SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS7510 | REV. B

Issued 1977-01
Revised 2006-09
Reaffirmed 2012-02

Superseding AMS7510A

Magnets, Rare-Earth/Cobalt, Permanent Powder-Metallurgy Product

RATIONALE

AMS7510B has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

1.1 Form

This specification and its supplementary detail specifications cover commonly-available rare-earth/cobalt permanent magnets produced by powder metallurgy.

1.2 Application

This product has been used typically for components of electrical, electronic, and magnetic devices, but usage is not limited to such applications.

1.3 Classification

The rare-earth/cobalt permanent magnets shall be as specified in the applicable detail specification, wherein each material is defined by chemical composition and energy level. An example is shown in 8.2. The material covered by each detail specification appears as part of the title.

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.

2.1 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, or www.astm.org.

ASTM A 341/A 341M	Direct-Current Magnetic Properties of Materials Using D-C Permeameters and the Ballistic Test Methods
ASTM B 193	Resistivity of Electrical Conductor Materials
ASTM B 311	Density Determination of Powder Metallurgy (PM) Materials Containing Less Than Two Percent Porosity

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS7510B

ASTM C 518	Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM E 8	Tension Testing of Metallic Materials
ASTM E 92	Vickers Hardness of Metallic Materials
ASTM E 228	Linear Thermal Expansion of Solid Materials with a Vitreous Silica Dilatometer
ASTM E 354	Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

2.2 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, or http://assist.daps.dla.mil/quicksearch/.

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes

3. TECHNICAL REQUIREMENTS

3.1 Detail Specification

The requirements for a specific product shall consist of all the requirements specified herein in addition to requirements specified in the applicable detail specification. In case of conflict between requirements of this basic specification and the applicable detail specification, requirements of the detail specification shall govern.

3.2 Composition

Shall be RCo5, where R is a rare-earth element or a combination of rare-earth elements, such as lanthanum (La), samarium (Sm), praseodymium (Pr), neodymium (Nd), cerium (Ce), or Misch metal (MM). Nominal composition shall be as specified in the applicable detail specification. Variations from the nominal composition will be permitted if the magnetic property requirements are met. Composition shall be determined by wet chemical analysis in accordance with ASTM E 354, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

3.3 Condition

Shall be as specified in the applicable detail specification. When ordered in the magnetized condition, each magnet shall be suitably keepered.

3.4 Properties

Magnets shall conform to the following requirements:

3.4.1 Magnetic Properties (See 8.3)

3.4.1.1 Magnetic Characteristics

Shall be as specified in the applicable detail specification, taken from direct current hysteresis data determined in accordance with ASTM A 341 at 20 to 30 °C (68 to 86 °F) on fully magnetized test specimens. The first quadrant data indicate the magnetization process and the field required (H_s) in a closed path to obtain saturation. The residual induction (B_r), the induction coercive force (H_c), the energy product $(BH)_m$, and the intrinsic coercive force (H_{ci}) shall be reported.

3.4.1.2 Performance as a Function of Temperature

Shall be as specified in the applicable detail specification, determined in accordance with 4.5.1.1 by the reversible coefficient expressed over a specified temperature range, and the irreversible loss of magnetism after exposure to a specified maximum temperature determined in accordance with 4.5.1.2, when the loss of magnetization is expressed in terms of the geometry or permeance coefficient of the specimen. The maximum service temperature to which a magnet can be subjected without any long-term structural or metallurgical instability shall be as shown in the applicable detail specification.

3.4.1.3 Individual Magnetic Component Evaluation

When specified, an individual magnetic component shall be evaluated by comparison with a standard reference magnet at one or more points on its hysteresis loop, determined by magnetic circuit parameters simulating the actual device circuit and in accordance with 4.5.1.3. The reference level and acceptance standard shall be as agreed upon by purchaser and vendor.

3.4.2 Properties, Other than Magnetic

Shall be as specified in the applicable detail specification, determined in accordance with the ASTM methods specified in 4.5.2. Variation from the specified values will be permitted if the magnetic requirements are met.

3.5 Quality

3.5.1 Magnets, as received by purchaser, shall be uniform in quality and condition, as free from foreign material as commercially practicable, and free from imperfections detrimental to usage of the magnets.

3.5.2 All magnet surfaces shall be free from foreign materials that would hold or collect extraneous particles on the magnet surface in the unmagnetized condition. (See 8.4).

3.5.3 Magnets shall be free of loose chips and burrs, and free from imperfections that would result in loose chips or particles under normal conditions of handling, shipping, or use of the magnet. A chipped edge or surface shall be acceptable if not more than 10% of the edge or 5% of the surface is removed, provided that no loose particles remain on the edge or surface, and that the magnet under examination meets the magnetic requirements.

3.5.4 Other imperfections, such as minor hairline cracks, porosity, or voids of the type commonly found in sintered metallic products, are acceptable if the magnet meets the minimum magnetic performance criteria agreed upon and, as tested by the magnet manufacturer, the imperfections do not create loose particles or other conditions which would interfere with proper functioning of the end device, and visual imperfections do not extend through more than 25% of any cross section.

3.5.5 When specified, high-purity magnets shall meet standards as agreed upon by purchaser and vendor.

3.6 Sizes and Tolerances

Sizes shall be as specified on the applicable drawing; tolerances shown in Table 1 shall apply.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of magnets 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 perform any confirmatory testing deemed necessary to ensure that the magnets conform to specified requirements and the applicable detail specification.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Determine conformance to requirements for composition (3.2), magnetic characteristics (3.4.1.1), reversible coefficient (3.4.1.2), hardness and density (from detail specification), quality (3.5), tolerance (3.6), and, when specified, individual magnetic component evaluation (3.4.1.3), are acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests

Determine conformance to all technical requirements of this specification and to the applicable detail specification are preproduction tests and shall be performed prior to or on the first-article shipment of a magnet to a purchaser, when a change in material, processing, or both requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.3 Sampling

Sufficient magnets shall be selected from each lot to perform each test in duplicate; a lot shall be all magnets of the same size and form manufactured under the same conditions from the same batches of raw materials in a continuous production run and presented for vendor's inspection at one time.

4.3.1 Sampling Schedule

Shall be in accordance with Single Sampling for Normal Inspection, General Inspection Level II, with an Acceptance Quality Level (AQL) of 1.0 specified in MIL-STD-105 as shown in Table 2. Test specimens shall be taken at random throughout the lot.

4.4 Approval

4.4.1 Sample magnets shall be approved by purchaser before magnets for production use are supplied, unless such approval is waived by purchaser. Results of tests on production magnets shall be essentially equivalent to those on the approved sample.

4.4.2 Vendor shall use composition, manufacturing procedures and processes, and methods of inspection on production magnets that are essentially the same as those used on approved sample magnets. If necessary to make any change in composition, processes, or manufacturing procedures, vendor shall submit for reapproval a statement of the proposed changes in material, processing, or both and, when requested, sample magnets. Production magnets made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods

4.5.1 Magnetic Properties

4.5.1.1 Reversible Coefficient

The magnetic characteristics of fully-magnetized test specimens shall be determined at 20 to 30 °C (68 to 86 °F) in accordance with ASTM A 341. The specimens shall be heated to the temperature specified in the applicable detail specification, held at temperature sufficiently long for the entire specimen to reach the test temperature, and cooled to room temperature in still air. The temperature cycling shall be repeated to achieve at least three complete cycles in a continuous operation prior to determining the magnetization change. After the third cycle, the magnetization shall be recorded at the upper and lower temperatures. The total change in magnetization, as indicated by the point of intersection of the hysteresis loop and the load line specified in the applicable detail specification (normally B/H = 1.0), divided by the temperature span, in Celsius degrees, shall be the reversible coefficient.

4.5.1.2 Irreversible Loss of Magnetization

The magnetic characteristics of fully-magnetized specimens shall be determined at 20 to 30 °C (68 to 86 °F) in accordance with ASTM A 341; a single value of magnetization shall be recorded. The specimens shall be heated to the temperature specified in the applicable detail specification, held at temperature sufficiently long for the entire specimen to reach the test temperature, cooled to room temperature, and the magnetization determined a second time. The difference of the magnetization value between the first and the second room-temperature determinations, expressed as a percentage of the original room-temperature magnetization value, is the irreversible loss.

4.5.1.3 Individual Magnetic Component Test

A method of test shall be chosen, which shall cause the magnet component under test to operate at one or more points on its hysteresis loop, established by magnetic circuit parameters, to simulate its performance in the final device or equipment. The level of induction or magnetomotive force can be determined by generation of a voltage or by a Hall effect gauss meter. The acceptability of the magnet shall be judged by comparison of the readings with those of a reference magnet that represents a known level of performance in the device. An alternate reference may be an absolute level of a defined magnetic quantity, such as induction; the reference level shall be as agreed upon by purchaser and vendor.

4.5.2 Properties Other than Magnetic

Shall be determined in accordance with the following:

Requirement	Test Method
Tensile Strength	ASTM E 8
Hardness	ASTM E 92
Density	ASTM B 311
Resistivity	ASTM B 193
Thermal Conductivity	ASTM C 518
Thermal Expansion	ASTM E 228

4.6 Reports

4.6.1 The vendor of magnets shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements (see 4.2.1) and stating that the magnets conform to the other technical requirements of this specification and to the applicable detail specification. This report shall include the purchase order number, AMS 7510B and its applicable detail specification number and revision letter if any, vendor's material designation, lot number, size or part number, date of manufacture, and quantity.

4.6.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 7510B and its applicable detail specification number and revision letter if any, contractor or other direct supplier of magnets, part number, and quantity. When magnets for making parts are produced or purchased by the parts vendor, that vendor shall inspect each lot of magnets to determine conformance to specified requirements and the applicable detail specification and shall include in the report either a statement that the magnets conform or copies of laboratory reports showing the results of tests to determine conformance.

4.7 Resampling and Retesting

If any specimen used in the above tests fails to meet the specified requirements, disposition of the magnets may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the magnets represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY

5.1 Identification

Shall be as agreed upon by purchaser and vendor, except that the unit and exterior package identification shall include not less than the following information:

RARE-EARTH/COBALT PERMANENT MAGNETS, (code from applicable detail specification)
(magnetized or unmagnetized)
AMS 7510B and Applicable Detail Specification
MANUFACTURER'S IDENTIFICATION _____
PURCHASE ORDER NUMBER _____
SIZE OR PART NUMBER _____
LOT NUMBER _____
QUANTITY _____

5.2 Packaging

5.2.1 Magnets 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 magnets to ensure carrier acceptance and safe delivery.

5.2.1.1 Special packaging and labeling requirements shall be applied to magnetized material as required by applicable codes and regulations.

6. ACKNOWLEDGEMENT

A vendor shall mention this specification number and the applicable detail specification number and their revision letters, if any, in all quotations and when acknowledging purchase orders.

7. REJECTIONS

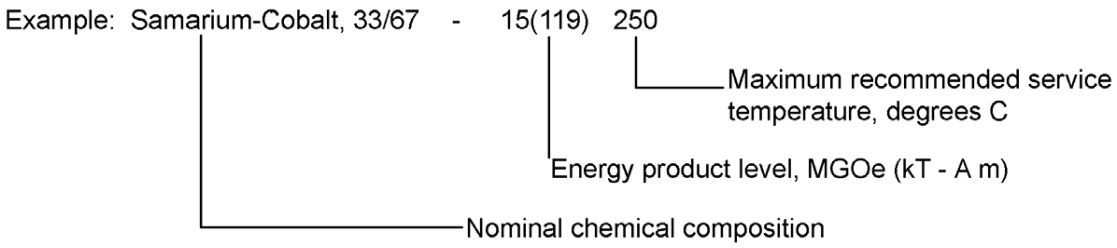
Magnets not conforming to this specification and to the applicable detail specification, or to modifications authorized by purchaser, will be subject to rejection.

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 this specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revisions. Change bars and (R) are not used in original publications, nor in specifications that contain editorial changes only.

8.2 Classification System (See 1.3)

The classification system used to identify each detail specification is shown by the following example of the second line in the title:



8.3 Magnetic Characteristics - Design

The nominal values for the magnetic characteristics may be used as a design value in noncalibrated devices. For use in calibrated devices, a minimum for a property should be determined by specific data exchange and agreement between purchaser and vendor.

8.4 Inspection Methods

Normally, inspection methods, such as use of penetrants, magnetic particle analysis, and ultrasonic or radiographic inspection are not acceptable methods for judging the quality of sintered rare-earth magnets. In cases where the magnet is expected to withstand abnormal conditions or stresses, such conditions should be specified and a mutually acceptable test devised to ensure the magnet will not fail under the specified service conditions. Such tests should duplicate service conditions with appropriate safety factors.

8.5 Terms used in AMS are clarified in ARP1917.

8.6 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.

8.7 Purchase documents should specify not less than the following:

AMS 7510B and the applicable detail specification
Condition desired
Size or part number of magnets desired
Quantity of magnets desired
Method of identification (See 5.1).

PREPARED BY AMS COMMITTEE "F"