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Brazing — Filler metals

Brasage fort — Métaux d'apport

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 13, *Brazing materials and processes,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 17672:2016), which has been technically revised.

The main changes are as follows:

— in Clause 6, the spatter test was added;

— in 8.2.2, a NOTE on foils with a width of less than 3 mm was added;

— in Table 6, four new silver brazing filler metals were added;

— in Table 7, the range of Si was changed to 0,01 up to 0,25 (mass fraction %) if intentionally added;

— in Table 11, two new Ni-Cr-P-Si alloys were added;

— in Table A.1, the codes were updated and corresponding GB codes were added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html. Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

Brazing — Filler metals

1 Scope

This document 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 document covers only the filler metal that forms parts 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, such as precious metal jewellery, aerospace and dental, filler metals other than those included in this document are often used. These are covered by other International Standards to which reference can be made.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 80000-1:2022, *Quantities and units — Part 1: General*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 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).

If the values for an element range from 0 (—) to a defined value, the element may be, but does not have to be, in that brazing filler metal.

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 document 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 conformity to the requirements of this document, the actual test values obtained shall be subjected to the rounding-off instructions given in ISO 80000-1:2022, 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.

5 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 conforming to 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 duties.

Table 1 — Impurity limits for special vacuum requirements

Impurity	Limit max. mass fraction %	
	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 can 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 %.

6 Chemical analysis

Chemical analyses shall be carried out by any suitable method but, in the case of many brazing alloys, the use of reference materials can 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.

To determine the oxide content of brazing filler metals for vacuum applications, a spatter test may be performed, see Reference [3].

7 Designation

The filler metal shall be designated by the description "filler metal," reference to this document (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 document, 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 reference to this document;

"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 reference to this document;

"B" denotes brazing;

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

8 Technical delivery conditions

8.1 Types of product

The form of the material shall be agreed between the purchaser and the manufacturer or 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 and wire can be completely or partially coated or cored with flux.

8.2 Dimensions

8.2.1 General

Dimensions and tolerances for foils (see 8.2.2), rods (see 8.2.3) and, to a lesser extent, wires (see 8.2.4) are defined. For other forms and dimensions not listed in the respective tables, the purchaser and the manufacturer or supplier shall agree on the dimensions and tolerances at the time of placing the order.

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

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	+0,2 0	+0,3 0	+0,4 0
0,1	1,0	+0,2 0	+0,3 0	+0,4 0
1,0	2,0	+0,3 0	+0,4 0	+0,5 0

Table 4 — Camber tolerance for foils

Thickness nominal size mm		Max. camber for width nominal size mm/m				
over	to	from 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

NOTE Foils with a width of less than 3 mm cannot be measured due to their very easy deformability, as they straighten out even under the slightest force. Therefore, the reproducibility of the values based on the existing measuring methods – and possibilities – is not given.

8.2.3 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.

8.2.4 Wires

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

8.3 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.

8.4 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 or supplier;

c) the trade name (if any);

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

e) the supplier's batch number;

f) any hazard warnings as applicable.

8.5 Packaging

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

8.6 Product certificates

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

9 Health and safety precautions

When working with filler metals, refer to the manufacturer safety data sheet (SDS) before use.

NOTE National legislation regarding transportation, storage, use and disposal of filler metals and regarding limiting exposure to metal hazards, for example fume, can exist. 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 mass fraction %										Melting temperature (approximate)	
	Si	Fe	Cu	Mn	Mg	Zn	Others	Non-defined elements		Al		
								Each	Total		Solidus	Liquidus
	min./max.	min./max.	min./max.	min./max.	min./max.	min./max.	min./max.	max.	max.	min./max.	°C	°C
Al-Si alloys												
Al 105	4,5/6,0	—/0,6	—/0,30	—/0,15	—/0,20	—/0,10	Ti: —/0,15	0,05	0,15	Remainder	575	630
Al 107	6,8/8,2	—/0,8	—/0,25	—/0,10	—/—	—/0,20	—/—	0,05	0,15	Remainder	575	615
Al 110	9,0/11,0	—/0,8	—/0,30	—/0,05	—/0,05	—/0,10	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	—/—	0,05	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	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	—/—	0,05	0,15	Remainder	555	590
Al 311	9,0/10,5	—/0,8	—/0,25	—/0,10	1,0/2,0	—/0,20	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	—/—	0,05	0,15	Remainder	559	591
Al 317	11,0/13,0	—/0,8	—/0,25	—/0,10	0,10/0,50	—/0,20	—/—	0,05	0,15	Remainder	562	582
Al 319	10,5/13,0	—/0,8	—/0,25	—/0,10	1,0/2,0	—/0,20	—/—	0,05	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	—/—	0,05	0,15	Remainder	576	588
Al 415	6,8/8,2	—/0,8	—/0,25	—/0,10	—/—	0,50/3,0	—/—	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	Be: 0,000 2/0,000 8 Ni: —/0,005	0,05	0,30	8,3/9,7	443	599
Maximum impurity limits applicable to all types are mass fractions Cd 0,010 and Pb 0,025.												

Table 6 — Class Ag: silver brazing filler metals

Code	Composition mass fraction %								Melting temperature (approximate)	
	Ag min./max.	Cu min./max.	Zn min./max.	Cd min./max.	Sn min./max.	Ni min./max.	Mn min./max.	Others 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	—/—	1,5/2,5	—/—	—/—	—/—	680	760
Ag 130	29,0/31,0	35,0/37,0	30,0/34,0	—/—	1,5/2,5	—/—	—/—	—/—	665	755
Ag 134	33,0/35,0	35,0/37,0	25,5/29,5	—/—	2,0/3,0	—/—	—/—	—/—	630	730
Ag 138	37,0/39,0	31,0/33,0	26,0/30,0	—/—	1,5/2,5	—/—	—/—	—/—	650	720
Ag 140	39,0/41,0	29,0/31,0	26,0/30,0	—/—	1,5/2,5	—/—	—/—	—/—	650	710
Ag 145	44,0/46,0	26,0/28,0	23,5/27,5	—/—	2,0/3,0	—/—	—/—	—/—	640	680
Ag 155	54,0/56,0	20,0/22,0	20,0/24,0	—/—	1,5/2,5	—/—	—/—	—/—	630	660
Ag 156	55,0/57,0	21,0/23,0	15,0/19,0	—/—	4,5/5,5	—/—	—/—	—/—	620	655
Ag 160	59,0/61,0	29,0/31,0	—/—	—/—	9,5/10,5	—/—	—/—	—/—	600	730
Ag-Cu-Zn alloys										
Ag 205	4,0/6,0	54,0/56,0	38,0/42,0	—/—	—/—	—/—	—/—	Si: 0,05/0,25	820	870
Ag 212	11,0/13,0	47,0/49,0	38,0/42,0	—/—	—/—	—/—	—/—	Si: 0,05/0,25	800	830
Ag 220	19,0/21,0	43,0/45,0	34,0/38,0	—/—	—/—	—/—	—/—	Si: 0,05/0,25	690	810
Ag 225	24,0/26,0	39,0/41,0	33,0/37,0	—/—	—/—	—/—	—/—	—/—	700	790
Ag 230	29,0/31,0	37,0/39,0	30,0/34,0	—/—	—/—	—/—	—/—	—/—	680	765
Ag 230A	29,0/31,0	35,0/37,0	29,5/34,0	—/—	—/—	2,0/2,5	—/—	Si: 0,05/0,15	675	790
Ag 235	34,0/36,0	31,0/33,0	31,0/35,0	—/—	—/—	—/—	—/—	—/—	685	755
Ag 244	43,0/45,0	29,0/31,0	24,0/28,0	—/—	—/—	—/—	—/—	—/—	675	735
Ag 245	44,0/46,0	29,0/31,0	23,0/27,0	—/—	—/—	—/—	—/—	—/—	665	745
Ag 250	49,0/51,0	33,0/35,0	14,0/18,0	—/—	—/—	—/—	—/—	—/—	690	775
Ag 250A[a]	49,0/51,0	49,0/51,0	—/—	—/—	—/—	—/—	—/—	—/—	780	870
Ag 260	59,0/61,0	25,0/27,0	—/—	—/—	—/—	—/—	—/—	In: 13,0/15,0	605	710
Ag 261[a]	60,5/62,5	23,0/25,0	—/—	—/—	—/—	—/—	—/—	In: 14,0/15,0	625	710
Ag 265	64,0/66,0	19,0/21,0	13,0/17,0	—/—	—/—	—/—	—/—	—/—	670	720
Ag 270	69,0/71,0	19,0/21,0	8,0/12,0	—/—	—/—	—/—	—/—	—/—	690	740
Ag 272[a]	71,0/73,0	27,0/29,0	—/—	—/—	—/—	—/—	—/—	—/—	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	—/—	—/—	—/—	—/—	605	720
Ag 330	29,0/31,0	27,0/29,0	19,0/23,0	19,0/23,0	—/—	—/—	—/—	—/—	600	690
Ag 335	34,0/36,0	25,0/27,0	19,0/23,0	17,0/19,0	—/—	—/—	—/—	—/—	610	700
Ag 340	39,0/41,0	18,0/20,0	19,0/23,0	18,0/22,0	—/—	—/—	—/—	—/—	595	630
Ag 345	44,0/46,0	14,0/16,0	14,0/18,0	23,0/25,0	—/—	—/—	—/—	—/—	605	620
Ag 350	49,0/51,0	14,5/16,5	14,5/18,5	17,0/19,0	—/—	—/—	—/—	—/—	620	640
Ag 351	49,0/51,0	14,5/16,5	13,5/17,5	15,0/17,0	—/—	2,5/3,5	—/—	—/—	635	655
Ag-Cu-Zn-Ni-Mn alloys										
Ag 425	24,0/26,0	37,0/39,0	31,0/35,0	—/—	—/—	1,5/2,5	1,5/2,5	—/—	705	800
Ag 427	26,0/28,0	37,0/39,0	18,0/22,0	—/—	—/—	5,0/6,0	8,5/10,5	—/—	680	830
Ag 440	39,0/41,0	29,0/31,0	26,0/30,0	—/—	—/—	1,5/2,5	—/—	—/—	670	780
Ag 449	48,0/50,0	15,0/17,0	21,0/25,0	—/—	—/—	4,0/5,0	7,0/8,0	—/—	680	705

Maximum impurity limits applicable to all types are mass fractions Al 0,001, Bi 0,030, Cd 0,010, P 0,008, Pb 0,025; Si 0,05; total of all impurities = 0,15; total of all impurities for Ag 427, Ag 449 and Ag 485 = 0,30.

If Si is intentionally added to all alloys of Table 6, the range shall be between 0,05 and 0,25 (mass fraction).

The filler metals then have to be designated additionally by description Si at the end.

For example, Filler metal ISO 17672-Ag 155Si or Filler metal ISO 17672-B-Ag55ZnCuSn(Si)-630/660.

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

Table 6 *(continued)*

Code	Composition mass fraction %								Melting temperature (approximate)	
	Ag min./max.	Cu min./max.	Zn min./max.	Cd min./max.	Sn min./max.	Ni min./max.	Mn min./max.	Others min./ max.	Solidus °C	Liquidus °C
Ag 450	49,0/51,0	19,0/21,0	26,0/30,0	—/—	—/—	1,5/2,5	—/—	—/—	660	705
Ag 454	53,0/55,0	37,5/42,5	4,0/6,0	—/—	—/—	0,5/1,5	—/—	—/—	720	855
Ag 456	55,0/57,0	41,0/43,0	—/—	—/—	—/—	1,5/2,5	—/—	—/—	770	895
Ag 456A	55,0/57,0	26,25/28,25	—/—	—/—	—/—	2,0/2,5		In: 13,5/15,5	600	710
Ag 463	62,0/64,0	27,5/29,5	—/—	—/—	5,0/7,0	2,0/3,0	—/—	—/—	690	800
Ag 471[a]	70,5/72,5	27,0/29,0	—/—	—/—	—/—	0,3/0,8	—/—	—/—	780	795
Ag 485	84,0/86,0	—/—	—/—	—/—	—/—	—/—	14,0/16,0	—/—	960	970

Maximum impurity limits applicable to all types are mass fractions Al 0,001, Bi 0,030, Cd 0,010, P 0,008, Pb 0,025; Si 0,05; total of all impurities = 0,15; total of all impurities for Ag 427, Ag 449 and Ag 485 = 0,30.

If Si is intentionally added to all alloys of Table 6, the range shall be between 0,05 and 0,25 (mass fraction).

The filler metals then have to be designated additionally by description Si at the end.

For example, Filler metal ISO 17672-Ag 155Si or Filler metal ISO 17672-B-Ag55ZnCuSn(Si)-630/660.

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

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

Code	Composition mass fraction %				Melting temperature (approximate)	
	Cu	P min./max.	Ag min./max.	Other min./max.	Solidus °C	Liquidus °C
Cu P alloys						
CuP 178	Remainder	4,8/5,3	—/—	—/—	710	925
CuP 179	Remainder	5,9/6,5	—/—	—/—	710	890
CuP 180	Remainder	6,6/7,4	—/—	—/—	710	820
CuP 181	Remainder	7,0/7,5	—/—	—/—	710	793
CuP 182	Remainder	7,5/8,1	—/—	—/—	710	770
Ag-Cu-P alloys						
CuP 279	Remainder	5,9/6,7	1,5/2,5	—/—	645	825
CuP 280	Remainder	6,8/7,2	1,8/2,2	—/—	645	788
CuP 281	Remainder	5,8/6,2	4,8/5,2	—/—	645	815
CuP 281A	Remainder	5,7/6,3	4,5/5,5	—/—	645	815
CuP 282	Remainder	6,5/7,0	4,8/5,2	—/—	645	771
CuP 283	Remainder	7,0/7,5	5,8/6,2	—/—	645	720
CuP 283A	Remainder	7,0/7,5	5,8/6,2	Ni 0,05/0,15	645	720
CuP 284	Remainder	4,8/5,2	14,5/15,5	—/—	645	800
CuP 285	Remainder	6,0/6,7	17,2/18,0	—/—	645	666

Maximum impurity limits applicable to all types are mass fractions 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.

If Si is intentionally added to the alloys of Table 7, the range shall be between 0,01 and 0,25 (mass fraction %) unless it is specified in Table 7.

The filler metals then shall be designated additionally by description Si at the end.

For example, Filler metal ISO 17672-CuP 279Si or Filler metal ISO 17672-B-Cu92PAg(Si)-645/825.

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

NOTE Unlike the majority of filler metals in this document, 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 7 *(continued)*

Code	Composition mass fraction %				Melting temperature (approximate)	
	Cu	P min./max.	Ag min./max.	Other min./max.	Solidus °C	Liquidus °C
CuP 286	Remainder	6,6/7,5	17,0/19,0	—/—	645	645
Cu-Sn-Si-Sb alloys						
CuP 385	Remainder	6,0/7,0	—/—	Sn 6,0/7,0 Si 0,01/0,4	635	675
CuP 386	Remainder	6,4/7,2	—/—	Sn 6,5/7,5	650	700
CuP 389	Remainder	5,6/6,4	—/—	Sb 1,8/2,2	690	825

Maximum impurity limits applicable to all types are mass fractions 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.

If Si is intentionally added to the alloys of Table 7, the range shall be between 0,01 and 0,25 (mass fraction %) unless it is specified in Table 7.

The filler metals then shall be designated additionally by description Si at the end.

For example, Filler metal ISO 17672-CuP 279Si or Filler metal ISO 17672-B-Cu92PAg(Si)-645/825.

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

NOTE Unlike the majority of filler metals in this document, 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 mass fraction %								Melting temperature (approximate)	
	Cu (including Ag)	Sn	Ag	Ni	P	Others	Cu_2O	Total impurity limits[a]	Solidus	Liquidus
	min.	min./max.	min./max.	min./max.	min./max.	min./max.	min./max.	max.	°C	°C
Copper-cuprous oxide										
Cu 087	86,50	—/—	—/—	—/—	—/—	—/—	Remainder	0,50	1 083	1 083
Cu 099	99,00	—/—	—/—	—/—	—/—	—/—	Remainder	0,30 (excluding O)	1 083	1 083
Copper (99,9 min.)										
Cu 102	99,95	—/—	—/—	—/—	—/—	—/—	—/—	0,03 (excluding Ag)	1 083	1 083
Cu 110	99,90	—/—	—/—	—/—	—/—	—/—	—/—	0,04 (excluding O and Ag)	1 083	1 083
Cu 141	Remainder	—/—	—/—	—/—	—/0,075	—/—	—/—	0,060 (excluding Ag, As and Ni)	1 083	1 083
Cu-Ag alloy										
Cu 188	Remainder	—/—	0,8/1,2	—/—	—/—	Bi: —/0,1	—/—	0,3 (including Bi 0,1 max.)	1 070	1 080
Cu-Ni alloys										
Cu 186	Remainder	—/—	—/—	2,5/3,5	—/—	B: 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

[a] Maximum impurity limits applicable to all types are mass fractions Al 0,02 (except Cu 922), Cd 0,010 and Pb 0,025.

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

Code	Composition mass fraction %							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 671	56,0/62,0	Remainder	0,5/1,5	0,1/0,5	0,2/1,0	0,2/1,5	—/—	870	890
Cu 680	56,0/60,0	Remainder	0,8/1,1	0,04/0,20	0,01/0,50	0,20/0,80	0,2/1,2	866	882
Cu 681	56,0/60,0	Remainder	0,8/1,1	0,04/0,15	0,01/0,50	—/—	0,2/1,2	866	888
Cu 773	46,0/50,0	Remainder	—/—	0,15/0,2	—/—	9,0/11,0	—/—	890	920
Maximum impurity limits applicable to all types are mass fractions 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 mass fraction %										Melting temperature (approximate)	
	Cu	Al	Fe	Mn	Ni	P	Si	Sn	Zn	Total impurities	Solidus	Liquidus
		min./max.	min./max.	min./max.	min./max.	min./max.	min./max.	min./max.	min./max.	max.	°C	°C
Cu-Si-Mn alloys												
Cu 511	Remainder	—/0,01	—/0,03	0,1/0,4	—/0,1	—/0,020	0,1/0,4	0,5/1,0	—	0,1	1 020	1 050
Cu 521	Remainder	—/0,01	—/0,1	0,5/1,5	—/—	—/0,02	1,5/2,0	0,1/0,3	—/0,2	0,5	1 030	1 050
Cu 541	Remainder	—/0,05	—/0,2	0,7/1,3	—/—	—/0,05	2,7/3,2	—	—/0,4	0,5	980	1 035
Cu-Al alloys												
Cu 551	Remainder	4,5/5,5	—/0,5	0,1/1,0	1,0/2,5	—/—	—/0,1	—	—/0,2	0,5	1 040	1 075
Cu 561	Remainder	7,0/9,0	—/0,5	—/0,5	—/0,5	—/—	—/0,2	—/0,1	—/0,2	0,2	1 030	1 040
Cu 565	Remainder	8,5/11,5	0,5/1,5	—/—	—/—	—/—	—/0,1	—	—/0,02	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	—/—	—/0,1	—	—/0,15	0,5	945	985
Cu 595	Remainder	—/0,01	—/—	11,0/14,0	1,5/5,0	—/—	0,10/0,25	—/—	—/—	0,5	965	1 000
Maximum impurity limits applicable to all types are mass fractions Cd 0,010 and Pb 0,025.												

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

Code	Composition mass fraction %													Melting temperature (approximate)	
	Ni	Co	Cr	Si	B	Fe	C	P	W	Cu	Mn	Mo	Nb	Solidus	Liquidus
	min./ max.	min./ max.	min./ max.	min./ max.	min./ max.	min./ max.	min./ max.	min./ max.	min./ max.	min./ max.	min./ max.	min./ max.	min./ max.	°C	°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 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-Cr-P-Si alloys															
Ni 740	Rem.	—/0,10	27,5/32,0	3,8/4,2	—/0,1	—/0,5	—/0,06	5,5/6,5	—/—	—/—	—/—	—/—	—/—	980	1 030
Ni 741	Rem.	—/0,10	21,0/23,0	6,0/7,0	—/0,1	—/0,5	—/0,16	3,5/4,5	—/—	—/—	—/—	—/—	—/—	980	1 070
Ni 742	Rem.	—/—	28,0/30,0	6,0/7,0	—/—	—/—	—/0,10	5,5/6,5	—/—	—/—	—/—	—/—	—/—	990	1 105
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															

Maximum impurity limits applicable to all types are mass fractions 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 here are found to be present, the amount of these elements shall be determined; the total of such elements shall not exceed 0,50 %.

NOTE Ni-Cr-P-Si group has been established in this document. Ni 741 is equivalent to and replaced Ni 655.

Table 11 *(continued)*

Code	Composition mass fraction %													Melting temperature (approximate)	
	Ni min./ max.	Co min./ 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 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 mass fractions 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 here are found to be present, the amount of these elements shall be determined; the total of such elements shall not exceed 0,50 %. NOTE Ni-Cr-P-Si group has been established in this document. Ni 741 is equivalent to and replaced Ni 655.															

Table 12 — Class Pd: palladium-bearing brazing filler metals

Code	Composition mass fraction %						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	31,0/33,0	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]	63,0/65,0	—/—	32,0/33,5	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

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 mass fractions Al 0,001 0, P 0,008, Ti 0,002, Zr 0,002; total of all impurities = 0,15.

For Pd 485 and Pd 597, maximum impurity limits are mass fractions 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 mass fraction %						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

Maximum impurity limits applicable to all types are mass fractions Al 0,001 0, 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
(informative)

Codification

Two systems for the codification of filler metals are used in this document. For the purposes of identifying a filler metal conforming to this document, for example 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:

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	ISO 3677	AWS (US standard)	GB (Chinese National Standard)	JIS (Japanese Industrial Standard)
Aluminium brazing filler metals				
Al 105	B-Al95Si-575/630		BAl95Si	
Al 107	B-Al92Si-575/615	BAlSi-2	BAl92Si	BA4343
Al 110	B-Al90Si-575/590	BAlSi-5	BAl90Si	BA4045
Al 112	B-Al88Si-575/585	BAlSi-4	BAl88Si	BA4047
Al 210	B-Al86SiCu-520/585	BAlSi-3	BAl86SiCu	BA4145
Al 310	B-Al89SiMg-555/590	BAlSi-7	BAl89SiMg	BA4004
Al 311	B-Al89SiMg(Bi)-555/590	BAlSi-11	BAl89SiMg(Bi)	BA4104
Al 315	B-Al90Si-559/591		BAl89Si(Mg)	BA4005
Al 317	B-Al88SiMg-562/582	BAlSi-9	BAl88Si(Mg)	
Al 319	B-Al89SiMg-559/579		BAl87SiMg	BA4N04

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