National Aeronautics and Space Administration

QuEST

Qualifying Environmentally Sustainable Technologies

April 2009 Volume 4

Message from the Principal Center Manager

Energy cost instability and the effects of fossil fuels on the environment have become global concerns. Industries around the world are looking to increase use of alternative energy sources and reduce fossil fuel consumption. In response to this growing issue, the NASA Technology Evaluation for Environmental Risk Mitigation Principal Center (TEERM) focus has expanded to include energy and water efficiency as part of its core program.

The merging of energy and water management with pollution prevention was inevitable. Conventional energy production results in large amounts of air pollutants along with trace elements that can be released into the environment. Water pollution has long been understood to be a problem and conservation has become even more important with increasing demand for limited resources.

While there are millions of planets in our universe, there is only one Earth. NASA understands its responsibility to use resources in the best manner possible. This not only improves mission readiness in the here and now, but protects our home planet while allowing NASA to continue its long term mission to explore the farthest reaches of our universe.

Thank you for your continued support,

Chuck Griffin

TEERM Principal Center Manager
NASA KSC/KT-A2

Portuguese Partnership

NASA TEERM has established partnerships with various entities in the U.S. and internationally. Partnering provides collaborative opportunities for engineers within the global science community and maximizes the scientific value of any engineering activity while minimizing costs. It provides access to information needed for validation under a broad range of conditions. It also helps NASA engineers stay abreast of European environmental directives that affect NASA and the U.S. in this global market.

It is for these reasons that in 2002, NASA signed a joint statement with the Portuguese Ministry of Environment to cooperate on matters of pollution prevention. The first outcome of this agreement was the creation of a not-for-profit organization in Portugal called the Centro Para Prevenção da Poluição (Portuguese Center for Pollution Prevention or C3P).

C3P is comprised of the Instituto de Soldadura e Qualidade (Institute of Welding and Quality or ISQ) in Portugal and ITB, Inc., headquartered in Dayton, OH. ISQ supports the identification of pervasive needs and technologies across Portugal and Europe and provides alternative materials, identification of potential technologies, and demonstration/validation testing. ITB, Inc. provides additional engineering and technical support.

The mission of C3P, like TEERM, is to foster innovation by identifying and validating environmentally sustainable technologies that reduce or eliminate hazardous materials or processes. Through joint activities, C3P projects reduce risk while minimizing duplication of effort and associated costs. On a day-to-day basis, C3P supports program managers, defense contractors, and industries from Portugal and Europe, particularly small and medium enterprises, in addressing problems in the uses of hazardous materials and waste generation and disposal.

Following is a discussion of three C3P projects from which NASA is benefitting.

C3P Non-Chrome Coatings Project

In 2004, in one of their first collaborative efforts, C3P teamed with TEERM and two Portuguese entities, TAP Portugal (Portuguese National Airline) and OGMA Indústria Aeronáutica de Portugal (Portuguese Aeronautics Industry), to target the reduction of hexavalent chromium, cadmium, and volatile

2008 C3P/NASA Workshop

The Centro Para Prevenção da Poluição (Portuguese Center for Pollution Prevention or C3P) and NASA hosted the 6th Annual International Workshop on Pollution Prevention and Sustainable Development on November 18-20, 2008, at the University of California San Diego.

The three-day workshop provided an excellent forum to showcase innovative and emerging pollution prevention and renewable energy technologies, share lessons learned, and identify new joint opportunities. More than 45 international scientists, technologists, and engineering experts presented on topics ranging from island sustainability and renewable energies to restricted chemicals and advances in materials and conventional processes, green chemistry, lead-free soldering, coating systems, and coating removal. This exchange of solutions provided direct and tangible benefits to NASA, the Department of Defense (DoD), academia, and commercial industries.

Presentations can be found on the TEERM website. The next Workshop is planned for November 2009 in Munich, Germany.

Mr. James Leatherwood, Director, NASA Headquarters Environmental Management Division, speaking at the 2008 C3P/NASA International Workshop

organic compounds (VOCs) in aircraft maintenance operations. This project focused on two coating systems that utilize non-chrome pretreatments and low-VOC primers and topcoats.

The two selected coating systems were applied to the exterior of a service door on an Airbus A319 aircraft for flight testing. Test panels were also concurrently prepared for a series of laboratory tests to further determine coating performance. One of the two systems satisfactorily passed all laboratory tests; after nearly three years of in-flight testing, the coating system shows no visual signs of deterioration. Findings from this project are being leveraged for TEERM follow-on projects.

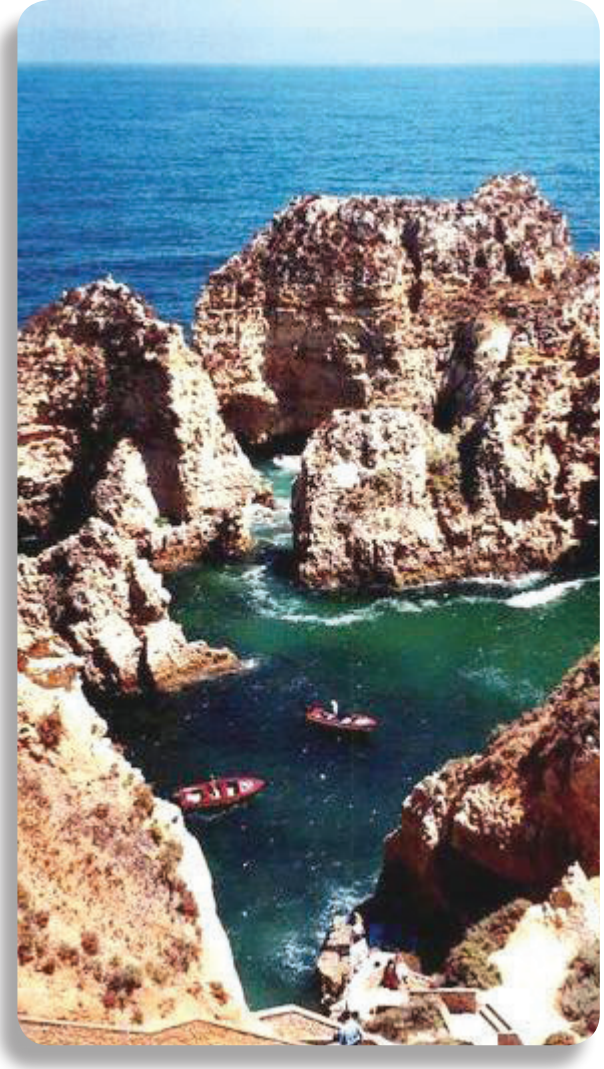
Sustainable Island Pilot Project

C3P, with support from TEERM and ITB, has embarked on a project to reduce the carbon footprint and environmental presence of a small island off the coast of Portugal. Berlenga Island is a prime location for fishing, recreation, and culture. TEERM has assisted in introducing U.S. companies and technologies to the Portuguese project team while gathering data useful to NASA sites planning renewable energy projects.

TEERM has provided suggestions to the team on technologies for renewable energy, energy conservation, potable water production, wastewater treatment, solid waste management, and visitor enhancement. Technology and expertise from NASA Ames Research Center for detecting and counting invasive species on Berlenga Island using satellites is being evaluated.

ECOS Network Project

C3P is working with Portugal municipalities to increase the energy efficiency of buildings using renewable energies and sustainable construction. The aim is to create competitive and innovative cities at an international level. During the proposal process, TEERM supported C3P by providing examples of U.S. city best practices in sustainability. The project was one of only five (from 26 submitted) that was selected for funding.



Picture from Berlenga Island Nature Reserve

Pollution Prevention Projects

Hexavalent Chrome-free Coating Systems

Historically, coating performance has been enhanced by use of hexavalent chromium in the pre-treatment or primer of a coating system. Increased awareness of the risks to human health and the environment, however, has led to more stringent regulations, which in turn, has led to concerns about potential material obsolescence.

This project aims to identify coating systems that are free of hexavalent chromium in any of the constituent coating layers and demonstrate their performance qualities for compatibility with NASA and DoD programs. NASA is also benefiting from the results of the C3P non-chrome coatings project.

The project focuses not only on typical aluminum alloys, but also NASA-specific lithium-aluminum alloys used on legacy and future space flight hardware. The first phase of testing is complete, and the second phase is currently underway. Alternatives were identified and the Joint Test Plan was completed and approved by stakeholders.

Low VOC Coatings for Launch Structures

The Low VOC Coatings and Depainting Field Testing project is a continuation of previous TEERM and Air Force Space Command (AFSPC) efforts to validate low-emission depainting and coating technologies. Depainting alternatives were evaluated for efficiency and reduced wastes and emissions. Alternative coatings were applied to two separate areas of a launch pad. Coatings in the first area were evaluated for corrosion protection while coatings in the second area were directly exposed to the exhaust gases and heat during multiple launches. Field observations are being made by technicians from the NASA Corrosion Technology Laboratory at Kennedy Space Center.

The coatings in the first area showed no degradation of color, gloss, or corrosion resistance after 18 months of exposure. The coatings in the second area have survived four launches and are still acceptable to remain for protection of the structure. Currently approved coatings require removal and reapplication after every launch. The plan is to leave the coatings for as many launches as possible to fully evaluate their resistance to the extreme conditions experienced during a launch. Other coatings are also being evaluated; if qualified, these low-VOC candidates will be suitable to replace the high-VOC coatings currently used on most NASA and AFSPC launch pads and ground support equipment.

Personnel examining launch structure to identify locations for testing low VOC coatings

Gas Dynamic Spray Technology Demonstration

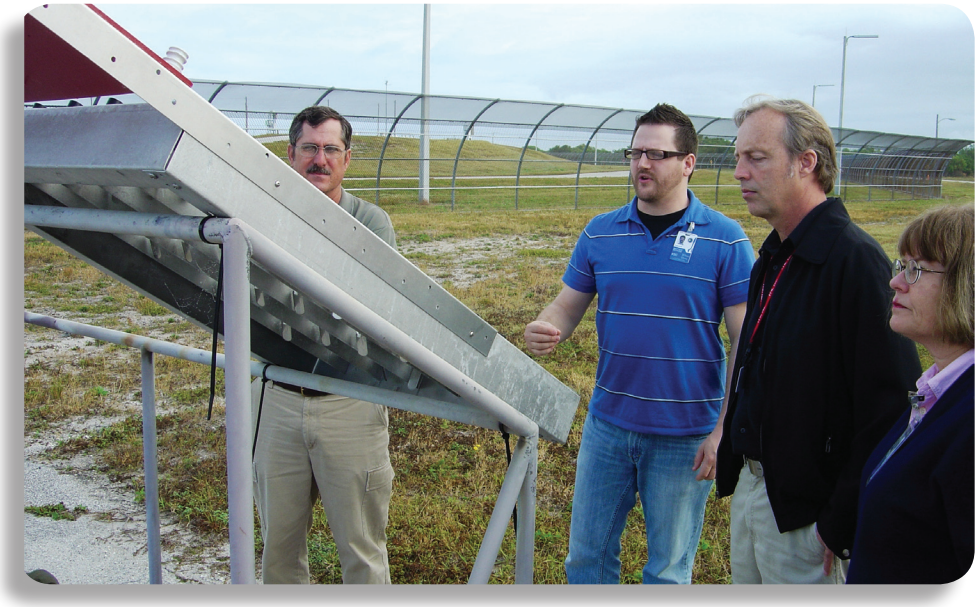
TEERM is teaming with AFSPC, Patrick Air Force Base, Cape Canaveral Air Force Station (CCAFS), and Kennedy Space Center to demonstrate gas dynamic spray technology, often referred to as cold spray technology. The technology can be used on a wide variety of substrates with many different materials available, but the focus of this demonstration is on steel substrates. The gas dynamic spray technology is being evaluated as a small, maneuverable approach to repairing metalized coatings where repair by thermal spray techniques are less effective. The technology can result in reduced maintenance and thus reduced hazardous materials/wastes associated with current processes.

Corn-Based Blast Media

Current coating removal methods for delicate substrates include harsh chemical strippers, labor-intensive manual removal, or waste-producing plastic blast media. Interest in corn-based media is due to its environmental benefits as well as its effectiveness at removing coatings from delicate substrates without causing damage. TEERM conducted a very successful product demonstration at Kennedy Space Center in 2008 and is currently looking for other opportunities to evaluate the bio-based, recyclable media.

Lead-Free Electronics

TEERM has initiated a multi-year project to evaluate the reliability of circuit cards soldered with new lead-free alloys. The assembled test boards will be subjected to accelerated testing (thermal, vibration, shock, etc.) to simulate real-world



TEERM Engineers examining test panels for Hexavalent-free Chrome Coatings project

conditions. Results of the testing will allow participating organizations to make informed decisions about lead-free implementation or mitigation strategies.

Membrane Removal of VOCs

Federal and local regulations continue to reduce the allowable level of VOCs that can be emitted into the atmosphere. Semi-permeable membranes have been developed that allow for high-efficiency separation and capture of VOCs from entrained air-streams. The technology is believed to have a wide range of applications such as solvent cleaning, metal finishing, ethanol processing, and solvent recycling.

In May 2008, TEERM conducted the third demonstration of the membrane technology at NASA Wallops Flight Facility. The focus of the demonstration was VOC emissions from a soil vapor extraction unit at a remediation site contaminated with jet fuel. Based on the positive results of this testing, TEERM is searching for another NASA or DoD facility to host additional field tests to evaluate the technology for other applications.

Alternative Energy Projects

Renewable Energy for Groundwater Cleanup

Green remediation is the practice of considering environmental impacts of remediation activities at every stage of the remedial process in order to maximize the net environmental benefit of a cleanup. Considerations include selection of a remedy, energy requirements, efficiency of on-site activities, and reduction of impacts on surrounding areas. Remediation activities can have a negative impact on the environment, such as greenhouse gas emissions from combustible fuels used by remedial technologies or from off-site water quality impacts of cleanup activities.

TEERM is collaborating with experienced partners to help NASA reduce project risk by applying renewable energy technology to NASA entities, such as planned work at NASA White Sands Test Facility. Knowledge and experience from renewable energy installations on Berlenga Island and elsewhere in Portugal and Europe are being shared and leveraged into the NASA project's energy plans.

Indoor Solid State Lighting

Typical office environments utilize fluorescent tubes for general lighting. While these tubes previously represented energy savings when compared to incandescent light bulbs, they are not as efficient or environmentally preferable as solid state lighting alternatives. Solid state lighting includes Light Emitting Diode (LED) and Organic LED technologies, which are at the forefront of energy efficient lighting. TEERM is looking for interested partners to explore evaluating and possibly demonstrating new and emerging solid state lighting alternatives as compared to fluorescent tubes.

Bio-based Materials Evaluation

The Joint Group on Pollution Prevention (JG-PP) is fostering joint efforts to address the increased use of bio-based products mandated by the regulatory, economic, and environmental landscape. The JG-PP efforts include a bio-diesel project and a bio-based metal working fluids project being led by the Navy and a bio-based hydraulic fluid project being led by the Defense Logistics Agency. The objective of these efforts is to validate bio-based products for use in ground equipment and machinery to reduce dependency on petroleum products and reducing lifecycle costs while meeting or exceeding performance requirements.

TEERM Support

ITB, Inc., headquartered in Dayton, OH, provides technical, engineering, business, and management support for TEERM. ITB also provides support to NASA Headquarters on JG-PP and energy/water matters and is a critical resource in NASA's partnership with C3P in Portugal. ITB has been part of TEERM since the program's inception in 1998. ITB staff identifies and develops opportunities for collaboration of joint projects, which ITB also then manages or otherwise supports.

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

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

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

NP-2009-2-018-KSC