

# AERONAUTICAL MATERIAL SPECIFICATIONS

AMS 2640F

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## MAGNETIC PARTICLE INSPECTION

1. **ACKNOWLEDGMENT:** A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.
2. **APPLICATION:** To detect the presence of small grinding or quenching cracks, seams, non-metallic inclusions, and other imperfections on and immediately below the surface of magnetizable materials.
  - 2.1 When this specification number appears on the drawing or is required by written instructions, magnetic particle inspection shall be performed on parts which have been fully heat treated and whose surfaces have been completely finish machined and electroplated when specified, except that if plating thickness is sufficient to prevent detection of defects, the inspection shall be performed immediately prior to plating. If surface treatments are to be applied, an inspection may be performed before such treatments. If surface treatments are of the type which may cause cracks, then an inspection shall be performed after such treatments, using a magnetic substance with a suitable color. This paragraph shall not be interpreted as prohibiting additional magnetic particle inspections during manufacture of parts.
  - 2.2 Either fluorescent or non-fluorescent magnetic particle inspection may be used unless one or the other is specifically called for on the drawing or in other inspection procedure instructions.
3. **WET PROCESS:** Unless otherwise specified, all materials and parts shall be inspected by the wet process, using either the continuous or the residual method as warranted by the particular material or part undergoing inspection.
  - 3.1 **Materials and Control:**
    - 3.1.1 **Liquid Vehicle:** Shall be a light petroleum distillate, unless use of water with a suitable corrosion inhibitor is specifically permitted. The petroleum distillate shall be similar in properties to AMS 3160.
    - 3.1.2 **Magnetic Substance:** Shall be suitable for the purpose and preferably in paste form, but dry powder may be used provided satisfactory dispersion in the liquid vehicle is effected. The magnetic substance shall conform to 3.1.3.1 or 3.1.3.2.
    - 3.1.3 **Suspensions:** The viscosity of the petroleum distillate vehicle shall never exceed 5.0 centistokes (42.5 SUS) at operating temperature. Suitable means shall be provided for agitating the suspension. The paste suspension shall consist of magnetic substance of adequate concentration in the liquid vehicle to produce clear indications of imperfections with the magnetizing procedure, type of paste, and examining method used.

Section 7C of the SAE Technical Board rules provides that: "All technical reports, specifications, standards, and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no attempt to conform to or to be guided by any technical report, in formulating and awarding patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against infringement of patents."

∅ 3.1.3.1 Non-Fluorescent Paste Suspension:

3.1.3.1.1 When petroleum distillate is used as the vehicle, a concentration of 1.0 - 1.5 oz by weight of solids per gallon of suspension as applied is recommended for the residual method; a concentration of 1.5 - 2.0 oz by weight of solids per gallon of suspension is recommended for the continuous method.

3.1.3.1.2 When water is used as the vehicle, a concentration of 2.0 - 3.0 oz by weight of solids per gallon of suspension is recommended for the special water-suspendible paste; a concentration of 0.8 - 1.2 oz by weight of solids per gallon of suspension is recommended when the paste usually used with petroleum distillate is used with a wetting agent.

3.1.3.2 Fluorescent Paste Suspension: When either petroleum distillate or water is used as the vehicle, a concentration of 0.10 - 0.20 oz by weight of solids per gallon of suspension is recommended with either the special water-suspendible paste or the paste usually used with petroleum distillate.

3.1.4 Test of Suspension: Suspensions shall be tested as often as necessary to maintain proper control; the following is a satisfactory method.

3.1.4.1 After not less than 30 min. continuous pump circulation of the suspension, fill a 100 ml graduated cylinder, cone, or centrifuge tube to the 100 ml mark with the suspension directly from the hose or other device used for pouring it over the part in making a test, demagnetize, and let stand for 30 min., or until the solid matter is apparently all down. Decant the clear liquid as far as practicable without loss of magnetic substance. Refill the tube containing magnetic substance, using AMS 3160 solvent or other light hydrocarbon distillate or benzol for petroleum distillate based suspensions and using water for water based suspensions, shake well, and let stand 1 hr to settle out a second time. Read the volume of settled solids in the tube. Convert the volume of settled solids per 100 ml of suspension to ounces of magnetic substance per gallon of suspension by use of the equation  $W = XV$  where:

W = weight of solids per gal of suspension.

X = multiplying factor from the table below.

V = volume of settled solids in 100 ml of suspension.

The value of X shall be as follows:

Type of Paste	Type of Vehicle	X
Non-fluorescent, distillate-suspendible	Petroleum Distillate	1.5
Non-fluorescent, distillate-suspendible	Water	1.0
Non-fluorescent, water-suspendible	Water	1.6
Fluorescent, distillate-suspendible	Petroleum Distillate	1.0
Fluorescent, distillate-suspendible	Water	1.0
Fluorescent, water-suspendible	Water	1.0

3.1.4.1 (Continued)

This test shall not be construed to represent a measure of the total amount of magnetic substance present in the tank, much of which may be lying unmixed on the bottom.

3.1.4.1.1 Other methods of test which produce equivalent results may be substituted for the above method.

3.1.4.1.2 Water based suspensions shall be tested to ensure presence of corrosion inhibitor and wetting agent by "water break", chemical analysis, or other suitable method.

3.1.5 Renewal of Suspension: A suspension shall be discarded and replaced before the vehicle exceeds a viscosity of 5.0 centistokes (42.5 SUS), or when it becomes discolored by oil or contaminated with lint or other foreign substance to the extent that proper distribution and concentration of the suspension or the intensity, character, or definition of the deposit of the magnetic substance is affected.

3.2 Operation: The suspension shall be applied to the magnetized part by flowing from a hose, pouring, or immersion, either while the magnetizing current is flowing (continuous method) or after the part has been magnetized and the current turned off (residual method).

4. DRY PROCESS: May be used when permitted by the Inspection and Engineering Departments for special applications where it might offer certain advantages.

4.1 Material: The magnetic substance shall be suitable for the purpose and in the form of a dry powder.

4.2 Operation: The powder shall be sprayed or dusted directly on the part and the part lightly tapped or otherwise vibrated in order to obtain efficient distribution of the powder. Care shall be exercised to avoid excessive use of powder as such use will interfere with effective indication of defects. Care shall be used in removing excess powder to avoid disturbing indications present. The most effective magnetizing method shall be used.

5. PROCEDURE:

5.1 Magnetic particle inspection shall be performed on a part in such a manner as to ensure satisfactory detection of all imperfections. A complete inspection test shall consist of one or more distinct magnetizing, inspection, and demagnetizing operations so conducted that the lines of force will be approximately at right angles to any discontinuity that may be in the part.

5.2 When the fluorescent magnetic particle process is used, the parts shall be examined in a darkened area under suitable "black light".

5.3 The surfaces of all materials and parts shall be properly cleaned to free them from oil, grease, dirt, or other contamination which might interfere with the proper distribution and concentration, or with the intensity, character, or definition of the deposit of the magnetic substance.

5.4 Oil holes and other openings which lead to areas from which the magnetic substance cannot be easily removed should be plugged with grease, or similar non-abrasive material readily soluble in engine oil, before the part is magnetized.

- 5.5 Direct current, as produced by batteries, generators, or rectifiers, shall be used for magnetizing unless alternating current is proven to be satisfactory for specific applications.
- 5.6 The magnetic field shall be induced in a part by one or more methods and in varying directions. The two methods used to produce such magnetic fields are: (1) Bi-Polar or Longitudinal, (2) Circular. The longitudinal method is produced by placing a part between the poles of an electro-magnet or within a solenoid coil. The circular method is produced by passing a high amperage, low voltage current through the part or through a conductor which might be placed through an opening in the part. The magnetic field shall be of suitable intensity and direction to reveal all indications which might be cause for rejection. The magnetic substance shall be applied to the magnetized part by the wet process, unless the dry process has been specifically approved for certain special conditions.
- 5.7 The current used for magnetizing should not be such that saturation results. Size and shape of parts under test shall be considered and current of satisfactory value selected to adequately magnetize various sections of the part. In some cases it may be necessary to magnetize a part by sections to produce the proper flux density and to prevent misinterpretation of the resulting indications. Saturation may be identified by excessive accumulations of magnetic substance at slight changes of section or by pronounced indication of grain flow.
- 5.8 It may be feasible to magnetize several parts simultaneously in the same magnetic field. This may be done by placing several parts in a coil in the same position or by means of a conductor placed through a hole in the parts. An example of this method would be placing a number of nuts, washers, etc., on a bar conductor.
- 5.9 Parts shall be satisfactorily demagnetized after each magnetizing and inspection operation, unless subsequent magnetizations are of sufficient intensity to mask the effects of the preceding magnetizations. Parts shall be satisfactorily demagnetized after the final inspection.
- 5.10 The inspected parts shall be cleaned at this or some subsequent stage to remove the retained magnetic substance and any material used to plug oil holes.
6. MARKING: Wherever practicable the letter "M" shall be legibly marked on all parts which have have satisfactorily passed the magnetic particle inspection, except those completely ground, polished, or otherwise finished because of functional operation. Small parts may be marked with a suitable dye.
7. DISPOSITION:
- 7.1 Parts containing certain minor indications which would not be considered detrimental to the part under operating conditions may be approved for acceptance without remedial operations, at the discretion of authorized personnel.
- 7.2 If an imperfection should be of such nature and so located that its removal would not adversely affect the serviceability of the part, although local sections might be outside the drawing limits, then the correction may be made with the approval of authorized personnel after due consideration of the stress distribution within the part together with the function of the part itself. If an imperfection is removed, the spot shall be well blended and polished and then completely reinspected.
- 7.3 Parts having defects detrimental to their strength and serviceability shall be rejected.