# Process Specification for Eddy Current Inspection

## Engineering Directorate

## Structural Engineering Division

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# Process Specification for Eddy Current Inspection

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| REVISIONS | | |
|---|---|---|
| VERSION | CHANGES | DATE |
| -- | Original version | 12/1/00 |
| A | Reviewed document per QMS requirements. Updated division name, organization codes, and document numbers. | 04/22/04 |

| | | |
|---|---|---|
| B | Added new NDE calibration notch classes and NDE standards. Added applicability to inspection of bolts. Defined standard NDE and special NDE in terms of calibration notch size and crack detectability | 05/01/08 |
| C | Added “array probes or wide area coverage probes” in para 2.1. Added source-detector probes in para. 5.5.1.2. Added explanation on crack detectability size in para. 5.5.4.5. | 9/30/10 |
| D | Added SNT-TC-1A to paragraph 4.0. Revised paragraph 8.0 for uniformity across all NDE PRCs. | 6/29/11 |

## 1.0 SCOPE

This process specification establishes the minimum requirements for eddy current inspection of flat surfaces, fastener holes, threaded fasteners and seamless and welded tubular products made from nonmagnetic alloys such as aluminum and stainless steel.

## 2.0 APPLICABILITY

This specification is primarily applicable to in-process, final, and in-service eddy current inspections to detect surface and near surface cracks and crack-like flaws. However, usage is not limited to those applications.

### 2.1 FLAT SURFACES

This specification is applicable to the inspection of relatively flat surfaces with a surface finish of 125 μin. or better. This process shall be used for directed inspections of critical or damaged areas. It shall not be used for global inspection of areas greater than 2 sq. ft. unless automated scanning equipment, array probes or wide area coverage probes are used.

### 2.2 FASTENER HOLES

This specification is applicable to the inspection of open fastener holes with an interior surface finish of 125 μin. or better using a rotating hole scanner or a manual bolt hole probe.

### 2.3 THREADED FASTENERS

This specification is applicable to the inspection of root of fastener threads, shank surface, shank neck down region and fillet radius under the bolt head with surface finish of 125 μin. or better and fillet radius of 1/32 in. or greater.

### 2.4 TUBULAR PRODUCTS

This specification is applicable to the inspection of both seamless and welded tubular products using either an encircling or probe coil technique. The use of ID probe techniques is not covered by this specification. This specification covers the inspection of tubular products ranging in diameter from 0.125 to 5 in. with wall thicknesses ranging from 0.005 to 0.250 in.

## 3.0 USAGE

This specification shall be invoked by an inspection callout on the engineering drawing or by a reference in a Process Specification, Task Performance Sheet, Discrepancy Report/Material Review Record, or other appropriate document. The engineering drawing or referencing document shall identify the specific part features or areas that require inspection. Typical eddy current inspection callouts are as follows:

**EDDY CURRENT INSPECT ALL HOLES PER NASA/JSC PRC-6509 TO STANDARD LEVEL NDE.**

When fracture control requirements necessitate Special Nondestructive Evaluation (NDE) of a fracture critical component, the requirement for Special NDE shall appear in the inspection note as shown below. When Special NDE is required, the specific inspection procedure and inspector shall be qualified in accordance with Section 6.0.

**EDDY CURRENT INSPECT AREA SHOWN PER NASA/JSC PRC-6509 TO SPECIAL LEVEL NDE. SPECIAL NDE CERTIFICATION REQUIRED.**

### 3.1 INSPECTION SEQUENCE

The stage in the manufacturing process where inspection is performed should be specified on the engineering drawing or in the referencing document.

### 3.2 ACCEPTANCE CRITERIA

Any indication greater than 50 percent of the reference notch response shall be cause for rejection. For fracture critical parts, questionable or relevant indications or indications that meet the noise ratio requirements per 5.5.4.4 and have less than 50 percent of the reference notch response shall be reported to the responsible engineering organization for disposition.

## 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 case of conflict between this specification and the technical requirements cited in other referenced documents, the requirements of this document take precedence.

ASTM E 426 *Standard Practice for Electromagnetic (Eddy Current) Examination of Seamless and Welded Tubular*

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|---|---|
| | *Products, Austenitic Stainless Steel and Similar Alloys* |
| NASA-STD-5009 | *Nondestructive evaluation requirements for Fracture Critical Metallic Components* |
| NAS 410 | *NAS Certification & Qualification of Nondestructive Test Personnel* |
| NASA –STD-5019 | *Fracture Control Requirements for Spaceflight Hardware* |
| PRC-5010 | *Process Specification for Pickling, Etching, and Descaling of Metals* |
| SAE ARP4402 | *Eddy Current Inspection of Open Fastener Holes in Aluminum Aircraft Structure* |
| SAE AS4787 | *Eddy Current Inspection of Circular Holes in Nonferrous Metallic Aircraft Engine Hardware* |
| SNT-TC-1A | *Personnel Qualification and Certification in Nondestructive Testing* |

The following references were used to develop this process specification:

| | |
|---|---|
| JSC 8500C | *Engineering Drawing System Requirements* |
| SOP-007.1 | *Preparation and Revision of Process Specifications* |
| SAE ARP K99-AA | *Eddy Current Surface Crack Detection in Aerospace Structures (Draft document prepared by SAE AMS Committee K, Nondestructive Methods and Processes)* |

## 5.0 PROCESS REQUIREMENTS

### 5.1 GENERAL

Eddy Current inspection of flat surfaces, including surfaces around fastener holes, shall be performed in accordance with this specification. Fastener holes in aluminum parts shall be inspected in accordance with SAE ARP4402 and in other alloys in accordance with SAE AS4787 except as modified by this

specification. Inspection of tubular products shall be performed in accordance with ASTM E 426 except as modified by this specification.

## 5.2 WRITTEN PROCEDURES

A written inspection procedure shall be used for inspection of each part. 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 of 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. Each procedure and technique shall be approved by a Level III inspector or by a cognizant NDE engineer.

At a minimum, the part specific procedure or the general procedure and part specific technique shall include the following:

- The applicable part name and number
- A description of the part, area of the part, or hole configuration to be inspected
- The alloy type and conductivity
- The potential defect location and orientation, if known
- The applicable eddy current instrument, probes, and fixturing equipment including the manufacturer and model numbers
- The applicable calibration standard and its conductivity
- The test frequency
- Part cleaning and preparation instructions
- Equipment setup, calibration, and operation procedures
- Scan plan indicating areas covered by the inspection and any limitations
- Procedure for evaluation of questionable indications

A copy of the inspection procedure shall be provided to the customer upon request.

## 5.3 SCAN PLAN

Unless otherwise specified on the engineering drawing or in the referencing document, scan plans shall be designed to detect discontinuities in all credible orientations. The scan plan should provide information on, expected crack direction, probe orientation, scan direction, scan index, effective probe width, scan overlap, probe holder aids, probe scanning aids etc.

## 5.4 REPORTS

An inspection report shall be prepared for each part or group of parts. The report shall indicate compliance with this specification, reference the appropriate written procedure and include the names of personnel performing the inspection. The report shall identify each part by part number and serial number and indicate whether each part was accepted or rejected. The report shall include description of the inspection coverage and any limitations. The locations and estimated sizes of all reportable flaws shall be noted in the inspection report. A JSC Form 2176, “Discrepancy Report/Material Review Record” may be used in place of an inspection report provided it contains all of the required information. Inspection reports shall be retained as a permanent quality record and a copy provided to the responsible design authority.

## 5.5 SURFACE INSPECTION

### 5.5.1 EQUIPMENT

Instrument/probe combinations shall be capable of meeting the calibration requirements of Section 5.5.4.

#### 5.5.1.1 INSTRUMENTS

Instruments shall be equipped with impedance plane, or time base signal display. Instruments shall be capable of operating between 100 kHz and 6.0 MHz. However, instruments may be operated at other frequencies if the requirements of Section 5.5.4 are met. Instruments shall be equipped with an audible and/or visual alarm system. For other than battery-powered instruments, a voltage regulator shall be used if instrument internal voltage regulators are not adequate to prevent a signal variation of 20% or more.

#### 5.5.1.2 PROBES

The recommended frequency range for aluminum alloys is 100-500 kHz and for inconel, CRES and titanium alloys the recommended frequency range is 800 kHz- 3.5 MHz.

Probes shall be marked with their operating frequency or frequency range. Recommended maximum coil diameter is 0.125 in in single coil or array probes. The impedance of probes and adapters shall match the instrument being used. Probes may have an absolute, differential or source-detector coil arrangement and may be shielded or unshielded. However, differential and source-detector probes shall be oriented appropriately with respect to the expected crack direction during scanning. Probes shall not give interfering responses from handling pressure or manipulation and meet the noise ratio requirements. Probe collars, edge/corner guides, should be used to aid in reducing lift-off effects.

When inspecting for cracks in concave surfaces, the probe tip shall be convex and shall nest in the radius with less than .005 in. lift-off.

Non-conductive tape may be applied over the probe coil to protect the probe from wear. If tape is used, calibration shall be accomplished after initial application and anytime it is replaced. Use of tape shall not violate the noise ratio requirements.

### 5.5.1.3 SCANNERS

Automated scanning systems may be used to obtain controlled indexing between scans. If an automated scanner is used, the calibration procedure shall include scanning of the reference standard to verify that the appropriate sensitivity level and noise ratio requirements are achieved.

Hand scanning may employ encoder or time scan for data acquisition.

### 5.5.1.4 REFERENCE STANDARDS

Reference standards are based on classes of EDM flaws provided in Table 1.

Table 1: EDM Notch Dimensions in NDE Standards

| Surface Notches (Surface width ≤ 0.004") | | | | | Corner Notches (Surface width ≤ 0.004") | | | Long Notches (Surface Width ≤ Depth for notches ≤ 0.004" deep else Surface Width ≤ 0.004") | | | Through Notches at the edge of 0.1" thick sheet stock (Surface Width ≤ Depth for notches ≤ 0.004" deep else Surface Width ≤ 0.004") | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Class of Surface Notchess | Surafce Notch, Nominal Length, (in) | Tolerance on Surface Notch Length, (in) | Surface Notch, Nominal Depth, (in) | Tolerance on Surface Notch Depth, (in) | Class of Corner Notchess | Corner Notch, Nominal radius, (in) | Tolerance on corner Notch radius, (in) | Size Designation of long notch, Length >0.75" | Nominal Depth, (in) | Tolerance on Depth (in) | Size designation of through Notch (in) | Nominal Depth (in) | Tolerance on Depth (in) |
| A0 | 0.015 | 0.013-0.017 | 0.007 | 0.006 -008 | A0 | 0.010 | 0.009 - 0.010 | | | | | | |
| A1 | 0.02 | 0.018-0.022 | 0.01 | 0.009- 0.011 | A1 | 0.014 | 0.012 - 0.015 | L1 | 0.001 | 0.001 - 0.002 | T1 | 0.002 | 0.001 - 0.002 |
| A2 | 0.025 | 0.023 - 0.027 | 0.012 | 0.011 - 0.013 | A2 | 0.017 | 0.016 - 0.018 | L2 | 0.002 | 0.002 - 0.003 | T2 | 0.003 | 0.003-0.004 |
| A3 | 0.03 | 0.028-0.032 | 0.015 | 0.013-0.017 | A3 | 0.021 | 0.019-0.023 | L3 | 0.003 | 0.003 - 0.004 | T3 | 0.004 | 0.004-0.005 |
| A4 | 0.04 | 0.038-0.042 | 0.02 | 0.018- 0.022 | A4 | 0.028 | 0.026-0.030 | L4 | 0.005 | 0.005-0.006 | T4 | 0.006 | 0.006-0.007 |
| A5 | 0.05 | 0.048-0.052 | 0.025 | 0.023-0.027 | A5 | 0.035 | 0.033-0.037 | L5 | 0.008 | 0.008 - 0.0010 | T5 | 0.010 | 0.009-0.011 |
| A6 | 0.06 | 0.058-0.062 | 0.03 | 0.028-0.032 | A6 | 0.042 | 0.040-0.044 | L6 | 0.011 | 0.011- 0.013 | T6 | 0.014 | 0.013-0.015 |
| A7 | 0.07 | 0.068-0.072 | 0.035 | 0.033-0.037 | A7 | 0.049 | 0.048-0.052 | L7 | 0.015 | 0.015 - 0.017 | T7 | 0.019 | 0.018-0.020 |

Table 2 provides a listing of common reference standards. EDM notches in other standards shall be classified per Table 1. An EDM class designation implies that the reference EDM size is same as or smaller than the EDM class size given in the Table 1. Figures 1 - 5 provide schematics of some of the applicable reference standards. In addition, the AF standards (7947479 series) are also applicable. The dimensions of the reference standard, including notch dimensions, shall be measured and documented. Reference standards shall be certified when required by the responsible engineering organization.

For non-ferromagnetic materials, the conductivity of the reference standard shall be no greater than 2 and no less than 2/3 times the conductivity of the material

to be inspected. When the part to be inspected has a coating, a shim or coating with the same conductivity (±5% IACS) and thickness (+0.003" -0.000") of the coating on the part shall be placed over the reference standard during instrument calibration.

Table 2: List of Applicable Eddy Current Crack Detection Standards

| Part # | Material | Description |
|---|---|---|
| 7947479-6AL4V-10 | 6AL-4V Titanium | Air Force General Purpose Eddy Current Standard |
| 7947479-304-10 | 304 Stainless Steel | Air Force General Purpose Eddy Current Standard |
| 7947479-7075T6-10 | 7075-T6 Aluminum | Air Force General Purpose Eddy Current Standard |
| | | |
| NEC-6365-2024T8 | 2024-T3 Alum, 30.08% IACS | Surface Notch Standard |
| NEC-6365-2024T8 | 2024-T8 Alum, 40.4% IACS | Surface Notch Standard |
| NEC-6366-2024T8 | 2024-T8 Alum, 40.37% IACS | Corner Notch Standard |
| NEC-6366-2024T3 | 2024-T3 Alum, 29.65% IACS | Corner Notch Standard |
| NEC-6367-2024T8 | 2024-T8 Alum, 40.64% IACS | Long Notch standard |
| NEC-6367-2024T3 | 2024-T3 Alum, 29.55% IACS | Long Notch standard |
| NEC-6368-2024T3 | 2024-T3 Alum, 29.92% IACS | Thru Notch standard |
| NEC-6368-2024T8 | 2024-T8 Alum, 39.98% IACS | Thru Notch standard |
| | | |
| NEC-6365-718 | Inconel 718, 1.43 %IACS | Surface Notch standard |
| NEC-6365-304 | CRES 304, 2.52 %IACS | Surface Notch standard |
| NEC-6365-6Al-4V | 6Al-4V, 1.05 %IACS | Surface Notch standard |
| | | |
| NEC-6367-718 | Inconel 718, 1.44 %IACS | Long Notch standard |
| NEC-6367-304 | CRES 304, 2.45 %IACS | Long Notch standard |
| NEC-6367-6Al-4V | 6Al-4V, 1.04 %IACS | Long Notch standard |
| | | |
| NEC-6366-718 | Inconel 718, 1.43 %IACS | Corner Notch standard |
| NEC-6366-304 | CRES 304, 2.52 %IACS | Corner Notch standard |
| NEC-6366-6Al-4V | 6Al-4V, 1.04 %IACS | Corner Notch standard |
| | | |
| NEC-6368-718 | Inconel 718, 1.26 %IACS | Thru Notch standard |
| NEC-6368-304 | CRES 304, 1.83 %IACS | Thru Notch standard |
| NEC-6368-6Al-4V | 6Al-4V, 0.98 %IACS | Thru Notch standard |

Note: The above standards can be procured from Olympus NDT. Equivalent standards are acceptable.

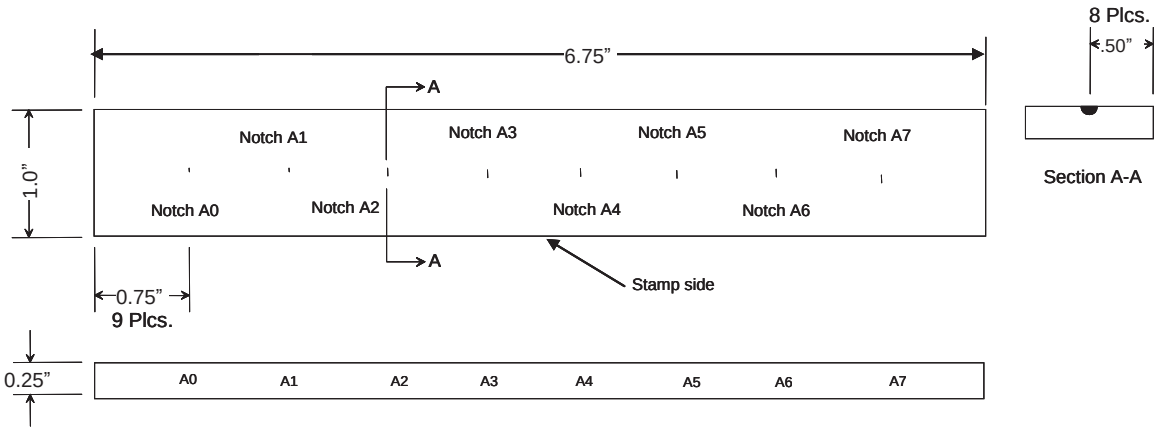



Figure 1: Surface Notch Calibration Standard

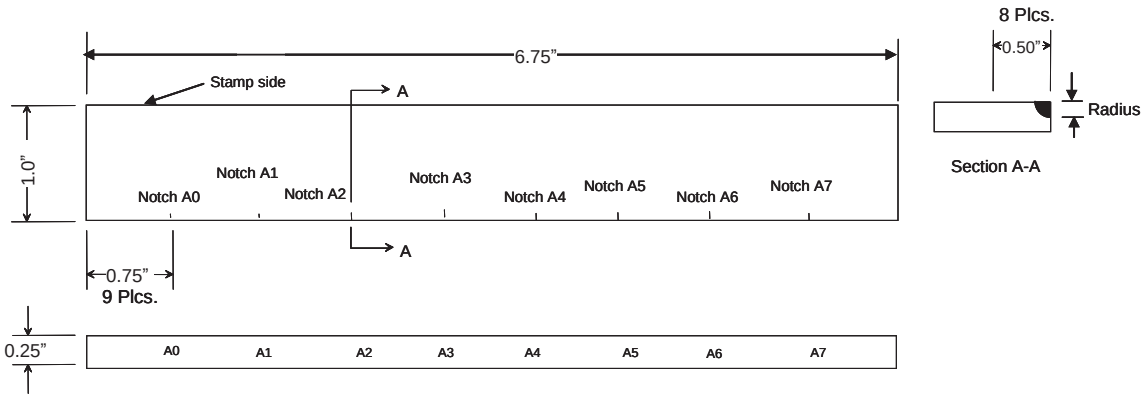



Figure 2: Corner Notch Calibration Standard

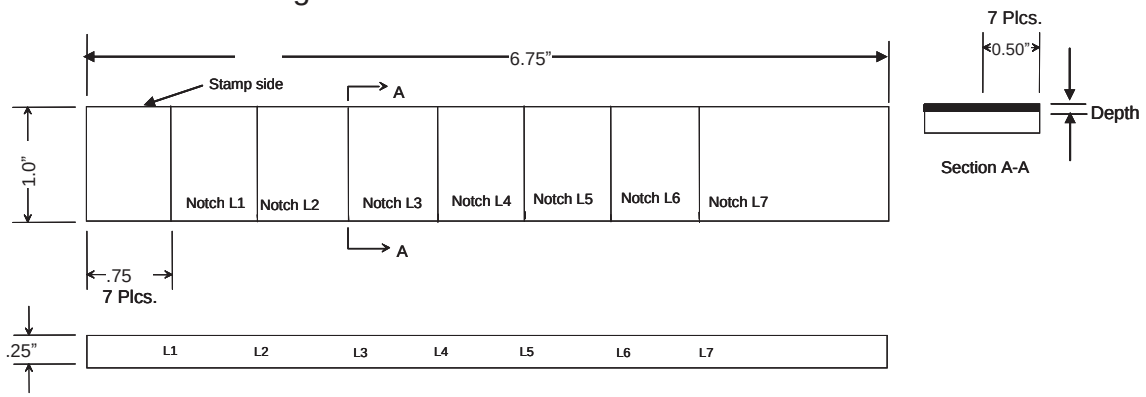



Figure 3: Long Notch Calibration Standard

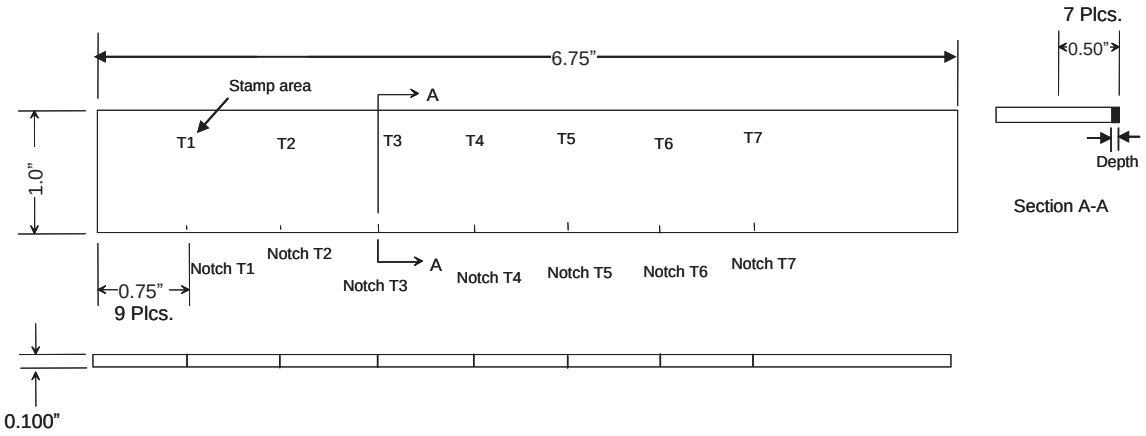
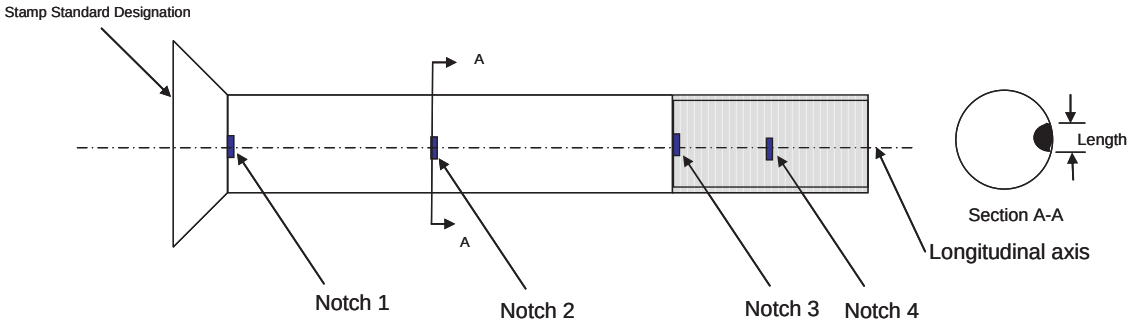



Figure 4: Through Notch Standard




Note: Notch dimensions are in accordance with the applicable Surface Notch Class in Table 1.

Figure 5: Bolt Surface Notch Standard (Notch 3 and 4 at Thread Root)

### 5.5.1.5 RECORDING DEVICES

Recording devices, when used, shall be compatible with the instrument and be capable of generating a permanent record or copy of the signal response.

### 5.5.2 PART PREPARATION

Dirt, grease, and/or loose paint shall be cleaned from the inspection surface. If necessary, determine the thickness of any coating with a coating thickness gage. A similar type and thickness shim or coating shall be placed over the reference standard for calibration (refer to Section 5.5.1.4).

### 5.5.3 LOCATION OF INSPECTION EQUIPMENT

Inspection equipment shall be located at least 10 ft. from any items that generate a large magnetic field, such as motors, generators, or transformers.

### 5.5.4 CALIBRATION, SCANNING AND ACCEPT/REJECT

#### 5.5.4.1 GENERAL

Inspection equipment shall be calibrated against the appropriate reference standard as specified in Section 5.5.1.4. Evaluation of flaw indications shall be accomplished by using a signal-versus-EDM-notch-size curve obtained on the reference standard notches.

#### 5.5.4.2 INTERVALS

Calibration shall be performed at the beginning and conclusion of each inspection operation and at least every four hours in between. Calibration shall also be performed if equipment is changed or replaced. If the response from the reference standard notch has changed by more than 5% of full scale from the original calibration, perform one of the following:

1. If the notch response is greater than that obtained during the original calibration, recalibrate and re-inspect any part which was rejected since the last calibration.

2. If the notch response is less than that obtained during the original calibration, recalibrate and re-inspect all parts inspected since the last calibration.

#### 5.5.4.3 CRACK ORIENTATION AND PROBE LIMITATIONS

Cracks are assumed to be oriented in the following directions.
For internal corner edges, cracks may run along the corner or across the fillet radius (>1/16”). Compound internal corners (1/8” wide region) with radius less than 1/8” can not be inspected by eddy current. 1/8” OD pencil probes recommended.

In bolt threads, cracks are assumed to run along the thread root in the helical/circumferential direction. For bolt shank, the cracks may run in the axial or circumferential direction. On bolt neck down areas (radius > 1/16”) and in corners (radius > 1/16”) under bolt heads, cracks are assumed to run in a circumferential direction. Zones at the thread termination on the shank side can not be inspected by a nut probe or V-probe if a thread relief zone is not provided. Special NDE inspection is not performed on the threaded fasteners due to lack of threaded crack specimens.

On external edges, the crack is assumed to run normal to the edge. Compound external corners (1/8” wide region) with radius less than 1/8” can not be inspected.

For bolt holes, the cracks are assumed to run axially.

Cracks caused by the fatigue or static load are assumed to appear across the direction of principal stress at the location of interest. Eddy current assumes that the cracks are scanned in a direction +/- 45 degree normal to the crack at an indexing width of ½ the probe coil diameter

### 5.5.4.4 NOISE RATIO REQUIREMENTS

Inspection sensitivities for scanning and evaluation are different. However, the reject level setting is the same during part scanning and indication evaluation. The reject level is set to 50% of vertical response from the calibration notch. The ratio of the reject level to the observed noise, called the noise ratio, shall be visually assessed during calibration, scanning and evaluation. During the calibration on the reference EDM notch and during evaluation of an indication, the ratio shall be 3:1 or greater. During part scanning, the noise ratio shall be 2:1 or greater.

### 5.5.4.5 SENSITIVITY LEVELS AND NOTCH CLASSES

General: Sensitivity level is achieved by use of an appropriate calibration EDM notch and meeting other requirements provided here. The calibration notches are classified by size as A2 , A3, A4 and A5. Lower notch class designations (e.g. A3) use a smaller calibration EDM notch compared to the higher notch class (e.g. A4). Each calibration notch class defines a primary reference notch as the surface notch and a secondary reference notch as the corner notch. The secondary notch is applicable for inspection of bolt holes and external corners. Notch Class A3 sensitivity level is considered to be the default level Standard level NDE. Use Table 3 in selection of the notch class if the notch class is not provided in the callout of eddy current inspection on the work authorizing document.

An example of notch class A4 sensitivity level is provided below. Use the surface notch A4 for surface inspection and fillet radius. For inspecting external corners, use the secondary notch (e.g. A4) with the same class designation. For inspecting edge of webs (0.1” thick) use the corresponding edge/through notch (e.g. T4) with matching numeral or select the edge notch based on comparison of eddy current signal amplitude from the edge notch to the eddy current response from the primary Notch A4. A long notch (e.g. L4) may be selected for calibration based on comparison of eddy current signal amplitude from the long notch to the eddy current response from the primary notch.

The reject level shall be 50% of the reference notch amplitude. When establishing the system sensitivity, the reference standard shall be scanned at the same speed that will be used on the part to be inspected. During scanning the vertical gain shall be set to 4-6 dB higher than during calibration without changing the reject level. If the alarm is used, the alarm level shall be less than

or equal to the reject level. Once an indication is detected the gain shall be lowered to the original calibration gain in order to evaluate the indication by rescanning to optimize the indication height.

Ratio of crack length to EDM length providing the same eddy current amplitude is assumed to be between 1.5 to 2 for class A3 with optimum eddy current set-up. Crack detectability for class A3 calibration can be as small as the size of the EDM notch upon POD demonstration. Follow recommendation of Table 3 for crack detectability size.

Standard NDE: Standard NDE Sensitivity Level is established by using the primary surface calibration notch A3, A4 or A5. This notch is applicable for inspection of root of threads, bolt neck down areas, shanks, and fillet radius. Standard NDE crack size is 0.100” long x 0.050” deep surface crack or 0.075” long x 0.075” long corner crack.

Special NDE: Special NDE sensitivity Levels shall have class levels A2, A3 and A4. A correlation between the EDM notch size and the crack size providing same signal amplitude is required. Moreover, a 90/95 point estimate demonstration of the eddy current technique on real crack specimens with the desired crack size is required. Successful demonstration is necessary to qualify the eddy current operator, equipment and the procedure. Upon qualification of the operator and the procedure, a Special NDE certificate is issued to the operator by NASA NDE. Special level eddy current can be performed only by a currently certified special level eddy current operator. Typical Special NDE crack size is 0.050” long x 0.025” deep surface crack or 0.035” long x 0.035” long corner crack. Special NDE requirements are applicable for crack detectability of size smaller than 0.075” long x 0.037” deep,

Crack Detectability Size: Where neither special nor standard NDE sensitivity levels as defined above are applicable, the cognizant NDE engineer or the eddy current level III is responsible for estimating flaw detectability size of a given eddy current procedure based on comparison of eddy current response from relevant cracks and EDM notches.

Table 3: Sensitivity and Class of Calibration Notch

| Sensitivity | Notch Class | Comment |
|---|---|---|
| Standard (Crack detectability: 0.1'' long X 0.050" deep crack) | A3 | Default class. Smaller Crack detectability size (≥ 0.075" long x 0.037" deep) with POD documentation* on similar technique and material |
| Standard (Crack detectability: 0.1'' long X 0.050" deep crack) | A4 | Use if A3 not feasible or not needed. Smaller Crack detectability size (≥ 0.075" long x 0.037" deep) with POD documentation* on similar technique and material |
| Standard (Crack detectability: 0.1'' long X 0.050" deep crack) | A5 | Use if A4 not feasible or not needed. Smaller Crack detectability size (≥ 0.075" long x 0.037" deep) with POD documentation* on similar technique and material |
| | | |
| Special NDE (0.050" long X 0.025" deep crack) | A2 | Need POD Demonstration and Certification, Smaller Crack detectability size (≥ 0.030" long x 0.015" deep) possible |
| Special NDE (Crack detectability: 0.050" long X 0.025" deep crack) | A3 | Default class, Need POD Demonstration and Certification |
| Special NDE (Crack detectability: 0.050" long X 0.025" deep crack) | A4 | Need POD Demonstration and Certification |
| * - The POD documentation shall constitute a POD study on fatigue cracks providing the 90/95 crack size equal to or smaller than 0.075" long x 0.0.37" deep using a calibration notch with the desired class. | | |

### 5.5.4.6 SCANNING

The probe shall be scanned on the reference notch in the same relative direction as the expected direction of the crack. Reject level is established as the 50% of the signal height from the reference notch. This is called the calibration set-up. Part scanning sensitivity shall be set by adding 4-6 dB vertical gain to the calibration set-up. This set-up is called the scanning set-up. If expected direction of crack is not known, the scan shall be performed in two orthogonal directions, unless the instrument settings are set to detect cracks oriented in the most unfavorable direction with respect to the scanning direction. The scanning index for both manual and automated scans shall not exceed one-half of the effective probe coil diameter. For shielded probes the effective probe coil diameter shall be equal to probe O.D.

For unshielded single coil probes, the effective probe coil width is based on eddy current scans of the calibration notch. Perform several closely spaced parallel scans of the calibration flaw and mark locations of the maximum signal scan line and 50% of the maximum signal scan lines on each side of the maximum signal scan line. The distance between the two 50% scan lines is a measure of the effective probe coil diameter.

For linear array probes, the effective probe width is distance between the centers of the first and last coil in the array. The minimum overlap between the adjacent scans shall be equal to the spacing between two adjacent coils.

For manual scans, a nonconductive probe guide, straight edges or template should be used to ensure that the required scan index is achieved. In addition, a grid pattern may be drawn on the part surface using approved temporary marking pencils to aid in ensuring scanning coverage. Scan plans shall be designed to detect discontinuities in all credible orientations.

### 5.5.6 INTERPRETATION OF INDICATIONS

The presence of a potential crack is indicated by a rapid signal response similar in appearance to the reference notch response. Once an indication is detected during scanning, it shall be evaluated using the calibration set-up. The indication area is carefully rescanned using the calibration set-up to optimize (maximize) the indication height by finding the most favorable scan direction and location. Compare the optimum crack response to the optimum reference notch response. A response amplitude greater than 50% of the reference notch response indicates the presence of a crack. Questionable indications or indications showing less than 50% of the reference notch response may indicate a defect condition. The following steps should be taken to evaluate the significance of such indications:

1. Non-conductive coatings may reduce the amplitude of the crack signal. Assess coating thickness and compensate for the coating thickness.

2. Smeared metal on the surface of the part may reduce the amplitude of the crack signal. Etch the part per PRC-5010, section 6.3.2 “Etching for Penetrant Inspection”, re-calibrate, and re-inspect.

3. If the defect condition is at an edge, use an edge guide with the slotted reference standard and re-calibrate. Using the edge guide, re-inspect the part.

## 6.0 SPECIAL NDE QUALIFICATION

Use of Special NDE in accordance with NASA-STD-5009 requires formal demonstration of the capability to detect Cracks at least as small as the critical initial crack size for the specific component to a 90/95 probability of 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).

## 7.0 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.

## 8.0 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.

## 9.0 DEFINITIONS

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| 90/95 | The point where the 95% lower confidence bound on the Probability of Detection (POD) vs. Crack size curve crosses 90% POD. |
| ASTM | American Society for Testing and Materials |
| Compound Corner | A corner formed by intersection of three or more surfaces. Internal corner is concave in shape and external corner is convex in shape. |
| EDM | Electrical Discharge Machining |
| 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. |

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|---|---|
| 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. |
| NAS | National Aerospace Standard |
| SAE | SAE International |
| 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. |