



# *NDCEE*

National Defense Center for Energy and Environment

## Evaluation of a Low Temperature Cure Powder Coating

Howard Weinick, NDCEE

13th Annual Joint Services Environmental Management Conference & Exhibition, May 5-8, 2008



**DoD Executive Agent**

Office of the  
Assistant Secretary  
of the Army  
(Installations and  
Environment)

The NDCEE is operated by:  *Concurrent Technologies Corporation*

**Technology Transfer – Supporting DoD Readiness, Sustainability, and Transformation**

# Report Documentation Page

*Form Approved  
OMB No. 0704-0188*

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.

1. REPORT DATE <b>MAR 2008</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-2008 to 00-00-2008</b>	
4. TITLE AND SUBTITLE <b>Evaluation of a Low Temperature Cure Powder Coating</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>National Defense Center for Energy and Environment (NDCEE), Concurrent Technologies Corporation, 100 CTC Drive, Johnstown, PA, 15904</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>31</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

# Overview

- Introduction
- Background
- Approach
- Testing
- Results
- Cost Benefit Analysis
- Conclusions
- Recommendations

# Introduction

- The National Defense Center for Energy and Environment (NDCEE)'s mission is to support DoD sustainability and readiness through:
  - Transition of environmentally acceptable materials and processes to defense industrial activities and private industry
  - Training that supports the use of new, environmentally acceptable technologies
  - Applied research and development, where appropriate, to transition new technologies.

# Background

- Low Temperature Cure Powder Coating (LTCPC) developed under Strategic Environmental Research and Development Program (SERDP) Project PP-1268
- SERDP PP-1268 completed by GE Global Research, Crosslink Powder Coatings, Inc., and several Department of Defense facilities
- Developed to address deficiencies of conventional powder coating materials
- Powder coating needed for temperature sensitive substrates such as Aluminum 2024 (Al 2024-T3)

# Background (cont'd)

- Dem/Val activities were performed under the Commercialization of Technologies to Lower Defense Costs (CT/LDC) Program executed by the NDCEE
- Dem/Val designed to supplement ongoing Environmental Security Technology Certification Program (ESTCP) efforts

# LTCPC Dem/Val Team

- LTCPC Dem/Val team included:
  - NDCEE (project management, laboratory services)
  - Fleet Readiness Center Southeast (FRC Southeast) (in-kind services and materials)
  - Crosslink Powder Coatings, Inc (in-kind services)
  - ESTCP Team (technical review and outreach)

# LTCPC Properties

- Coating cures at 120°C (250°F) in 30 minutes
- Applied with conventional powder coating equipment
- Coating does not require a primer
- No VOCs or HAPs

# Approach

Evaluate the LTCPC against the baseline liquid coating by performing the following tests:

- Impact Resistance ASTM D3170-03 (Gravelometer)
- Corrosive Environments
  - ASTM B117 (Salt Spray Fog),
  - SAE J2334 (Cyclic Corrosion),
  - ASTM G155 (Weatherometer)
- Fluid Resistance MIL-PRF-85285D
  - Hydraulic Fluid
  - Jet Fuel (JP-5)
  - Lubricating Oil

# Pre-Test Activities

## Panel Pre-Treatment

- 27 – 4"x6"x1/4" Al 2024-T3 panels were chromate conversion coated by NDCCEE per MIL-DTL-5514F Type 1 Class A
- Reserved for LTCPC
  
- 27 – 4"x6"x1/4" Al 2024-T3 panels were chromate conversion coated by FRC Southeast per MIL-DTL-5514F Type 1 Class A
- Reserved for baseline coating

# Pre-Test Activities

- Oven Scan Profile for LTCPC panels
- Determines time required to heat a batch of panels to cure temperature of 250 °F (15 minutes)
- 15 minutes added to cure time of 30 minutes



# Coating Processes

- Baseline coating performed by FRC Southeast using a standard air assisted spray gun
- Cured for several days at room temperature
- Coating thickness 2-4 mils
  
- LTCPC performed by Crosslink Powder Coatings, Inc. using a Gema® powder application gun
- Coating thickness 2-4 mils



# Testing Activities

## ■ Coating Evaluation

- Atlas VIEEW™ Digital Image Analyzer in accordance with the Test for Chip Resistance of Surface Coatings (SAE J400)
- Illuminates the surface of the panels and quantifies the contrasting areas of damaged coating and undamaged coating



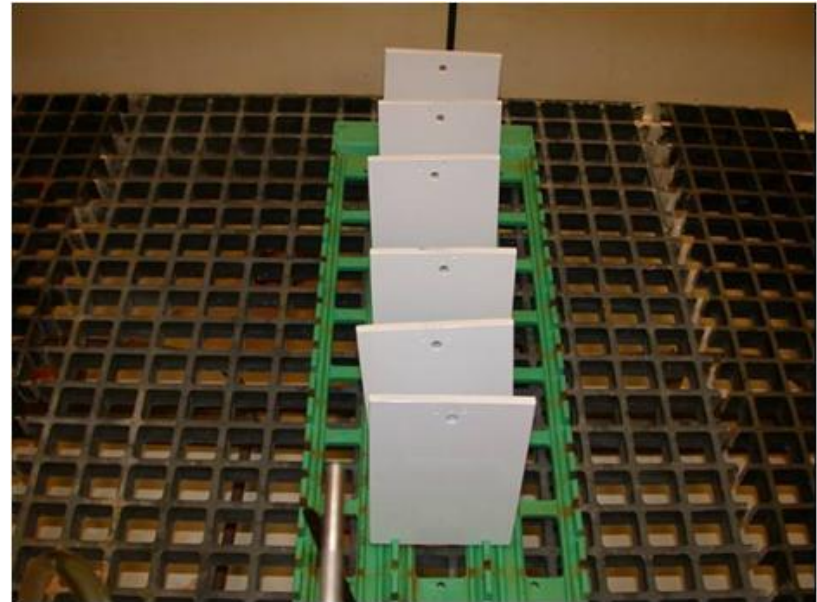
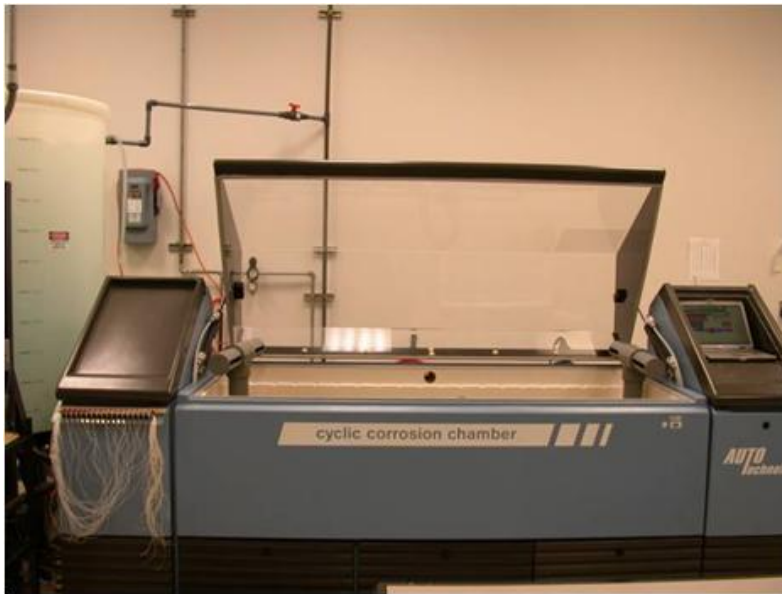
# Testing Activities (cont.)

- Gravelometer Testing per ASTM D3170
  - Standard size gravel (i.e. approximately 3/8”–5/8” diameter) at a 45° angle of impact
  - Panels gravelometered before and after exposure to corrosive environments and fluid resistance tests



# Testing Activities (cont.)

- SAE J2334 Cyclic Corrosion Test - 120 cycles (120 days)
- ASTM B117 Salt Spray Fog Test – 2,000 hours



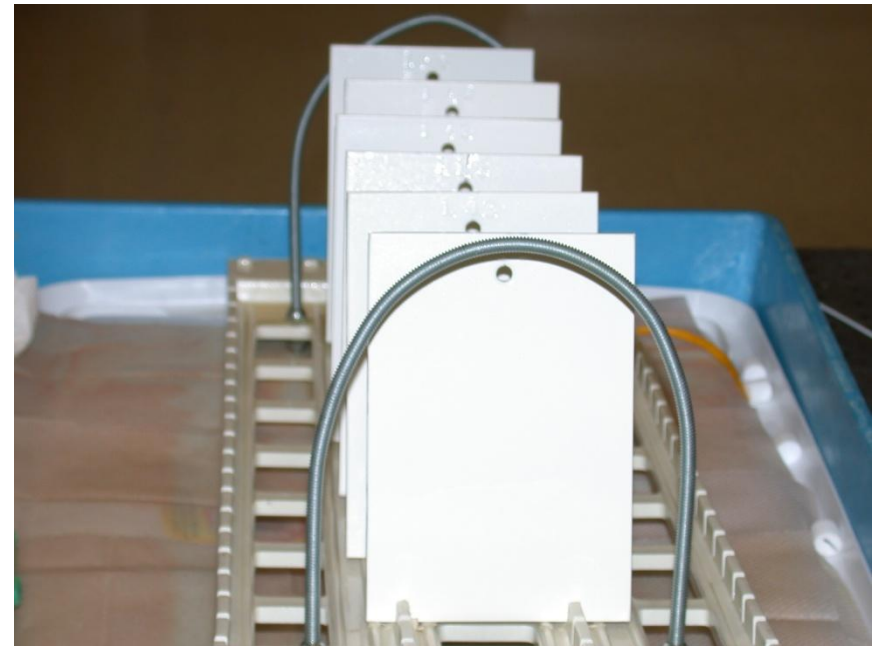
# Testing Activities (cont.)

- ASTM G155 Weatherometer Test – 1,000 hours



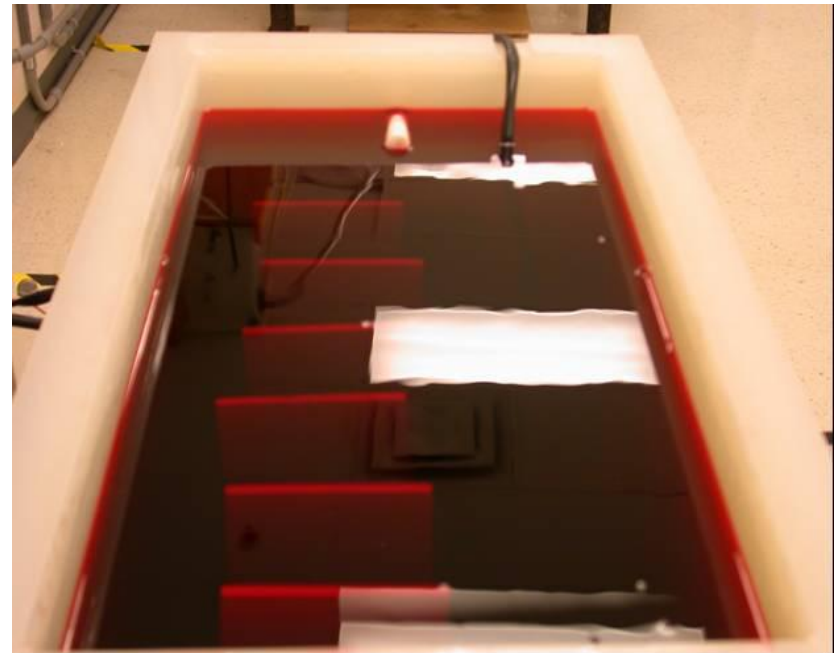
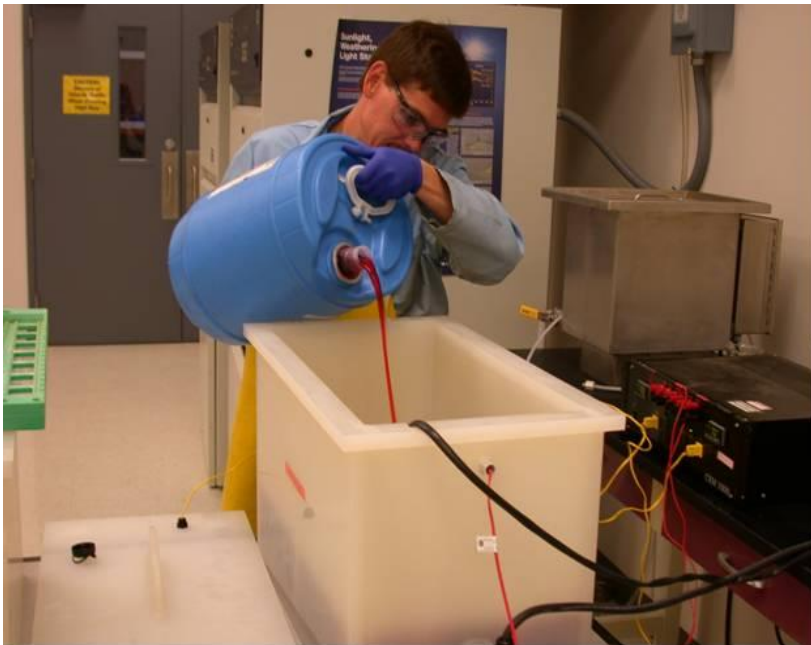
# Testing Activities (cont.)

- Lubricating Oil – Royco 899
  - 24 hours at  $121^{\circ}\text{C} \pm 3^{\circ}\text{C}$  ( $250^{\circ}\text{F} \pm 5^{\circ}\text{F}$ )



# Testing Activities (cont.)

- Hydraulic Fluid – Royco 782
  - 24 hours at  $66^{\circ}\text{C} \pm 3^{\circ}\text{C}$  ( $151^{\circ}\text{F} \pm 5^{\circ}\text{F}$ )



# Testing Activities (cont.)

- JP-5 Jet Fuel
  - 7 days at room temperature



# Results

## ■ Coating Evaluation

- SAE J400, Chip Rating System


Rating Number	Number of Chips	Rating Number	Number of Chips
10	0	4	50-74
9	1	3	75-99
8	2-4	2	100-149
7	5-9	1	150-250
6	10-24	0	>250
5	25-49		

Rating Letter	Size of Chips
A	< 1 mm (<approximately 0.03 in)
B	1-3 mm (approximately 0.03 – 0.12 in)
C	3-6 mm (approximately 0.12 – 0.25 in)
D	> 6 mm (>approximately 0.25 in)

# Results (cont.)

## ■ Example Chip Rating: Initial Gravelometer Test

Panel Coating/Panel #	Damaged Area, %	Chip Rating
Powder Coat, 102	0.61	2A-5B-10C-10D
Powder Coat, 104	0.56	2A-6B-10C-10D
Powder Coat, 108	0.74	2A-5B-10C-10D
Powder Coat, 114	0.71	1A-5B-10C-10D
Avg.	0.65	
Liquid Coating, 127	1.15	1A-4B-10C-10D
Liquid Coating, 128	1.04	1A-5B-10C-10D
Liquid Coating, 129	1.42	1A-4B-10C-10D
Liquid Coating, 130	1.28	1A-4B-10C-10D
Avg.	1.22	

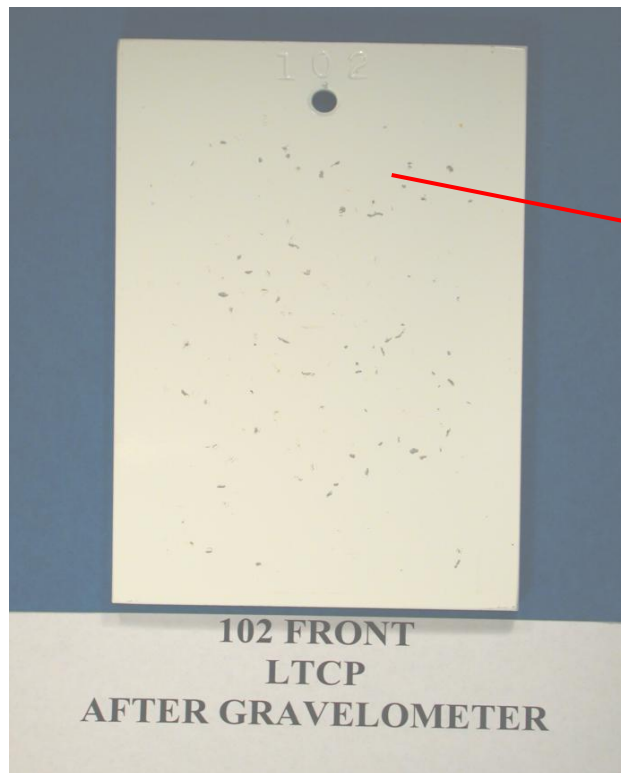


2A	100 -149 Chips	< 1 mm
5B	25-49 Chips	1-3 mm
10C	0 - Chips	3-6 mm
10D	0 - Chips	> 6 mm

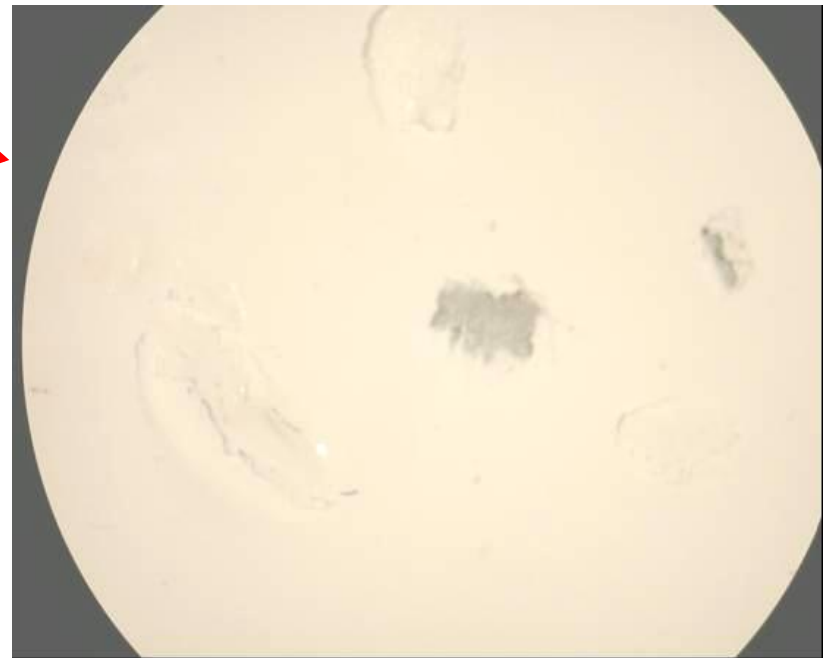
## Results (cont.)

### ■ Initial Gravelometer Test

- Notice deformation/divots on the powder coated panel
- Coating damaged but adheres to substrate



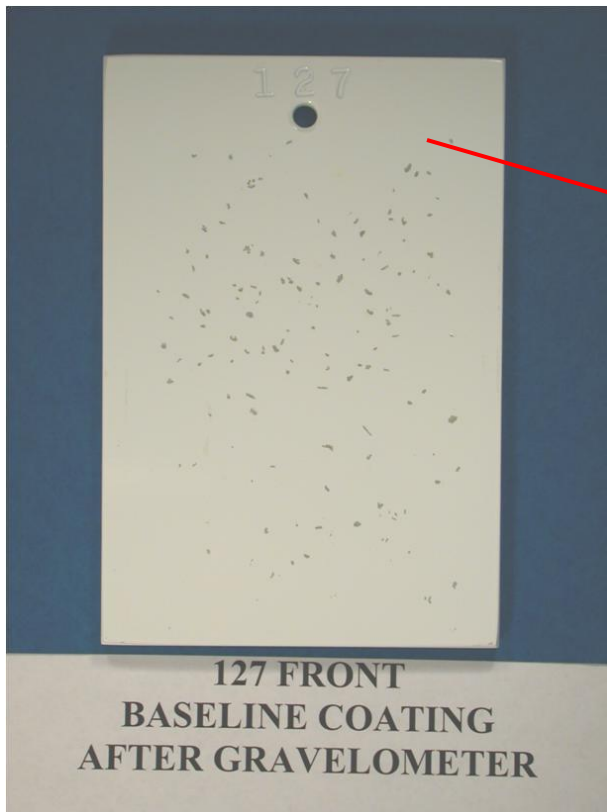
LTCP panel (10x)



## Results (cont.)

### ■ Initial Gravelometer Test

- Notice chipping on the liquid coated panel
- Coating damaged, chips do not adhere to substrate



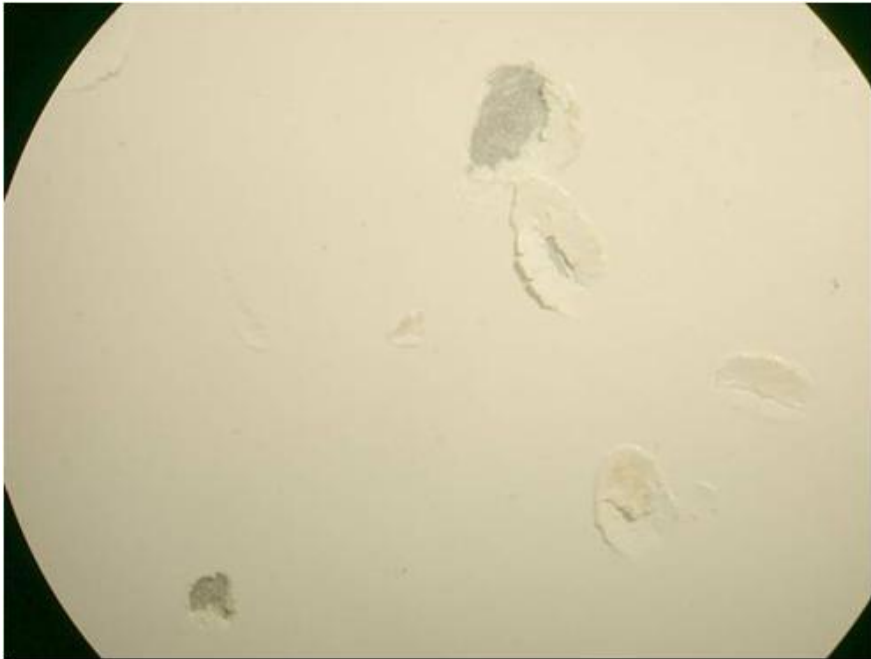
Liquid coated panel (10x)



## Results (cont.)

- Panels after 1,000 hours exposure in the Weatherometer and subsequent gravelometer treatment

LTCPC panel (10x)



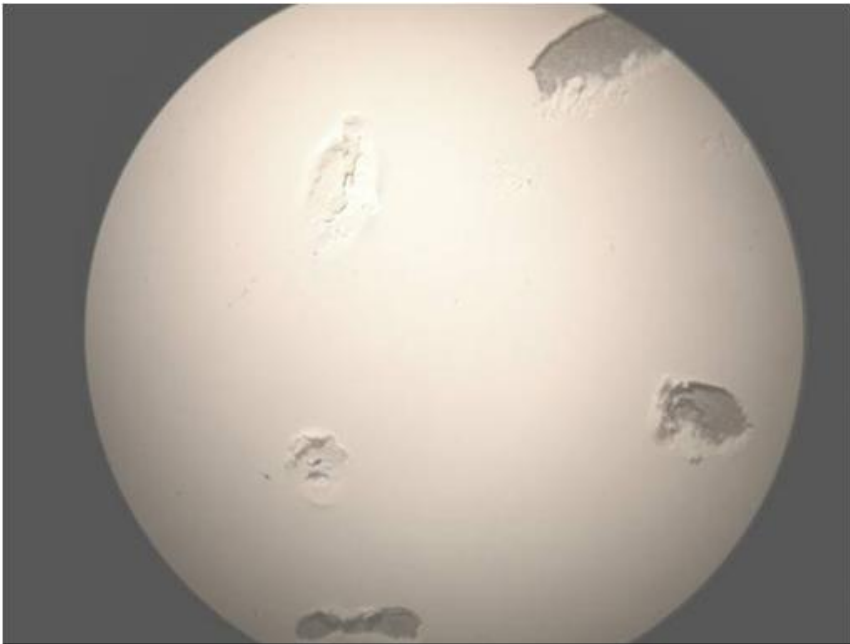
Liquid coated panel (10x)



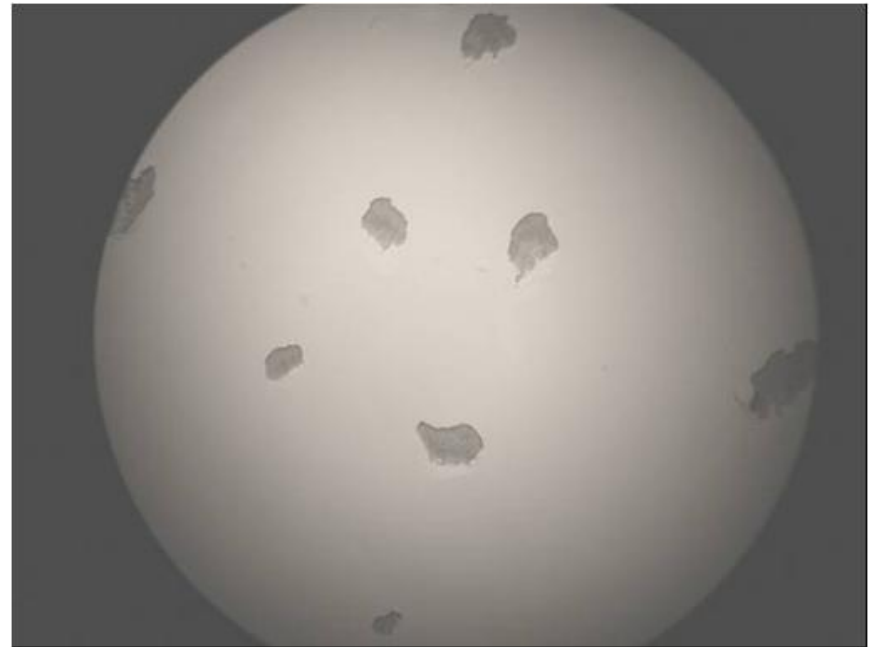
## Results (cont.)

- Panels after 24 hours immersion in JP-5 jet fuel and subsequent gravelometer treatment

LTCPC panel (10x)

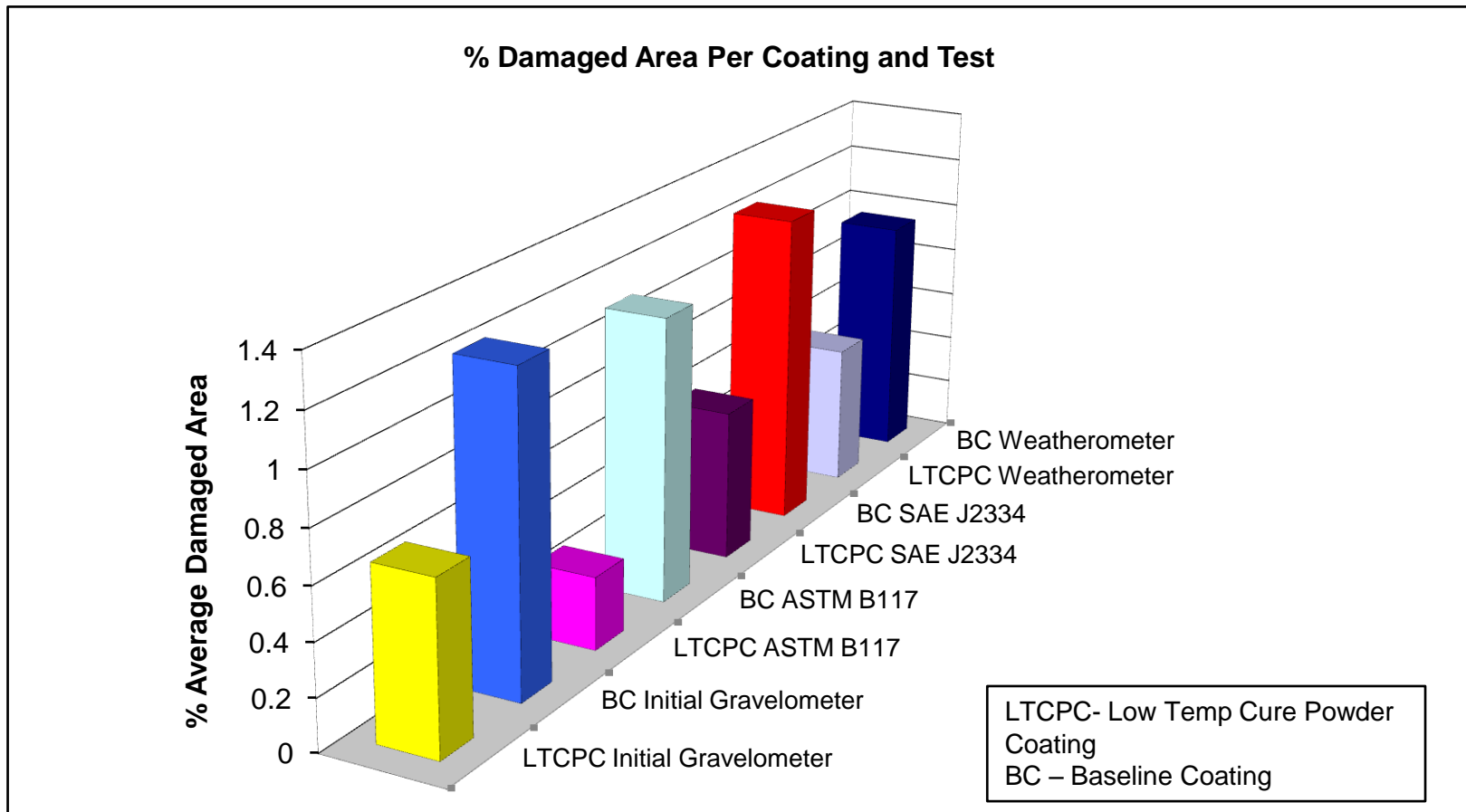


Liquid coated panel (10x)



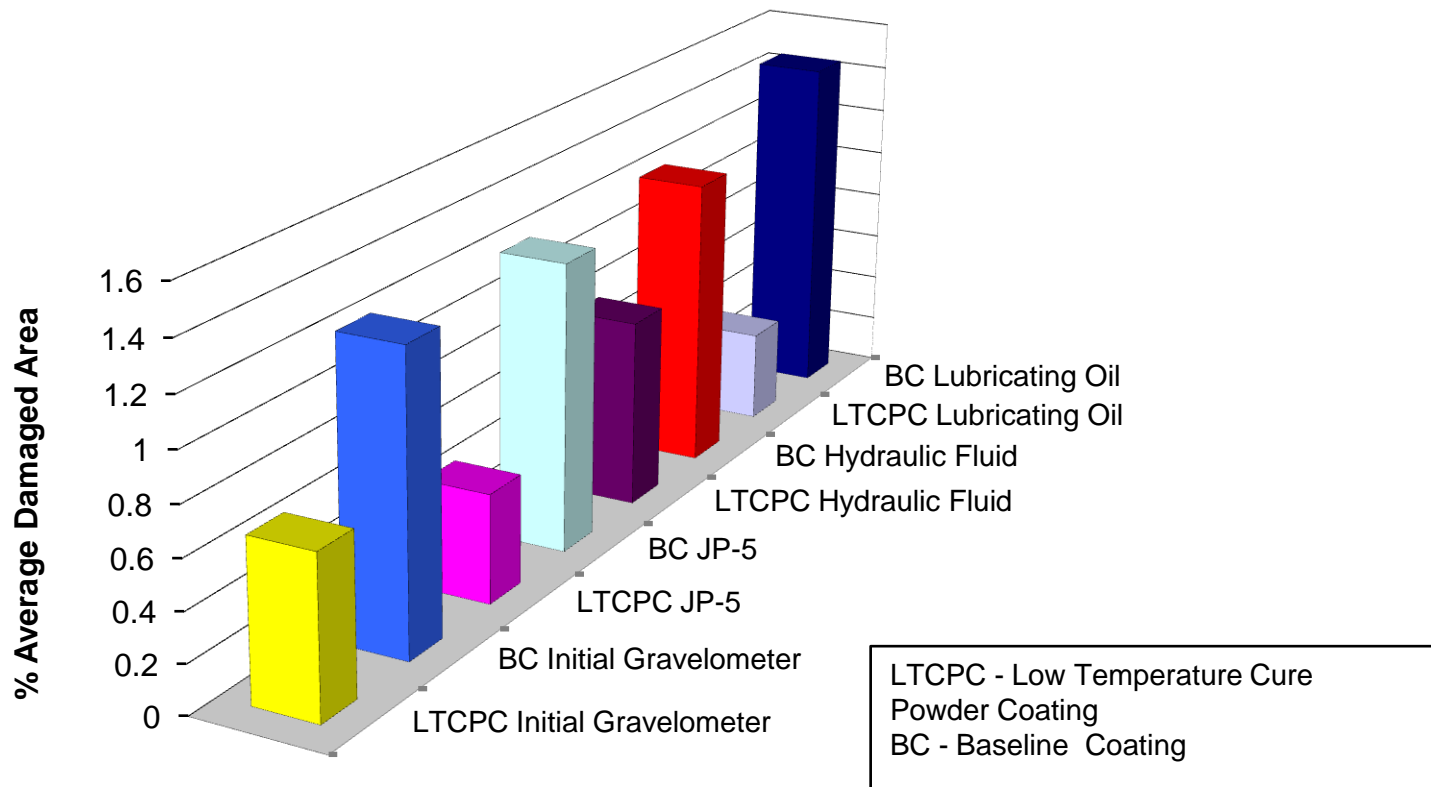
# Results (cont.)

## ■ Percent Damaged Area per SAE J400



# Results (cont.)

% Damaged Area Per Coating and Test



# Cost Benefit Analysis

## ■ Cost Summary Table

	Baseline (current process)	Alternative 1 (low eqpt cost)	Alternative 2 (high eqpt cost)
<b>Capital Costs</b>			
Labor	\$0	\$9,600	\$9,600
Materials	\$0	\$0	\$0
Equipment	\$0	\$149,803 <sup>a</sup>	\$349,803 <sup>b</sup>
Utilities	\$0	\$0	\$0
EHS	\$0	\$0	\$0
Other	\$0	\$0	\$0
<b>Subtotal</b>	<b>\$0</b>	<b>\$159,403</b>	<b>\$359,403</b>
<b>O&amp;M Costs</b>			
Labor	\$918,905/yr	\$712,604/yr	\$712,604/yr
Materials	\$24,626/yr	\$8,601/yr	\$8,601/yr
Equipment	\$0/yr	\$10,486/yr	\$10,486/yr
Utilities	\$0/yr	\$38,155/yr	\$38,155/yr
EHS	\$13,054/yr	\$13,343/yr	\$13,343/yr
Other	\$0/yr	\$0/yr	\$0/yr
<b>Subtotal</b>	<b>\$956,585/yr</b>	<b>\$783,190/yr</b>	<b>\$783,190/yr</b>

a. Alternative 1 assumes equipment costs are low (excludes design, procurement, installation costs)

b. Alternative 2 assumes equipment costs are high (includes design, procurement, installation costs)

# Cost Benefit Analysis (cont.)

## ■ Financial Indicators

Financial Indicator	Alternative 1 (low equipment cost assumed)			Alternative 2 (high equipment cost assumed)		
	5-year	10-year	15-year	5-year	10-year	15-year
Net Present Value of Savings	\$641,544	\$1,342,598	\$1,956,218	\$436,968	\$1,127,270	\$1,725,629
Incremental Rate of Return	106%	109%	109%	39%	47%	48%
Discounted Payback Period	0.9 years			2.1 years		

Calculations based on OMB Circular A-94 real interest rate of 2.7% for 15-year study period (revised January 2008)

# Conclusions

- LTCPC product performs equal to or better than the baseline coating:
  - Increased Gravelometer impact resistance over the baseline coating
  - Comparable resistance to JP-5 jet fuel, hydraulic fluid, and turbine engine oil
  - Comparable corrosion resistance
  - Shorter curing time
  - Favorable financial indicators suggest a positive cost benefit

# Recommended Activities

- Full-scale, life cycle testing of LTCPC should be evaluated on actual military components (e.g., F/A-18 aircraft landing gear, ground support equipment)
- Based on results to date, FRC Southeast should proceed with plans to procure a powder coating booth and other equipment needed to implement LTCPC on components
- Use of low temperature cure powder coat on FRC Southeast parts manufactured from other substrates (e.g., steel) should be evaluated

# Points of Contact

Mr. Howard Weinick, Technical Lead  
NDCEE-CTC  
(727) 549-7221  
[weinickh@ctc.com](mailto:weinickh@ctc.com)

Mr. Brian Yallaly, Technical Assistant  
NDCEE-CTC  
(904) 486-4007  
[yallalb@ctc.com](mailto:yallalb@ctc.com)

Mr. Hany Zaghloul, Government Technical Monitor  
ERDC-CERL  
(217) 373-3433  
[Hany.H.Zaghloul@erdc.usace.army.mil](mailto:Hany.H.Zaghloul@erdc.usace.army.mil)

*This work was funded through the Office of the Assistant Secretary of the Army (Installations and Environment) and conducted under contract W74V8H-04-D-0005 Task 427.*

*DISCLAIMER: The contents of this document are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products. All product names and trademarks cited are the property of their respective owners. The views, opinions, and/or findings contained in this presentation are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision unless so designated by other official documentation.*