Benefits

- Environmentally-preferable replacements for nitric acid passivation, and for coatings containing hexavalent chromium and volatile organic compounds reduced risks to NASA
- Risks reduced include occupational exposures, materials obsolescence risks and costs associated with management of hazardous waste
- Leveraged resources from other agencies reduced the cost of testing for NASA

Challenge

The National Aeronautics and Space Administration (NASA) is well on its way to making Kennedy Space Center (KSC) a multi-user spaceport of the future. KSC is preparing to process and launch the next generation of rockets and spacecraft in support of NASA’s exploration objectives. To achieve this transformation, program personnel are developing multi-use ground systems while refurbishing and upgrading infrastructure and facilities with sustainability and affordability in mind. ITB is working with KSC to ensure long-term sustainability by incorporating environmentally-responsible processes, products, and materials.

One of KSC’s biggest challenges is combating corrosion in a sustainable way. Located on Florida’s Atlantic Ocean coastline, KSC is an extremely corrosive site location, and one for which the costs to mitigate corrosion are comparatively high. Traditional methods of preventing corrosion of launch pads and ground support equipment often involve the use of hazardous products in preparing and coating metallic surfaces. For example, harmful chemicals such as hexavalent chromium (CrVI) and volatile organic compounds (VOCs) sometimes comprise the formulations of coatings. Concentrated nitric acid is often used to clean and protect stainless steel alloys. Although these chemicals have a proven reliability, they are unsustainable due to their hazardous attributes and risk of obsolescence due to increased regulatory pressure. Potential replacement materials can reduce the costs associated with regulatory compliance, worker health and safety protection, and other environmental risks to NASA’s mission.

Solution

In response to this mission risk, ITB and KSC began working together on projects to identify and validate environmentally preferable replacements for nitric acid passivation, coatings containing CrVI, and coatings with high levels of VOCs. ITB worked with NASA to leverage resources from multiple project participants including other NASA Programs/Centers, the Department of Defense, the European Space Agency, and industry partners, to maximize the value of KSC Program funding.

Alternative to Nitric Acid Passivation

ITB worked with KSC in an effort to qualify citric acid as an environmentally-preferred alternative to nitric acid for passivation of stainless steel alloys. The results of testing completed to date have shown that citric acid is performing as well as, or better than, nitric acid in corrosion resistance. Overall, regardless of alloy, the higher citric acid concentration, temperature, and bath dwell time yielded the best results. As the citric acid concentration increased, the percent of panels that passed also increased.

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Alternatives to CrVI and VOCs in Coatings

ITB's also worked with KSC to evaluate coatings that do not contain CrVI or have high levels of VOCs. Three coating alternatives showed enough promise in preliminary testing as compared to the baseline coating system to continue to the next stage of testing. This effort determined the feasibility of environmentally friendly corrosion protection coatings for launch facilities and ground support equipment.

The European Space Agency (ESA) faces many of the same challenges associated with sustainably protecting launch facilities and ground support equipment from corrosion. The results of the work funded by KSC Programs encouraged ESA to team with NASA and ITB in a collaborative project to continue to evaluate environmentally friendly coatings used for the protection of steel launch structures. This effort included evaluating test panels that were exposed at the KSC Atmospheric Exposure Site and panels located on launch structures at NASA's Wallops Flight Facility (WFF). Four coating systems passed the minimum criteria established by KSC NASA-STD-5008B: Carboline, Polyset, PPG and Sherwin Williams. Corrosion rate data collected so far at WFF suggest that KSC is a much more corrosive location.

ITB Approach

ITB employs the unique approach of distributing costs among project participants. ITB reduces NASA's cost burden by creating partnerships that provide additional funding, resources and expertise for its projects. These collaborations reduce the individual contributors’ shares of total research costs and the duplication of effort that might otherwise occur if individual organizations worked alone. ITB’s expertise joined with that of the stakeholders also broadens the knowledge base available to NASA overall.