National Aeronautics and Space Administration

QuEST

Qualifying Environmentally Sustainable Technologies

April 2006 Volume 1

Message from the Program Manager

Over the years, pollution prevention has proven to be a means to comply with environmental regulations, improve product performance and reduce costs. The NASA Acquisition Pollution Prevention (AP2) Program was created to help individual NASA Centers and programs work together to evaluate and adopt environmentally preferable technologies and practices.

The AP2 Program accomplishes its mission using a variety of tools such as networking, information/technology exchange and partnering. Due to its extensive network of contacts, the AP2 Program is an excellent resource for finding existing solutions to problems. If no solution is readily known, the AP2 Program works to identify potential solutions and partners for demonstration/validation projects.

Partnering to prevent pollution is a cornerstone of NASA's prime mission and the One NASA Initiative. This annual newsletter highlights some of our program's collaborative efforts.

I believe you will discover how the AP2 Program is responsive in meeting the Agency's environmental management strategic plans.

Christina Brown
NASA AP2 Program Manager
NASA KSC/KT-F

NASA AP2 Partnering

Within NASA, the Acquisition Pollution Prevention (AP2) Program has the responsibility for helping NASA Centers and programs identify and test environmentally preferable and sustainable technologies. A major component of that responsibility is forming partnerships. Partnerships help AP2 extend its impact and fulfill its mandate of reducing or eliminating hazardous materials within NASA manufacturing and maintenance processes.

Testing of materials such as environmentally preferable coatings and cleaning/depainting technologies can cost hundreds of thousands of dollars. Individual NASA Centers or programs usually cannot fulfill all demands to pay for this testing. Fortunately, through collaboration and financial commitment from project stakeholders and third-party sources, it is possible to fully fund expensive demonstration/validation efforts.

Characteristics of AP2 Partnerships

The specifics of NASA AP2 partnerships can vary. In general, AP2 partnerships involve working together on a joint effort, with shared technical and financial responsibilities, to develop test plans and conduct testing on new, more environmentally friendly materials or processes. In this type of partnership, collaboration on demonstration/validation activities is a tool for a two-way transfer of knowledge. The partners share their knowledge of the current material or process and of the proposed replacements. Once testing begins, partners may share the cost of the testing, in some cases by conducting some of the testing at their facility as an "in-kind" contribution to the project.

The AP2 Program manages or otherwise supports the project through its completion, which can take up to two years or more. Partner organizations also contribute finances and staff and commit to reviewing the results and conclusions for possible implementation if an alternative material is validated.

Partnership Benefits

The AP2 Program develops national and international partnerships to more efficiently address the pollution prevention needs of NASA as well as others. Partnerships have a role in helping to fulfill AP2's mandate for fostering collaboration and reducing duplication of effort. Partnerships typically reduce individual contributors' shares of the total cost of technology validation. Validation of pollution prevention technologies through partnerships leverages all participants' contributions to the project. Although partnerships may not be applicable to all types of validation projects, it is the cornerstone of all AP2 projects.

The continued success of the AP2 Program depends upon a strong Agency demand and support for validating environmentally preferable technologies for NASA-specific applications

and upon a commitment for collaboration by AP2 partners. Collaboration benefits everyone.

Success of the Partnership Approach

NASA AP2 is a member of the Department of Defense's (DoD) Joint Group on Pollution Prevention (JG-PP). JG-PP manages and facilitates joint pollution prevention projects benefiting DoD/NASA organic and contractor installations where weapon/space systems are designed, manufactured, remanufactured, or maintained.

One JG-PP project that has benefited NASA was an effort to identify and qualify environmentally acceptable alternatives for chromate-containing primers used on military aircraft exterior moldlines. Hexavalent chromium has long since been recognized as a hazardous material and human carcinogen. JG-PP testing resulted in two chrome-free primers being qualified to military requirements.

Picture of flipper doors where JG-PP non-chrome primer was applied on Orbiter Columbia

The AP2 Program shared these findings with Boeing-Palmdale, the NASA contractor that built the Space Shuttle Orbiters, who was interested in finding an environmentally preferable replacement for the hexavalent chromium-containing primer used on the Orbiters' exterior aluminum surfaces. By accepting the JG-PP test results, Boeing was able to avoid up to $50,000 of testing that it otherwise would have incurred. NASA ultimately approved pilot testing of one of the non-chrome primers on the flipper doors of STS-107.

The AP2 Program is also involved in a coatings project and a depainting project with partners from NASA Centers and Air Force Space Command (AFSPC). The objective of the coatings project is to test and validate alternatives to isocyanate-containing coatings used on launch pads and other steel structures. The depainting project is looking at low-dusting alternatives to conventional grit blasting. Both of these efforts involve technical stakeholders from Stennis Space Center (SSC), Kennedy Space Center (KSC), and AFSPC.

Another AP2 partner institution is the Centro Para Prevenção da Poluição (Portuguese Center for Pollution Prevention or C3P). C3P is effectively the AP2 counterpart organization in Portugal. Through joint terms of reference between NASA and Portugal's Institute of Environment, NASA has a formal working relationship with C3P. NASA AP2 staff has provided mentorship and technical and administrative support to C3P for a number of pollution prevention efforts. For example, AP2 and C3P staff are working together on a joint project between Portugal's national airline, TAP Portugal, and the Oficinas Gerais de Material Aeronáutico (General Shops of Aeronautical Materials), which maintains aircraft for TAP Portugal and the Portuguese Air Force, to demonstrate suitable alternatives to hexavalent chromium in coatings used on TAP Portugal aircraft.

The involvement of partners from the outset of a demonstration project is essential to transferring knowledge and thus, technology acceptance. Trust and mutual respect between AP2 and the partner is developed as quickly as possible in the relationship and maintained throughout the collaboration.

Completed Projects

Non-Chrome Primer on Orbiter Columbia

As part of the JG-PP Nonchromate Primers for Aircraft Exteriors project (J-95-OC-002) field testing, a non-chrome primer was applied to the flipper doors on the Orbiter Columbia. The doors were specifically selected because they are "drip points" and due to paint thinning effects, see more than average amounts of corrosion. The purpose of the flipper door/chrome testing program was to convince space shuttle design personnel that the alternative non-chrome primer will hold up to space environments, launch/re-entry and the harsh environmental conditions found in Florida.

Based on the initial results, the non-chrome primer is now being applied to some brackets in the Orbiter's Payload Bay and at least one drawing has been changed to specify the non-chrome primer. The Orbiter's Corrosion Control Review Board is currently looking for other opportunities to use the alternative.

Parts Washers Guidance Document

The AP2 Office developed a "Consumer's Guide to Alternative Parts Washers" to assist environmental managers, shop owners, and procurement personnel in deciding which environmentally preferable parts washer will work best for their shops. Information about chemical characteristics, cleaning efficiencies, volatile organic chemical (VOC) content and cost are included for each chemistry. Charts allow for quick identification and comparison among alternatives. The guide covers 53 alternative and four benchmark chemistries (Methyl Ethyl Ketone, Mineral Spirits, Isopropanol and Acetone), each of which was lab tested to determine cleaning efficiency.

The document also covers the nine alternatives that were demonstrated at NASA Centers [KSC, Goddard Space Flight Center (GSFC), Michoud Assembly Facility (MAF), Marshall Space Flight Center (MSFC) and Wallops Flight Facility (WFF)] in greater detail. To date, four of the nine shops that tested alternatives have decided to purchase their test chemistries or other alternatives recommended by the guide and several other shops are considering doing the same.

There was significant cost avoidance found within the project on several levels. First, seven of nine units and chemistries were provided as in-kind for the on-site test period by the vendors. Secondly, the 57 chemistries for laboratory testing were also provided as in-kind by vendors. Additionally, the

Picture of technician at WFF using one of the parts washers and chemistries tested

2005 C3P/NASA Technical Workshop

C3P and NASA hosted a technical workshop at the Universidade Católica in Lisbon, Portugal on September 8-9, 2005. The two-day workshop provided an excellent forum to showcase innovative and emerging pollution prevention technologies, share lessons learned, and identify new joint opportunities. In total, 133 individuals from 9 countries attended the technical workshop. More than 30 international scientists, technologists, and engineering experts presented slides on topics ranging from advanced coatings and coating removal technologies to fuel cells to lead-free electronics. This exchange of solutions provided direct and tangible benefit to attendees from academia, defense, and commercial industries, thereby helping meet the mission not only of C3P, but key workshop supporters such as the Luso-American Foundation for Development and the Office of Naval Research Global.

At the workshop, the Israeli Users' Association of Advanced Technologies in Electronics (ILTAM) signed a Cooperation Protocol with C3P joining seven other international organizations. ILTAM is the first Israeli organization to sign a protocol with C3P and represents an opportunity to leverage key resources and knowledge on validating green technologies.

Presenters at the 2005 C3P/NASA Technical Workshop

AP2 Office received in-kind contributions from the Rochester Institute of Technology which allowed them to test an additional 21 chemistries.

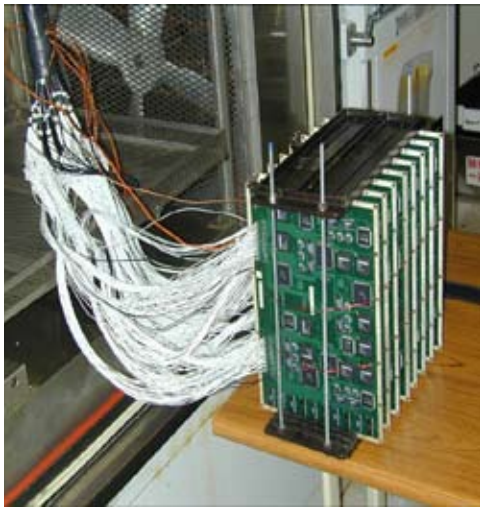
Six NASA Centers working together achieved nine-times the amount of work reviewing alternative cleaners than could be completed at one test site during the same time period at no additional cost to the individual Centers. Centers that have adopted or will soon adopt any of the environmentally preferable alternatives from the project will stand to see reduced hazardous waste streams for cleaning operations.

On-going Projects

Lead-free Solder Project

Industry is pushing towards the use of lead-free solder for interconnections and lead-free finishes on components. This push is fueled by European legislative actions on the use of lead and increasingly, by commercial and marketing activities outside the U.S. While military and aerospace electronic equipment is exempt, they comprise only 1% of the total electronics market and will feel the impact of the lead-free conversion as manufacturers work to comply with emerging regulations and continue to compete globally.

Therefore, government managers with NASA, the military, and space and defense contractors face numerous risks from the continued use of tin-lead solder. Concerns include: contamination of leaded parts with lead-free, contamination of lead-free parts with leaded which can adversely affect lead-free finishes, the propensity of lead-free finishes to develop tin whiskers, reduced supply resulting in rising costs, component obsolescence, and reduced mission readiness. A great concern is that lead-free solder on interconnects has largely unknown long-term reliability especially in high-reliability applications common in aerospace and military applications.



Picture of lead-free test assemblies ready for Thermal Shock testing

In order to address such data gaps, JG-PP partnered with the DoD's Joint Council on Aging Aircraft, the European Space Agency and international and domestic original equipment manufacturers 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 majority of testing is complete and failure analysis is underway.

Isocyanate-Free Coatings Project

The AP2 Office partnered with KSC, SSC 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. 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.

Phase I of testing has been completed and all of the alternatives were placed at the KSC Corrosion Testbed for 18-month Marine Exposure. Plans are underway for Phase II testing of those alternatives that passed the initial screening tests. All of the alternatives were applied to an engine test stand at Stennis Space Center, MS, for field evaluation with inspections planned at 6 months and 12 months.

Low-Emission Depainting Project

The AP2 Office partnered with KSC, SSC, Glenn Research Center (GRC) and AFSPC to identify, evaluate and approve alternative surface preparation technologies for

structural steel applications due to increasing environmental and safety regulations. Field evaluations were conducted at GRC on ground support equipment and on facilities at SSC. Test panels were also prepared for laboratory evaluation.

Materials and processes were evaluated with the goal of selecting processes that will improve corrosion protection at critical systems, facilitate easier maintenance activity, extend maintenance cycles, eliminate flight hardware contamination and reduce the amount of hazardous waste generated.

Preparation of test panel for analysis of depainting technology at SSC

New Projects

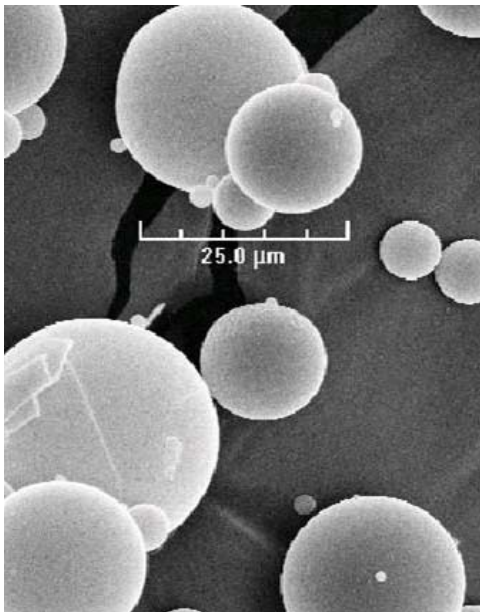
Portable Laser Coating Removal

As a follow on to the Environmental Security Technology Certification Program (ESTCP)/ JG-PP Portable Laser Coating Removal System project, several NASA Centers are participating in an effort to demonstrate the technology for use on Ground Service Equipment (GSE), facility structures and flight hardware. This project is being undertaken to demonstrate this and other alternatives to hazardous chemical strippers and standard stripping technologies that generate large amounts of hazardous waste.

The technology shows promise in removing coatings and corrosion from hard-to-reach areas and weld lines. Lasers were tested on a variety of GSE from several NASA Centers and Boeing for use on several types of Orbiter hardware including tile cavity applications as well as aluminum honeycomb and composite substrates. Field testing occurred at GRC and Wright Patterson Air Force Base, both in Ohio.

Novel Fire Extinguishing Agent

KSC's Applied Technology Directorate has developed a novel dry chemical fire extinguishing agent based on the micro-encapsulation of water in a polymer. Unlike Halons, which are banned from production, the material is not an ozone depleting compound. It also does not exhibit the corrosive effects of many other dry chemical agents. The AP2 Office is working with the Air Force Research Laboratory's Fire Research Branch located at Tyndall Air Force Base, FL, to determine the fundamental fire extinguishing capabilities of the material.



Scanning electron microscope image of fire extinguishing microspheres filled with water

This is a publication of
NASA's Acquisition Pollution Prevention (AP2)
Program Office located at Kennedy Space Center, FL.

For more information, please visit our website at
www.acqp2.nasa.gov

If you have questions, please send us an email at
ap2newsletter@itb-inc.com