

**Beryllium Aluminum Alloy Investment Castings**  
**64.9Be - 30Al - 3Ag - 1Co - 0.75Ge**  
**As Cast**

**1. SCOPE:**

**1.1 Form:**

This specification covers a beryllium aluminum alloy in the form of investment castings.

**1.2 Application:**

These castings have been used typically for optical support structures and other parts requiring higher stiffness, damping capability, and lighter weight than cast aluminum alloys with similar strength levels, but usage is not limited to such applications.

**1.3 Safety - Hazardous Materials:**

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

**2. APPLICABLE DOCUMENTS:**

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

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**SAE WEB ADDRESS:**

## 2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or [www.sae.org](http://www.sae.org).

AMS 2360 Room Temperature Tensile Properties of Castings  
 AMS 2694 Repair Welding of Aerospace Castings  
 AMS 2804 Identification, Castings  
 AMS-STD-2175 Castings, Classification and Inspection of

## 2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or [www.astm.org](http://www.astm.org).

ASTM E 8 Tension Testing of Metallic Materials  
 ASTM E 8M Tension Testing of Metallic Materials (Metric)  
 ASTM E 155 Reference Radiographs for Inspection of Aluminum and Magnesium Castings  
 ASTM E 439 Chemical Analysis of Beryllium  
 ASTM E 1417 Liquid Penetrant Examination  
 ASTM E 1742 Radiographic Examination

## 3. TECHNICAL REQUIREMENTS:

## 3.1 Composition:

Castings shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 439, by spectrochemical methods, or by other analytical methods acceptable to purchaser (See 8.2.1 and 8.2.2).

TABLE 1 - Composition

Element	min	max
Beryllium	61.1	68.6
Silver	2.65	3.35
Cobalt	0.65	1.35
Germanium	0.55	0.95
Iron	--	0.20
Silicon	--	0.25
Other (total)	--	0.30
Aluminum (3.1.1)	remainder	

3.1.1 Determination not required for routine acceptance.

## 3.2 Melting Practice:

Castings and specimens shall be poured at casting vendor's facility either from a melt (See 8.2.4) of a master heat, or directly from a master heat (See 8.2.5).

- 3.2.1 Revert (gates, sprues, risers, and rejected castings) may be used only in the preparation of master heats; revert shall not be remelted directly without refining for pouring of castings. Melting of revert creates a new master heat.
- 3.2.1.1 The metal for castings and specimens shall be melted and poured under vacuum without loss of vacuum between melting and pouring. When authorized by purchaser (See 8.2.6), protective atmosphere may be used in lieu of vacuum for pouring of castings.
- 3.2.2 Portions of two or more qualified master heats (See 3.4.2) may be melted together and poured into castings using a procedure authorized by purchaser.
- 3.2.3 If modifications, such as alloy additions or replenishments (See 8.2.10), are made by the vendor at remelt, vendor shall have a written procedure acceptable to purchaser which defines the controls, test, and traceability criteria for both castings and separately-cast specimens. Control factors of 4.4.2.2 shall apply.
- 3.2.4 When authorized by purchaser, a master heat may be one or more melts made to a standard practice using raw materials from the same lots, revert, or mixtures of revert and raw materials from the same lots. If revert is used, it shall be traceable to an originating melt or melts of raw material only, from the same lots.
- 3.3 Condition:
- Castings shall be delivered in the as cast condition.
- 3.4 Test Specimens:
- Specimens shall be either separately-cast, integrally-cast (See 8.2.7), or machined from a casting, and shall conform to 3.2.
- 3.4.1 If specimens are separately-cast, vendor shall have a written procedure acceptable to purchaser. Control factors of 4.4.2.2 shall apply.
- 3.4.2 Each master heat shall be qualified by evaluation of chemical and tensile specimens.
- 3.4.2.1 If alloy additions or replenishments are made at remelt as in 3.2.3, the frequency of sampling and testing used by the vendor for qualification to 3.4.2 shall be acceptable to purchaser.
- 3.4.2.2 Tensile tests of 3.4.2 are not required if these tests are conducted using integrally-cast specimens (4.3.3.2) or specimens from a casting (4.3.3.3).
- 3.4.3 Chemical Analysis Specimens: Shall be of any convenient size and shape.
- 3.4.4 Tensile Specimens: Shall be of standard proportions in accordance with ASTM E 8 or ASTM E 8M (See 8.3).

3.4.4.1 Separately-cast and integrally-cast specimens may be either cast to size, or cast oversize and subsequently machined to 0.250 inch (6.35 mm) diameter at the reduced parallel gage section.

3.4.4.2 When integrally-cast specimens and specimens machined from a casting are specified (See 8.2.3), specimen size and location shall be agreed upon by purchaser and vendor (See 8.2.8 and 8.5).

### 3.5 Properties:

Conformance shall be based upon testing of integrally-cast specimens unless purchaser specifies specimens machined from a casting.

3.5.1 Room Temperature Tensile Properties: Shall be as specified in Table 2, determined in accordance with ASTM E 8 or ASTM E 8M. Properties other than those listed may be defined as specified in AMS 2360.

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	35.0 ksi
Yield Strength at 0.2% Offset	25.0 ksi
Elongation in 2 Inches (50.8 mm), min	1%

### 3.6 Quality:

3.6.1 Castings, as received by purchaser, shall be uniform in quality and condition. Castings shall, to the extent defined in subsequent paragraphs or in supplemental standards specified by purchaser, be free from porosity, foreign materials, and imperfections detrimental to their performance. Castings shall be free of cracks, laps, hot tears, and cold shuts, and free of scale and other surface contamination which would obscure defects.

3.6.2 Castings shall be produced under radiographic control. This control shall consist of radiographic examination of each casting part number until foundry manufacturing controls in accordance with 4.4.2 have been established. Additional radiography shall be conducted in accordance with the frequency of inspection specified by purchaser, or as necessary to ensure continued maintenance of internal quality.

3.6.2.1 Radiographic inspection shall be conducted in accordance with ASTM E 1742 or other method specified by purchaser.

3.6.3 When specified, additional nondestructive testing shall be performed as follows:

3.6.3.1 Fluorescent penetrant inspection in accordance with ASTM E 1417 or other method specified by purchaser.

3.6.4 Acceptance standards for radiographic, fluorescent penetrant, visual, and other inspection methods shall be agreed upon by purchaser and vendor (See 8.2.8). AMS-STD-2175 may be used to specify acceptance standards (casting grade) and frequency of inspection (casting class). If ASTM E 155 is used as an acceptance standard, the use of supplemental plates as agreed upon by purchaser and vendor is required to control discontinuities unique to beryllium-aluminum eutectic alloys.

3.6.5 Castings shall not be peened, plugged, impregnated, or welded unless authorized by purchaser.

3.6.5.1 When authorized by purchaser, welding in accordance with AMS 2694 or other welding program acceptable to purchaser may be used.

#### 4. QUALITY ASSURANCE PROVISIONS:

##### 4.1 Responsibility for Inspection:

The vendor of the product shall supply all samples for vendor's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the castings conform to the specified requirements.

##### 4.2 Classification of Tests:

4.2.1 Acceptance Tests: Composition (3.1), tensile properties (3.5.1), and quality (3.6) are acceptance tests and shall be performed as specified in 4.3.

4.2.2 Periodic Tests: Radiographic soundness (3.6.2) is a periodic tests and shall be performed at a frequency selected by vendor, unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: All technical requirements are preproduction tests and shall be performed on specimens or sample castings (4.2.3), when a change in control factors occurs (4.4.2.2), or when purchaser deems confirmatory testing to be required.

##### 4.3 Sampling and Testing:

The minimum testing performed by vendor shall be in accordance with the following:

4.3.1 One chemical analysis specimen or a casting from each master heat shall be tested for conformance with Table 1; if 3.4.2.1 applies, test frequency shall be acceptable to purchaser.

4.3.2 One preproduction casting in accordance with 4.4 shall be tested to the requirements of the casting drawing and to all applicable technical requirements.

4.3.2.1 Dimensional inspection sample quantity shall be as specified by purchaser.

4.3.3 Tensile tests shall be conducted to determine conformance with Table 2. Sampling and test frequency is dependent upon the type and origin of specimen specified by purchaser (See 3.4.4) or

selected by vendor (See 4.3.3.4). When 3.4.2.1 applies, test frequency shall be acceptable to purchaser.

- 4.3.3.1 For separately-cast specimens, at least one specimen from each master heat shall be tested for conformance to properties specified by purchaser.
- 4.3.3.2 For integrally-cast specimens, at least two specimens from each master heat (See 8.2.5) shall be randomly selected and tested to 3.5.1.1.
- 4.3.3.3 For specimens machined from a casting, at least one casting shall be randomly selected from each master heat and tested at each location shown on the engineering drawing to 3.5.1.2.
  - 4.3.3.3.1 When size and location of specimens are not shown, at least two test specimens shall be tested, one from the thickest section and one from the thinnest section. Once established under 4.4.2.2, test locations may be changed only as agreed upon by purchaser and vendor.
- 4.3.3.4 When acceptable to purchaser, specimens machined from a casting may be used in lieu of both separately-cast and integrally-cast specimens, and integrally-cast specimens may be used in lieu of separately-cast specimens. In each case, the resultant properties shall conform to the requirements of 3.5.1 or to alternative requirements specified by purchaser (See 8.5).
  - 4.3.3.4.1 When specimens are selected for test as in 4.3.3.4 from an origin other than that specified by purchaser, vendor shall include in the report of 4.5 a description of the origin of the specimen that was tested.
- 4.3.3.5 When casting size, section thickness, gating method, or other factors do not permit conformance with 4.3.3.2 or 4.3.3.3, sampling, testing, and properties shall be agreed upon by purchaser and vendor.
- 4.3.4 Castings shall be inspected in accordance with 3.6 to the methods, frequency, and acceptance standards specified by purchaser.
- 4.4 Approval:
  - 4.4.1 Sample casting(s) from new or reworked master patterns produced under the casting procedure of 4.4.2 shall be approved by purchaser before castings for production use are supplied, unless such approval be waived by purchaser.
  - 4.4.2 For each casting part number, vendor shall establish parameters for process control factors that will consistently produce castings and test specimens meeting the requirements of the casting drawing and this specification. These parameters shall constitute the approved casting procedure and shall be used for production of subsequent castings and test specimens. If necessary to make any change to these parameters, vendor shall submit a statement of the proposed change for purchaser reapproval. When requested, vendor shall also submit test specimens, sample castings, or both to purchaser for reapproval.

- 4.4.2.1 Production castings produced prior to receipt of purchaser's approval shall be at vendor's risk.
- 4.4.2.2 Control factors for producing castings and separately-cast specimens include, but are not limited to, the factors shown below. Supplier's procedures shall identify tolerances, ranges, and/or control limits, as applicable. Control factors for separately-cast test specimens must generally represent, but need not be identical to, those factors used for castings (See 3.2.3 and 3.4.1):

Composition of ceramic cores, if used  
Arrangement and number of patterns in the mold (including integrally-cast specimens, if applicable)  
Size, shape, and location of gates and risers  
Mold refractory formulation  
Grain refinement methods, if applicable  
Mold backup material (weight, thickness, or number of dips)  
Type of furnace, vacuum, or protective atmosphere, and charge for melting  
Mold preheat and metal pouring temperatures  
Fluxing or deoxidation procedure  
Replenishment and alloy addition procedures, if applicable  
Time molten metal is in furnace  
Solidification and cooling procedures  
Cleaning operations (mechanical and chemical)  
Straightening  
Final inspection methods  
Location and size of integrally-cast specimens machined from a casting, if applicable

- 4.4.2.2.1 Any of the control factors for which parameters are considered proprietary by vendor may be assigned a code designation. Each variation in such parameters shall be assigned a modified code designation.
- 4.4.2.2.1.1 Unless otherwise agreed upon by purchaser and vendor, purchaser shall be entitled to review proprietary control factor details and coding at the vendor's facility.

#### 4.5 Reports:

The vendor of castings shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements. This report shall include the purchase order number, master heat identification, AMS 7918, part number, quantity, and source of any tensile property specimens used according to 4.3.3.4.1.

#### 4.6 Resampling and Retesting:

If the results of a valid test fail to meet requirements, two additional specimens in accordance with 4.3 from the same master heat, or modified melt (See 3.2.3), as applicable, shall be tested for each nonconforming characteristic. The results of each additional test, and the average of the results of all tests (original and retests) shall meet the specified requirements; otherwise, the master heat shall be rejected. Results of all tests shall be reported.

4.6.1 A test may be declared invalid if failure is due to specimen mispreparation, test equipment malfunction, improper test procedure, or the presence of random process defects such as inclusions or gas holes in a tensile specimen.

5. PREPARATION FOR DELIVERY:

5.1 Identification:

Unless otherwise specified by purchaser, individual castings shall be identified in accordance with AMS 2804.

5.2 Individual castings shall be traceable to their conditions of manufacture and inspection up to and including the point of acceptance by purchaser.

5.3 Packaging:

Castings shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the castings to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT:

A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

7. REJECTIONS:

Product not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES:

8.1 A change bar (|) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of a specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revision. Change bars and (R) are not used in original publications, nor in specifications that contain editorial changes only.

8.2 Terms used in AMS are clarified in ARP 1917 and defined as follows:

8.2.1 "Acceptable to Purchaser": Does not require prior written approval from purchaser, but allows vendor to make a decision and purchaser the right to disapprove the decision.

8.2.2 "Purchaser": The cognizant engineering organization responsible for casting design and fitness for use, or the designee of this engineering organization.

- 8.2.3 “Specified”: Requires documented instruction from purchaser through casting drawing, purchase order, specification, or other engineering documentation.
- 8.2.4 “Melt”: All castings poured from a single furnace charge. Also referred to as remelt, submelt, heat, or subheat.
- 8.2.5 “Master Heat”: Refined metal (See 8.2.10) of a single furnace charge, poured directly into castings and/or converted into ingot for remelting in accordance with 3.2. One or more melts can be poured from a master heat.
- 8.2.6 “Authorized by Purchaser”: Requires prior written approval from the purchaser.
- 8.2.7 “Integrally-Cast Specimen”: An attached specimen that is cast in the mold. The casting drawing may identify a specific location for the attachment of each integrally-cast specimen. A correlation between test results from integrally-cast specimens and specimens machined from the casting may exist which will allow for reduction or elimination of specimens machined from castings.
- 8.2.8 “Agreed Upon by Purchaser and Vendor”: Requires concurrence of both purchaser and vendor. Such concurrence is typically documented by way of the casting drawing, purchase order, or other engineering documentation.
- 8.2.9 “Lot”: For visual and nondestructive testing, an inspection lot shall consist of castings of the same part number, manufactured under the same process control parameters of 4.4.2.2, and submitted for those tests in a single group.
- 8.2.10 “Refined Metal”: Metal derived from raw materials in the form of virgin elements, master alloy, and/or revert melted in any combination, replenished as needed, fluxed for nonmetallics, and degassed as necessary. Melting revert creates a new master heat.
- 8.3 ASTM E 8M may be used for establishing dimensions in SI units, except that the gage length shall be equal to four times the nominal diameter of the reduced section of the tensile specimen.
- 8.4 Dimensions and properties in inch/pound units and the Fahrenheit temperatures are primary; dimensions and properties in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.
- 8.5 Purchase documents should specify not less than the following:
- AMS 7918
  - Part number or pattern number of castings desired
  - Quantity of castings desired
  - Size, location, and properties of specimens for room temperature tensile testing when integrally-cast or machined-from-casting properties are specified (See 3.4.4.2 and 3.5)
  - Inspection methods and acceptance standards (See 3.6.4).

8.6 Key Words:

Beryllium, aluminum, cast, investment