Lockheed Martin Lessons Learned – Stainless Steel Passivation

General Information

QQ-P-35 has been cancelled and superseded by ASTM A967 or AMS-QQ-P-35.

AMS-QQ-P-35 has been cancelled and superseded by AMS 2700.

AMS-QQ-P-35 Type	Superseding AMS 2700 Type
II	2
VI	6
VII	7
VIII	8
Not Specified	Use type appropriate for alloy, subject to purchaser acceptance.

This document is written in accordance with the requirements of AMS2700. However, the technical information contained here is sound and applicable beyond. Care should be taken to ensure that all drawing requirements are met.

Passivation is a multi-step process. Each step of the process is important and has the potential to negatively impact subsequent steps. For example, if the pre-cleaning is not completed successfully, then the acid solution cannot get to the surface of the part and accomplish its task. The passivation process removes free iron and other contaminants from the surface of stainless steel. It does this by dissolving tramp metals, metals left from machining processes and contaminants from other sources with an acid solution in a controlled manner. This leaves the stainless steel surface free to form chromium oxides thus providing corrosion resistance inherent to stainless steels.

Purpose

The objective of this document is to delineate some of the requirements of AMS2700 and illustrate lessons learned from both internal and external sources. It will also provide some technical background with regard to demonstrated issues found in the processing of stainless steel parts. The goal of this document is to help suppliers provide a clean and protected stainless steel part. This document is not a substitute for the drawing or the passivation specification. It is intended to highlight and clarify areas where problems have been found.

If there is a conflict between this document and the drawing or specification, both the drawing and specification take precedence.

Scale

Paragraph 3.1.1 of AMS2700 states *"Passivation shall be performed only on surfaces free from water breaks and visible rust or scale."* This means that dirt, oils, rust, smut, carbon deposits, oxide layers, scale on the stainless steel parts MUST be removed prior to passivation. Yard scale is not acceptable, as neither is heat scale, mill scale etc. The parts shown in Figure 1 below all show varying degrees of scale; none of the parts shown below are acceptable.

Figure 1 Various degrees of scale.

Figure 2 shows two parts; both of these parts developed heat scale during the heat treat processes. The part on the right has been mechanically cleaned and is acceptable provided it meets surface roughness requirements.

Figure 2 Heat treat scale on left, after mechanical cleaning on right.

Figure 3 Examples of scale

Heat Scale, whether it is caused by heat treatment, welding or other hot work, can appear in a range of colors. It can be very light and gray, through blues and purples and back to very light blues (Figure 3). The different alloys, different temperatures, as well as different contaminants can affect the color of the scale. Below is one example of a heat treat rainbow (Figure 4), starting at lower temperatures to the left and ranging to higher temperatures on the right.

Figure 4 Heat Scale Rainbow

Scale is detrimental to the passivation process of a stainless steel part. The scale will prevent the passivating solution from reaching the base stainless metal. If the solution does not have intimate contact with the stainless material it cannot do its job of dissolving and removing tramp metals and free iron. Scale, whether heat scale or other, will block the passivation solution from the base metal, leaving free iron or other metals behind. The scale itself is an unstable oxide and will not provide adequate corrosion protection of the part. Only a properly passivated part will allow the natural chromium oxides to form, ensuring good protection and a good part. A properly passivated part should be metallic in color and shiny.

Typically it is easier to prevent scale than to remove it. Once scale has developed the method of removal has to be carefully chosen. The base metal, and type of scale, are both important factors to consider when determining a path forward. Chemical and mechanical means are both available and can be effective methods of removal. ISO 8074, ISO 8075 and ASTM A 380 provide methods for removing scale and other foreign contaminants.

Chemical Removal

Chemical removal of the scale is perhaps the least time consuming and less labor intensive. However, care must be taken to ensure that chemical properties of the stainless steel are not compromised. Multiple steps may be required to remove the original scale as well as any smut that may form during the removal process. Chemical pitting, intergranular attack, hydrogen embrittlement and other damage may be caused by chemical cleaning and must be considered. Alloy type may dictate what chemicals are acceptable to use. Deleterious processes must be guarded against (see Figure 5). It is the supplier’s responsibility to determine the best method for the particular part and ensure proper relief measures are taken.

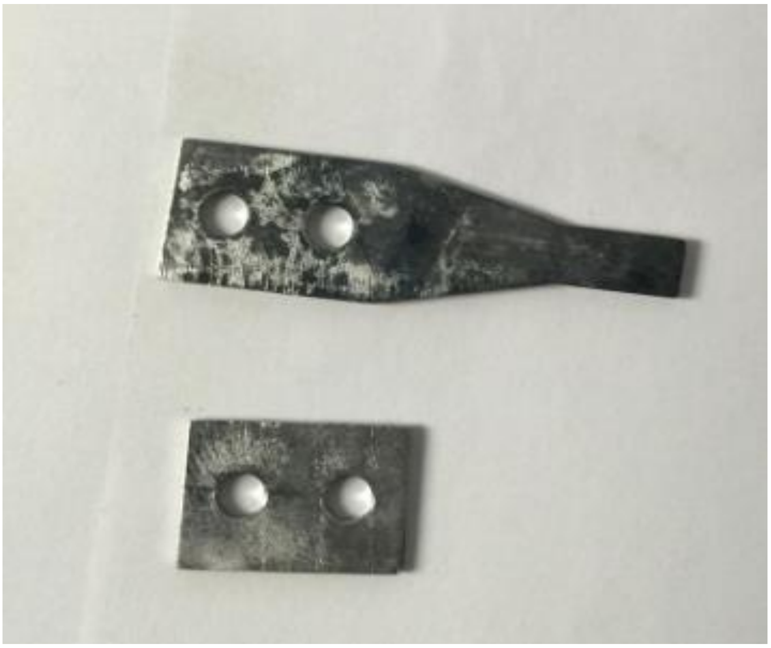

Figure 5 Improper chemical cleaning can cause additional problems.

Mechanical Removal

Mechanical removal may be the only way to remove scale due to the alloy type or other warranted circumstances. Care shall be taken to ensure that mechanical removal means do not affect the part dimension or in themselves contribute to contamination. Blast media needs to be clean and free of any contaminates that would decrease the effectiveness of the passivation solution. Aluminum oxide grit in the 220 size range has been found to be effective. However, parts must have all of the residual aluminum oxide removed (see figure 6). Glass bead blasting can be used, but whole beads are typically ineffective. It is only after the beads begin to break apart that they become effective in removing scale. If chipping, power brush, or other hand methods are used, it is recommended that only stainless steel tools be used to avoid implanting rogue metals into the surface.

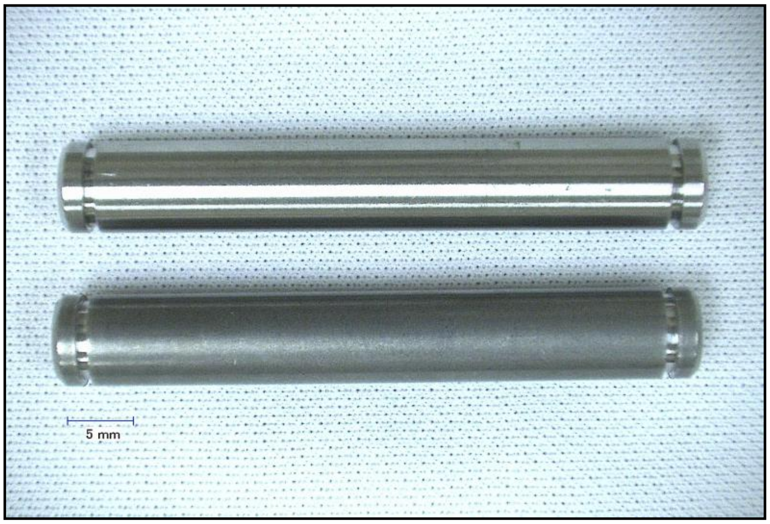

Figure 6 The bottom pin has aluminum oxide residue.

EDM

Wire EDM has shown to leave a surface that is not conducive to the formation of the protective chromium oxide. It may leave behind contaminates, scale or a surface with different metallurgical characteristics than the base metal. This will cause problems and the part will not become properly passivated without additional steps. If EDM is chosen, care must be taken to ensure the surface is properly cleaned to eliminate any scale, contaminants or metallurgical transformations caused by the EDM.

Part Handling and Packaging

Stainless steel corrodes less than other steels; however it is not 100% immune from the effects of the environment. Moist atmospheres, chemical contamination, and oils from handling can all contribute to premature oxidation of the parts. A properly cleaned and passivated part may, in time, corrode (Figure 7). It is therefore recommended that completed parts be handled with appropriate gloves and packaged in a way to mitigate contamination and humid atmospheres. Sufficient drying time or methods are also recommended to remove any residual moisture from any wet-processes.

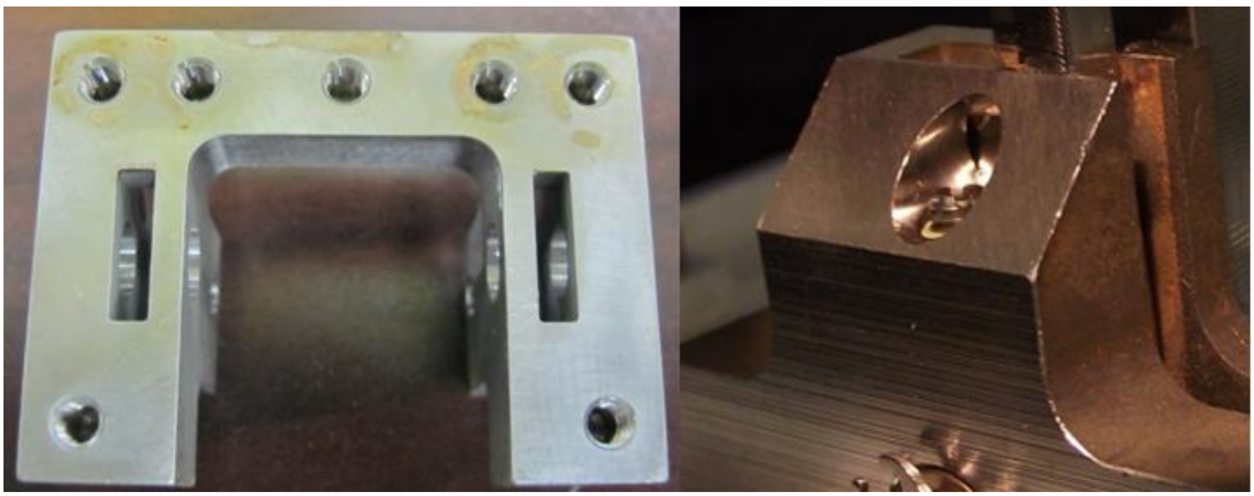

Figure 7 The part on the left appears to have residual chemical run out after processing, the one on the right may have been stored improperly.

Specific packaging requirements may be listed in the Purchase Order notes as well as other requirements in addition to the drawing and specifications. Do not hesitate to contact Lockheed Martin with any questions or concerns.