Structures Bulletin

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Introduction:

This document defines the recommended nondestructive inspection (NDI) capability flaw sizes that should be assumed when computing the reinspection intervals for structures managed by the Air Force Aircraft Structural Integrity Program (ASIP) when no other supporting data is available.

MIL-STD-1530C (Reference 24) paragraph 5.4.3.2 states that "implicit in damage tolerant structural designs are inspection requirements intended to ensure that damage never reaches the sizes that can cause catastrophic failures. Inspections are required initially and at repeat intervals as described in paragraph 5.4.3.2.1." Paragraph 5.4.3.2.1 states that "initial inspections for slow crack growth designs shall occur at or before one-half the life from the assumed maximum probable initial flaw size to the critical flaw size", and that "the repeat inspection intervals shall occur at or before one-half the life from the minimum detectable flaw size (based on the probability of detection) to the critical flaw size."

The assumed minimum detectable flaw size is referred to as a_{NDI} and should be based on the capability of the NDI technique being used. a_{NDI} is called an "in-service inspection flaw assumption" in JSSG-2006 (Reference 25). The purpose of this structures bulletin is to provide realistic in-service flaw assumptions that supersede information in Table XXXII of Reference 25.

These values were established by consensus of the Air Force NDI Capability Task Group comprised of the USAF Air Logistics Complex (ALC) NDI Program Managers, representatives from the Air Force Research Laboratory Materials and Manufacturing Directorate (AFRL/RXSST, AFRL/RXLP and AFRL/RXSA) and the Air Force Life Cycle Management Center Engineering Directorate (AFLCMC/EZFS). These values were established using the results of USAF and industry NDI capability studies (see References), industry best practices, as well the experience of the task group members.

The use of these values is subject to method specific criteria defined within this document. Furthermore, use of these values requires that inspectors (depot or field) be adequately trained to perform the required inspections and that detailed procedures are developed, validated and verified. The responsible NDI Level 3 and ASIP Manager must ensure that the requirement for additional task specific or site specific training is considered based on the available skill set and, if required, additional task specific or site specific training is implemented when these values are used. If a program utilizes an NDI Requirements Review Board (NDIRRB), the proposed inspection processes and capability assumptions must be approved by the NDIRRB.

Use of values smaller than those recommended by this document shall be demonstrated through capability experiments using the guidance of MIL-HDBK-1823A (Reference 23) or alternate approaches described by the *Recommended Processes and Best Practices for Nondestructive Inspection of Safety-of-Flight Structures (*Reference 17*)* or as approved by the responsible NDI Level 3.

The Air Force NDI Capability Task Group will meet on an annual basis to update and expand this document to include additional inspection methods and materials as new data is made available.

Applicability:

This bulletin is applicable to both field and depot level inspections for USAF personnel performing NDI wherein knowledge of the NDI capability is required to establish recurring inspection intervals (to include aircraft that maintain an FAA Type certification). This bulletin is NOT applicable for certified contractor personnel performing NDI of aircraft that maintain an FAA Type certification.

Additionally, this bulletin applies only to the detection of fatigue cracks in metallic components whose inspection requirements are based upon damage tolerance or durability analysis results. For other damage mechanisms (e.g. – corrosion) or other situations (e.g. – repairs that add new structural components), the use of production NDI requirements and capability may be more appropriate. However, the decision to use production NDI capability in lieu of the capability values in this bulletin shall be the responsibility of the program ASIP Manager and NDI Level 3.

NDI Capability Guidelines:

It is the responsibility of an aircraft program's structures and NDI Level 3 to understand the limitations of the specific inspection requirements, and to validate the application of values defined within this document considering the impact of access, geometry, material variations and human factors. All NDI-related assumptions used to calculate recurring inspection intervals should also be reviewed and approved by the program Nondestructive Inspection Requirements Review Board, or Nondestructive Inspection Advisory Board (if applicable) as well as the program ASIP Manager.

The $a_{90/95}$ value (90 percent probability of detection at 95 percent confidence) shall be used to establish a_{NDI} for calculating recurring inspection intervals. The a_{90} values are provided for reference only. TBD – refers to information to be determined by the task group as time, budget, and program office priorities dictate.

1.0 High Frequency Eddy Current Inspection (ECI) Requirements

The eddy current inspection capability values shown in Sections 1.1 and 1.2 are dependent on the following:

1) Surface Scan Eddy Current (SSEC) and Rotary Bolt Hole Eddy Current (BHEC) inspections are conducted using the procedures, equipment and requirements as defined in TO 33B-1-2.

2) For the purposes of this document high frequency eddy current is defined as eddy current inspections performed with coil excitation frequencies of 100 KHz through 2 MHz.

3) Edges shall possess no greater than 0.050 inch radius edge breaks for surface eddy current methods or 0.015 inch for rotary bolt hole eddy current. When specially designed edge probes are used, the limit for blended edges shall be clearly defined within the general and part specific procedures.

4) Areas of inspection are completely accessible both visually and physically. Visual access is defined as: Inspection location, suspect crack location and assumed crack direction can be identified without the use of visual aids such as a mirror or borescope. Physical access is defined as: Inspection location must accommodate the inspector and the inspection sensor (i.e. probe, transducer, etc.) allow for unencumbered manipulation of the sensor, and the ability to monitor the signal and while scanning the component ensuring positive contact of the probe to the inspection surface at all times.

5) Inspection surface area must be ≤ 4 square inches when pencil or small diameter coils are used,. All part geometries (i.e. edges, radii, contours, etc.) fall within the boundaries of the approved method of inspection.

6) Inspections are performed within acceptable noise levels, designed sensor limitations and allowable surface condition as defined by the inspection procedure. Surface roughness is no worse than 125 μ inch root mean square (RMS).

7) When inspecting around raised head fasteners or overlapping bushings, the extent of the fastener head or bushing overlap is added to the applicable capability flaw size.

8) All holes requiring rotary bolt hole eddy current inspection are prepared (i.e. flex-honing, reaming, etc.) per approved technical data prior to the initial inspection to achieve the minimum acceptable noise level. Individual holes must be dispositioned by the engineering authority if found unacceptable due to excessive noise.

9) Sufficient guidance for interpretation is provided within the inspection technical data provided when inspecting multiple layer structures by rotary bolt hole eddy current particularly for a stack-up of multiple materials. The effect of multiple material stack ups on capability must be assessed.

10) Aluminum alloys shall have conductivity between 29% and 40% International Annealed Copper Standard (IACS).

11) Coating compensation is performed in accordance with TO 33B-1-2. Non-conductive coatings greater than 0.010 inch are removed (or reduced to uniform thickness <0.010 inch) prior to inspection. All conductive coatings, regardless of thickness, are removed prior to inspection.

12) The part-specific inspection procedures clearly detail (both in text and graphics) the inspection location, the inspection zone, the flaw orientation and scan requirements.

13) The inspection procedures have been validated and verified by the responsible NDI Level 3 in accordance with the *USAF NDI Procedure Qualification Process* (Reference 17, Section 7.0) or local operating instructions.

14) The application of specialty eddy current probes, including ribbon radius coils, bull-nose edge probe, off-set edge probes, rotary fastener hole and raised head fastener scanners shall be in accordance with the standard practice procedures defined within TO 33B-1-2 or part specific procedures as defined and approved by the responsible NDI Level 3.

1.1 Surface Scan Eddy Current (SSEC) - IAW TO 33B-1-2

NOTE: For parts with thicknesses less than the crack depths defined above the crack depth is assumed to be equivalent to the material thickness.

1.1.1 SSEC - Flat Open Surfaces, Manual Scanning, Pencil Probes - *Radius of Curvature > 1.0 inch* (Figure 1a)

	a_{90}		$a_{90/95}$	
	Crack Length, *2c*	**Crack Depth, *a***	**Crack Length, *2c***	**Crack Depth, *a***
Aluminum:	0.200 inch	0.100 inch	0.250 inch	0.125 inch
Titanium:	0.200 inch	0.100 inch	0.250 inch	0.125 inch
Steel:	TBD	TBD	TBD	TBD

NOTE: radii >1.0 inch R are considered flat open surfaces.

1.1.2 SSEC - Flat Open Surfaces, Manual Scanning, Pencil Probes - *Radius of Curvature > 1.0 inch,* Using a Template (e.g. straight edge to guide and ensure coverage) (Figure 1a)

	a_{90}		$a_{90/95}$	
	Crack Length, *2c*	**Crack Depth, *a***	**Crack Length, *2c***	**Crack Depth, *a***
Aluminum:	0.150 inch	0.075 inch	0.200 inch	0.100 inch
Titanium:	0.150 inch	0.075 inch	0.200 inch	0.100 inch
Steel:	TBD	TBD	TBD	TBD

NOTE: radii >1.0 inch R are considered flat open surfaces.

1.1.3 SSEC - Radii, Manual Scanning, Pencil Probes - *Radius of Curvature: < 1.0 inch (Figure 1a)**

	a_{90}		$a_{90/95}$	
	Crack Length, *2c*	**Crack Depth, *a***	**Crack Length, *2c***	**Crack Depth, *a***
Aluminum:	0.250 inch	0.125 inch	0.500 inch	0.250 inch
Titanium:	0.250 inch	0.125 inch	0.500 inch	0.250 inch
Steel:	TBD	TBD	TBD	TBD

1.1.4 SSEC - Radii, Manual Scanning, Conformal Ribbon Coils - *Radius of Curvature: ≤ 0.5 inch* (Figure 1a)

	a_{90}		$a_{90/95}$	
	Crack Length, *2c*	**Crack Depth, *a***	**Crack Length, *2c***	**Crack Depth, *a***
Aluminum:	0.150 inch	0.075 inch	0.200 inch	0.100 inch
Titanium:	0.150 inch	0.075 inch	0.200 inch	0.100 inch

NOTE: These values are applicable for the conformal ribbon coil designs defined in Reference 18 and 19. Crack orientation relative to coil orientation and scan direction must be considered by the responsible NDI Level 3 when these values are used. Performance equivalency for similar probe designs must be approved by the responsible NDI Level 3 and if applicable the aircraft Nondestructive Inspection Requirements Review Board.

1.1.5 SSEC - Edges, Manual Scanning, Pencil Probes (Figure 1b)

	a_{90}		$a_{90/95}$	
	Crack Length, *c*	**Crack Depth, *a***	**Crack Length, *c***	**Crack Depth, *a***
Aluminum:	0.200 inch	0.200 inch	0.250 inch	0.250 inch
Titanium:	0.200 inch	0.200 inch	0.250 inch	0.250 inch
Steel:	TBD	TBD	TBD	TBD

1.1.6 SSEC - Edges, Manual Scanning Using Edge Guide, Pencil Probes (Figure 1b)

	a_{90}		$a_{90/95}$	
	Crack Length, *c*	**Crack Depth, *a***	**Crack Length, *c***	**Crack Depth, *a***
Aluminum:	0.150 inch	0.150 inch	0.200 inch	0.200 inch
Titanium:	0.150 inch	0.150 inch	0.200 inch	0.200 inch
Steel:	TBD	TBD	TBD	TBD

1.1.7 SSEC - Edges, Manual Scanning Using an Engineered Fixture (fixed tooling, specialty designed probes not otherwise specified) (Figure 1b)

	a_{90}		$a_{90/95}$	
	Crack Length, *c*	**Crack Depth, *a***	**Crack Length, *c***	**Crack Depth, *a***
Aluminum:	0.100 inch	0.100 inch	0.150 inch	0.150 inch
Titanium:	0.100 inch	0.100 inch	0.150 inch	0.150 inch
Steel:	TBD	TBD	TBD	TBD

NOTE: Smaller assumptions may be achieved with well-engineered kits that isolate and control inspections to specific structural details. Use of flaw sizes above these values shown above must be demonstrated IAW MIL-HDBK-1823A and approved by the responsible NDI Level 3 and if applicable the aircraft Nondestructive Inspection Requirements Review Board.

1.1.8 SSEC - Edges, Manual Scanning Using Bull-Nose, Differential Coil Probes (Figure 1b)

	a_{90}		$a_{90/95}$	
	Crack Length, *c*	**Crack Depth, *a***	**Crack Length, *c***	**Crack Depth, *a***
Aluminum:	0.040 inch	0.040 inch	0.080 inch	0.080 inch
Titanium:	0.050 inch	0.050 inch	0.100 inch	0.100 inch
Steel:	TBD	TBD	TBD	TBD

NOTE: These values are applicable for the probe designs defined in Reference 20. Performance equivalency for similar probe designs must be approved by the responsible NDI Level 3 and if applicable the aircraft Nondestructive Inspection Requirements Review Board.

1.1.9 SSEC - Edges, Manual Scanning Using Off-set Edge, Differential Coil Probes (Figure 1b)

	a_{90}		$a_{90/95}$	
	Crack Length, *c*	**Crack Depth, *a***	**Crack Length, *c***	**Crack Depth, *a***
Aluminum:	0.075 inch	0.075 inch	0.080 inch + co	0.080 inch + co
Titanium:	0.085 inch	0.085 inch	0.080 inch + co	0.080 inch + co
Steel:	TBD	TBD	TBD	TBD

NOTE: These values are applicable for the probe designs defined in Reference 20.
The coil offset (co) must be added to the values stated above. The coil offset is measured from the part edge to the center of the coil. Performance equivalency for similar probe designs must be approved by the responsible NDI Level 3 and if applicable the aircraft Nondestructive Inspection Requirements Review Board.

1.1.10 SSEC - Manual Scanning, Pencil Probes, Around Raised Fastener Heads – Using Fastener Head as a Guide * ** (Figure 2)

	a_{90}		$a_{90/95}$	
	Crack Length, *c*	**Crack Depth, *a***	**Crack Length, *c***	**Crack Depth, *a***
Aluminum:	0.150 inch + fho	0.150 inch + fho	0.200 inch + fho	0.200 inch + fho
Titanium:	0.150 inch + fho	0.150 inch + fho	0.200 inch + fho	0.200 inch + fho
Steel:	TBD	TBD	TBD	TBD

**NOTE: The fastener head overlap (fho) must be added to the values stated above.*
*** NOTE: The above values are independent of fastener alloy provided shielded probes are used.*

1.1.11 SSEC - Manual Scanning, Pencil Probes, Around Flush Head Fasteners Using a Circle Template as a Guide * ** (Figure 2)

	a_{90}		$a_{90/95}$	
	Crack Length, *2c*	**Crack Depth, *a***	**Crack Length, *2c***	**Crack Depth, *a***
Aluminum:	0.150 inch + fho	0.150 inch + fho	0.200 inch + fho	0.200 inch + fho
Titanium:	0.150 inch + fho	0.150 inch + fho	0.200 inch + fho	0.200 inch + fho
Steel:	TBD	TBD	TBD	TBD

**NOTE: The fastener head overlap (fho) must be added to the values stated above.*
*** NOTE: The above values are independent of fastener alloy provided shielded probes are used.*

1.1.12 SSEC - Manual Scanning Around Fastener Heads (Raised and Flush Head) – Using an Engineered Fixture (fixed tooling, specialty designed probes) * ** *(Figure 2)**

	a_{90}		$a_{90/95}$	
	Crack Length, *c*	**Crack Depth, *a***	**Crack Length, *c***	**Crack Depth, *a***
Aluminum:	0.100 inch + fho	0.100 inch + fho	0.150 inch + fho	0.150 inch + fho
Titanium:	0.100 inch + fho	0.100 inch + fho	0.150 inch + fho	0.150 inch + fho
Steel:	TBD	TBD	TBD	TBD

** NOTE: The fastener head overlap (fho) must be added to the values stated above.*
*** NOTE: Smaller assumptions may be achieved with well-engineered kits that isolate and control inspections to specific structural details. Use of flaw sizes above these values shown above must be demonstrated IAW MIL-HDBK-1823A and approved by the responsible NDI Level 3 and if applicable the aircraft Nondestructive Inspection Requirements Review Board.*
**** NOTE: The above values are independent of fastener alloy provided shielded probes are used.*

1.1.13 SSEC - Rotary Raised Head Fastener Scanning, with Differential Coils, * ** *** **(Figure 2)**

	a_{90}		$a_{90/95}$	
	Crack Length, *c*	**Crack Depth, *a***	**Crack Length, *c***	**Crack Depth, *a***
Aluminum:	0.075 inch + fho	0.75 inch + fho	0.100 inch + fho	0.100 inch + fho
Titanium:	0.075 inch + fho	0.75 inch + fho	0.100 inch + fho	0.100 inch + fho

** NOTE: The fastener head overlap (fho) must be added to the values stated above.*
*** NOTE: The above values are independent of fastener alloy.*
**** NOTE: These values are applicable for a high speed rotary scanner and probe designs defined in Reference 20. Performance equivalency for similar probe designs must be approved by the responsible NDI Level 3 and if applicable the aircraft Nondestructive Inspection Requirements Review Board.*
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1.2 Rotary Bolt Hole Eddy Current (BHEC) IAW TO-33B-1-2 (Figure 3)

	a_{90}		$a_{90/95}$	
	Crack Length, *a*	**Crack Depth, *c***	**Crack Length, *a***	**Crack Depth, *c***
Edge Crack				
Aluminum:	0.040 inch	0.040 inch	0.050 inch	0.050 inch
Titanium:	0.040 inch	0.040 inch	0.050 inch	0.050 inch
Steel:	TBD	TBD	TBD	TBD
	Crack Length, *2a*	**Crack Depth, *c***	**Crack Length, *2a***	**Crack Depth, *c***
Mid Bore Crack				
Aluminum:	0.080 inch	0.040 inch	0.100 inch	0.050 inch
Titanium:	0.080 inch	0.040 inch	0.100 inch	0.050 inch
Steel:	TBD	TBD	TBD	TBD

NOTE: These values apply only to high speed rotary scanner applications.

2.0 Fluorescent Penetrant Inspection (FPI) Baseline Requirements

The penetrant inspection capability values shown in Sections 2.1 and 2.2 are dependent on the following:

1) All fluorescent penetrant inspections require all coatings to be removed. If any form of abrasive removal process is used, a pre-penetrant etch process per approved technical data shall be accomplished prior to the inspection.

2) Inspection is performed using a Type 1 (Fluorescent), Method C (Solvent Wipe) or Method D (hydrophilic emulsified) process in accordance with TO 33B-1-2. Form d (nonaqueous) developer shall be used for focused inspections when the values of section 2.1.1 and 2.2.1 are applied. Form d (nonaqueous) or form b (water soluble) developers shall be used when the values of sections 2.1.2 and 2.2.2 are applied.

3) All penetrant materials are qualified in accordance with SAE AMS 2644.

4) All areas of inspection are completely accessible both visually and physically. Visual access is defined as: Inspection location, suspect crack location and assumed crack direction can be identified without the use of visual aids such as a mirror or borescope. Physical access is defined as: Inspection location must accommodate the inspector, allow for unencumbered application of penetrant materials, and the ability to view the inspection surface during the dwell and inspection processes.

5) Areas that exceed 200 square inches are subdivided into smaller individual inspection zones.

6) Bearings, bushings and other similarly installed hardware that can entrap penetrant are removed prior to penetrant inspections.

7) Inspection surface does not exhibit excessive background fluorescence which could impede evaluation and interpretation.

8) The inspection procedures have been validated and verified by the responsible NDI Level 3 in accordance with the *USAF NDI Procedure Qualification Process* (Ref.17, Sect. 7.0) or local operating instructions.

2.1 Fluorescent Penetrant Inspection (FPI), Level 4 Sensitivity (Figure 1)

NOTE: For parts with thicknesses less than the crack depths defined below the crack depth is assumed to be equivalent to the material thickness.

2.1.1 FPI - Level 4 Sensitivity, Focused Inspection: < 36 $inch^2$

	a_{90}		$a_{90/95}$	
	Crack Length, 2*c*	**Crack Depth, *a***	**Crack Length, 2*c***	**Crack Depth, *a***
Open Surface Crack				
Aluminum:	0.080 inch	0.040 inch	0.100 inch	0.050 inch
Titanium:	0.080 inch	0.040 inch	0.100 inch	0.050 inch
Steel:	0.080 inch	0.040 inch	0.100 inch	0.050 inch

	a_{90}		$a_{90/95}$	
	Crack Length, *c*	**Crack Depth, *a***	**Crack Length, *c***	**Crack Depth, *a***
Edge Crack				
Aluminum:	0.080 inch	0.080 inch	0.100 inch	0.100 inch
Titanium:	0.080 inch	0.080 inch	0.100 inch	0.100 inch
Steel:	0.080 inch	0.080 inch	0.100 inch	0.100 inch

2.1.2 FPI - Level 4 Sensitivity, Large Area Inspection: 36 $inch^2$ - 200 $inch^2$

	a_{90}		$a_{90/95}$	
	Crack Length, 2*c*	**Crack Depth, *a***	**Crack Length, 2*c***	**Crack Depth, *a***
Open Surface Crack				
Aluminum:	0.150 inch	0.075 inch	0.200 inch	0.100 inch
Titanium:	0.150 inch	0.075 inch	0.200 inch	0.100 inch
Steel:	0.150 inch	0.075 inch	0.200 inch	0.100 inch

	a_{90}		$a_{90/95}$	
	Crack Length, *c*	**Crack Depth, *a***	**Crack Length, *c***	**Crack Depth, *a***
Edge Crack				
Aluminum:	0.150 inch	0.150 inch	0.200 inch	0.200 inch
Titanium:	0.150 inch	0.150 inch	0.200 inch	0.200 inch
Steel:	0.150 inch	0.150 inch	0.200 inch	0.200 inch

NOTE: Large area inspection values are based on POD studies that have been conducted on individual coupons with areas generally smaller than 36 $inch^2$. Inspections that cover areas larger than 200 $inch^2$ must be subdivided into smaller, focused inspection zones to meet the focused inspection requirements above.

2.2 Fluorescent Penetrant Inspection (FPI), Level 3 Sensitivity (Figure 1)

NOTE: For parts with thicknesses less than the crack depths defined below the crack depth is assumed to be equivalent to the material thickness.

2.2.1 FPI - Level 3 Sensitivity, Focused Area Inspection: < 36 inch^2

	a_{90}		$a_{90/95}$	
	Crack Length, 2*c*	**Crack Depth, *a***	**Crack Length, 2*c***	**Crack Depth, *a***
Open Surface Crack				
Aluminum:	0.120 inch	0.060 inch	0.150 inch	0.075 inch
Titanium:	0.120 inch	0.060 inch	0.150 inch	0.075 inch
Steel:	0.120 inch	0.060 inch	0.150 inch	0.075 inch

	a_{90}		$a_{90/95}$	
	Crack Length, *c*	**Crack Depth, *a***	**Crack Length, *c***	**Crack Depth, *a***
Edge Crack				
Aluminum:	0.120 inch	0.120 inch	0.150 inch	0.150 inch
Titanium:	0.120 inch	0.120 inch	0.150 inch	0.150 inch
Steel:	0.120 inch	0.120 inch	0.150 inch	0.150 inch

2.2.2 FPI - Level 3 Sensitivity, Large Area Inspection: 36 inch^2 - 200 inch^2

	a_{90}		$a_{90/95}$	
	Crack Length, 2*c*	**Crack Depth, *a***	**Crack Length, 2*c***	**Crack Depth, *a***
Open Surface Crack				
Aluminum:	0.200 inch	0.100 inch	0.250 inch	0.125 inch
Titanium:	0.200 inch	0.100 inch	0.250 inch	0.125 inch
Steel:	0.200 inch	0.100 inch	0.250 inch	0.125 inch

	a_{90}		$a_{90/95}$	
	Crack Length, *c*	**Crack Depth, *a***	**Crack Length, *c***	**Crack Depth, *a***
Edge Crack				
Aluminum:	0.200 inch	0.200 inch	0.250 inch	0.250 inch
Titanium:	0.200 inch	0.200 inch	0.250 inch	0.250 inch
Steel:	0.200 inch	0.200 inch	0.250 inch	0.250 inch

NOTE: Large area inspection values are based on POD studies that have been conducted on individual coupons with areas generally smaller than 36 inch^2. Inspections that cover areas larger than 200 inch^2 must be subdivided into smaller, focused inspection zones to meet the focused inspection requirements above.

3.0 Ultrasonic Inspection (UT)

Ultrasonic NDI capabilities are unique to each specific location (geometry and material). The specific NDI capabilities for each control point must be established on a case-by-case basis and consider the following:

1) Internal condition of the material to be inspected must be free of inconsistent grain structure.

2) Surfaces of composite and metallic structure (laminate, honeycomb, etc.) to be inspected must be smooth and free of flaking and/or non-uniform coatings. If inspecting primary structure (such as composite skins, stringers, longerons, etc.), all low observable (LO) coatings will be removed.

3) Inspection capability is based on the part/geometry, structural complexity, ease of inspection and signal interpretation (including signal-to-noise).

4) Inspection procedures clearly detail (both in text and graphics) the inspection location, inspection zone, and the flaw orientation and scan requirements.

5) The inspection procedures have been validated and verified by the responsible NDI Level 3 in accordance with the *USAF NDI Procedure Qualification Process* (Ref.17, Sect. 7.0) or local operating instructions.

4.0 Visual Inspection (VT)

The capability of visual inspections, to include borescopes, has not been formally evaluated. VT inspections are typically performed by non-NDI personnel with no VT-specific training, and are routinely performed in addition to NDI or when no other reliable NDI options are available. Although VT is not recognized as an NDI method by the USAF, it is an extremely useful tool to identify structural damage. Any use of VT methods should consider the following (definitions of terms can be found in Ref. 24):

1) VT inspection requirements published in NDI technical manuals must be documented, validated, verified, and approved by the NDI Level 3 similarly to NDI methods.

2) Visual inspections shall NOT be used for NDI of safety-of-flight structures whose NDI requirement is based upon a slow crack growth damage tolerant design.

3) It is acceptable to use VT to detect failed (i.e. severed) safety-of-flight structures that incorporate a fail-safe damage tolerant design.

4) It is acceptable to use VT on structures, including safety-of-flight structures, as an over-and-above requirement to a damage tolerance based inspection.

5) It is acceptable to use VT to identify foreign object debris or damage (FOD) and gross system damage from overloads, hard landings, etc.

6) In all cases, the capability of visual inspection shall be assumed at > 2.0 inches or a severed component if the component is less than 2.0 inches.

5.0 Magneto Optical Imaging (MOI) Requirements

The MOI capability values shown in Section 5.1 are dependent on the following:

1) The MOI 306, MOI 308/7 or equivalent instrument is used with rotating eddy current field. The sensor area shall be no larger than 1.5 inch x 1.5 inch. Equivalency must be determined by the responsible NDI Level 3.

2) Inspection area must be sufficiently flat to maintain direct contact of the entire sensor to the inspection surface.

3) The POD values established herein are based on an inspection frequency of 150 kHz and Mid/High excitation level. The responsible NDI Level 3 must verify the performance and capability of procedures that deviate from these parameters.

4) The temperature of the inspection surface must be between 32°F to 104°F. The sensitivity of the MOI inspection will be degraded outside of this range.

5) Ferromagnetic fasteners shall be degaussed prior to inspection.

6) Inspection areas are completely accessible both visually and physically. Visual access is defined as: Inspection location, suspect crack location and assumed crack direction can be identified without the use of visual aids such as a mirror or borescope. Physical access is defined as: Inspection location must accommodate the inspector and the MOI sensor allow for unencumbered manipulation of the sensor, and the ability to monitor the MOI image while scanning the component.

7) Inspections are performed on a single row of fasteners at a time unless otherwise approved by NDI Level 3.

8) The scan speed is limited to not more than 2 inches per second. Inspectors should be provided a ten minute break with every 30 minutes of continuous scanning.

9) Procedures must clearly define all set-up and system performance check parameters. Recurring performance checks on representative specimen with known flaws must be performed.

10) Lift-off as a result of non-conductive coatings shall be no greater than 0.010 inch (10 mils) thick.

11) Sufficient guidance for image interpretation is provided within the inspection procedure.

12) Part specific procedures clearly detail (both in text and graphics) the inspection location, inspection zone, the flaw orientation and scan requirements.

13) The inspection procedures have been validated and verified by the responsible NDI Level 3. Use of the USAF NDI Procedure Qualification Process is the preferred method.

14) Procedures and training should address interpretation of connected indications (fastener-to-fastener cracks).

5.1 Magneto Optical Imaging * ** (Figure 2b)

		a_{90}		$a_{90/95}$	
Substrate	**Fastener Type**	**Crack Length (c)**	**Crack Depth (a)**	**Crack Length (c)**	**Crack Depth (a)**
Aluminum	Aluminum	0.12 + fho	0.120 + fho	0.200 + fho	0.200 + fho
Aluminum	Steel	0.12 + fho	0.120 + fho	0.200 + fho	0.200 + fho
Aluminum	Titanium	0.12 + fho	0.120 + fho	0.200 + fho	0.200 + fho

** NOTE: The fastener head overlap (fho) must be added to the values stated above.*
*** NOTE: For parts with thickness less than the crack depths defined above the crack depth (a) is assumed to be equivalent to the material thickness.*

6.0 NDI Capability Adjustment Factors

Conditions such as difficult access, large inspection areas, complex geometries, challenging signal interpretation, etc. may require adjustments to be made to the a_{NDI} detectable flaw size capabilities specified previously in this document. It is the responsibility of the NDI Level 3 to consider the use of adjustment factors for specific applications. These adjustment factors, account for human induced variables, typically range from 1.0 to 2.0, and are applied as a multiplicative factor to the flaw sizes identified previously in this document. General guidelines for applying adjustment factors can be found in *Recommended Processes and Best Practices for Nondestructive Inspection of Safety of Flight Structures, Section 6.0* (Reference 17).

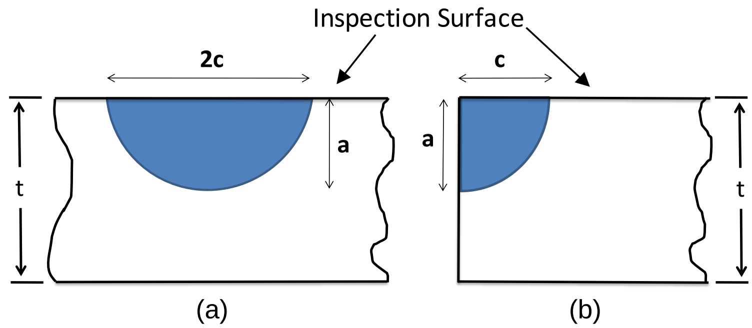

Figure 1. Crack profile for surface inspections.

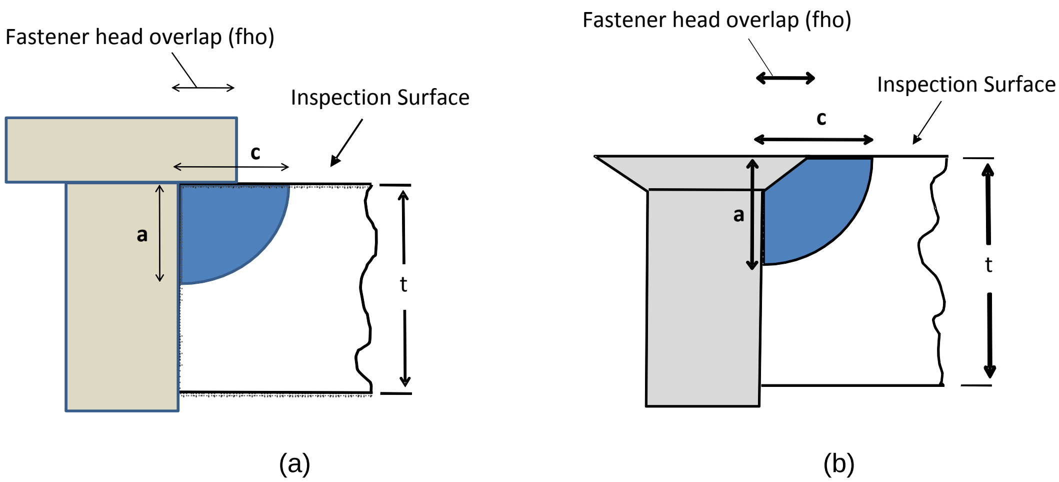

Figure 2. Crack profile for inspection around fastener heads.

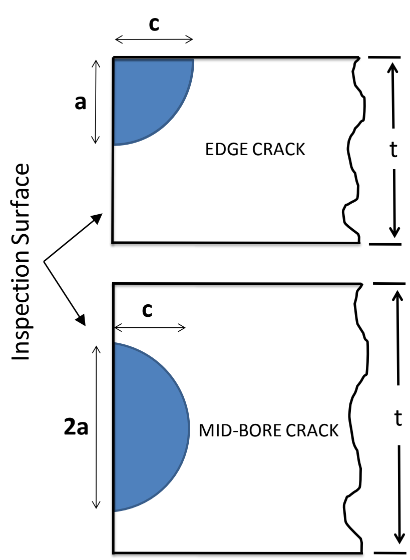

Figure 3. Crack profile for inspection of fastener holes or bore holes.

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