

Specification for Filler Metals for Brazing and Braze Welding



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American National Standards Institute
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Specification for Filler Metals for Brazing and Braze Welding

11th Edition

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Prepared by the
American Welding Society (AWS) A5 Committee on Filler Metals and Allied Materials

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

Abstract

This specification prescribes the requirements for the classification of brazing filler metals for brazing and braze welding. The chemical composition, physical form, and packaging of more than 120 brazing filler metals are specified. The brazing filler metal groups described include aluminum, cobalt, copper, gold, magnesium, nickel, palladium, silver, titanium, and brazing filler metals for vacuum service. Information is provided concerning the liquidus, the solidus, the brazing temperature range, and general areas of application recommended for each brazing filler metal. Additional requirements are included for manufacture, sizes, lengths, and packaging. A guide is appended to the specification as a source of information concerning the classification system employed and the intended use of the brazing filler metals for brazing and braze welding.

This specification makes use of both the International System of Units (SI) and U.S. Customary Units. Since these are not equivalent, each must be used independently of the other.



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Foreword

This foreword is not part of this standard but is included for informational purposes only.

This document is the third of the AWS A5.8 specification revisions that makes use of both the International System of Units (SI) and U.S. Customary Units. The measurements are not exact equivalents; therefore, each system must be used independently of the other without combining values in any way. In selecting rational metric units, AWS A1.1, *Metric Practice Guide for the Welding Industry*, and International Standard ISO 544, *Welding consumables—Technical delivery conditions for filler materials and fluxes — Type of product, dimensions, tolerances and markings*, are used where suitable. Tables and figures make use of both SI Units and U.S. Customary Units, which with the application of the specified tolerances provides for interchangeability of products in both the SI Units and U.S. Customary Units.

The current document is the tenth revision of the initial joint ASTM/AWS document issued in 1952. The practice of issuing filler metal specifications as joint AWS/ASTM documents was discontinued shortly after the original version of this specification was issued. The 1969 revision and all subsequent versions, developed and published by AWS, have been certified by the American National Standards Institute (ANSI). The evolution of AWS A5.8M/A5.8, *Specification for Filler Metals for Brazing and Braze Welding*, is shown below:

ASTM B260–52T, AWS A5.8–52T *Tentative Specification for Brazing Filler Metal*;
 ASTM B260–56T, AWS A5.8–56T *Tentative Specification for Brazing Filler Metal*;
 AWS A5.8–62T, ASTM B260–62T *Tentative Specification for Brazing Filler Metal*;
 AWS A5.8–69, *Specification for Brazing Filler Metal*;
 ANSI/AWS A5.8–76, *Specification for Brazing Filler Metal*;
 ANSI/AWS A5.8–81, *Specification for Brazing Filler Metal*;
 ANSI/AWS A5.8–89, *Specification for Filler Metals for Brazing*;
 ANSI/AWS A5.8–92, *Specification for Filler Metals for Brazing and Braze Welding*;
 AWS A5.8/A5.8M:2004, *Specification for Filler Metals for Brazing and Braze Welding*;
 AWS A5.8M/A5.8:2011, *Specification for Filler Metals for Brazing and Braze Welding*; and
 AWS A5.8M/A5.8:2011-AMD 1, *Specification for Filler Metals for Brazing and Braze Welding*

The present edition, which supersedes AWS A5.8M/A5.8:2011-AMD1, includes the following updates:

- (1) Two new brazing filler metals are added; BNi-15 and BNi-16.
- (2) Chemical composition has been adjusted for several classifications: Zr and Hf in the BTi group; a revised Be limit for the BAISi group; a revised Cd limit for non-Cd BAg filler metals; and a Ni correction to classifications RBCuZn-A and RBCuZn-B.
- (3) ASTM B215 has been added to provide a metal powder sampling standard.
- (4) ASTM E1371–05, *Standard Test Method for Gravimetric Determination of Phosphorus in Phosphorus-Copper Alloys or Phosphorus-Copper-Silver Alloys*, is no longer listed as a reference analytical method. It is included in Annex C, however, as a suggested analysis approach for certain phosphorus ranges.

All substantive updates within this document are italicized and underlined. A vertical line in the margin indicates a revision of that item from the previous edition.

The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights.

By publication of this standard, no position is taken with respect to the validity of any such claim(s) or of any patent rights in connection therewith. If a patent holder has filed a statement of willingness to grant a license under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license, then details may be obtained from the standards developer.

Comments and suggestions for the improvement of this standard are welcome. They should be sent to the Secretary, AWS A5 Committee on Filler Metals and Allied Materials, American Welding Society, 8669 NW 36 St, #130, Miami, FL 33166.

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Specification for Filler Metals for Brazing and Braze Welding

1. General Requirements

1.1 Scope. This specification prescribes requirements for the classification of filler metals for brazing and braze welding. It includes brazing filler metals for brazing with or without a flux and in all protective atmospheres for various applications, including those for vacuum service.¹ *In the case of composite products – flux cored wire or rods, flux-coated rods, transfer tape, or paste – this standard covers only the filler metal that forms part of such products.*

1.2 Units of Measurement. This specification makes use of both the International System of Units (SI) and U.S. Customary Units. The measurements are not exact equivalents; therefore, each system must be used independently of the other without combining in any way when referring to material properties. The specification with the designation A5.8M uses the International System of Units. The specification A5.8 uses U.S. Customary Units. The latter are shown within brackets ([]) or in appropriate columns in tables and figures. Standard dimensions based on either system may be used for the sizing or packaging of brazing filler metal, or both, under A5.8M or A5.8 specifications.

1.3 Safety. Safety issues and concerns are addressed in this standard, although health issues and concerns are beyond the scope of this standard. Some safety and health information can be found in non-mandatory Annex B, clauses B5 and B10.

Safety and Health information is available from the following sources:

American Welding Society:

- (1) ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*
- (2) AWS Safety and Health Fact Sheets (see Annex B, clause B10)
- (3) Other safety and health information on the AWS website

Material or Equipment Manufacturers:

- (1) Safety Data Sheets supplied by the materials manufacturers
- (2) Operating Manuals supplied by equipment manufacturers

Applicable Regulatory Agencies

Work performed in accordance with this standard may involve the use of materials that have been deemed hazardous, and may involve operations or equipment that may cause injury or death. This standard does not purport to address all safety and health risks that may be encountered. The user of this standard should establish an appropriate safety program to address such risks as well as to meet applicable regulatory requirements. ANSI Z49.1 should be considered when developing the safety program.

2. Normative References

The standards listed below contain provisions that, through reference in this text, constitute mandatory provisions of this AWS standard. For undated references, the latest edition of the referenced standard shall apply. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply.

¹ Filler metals for vacuum service are for devices operating in vacuum service, regardless of the atmosphere used in making the joint.

2.1 American Welding Society (AWS) standards:

AWS A3.0M/A3.0, *Standard Welding Terms and Definitions, Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying*.

AWS A5.01M/A5.01 (ISO 14344 MOD), *Welding Consumables – Procurement of Filler Metals and Fluxes*.

2.2 American National Standards Institute (ANSI) standard:

ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*.

2.3 ASTM International standards:

ASTM B214, *Standard Test Method for Sieve Analysis of Metal Powders*

ASTM B215, *Standard Practices for Sampling Metal Powders*

ASTM E11, *Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves*

ASTM E29, *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*
Annual Book of ASTM Standards, Volume 03.05 – Analytical Chemistry for Metals, Ores, and Related Materials

2.4 ASTM International/SAE International standard:

ASTM DS-56/SAE HS-1086, *Metals & Alloys in the Unified Numbering System*

2.5 International Organization for Standardization (ISO) standard:

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

3. Classification²

3.1 The brazing filler metals covered by the A5.8M/A5.8 specification are classified using a system that is independent of the International System of Units (SI) and U.S. Customary Units. Their classification is according to the chemical composition as specified in Tables 1 through 7.

3.2 Brazing filler metal classified under one classification shall not be classified under any other classification in this specification. However, material may be classified under both A5.8M and A5.8 specifications.

4. Acceptance³

Acceptance of the brazing filler metal shall be in accordance with the provisions of AWS A5.01M/A5.01 (ISO 14344 MOD).

5. Certification⁴

By affixing the AWS specification and classification designations to the packaging, or the classification to the product, the manufacturer certifies that the product meets the requirements of this specification.

² An explanation of the method of classification of the filler metals is included in *Annex B, clause B2*.

³ *Refer to Annex B, clause B3* for further information concerning acceptance, testing of the material shipped, and AWS A5.01M/A5.01 (ISO 14344 MOD).

⁴ *Refer to Annex B, clause B4* for further information concerning certification and the testing called for to meet this requirement.

Table 1^{a, b}
Chemical Composition Requirements for Silver Brazing Filler Metals

AWS Classification	UNS Number ^d	Chemical Composition, Weight Percent ^c								Other Elements, Total ^e
		Ag	Cu	Zn	Cd	Ni	Sn	Li	Mn	
BAG-1	P07450	44.0–46.0	14.0–16.0	14.0–18.0	23.0–25.0	—	—	—	—	0.15
BAG-1a	P07500	49.0–51.0	14.5–16.5	14.5–18.5	17.0–19.0	—	—	—	—	0.15
BAG-2	P07350	34.0–36.0	25.0–27.0	19.0–23.0	17.0–19.0	—	—	—	—	0.15
BAG-2a	P07300	29.0–31.0	26.0–28.0	21.0–25.0	19.0–21.0	—	—	—	—	0.15
BAG-3	P07501	49.0–51.0	14.5–16.5	13.5–17.5	15.0–17.0	2.5–3.5	—	—	—	0.15
BAG-4	P07400	39.0–41.0	29.0–31.0	26.0–30.0	0.0/0	1.5–2.5	—	—	—	0.15
BAG-5	P07453	44.0–46.0	29.0–31.0	23.0–27.0	0.0/0	—	—	—	—	0.15
BAG-6	P07503	49.0–51.0	33.0–35.0	14.0–18.0	0.0/0	—	—	—	—	0.15
BAG-7	P07563	55.0–57.0	21.0–23.0	15.0–19.0	0.0/0	—	4.5–5.5	—	—	0.15
BAG-8	P07720	71.0–73.0	Remainder	—	0.0/0	—	—	—	—	0.15
BAG-8a	P07723	71.0–73.0	Remainder	—	0.0/0	—	—	0.25–0.50	—	0.15
BAG-9	P07650	64.0–66.0	19.0–21.0	13.0–17.0	0.0/0	—	—	—	—	0.15
BAG-10	P07700	69.0–71.0	19.0–21.0	8.0–12.0	0.0/0	—	—	—	—	0.15
BAG-13	P07540	53.0–55.0	Remainder	4.0–6.0	0.0/0	0.5–1.5	—	—	—	0.15
BAG-13a	P07560	55.0–57.0	Remainder	—	0.0/0	1.5–2.5	—	—	—	0.15
BAG-18	P07600	59.0–61.0	Remainder	—	0.0/0	—	9.5–10.5	—	—	0.15
BAG-19	P07925	92.0–93.0	Remainder	—	0.0/0	—	—	0.15–0.30	—	0.15
BAG-20	P07301	29.0–31.0	37.0–39.0	30.0–34.0	0.0/0	—	—	—	—	0.15
BAG-21	P07630	62.0–64.0	27.5–29.5	—	0.0/0	2.0–3.0	5.0–7.0	—	—	0.15
BAG-22	P07490	48.0–50.0	15.0–17.0	21.0–25.0	0.0/0	4.0–5.0	—	—	7.0–8.0	0.15
BAG-23	P07850	84.0–86.0	—	—	0.0/0	—	—	—	Remainder	0.15
BAG-24	P07505	49.0–51.0	19.0–21.0	26.0–30.0	0.0/0	1.5–2.5	—	—	—	0.15
BAG-26	P07250	24.0–26.0	37.0–39.0	31.0–35.0	0.0/0	1.5–2.5	—	—	1.5–2.5	0.15
BAG-27	P07251	24.0–26.0	34.0–36.0	24.5–28.5	12.5–14.5	—	—	—	—	0.15
BAG-28	P07401	39.0–41.0	29.0–31.0	26.0–30.0	0.0/0	—	1.5–2.5	—	—	0.15
BAG-33	P07252	24.0–26.0	29.0–31.0	26.5–28.5	16.5–18.5	—	—	—	—	0.15
BAG-34	P07380	37.0–39.0	31.0–33.0	26.0–30.0	0.0/0	—	1.5–2.5	—	—	0.15
BAG-35	P07351	34.0–36.0	31.0–33.0	31.0–35.0	0.0/0	—	—	—	—	0.15
BAG-36	P07454	44.0–46.0	26.0–28.0	23.0–27.0	0.0/0	—	2.5–3.5	—	—	0.15
BAG-37	P07253	24.0–26.0	39.0–41.0	31.0–35.0	0.0/0	—	1.5–2.5	—	—	0.15

^a See Table B.3 for discontinued brazing filler metal classifications.

^b See Table 7 for the following Ag classifications intended for vacuum service not included here: BVAg-0, BVAg-6b, BVAg-8b, and BVAg-29 to BVAg-32.

^c *Single values are maximum unless otherwise indicated.*

^d ASTM D5-56/SAE HS-1086, *Metals & Alloys in the Unified Numbering System*.

^e The brazing filler metal shall be analyzed for those specific elements for which values are shown in this table. If the presence of other elements is indicated in the course of this work, the amount of those elements shall be determined to ensure that their total does not exceed the limit specified.

Table 2^{a,b}
Chemical Composition Requirements for Gold Brazing Filler Metals

AWS Classification	UNS Number ^c	Chemical Composition, Weight Percent				Other Elements, Total ^d
		Au	Cu	Pd	Ni	
BAu-1	P00375	37.0–38.0	Remainder	—	—	0.15
BAu-2	P00800	79.5–80.5	Remainder	—	—	0.15
BAu-3	P00350	34.5–35.5	Remainder	—	2.5–3.5	0.15
BAu-4	P00820	81.5–82.5	—	—	Remainder	0.15
BAu-5	P00300	29.5–30.5	—	33.5–34.5	35.5–36.5	0.15
BAu-6	P00700	69.5–70.5	—	7.5–8.5	21.5–22.5	0.15

^a See Table B.3 for discontinued brazing filler metal classifications.

^b See Table 7 for the following Au classifications intended for vacuum service not included here: BVAu-2, BVAu-3, BVAu-4, BVAu-7, BVAu-8, BVAu-9, and BVAu-10.

^c ASTM D5-56/SAE HS-1086, *Metals & Alloys in the Unified Numbering System*.

^d The brazing filler metal shall be analyzed for those specific elements for which values are shown in this table. If the presence of other elements is indicated in the course of this work, the amount of those elements shall be determined to ensure that their total does not exceed the limit specified.

6. Rounding Procedure

For purposes of determining compliance with the requirements of this standard, the actual test values shall be subjected to the rounding rules of ASTM E29, *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*, or Rule A in Clause B.3 of ISO 80000-1, *Quantities and units — Part 1: General* (the results are the same). If the measured values are obtained by equipment calibrated in units other than those of the specified limit, the measured values shall be converted to the units of the specified limit before rounding. If an average value is to be compared to the specified limit, rounding shall be done only after calculating the average. The rounded results shall fulfill the requirements for the classification under test.

7. Summary of Tests

7.1 The tests required for each classification or product form are as follows:

- (1) Chemical analysis of the brazing filler metal is required for all classifications.
- (2) *A melt cleanliness test and a spatter test are required for brazing filler metals for vacuum service.*
- (3) Sieve analysis is required for all powdered brazing filler metal.
- (4) A binder content test for transfer tape used in conjunction with powdered brazing filler metals is required.

7.2 The material for the preparation of test samples, the brazing and testing procedures to be employed, and the results required are specified in Clauses 9 through 13.

8. Retest

If the results of any test fail to meet the requirement, that test shall be repeated twice. The results of both retests shall meet the requirement. Samples for retest may be taken from the original sample or from one or two new samples. For chemical analysis, retest need be only for the specific elements that failed to meet the requirement.

If the results of one or both retests fail to meet the requirement, the material under test shall be considered as not meeting the requirements of this specification for that classification.

In the event that during the preparation or after the completion of any test it is clearly determined that prescribed or proper procedures were not followed in preparing the test sample(s) or in conducting the test, the test shall be considered invalid.

Table 3^a
Chemical Composition Requirements for Aluminum and Magnesium Brazing Filler Metals

Chemical Composition, Weight Percent ^b															Other Elements, ^d	
AWS	UNS															
Classification	Number ^c	Si	Cu	Mg	Bi	Fe	Zn	Mn	Cr	N	Ti	Be	Al	Each	Total	
BAISi-2	A94343	6.8–8.2	0.25	—	—	0.8	0.20	0.10	—	—	—	<u>0.0003</u>	Remainder	0.05	0.15	
BAISi-3	A94145	9.3–10.7	3.3–4.7	0.15	—	0.8	0.20	0.15	0.15	—	—	<u>0.0003</u>	Remainder	0.05	0.15	
BAISi-4	A94047	11.0–13.0	0.30	0.10	—	0.8	0.20	0.15	—	—	—	<u>0.0003</u>	Remainder	0.05	0.15	
BAISi-5	A94045	9.0–11.0	0.30	0.05	—	0.8	0.10	0.05	—	—	0.20	<u>0.0003</u>	Remainder	0.05	0.15	
BAISi-7	A94004	9.0–10.5	0.25	1.0–2.0	—	0.8	0.20	0.10	—	—	—	<u>0.0003</u>	Remainder	0.05	0.15	
BAISi-9	A94147	11.0–13.0	0.25	0.10–0.50	—	0.8	0.20	0.10	—	—	—	<u>0.0003</u>	Remainder	0.05	0.15	
BAISi-11	A94104	9.0–10.5	0.25	1.0–2.0	0.02–0.20	0.8	0.20	0.10	—	—	—	<u>0.0003</u>	Remainder	0.05	0.15	
BMg-1	M19001	0.05	0.05	Remainder	—	0.005	1.7–2.3	0.15–1.50	—	0.005	—	0.0002–0.0008	8.3–9.7	—	0.30	

^a See Table B.3 for discontinued brazing filler metal classifications.

^b Single values are maximum unless noted.

^c ASTM D5-56/SAE HS-1086, *Metals & Alloys in the Unified Numbering System*.

^d The brazing filler metal shall be analyzed for those specific elements for which values are shown in this table. If the presence of other elements is indicated in the course of this work, the amount of those elements shall be determined to ensure that their total does not exceed the limit specified.

Table 4
Chemical Composition Requirements for Copper, Copper-Zinc, and Copper-Phosphorus Brazing Filler Metals^{a, b}

Chemical Composition, Weight Percent ^c													
AWS Classification	UNS Number ^d	Cu	Ag	Zn	Sn	Fe	Mn	Ni	P	Pb	Al	Si	Other Elements, Total ^e
BCu-1	C14180	99.90 min.	—	—	—	—	—	—	0.075	0.02	0.01	—	0.10
BCu-1a	None	99.00 ^f min.	—	—	—	—	—	—	—	—	—	—	0.30
BCu-1b	C11000	99.90 min.	—	—	—	—	—	—	—	—	—	—	0.10
BCu-2 ^g	None	86.50 ^f min.	—	—	—	—	—	—	—	—	—	—	0.50
BCu-3 ^h	C10200	99.95 min.	—	—	—	—	—	—	—	—	—	—	0.05
RBCuZn-A	C47000	57.0–61.0	—	Remainder	0.25–1.00	*	*	—	—	0.05*	0.01*	*	0.50
RBCuZn-B	C68000	56.0–60.0 ⁱ	—	Remainder	0.80–1.10	0.25–1.20	0.01–0.50	0.20–0.80 ⁱ	—	0.05*	0.01*	0.04–0.20	0.50
RBCuZn-C	C68100	56.0–60.0 ⁱ	—	Remainder	0.80–1.10	0.25–1.20	0.01–0.50	—	—	0.05*	0.01*	0.04–0.15	0.50
RBCuZn-D	C77300	46.0–50.0 ⁱ	—	Remainder	—	—	—	9.0–11.0 ⁱ	0.25	0.05*	0.01*	0.04–0.25	0.50
BCuP-2	C55181	Remainder	—	—	—	—	—	—	7.0–7.5	—	—	—	0.15
BCuP-3	C55281	Remainder	4.8–5.2	—	—	—	—	—	5.8–6.2	—	—	—	0.15
BCuP-4	C55283	Remainder	5.8–6.2	—	—	—	—	—	7.0–7.5	—	—	—	0.15
BCuP-5	C55284	Remainder	14.5–15.5	—	—	—	—	—	4.8–5.2	—	—	—	0.15
BCuP-6	C55280	Remainder	1.8–2.2	—	—	—	—	—	6.8–7.2	—	—	—	0.15
BCuP-7	C55282	Remainder	4.8–5.2	—	—	—	—	—	6.5–7.0	—	—	—	0.15
BCuP-8	C55285	Remainder	17.2–18.0	—	—	—	—	—	6.0–6.7	—	—	—	0.15
BCuP-9	C55385	Remainder	—	—	6.0–7.0	—	—	—	6.0–7.0	—	—	0.01–0.40	0.15
BCuP-10	C55386	Remainder	—	—	5.5–6.5	—	—	3.0–5.0	6.8–7.2	—	—	—	0.15

^a See Table B.3 for discontinued brazing filler metal classifications.

^b See Table 7 for the following Cu classifications intended for vacuum service not included here: BVCu-1x.

^c Single values are maximum unless noted.

^d ASTM D5-56/SAE HS-1086, *Metals & Alloys in the Unified Numbering System*.

^e The brazing filler metal shall be analyzed for those specific elements for which values and/or asterisks (*) are shown in this table. If the presence of other elements is indicated in the course of this work, the amount of those elements shall be determined to ensure that their total, plus the values for those elements marked with an asterisk, does not exceed the limit specified in "Other Elements, Total."

^f The balance is oxygen, which is present as cuprous oxide. Oxygen is not to be included in "Other Elements."

^g These chemical composition requirements pertain only to the cuprous oxide powder and do not include requirements for the organic vehicle in which the cuprous oxide is suspended, when supplied in paste form.

^h The maximum allowable percentage of oxygen for this alloy is 0.001%.

ⁱ Includes residual cobalt.

^j Includes residual silver.

Table 5^a
Chemical Composition Requirements for Nickel and Cobalt Brazing Filler Metals

Chemical Composition, Weight Percent ^b																				Other Elements, Total ^d
AWS Classification	UNS Number ^c	Ni	Cr	B	Si	Fe	C	P	S	Al	Ti	Mn	Cu	Zr	W	Co	Mo	Nb	Se	
BNi-1	N99600	Remainder	13.0–15.0	2.75–3.50	4.0–5.0	4.0–5.0	0.60–0.90	0.02	0.02	0.05	0.05	—	—	0.05	—	—	0.10	—	—	0.005
BNi-1a	N99610	Remainder	13.0–15.0	2.75–3.50	4.0–5.0	4.0–5.0	0.06	0.02	0.02	0.05	0.05	—	—	0.05	—	—	0.10	—	—	0.005
BNi-2	N99620	Remainder	6.0–8.0	2.75–3.50	4.0–5.0	2.5–3.5	0.06	0.02	0.02	0.05	0.05	—	—	0.05	—	—	0.10	—	—	0.005
BNi-3	N99630	Remainder	—	2.75–3.50	4.0–5.0	0.5	0.06	0.02	0.02	0.05	0.05	—	—	0.05	—	—	0.10	—	—	0.005
BNi-4	N99640	Remainder	—	1.50–2.20	3.0–4.0	1.5	0.06	0.02	0.02	0.05	0.05	—	—	0.05	—	—	0.10	—	—	0.005
BNi-5	N99650	Remainder	18.5–19.5	0.03	9.75–10.50	—	0.06	0.02	0.02	0.05	0.05	—	—	0.05	—	—	0.10	—	—	0.005
BNi-5a	N99651	Remainder	18.5–19.5	1.0–1.5	7.0–7.5	0.5	0.10	0.02	0.02	0.05	0.05	—	—	0.05	—	—	0.10	—	—	0.005
BNi-5b	N99652	Remainder	14.5–15.5	1.1–1.6	7.0–7.5	1.0	0.06	0.02	0.02	0.05	0.05	—	—	0.05	—	—	1.0	—	—	0.005
BNi-6	N99700	Remainder	—	—	—	—	0.06	10.0–12.0	0.02	0.05	0.05	—	—	0.05	—	—	0.10	—	—	0.005
BNi-7	N99710	Remainder	13.0–15.0	0.02	0.10	0.2	0.06	9.7–10.5	0.02	0.05	0.05	0.04	—	0.05	—	—	0.10	—	—	0.005
BNi-8	N99800	Remainder	—	—	6.0–8.0	—	0.06	0.02	0.02	0.05	0.05	21.5–24.5	4.0–5.0	0.05	—	—	0.10	—	—	0.005
BNi-9	N99612	Remainder	13.5–16.5	3.25–4.00	—	1.5	0.06	0.02	0.02	0.05	0.05	—	—	0.05	—	—	0.10	—	—	0.005
BNi-10	N99622	Remainder	10.0–13.0	2.0–3.0	3.0–4.0	2.5–4.5	0.40–0.55	0.02	0.02	0.05	0.05	—	—	0.05	15.0–17.0	0.10	—	—	—	0.005
BNi-11	N99624	Remainder	9.00–11.75	2.2–3.1	3.35–4.25	2.5–4.0	0.30–0.50	0.02	0.02	0.05	0.05	—	—	0.05	11.00–12.75	0.10	—	—	—	0.005
BNi-12	N99720	Remainder	24.0–26.0	0.02	0.1	0.2	0.06	9.0–11.0	0.02	0.05	0.05	—	—	0.05	—	—	0.10	—	—	0.005
BNi-13	N99810	Remainder	7.0–9.0	2.75–3.50	3.8–4.8	0.4	0.06	0.02	0.02	0.05	0.05	—	2.0–3.0	0.05	—	—	0.10	1.5–2.5	1.5–2.5	0.005
BNi-14	N99660	Remainder	21.0–23.0	0.1	6.0–7.0	0.5	0.16	3.5–4.5	0.02	0.05	0.05	—	—	0.05	—	—	0.10	—	—	0.005
BNi-15	None	Remainder	28.0–32.0	0.1	3.8–4.2	—	0.06	5.5–6.5	0.02	0.05	0.05	—	—	0.05	—	—	0.10	—	—	0.005
BNi-16	None	Remainder	28.0–30.0	—	6.0–7.0	—	0.10	5.5–6.5	0.02	0.05	0.05	—	—	0.05	—	—	—	—	—	0.005
BCo-1	R39001	16.0–18.0	18.0–20.0	0.70–0.90	7.5–8.5	1.0	0.35–0.45	0.02	0.02	0.05	0.05	—	—	0.05	3.5–4.5	Remainder	—	—	—	0.005

^a See Table B.3 for discontinued brazing filler metal classifications.

^b Single values are maximum.

^c ASTM DS-56/SAE HS-1086, *Metals & Alloys in the Unified Numbering System*.

^d The brazing filler metal shall be analyzed for those specific elements for which values are shown in this table. If the presence of other elements is indicated in the course of this work, the amount of those elements shall be determined to ensure that their total does not exceed the limit specified.

Table 6
Chemical Composition Requirements for Titanium and Titanium-Zirconium Brazing Filler Metals

Chemical Composition, Weight Percent ^a														
AWS Classification	UNS Number ^b	Ti	Zr	Cu	Ni	Mo	Hf	Fe	Al	Si	O	N	C	Other Elements, Total ^c
BTi-1	<u>R59100</u>	Remainder	—	14.0–16.0	14.0–16.0	—	—	0.1	0.05	0.02	0.15	0.02	0.04	0.30
BTi-2	<u>R59110</u>	Remainder	—	14.0–16.0	24.0–26.0	—	—	0.1	0.05	0.02	0.15	0.02	0.04	0.30
BTi-3	<u>R59120</u>	Remainder	<u>36.5–38.5</u>	14.0–16.0	9.5–10.5	0.1	<u>0.5</u>	0.08	0.05	0.02	0.20	0.03	0.04	0.50
BTi-4	<u>R59130</u>	Remainder	<u>23.0–25.0</u>	15.0–17.0	15.0–17.0	1.5	<u>0.5</u>	0.08	0.05	0.02	0.20	0.03	0.04	0.50
BTi-5	<u>R59140</u>	Remainder	19.0–21.0	19.0–21.0	19.0–21.0	0.1	<u>0.5</u>	0.08	0.05	0.02	0.20	0.03	0.04	0.50

^a Single values are maximum.

^b ASTM D5-56/SAE HS-1086, *Metals & Alloys in the Unified Numbering System*.

^c The brazing filler metal shall be analyzed for those specific elements for which values are shown in this table. If the presence of other elements is indicated in the course of this work, the amount of those elements shall be determined to ensure that their total does not exceed the limit specified.

Table 7
Chemical Composition Requirements for Brazing Filler Metals for Vacuum Service

AWS Classification	UNS Number ^c	Chemical Composition, Weight Percent ^{a,b}											
		Ag	Au	Cu	Ni	Co	Sn	Pd	In	Zn	Cd	Pb	C
Grade 1													
BVAg-0	P07017	99.95 min.		0.05	—	—	—	—	—	0.001	0.001	0.002	0.005
BVAg-6b	P07507	49.0–51.0	—	Remainder	—	—	—	—	—	0.001	0.001	0.002	0.005
BVAg-8	P07727	71.0–73.0	—	Remainder	—	—	—	—	—	0.001	0.001	0.002	0.005
BVAg-8b	P07728	70.5–72.5	—	Remainder	0.3–0.7	—	—	—	—	0.001	0.001	0.002	0.005
BVAg-18	P07607	59.0–61.0	—	Remainder	—	—	9.5–10.5	—	—	0.001	0.001	0.002	0.005
BVAg-29	P07627	60.5–62.5	—	Remainder	—	—	—	14.0–15.0	—	0.001	0.001	0.002	0.005
BVAg-30	P07687	67.0–69.0	—	Remainder	—	—	—	4.5–5.5	—	0.001	0.001	0.002	0.005
BVAg-31	P07587	57.0–59.0	—	31.0–33.0	—	—	—	Remainder	—	0.001	0.001	0.002	0.005
BVAg-32	P07547	53.0–55.0	—	20.0–22.0	—	—	—	Remainder	—	0.001	0.001	0.002	0.005
BVAu-2	P00807	—	79.5–80.5	Remainder	—	—	—	—	—	0.001	0.001	0.002	0.005
BVAu-3	P00351	—	34.5–35.5	Remainder	2.5–3.5	—	—	—	—	0.001	0.001	0.002	0.005
BVAu-4	P00827	—	81.5–82.5	—	Remainder	—	—	—	—	0.001	0.001	0.002	0.005
BVAu-7	P00507	—	49.5–50.5	—	24.5–25.5	0.06	—	Remainder	—	0.001	0.001	0.002	0.005
BVAu-8	P00927	—	91.0–93.0	—	—	—	—	Remainder	—	0.001	0.001	0.002	0.005
BVAu-9	P00354	—	34.5–35.5	Remainder	—	—	—	—	—	0.001	0.001	0.002	0.005
BVAu-10	P00503	—	49.5–50.5	Remainder	—	—	—	—	—	0.001	0.001	0.002	0.005
BVPd-1	P03657	—	—	—	0.06	Remainder	—	64.0–66.0	—	0.001	0.001	0.002	0.005
Grade 2													
BVAg-0	P07017	99.95 min.		0.05	—	—	—	—	—	0.002	0.002	0.002	0.005
BVAg-6b	P07507	49.0–51.0	—	Remainder	—	—	—	—	—	0.002	0.002	0.002	0.005
BVAg-8	P07727	71.0–73.0	—	Remainder	—	—	—	—	—	0.002	0.002	0.002	0.005
BVAg-8b	P07728	70.5–72.5	—	Remainder	0.3–0.7	—	—	—	—	0.002	0.002	0.002	0.005
BVAg-18	P07607	59.0–61.0	—	Remainder	—	—	9.5–10.5	—	—	0.002	0.002	0.002	0.005
BVAg-29	P07627	60.5–62.5	—	Remainder	—	—	—	14.0–15.0	—	0.002	0.002	0.002	0.005
BVAg-30	P07687	67.0–69.0	—	Remainder	—	—	—	4.5–5.5	—	0.002	0.002	0.002	0.005
BVAg-31	P07587	57.0–59.0	—	31.0–33.0	—	—	—	Remainder	—	0.002	0.002	0.002	0.005
BVAg-32	P07547	53.0–55.0	—	20.0–22.0	—	—	—	Remainder	—	0.002	0.002	0.002	0.005
BVAu-2	P00807	—	79.5–80.5	Remainder	—	—	—	—	—	0.002	0.002	0.002	0.005
BVAu-3	P00351	—	34.5–35.5	Remainder	2.5–3.5	—	—	—	—	0.002	0.002	0.002	0.005
BVAu-4	P00827	—	81.5–82.5	—	Remainder	—	—	—	—	0.002	0.002	0.002	0.005
BVAu-7	P09507	—	49.5–50.5	—	24.5–25.5	0.06	—	Remainder	—	0.002	0.002	0.002	0.005
BVAu-8	P00927	—	91.0–93.0	—	—	—	—	Remainder	—	0.002	0.002	0.002	0.005
BVAu-9	P00354	—	34.5–35.5	Remainder	—	—	—	—	—	0.002	0.002	0.002	0.005
BVAu-10	P00503	—	49.5–50.5	Remainder	—	—	—	—	—	0.002	0.002	0.002	0.005
BVPd-1	P03657	—	—	—	0.06	Remainder	—	64.0–66.0	—	0.002	0.002	0.002	0.005
BVCu-1x	C14181	—	—	99.99 min.	—	—	—	—	—	0.002	0.002	0.002	0.005

^a The brazing filler metal shall be analyzed for those specific elements for which values are shown in this table. If the presence of other elements is indicated in the course of this work, the amount of those elements shall be determined. Elements detected that have a vapor pressure higher than 1.3×10^{-5} Pa [10^{-7} torr] at 500°C [932°F] are limited to 0.001% each for Grade 1 brazing filler metals and 0.002% each for Grade 2 brazing filler metals. The total of all high vapor pressure elements (including zinc, cadmium, and lead) is limited to 0.010%. The total of all other impurity elements is 0.01% maximum for Grade 1 and 0.05% maximum for Grade 2.

^b Single values are maximum unless noted.

^c ASTM DS-56/SAE HS-1086, *Metals & Alloys in the Unified Numbering System*.