300	B-Ni36PdAu-1135/1166	BAu-5		BAu-5
Au 351	P00350	B-Cu62AuNi-975-1030	BAu-3		BAu-3
Au 354	P00354	B-Cu65Au-990/1020	BVAu-9		
Au 375	P00375	B-Cu62Au-980/1000	BAu-1	AU 103	BAu-1
Au 503	P00503	B-Au50Cu-955/970	BVAu-10		BAu-11
Au 507	P00507	B-Au50NiPd-1102/1121	BVAu-7		
Au 625	P00625	B-Au62Cu-930/940		AU 102	
Au 700	P00700	B-Au70NiPd-1007/1046	BAu-6		BAu-6
Au 752	P00752	B-Au75Ni-950/990		AU 106	
Au 755	P00753	B-Au75AgCu-880/895			BAu-12
Au 800	P00800	B-Au80Cu-890	BAu-2		BAu-2
Au 801	P00807	B-Au80Cu(Fe)-905/910		AU 101	
Au 827	P00827	B-Au82Ni-950	BAu-4	AU 105	
Au 927	P00927	B-Au92Pd-1200/1240	BVAu-8		

Bibliography

[1] EN 1044, *Brazing — Filler metals*

[2] ISO 14344, *Welding consumables — Procurement of filler materials and fluxes*

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