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TITLE: Requirements for Visual Inspection of Aerospace Products

Prepared by: Jenny Fullum
Jenny Fullum
Sr. Quality Engineer - Erie Plant

Approved by: Lisa Erdely - Causey
Lisa M. Erdely
Quality Manager - Global Quality

Approved by: David Catanzarite
David Catanzarite
Manager, Rotary Wing Engineering/Product Development

Approved by: John Smid
John Smid
Manager, Fixed Wing Engineering/Product Development

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Revision Summary

Revision	Date	Prepared By	Change Description
Original	05/06/2009	R.P. Biondi	Initial release
A	10/8/10	J. Fullum	Paragraph 7.1 Added the term "Tin Solder" method and added the need to establish a "Master" part from the manufacturing lot and compare remaining parts to the master. This change is being made as a result of DMAIC 100266 Part Marking Project.

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1.0 SCOPE

1.1 Purpose. This specification describes the general requirements for evaluating surface imperfections on parts using visual techniques. It also defines the acceptance limits for imperfections on parts.

1.2 Application. This specification applies to aerospace products and is applicable when referenced on a LORD engineering drawing or LORD inspection procedure or in the case of a supplier when invoked by contract (if not invoked by the LORD engineering drawing). When there is a conflict between this specification and a visual inspection requirement specified by the engineering drawing, the drawing requirement shall take precedence.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent applied herein. Unless otherwise specified, the latest issue of the documents shall apply. In the event of conflicts between the requirements of this specification and the references cited herein, the requirements of this specification shall take precedence.

2.1 LORD Corporation Documents

TS-002 Standard Elastomeric Component Quality Requirements
(LORD Corporation proprietary document)

3.0 DEFINITIONS

The listed below definitions apply to machined parts. Refer to TS-002 for definitions that apply to elastomer products.

Imperfection: An interruption (non-uniformity) in the normal surface condition of a part configuration which shall be evaluated for acceptance to the applicable standard.

Lay: The direction of the predominant surface pattern.

Smooth: A surface that is continuously even, free of irregularities, presenting no resistance to the sliding of a finger or probe.

Superficial Imperfection: An imperfection on a surface which although appears to penetrate the surface finish texture, does not have a dark bottom, and would not cause a probe to hesitate (catch) when passed over it.

Surface Roughness: Marks left on the surface of a part by the action of machined tools.

4.0 EQUIPMENT REQUIREMENTS

4.1 Lighting. Fixed white lighting in the inspection area shall be a white light intensity of 100 foot-candles minimum when measured at the inspection surface for the parts. The lighting shall be designed and arranged so as to provide shadow free and glare free illumination of the part surface to be inspected.

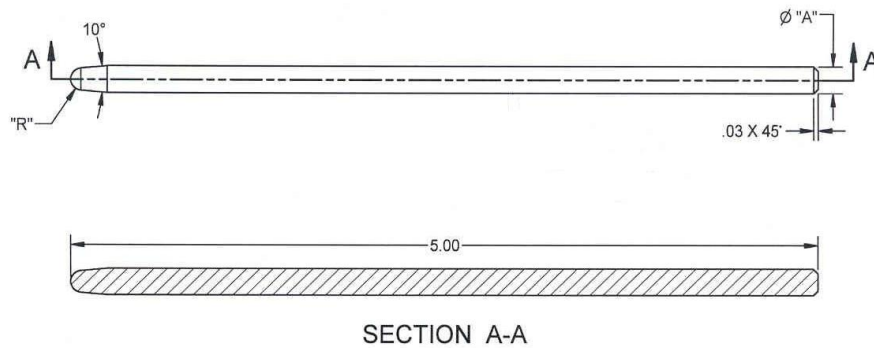
4.2 Supplemental Lighting. Hand held white lights shall be available to provide a minimum of 200 foot-candles at a distance of 8 inches. High intensity light sources shall have an intensity of 200 foot-candles at 1.5 inches.

4.3 Probe. A probe (stylus) with a spherical end (nose) radius ranging in size from 0.005 to 0.025 inch shall be available to assist in the detection of raised material or an imperfection. See LORD Corporation part number FIS-56177-1 probe shown in Figure 1. For inside surfaces that cannot be accessed by a straight probe, an angle probe shall be available for use. Probes may be purchased from:

Gary Tool Company
 26 Grant Street
 Stratford, CT 06615-6136
 Phone No. (203) 377-3077

Probes can be ordered in any end radius size. The following standard part number probes are available from Gary Tool Company:

P/N STD 1360-453-005 straight probe
 P/N STD 1360-453-006 angled probe



A Diameter	R Radius
.130	0.025

Figure 1. LORD Part Number FIS-56177-1 Inspection Probe

4.4 Special Aids. Mirrors, borescopes (rigid and non-rigid), video systems and other optical devices.

5.0 PERSONNEL REQUIREMENTS

5.1 Proficiency. Personnel performing visual inspection shall be proficient in the operation of all visual inspection equipment and techniques and be capable of interpreting engineering drawings, standards and inspection instructions that pertain to the parts being inspected.

5.2 Vision. Personnel performing visual inspection shall meet the near vision and color perception requirements listed in Table 1 in at least one eye natural or corrected. Near vision and color perception examinations shall be administered annually.

Table 1 - Vision Requirements

Vision Examination	Requirement
Near Vision	Snellen 14/18 (Snellen 20/25) or equivalent
Color Perception	Distinguish and differentiate between colors applicable to the product being inspected.

6.0 GENERAL REQUIREMENTS

- 6.1 Visual inspection shall be performed without magnification. However, magnification up to 10X may be used as an aid in the evaluation of an observed condition.
- 6.2 A probe (see 4.3) shall be used to assist in the detection and evaluation of surface imperfections and conditions. See Appendix A for the instructions in using a probe.
- 6.3 All accessible surfaces shall be inspected. Parts shall be inspected from various angles and directions to assure the detection of all imperfections. Holes shall be inspected at both ends when possible.
- 6.3.1 In areas when visual access results in a line of sight viewing angle greater than 45 degrees from a line perpendicular to the surface being inspected, or where the surface to be inspected extends beyond a depth to opening ratio greater than 1, or where other limitations prevent a valid unaided (direct vision) inspection, probes and special aids (see 4.4) shall be used. Inspection of holes less than 0.25 inches in diameter shall be confined to the edges.
- 6.3.2 Enclosed surfaces shall be inspected prior to closing.
- 6.4 Visual imperfections which will be removed by subsequent machining or processing operations specified in the work instructions/routing/planning may be disregarded.

7.0 SPECIFIC INSPECTION REQUIREMENTS

- 7.1 General Appearance. When visually inspecting a group of parts, use the "Tin Soldier Method". Establish a "Master" part from the manufacturing lot and verify it meets the drawing requirement for part marking. Line up the remaining parts from the manufacturing lot on the examination surface such that they are all in the same orientation. Visually inspect the remaining parts against the "Master" checking for the following:
- Proper geometry (i.e., no missing features such as holes, threads, chamfers, radii, etc.)
 - For an assembly, presence and proper installation of all components (including inserts, bushings, hardware, lock-wire, etc.)
 - Presence of required surface treatment (e.g., shot peen, plating, anodize, paint, etc.)
 - Correct, legible and properly located marking
 - No damage
- 7.2 Surface Condition. Visually inspect surfaces of the parts to identify any surface imperfections or flaws. Use a probe, magnification and other special aids as required to assist in the detection of any imperfections. Comparison with similar parts or photographs may be used to assess any observed conditions.

- 7.2.1 Machined Parts. Typical surface imperfections for machined parts are listed in Table 2. Table 2 also includes imperfections associated with surface treatments applied to machined parts.
- 7.2.2 Elastomeric Bonded or Molded Parts. Typical elastomer surface defects for elastomeric bonded or molded parts are listed in TS-002.
- 7.3 Acceptance Limits. Visual surface imperfections for machined parts shall be evaluated in accordance with Table 2. Visual surface imperfections or flaws for elastomeric bonded and molded parts shall be evaluated in accordance with TS-002. Superficial imperfections are acceptable unless other specified by the engineering drawing.

Table 2 – General Acceptance Criteria for Surface Imperfections of Machined Parts

Imperfection Type	Definition	Applicable Parts	Disposition	Comments
Blister	A localized lifting of a coating, plating or paint from the surface of the part base material. It appears as a protuberance that may break when probed.	All coated, plated or painted parts	Not Acceptable	
Burnish Mark	A local smoothing of a metal surface, often to a high luster from rubbing. It may show scratches of no apparent depth. Includes buffing and polishing marks.	All parts	Acceptable (see comments)	Acceptable provided it cannot be felt by a probe and that the material thickness still meets the drawing requirement.
Burr	A rough ridge or edge left at the intersection of two surfaces. A fragment of metal which remains attached to the surface after a machining operation.	All parts	Not Acceptable	
Chatter Mark	Recurring undulations or irregularities on the surface that result from vibration or jumping of a machining cutting tool.	All parts	Acceptable (see comments)	Acceptable provided it meets the drawing surface roughness requirement.
Corrosion	A deterioration of a metal surface resulting in a change of color and leaving a rough surface that may show pitting. Caused by chemical or electrochemical interaction.	All parts	Not Acceptable	
Crack	A separation of metal on the surface visible to the un-aided eye.	All parts	Not Acceptable	
Crazing	A network of fine cracks	All parts	Not Acceptable	
Deformation	Convex or Concave change in the profile a part.	All parts	Not Acceptable	
Dent	A surface depression having rounded edges, corners and bottom caused by impact with an object.	All parts	Not Acceptable	
Foreign material	Material or substance not integral to the part. The material or substance may or may not be adherent to the part surface. Chips from machining are considered foreign material.	All parts	Not Acceptable	

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Table 2 – General Acceptance Criteria for Surface Imperfections of Machined Parts

Imperfection Type	Definition	Applicable Parts	Disposition	Comments
Gouge	A relatively wide trough-like depression caused by tearing away of the surface by another object.	All parts	Not Acceptable	
Heat Discoloration	Staining, ranging from straw color (low temperature effects) to purple in color (high temperature effect).	Heat treated parts	Acceptable (see comments)	Acceptable provided it is light straw to light blue in color.
Nick	A negative indication having raised sharp edges, corners or bottom.	All parts	Not Acceptable (see comments)	Acceptable provided it can not be felt by a probe or it is not deeper then the machining lay.
Peeling	A section of a coating, plating or paint lifting away from the surface.	All coated, plated or painted parts	Not Acceptable	
Pits	Small irregular cavities in surfaces generally rough or dark bottomed resulting from corrosion.	All parts	Not Acceptable	
Rolled Edges	A plastic deformation of the edges resulting in a lap of the adjacent surface and normally appearing after shot peeing.	Shot peened parts	Not Acceptable	
Scoring	Multiple scratches caused by contact with a mating part or tooling.	All parts	Not Acceptable (see comments)	Acceptable provided the scratches cannot be felt by a probe (see 4.3).
Scratch	A linear depression with a sharp bottom.	All parts	Not Acceptable (see comments)	Acceptable provided it cannot be felt by a probe (see 4.3).
Stain	Visual indication result from liquid drying on a part surface.	All parts	Acceptable (see comments)	Acceptable provided it does not detract from the overall appearance of the part.
Step	An abrupt change in the surface contour which looks like a step in cross section.	All parts	Not Acceptable	
Tool Marks	A mark in the direction of the machining lay left by the machining tool or across the lay caused by improper tool withdrawal or metal chips. Mark can be straight, circular or spiral.	All machined parts	Acceptable (See comments)	Acceptable provided they cannot be felt by a probe (see 4.3).

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USE OF A PROBE FOR VISUAL INSPECTION

A probe with a specified radius is used to detect raised material around a surface imperfection or the minimum drop of the imperfection from the surrounding surface. The proper use of a probe shall be as follows:

- The probe shall be held lightly near the top, between the thumb and forefinger, inclined at a 60 degree angle to the part surface toward the imperfection, and be pushed forward over the surface without applying pressure other than the weight of the probe itself, in a direction approximately 90 degrees to the lay of the imperfection. If the movement is smooth with no interruption and the radius point of the probe does not hesitate or pause in the imperfection, the imperfection is acceptable.
- If the 60 degree probe position is impractical due to the part configuration, the probe can be held at any angle between 60 and 90 degrees.