Title
Using neutrons to fight forest fires

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Publication Date
2006

USING NEUTRONS TO FIGHT FOREST FIRES

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INTRODUCTION

Many papers have discussed the ability of neutron radiography to detect moisture and corrosion in a variety of materials [1, 2, 3]. We are presenting here another example of neutron radiography of aluminum components. This was definitely not an experimental data acquisition project. We provided NDI results to the customer so as to make sound engineering evaluation of the items tested. The customer was Dyncorp International Inc. Their contract with “The United States Forest Service” was to provide a five year components certification for their "Modular Airborne Firefighting Systems", MAFFS. The MAFFS are carried aboard Air National Guard C-130 aircraft to deliver fire retardant to the scene of forest fires. One system that goes in to the C-130 contains five “three hundred gallon tanks”, a port and starboard delivery tube system. We performed neutron radiography on two of the delivery tubes and eleven of the tanks.

1. THE NEUTRON SOURCE

The University of California, Davis-McClellan Nuclear Radiation Center (UCD-MNRC) is located at the former McClellan Air Force Base near Sacramento, California. The neutron source is a 2 Megawatts TRIGA reactor developed by General Atomics. The facility was built between 1986 and 1990 and initial criticality was achieved in 1990.

MNRC was turned over to The University of California at Davis, in February 2000, as part of the closure of the air force base. We have a balance of research and industrial partnerships, providing a variety of reactor related services:

- In core and in tank out of core irradiations, isotope production, and survivability
- Conventional film radiography
- Computed radiography
- Computed Tomography
- Real-time radiography
- Research use of the neutron beam

2. WHAT ARE MAFFS?

The United States Forest Service uses MAFFS in Air National Guard C-130 aircraft to deliver fire retardant to the scene of forest fires.

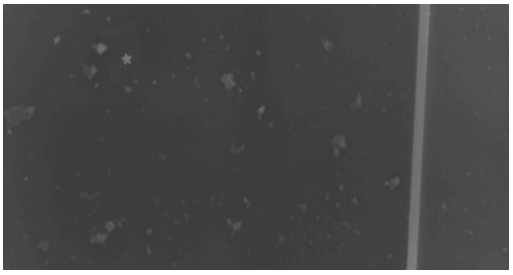
MAFFS is the acronym for the entire unit containing the components to deliver the fire retardant. Failure of a tank or component of the system could be costly. There could be a very high cost of cleanup or worse, loss of life or aircraft. The retardant is very corrosive, requiring fresh water rinsing following use. Inside the aircraft, it would not be a simple hose down. These systems have been in use since the early ’70’s. There have been some minor to major failures. The USFS wants to minimize the failures. DynCorp International won the contract to upgrade, repair, and certify the MAFFS for five years.

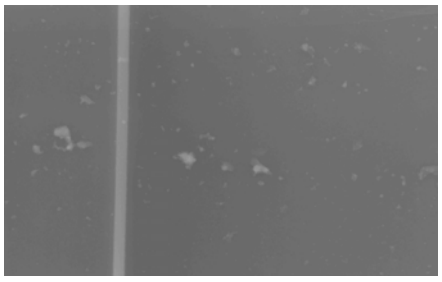
3. NEUTRON RADIOGRAPHY OF ALUMINUM COMPONENTS

3.1. INSPECTION OF THE DELIVERY TUBES

We completed the certification of the first four units. First we looked at two of the delivery tubes. Dyncorp’s first approach was media blasting of the interior surfaces of the tubes, followed by visual inspection of the cleaned surfaces.

We then performed neutron computed radiography of the delivery tubes. The radiographs showed all the pitting they’ve seen when they media blasted the tubes.

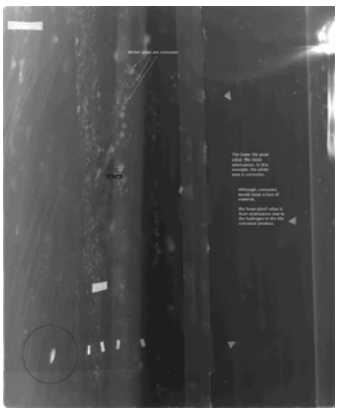


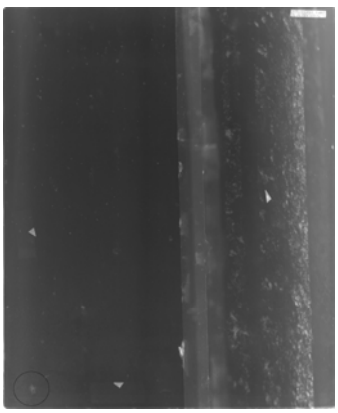


After the visual and radiography of two of the tubes, Dyncorp blasted and cleaned all of the ten tubes. They manufactured and welded liners into the bottom half of each of the ten tubes.

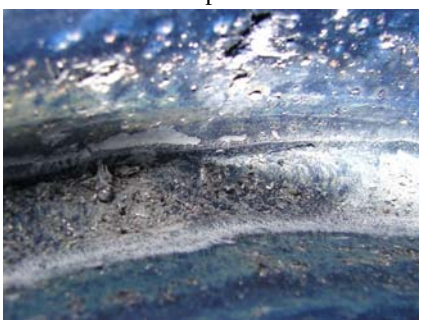
3.2. INSPECTION OF THE MAFFS TANKS

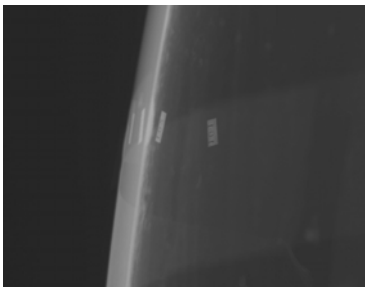
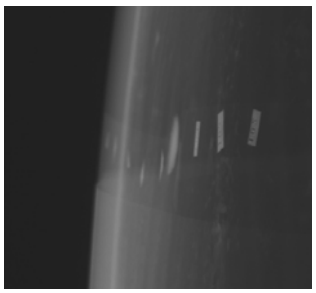
The MAFFS tanks have no openings big enough to allow a person entry inside to perform a visual inspection. A digital camera was inserted into an opening in the bottom of the tank. The photographs showed irregularities on the inner surface of the end bell of the tanks. Because of the uncertainty of what was seen in the photographs, Dyncorp asked us to see what could be learned through neutron radiography.



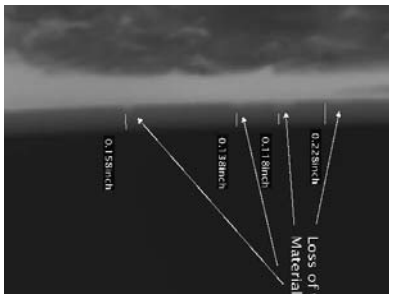


Initial radiographs revealed the same thing seen in the photographs only, from the outside of the tank looking in. Evaluation of the corrosion penetration into the inner surface of the tank wall could not be easily made.



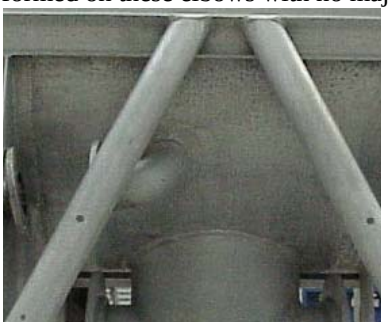




We started shooting profiles of the tank wall to see if metal loss had occurred. Rotating slightly with each exposure, we could evaluate if an indication was evasion into the wall or buildup on the inside of the tank wall.
However, because of the size of the tanks and the number of radiographs that may be required with these profiles, the decision was made to limit the inspection to only the bottom of the tank since that's where the retardant and water would lay. Any resulting corrosion and evasion of the wall thickness should be in the bottom of the tank. Wall thickness evasion was easily identified and measured. The end bell was cut off the tank with the most significant amount of evasion. Pitting sites were identified by an overlay of the original radiograph. Depth micrometer readings agreed with radiograph depth measurements with in 0.005". Our process was validated.

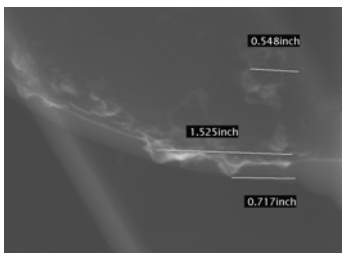


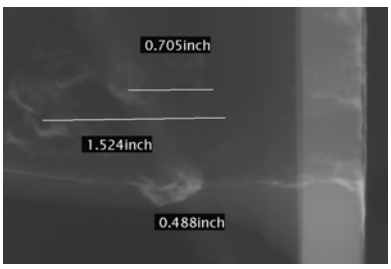
3.3. INSPECTION NOT ASKED FOR

We were told a visual had been performed on these elbows with no major concerns?

The radiographer suspected a problem when he looked inside this elbow? We decided to radiograph these concerns. Engineering determined the elbows were of a different grade aluminum than the tanks. The elbows on all twenty tanks were replaced with new elbows on the same grade aluminum as the tanks.





CONCLUSIONS

Neutron radiography and computed radiography was a good choice for this project. The excellent images, with on screen enhancements, and measuring tools provided information necessary to make the engineering evaluations. The elbows on all twenty tanks were replaced. Liners were placed in all of the delivery tubes. Combining these factors along with an evaluation of the amount and type of corrosion present in the tanks allowed certification of the MAFFS units for another five years. Also, the USFS has awarded Dyncorp another contract to inspect, repair, and certify the remaining four MAFFS units. This tank project provided UCD-MNRC and neutron radiography some very good public relations. All the local TV news crews showed up. We were on all the TV channels that night. Also one of the TV stations in San Francisco aired our story. There was PBS coverage and talk radio. We were covered on C-Net. There was an article in “Wildfire Magazine”. UC Davis web site had a good article about the tank project.

ACKNOWLEDGMENTS

The authors would like to thank Wade Meith of Hill Engineering LLC, Jeff Cavarra of Dyncorp International Inc. and the U.S. Department of Agriculture-Forest Service.
The U.S. Forest Service, UC Davis, and Dyncorp are partners in the Center of Excellence for Aircraft Health Management. Other partners include NASA Ames Research Center, Aerobotics Inc., Hill Engineering LLC and Eclypse International.

REFERENCES

[1] Berger, H., “Neutron Radiographic Detection of Corrosion”, January 1986.

[2] W. J. Lewis and L.G. I. Bennett., “Neutron Radiography Of Aircraft Composite Flight Control Surfaces”, the 8th ECNDT in Barcelona, June 2002.

[3] M. Boussoufi, W. Steingass, H. Egbert, H. B. Liu, R. Flocchini, “Non-Destructive Testing With Neutron Radiography At The UC Davis/ McClellan Nuclear Radiation Center,” Presented at the TRTR Conference for 2006, University of Texas at Austin.