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TITLE

SUPPLIER WORKMANSHIP GUIDELINES

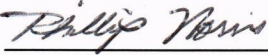
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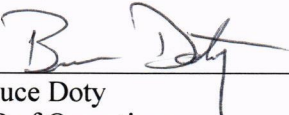
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REVISIONS

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1.0 Scope. This document is applicable to all RAM orders. This document does not supersede any drawing or engineering document requirements that may pertain to items contained in this document. Engineering disposition for specific items will always take precedence over this document. This document is intended to be used by RAM and RAM's external providers (suppliers) to provide guidance for product acceptance.

2.0 Tolerances. Unless otherwise stated refer to the defaults noted on RAM's drawing title block.

3.0 Definitions.

Blister. A localized lifting of coating, plating or paint from base material, appearing as a protuberance that may break when probed.

Bore. A hole drilled or milled by boring.

Boring. Process of enlarging a hole that has already been drilled.

Burnish Mark. A local smoothing of a metal surface, often to a high luster resulting from rubbing. It may contain scratches of no apparent depth. Definition includes buffing and polish marks.

Burrs. Non-functional pieces of material extending from the parent surface of a part. A burr can be sharp, ragged projection, firmly adhered, or a loosely hanging projection.

Chatter Mark. A tool mark on material caused by vibration or jumping of a machining cutting tool.

Clamp Mark. A depression or groove on an external surface caused by clamping pressure.

Corrosion. Also known as Rust, deterioration of the metal resulting in change of color and leaving a rough surface that may show pits (small cavities).

Crack. A separation of material visible to the naked eye.

Crazing. A network of fine cracks.

Deburr. Removal of non-functional material with conventional tools, for example: a file, grit blasting, thermal, electrochemical, tumbling, etc.

Deformation. Convex or concave change in the profile of a flat metal part or surface.

Dent. A depression in a surface normally having rounded edges, corners and bottom, caused by impact with an object.

Discoloration. A localized or generalized change in color of the part.

Draw Mark. A linear trough-like groove which normally results from the action of a die.

Embedded Material. Shot, beads or fragments entrapped in base material.

Erosion. Process of eroding (being worn away) or being eroded by outside factor.

Expander Marks. Marks left by the tooling used in a sizing operation.

Finger Print. Stains left by touching parts with unprotected hands.

Flaking. Loose, scale-like fragments on a surface.

Flash. Excess material on a forging, casting or molding caused by excess material or imperfect fit of mating mold or die.

Flux. A substance used to clean and activate surfaces to assist the flow of filler metals over base metals in a special process.

Foreign Object Debris (FOD). A solid or liquid material or substance not integral to a part. Such material or substance may or may not be adhered to part surfaces or passages. Material chips are considered foreign material (FOD).

Frosting. White haze generated after contamination in the plating process.

Groove. A surface depression having sharp edges and bottom located in a flat surface.

Lap. A tongue-like detachment of minor thickness, often appearing as a seam, caused by folding over material forced into the surface with rolling forging, etc.

Loose Burr. Material that is not rigidly fastened or securely attached to the parent surface or material that has worked partly free from the parent surface.

Nick. A negative indication having raised sharp edges, corners or bottom.

Nodule. A small, rounded, raised particle of metal, plating or coating material.

Orange Peel. A dimpled or grainy surface texture resembling that of an orange peel.

Penetration. The depth of an impact or other impression on the surface.

Pits. Small irregular cavities in surfaces generally rough or dark bottomed.

Polishing. Smoothing metal surfaces, often to a high luster, by rubbing the surface with a fine abrasive.

Rolled Edges. A plastic deformation of the edges resulting in a lap on the adjacent surface and normally appearing after peening.

Scratch. A linear depression with a sharp bottom.

Separation. A linear indication caused by the termination of material parallel to worked surface.

Stain. Visual indication resulting from liquid drying on parts.

Streak. A line, mark or smear differentiated by color or texture from its surroundings.

Step. An abrupt change in a surface profile or mismatch between two or more surfaces.

Tear. Separation of the material resulting from machining or processing material.

Thread. A spiral ridge on the outside of a screw, bolt, etc. or on the inside of a cylindrical hole, to allow two parts to be screwed together.

Tight Burr. Strongly fixed or held to the parent surface with no slack or looseness.

Tool Mark. 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. Marks can be straight, circular or spiral. These marks can also be caused by a dull or broken tool.

Undercut. A groove or recess into a surface near a shoulder or other projection.

Void. A lack of material.

Waviness. A smooth wavelike variation (undulation) in a flat or curved surface.

Witness Line. An indication on a surface resulting from contact with another part or fixture, such as impressions from pressure test fixture ferrule on conical seat sealing surfaces, tooling marks, mold lines, etc.

Wrinkle. A rippled or creased surface that occurs in areas of sharp contour changes.

4.0 Raw Material Condition.

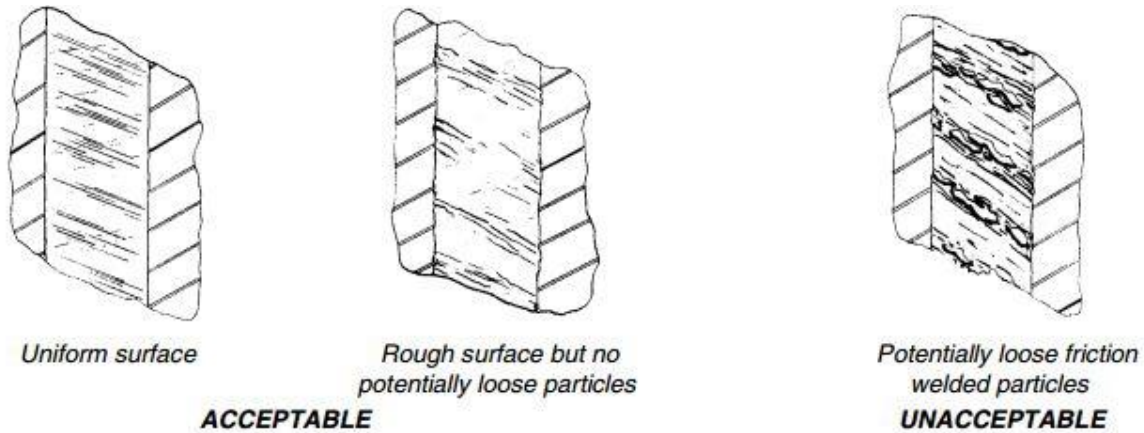
- 4.1 Receiving Raw Material. When receiving raw material, surfaces shall be free from cracks in base material which may interfere with structural integrity of resulting product. Heat treat discoloration may be acceptable if while in the machining process, all discoloration is removed prior to assembly of product.
- 4.2 Machining Raw Material. For conditions prior to or following machining process, refer to Table 2 in the Appendix.
- 4.3 Surface/Edge Condition. The surface edge condition is the result of a machining/manufacturing process which has the potential of creating a **sharp edge or burr**. Classifications are given for identification/communication purposes. However, all burrs must be removed on all parts as they may interfere with function/form.

Class 1: This classification of the surface/edge condition is generally detectable by the naked eye. The removal of a burr is performed using conventional machine shop practices and does not require the aid of magnification for detection and disposition. **Parts would be free of burrs when inspected at 10X magnification.**

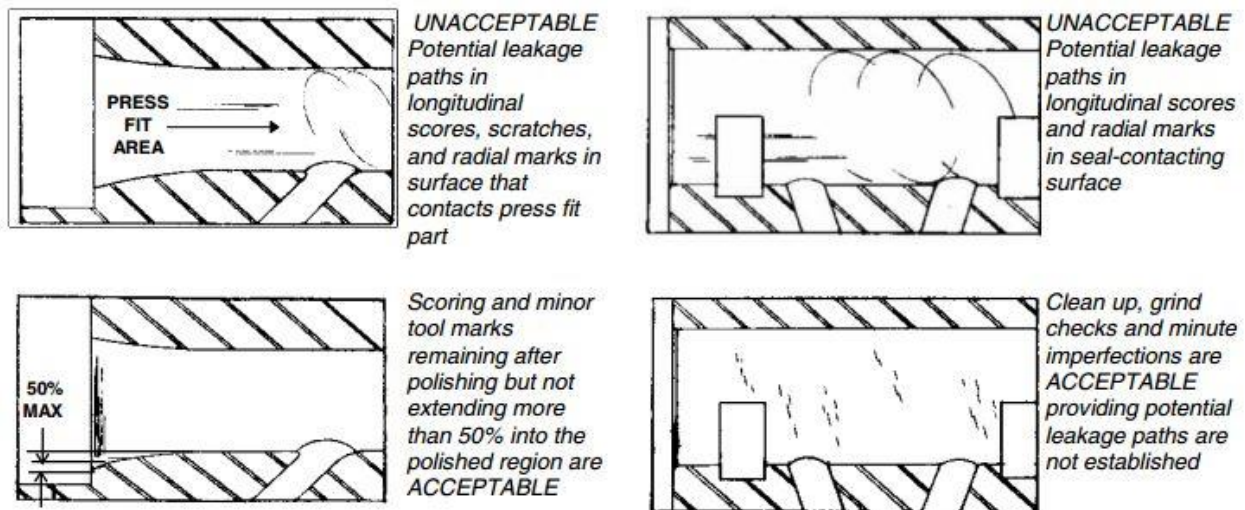
Class 2: This classification of the surface/edge condition is a consideration for micro de-burring. The condition of the edge/surface is detected and dispositioned with the aid of **10X magnification.** **The presence of a burr could cause functional issues within the assembly and must be removed.**

Class 3: This classification of the surface/edge is generally used where the edge must be sharp and free of flaws such as nicks and scratches. This classification is generally used for valve seat edges. The removal of a burr or creating an intended sharp edge is generally performed during the machining process. When identified, this surface/edge condition will require the aid of **10X magnification for removal.**

- 4.3.1 Machined Surfaces. Surfaces of machined holes should be free of stripped and potentially loose metal particles.



Critical bores with better than or equal to 32.5 RMS finish must be free of scratches/defects that may cause leakage.



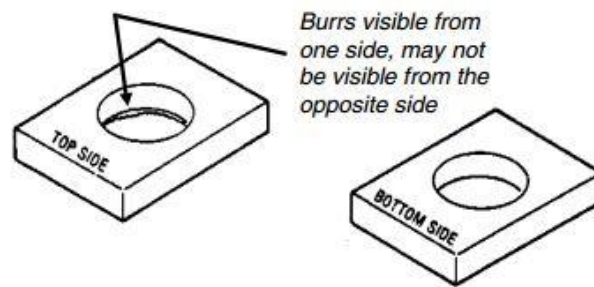
4.4 Burrs.

4.4.1 Acceptable/Rejectable Characteristics. Acceptance limits for RAM parts containing burrs are given in Table 1.

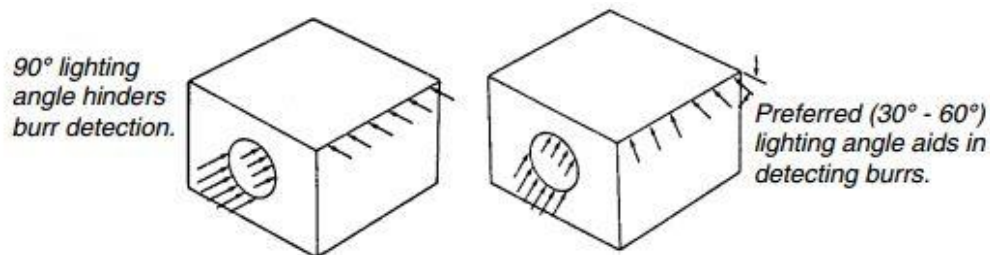
4.4.2 Secondary Burr. Often after primary deburring operation such as countersinking or chamfering, a small burr will be generated at the intersection of the countersink or chamfer surfaces and the original part surfaces. These burrs are known as secondary burrs. This type of burr could appear as any of the previously mentioned burr types and needs to be removed.

4.4.3 Viewing of Burrs

4.4.3.1 Direction of Viewing. Frequently, easily detectable burrs may be overlooked when viewing the part from a single direction. It is good practice to view components from varying directions and angles when inspecting for burrs. In general, parts should not be viewed looking straight down but should be viewed with the line of sight between 30° and 60° to the edge or surface being inspected.



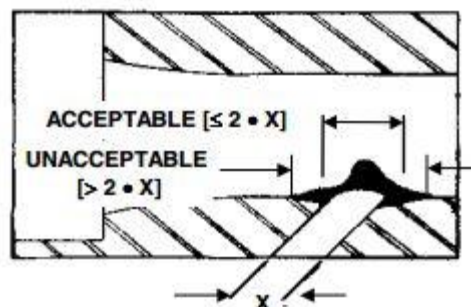
- 4.4.3.2 Proper Lighting. Similar to the direction of viewing workpieces, lighting should also be at an angle between 30° and 60° to the surface being inspected. Intensity and angle of lighting used shall be mainly dictated by size of part, shape of part, material and detail of the workpiece. The recommended lighting used is from a bifurcated (2 forked) light source such as that found on an optical microscope. The microscope must have a minimum lux reading of 3,229.



- 4.4.3.3 Proper Equipment. An optical microscope or equivalent may be used for detection and evaluation of many burr types. In general, parts shall be inspected at 10X magnification. In some cases, higher magnification may be required. Refer to specific instructions on drawings, purchase order, special work instructions, etc.

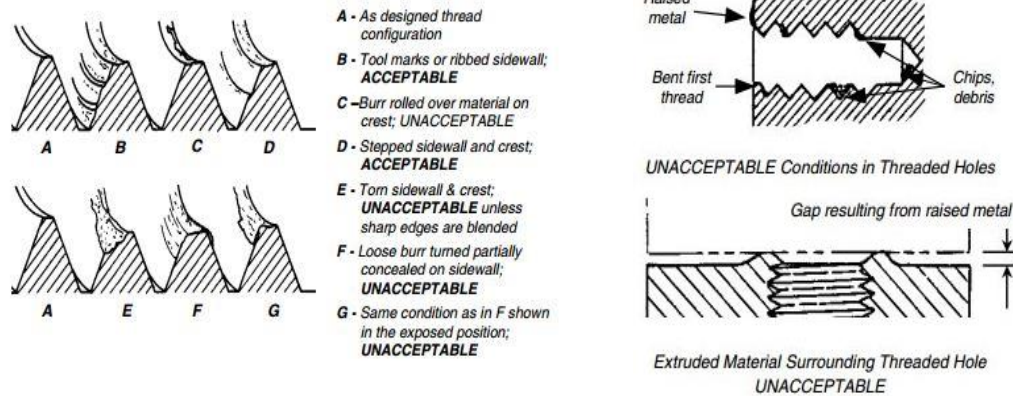
4.5 Intersecting Passages.

- 4.5.1 Intersecting passages form essential flow paths that must be free of restrictions and debris. Intersections should be verified, and passages should be free of chips and burrs.
- 4.5.2 For flow passage edge breaks, washout resulting from deburring should not exceed an area twice the diameter of the flow passage in the longitudinal direction.



4.6 Thread Conditions.

- 4.6.1 Surface Condition. Threaded bores/holes should be free of chips, burrs and major discontinuities. Chips and dislodged burrs may degrade or entirely disable systems, while major discontinuities may damage mating parts or complicate assembly.



5.0 Special Process Acceptance Criteria.

- 5.1 For special process acceptance criteria, refer to the applicable requirements called out in the **Purchase Order, process specifications, drawing notes, special work instructions, etc.**

6.0 Visual Acceptance.

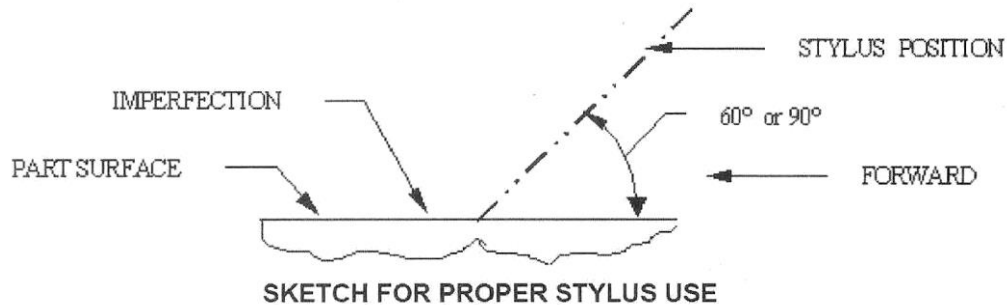
- 6.1 Inspection Requirements. The examination shall be performed under adequate lighting conditions by an inspector possessing normal or corrected vision. **4X magnification is recommended for the aid in evaluation for defects, but may require 10X or greater as necessary.**
- 6.2 Acceptable/Rejectable Characteristics. General acceptance limits for RAM parts are given in Table 2 in Appendix A.

When required by drawing, purchase order or other requirement called out, surfaces shall be inspected with a probe to evaluate the roughness. The probe used for evaluation must be made of a suitable material that will not contaminate the part. The stylus nose radius shall be per the following table (stylus nose radius is in inches):

Defined Surface Roughness	
Roughness	Stylus Nose Radius
over 63	0.040 ± .002
16 to 63	.015 ± .001
under 16	.005 ± .0005

- 6.2.1 General Probe Use. The probe (stylus) should be lightly held near the top, between the thumb and forefinger, inclined at 60° 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° to the lay of the imperfection. If the movement is smooth with no interruption and the spherical point does not hesitate in the imperfection being judged, the imperfection is

acceptable. If the 60° probe position is impractical due to part configuration, hold the probe 90° to the work surface.



7.0 Handling and Packaging.

Handling damage is the number one cause for rejection of parts at RAM. Most occurrences of damage can be prevented by awareness and proper handling of parts. Proper handling can include using proper trays, avoiding part-to-part contact, not stacking parts, not transporting too many parts at once, following standard procedures and instructions, using correct tools and fixtures, etc. It is the responsibility of RAM's suppliers to follow instructions and best practices to minimize or eliminate rejections due to damage, and to flow down these requirements to sub-tier suppliers as necessary.

7.1 General Handling of Products. Product should be handled and packaged to protect part dimensions and surfaces. Individual parts should be placed in containers or trays to prevent metal-to-metal contact when necessary. Containers and trays should be clean and free of FOD. Special instructions for handling of parts, as well as critical features may also be included on purchase order instructions, drawings, or special processing notes.

7.2 Machined Parts. Machined parts in general should be in trays with individual slots to prevent metal-to-metal contact. Parts with critical dimensions, features, surfaces shall be packaged in trays with individual slots and may also require additional packaging or specific trays to prevent damage. Refer to purchase order for additional part specific notes regarding packaging and handling.

7.3 Castings. Similar to machined parts, castings in general should be in individual slots to prevent metal-to-metal contact as necessary.

7.4 Outside Process (Plating, Heat Treat, etc.). Finished parts being sent to outside process are typically the most critical and most likely to be damaged. Parts shall be packaged in trays with individual slots to prevent metal-to-metal contact. Packaging must ensure critical dimensions, features and surfaces are protected before and after processing. Refer to purchase order for additional part specific notes regarding packaging and handling.

7.5 Raw Material. Raw material should be clearly separated and tagged with necessary identification information (PO, P/N, description, etc.). Precision ground or finished bars should be handled carefully to avoid damage. Smaller diameter bar and wire may require tubes, containers or additional packaging to prevent damage during shipping and handling.

7.6 Commercial off the Shelf (COTS) and Bulk Items. Commercial off the shelf items (screws, bolts, etc.) and bulk items (springs, shims, etc.) can be packaged and handled in bulk per industry standards, unless otherwise noted on item instructions, travelers, special process, build book or other standard operating procedures.

8.0 Picture Examples. Pictures of various unacceptable conditions can be found in the Appendix for reference.

APPENDIX

Periodically, changes to industry specifications that form a part of this specification may change or as the result of an internal process improvement or other activity the documents contained in the Appendix may require modification without the change affecting the main body of this specification. Therefore, changes may be made to these documents without requiring a revision change to the actual specification.

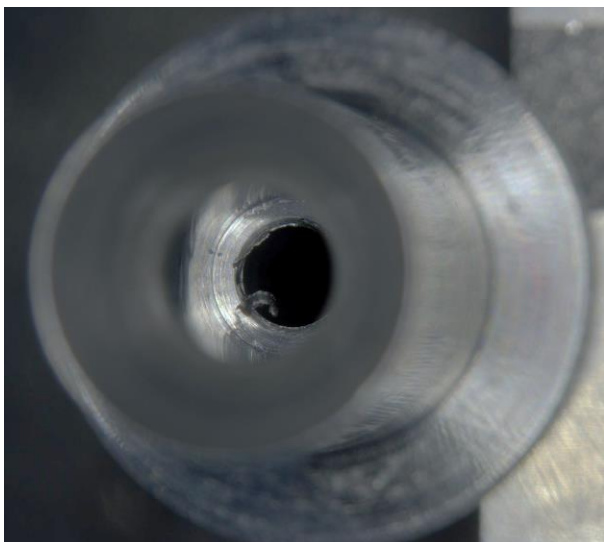
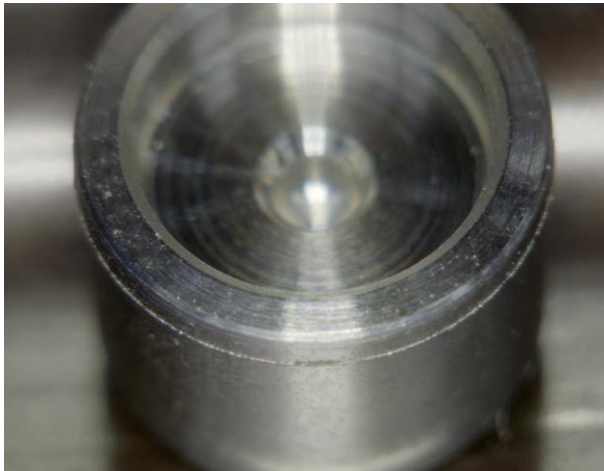
It is the responsibility of the user to ensure old forms are destroyed and replaced by the new document(s) found in this Appendix.

Pictures contained in this appendix for reference may also be modified, added to or deleted without requiring a revision change to the actual specification.

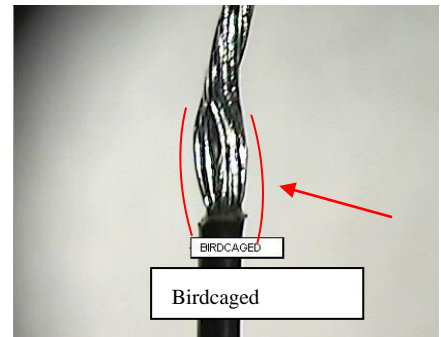
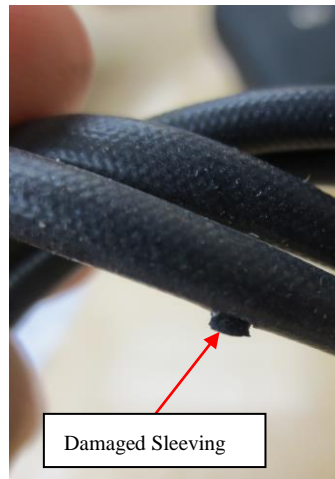
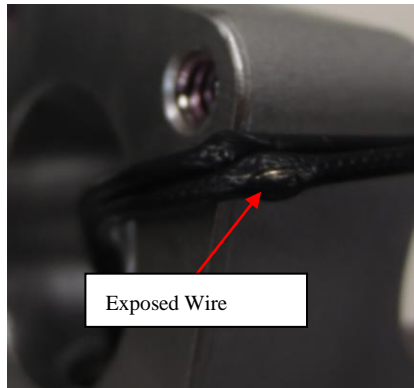
- A) Reference Pictures
- B) Table 1: General Acceptance Limits for Burred Products
- C) Table 2: General Acceptance Limits for RAM Products

A) Reference Pictures (Unacceptable Conditions):

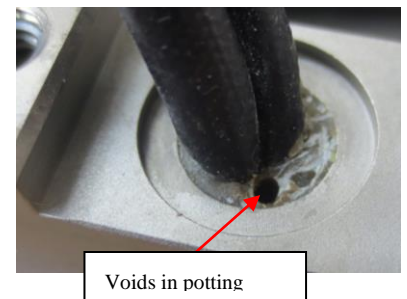
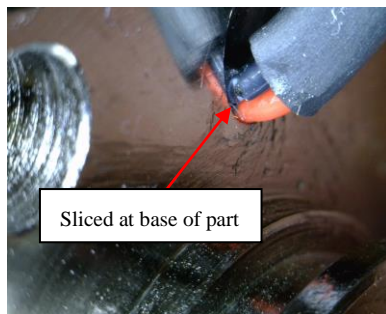
Burrs.



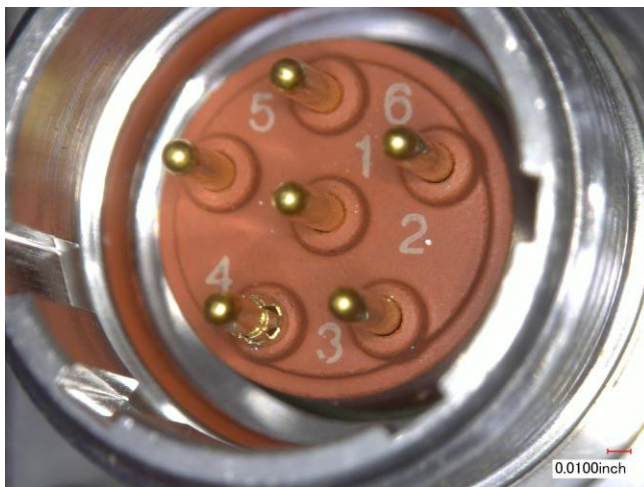
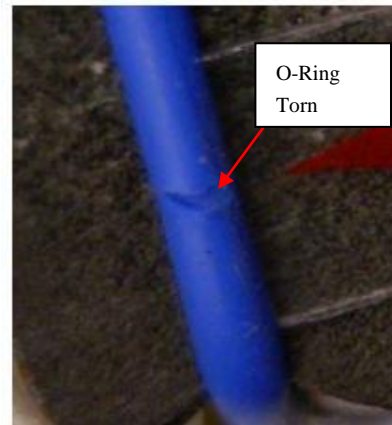
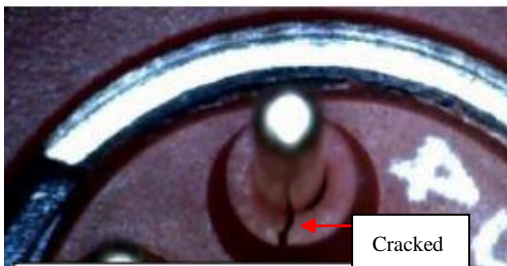
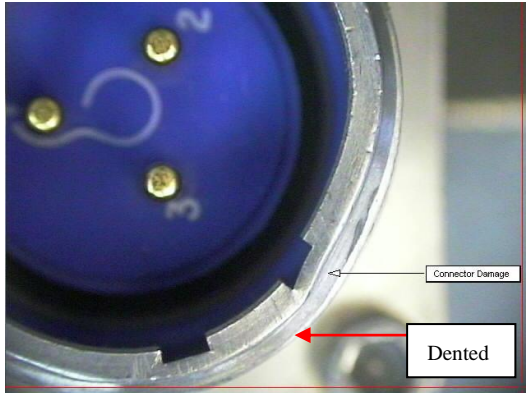
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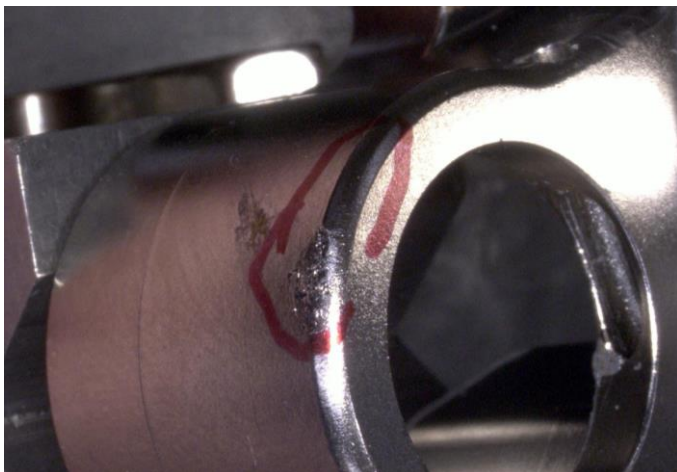
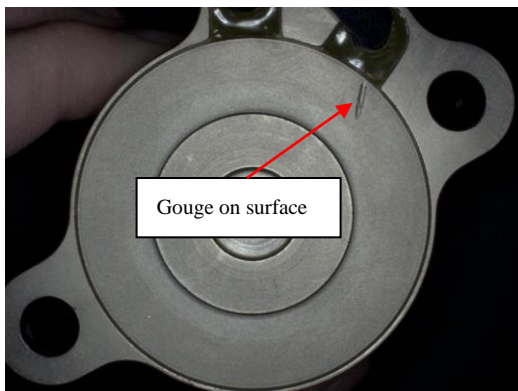
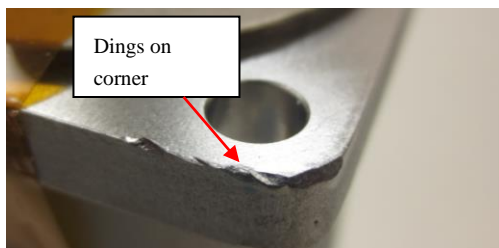
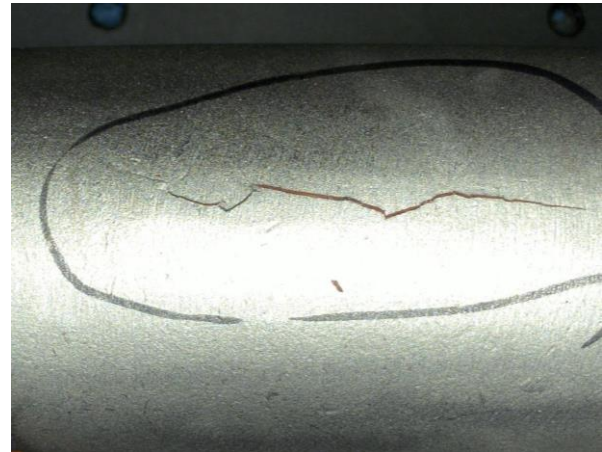
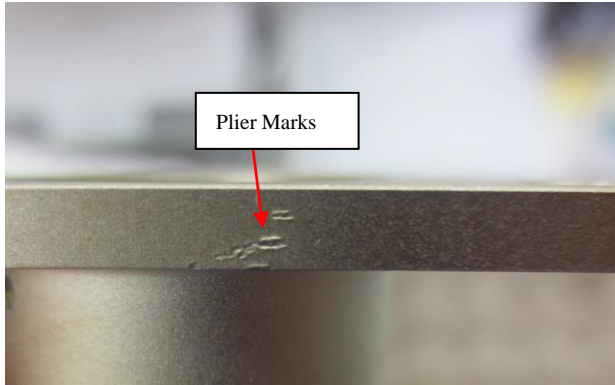
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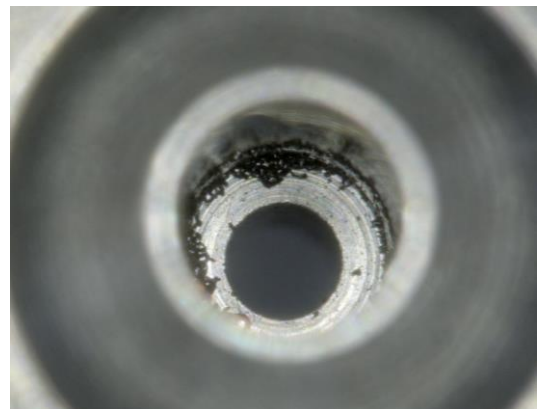
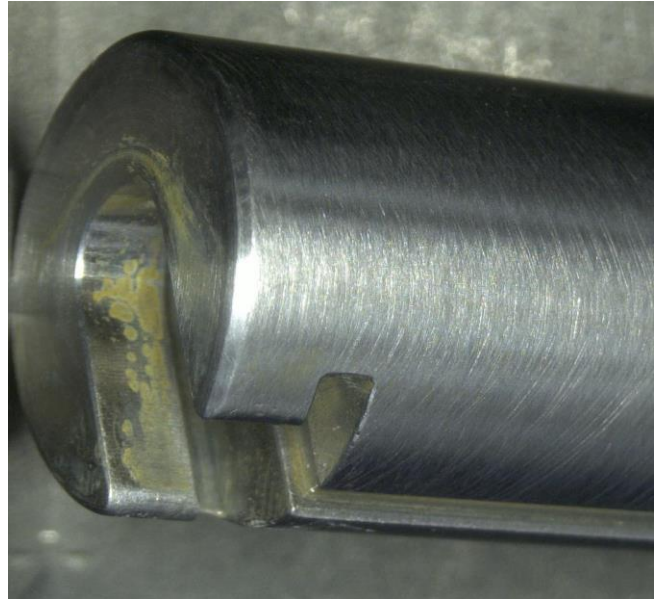
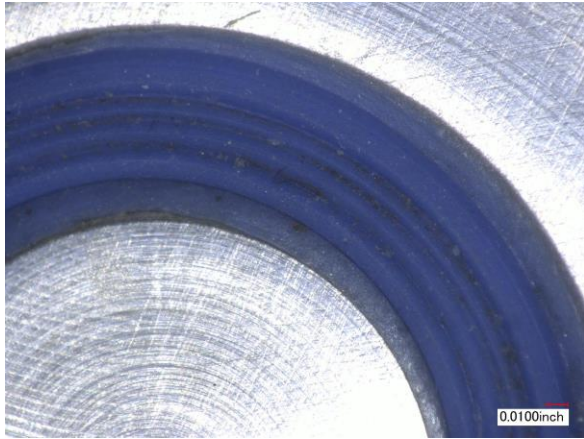
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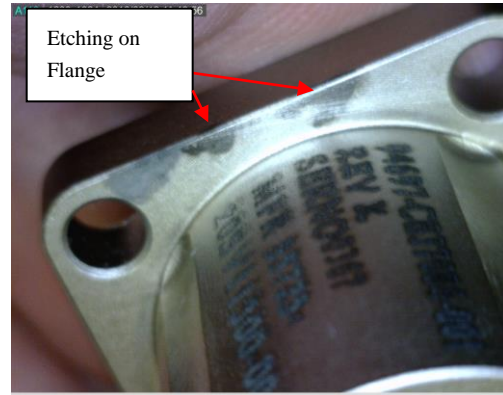
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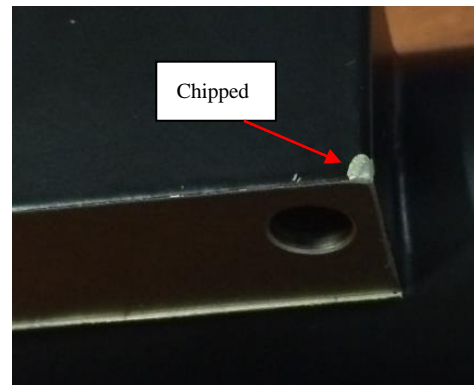
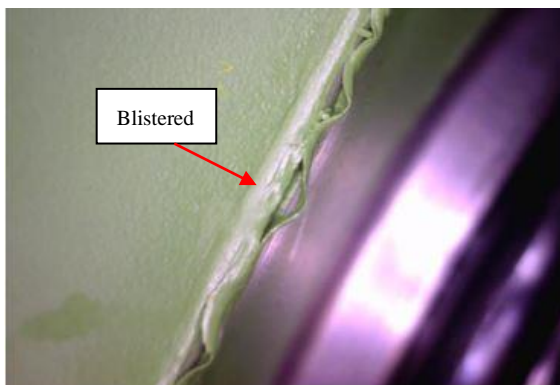
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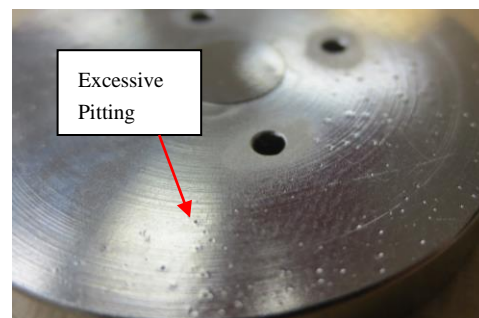
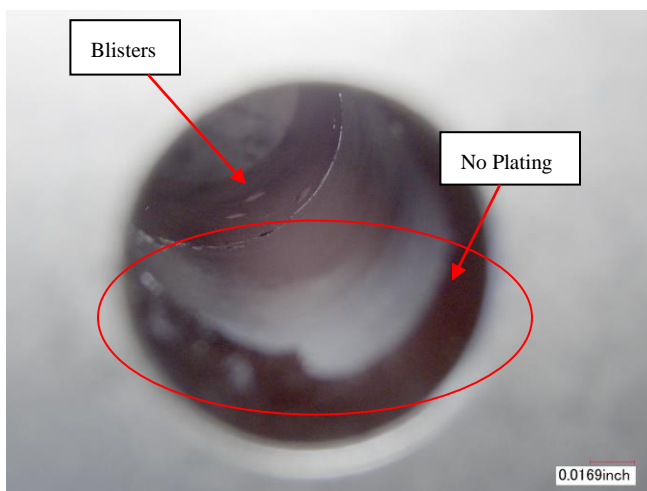
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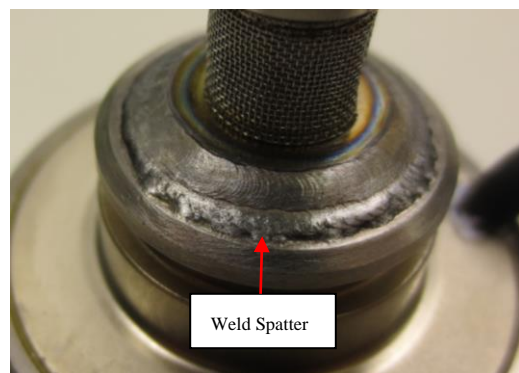
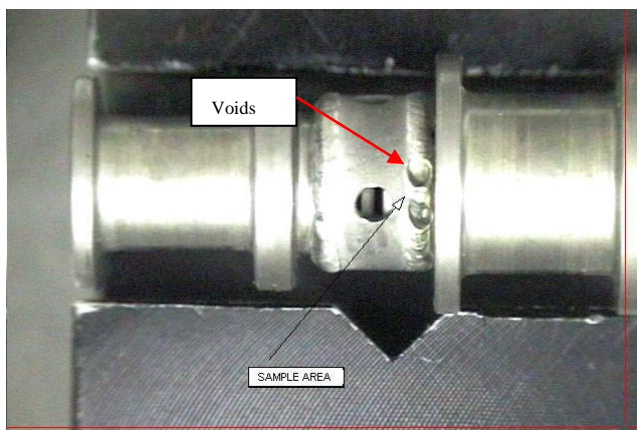
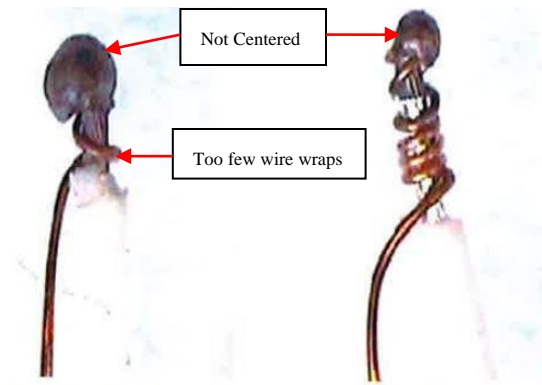
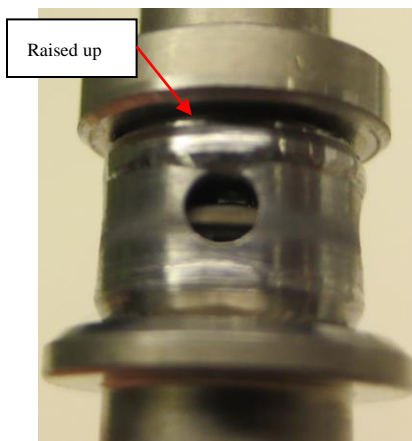
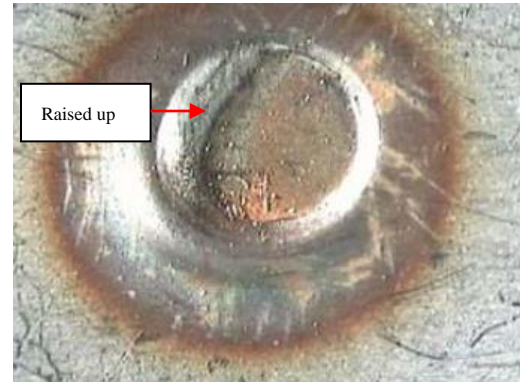
Painting.



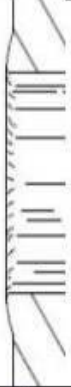
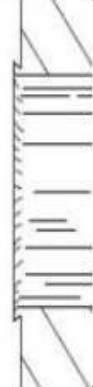

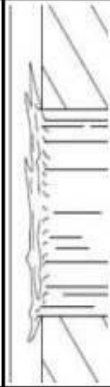


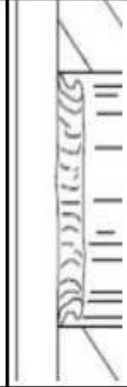
Plating.



Welding.



B) Table 1: General Acceptance Limits for RAM Burred product

Burr Type	Applicable Parts	Conditions	Comments	Reference
Extruded	All parts and details	Acceptable	Provided it does not alter hole dimensions or affects surface to surface contact.	
Feathered	All parts and details	Rejectable		
Doughnut	All parts and details	Rejectable		
Loose/Sliver	All parts and details	Rejectable	Loose burrs may contaminate system or damage mating parts	
Hinged	All parts and details	Rejectable	Hinged burrs may result in damage during assembly or testing of part(s).	
Crowned	All parts and details	Rejectable		
Rolled	All parts and details	Rejectable	Rolled burrs may potentially hinder assembly mating parts and obstruct plating	
Rev 10/16				

C) Table 2: General Acceptance Limits for RAM product

Indications	Applicable Parts	Conditions	Comments
Burnish Mark	All parts and details	Acceptable	Provided it cannot be felt by the probe and that material thickness meets drawing requirements
Chatter Mark	All parts and details	Acceptable	Provided part meets drawing surface requirements and is not on a sealing surface
Corrosion	All parts and details	Rejectable	
Crack	All parts and details	Rejectable	
Crazing	All parts and details	Rejectable	
Dent	All parts and details	Acceptable	Maximum depth of .005 and maximum size of .125 diameter (do not violate drawing limits) and away from braze joints/sealing surfaces
Discoloration	Parts after machining that undergo special processing	Rejectable	Discoloration from heat treat may cause parts not to pass passivation or other special processing
Fingerprint	All parts and details after cleaning process is complete	Rejectable	Oils from skin may cause failure in special processing or functionality of part
Flaking	All parts and details	Rejectable	
Foreign Material	All parts and details	Rejectable	
Lap	All parts and details	Rejectable	
Nick	All parts and details	Acceptable	Provided it cannot be felt by probe or is not on sealing surface
Nodule	All parts and details	Acceptable	Provided it is not affecting function and is firmly secured to the part
Pits	All parts and details	Rejectable	
Scratch	All parts and details	Acceptable	Provided it cannot be felt by the probe and is less than 1 in of length and not on sealing surface
Seperation	All parts and details	Rejectable	
Stain	All parts and details	Acceptable	Provided there is no visible change in material height and cannot be felt by a finger
Step	All parts and details	Acceptable	Provided it cannot be felt by the probe
Tear	All parts and details	Rejectable	
Tool Mark	All parts and details following machining process	Acceptable	Provided it cannot be felt by the probe and not on sealing surface
Undercut	All parts and details	Acceptable	Provided it blends smoothly with adjacent surfaces and that it is within drawing tolerances
Waviness	All parts and details	Acceptable	Provided contour changes have a smooth transition and profile variations are within drawing limits
Witness Line	All parts and details	Acceptable	Provided it cannot be felt by probe
Wrinkle	All parts and details	Rejectable	