Birthplace, Home and Future of Aerospace

Low VOC, Plural Component Spray (PCS) Coatings Program

7 May 2009

Thomas A. Ferrill
SAIC – Dayton, OH
(937) 431 - 2330
thomas.a.ferrill@saic.com

Roddy Keish
ASC/ENVV – WPAFB, OH
(937) 255 - 3541
roddy.keish@wpafb.af.mil
**Report Documentation Page**

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

<table>
<thead>
<tr>
<th>1. REPORT DATE</th>
<th>2. REPORT TYPE</th>
<th>3. DATES COVERED</th>
</tr>
</thead>
<tbody>
<tr>
<td>07 MAY 2009</td>
<td></td>
<td>00-00-2009 to 00-00-2009</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. TITLE AND SUBTITLE</th>
<th>5a. CONTRACT NUMBER</th>
<th>5b. GRANT NUMBER</th>
<th>5c. PROGRAM ELEMENT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low VOC, Plural Component Spray (PCS) Coatings Program</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6. AUTHOR(S)</th>
<th>5d. PROJECT NUMBER</th>
<th>5e. TASK NUMBER</th>
<th>5f. WORK UNIT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</th>
<th>8. PERFORMING ORGANIZATION REPORT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Applications International Corp, 5100 Springfield Street, Dayton, OH, 45431</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</th>
<th>10. SPONSOR/MONITOR’S ACRONYM(S)</th>
<th>11. SPONSOR/MONITOR’S REPORT NUMBER(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12. DISTRIBUTION/AVAILABILITY STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved for public release; distribution unlimited</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>13. SUPPLEMENTARY NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presented at the NDIA Environment, Energy Security &amp; Sustainability (E2S2) Symposium &amp; Exhibition held 4-7 May 2009 in Denver, CO.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>14. ABSTRACT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>15. SUBJECT TERMS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>16. SECURITY CLASSIFICATION OF:</th>
<th>17. LIMITATION OF ABSTRACT</th>
<th>18. NUMBER OF PAGES</th>
<th>19a. NAME OF RESPONSIBLE PERSON</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. REPORT</td>
<td>Same as Report (SAR)</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>unclassified</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. ABSTRACT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>unclassified</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. THIS PAGE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>unclassified</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18
Presentation Overview

- Program Organization
- Issues
- PCS Program Objectives
- Technical Approach
- Technical Progress
Program Organization

Issues

PCS Program Objectives

Technical Approach

Technical Progress
Rapidly delivering war-winning capability

Program Organization

Issues

PCS Program Objectives
Technical Approach
Technical Progress
Batch Application Method

Ad-Mixed Batch

Drawbacks
- Manual proportioning
- Not quick cure compatible
- Pot-life limitations with ad-mixed material
- Large volumes of paint and solvent waste
Aerospace Coating Issues

- **Time and labor intensive**
  - Large required coating thickness
  - Wet mils per pass limitations
  - Long dwell time between passes
  - Time to topcoat limited by slow cure

- **High VOC content**
  - Above targeted VOC goal
  - Costly permitting, monitoring, and controlling
Environmental Impact

Rapidly delivering war-winning capability

- VOC flash-off contributes to overall facility allotment
- Cleaning generates large volumes of hazardous waste
- Generated waste must be disposed of
- VOC monitoring and health screening burden
Program Organization

Issues

PCS Program Objectives

Technical Approach

Technical Progress
Program Objectives

Rapidly delivering war-winning capability

• Reduce VOC content
  – Objective: 0 g/L; Threshold: 150 g/L

• Reduce overall production flow time
  – Increased build rate
  – Decreased cure time

• Reduce waste generation
  – Unused coating
  – Cleaning solvent

• Support follow-on efforts
  – Collect remaining cost benefit data
  – Prepare for full-scale validation
## Coating Properties

*Rapidly delivering war-winning capability*

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC Content (g/L)</td>
<td>0</td>
</tr>
<tr>
<td>Cure Time (hr)</td>
<td>66% of Baseline</td>
</tr>
<tr>
<td>Build Rate (wet mils/pass)</td>
<td>≥ Baseline</td>
</tr>
<tr>
<td>Time Between Passes (min)</td>
<td>≤ Baseline</td>
</tr>
<tr>
<td>Coating Waste Generated (gal)</td>
<td>50% of Baseline</td>
</tr>
<tr>
<td>Cleaning Solvent Used (gal)</td>
<td>50% of Baseline</td>
</tr>
<tr>
<td>Occupational Health Risk</td>
<td>No Increased Risk</td>
</tr>
</tbody>
</table>
## Expected Program Benefits

**Rapidly delivering war-winning capability**

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Result</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced VOC content</td>
<td><strong>Reduced facility VOC emissions</strong></td>
<td>• Decreased permitting costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Decreased monitoring costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Decreased controlling costs</td>
</tr>
<tr>
<td>Plural Component Design</td>
<td><strong>Decreased coating and solvent waste</strong></td>
<td>• Decreased material usage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Decreased material cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Decreased labor hours for equipment clean-up</td>
</tr>
<tr>
<td></td>
<td><strong>Decreased hazardous waste generation</strong></td>
<td>• Decreased hazardous waste storage and disposal costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Decreased health screening costs</td>
</tr>
<tr>
<td>Increased build rate</td>
<td><strong>Decreased application time</strong></td>
<td>• Decreased application labor hours</td>
</tr>
<tr>
<td>Improved cure package</td>
<td><strong>Decreased time for full cure</strong></td>
<td>• Decreased production flow time</td>
</tr>
</tbody>
</table>
Rapidly delivering war-winning capability

Program Organization
Issues
PCS Program Objectives
Technical Approach
Technical Progress
Continuous Application Method
Rapidly delivering war-winning capability

Plural Component Spray

Benefits
- Automated proportioning
- Precision mixing
- Utilizes HVLP spray guns
- Accommodates quick cure coating
- Minimizes waste material
- Minimizes cleanup waste and time
Detailed PCS Schematic

Rapidly delivering war-winning capability

- Line Heaters
- Flow Meters
- Fluid Pumps
- Air Valves
- 4 QT Pressure Pot A
- 4 QT Pressure Pot B
- 4 QT Solvent Pressure Pot
- 4 QT Dump Pot
- Clean System
Methodology – Phase I

Rapidly delivering war-winning capability

- Candidate Evaluation
- Cost-Benefit Data
- Future Dem/Val

Phase II Activities

Performance Testing
- Comparison to baseline material
- Full properties testing & reformulation (if needed)
- Final candidate(s) recommendations (Maximum of 2)

Screening Testing
- Comparison to baseline material
- Critical properties testing & reformulation (if needed)

Verification and Down-Selection
- Verification of vendor claims
- Limited testing & reformulation (if needed)
- Selection of screening candidates (Maximum of 5)

Material Selection and Formulation
- Industry survey of vendor products
- Evaluation against Raytheon criteria
- Selection of initial candidates

Test Plan Development
- Outline of individual tests
- Candidate performance criteria
- Identify stakeholder concerns
Methodology – Phase II

Rapidly delivering war-winning capability

- Candidate Qualification
- Cost-Benefit Data
- Documentation

Phase I Activities

Demonstration Plan Development
- Programmatic document for Phases II & III
- Coordination of project stakeholders
- Promote successful technology transition

Phase II

Production Acceptance Testing
- Production size batches
- Verification of product consistency
- Critical properties testing

Full-Scale Demonstration
- Comparison to baseline material
- Full-scale engineering structure
- Application & usage properties

Phase III Activities

Candidate Qualification
Cost-Benefit Data
Documentation
Methodology – Phase III

Rapidly delivering war-winning capability

- Documentation
- Implementation

Transition Activities
- Present project results to engineering change boards
- Acquire government and contractor approvals
- Include PCS technology within all relevant QPLs and TOs

Cost & Performance Report
- Technology overview
- Cost and performance assessments
- Identification of implementation issues

Final Report
- Project overview
- Summary of test results
- Support documents

Full-Scale Validation
- Production spray equipment
- Optimization of critical application parameters
- Comparison to baseline material

Phase II Activities
Demonstration Plan Development

Rapidly delivering war-winning capability

- **Consideration of**
  - Performance & application parameters
  - Barriers to implementation
  - Initial cost-benefit analysis

- **Guidance**
  - Full-scale demonstration (Phase II)
  - Production acceptance testing (Phases II & III)
  - Full-scale validation (Phase III)
Production Acceptance Testing

Rapidly delivering war-winning capability

- Production Consistency
  - Between batches
  - Within batches

- Phase II
  - Two production-sized batches
  - Two PCS candidates

Candidate Recommendations (Phase I)

Demonstration Plan

Production Acceptance Testing

Confirmation of Batch Consistency
Full-Scale Demonstration
Rapidly delivering war-winning capability

- Demonstration of application properties
  - Spray-up engineering prototype/structure
  - Two PCS candidates & baseline

- Compare
  - Application performance
  - Cost metrics
  - Spray data/results
Follow-On Efforts

Rapidly delivering war-winning capability

• Plan Full-Scale Validation
  – Suggested Raytheon facility
  – Identify window of opportunity

• Complete Data Collection
  – Collect facility baseline & PCS cost data
  – Identify technology transition timeframe

![Diagram showing the flow of events with Tech Order Changes, Dem/Val Results, Cost-Benefit Analysis, and Successful Implementation]
## Task Plan

**Rapidly delivering war-winning capability**

<table>
<thead>
<tr>
<th>Task Name</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low VOC PCS Aerospace Coating Project</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Phase I Activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verification and Downselection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screening Testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance Testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future Dem/Val and CBA Support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Phase II Activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demonstration Plan Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production Acceptance Testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-Scale Demonstration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Phase III Activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-Scale Validation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost &amp; Performance Report</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Report</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tech Transition Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

[Diagram showing the timeline of activities for each phase]
Rapidly delivering war-winning capability

Program Organization
Issues
PCS Program Objectives
Technical Approach
Technical Progress
Test Plan Development

Rapidly delivering war-winning capability

- Test Plan – Delivered
  - Outlines all material testing by phase
  - Describes test procedures
  - Identifies associated pass/fail criteria
  - Documents test and control panel quantities
Material Selection and Formulation

Rapidly delivering war-winning capability

- **MS&F – Completed**
  - Vendors submitted candidate coatings
  - Candidates identified
  - Transitioned to next stage
Verification and Down-Selection

Rapidly delivering war-winning capability

- V&D – Completed
  - Candidate materials procured
  - Spray evaluation completed
  - Limited testing accomplished
  - No product reformulations
  - All candidates demonstrated potential
  - Transitioned to next stage
Screening & Performance Testing

Rapidly delivering war-winning capability

- S&PT – Completed
  - Candidate materials procured
  - Robust performance testing accomplished
  - No product reformulations
  - Recent down-selection decision
  - Two candidates move onto full-scale Phase II activities
Demo Plan Development

Rapidly delivering war-winning capability

- Demonstration Plan – Draft Development
  - Populating document with required information
  - Gathering inputs from stakeholders
  - Demo Plan approval projected for Q4 2009
Summary

Rapidly delivering war-winning capability

• Current Aerospace Coatings Application Methods
  – Batch mixed
  – Continuous (plural component spray)

• PCS Program Goals
  – Identify promising candidates
  – Confirm full-scale applicability
  – Qualify & implement PCS alternative

• Expected Environmental Benefits of PCS Technology
  – Reduced VOC content
  – Reduced overall application and cure times
  – Reduced hazardous waste generation
  – Reduced labor hours for clean-up

• Status
  – Candidate material test matrix identified
  – Candidate performance testing completed
  – Down-selection decision occurred (Phase I close-out)
  – Phase II activities beginning
Questions?


