National Aeronautics and Space Administration

# QuEST

Qualifying Environmentally Sustainable Technologies

June 2008 Volume 3

## Message from the Principal Center Manager

This is an exciting new chapter for the NASA Technology Evaluation for Environmental Risk Mitigation Principal Center (TEERM). The Principal Center's past successes have created new opportunities for partnership and technology implementation. TEERM is continuing to support the current NASA Programs while reaching out and offering our assistance and experience to Constellation.

NASA has also assumed Chairmanship responsibility of the Joint Group on Pollution Prevention (JG-PP) and Chairmanship of the JG-PP Working Group (WG). Both JG-PP and TEERM strive to improve mission readiness and reduce risk to personnel and assets by solving joint problems through cooperation. JG-PP and TEERM not only show our commitment to environmental stewardship, but also our commitment to fiscal responsibility.

I am pleased to join TEERM and serve as the JG-PP WG Chairman. I am looking forward to bringing my experience to the team. TEERM has developed an effective and robust program that I look forward to leading into the future. I know that TEERM will continue to be a valuable asset to NASA and our partners.

Thank you,

*Chuck Griffin*

TEERM Principal Center Manager
NASA KSC/KT-A2

# NASA Assumes JG-PP Chairmanship

The NASA Technology Evaluation for Environmental Risk Mitigation Principal Center (TEERM) was created in 1998 to support the Joint Group on Pollution Prevention (JG-PP) and be the focal point for NASA-wide pollution prevention activities. In that time, NASA has benefited greatly from its association with JG-PP and the numerous projects JG-PP and TEERM have undertaken.

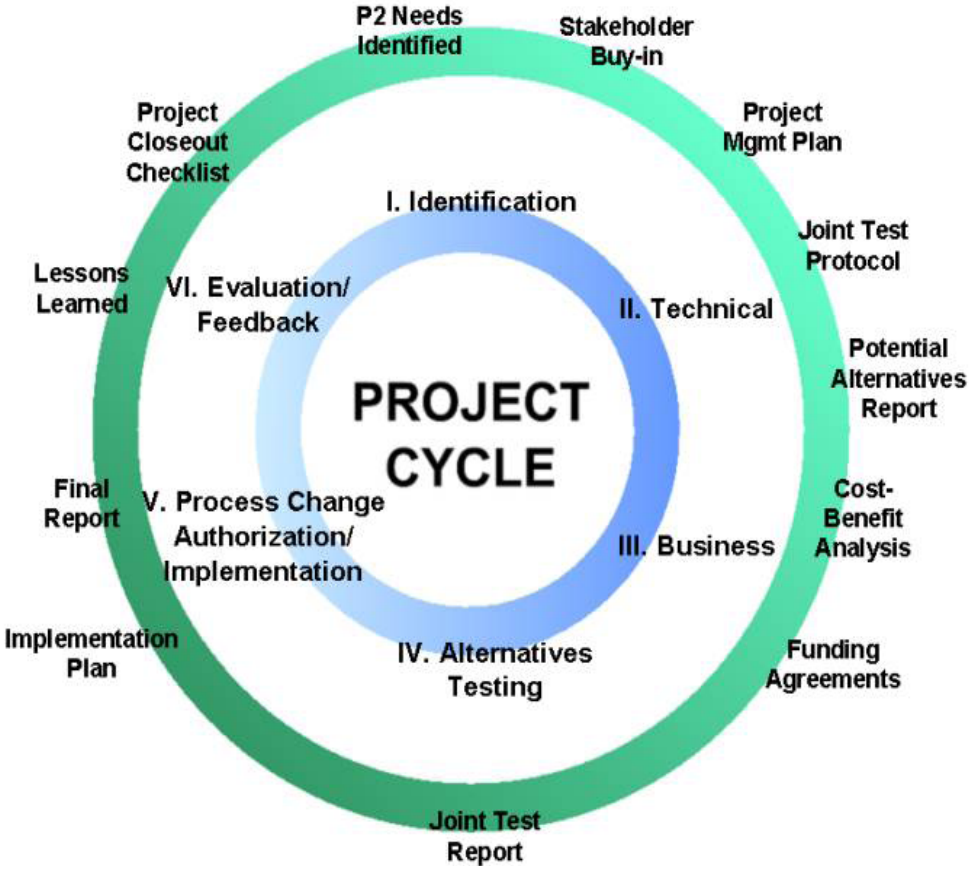
In October 2007, NASA accepted the leadership of JG-PP. Mr. James Leatherwood, Director of NASA Headquarters Environmental Management Division became the JG-PP Principal Chairman. Principal Chairman duties include direct communication to the Joint Logistics Commanders (JLC), coordinate actions with group members, establish subgroups, prepare plans and group communications, provide progress reports and briefing to the JLC and other interests and coordinate with other joint groups.

The TEERM Manager also became Chairman of the JG-PP Working Group (WG). Working Group Chairman duties include arranging and coordinating functions, such as meetings and conferences; coordination with JG-PP Principal Members; managing the JG-PP budget; and ensuring that the JG-PP charter is followed.

JG-PP was chartered by the JLC to reduce duplication of effort within the Department of Defense (DoD) when qualifying new environmentally preferable materials or processes. It is a partnership between the Military Services, NASA, the Defense Logistics Agency (DLA), and the Defense Contract Management Agency. By establishing these partnerships, JG-PP addresses common problems through shared efforts to produce joint solutions.

The ultimate goal of the JG-PP Program is to implement alternatives identified using the validated JG-PP Methodology. Stakeholders apply the six-phase methodology to implement material and process changes to reduce hazardous materials. By fostering joint cooperation, the goal can be met more efficiently and economically. Joint cooperation identifies shared opportunities, common qualification requirements, and reduces duplication of effort.

NASA and DoD operations are faced with a challenging and changing work environment. Government agency resources are limited and available funding




*JG-PP Methodology and Products*

is constrained. Previous JG-PP efforts focused solely on pollution prevention and were driven by compliance motivators. As time has progressed, new efforts are needed to focus JG-PP activity toward projects in a manner associated with mission goals through mitigation of environmental risks threatening the successful execution of NASA and DoD Programs. By mitigating these risks, JG-PP can ensure mission success.

After review of the JG-PP Charter and Concept of Operations, NASA felt that its experience and success applying risk-to-mission concepts could greatly benefit JG-PP objectives. In response, JG-PP is also moving to a risk-to-mission approach in an effort to better prioritize its work approach and make the best use of limited resources. Communication and prioritization are key to staying focused on mission objectives.

# JG-PP Activities

Over the years, a number of JG-PP projects have been instrumental in addressing common problems that have resulted from environmental regulations. Resolving these issues not only demonstrates environmental stewardship, but oftentimes improves the current process while increasing mission readiness by removing any restrictions that may prevent the availability of necessary equipment.

Like TEERM, all JG-PP test plans and test reports are free and publicly available. These reports and other JG-PP information are available at http://www.jgpp.com.

## Biobased Products

Federal agencies are required to deveop affirmative procurement programs for preferential purchasing of products containing biobased material under the Farm Security and Rural Investment Act of 2002. Biobased products have become more prominent in recent years as the cost of petroleum based products continues to rise and legislation continues to demand more sustainable alternatives. The Energy Act of 2005, Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, and Executive Order 13432, Cooperation Among Agencies in Protecting the Environment With Respect to Greenhouse Gas Emissions From Motor Vehicles, Nonroad Vehicles, and Nonroad Engines, mandate an increased use of alternative fuels and reduced use of petroleum products by all federal agencies. TEERM has been participating in several JG-PP sponsored projects involving biobased materials.

While biodiesel use in fleet vehicles has grown significantly, biodiesel has not been approved for use in tactical vehicles. JG-PP formed a team led by the Navy that is currently working on a Joint Demonstration Plan to evaluate the use of biodiesel and establish parameters for its use in tactical vehicles. Demonstrations are scheduled to begin in 2008.

The DLA and Defense Supply Center Richmond previously evaluated the technical data of commercially available biobased hydraulic fluids to determine whether any meet the requirements of existing Government specifications. It was determined that there was not a sufficient product specification to address performance and test requirements for biobased fluids in DoD or NASA applications. In response, DLA teamed with JG-PP to establish a Biobased Hydraulic Fluids WG whose purpose is to identify testing requirements that address concerns about the unique attributes that biobased fluids possess.

The WG plans to address these unique attributes by developing a set of performance parameters based on an existing specification and then perform testing to identify candidates for implementation. The results of the effort will be highly transferable to other biobased material specifications. A closely related metal working fluids project will be starting up in 2008.

## Low Temperature Cure Powder Coatings

The Low Temperature Cure Powder Coatings (LTCPC) project is an example of a JG-PP-supported project for coating technologies. LTCPC can replace conventional coating applications that emit Volatile Organic Compounds (VOCs) and Hazardous Air Pollutants (HAPs). LTCPC is also an alternative to high temperature cure powder coatings that have higher energy demands and which can damage delicate substrates like aluminum and magnesium. A powder coating was developed through the Strategic Environmental Research and Development Program (SERDP) that cures at much lower temperatures.

Following the success of the SERDP initiative, the Environmental Security Technology Certification Program funded a follow-on project to test the material to stringent DoD and NASA requirements. Initial validation testing on various metal substrates has been successfully completed and coordination has begun for additional laboratory testing and field demonstrations with the Air Force and Navy identifying components and Ground Support Equipment (GSE) to be coated.

## Lead-free Solder for High Reliability Applications

Government managers with NASA, the military, and space and defense contractors have concerns about the long term reliability of lead-free solder on interconnects in high-reliability applications. To address this data gap, JG-PP partnered with the DoD's Joint Council on Aging Aircraft (JCAA), the European Space Agency, and international and domestic original equipment manufacturers on the JCAA/JG-PP Lead-Free Solder Project. The project's purpose was to conduct solder-joint reliability (laboratory) testing of lead-free solder alloys on newly manufactured and reworked circuit cards to generate performance data for high-reliability applications.

The project represented one of the most comprehensive and technically thorough studies to date of how promising lead-free solders perform under harsh military/aerospace environments. The results will be used by original equipment manufacturers, suppliers, and system managers as they consider transitioning to lead-free materials in electronic assemblies. A follow-on study on lead-free electronics is already underway to help address remaining data gaps.

## Portable Laser Coating Removal System

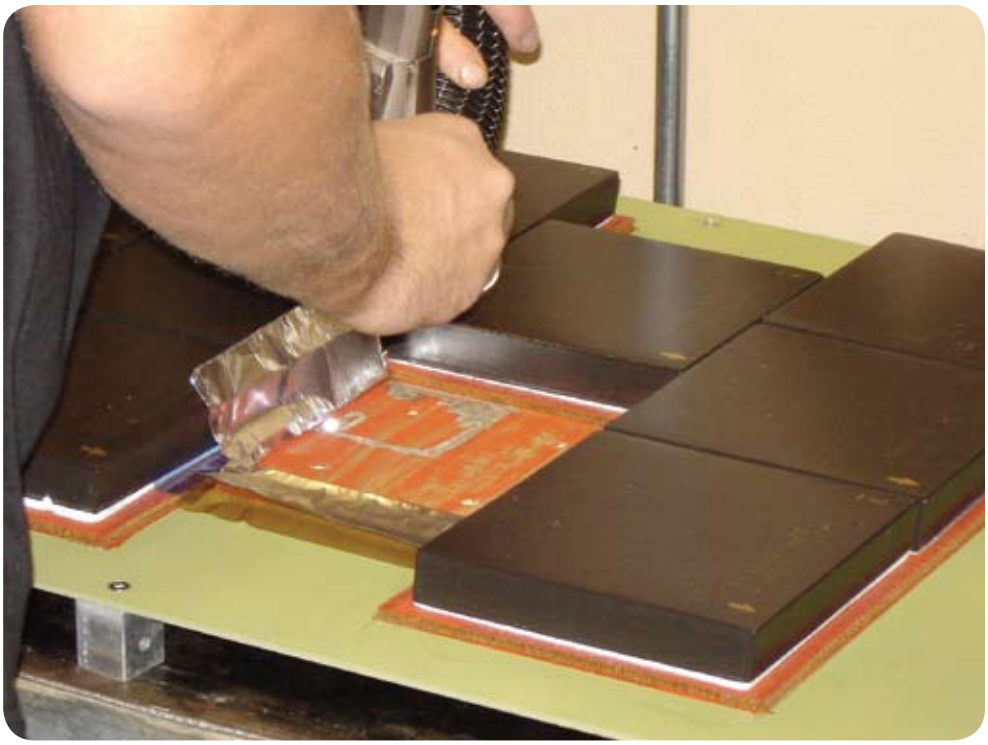
The Portable Laser Coating Removal System (PLCRS) is attractive because of minimal environmental and safety impacts and a reduction in the purchasing, handling, storage, and disposal of chemicals. The successful JG-PP PLCRS Project was followed by a TEERM effort that is drawing towards completion. Results from field demonstrations have shown excellent potential for implementation for non-destructive evaluation and inspection of weldlines and for small-area depainting/corrosion removal where blast media is prohibited and hazardous chemical strippers must be used.

While PLCRS was able to remove the coatings, it also resulted in what is considered a "remelt layer" on some substrates. Laboratory testing is still underway to better understand these changes in the surface structure after coating removal. The project team is planning to release a final test report in 2008 that encompasses all of the field demonstrations and laboratory testing and hopes to identify other implementation opportunities.

## Corn Hybrid Coating Removal

The DoD and NASA have a strong interest in coating/depainting technologies. Maintenance and corrosion protection represent significant costs within the life cycle of supported systems. A JG-PP-supported effort was the Corn Hybrid Polymer Coating Removal on Delicate Substrates project. Many of the traditional methods of coating removal involve the use of hazardous materials or employ processes that have the potential to damage delicate substrate materials. Biobased products, such as corn-based blasting media, are biodegradable and classified as non-hazardous waste.

An evaluation of the corn based blasting media was conducted on U.S. Navy surface ship radome sections and a passive countermeasure system. The results indicated that this type of media provided an



*PLCRS Being Tested as Repair Method on a Space Shuttle Tile Mock-up*

acceptable stripping rate without damaging the surface of the delicate substrates. In addition, cost analyses completed for several different applications indicate significant potential cost savings upon implementation.

# Coatings Projects

NASA and the DoD have valuable assets from aircraft made of aluminum and delicate substrates to large steel structures that withstand the immense forces of a launch. In a report released in 2007 by the DoD Office of Corrosion Policy and Oversight, the estimated annual corrosion costs for DoD facilities and infrastructure alone was $1.77 billion per year. Protection of these assets can be enhanced through the careful selection and application of coatings; however, these coatings are subject to increasing environmental and safety regulations.

One regulation that is having a large impact on NASA and DoD coating operations is the lowered Permissible Exposure Limit for hexavalent chromium from the Occupational Safety and Health Administration. The lower limit may require upgraded ventilation systems and increased exposure monitoring, engineering controls, and the use of personal protection equipment. The result is increased costs including air and water emissions controls, monitoring, and disposal of hazardous waste. There is also an increased obsolescence risk where manufacturers may stop making the materials as the demand for such products is reduced.

Federal and state regulations govern the amount of VOCs that an installation can emit during coating operations. In order to meet these guidelines, more environmentally friendly coatings have been developed. While these new formulations may meet environmental and safety requirements, they must be validated to the performance requirements of NASA and DoD.

## Non-Chrome Coating Systems for Aerospace Applications

Historically, coating performance has been ensured by use of hexavalent chromium, typically found within the pretreatment or primer of a coating system. Increased awareness of the risks to human health and the environment have led to more stringent regulations, which in turn, leads to concerns about potential material obsolescence. NASA and the U.S. Air Force are looking for alternative coating systems that are safer and more environmentally friendly, but still able to meet rigorous performance requirements.

The Non-Chrome Coating Systems for Aircraft and Aerospace Applications project is a coordinated effort by NASA and the U.S. Air Force to test complete coating systems that are free of hexavalent chromium. Stakeholders include personnel from NASA Kennedy Space Center (KSC), NASA Marshall Space Flight Center, the Air Force Research Laboratory, the University of Dayton Research Institute, Hill Air Force Base, Boeing, and United Space Alliance.

The 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. The project is focused not only on typical aluminum alloys, but also includes NASA-specific lithium-aluminum alloys that are used on both legacy space flight hardware and will be used as future hardware for the Constellation Program.

Initial project testing analyzed the corrosion protection properties of selected chromium-free systems to determine whether they are viable alternatives and warrant further testing. The most promising alternatives will continue on to the next phase of testing, along with several systems that were identified after the onset of the first phase of testing.

## Low VOC Coatings and Depainting Field Testing

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. Its purpose is to field demonstrate and qualify alternative surface preparation/depainting processes and low/no-VOC, non-hazardous coatings for launch structure maintenance operations. Emphasis is on coatings that eliminate environmental, safety, and health risks associated with the use of conventional high-VOC, isocyanate-containing coatings. Of added interest was surface preparation technologies that reduce particulate emissions while minimizing labor costs.

Two depainting alternatives and six coating alternatives, identified in part from prior NASA studies, were demonstrated at Space Launch Complex 17, Cape Canaveral Air Force Station. Depainting alternatives were evaluated for efficiency

# TEERM and the Shuttle Environmental Assurance Initiative

TEERM is a member of the NASA Shuttle Environmental Assurance Initiative (SEA). SEA provides an integrated approach promoting environmental excellence, proactively managing materials obsolescence, and optimizing resources for the Space Shuttle Program. The SEA team works to identify environmental regulations that may result in the obsolescence of materials used in the Space Shuttle Program. SEA members also work together to exchange information and data on materials replacements, pollution prevention, and environmental impacts. TEERM works with SEA to ascertain Space Shuttle Program needs and assists in identifying and qualifying alternatives. Recently, TEERM prepared a SEA "Lessons Learned" report to give to the NASA Constellation Program. The report discusses concerns with continued use of hexavalent chromium coatings and cadmium plating and identifies previous efforts and potential alternatives for consideration.

# 2007 C3P/NASA Workshop

The Centro Para Prevenção da Poluição (Portuguese Center for Pollution Prevention or C3P) and NASA hosted the 5th Annual International Workshop on Pollution Prevention and Sustainable Development on November 7-9, 2007, in Peniche, Portugal. The workshop was co-organized by the Escola Superior de Tecnologia do Mar (School of Maritime Technology or ESTM) of Peniche and by the City Council of Peniche.

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. In total, 243 individuals from 8 countries attended the technical workshop. 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, and coatings and coating removal. This exchange of solutions provided direct and tangible benefit to attendees from academia, defense, and commercial industries.

At the workshop, C3P and NASA also celebrated the 5-year anniversary of the "Joint Statement Between NASA and the Portuguese Ministry of Environment Regarding Cooperation in the Field of Environmental Pollution Prevention," signed in September 2002.

Presentations can be found on the TEERM website. The next Workshop is planned for November 18-20, 2008 in San Diego, CA.


*From Left to Right: the Mayor of Peniche, the President of ESTM, the NASA Assistant Administrator, the US Ambassador to Portugal, and the C3P President*

and reduced wastes and emissions. The alternative coatings were applied to two separate areas of the pad. Coatings in the first area will be evaluated for corrosion protection over an 18 month period at 6 month intervals. The second area is directly exposed to the exhaust gases and heat during a launch. Field observations are being made by technicians from the NASA Corrosion Technology Laboratory at KSC.

The coatings in the first area showed no degradation of color, gloss, or corrosion resistance after 6 months of exposure. The coatings in the second area have survived three launches and are still acceptable to remain for protection of the structure. Previous coatings are typically reapplied 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. 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 GSE.

*Adhesion Testing on Thermal Spray Coatings at Complex 17 after Launch*

## Gas Dynamic Spray Technology Demo

TEERM is teaming with AFSPC, Patrick Air Force Base, Cape Canaveral Air Force Station, and the KSC maintenance contractor to demonstrate Gas Dynamic Spray Technology. Also commonly called Cold Spray, the technology uses a gas jet to accelerate particles to supersonic velocities, producing coatings or freestanding deposits by solid state deformation of the impacting particles onto a substrate. The technology can result in reduced maintenance and thus reduced hazardous materials/wastes associated with current processes.

The technology can be used on a wide variety of substrates with many different materials available, but the focus of this demonstration will be on steel substrates. Thermal spray coatings are extremely durable and environmentally friendly coat-

ings, but utilize large cumbersome equipment for application that make them difficult and time consuming to repair. The Cold Spray technology is being evaluated as a smaller, more maneuverable repair method and for areas that thermal spray techniques are ineffective.

### C3P Non-Chrome Coatings Project

Through its European partnerships, notably the C3P, TEERM and two Portuguese entities, TAP Portugal (Portuguese National Airline) and OGMA Indústria Aeronáutica de Portugal (Portuguese Aeronautics Industry), targeted hexavalent chromium and VOCs as hazardous materials for possible elimination or reduction. 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, but the other system failed some of the critical laboratory test requirements. After nearly three years of in-flight testing, however, both systems showed no signs of deterioration in coating thickness or color when visually examined. Findings from this project are being leveraged for follow-on projects.

*Service Door of Airbus 319 where Chrome-free Coatings were Applied*

## Green Electronics

The current increased interest in lead-free electronics is being driven by legislation in the European and Asian communities and commercial activities in Japan. Most high volume applications (i.e. mobile phones, consumer electronics, etc.) have already transitioned to lead-free electronics. Low volume applications, such as military and aerospace, have no control over the market and are being forced to deal with lead-free solder terminations on commodity components much earlier than their roadmaps mandate for lead-free solder implementation.

NASA programs require high reliability electronic parts and assemblies, but are increasingly dependent on commercial off the shelf electronic products due to the ever diminishing market share that the aerospace electronics sector holds. In the United States, any decision to convert high-reliability aerospace electronics to lead-free technology is most likely going to be made for reasons of enhanced product performance and mission safety, not environmental legislative requirements.

As the commercial electronics industry continues to move to 100-percent lead-free, the latest micro-electronics, the best materials, the most efficient manufacturing processes, and eventually the most reliable product designs, will be available predominantly, if not exclusively, in lead-free technology. Market competition, even in the narrow aerospace market, will eventually push the introduction of entirely lead-free electronics into new systems.

Original equipment manufacturers, maintenance depots, and support contractors have to be prepared to deal with an electronics supply chain that increasingly provides more and more parts with lead-free finishes—some labeled no differently than their lead counterparts. The longer the transition period, the greater the likelihood of lead-free parts inadvertently being mixed with lead parts and ending up on what are supposed to be lead systems.

As a result, NASA, the DoD, and their support contractors need to take action now to either abate the influx of lead-free parts, or accept it and deal with the likely interim consequences of mixed lead and lead-free finishes. Reduced reliability will come from a variety of issues such as lead contamination, high temperature incompatibility, and tin whiskering.


*Scanning Electron Microscope Image of a Single Tin Whisker—Tin Whiskers are a Critical Concern in Aerospace and Military Electronics*

### Lead-Free Electronics Testing

Following the JCAA/JG-PP Lead-Free Solder Project, TEERM became the focal point for new NASA, DoD, and international lead-free electronics initiatives. In response to concerns about risks from lead-free induced faults to high reliability products, NASA has begun a joint project to provide manufacturers and users with data to clarify the risks of lead-free materials in their products.

The new joint project builds on the results from the JCAA/JG-PP Lead-Free Solder Project and focuses on the rework of Tin-Lead and lead-free solder alloys and will include the mixing of Tin-Lead and lead-free solder alloys. Data generated from the project will help in gaining a better understanding of how lead-free electronics will perform in high-reliability applications thus reducing risks. The project will also be of potential interest to component manufacturers supplying to high reliability markets.

The primary technical objective of the project is to generate information on failure modes/criteria to better understand the reliability of (1) packages assembled and reworked with solder interconnects consisting of lead-free alloys and (2) pack-

# Project Highlight

## Isocyanate-Free Coatings Testing

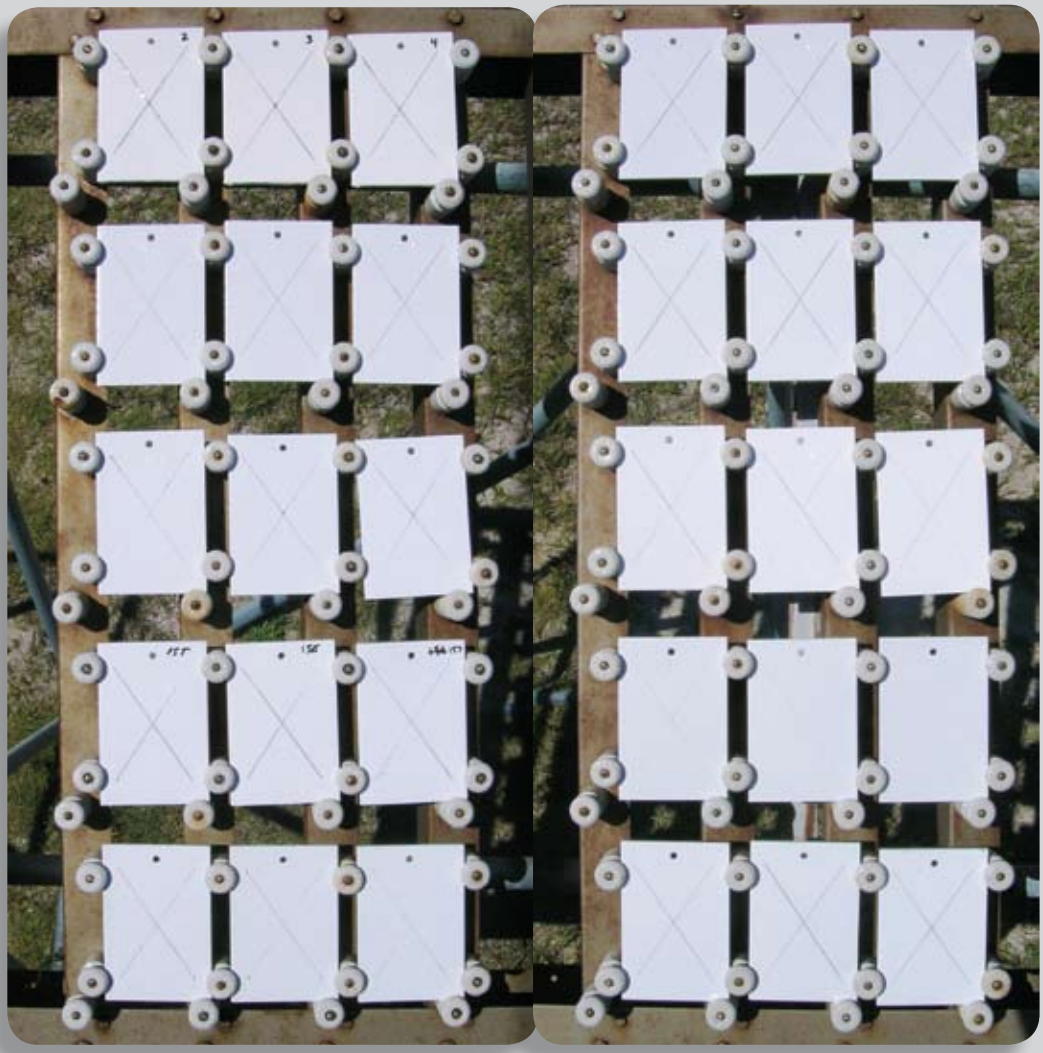
TEERM partnered with NASA Stennis Space Center (SSC), KSC, and AFSPC to demonstrate and validate alternatives to aliphatic isocyanate polyurethanes. The use of isocyanates in coatings is being threatened today by environmental and safety concerns and increasing regulations. The pressure to reduce or remove isocyanates is growing at a significant rate and thus may affect the availability of corrosion resistant coatings that protect infrastructure and support equipment used across NASA. Coatings with isocyanates are banned from use at SSC and restricted at KSC. These coatings provide excellent corrosion resistance, color, and gloss properties among the many other attributes that an alternative must exhibit.

The project also considered the level of VOCs, HAPs, and other hazardous constituents associated with the alternatives in order to select those most environmentally benign. Expected benefits of the project include improved corrosion protection of critical systems, easier and less costly maintenance, reduced flight hardware contamination, reduced hazardous waste, and less personal protection equipment required for workers. All of these factors would decrease down-time and increase mission readiness.

The project was divided into two phases of laboratory testing and a separate field demonstration. The first phase was to allow for screening of the alternatives. Only those coatings that performed the best in the laboratory testing were carried onto the next phase. Phase I tests included pot life, coating appearance, cure time, cleanability, accelerated storage stability, and adhesion.

Four of the eight alternatives were identified as best performing and were carried on to Phase II testing which included removability, repairability, abrasion resistance, fungus resistance, weathering, cyclic corrosion resistance, flexibility, and hypergol compatibility. Phase II also included an 18-month Marine Exposure Test at the KSC Corrosion Testbed; due to the extended time required, this test began before Phase I testing was complete and included all of the alternatives.

All of the alternatives and control coatings were also applied to an engine test stand at SSC in Mississippi. The coatings were evaluated after six and twelve months of exposure. Of the eight alternatives tested, five showed satisfactory performance in the overall testing and were approved for use across NASA by inclusion in the Qualified Products List of NASA-STD-5008, Protective Coating of Carbon Steel, Stainless Steel, and Aluminum on Launch Structures, Facilities, and Ground Support Equipment. The information gathered during this project was also included in follow-on projects and is being disseminated across NASA and AFSPC.



*Test Panels for 18 Months of Exposure Testing*

ages assembled and reworked with solder interconnects consisting of mixed alloys, lead component finish/lead-free solder and lead-free component finish/Tin-Lead solder.

The Joint Test Protocol was finalized in October 2007 and includes the following: Thermal Cycling, Vibration, Combined Environments Testing, Drop Testing, Mechanical Shock, Integrated Stress Testing, and Copper Dissolution. Results from the project will be available during the duration of the project allowing advance information to assist organizations in their own implementation or mitigation strategies.

# Process Improvement

## Membrane Removal of VOCs

Federal and local regulations continue to reduce the allowable level of VOCs that can be emitted into the atmosphere. This can affect whether or not new or modified operations receive permits. Recent developments have been made with semi-permeable membranes that can 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 remediation sites, paint booths, fuel farms, solvent cleaning, metal finishing, ethanol processing, and solvent recycling.

*VOC Membrane Removal Test Set-up at Wallops Flight Facility*

The excellent separation performance obtained with small membrane modules has inspired the exploration of the performances of larger commercial-size hollow fiber cartridges and multiple cartridge-containing modules for treating real-life VOC-containing gas streams. This novel membrane technology has shown the capability to remove up to 98% of VOCs from nearly any entrained air stream in laboratory testing. VOCs can then be captured and condensed into a liquid that may be disposed of, recycled, or reused.

The construction of a larger-scale test unit was completed in July 2007 and it was transported to NASA Wallops Flight Facility to begin field testing. The site selected for testing is now a remediation site that was once used to store fuel for the nearby airfield. The initial testing is showing promise, but modifications to the test platform are required before full-scale testing can begin in-earnest. Once testing is completed at WFF, TEERM plans to test the technology at other sites. TEERM is currently identifying NASA and DoD facilities for continued demonstration of the membrane filter to capture VOCs from process air-streams of other candidate processes.

## Oxygen Line Cleaning

TEERM is engaging academia to design environmentally benign cleaning agents for oxygen systems and related components. Historically, solvents have been the chemicals of choice for NASA, the DoD, and the aerospace industry in cleaning aviation oxygen systems and components. Many of these chemicals have been classified as ozone depleting substances (ODSs) and are therefore regulated by the Clean Air Act and Montreal Protocol, which have set finite caps and phase-out dates for their manufacture and use.

A thorough understanding of oxygen cleaning standards and cleanliness verification science must be examined and evaluated for potential exploitation by new chemical science to overcome the inclusion of environmentally hazardous components to achieve the desired results. Successful completion of the project will eliminate the obsolescence risk due to pending phase out of existing ozone depleting substances for cleaning oxygen systems and components and provide environmentally benign cleaning technology for space and aviation breathing systems.

Based upon a literature review, a list of potential alternative solvents is being generated. This list includes several well known and established aqueous/surfactant solutions used for non-oxygen degreasing applications as well as a variety of fluorinated compounds that are expected to be compatible in an oxygen environment. Some initial testing is complete and the data represents the first results in the series of potential new solvents being considered.

# Other Work

## Sustainability

TEERM is supporting C3P in the preservation of the Berlenga Island Nature Reserve off the coast of Portugal. The challenge is to preserve the heritage of the archipelago while satisfying the needs of the population. The Reserve has over 1000 visitors per day during the summer. Other C3P partners include the Portu-

*Picture from Berlenga Island Nature Reserve*

# New Principal Center Manager for TEERM

Mr. Charles (Chuck) Griffin has been named the NASA TEERM Manager. Mr. Griffin is responsible for spearheading initiatives to reduce pollution and to minimize or eliminate the use of hazardous materials and volatile organic compounds in the design, production, and operation of NASA programs. He will also assume the duties as Working Group Chairman of JG-PP, tasked with combining resources to find solutions to common environmental problems.

Mr. Griffin has 35 years with NASA at the Kennedy Space Center (KSC) and has held numerous positions within the Design Engineering Directorate. Prior to managing TEERM, Mr. Griffin spent 10 years in the NASA Technology Programs & Partnerships Branch, the last 5 years as Manager of the Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) Program.

Consistent with his previous duties as KSC SBIR/STTR Program Manager, Mr. Griffin also served as the KSC Small Business Technical Advisor. In this role, Mr. Griffin served as technical advisor to small businesses seeking opportunities for research and development, as well as technical support, among the KSC NASA and prime contractor organizations. Mr. Griffin has experience with successfully transferring technology to industry due to his prior role as a NASA Licensing Agent negotiating licensing agreements on intellectual property.

He is the recipient of many awards including the Exceptional Engineering Achievement Medal from NASA Headquarters and the Silver Snoopy Award from the Astronaut Corp. Mr. Griffin is a graduate of the University of Central Florida with a B.S. in Electrical Engineering. He was born in Grove City, PA, and currently resides in Chuluota, FL. He and his wife Judy have three daughters with the oldest having just completed a Master's degree and the other two pursuing B.S. degrees. His favorite hobby is saltwater fishing (and he's good at it as you can see!).

*Chuck Griffin and the Mutton Snapper He Caught Off the Florida Keys*

guese Ministry for the Environment, the Institute for Nature Conservation and Biodiversity, the Municipality of Peniche, the Navy Lighthouse Authority, and utility companies.

Three diesel generators currently supply power to the islands, which leads to supply problems and the release of over 40 tons of carbon dioxide per year. The plan is to replace the use of diesel fuel with combinations of renewable energy such as solar, wind, and eventually biomass and wave power. Hydrogen fuel cells, which NASA has a good deal of experience with, are also being considered. This would solve the supply problems as well as reduce the carbon footprint of the island. The project is also looking at solving the problem of providing potable water and managing wastewater and solid waste.

These are issues that threaten not only the Berlenga Island Nature Reserve, but public parks and similar islands around the world. Berlenga Island will be used as a testbed to demonstrate alternatives in a real world setting. It is imperative to find the appropriate infrastructure to support the continued use of these natural wonders while preserving them for generations to come.

## Energy and Water Management

Energy efficiency is not just a good idea; it is a necessity as energy costs continue to rise and erode mission funding. The National Energy Conservation Policy Act, as amended by the Energy Policy Act of 2005 and Executive Order 13423, mandates energy and water management goals for all federal agencies, including NASA. The newly enacted Executive Order 13423 establishes new water conservation goals and sets FY 2007 as the baseline year. NASA is required to report on its progress in meeting directives. The Energy/Water Management Task was created to support NASA Headquarters Environmental Management Division (HQ EMD) in meeting these requirements.

With assistance from TEERM, HQ EMD compiled and submitted the NASA Annual Report to the Department of Energy FY 2007. The report contains information on how NASA is meeting federally mandated energy and water management goals. TEERM monitored input for timeliness, errors, and conformity to the new energy/water reporting guidelines and helped compile the information into the final report.

TEERM is also supporting NASA and the Interagency Working Group on Hydrogen and Fuel Cells. Established shortly after the President announced the Hydrogen Fuel Initiative in 2003, it serves as the mechanism for collaboration

among the Federal agencies involved in hydrogen-related research, development, and demonstration. TEERM developed a matrix showing all Hydrogen and Fuel Cell activities from the various NASA Centers to be included in the Group's extensive hydrogen research taxonomy of past, present, and future hydrogen activities of the Federal government.

## KSC Corrosion Activities

TEERM has teamed up with the KSC Corrosion Technology Laboratory and other maintenance personnel to update the NASA-STD-5008, Protective Coating of Carbon Steel, Stainless Steel, and Aluminum on Launch Structures, Facilities, and Ground Support Equipment. The standard identifies the requirements and approved coatings for protection of facilities and GSE across NASA. The document was last updated in 2004 and did not reflect the most up to date specifications or identify those coatings that meet the newest restrictions from environmental regulations.

TEERM is also supporting the "Corrosion Control Facility Goes Green Initiative." The purpose of the initiative is to validate state of the art technology improvements to make the primary maintenance facility at KSC the most up to date and environmentally friendly. TEERM supported the group in the development of a proposal for the KSC Call for Project Proposals for 2008 Energy and Environmental Projects. This first project was approved and will receive funding to validate low-VOC topcoats atop thermal spray coatings to replace the inorganic zinc based systems currently used.

# 2008 Events of Interest

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| **January** | | |
| 9-10 | 3rd Advanced Aerospace Coating/Decoating Technologies Symposium | Orlando, FL |
| 21-22 | Surface Engineering for Aerospace and Defense Conference | Orlando, FL |
| 29 | Industry & Government Executive Lead-Free Cooperative Integrated Process Team (ELFIPT) Meeting | Irving, TX |
| **February** | | |
| 6 | Joint Services Lead-Free Technical Coordination Meeting (TEERM presenting) | Robins AFB, GA |
| **March** | | |
| 4-6 | JG-PP Working Group Face-to-Face Meeting | Washington, DC |
| 16-20 | NACE Corrosion 2008 Conference (TEERM presenting) | New Orleans, LA |
| 18-20 | 18th Annual Cleaner, Sustainable Industrial Materials & Process (CSIMP) Workshop (TEERM presenting) | Coronado, CA |
| 24 | Emerging Hydrogen Economy Conference | Cocoa Beach, FL |
| 25-28 | 2008 Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Workshop | San Antonio, TX |
| 31Mar-4 Apr | 2008 Annual Hydrogen Conference | Sacramento, CA |
| **April** | | |
| 1-4 | 2008 IPC-Apex Conference | Las Vegas, NV |
| 8 | JG-PP Principals Face-to-Face Meeting | Washington, DC |
| **May** | | |
| 5-8 | Joint Services Environmental Management Training Conference & Expo (JSEM) | Denver, CO |
| 13-16 | Air Force Corrosion Conference (TEERM presenting) | Macon, GA |
| **August** | | |
| 3-6 | GovEnergy Workshop and Tradeshow | Phoenix, AZ |
| **November** | | |
| 18-20 | C3P/NASA International Workshop (TEERM presenting) | San Diego, CA |
| **December** | | |
| 2-4 | Partners in Environmental Technology Technical Symposium & Workshop | Washington, DC |

# Aerospace Students Visit Kennedy Space Center

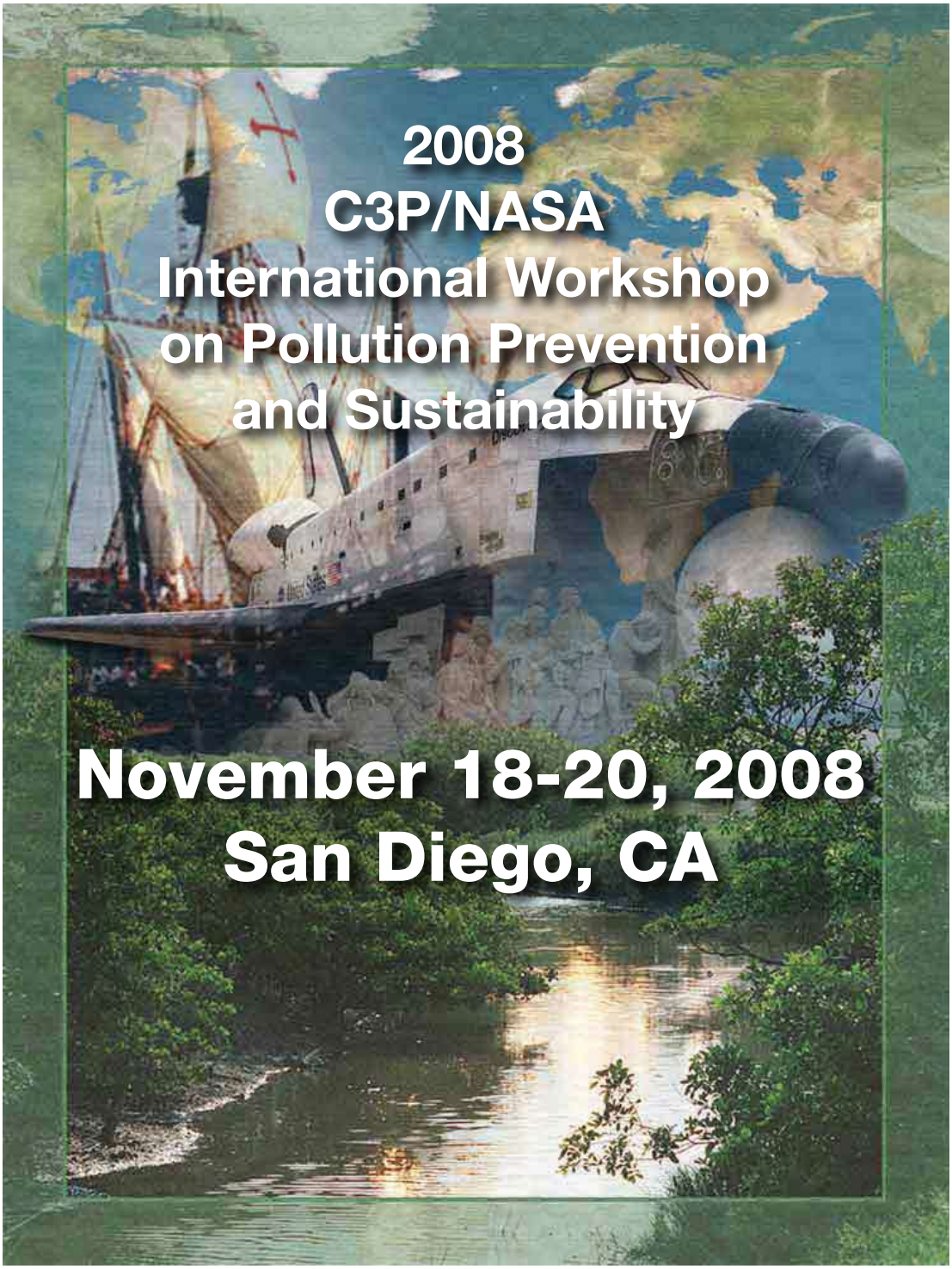
In 2007, the Concordia Institute of Aerospace Design and Innovation (CIADI) from Concordia University in Montreal began a new initiative to have students learn about developments within the North American aerospace industry. The primary topic of research for 2007 was the environment. CIADI student ambassadors visited Bombardier (Mexico), Aeroman/ACTS (El Salvador), NASA Glenn Research Center (Ohio), Rolls Royce (Ohio), PIPER Aircraft (Florida), and finally, for their last stop, NASA Kennedy Space Center in Florida. TEERM assisted in providing a tour of KSC for the CIADI students.

TEERM gave a brief presentation and answered questions regarding all of the environmentally focused projects TEERM has been working for NASA. The students visited several KSC sites in order to investigate environmental protection initiatives including the KSC Corrosion Testbed where marine exposure testing occurs, the Solid Rocket Booster processing facility, the Crawler Transporter, and the Orbiter Processing Facility. The CIADI students were also able to visit the launch pad with Space Shuttle Endeavour in place for the August 8 launch of STS-118.

CIADI students at KSC

# 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. More than one ITB TEERM engineer has prior experience with JG-PP, the DoD group for which TEERM was originally created to support. ITB staff identify opportunities for collaboration and develop them into joint projects, which ITB then manages or otherwise supports. ITB also provides support to NASA Headquarters on JG-PP and energy/water matters. ITB is also a valuable resource in NASA's partnership with C3P in Portugal.




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,
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