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SUPERSEDING
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FEDERAL SPECIFICATION

BRAZING ALLOYS, ALUMINUM AND MAGNESIUM, FILLER METAL

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. Brazing alloys covered by this specification are nonferrous metals and alloys melting above 300°F., and employing the principle of capillary attraction to join together two or more members with closely fitted surfaces and, at temperatures below the melting point of the metal of either member (see 6.1).

1.2 Classification.

1.2.1 Classes and forms. Brazing alloys covered by this specification shall be furnished in the following classes and forms, as specified (see 6.2):

Classes:

Aluminum-Silicon

FS-BAlSi-2 (4343)
FS-BAlSi-3 (4145)
FS-BAlSi-4 (4047)
FS-BAlSi-5 (4045)

Magnesium

FS-BMg-1 (AZ92A)
FS-BMg-2 (AZ125)
FS-BMg-2a

Forms:

Wire
Rod
Sheet

2. APPLICABLE DOCUMENTS

2.1 The following specifications and standards, of the issues in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

Federal Standards:

Fed. Std. No. 123 - Marking for Domestic Shipment (Civilian Agencies).
Fed. Test Method Std. No. 151 - Metals; Test Methods.
Fed. Std. No. 184 - Identification Marking of Aluminum, Magnesium, and Titanium.
Fed. Std. No. 245 - Tolerances for Aluminum Alloy and Magnesium Alloy Wrought Products.

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(Activities outside the Federal Government may obtain copies of Federal Specifications Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C., 20402.

(Single copies of this specification and other product specifications required by activities outside the Federal Government for bidding purposes are available without charge at the General Services Administration Regional Office in Boston, New York, Washington, D. C., Atlanta, Chicago, Kansas City, Mo., Ft. Worth, Denver, San Francisco and Seattle, Washington.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-649 - Aluminum and Magnesium Products, Preparation for Shipment and Storage.

(Copies of Military Specifications and Standards, required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1. Chemical composition. The material shall conform to the chemical requirements specified in table 1.

TABLE 1. Chemical composition, percent maximum unless a range is indicated

FS Class	Silicon	Copper	Iron	Zinc	Magnesium	Manganese	Chromium	Titanium	Aluminum	Others, each	Others, total
Aluminum-Silicon											
BAlSi-2	6.8- 8.2	0.25	0.8	0.20	—	0.10	—	—	Rem.	0.05	0.15
BAlSi-3	9.3-10.7	3.3-4.7	.8	.20	0.15	.15	0.15	—	Rem.	.05	.15
BSiSi-4	11.0-13.0	.30	.8	.20	.10	.15	—	—	Rem.	.05	.15

	Aluminum	Manganese	Zinc	Silicon	Copper	Nickel	Magnesium	Beryllium	Others, total
Magnesium									
BMg-1	8.3- 9.7	0.15[1]/	1.7-2.3	0.5	0.05	0.005	Rem.	0.0002-0.0008	0.30
BMg-2	11.0-13.0	—	4.5-5.5	—	—	—	Rem.	—	.30
BMg-2a	11.0-13.0	—	4.5-5.5	—	—	—	Rem.	0.0003-0.0008	.30

1/ Minimum.

3.2 Standard forms and sizes. Unless otherwise specified (see 6.2), brazing alloys covered by this specification shall be of the standard forms and sizes listed in table II.

TABLE II. Standard forms and sizes

FS class	Standard form	Sizes, inch (except as noted)
Aluminum Silicon BAiSi-2[1]/ and BAlSi-5[1]/	Sheet	0.010, 0.015, and 0.020
BAlSi-3 and BAlSi-4	Wire in coil	Round 1/16, 3/32, 1/8, 5/32, and 3/16
	Rod	Round 1/16, 3/32, 1/8, 5/32, and 3/16 by 36
	Sheet	0.010, 0.015, 0.020
BALSI-4	Powder	100 Mesh
Magnesium BMg-1	Wire in coil	Round 1/16, 3/32, 1/8, 5/32, and 3/16
	Rod	Round 1/16, 3/32, 1/8, 5/32, and 3/16 by 36
BMg-2 and BMg-2a	Wire in coil	Round 1/16 and 1/8
	Rod	Round 1/16 and 1/8 by 36
	Sheet	0.005 and 0.010

1/Brazing sheet cladding alloy; cladding varies from 5 to 10 percent of the thickness of the base metal. Several aluminum base metals are available and cladding supplied on one or both sides.

3.3 Dimensional tolerances. The wire, rod, and sheet shall conform to the dimensional tolerances shown in Fed. Std. No. 245.

3.4 Identification marking. Unless otherwise specified in the contract order, wire, rod, and sheet shall be marked in accordance with Fed. Std. No. 184.

3.5 Workmanship. Brazing alloys shall be free from excessive oxide, dirt, or other foreign elements which will affect the working qualities of the material.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements, as specified herein. Except as otherwise specified, the supplier may utilze his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Classes of inspection. All examination and testing shall be to determine conformance with the requirements of this specification to serve as a basis for acceptance.

4.3 Lot. Unless otherwise specified, a lot shall consist of all brazing alloys of the same class, form, and size submitted for inspection at the same time.

4.4 Sampling. Samples taken for the purposes of tests prescribed in this specification shall be selected in a manner as to correctly represent the material furnished and avoid needless destruction of finished material when samples representative of the material are available from other sources.

4.4.1 Sampling for chemical analysis.

4.4.1.1 Ingot analysis. At least one sample shall be taken from each group of ingots of the same alloy poured simultaneously from the same source of molten metal by the producer and analyzed to determine conformance with 3.1. Ingots not conforming to the requirements of this specification shall be cause for rejection. Complete ingot analysis records shall be available to the procuring agency.

4.4.1.2 Sheet analysis. When compliance with 4.4.1.1 cannot be established, samples shall be taken for each 2000 pounds or less of sheet comprising a lot.

4.4.1.3 Wire and rod analysis. When compliance with 4.4.1.1 cannot be established, samples shall be selected as follows: one sample shall be selected from each lot weighing 500 pounds or less; from lots weighing more than 500 pounds, one additional sample shall be taken for each 1,000 pounds or fraction thereof in excess of the first 500 pounds.

4.4.2 Sampling for visual and dimensional examination. Unless otherwise specified, a random sample of brazing filler metal material shall be selected from each lot in accordance with procedures of MIL-STD-105, inspection level II, acceptable quality level (AQL) 1.5 percent defective for visual and dimensional examination as specified in 4.5.1.

4.5 Examination.

4.5.1 Visual and dimensional. Pieces selected in accordance with 4.4.2 shall be visually examined to determine compliance with the requirements for identification (see 3.4), and workmanship (see 3.5) and shall be measured for compliance with the dimensional requirements (see 3.3).

4.5.2 Preparation for shipment. Examination of the packaging, packing, and marking for shipment shall be made for conformance to the requirements of section 5.

4.6 Tests.

4.6.1 Test procedures.

4.6.1.1 Chemical analysis. The samples selected in accordance with 4.4.1 shall be analyzed by the wet chemical method in accordance with method 111 of Fed. Test Method Std. No. 151 or the spectrochemical method in accordance with method 112 of Fed. Test Method Std. No. 151 to determine conformance with 3.1. A single analysis of a composite sample may be made. In case of dispute, analysis by the wet method (method 111) shall be the basis for acceptance.

4.7 Rejection. If any specimen fails to conform to the requirements of this specification, it shall be cause for rejection of the material represented by the specimen subject to the retest provisions of Fed. Test Method Std. No. 151.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, and packing. All wire, rod, and sheet shall be preserved, packaged, and packed in accordance with the requirements of MIL-STD-649. Unless otherwise specified (see 6.2), material shall be preserved, packaged, and packed in accordance with level C.

5.2 Marking. Marking shall be in accordance with 5.2.1 and 5.2.2, as specified (see 6.2).

5.2.1 Civil agencies. In addition to any special marking required in the contract or order, marking for shipment shall be in accordance with Fed. Std. No. 123.

5.2.2 Military agencies. In addition to any special marking required in the contract or order, marking for shipment shall be in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use.

6.1.1 Aluminum alloys. Brazing filler metals of the FS-BAlSi classification are used for joining the following grades of aluminum and aluminum alloys: 1060, EC, 1100, 3003, 3004, 5005, 5050, 6053, 6061, 6063, 6951, and cast alloys A612 and C612. All classified filler metals are suitable for the furnace and dip brazing processes. The FS-BAlSi-3, -4, and -5 filler metals are suitable for the manual and automatic torch brazing processes. These filler metals are also used to a limited extent with the other brazing processes. They are generally used with lap or tee joints rather than butt joints. Joint clearances of 0.006 to 0.010 inch are common for members which are overlapping less than 1/4 inch. Joint clearances up to 0.025 inch are used for members which are overlapping more than 1/4 inch. Fluxing is essential for all processes. After brazing, the brazed parts must be cleaned thoroughly. Immersion in boiling water generally will remove the residue; if this is not adequate, the parts are usually immersed in a concentrated commercial nitric acid or other suitable acid solution and then rinsed thoroughly.

6.1.1.1 FS-BAlSi-2 brazing filler metal is available as sheet and as a standard cladding on one or both sides of brazing sheet having a core of either 3003 or 6951 aluminum alloy. It is used for furnace and dip brazing only.

6.1.1.2 FS-BAlSi-3 is a general purpose brazing filler metal. It is used with all brazing processes, with some casting alloys, and where controlled flow is desired.

6.1.1.3 FS-BAlSi-4 is a general purpose brazing filler metal. It is used with all brazing processes, for complete flow, and for good corrosion resistance.

6.1.1.4 FS-BAlSi-5 brazing filler metal is available as sheet and as a standard cladding on one or both sides of brazing sheet having a core of 6951 aluminum alloy. BAlSi-5 is used for furnace and dip brazing at lower temperatures than BAlSi-2. The core alloy employed in brazing sheet with this filler metal cladding can be heat treated and aged after brazing.

6.1.2 Magnesium alloy. Brazing filler metal FS-BMg-1 is used for joining AZ10A, K1A, and M1A magnesium-base metals while FS-BMg-2 and -2a are used for joining these alloys and the AZ31B and ZE10A compositions.

6.1.2.1 FS-BMg-1 and -2 brazing filler metals are suitable for either the torch or dip-brazing processes. For furnace brazing, the beryllium containing BMg-1 and -2a filler metals are used to reduce the possibility of ignition of the magnesium. Because of their lower melting range, BMg-2 and -2a are usually preferred in most brazing applications. Heating must be closely controlled with all filler metals to prevent melting of the base metal. A flux is used with all processes. Joint clearances of 0.004 to 0.010 inch are best for most applications. Corrosion resistance is good if the flux is completely removed after brazing.

6.2 Ordering data. Purchasers should select the preferred options permitted herein, and include the following information in procurement documents.

(a) Title, number, and date of this specification.
(b) Class of material required (see 1.2).
(c) Form and size required (see 3.2).
(d) Selection of applicable level of packaging and packing required (see 5.1).
(e) Marking requirements (see 5.2).
(f) Maximum gross weight of containers.

6.3 Cleaning. When brazing with any of the various processes, the prebraze cleaning of the base metal is essential. The surface should be free from grease, oxides, scale, and dirt, of any kind. Cleaning can be done chemically or mechanically. Grease or oil can be removed by a reliable degreasing solution such as trichloroethylene or trisodium phosphate. Oxides should be removed by a chemical bath or mechanically with a fine emery after degreasing. Steel grip blasting or sanding with a fine wheel can be used to remove surface scale.

6.4 Temperatures. The solidus, liquidus, and the recommended brazing temperature ranges are listed in table III.

TABLE III. Solidus, liquidus, and brazing temperature ranges 1/ 2/

FS Class	Solidus °F.	Liquidus °F.	Brazing temperature range °F.
Aluminum-Silicon			
BAlSi-2	1070	1135	1110-1150
BAlSi-3	970	1085	1060-1120
BAlSi-4	1070	1080	1080-1120
BAlSi-5	1070	1095	1090-1120
Magnesium			
BMg-1	830	1110	1120-1160
BMg-2	770	1050	1080-1130
BMg-2a	770	1050	1080-1130

1/ Solidus and liquidus shown are for nominal compositions in each class.
2/ The terms solidus and liquidus are well established in metallurgical usage. Their definitions are as follows:

Solidus: Highest temperature at which the metal is completely solid; i.e., the temperature at which melting starts.

Liquidus: Lowest temperature at which the metal is completely liquid; i.e., the temperature at which freezing starts.

6.5 Selection of symbols. The basic classes of brazing alloy adopted by the American Welding Society and the American Society for Testing and Materials for similar brazing filler materials are identified by principal elements in their chemical composition as follows:

FS is for Federal Specification.
B is for brazing alloys.

AlSi is for aluminum and silicon, the principal elements in this group. The numbers following the letters indicate the particular composition within the group. In a similar way, the other brazing alloys are indicated by using standard chemical symbols and numbers. Cross reference of symbols as follows:

AWS-ASTM QQ-B-655c	Aluminum Association	Magnesium Association	Commercial	QQ-R-655 and QQ-B-655
BAlSi-2	4343	-	713	-
BAlSi-3	4145	-	716	FS-RAl-716
BAlSi-4	4047	-	718	FS-RAl-718
BAlSi-5	4045	-	714	-
BMg-1	-	AZ92A	-	BMg
BMg-2	-	AZ125	-	-
BMg-2a	-	-	-	-

MILITARY INTEREST:

CUSTODIANS:

Army - MR
Navy - SH
Air Force - 11

Review activities:

Army - MR, MU, WC
Navy - AS, OS
Air Force - 11, 84

User activities:

Army - SM, MO, GL, CE
Navy - YD, MC
Air Force - None

CIVIL AGENCY INTEREST:

COMM
INT
VA
PO
AGRI
GSA
TREAS

Preparing activity:

Army - MR

Orders for this publication are to be placed with General Services Administration, acting as an agent for the Superintendent of Documents. See section 2 of this specification to obtain extra copies and other documents referenced herein. Price 5 cents each.

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity *(as indicated on reverse hereof)*.

SPECIFICATION

ORGANIZATION *(Of submitter)* | CITY AND STATE

CONTRACT NO. | QUANTITY OF ITEMS PROCURED | DOLLAR AMOUNT $

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO IF "YES", IN WHAT WAY?

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity)* | DATE

DD FORM 1 APR 63 1426 REPLACES NAVSHIPS FORM 4863, WHICH IS OBSOLETE PLATE NO. 15419