

# Process Specification for Magnetic Particle Inspection

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**Engineering Directorate**

**Structural Engineering Division**

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# Process Specification for Magnetic Particle Inspection

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<b>REVISIONS</b>		
<b>VERSION</b>	<b>CHANGES</b>	<b>DATE</b>
Baseline	Original version	7/22/99
A	Reviewed document per QMS requirements. Updated division name, organization codes, and document numbers.	12/19/02
B	Deleted SNT-TC-1A and MSFC-STD-1249. Added NASA-STD-5009 and NASA-STD-5019.	02/14/07
C	Revised 4.0 References (added SNT-TC-1A and SOP 009.86), 9.0 Training and Certification of Personnel (added SNT-TC-1A and SOP 009.86)	02/23/10
D	Deleted SOP-009.86 from paragraph 4.0. Revised paragraph 9.0 for uniformity across all NDE PRCs.	6/29/2011
E	Reviewed document per QMS requirement. Updated document signatures. Added requirements for Standard Magnetic particle inspection per NASA-STD- 5009. 1.0 Scope – Added “detection of surface or slightly subsurface discontinuities”. 2.0 Applicability – Added “detect cracks, laps, seams, inclusions”. 3.0 Usage – Added “Continuous Method” in inspection note for flight hardware. 3.1 Inspection Sequence – Replace “should” with “shall”. Added “Fasteners with ultimate tensile strength of 160 ksi (36 HRC) or higher that are electroplated shall be inspected after the electroplating operation”. 3.2 Special NDE of Fracture Critical Components added “Continuous Method” in Special NDE inspection note. 6.1 General – Added “A Quantitative Quality Indicator (QQI) shall be used to validate local field intensities. Hall Effect probes are acceptable provided they are verified with a QQI”. 6.3 Fracture Critical Components – deleted “c”; added “When a Hall Effect probe is used to validate field intensities, readings shall be correlated with a QQI in an equivalent part location”. 7.0 Special NDE Qualification deleted “NASA-STD-5003 or SSP 30558”. 10.0 Definitions – 90/95 deleted “lower” and “bound”.	04/1/2020

Verify correct version before use.

**1.0 SCOPE**

This process specification establishes the minimum requirements for magnetic particle inspection used for the detection of surface or slightly subsurface discontinuities in ferromagnetic materials and components.

**2.0 APPLICABILITY**

This specification is applicable to in-process, final, and in-service magnetic particle inspections to detect cracks, laps, seams, inclusions, and other discontinuities on or near the surface. Magnetic particle inspection is not applicable to nonferromagnetic metals and alloys.

**3.0 USAGE**

This specification shall be invoked by including an inspection note on the applicable engineering drawing or by reference in a Process Specification, Task Performance Sheet, Discrepancy Report/Material Review Record, or other appropriate work authorizing document. The engineering drawing or referencing document shall specify the criteria by which components are judged acceptable. Where acceptance criteria are not otherwise specified the criteria in Section 3.3 shall apply. Other acceptance criteria, such as those in MIL-STD-1907, may be used as appropriate. When there are different acceptance criteria for different areas on a component, the drawing shall be zoned with the acceptance criteria identified for each zone. If the number of components to be inspected and the amount of coverage of each component is not specified, all components shall be examined and shall receive 100 percent magnetic particle coverage.

The magnetic particle inspection note for flight hardware and critical ground equipment is given below.

**PERFORM WET, FLUORESCENT, CONTINUOUS METHOD MAGNETIC PARTICLE INSPECTION PER JSC PRC-6505.**

A magnetic particle inspection note for non-critical ground equipment using the acceptance criteria in MIL-STD-1907 is given below.

**PERFORM MAGNETIC PARTICLE INSPECTION PER JSC PRC-6505. ACCEPTANCE CRITERIA PER MIL-STD-1907, GRADE A.**

### 3.1 INSPECTION SEQUENCE

The stage in the manufacturing process where magnetic particle inspection is performed shall be specified on the engineering drawing or in the referencing document. Final magnetic particle inspection shall be performed after completion of all manufacturing operations that can generate surface or near surface discontinuities. These operations include, but are not limited to, forging, heat treating, plating, passivation, cold forming, welding, grinding, straightening, machining, and proof loading. In general, components should be inspected prior to the application of any coatings. Components other than fasteners heat treated to an ultimate tensile strength of 180 ksi (40 HRC) or higher that are subsequently electroplated shall be inspected after the electroplating operation. Fasteners heat treated to an ultimate tensile strength of 160 ksi (36 HRC) or higher that are subsequently electroplated shall be inspected after the electroplating operation.

### 3.2 SPECIAL NDE OF FRACTURE CRITICAL COMPONENTS

When implementation of fracture control requirements necessitates Special Nondestructive Evaluation (NDE) of a fracture critical component, the requirement for Special NDE shall appear in the inspection note as shown in below. When Special NDE is required, the specific inspection procedure and inspector shall be qualified in accordance with Section 7.0.

<p><b>PERFORM WET, FLUORESCENT, CONTINUOUS METHOD MAGNETIC PARTICLE INSPECTION PER JSC PRC-6505. SPECIAL NDE CERTIFICATION REQUIRED.</b></p>
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### 3.3 ACCEPTANCE CRITERIA

The engineering drawing or referencing document shall indicate the criteria by which components are judged acceptable. Where acceptance criteria are not otherwise specified the following criteria shall apply:

- a. Linear indications – all linear indications, regardless of length, shall be cause for rejection of the component.
- b. Single rounded indications – a single rounded indication greater than 0.030 inches in diameter shall be cause for rejection of the component.
- c. Multiple rounded indications - two or more rounded indications each less than 0.030 inches in diameter but separated by less than 0.030 inches shall be cause for rejection of the component.

**4.0 REFERENCES**

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. All documents listed are assumed to be the current revision unless a specific revision is listed. In the case of conflict between this specification and the technical requirements cited in other referenced documents, the requirements of this document take precedence.

ASTM E 1444	<i>Standard Practice for Magnetic Particle Inspection</i>
MIL-STD-1907	<i>Inspection, Liquid Penetrant and Magnetic Particle, Soundness Requirements for Materials, Parts, and Weldments</i>
NASA-STD-5009	<i>Nondestructive Evaluation Requirements for Fracture Critical Metallic Components</i>
NAS 410	<i>NAS Certification &amp; Qualification of Nondestructive Test Personnel</i>
SNT-TC-1A <i>Nondestructive Testing</i>	<i>Personnel Qualification and Certification in</i>

The following references were used to develop this process specification:

JPR 8500.4	<i>Engineering Drawing System Requirements</i>
SOP-007.1 <i>(PRC's)</i>	<i>Preparation and Revision of Process Specifications</i>

**5.0 MATERIAL REQUIREMENTS**

Inspection materials shall meet the requirements in ASTM E 1444.

## **6.0 PROCESS REQUIREMENTS**

### **6.1 GENERAL**

Magnetic particle inspections shall be performed in accordance with ASTM E 1444 except as modified by this specification. Unless otherwise specified, the wet, fluorescent, continuous method shall be used for flight hardware and critical ground equipment. A Quantitative Quality Indicator (QQI) shall be used to validate local field intensities. Hall Effect probes are acceptable provided they are verified with a QQI.

### **6.2 WRITTEN PROCEDURES**

A detailed written procedure shall be prepared for each part to be inspected. The procedure shall meet the requirements of this specification and shall ensure the consistency and reproducibility of the inspection at the required sensitivity level. General procedures covering a variety different parts may be used provided they meet the requirements of this specification and clearly apply to the parts to be inspected. When general procedures are used, a written part specific technique shall be prepared. At a minimum, the part specific procedure or the general procedure and part specific technique shall cover all the information required by ASTM E 1444.

For work performed at JSC facilities, written procedures should consist of Detailed Process Instructions (DPIs) selected for use from the DPI-6505-XX series of work instructions.

### **6.3 FRACTURE CRITICAL COMPONENTS**

Magnetic particle inspection of fracture critical flight hardware shall be performed in accordance with the process requirements in NASA-STD-5009. Requirements not explicitly covered in NASA-STD-5009 include the following:

- a. Examination surfaces must be easily accessible with a surface roughness of 125 RMS or better.
- b. Inspections shall be performed prior to the application of any coatings.
- c. When a Hall Effect probe is used to validate field intensities, readings shall be correlated with a QQI in an equivalent part location. Pie gages are not acceptable for verifying field strength.

When Special NDE is specified by the engineering drawing or referencing document, the inspection procedure and inspector shall be qualified in accordance with Section 7.0.

## **7.0 SPECIAL NDE QUALIFICATION**

Use of Special NDE in accordance with NASA-STD-5009 requires formal demonstration of the capability to detect flaws at least as small as the critical initial crack size for the specific component to a 90/95 detection level. Each procedure, procedure application, and operator must demonstrate the required capability. Requests for Special NDE qualification shall be directed to the JSC Materials and Processes Branch (ES4).

## **8.0 DEVIATIONS AND WAIVERS**

Any deviations or waivers regarding the use of this process specification shall be requested in writing. This request shall be directed to the JSC Materials and Processes Branch (ES4) with the appropriate justification and rationale. A written response will be provided upon such a request.

## **9.0 TRAINING AND CERTIFICATION OF PERSONNEL**

Personnel performing acceptance inspections of Class I, II, IIIW and GSE hardware shall be qualified and certified, at a minimum, to Level 2 in accordance with NAS 410. Personnel performing acceptance inspections requiring Special NDE shall also be qualified and certified for Special NDE in accordance with NASA-STD-5009.

Personnel performing acceptance inspections of Class III, STE/D, mockup, and facility hardware shall be qualified and certified in accordance with either NAS 410 or SNT-TC-1A. Personnel making accept/reject decisions shall, at a minimum, be certified to Level 2. Level 3 personnel making accept/reject decisions shall have successfully completed a hands-on practical examination equivalent to the examination required for Level 2. Level 1 personnel may perform acceptance inspections under the direct supervision of a Level 2 but shall not make accept/reject decisions.

Formal qualification and certification is not required for personnel performing engineering evaluation inspections.

## **10.0 DEFINITIONS**

90/95	The point where the 95% lower confidence bound on the Probability of Detection (POD) vs. flaw size curve crosses 90% POD or 90% POD with 95% confidence.
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Discontinuity	An intentional or unintentional interruption in the physical Verify correct version before use.
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structure or configuration of a material or component that may be detectable by nondestructive testing; a flaw. Discontinuities are not necessarily rejectable.

Final Inspection	The final inspection performed for the acceptance of the component.
Fracture Critical Component	Classification which assumes that fracture or failure of the component resulting from the occurrence of a crack will result in a catastrophic hazard. Fracture critical components will be identified as such on the engineering drawing.
Indication	Evidence of a discontinuity that requires interpretation to determine its significance.
In-Process	Inspections which occur during manufacturing before a component is in final form.
In-Service	Inspections performed on components that are in use or storage.
Linear Indication	Penetrant indication with a length to width ratio of 3:1 or greater.
Rounded Indication	Penetrant indication with a length to width ratio of less than 3:1.
Special NDE	A fracture control term denoting nondestructive inspection personnel, procedures, and equipment with a demonstrated capability to reliably (90/95) detect flaws smaller than those normally detected by typical procedures.