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Experimental Design for the Evaluation of Detection Techniques of Hidden Corrosion Beneath the Thermal Protective System of the Space Shuttle Orbiter

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ABSTRACT: The detection of corrosion beneath Space Shuttle Orbiter thermal protective system is traditionally accomplished by removing the Reusable Surface Insulation tiles and performing a visual inspection of the aluminum substrate and corrosion protection system. This process is time consuming and has the potential to damage high cost tiles. To evaluate non-intrusive NDE methods, a Proof of Concept (PoC) experiment was designed and test panels were manufactured. The objective of the test plan was three-fold: establish the ability to detect corrosion hidden from view by tiles; determine the key factor affecting detectability; roughly quantify the detection threshold. The plan consisted of artificially inducing dimensionally controlled corrosion spots in two panels and rebonding tile over the spots to model the thermal protective system of the orbiter. The corrosion spot diameter ranged from 0.100" to 0.600" inches and the depth ranged from 0.003" to 0.020". One panel consisted of a complete factorial array of corrosion spots with and without tile coverage. The second panel consisted of randomized factorial points replicated and hidden by tile. Conventional methods such as ultrasonics, infrared, eddy current and microwave methods have shortcomings. Ultrasonics and IR cannot sufficiently penetrate the tiles, while eddy current and microwaves have inadequate resolution. As such, the panels were interrogated using Backscatter Radiography and Terahertz Imaging. The terahertz system successfully detected artificially induced corrosion spots under orbiter tile and functional testing is in-work in preparation for implementation.

KEYWORDS:
Design of Experiment, Nondestructive Evaluation, Corrosion

CONFERENCE:
Aging Aircraft 2007
Palm Springs, CA
16-19 April 2007

Routing: Al Fertig
Paul Hayes