Grit Blast Cleaning in Water-Washable Fluorescent Liquid Penetrant Examination (LPE)

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Abstract
NDT is a required process for the fabrication of aerospace components at the W.R. Davis Engineering plant. The American Society for Testing and Materials (ASTM) Standard E1209 specifies water-washable fluorescent Liquid Penetrant Examination (LPE). The Standard that governs LPE of aerospace components at Davis is ASTM E1417.

This paper describes the Standard's pre-cleaning requirements after Grit Blasting (GB) before LPE and presents a project conducted by W.R. Davis Engineering. The LPE project required per the Standard was intended to provide evidence and a technical justification on the adequacy of the procedure. The paper describes the acceptable cleaning method after grit blasting with considering peening effect. This will be followed by how Davis produced an Inspection Specification (IS), an Inspection Procedure (IP), test and qualification samples, independent peer reviews and a Technical Justification (TJ).

Keywords: Liquid Penetrant Examination (LPE), Performance Demonstration (PD), Grit Blasting (GB)

1. Introduction

In the ASTM E1417 Standard, it specifies that the cognizant engineering organization is responsible for Performance Demonstration (PD). PD is a dynamic combination of procedure, qualified personnel, and equipment; with the goal of proving defect detecting and sizing. The current version of the Standard is the 2011 version. In this paper, the term ASTM E1417 and the Standard will be used interchangeably.
Although the Standard specifies this PD requirement, it does not specify how to conduct PD and how to present the evidence of PD.

This paper summarizes the testing conducted as per the Standard. It is intended to demonstrate the validity of the LPE without etching after grit blasting (glass beading) which fulfils the requirements of clause 7.1.4 of the Standard.

Table 1 below lists some key differences between etch and alkaline cleaning.

Table 1. The Differences Between Etch and Alkaline Cleaning

Etch Vs. Alkaline Cleaning	
Etch	**Alkaline**
Waste Stream Water Management	Environment Friendly
High Safety Consideration	Safe Process
Surface Metal Lost	No Metal Lost
Time and Cost Consuming	Faster Process

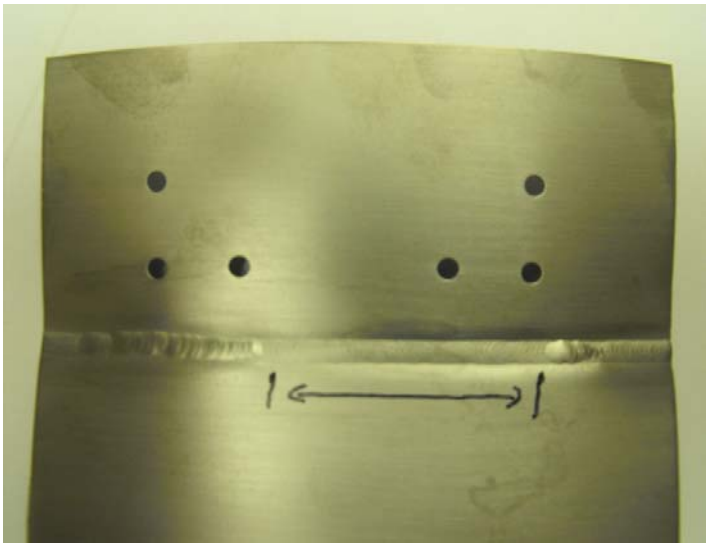
2. Preparing Test Samples

One production test sample made from 0.025 inches thick titanium (AMS 4900, Type CP2) with some accumulated pin holes in the weldment was chosen. Prior to testing, the sample was subjected to LPE to confirm the presence and number of pinholes and defects. This was measured and confirmed using a measuring microscope. Some accumulated pin holes (a total of 5) were found within 1.70 inches length of weld seam on the face of the sample and on the reverse side 3 isolated pin holes were found.

LPE was performed on this sample using two different surface preparations. In the first process, the surface was cleaned by glass beading as per Standard, using FLEX-O-LITE grade BOL 100-170 glass beads and then by an alkaline cleaner (MC3 all purpose cleaner). In the second process, the surface was cleaned first by glass beading and then by etching using Kroll's solution as per Standard. Photographs of the sample are shown in Figures 1 and 2.

Figure 1. Reverse Side of Sample with 3 Isolated Pinholes

Figure 2. Face Side of Sample with Accumulated Pinholes within 1.70 Inches of the Length



3. Performance Demonstration

The sample was subjected to both processes as outlined in Section 2 above. Following each process, the sample was inspected with Type 1, Method A penetrant sensitivity Level 3 with non-aqueous developer as per ASTM E1209. Photographs of the sample are shown in Figures 3 through 6.

For both processes, the same numbers of defects were found at the same locations.

Figure 3. Fluorescent Glass Beaded and Alkaline Clean Surface (Face Side)

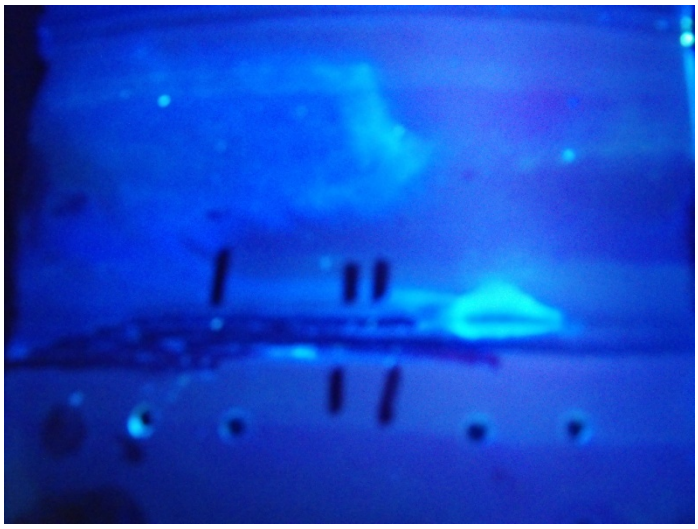


Figure 4. Fluorescent Glass Beaded and Etch Clean Surface (Face Side)

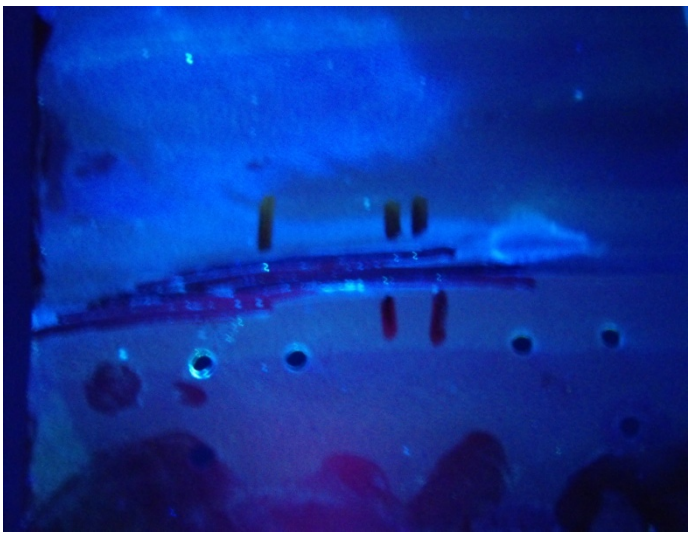


Figure 5. Fluorescent Glass Beaded and Alkaline Clean Surface (Reverse side)

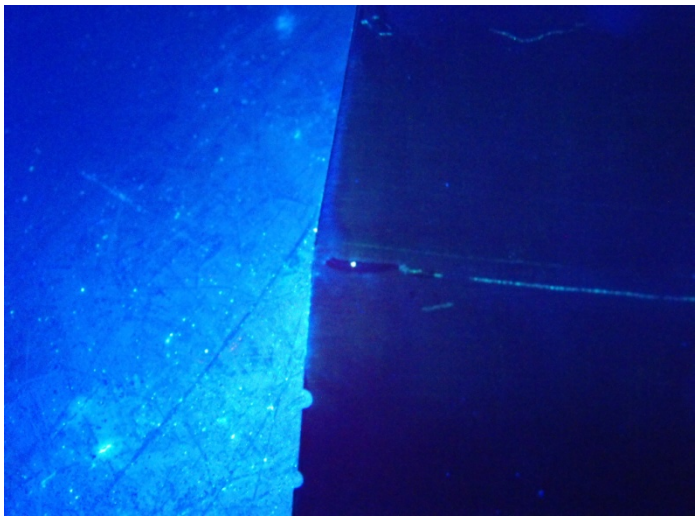
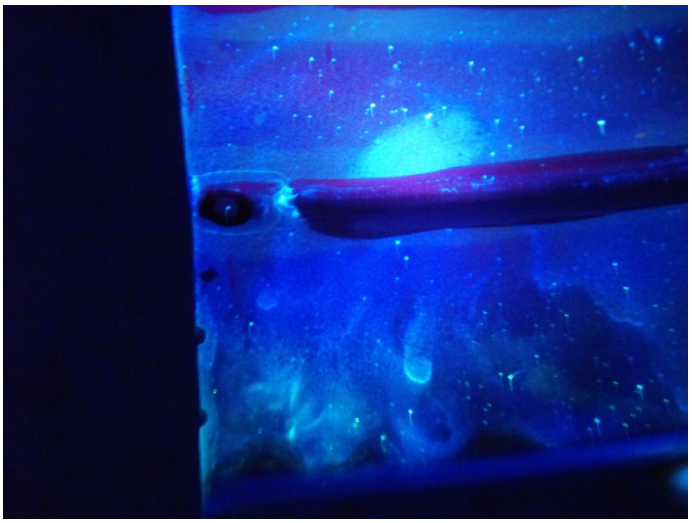


Figure 6. Fluorescent Glass Beaded and Etch Clean Surface (Reverse Side)



3. Conclusion

It is a regulatory and ASTM E1417 compliance requirement for LPE to be performance demonstrated when using an alkaline pre-cleaning instead of etching after grit blasting. The cognizant engineering organization is responsible for meeting this requirement. W.R. Davis Engineering penetrant testing methodology in accordance with the Standard was proven to be acceptable for titanium components inspection and demonstrated that:

1. Pre-cleaning parts with an alkaline cleaner prior to inspection fulfils the requirements of clause 7.1.4 of the Standard ASTM E1417.

2. The procedure identified the same defects with or without etching and demonstrated that fine abrasive glass beading (grit blasting) will not cause peening and can be removed by a detergent or alkaline cleaner.

References

1. ASTM Standard E1417-11, ‘Standard Practice for Liquid Penetrant Testing’
2. ASTM Standard E1209-10, ‘Standard Practice for Fluorescent Liquid Penetrant Testing Using the Water-Washable Process’