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Standard Specification for Low Melting Point Alloys[1]

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1. Scope

1.1 This specification covers low-melting point metal alloys and soldiers, including bismuth–tin, bismuth–lead, bismuth–tin–lead, bismuth–tin–lead–cadmium, bismuth–tin–lead–indium–cadmium, bismuth–tin–lead–indium, indium–lead, and indium–lead–silver, and indium–tin joining together two or more metals at temperatures below their melting points; blocking for support and removable borders; radiation shielding; fusible plugs; fuses; tube bending; and punch setting.

1.1.1 This specification shall include those alloys having a liquidus temperature not exceeding 361°F (183°C), the melting point of the tin lead eutectic.

1.1.2 This specification includes low-melting point alloys in the form of solid bars, ingots, powder and special forms, and in the form of solid ribbon and wire.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[2]

E 88 Practice for Sampling Nonferrous Metals and Alloys in Cast Form for Determination of Chemical Composition[2]

2.2 *Military Standard:*

MIL-STD 129 Marking for Shipment and Storage[3]

2.3 *Federal Standard:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[3]

3. Terminology

3.1 *Definition*:

3.1.1 *producer*— the primary manufacturer of the material.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *liquidus*—the lowest temperature at which an alloy is fully transformed from a solid to a liquid.

3.2.2 *lot*—the term "lot" as used in this specification shall be defined as follows: *for solid alloy metal*, a lot shall consist of all the metal of the same time designation, produced from the same batch of raw materials under essentially the same conditions, and offered for inspection at one time.

3.2.3 *lot number*— the term "lot number" as used in this specification refers to a numerical designation for a lot that is traceable to a date of manufacture.

3.2.4 *solidus*—The highest temperature at which an alloy is fully transformed from a liquid to a solid.

4. Classification

4.1 *Type Designation*— The type designation shall use the following symbols to properly identify the material:

4.1.1 *Alloy Composition*—The composition is identified by three numbers that relate to the melting point in degrees Farenheit where it is eutectic or six numbers where it is a range alloy.

4.1.2 *Form*—The form is indicated by a single letter in accordance with Table 1.

4.1.3 *Powder Mesh Size*— The powder mesh size is identified by a size symbol number (Table 2).

5. Ordering Information

5.1 Orders for material under this specification shall indicate the following information, as required, to adequately describe the desired material:

5.1.1 Type designation (see 4.1),

5.1.2 Detailed requirements for special forms,

5.1.3 Dimensions of ribbon and wire solder (see 9.2),

5.1.4 Unit weight,

5.1.5 Packaging (see Section 18),

5.1.6 Marking (see Section 17),

5.1.7 ASTM specification designation and year of issue, marked on the purchase order and on the package or spool, and

[1] This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.02 on Refined Lead, Tin, Antimony, and Their Alloys.

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[2] *Annual Book of ASTM Standards*, Vol 03.05.

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

TABLE 1 Form

Symbol	Form
B	bar
I	ingot
P	powder
R	ribbon
S	special (includes pellets, preforms, shot, etc.
W	wire

TABLE 2 Powder Mesh Size

Size Symbol	Powder Mesh Size
3	325
2	200
1	100

5.1.8 Special requirements, as agreed upon between supplier and purchaser.

6. Materials and Manufacture

6.1 The producer shall use care to have each lot of alloy as uniform in quality as practicable and of satisfactory appearance in accordance with the best industrial practices. Each bar, ingot, or other form in which the alloy is sold shall be uniform in composition within the entire lot.

7. Chemical Composition

7.1 The composition of the alloys covered by this specification shall be as shown in Table 3.

NOTE 1—By mutual agreement between the supplier and the purchaser, analysis may be required and limits established for elements or compounds not specified in Table 3.

8. Physical and Performance Requirements

8.1 Alloy must freeze within 2°F of its solidus.

8.2 *Powder Mesh Size*— The powder mesh size shall be as specified in 5.1.1 and 4.1.3.

9. Dimensions and Unit Weight

9.1 *Bar and Ingot*— The dimensions and unit weight of bar and ingot shall be agreed between the supplier and purchaser.

9.2 *Wire (Solid)*— The dimensions and unit weight of wire alloys shall be as specified in 5.1.3 and 5.1.4. The tolerance on the specified outside diameter shall be ±5 % or ±0.002 in. (0.05 mm), whichever is greater.

9.3 *Other Forms*:

9.3.1 Dimensions for ribbon and special forms shall be as agreed between the supplier and purchaser.

9.3.2 The unit weight of alloy powder shall be as specified in 5.1.4.

10. Workmanship, Finish, and Appearance

10.1 All forms of the alloys shall be processed in such a manner as to be uniform in quality and free of defects that will affect life, serviceability, or appearance.

11. Sampling for Chemical Analysis

11.1 Care must be taken to ensure that the sample selected for testing is representative of the material. The method of sampling shall consist of one of the following methods:

11.1.1 Samples may be taken from the final solidified cast or fabricated product.

11.1.2 Representative samples may be obtained from the lot of molten metal during casting. The molten sample shall be poured into a cool mold, forming a bar approximately 0.25 in. (6.4 mm) thick.

11.2 *Frequency of Sampling*—Frequency of sampling for determination of chemical composition shall be in accordance with Table 4. For spools and coils, the sample shall be obtained by cutting back 6 ft (1.8 m) of wire from the free end and then taking the next 6 ft for test. In other forms, an equivalent sample shall be selected at random from the container.

**TABLE 3 Chemical Requirements Composition, wt. %
(range or maximum rules)**

Alloy Designation	Constituents — wt %									Melting Points			
										Solidus		Liquidus	
	Bi	Pb	Sn	Cd	In	Ag	Cu	Sb	Zn	°F	°C	°F	°C
117	44.2–45.2	22.1–23.1	7.8–8.8	4.8–5.8	18.6–19.6	0.001	0.08	0.1	0.08	117	47	117	47
129–133	48.14–50.14	16.92–18.92	10.55–12.55							129	54	133	56
136	48.5–49.5	17.5–18.5	11.5–12.5	0.005	20.5–21.5	0.001	0.08	0.1	0.08	136	58	136	58
158	49.5–50.5	26.2–27.2	12.8–13.8	9.5–10.5	0.008	0.001	0.08	0.1	0.08	158	70	158	70
158–165	49.5–50.5	24.45–25.45	12.0–13.0	12.0–13.0		0.10				158	70	165	74
158–190	42.0–43.0	37.2–38.2	10.8–11.8	8.0–9.0	0.008	0.001	0.08	0.1	0.08	158	70	190	88
174	56.5–57.5	0.05	16.5–17.5	0.005	25.5–26.5	0.001	0.08	0.1	0.08	174	79	174	79
203	52.0–53.0	31.5–32.5	15.0–16.0	0.005	0.008	0.001	0.08	0.1	0.08	203	95	203	95
203–239	49.5–50.5	24.5–25.5	24.5–25.5							203	95	239	115
216–217	53.5–54.5		25.5–26.5	19.5–20.5						216	102	217	103
255	55.0–56.0	44.0–45.0	0.01	0.005	0.008	0.001	0.08	0.1	0.08	255	124	255	124
281	57.5–58.5	0.05	41.5–42.5	0.005	0.008	0.01	0.08	0.1	0.08	281	138	281	138
281–338	39.5–40.5	0.05	59.5–60.5	0.005	0.008	0.01	0.08	0.1	0.08	281	138	338	170
291–325	13.5–14.5	42.5–43.5	42.5–43.5	0.005	0.008	0.01	0..08	0.1	0.08	291	144	325	163
244	0.01	0.05	47.5–48.5	0.005	51.5–52.5	0.01	0.08	0.1	0.08	244	118	244	118
296	0.01	0.05	0.01	0.005	96.5–97.5	2.8–3.2	0.08	0.1	0.08	296	147	296	147
293	0.01	29.9–31.1	50.7–51.7	17.7–18.7	0.008	0.01	0.08	0.1	0.08	293	145	293	145
300–302	0.01	14.5–15.5	0.01	0.005	79.5–80.5	4.5–5.5	0.08	0.1	0.08	300	149	302	150
307–323	0.01	17.5–18.5	69.5–70.5	0.005	11.5–12.5	0.01	0.08	0.1	0.08	307	153	323	162
320–345	0.01	29.5–30.5	0.01	0.005	69.5–70.5	0.01	0.08	0.1	0.08	320	160	345	174

TABLE 4 Frequency of Sampling

Size of Lot, lb (kg)	Number of Samples (spools, coils, containers or pieces)
Up to 1000 (450), incl	3
Over 1000 to 10 000 (450 to 4500), incl	5
Over 10 000 (4500)	10

11.3 *Other Aspects of Sampling*—Other aspects of sampling shall conform, in the case of bar and ingots, to Practice E 88. For fabricated alloys the appropriate reference is Practice E 55.

12. Sample Preparation

12.1 *Bar and Ingot*— Each sample piece shall be cut in half, and one half marked with sampling date and composition, and shall be held in reserve. The remaining half shall be melted in a clean container, mixed thoroughly and poured into a cool mold, forming a bar approximately 0.25 in. (6.4 mm) thick. Sampling may be performed by one of the following methods:

12.1.1 *Sawing*—If it is impractical to melt the bar or ingot as specified in 12.1, saw cuts shall be made across each piece at equal intervals of not more than 1 in. (25 mm) throughout its length. No lubricants shall be used during sawing. The sample shall consist of not less than 5 oz (143 g) of mixed sawings.

12.1.2 *Drilling*—The bar shall be drilled at least halfway through from two opposite sides. A drill of about 0.50 in. (12.7 mm) in diameter is preferred. In drilling, the holes shall be placed along a diagonal line from one corner of the pig to the other. The drillings shall be clipped into pieces not over 0.50 in. (12.7 mm) in length and mixed thoroughly. The sample shall consist of not less than 5 oz (143 g).

13. Test Methods

13.1 *Visual and Dimensional Examination*:

13.1.1 *Ribbon and Wire*— Ribbon and wire shall be examined to verify that the dimensions, unit weight, and workmanship are in accordance with the applicable requirements.

13.1.2 *Bar and Ingot*— Bar and ingot shall be examined to verify that the unit weight, marking, and workmanship are in accordance with the applicable requirements.

13.2 *Alloy Composition*—In case of dispute, the chemical analysis shall be as agreed by buyer and seller.

13.3 *Alloy Freezing Point*—This shall be determined by plotting on a time temperature graph the results of a room temperature cooldown to 72°F (22°C) on a 2-lb (1000-g) sample of alloy, non-stirred using an ASTM approved thermometer. An example of commercial equipment available for this is a Leeds and Northrop Speedomax W.[4] Use of a differential scanning calorimeter is also permissible under this section (Dupont Model 912[5] or equivalent).

13.4 *Powder Mesh Size*— A minimum of 98 % of the powder shall pass through the appropriate size sieve (see 4.1.3) in order to be classified for that mesh size.

[4] Leeds and Northrop Speedomax W, available from Leeds and Northrop, MD 363-TR North Wales, PA 19454 has been found suitable for this purpose.

[5] Differential Scanning Calorimeter Dupont Model 912, available from DuPont Instrument Systems Division, Wilmington, DE 19898 has been found suitable for this purpose.

14. Inspection

14.1 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 in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified unless disapproved by the purchaser. The purchaser reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure that supplies and services conform to prescribed requirements.

14.1.1 *Test Equipment and Inspection Facilities*—Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspection shall be established and maintained by the supplier.

15. Rejection and Rehearing

15.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection shall be reported to the producer or supplier promply and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make a claim for a rehearing.

16. Certification

16.1 When specified in the purchase order or contract, a producer's or supplier's certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

17. Product Marking

17.1 The producer's name or trademark shall be stamped or cast on each bar or ingot. The alloy grade designation or nominal composition, or both, shall be stamped on each bar or ingot for identification along with the specification number.

17.2 Each spool or container shall be marked to show the specification number, type designation, dimensions, and unit weight of wire or other form and lot number. The producer's name or trademark shall be marked on the spool or container.

18. Packaging and Package Marking

18.1 The material shall be packaged to provide adequate protection during normal handling and transportation. The type of packaging and gross weight of containers shall, unless otherwise agreed upon, be at the producer's or supplier's discretion, provided that they are such as to ensure acceptance by common or other carriers for safe transportation to the delivery point.

18.1.1 For bar and ingot a lot number shall be marked on each shipping container or inside package.

18.1.2 When special preservation, packaging and packing requirements are agreed upon between purchaser and supplier, marking for shipment of such material shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

18.2 Each shipping container shall be marked with the purchase order number, unit weight, and producer's name or trademark.

19. Keywords

19.1 bismuth; cadmium; freezing point; fuses; fusible alloys; indium; ingot; joining; lead; liquidus; low melting point alloys; powder; silver; solder; solidus; tin; wire