



NASA Technology Evaluation for Environmental Risk Mitigation Principal Center Overview



**2013 International Workshop on Environment and Alternative Energy
October 22-25, 2013
ESRIN, Frascati, Italy**

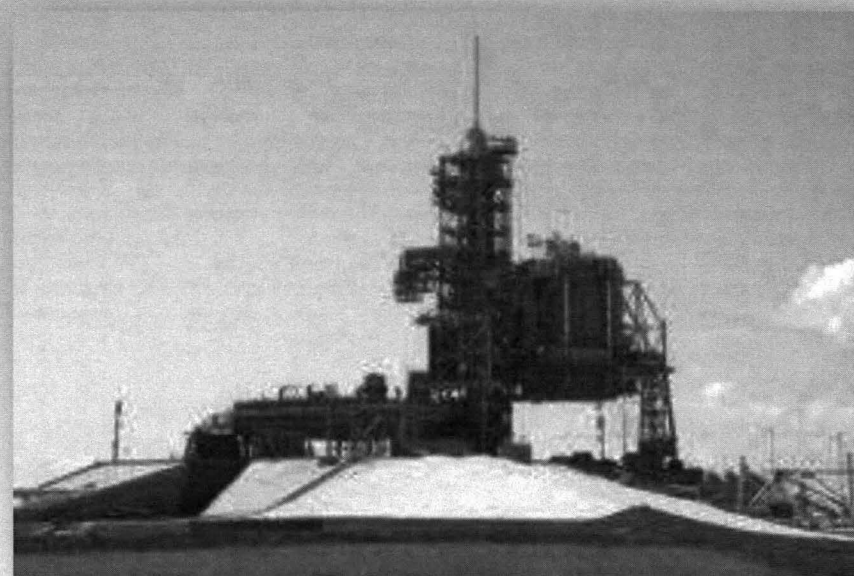
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Mitigation Principal Center (TEERM)

Agenda

NASA TEERM Principal Center Overview

- TEERM Mission
- TEERM Process
- Lessons Learned
- Summary



NASA Kennedy Space Center, FL



TEERM Mission

Mission

The Technology Evaluation for Environmental Risk Mitigation (TEERM) Principal Center limits risk to NASA's mission caused by environmental drivers.

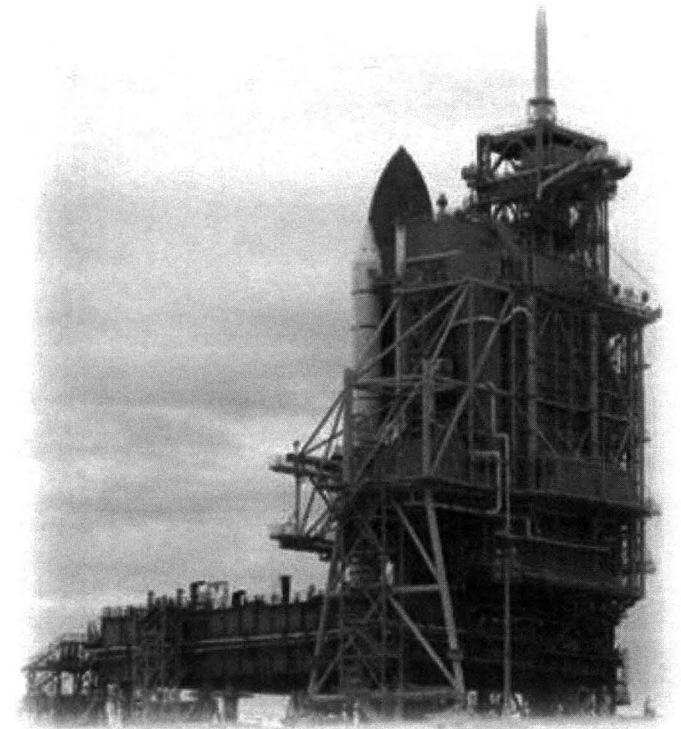
Objectives:

- Be an integration activity for the Agency to help improve NASA's ability to adopt new environmental or energy technologies
- Foster collaboration on projects to reduce duplication of effort and costs of technology validation.
- Ensure project results are applicable to current and future NASA programs.

TEERM Project Approach

Hallmarks of TEERM Project Process:

- Solutions that reduce environmentally-driven risk
- Partnerships
- Comprehensive test planning
- Leveraging resources



Solutions that Reduce Environmentally-driven Risk

- TEERM identifies high-priority risks impacting NASA.
 - Material availability and obsolescence
 - Climate change impacts and adaption
 - Extended loss of energy or water supply to critical operations
 - Changing laws and increasing requirements
 - Increasing energy costs
 - Encroachment
 - Environmental cleanup – Apollo era
- TEERM evaluates, in an unbiased fashion, viable technological solutions to environmentally-driven risks



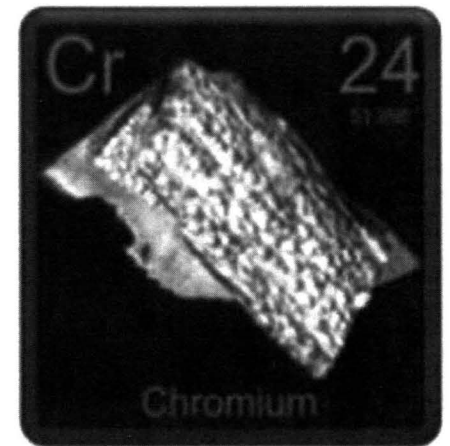
View of KSC after heavy rain event

Solutions that Reduce Environmentally-driven Risk

(continued)

Example of material availability and obsolescence risk - Hexavalent Chromium

- Hexavalent chromium is an ingredient in coating formulations that inhibits corrosion and promotes adhesion
- Regulatory restrictions threaten the supply chain for products containing hexavalent chromium
- TEERM's work for NASA focuses on totally hexavalent chromium-free systems, not just chrome reduction





Solutions that Reduce Environmentally-driven Risk

(continued)

Example of material availability and obsolescence risk –
Chlorinated Solvents

- Applications include general degreasing and precision cleaning
- We are interested in alternative cleaning chemicals and cleaning processes that are “green” throughout the entire product life cycle

Partnerships

- Partnering is key to TEERM project approach
 - Environmental/energy regulations & drivers have global impact.
 - Benefits of partnering include:
 - Reduces cost burden on any one team member
 - Enhances technical quality
 - Can speed implementation
 - TEERM project partners have included:
 - NASA Centers
 - European Space Agency
 - Industry contractors
 - U.S. Dept. of Defense
 - Other U.S. government agencies



Fuel cell mobile light in support of final Shuttle launch (Atlantis), July 2011

Fuel cell mobile light team, led by Sandia National Laboratories

Partnerships – Example

Project: Low-VOC Coatings for Aerospace

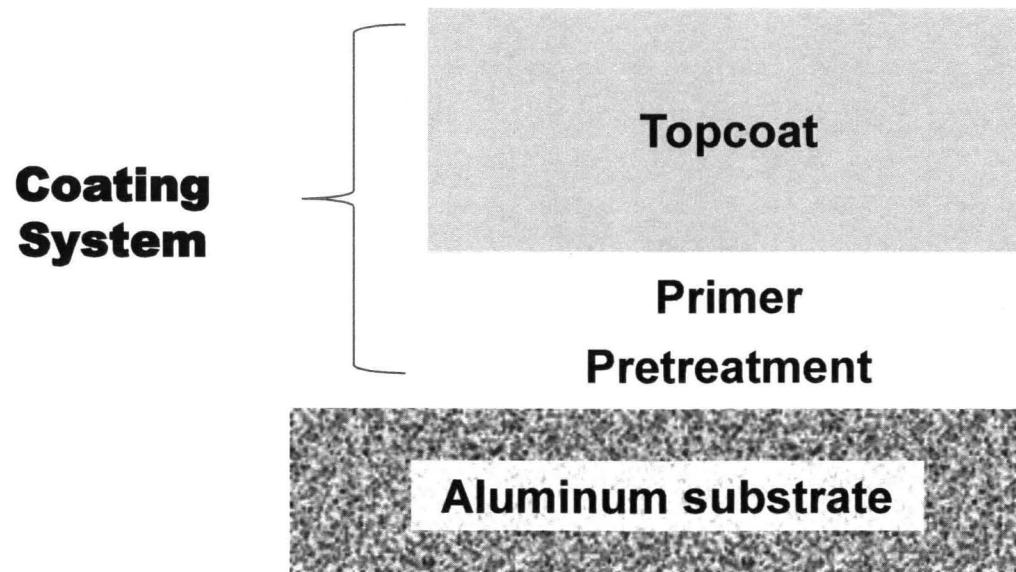
- NASA, TAP Air, and Portuguese Center for Pollution Prevention (C3P)
- Demonstrate low-VOC and non-chrome coating systems on Portuguese commercial aircraft
- First TEERM-international collaboration involving testing & evaluation.
- Laboratory Testing: 16 unique tests
- Field Testing: Airbus A319 Service Door
- Findings transferred to follow-on NASA coatings projects



Partnerships – Example

Project: NASA-ESA Hexavalent Chromium-free Coatings

- First TEERM-ESA collaboration on a shared problem for which driver is multi-national regulations.
- Evaluating and testing individual coatings and coating systems as replacements for hexavalent chrome coatings in aerospace applications, primarily for rockets and spacecraft.



Comprehensive Test Planning

TEERM takes opportunities from concept through project execution:

1. Target the need
2. Identify and assess promising alternatives
3. Identify technical requirements alternatives must meet
4. Prepare test plan
5. Identify total project resources and advocate for them
6. Proceed with project (testing/demonstration)



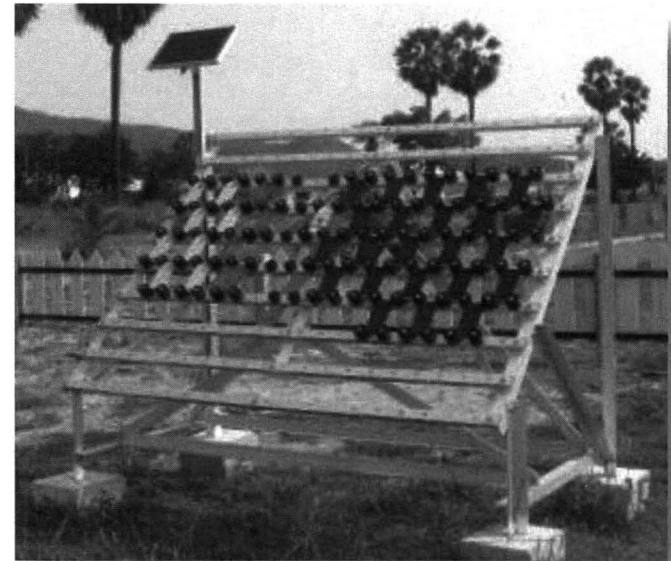
Inside the Corrosion Technology Lab at NASA KSC, workers from TEERM are comparing several coating test samples with some new environmentally friendly coatings.

Comprehensive Test Planning

TEERM experience coupled with team consensus is necessary to translate technical specifications into useful test procedures.

Reasons can include:

- Specs may not contain sufficient detail
- Specs often provide options rather than a singular test procedure



*Atmospheric Corrosion Testing of
Passivated Test Panels during USA study*

Leveraging Resources

- Leveraging resources is increasingly necessary to execute projects
- Why? To overcome factors that can complicate Agency ability to meet challenges:
 - Testing and qualification of new materials and processes is expensive.
 - Experience of team members is valuable in reducing project risks
 - Increasingly, funding sponsors look for proposed projects involving multiple partners and cost sharing

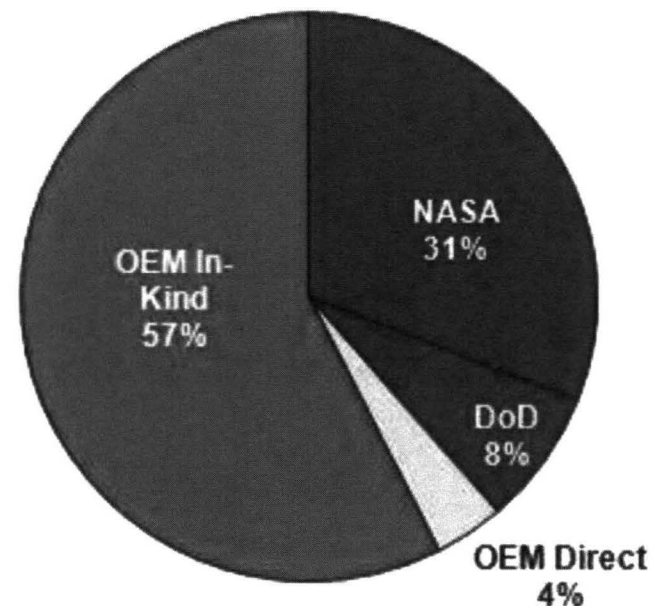


Chart showing the sharing of resources to execute a TEERM-led NASA-DoD lead-free electronics project

Leveraging Resources - Example

Hexavalent Chromium-free Coatings

- TEERM has initiated and managed several projects to evaluate hexavalent chromium-free coatings
- NASA-ESA Hexavalent Chromium Free Coatings incorporates expanded requirements and enhanced test procedures
- These projects exemplify :
 - How TEERM's approach to projects reduces the cost to test and qualify alternatives through sharing of resources
 - How TEERM and ESA can utilize each others needs to qualify alternatives in a complementary fashion, and not duplicate effort.



Lessons Learned

- When formulating a project, an agreement is not necessary to begin discussions
- Face-to-face meetings are the most effective means of communication
- Benefits are realized when sometimes working with smaller groups
- Workshops like this one foster collaboration





TEERM Summary

- TEERM facilitates NASA evaluation of materials and processes that are inherently safer, generate less waste, and use energy efficiently.
- Government/industry partnerships are key to TEERM and NASA success.
- TEERM is proactive – sometimes ahead of regulations.
- TEERM's evaluation of technologies is unbiased.



**For more information visit the
NASA TEERM Website:**

www.teerm.nasa.gov/