



QuEST

Qualifying Environmentally Sustainable Technologies

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Message from the Principal Center Manager

Earlier this year, KSC friends and colleagues gathered to wish Charles (Chuck) Griffin a farewell at his retirement celebration and reflect on his 42 years of service with NASA. In his final seven years with NASA, Chuck was the Program Manager for TEERM. I am extremely honored to step into this role and look forward to forging new relationships in addition to expanding collaborative initiatives that focus on evaluating state-of-the-art environmental and renewable energy technologies. TEERM has a proven track record that is based on successful agreements and joint testing efforts with NASA field centers, government agencies, industry and international partners such as the European Space Agency (ESA), German Aerospace Center, and Portugal's Center for Pollution Prevention Program (C3P).

Last year, QuEST featured the partnership that was formed with the Ground Systems Development and Operations (GSDO) Program. One of their biggest issues is combating corrosion in a sustainable way. The World Corrosion Organization (WCO) recently published that the annual cost of corrosion worldwide is \$2.2 trillion, more than three percent of the world's gross domestic product (GDP). In 2010, WCO declared April 24th as Corrosion Awareness Day to build upon Earth Day, April 22nd, which began in 1970.

Another area of emphasis involves seeking out cooperative opportunities to meet new climate and energy targets that both NASA, through its Strategic Sustainability Performance goals, and the European Union, through its 20/20/20 Vision, have to reduce greenhouse gas emissions and evaluate renewable energy efficiency options for operational improvements. TEERM complements NASA's environmental stewardship through Earth observation and science, the development of green technologies and capabilities in NASA missions and facilities.

With so much exciting activity going on, including the development of NASA's heavy-lift launch vehicle, also referred to as the Space Launch System, and the recent agreement with Space Exploration Technologies Corporation (SpaceX), giving them the rights to occupy and operate KSC's Launch Complex 39A, these are just a few ideas that I view as having untapped potential for convening and collaborating to address global issues that are of mutual interest.



Thank you,

Joni Richards

TEERM Principal Center Manager
NASA KSC/AD-T

TEERM and ESA Collaborate on Replacement Materials Studies

From the very inception of NASA, one of its aims has been to foster international collaboration. The National Aeronautics and Space Act of 1958, which created NASA, states that NASA shall "engage in a program of international cooperation in work done pursuant to this Act, and in the peaceful application of the results thereof." This concept has been a cornerstone of NASA's activities throughout history, as evidenced by more than 3,000 agreements with over 100 nations. Of the active agreements currently in place, about half are with partners in Europe.

This is also the spirit in which the NASA Technology Evaluation for Environmental Risk Mitigation Principal Center (TEERM) was created. The TEERM program identifies and validates environmental and energy technologies that enhance NASA mission readiness and reduce risk. TEERM often accomplishes this through collaborative multi-agency projects.

Collaboration offers many advantages. Qualifying a new material or process is a costly effort; partnering allows resources to be shared, thus reducing costs to test alternatives. Collaboration also improves the overall technical quality of the effort through knowledge sharing and can accelerate the implementation of qualified alternatives.

NASA and ESA operate facilities around the world. Both agencies process flight hardware and maintain ground-based mission critical facilities that must offer high performance in harsh, corrosive environments. Increasing environmental regulations in the U.S. and European Union, however, pose cost, schedule, and technical risks for NASA and ESA in executing missions.

One such concern is the use of hexavalent chromium (CrVI) in coatings for corrosion protection. Hexavalent chromium, a carcinogen, is regulated in the U.S. by the Environmental Protection Agency and the Occupational Safety and Health Administration. Hexavalent chromium is regulated in Europe through the Registration, Evalua-

tion, Authorisation and Restriction of Chemical Substances (REACH) and the European Chemicals Agency. These restrictions present materials obsolescence and qualification risks to NASA and ESA should manufacturers of CrVI-containing products cease production.

To address the shared need to qualify coatings that do not contain CrVI, TEERM engaged ESA through a Space Act Agreement under which each Agency is preparing and testing complementary alternatives to compare and share results. TEERM and ESA are currently exploring other opportunities for collaboration in areas of qualifying replacement materials for vehicle processing and facility maintenance.

ESA has also been an active partner in TEERM's international workshops that provide a forum for NASA and ESA to share information on each other's activities on materials/process management and substitution and increasing critical ground infrastructure resiliency. In addition, TEERM has begun attending ESA's Industry Working Group Meetings where ESA and its industry partners discuss projects working to identify and validate materials that pose an obsolescence risk.

Ms. Olga Dominguez, retiring NASA Assistant Administrator for Strategic Infrastructure, has been instrumental in bringing NASA and international partners together to improve mission readiness through sustainability. Reflecting on her career with NASA, Ms. Dominguez said, "During my tenure with NASA, my most cherished partnerships have been the ones we have fostered with our European colleagues, particularly those of ESA, including ESTEC and European Space Research Institute (ESRIN), and Portugal through the help of C3P. TEERM has laid the groundwork for these relationships and has provided the necessary frequent contact and substantive technology evaluations that are so important to ensuring sound and scientific results to our space program and to each other's mutual benefit."

As the global economy has expanded it has made NASA and ESA much more susceptible to global drivers for change. It is therefore natural that we would see the value in working together. By sharing subject matter expertise and data, well-structured international cooperation is a major component of the goals of both Agencies.

2013 International Workshop: "Increasing Space Mission Resiliency through Sustainability"



2013 INTERNATIONAL WORKSHOP ON ENVIRONMENT AND ALTERNATIVE ENERGY "Increasing Space Mission Resiliency through Sustainability"

ESRIN, Frascati, Italy - October 22 - 25, 2013

Ms. Olga Dominguez, NASA Assistant Administrator for Strategic Infrastructure, and Ms. Nathalie Muesy, ESA Head of Sustainability, during panel discussion

NASA and European partners held the 11th annual International Workshop on Environment and Alternative Energy, October 22-25, 2013, at ESRIN in Frascati, Italy.

European organizations supporting this event were ESA, C3P, and the Luso-American Development Foundation. U.S. and international subject matter experts presented on the topics of increasing space mission critical ground infrastructure resiliency through sustainability and environmentally driven changes to aerospace materials and process management. Student presentations were very impressive with the top four students receiving awards from NASA and ESA.

Please visit our website (<http://teerm.nasa.gov/workshop.htm>) for more information on past workshops and on our upcoming 2014 workshop being held at NASA's Kennedy Space Center, Florida.



*Test Well Measurements for EISB Field
Demonstration at SSC*

Remediation

NASA's Remediation Technology Collaboration Development program was established in 2010 to target reductions in the long-term liability associated with NASA's most challenging remediation sites through collaborative technology evaluations. In 2013, TEERM introduced NASA remediation managers to a new cutting-edge product designed to enhance natural bioremediation processes.

TEERM coordinated the donation of pilot-scale volumes of the new product and the vendor's time to initiate a field demonstration of this enhanced in situ bioremediation at NASA John C. Stennis Space Center (SSC). The demonstration is expected to end in June 2014, at which time a full evaluation of the technology's effectiveness will be completed. TEERM also introduced the vendor to a subject matter expert who donated his time and laboratory services to perform a laboratory treatability study. Findings indicated that the new technology outperforms conventional chemical stimulants.

In addition to the EISB project, TEERM is evaluating other technologies and processes that can potentially reduce NASA's cleanup liabilities. These technologies include in situ thermal desorption using electrical resistive heating technology, horizontal directional drilling for assessment and remediation, and high resolution site characterization techniques, to name a few. The groundwork laid in 2013 is paving the way for field deployment of one or more of these techniques at SSC in 2014.

Materials Management

CrVI-free Coatings

TEERM is working with government agencies and industry partners to evaluate CrVI alternative coatings for NASA flight and ground applications.

GSDO Program CrVI-free Coatings

Along with the NASA Ground Systems Development and Operations (GSDO) Program and NASA's Corrosion Technology Laboratory (CTL), TEERM is evaluating CrVI-free coatings for ground support equipment. TEERM testing data has shown that CrVI-free pretreatments exceed salt spray requirements for two different alloys. When evaluating electrical bonding, the CrVI-free pretreatments performed as well as, and in some cases better than, the CrVI baseline. Follow-on testing will include primers and topcoats.

Electronic Enclosures

TEERM is also continuing to collaborate with over 40 public and private organizations, including GSDO Program and Department of Defense (DOD), to test CrVI-free coatings for electronic enclosures. Results of this project showed that a majority of the CrVI-free pretreatments has either met or exceeded salt spray requirements for common aluminum alloys. The next phase of the project is being developed and will focus on the evaluation of how CrVI-free pretreatments affect electromagnetic interference properties.

ESA & NASA Collaboration

ESA and TEERM made further progress in their efforts to find CrVI alternatives. Building off the success of other TEERM projects, ESA and TEERM are working together to evaluate CrVI-free coatings for various aerospace applications. A comprehensive test plan has been developed in coordination with ESA and TEERM and testing will be

conducted at KSC and ESA's European Space Research and Technology Centre in the Netherlands.

Citric Acid Passivation

TEERM is working with NASA and DOD partners to determine whether citric acid is a feasible alternative to nitric acid for passivating stainless steel alloys. Nitric acid is the world-wide standard, yet comes with burdensome environmental and occupational safety concerns. On the other hand, citric acid is a natural substance that is biodegradable, rarely classified as a hazardous waste upon disposal, and does not create toxic fumes during the passivation process. Based on test results thus far, citric acid is showing comparable performance to nitric acid with no issues associated with adhesion or corrosion resistance.

Structural Steel Coatings

The NASA technical standard for protecting structural steel assets contains a relatively short list of approved coatings, many of which are no longer compatible with current environmental regulations, resulting in increased costs and materials obsolescence risks. In response, TEERM is leading a project, supported by the NASA GSDO Program, NASA CTL, multiple NASA Centers, and Air Force Space Command, to qualify more environmentally friendly coatings for use on launch facilities and ground support equipment.

Three alternatives have shown enough promise in preliminary testing as compared to the baseline coating system to continue to the next stage of testing. Due to additional funding, a second group of alternative coatings were selected and testing is currently underway at NASA CTL's Beachside Atmospheric Test Facility located at KSC, one of the most corrosive locations on the planet.

Project Highlight

Evaluation of Non-Hazardous Spent Blast Media in Concrete Applications

Historically, one of NASA's largest waste streams is spent blast media (SBM) generated from various abrasive blasting processes such as corrosion control, inspection procedures, and coating removal, among others. TEERM helped NASA evaluate the applicability of reducing the amount of non-hazardous SBM currently disposed of as solid waste, by incorporating it as an alternative aggregate in concrete projects constructed on site at KSC.

For the project, KSC built two small concrete structures incorporating the modified concrete mixture and observed how it performed as a comparison to traditional concrete. As a result of TEERM's collaborative efforts, KSC has referenced the spent media recycling process in its Center-wide Sustainability Plan, and recommended editing contract language to require the use of recyclable blast media in future KSC concrete work.

On-site and laboratory test results, as well as subsequent interviews with installation technicians and KSC personnel, indicate the alternative concrete met all stated requirements for the specific locations and was generally the same to handle, work with and apply. The results and recommendations have been shared across the Agency and the project is considered a model for potential future efforts across NASA.



Laying Concrete with SBM as an Aggregate at KSC

Energy and Water

Green Roof and Wind Power Study

TEERM brought together subject matter experts from the U.S. Department of Energy (DOE), the National Renewable Energy Laboratory (NREL), and NASA Lyndon B. Johnson Space Center (JSC) to conduct a study to better understand the performance of new types of wind turbines. The project will last for several years to allow capture of seasonal variation of wind resource, solar radiation, and extreme winds to help develop wind flow modeling and predict turbine annual energy reduction.

TEERM also brought in Portland State University (PSU) and University of Maryland College Park (UMCP) to monitor the water storage and runoff of the green roof. The researchers will use the information, along with data from other green roofs across the country, to refine their models. The goal is to make predictions about how things like roof design features and irrigation scheduling can be fine-

tuned in order to optimize green roof benefits associated with storm water management, energy efficiency, and possibly even wildlife habitat.

Solar Power Shade Structure

In an effort to showcase solar power, TEERM engaged utility provider Florida Power and Light and the KSC Visitors Complex to install photovoltaic panels on their shade structures, where tourists stand in line to board the buses. The south facing structure was an ideal location that required only minor reinforcement. The structure now supports a photovoltaic system that provides 25 kilowatts of power to the Complex's new Space Shuttle Atlantis exhibit. A real-time video monitor display of the system's power production is located within the exhibit's entry ramp area in order to inform the public that this subtle modification is having a positive impact on our environment by reducing our carbon footprint.



JSC Building 12 Green Roof with Wind and Water Instrumentation

Chuck Griffin Retires

After more than 40 years with NASA, including seven years as the NASA TEERM Program Manager, Mr. Chuck Griffin has retired. Before taking the helm at TEERM, Mr. Griffin held numerous positions within the KSC Design Engineering Directorate including 10 years in the NASA Technology Programs & Partnerships Branch and five years as Manager of the Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) Program.

Mr. Griffin was the recipient of many awards including the Exceptional Engineering Achievement Medal from NASA Headquarters and the Silver Snoopy Award from the Astronaut Corp. He and his wife Judy have three daughters and a new grandson.

Ms. Joni Richards was selected as the new TEERM Program Manager and has worked with Mr. Griffin over the years. We are excited to continue the work that Mr. Griffin so successfully managed. Everyone at TEERM and NASA wish him the best and hope that the weather is good and the fish are biting.



Chuck Griffin and the Mutton Snapper he Caught Off the Florida Keys

TEERM Support

Technical, engineering, business, and management support for TEERM is provided by staff from ITB, Inc., headquartered in Dayton, Ohio. ITB has been part of TEERM since the program's inception in 1998. ITB engineers identify opportunities for collaboration and develop them into joint projects, which ITB then manages or otherwise supports. ITB provides support to NASA Headquarters on environmental, remediation, energy, and water matters.

QuEST is a publication of the NASA Technology Evaluation for Environmental Risk Mitigation Principal Center (TEERM) located at wKennedy Space Center, FL.

For more information, please visit our website at <http://teerm.nasa.gov>

If you have questions, please send us an email at teermnewsletter@itb-inc.com