

## **Goddard Space Flight Center**

**Task:** Probability of Detection (POD) Demonstration Transferability

### **Objectives:**

NASA Special Level POD demonstration tests are typically performed on flat plates of a single material containing fatigue cracks with aspect ratios between 0.3 and 0.5. Subsequent fracture mechanics analyses consider aspect ratios that range from 0.1 to 0.5. There is debate within the NDE community about the detectability of shallow cracks associated with NASA Special Level penetrant inspections that are routinely performed by propellant tank manufactures. The objective of the task is to investigate effect of crack aspect ratio on POD crack sizes for the penetrant inspection technique.

### **Center Point of Contact:**

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### **Technical Methodology/Approach:**

One aspect of the task requires the production of a crack panel set with low aspect ratio cracks. This will require first developing a process for producing shallow cracks and then employing the process to produce a set of cracks suitable for POD demonstration testing. A second aspect of the task involves performing a series of skim cut on cracks and measuring crack detectability as the crack aspect ratio gets progressively smaller.

### **Customers:**

James Webb Space Telescope

Global Precipitation Measurement Mission

### **Recent Accomplishments:**

A process for producing cracks with low aspect ratios (ratio of crack depth to crack length less than 0.1) has been developed. The process has been used to create a set of 6061-Al crack specimens with 46 cracks with crack lengths ranging between 0.009 to 0.093 inches. The specimens will be used in POD

demonstration tests to investigate the effect of aspect ratio on crack detection for the penetrant inspection process.

A series of surface skim cuts was performed on several low cycle fatigue cracks in 6061-Al. Prior to each cut, the crack length was measured and the specimen was penetrant inspected to determine if a penetrant indication was produced and also to look at the persistence of the indication, which was determined by measuring the number of alcohol dampened swab wipes necessary to completely remove the indication. By measuring the crack lengths and the amount of material removed with each cut, we were able to reconstruct the crack profile (aspect ratio at each inspection point).

### **Benefits/Payoffs:**

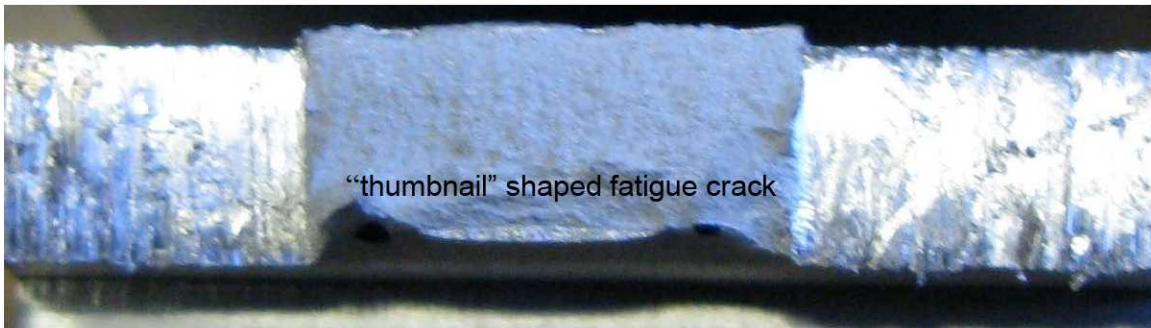
A final report with POD results from low aspect ratio cracks will provide agency guidance on how to address the range of crack aspect ratios (0.1 to 0.5) and corresponding lengths and that are used in fracture mechanics analyses.

### **Status:**

POD demonstration testing on the low aspect ratio specimen set is underway. Additional funding from the continuing resolution is required in order to continue the effort.

### **Additional Information:**

The figure below is an optical photograph of a fatigue crack that has been broken open in order to measure the crack aspect ratio. The crack pictured is 0.19 inches long and 0.014 inches deep for an aspect ratio of approximately 0.07. This low aspect ratio was achieved by carefully controlling the amount of material removed from the cracked surface during removal of the starter notch.



The table below shows the number of alcohol dampened swab wipes necessary to completely remove penetrant indications from cracks with low aspect ratios (ratio of crack depth to crack length less than 0.1). The persistence of the indications as indicated by the number of wipes required to remove the indication suggests that cracks at these depths are unlikely to be susceptible to over-wash or over-emulsification during the penetrant inspection process. This in turn suggests that crack length is the dominate factor in crack detection for the penetrant inspection technique.

Crack Number	Crack Length (inches)	Crack Depth (inches)	Aspect Ratio	Number of Wipes to Remove Indication
1	0.059	0.0045	0.076	6
2	0.050	0.0017	0.034	7
3	0.051	0.0038	0.075	>10
4	0.052	0.0024	0.046	7