Next Generation Coatings
presented to
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### Title
Next Generation Coatings presented to US Army Corrosion Summit

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### Abstract
2009 U.S. Army Corrosion Summit, 3-5 Feb, Clearwater Beach, FL
A Historical Perspective on Metal Pretreatment

1900

1906, 1st FePO₄
T. Coslett

1910 Zinc Phosphate Introduction

1943 Introduction of Jernstadt “Salt”

1950

1998 First Work on Next Generation Coatings

1986 Tri-Cationic Zinc Phosphate Today’s Standard

2000

2001 Replacement for Iron Phosphate Begins

2002 Replacement for Zinc Phosphate Begins
Historical Perspective of Metal Pretreatment

December 2006
1st OEM trial to replace Zinc Phosphate

November, 2007
1st N. American OEM Conversion

February 2008
1st S. American OEM Conversion

March 2007
2nd OEM Trial

January 2007
1st Auto Parts Conversion

4 Qtr 2008 - 2009
Global Roll Outs Automotive

2005 2006 2007 2008 2009
Why the trend to Change? Significantly Strong Headwinds

Headwinds
- Raw material price volatility
- Increased logistics and transportation costs
- Increased Energy costs
- Credit crunch
- Increased inflation
- Consumer Confidence Index 5-year low
- Environmental Impact

Source: A.T. Kearney
New Generation Coatings

Objective: Eliminate conventional iron and zinc pretreatment systems

**Features:**
- Phosphate-free
- Zirconium is not a regulated metal
- Operates at ambient temperature
- Generates very little sludge

**Benefits:**
- Comply with ever-tightening municipality restrictions
- Minimize waste treatment costs; eliminate need for sludge hauling and clean-outs
- Significantly reduce energy costs
- Lowers operating costs and improves reject rates

- New Generation Coatings are a reactive, rinsable pretreatment that can be used on steel, zinc, and aluminum surfaces.
- New Generation Coatings offer the adhesion and corrosion protection on painted metal surfaces
New Generation Coatings Achieved Pretreatment Goals

Process Cost
- Shorten Line
- Reduce Water Usage
- Reduce Energy Consumption

Environment
- Eliminate Phosphate
- Significant Sludge Reduction
- Reduce Heavy Metals

Performance
- Meet Customer Specifications
Zinc Phosphate Solution
~50% Efficient in the use of Zn

H₂ZrF₆

Zn(H₂PO₄)₂ → Zn₃(PO₄)₂ + FePO₄

Solid by-products
Solid Waste!

NGC Solution
~99% Efficient in the use of the bath

Zn⁺² + F⁻

H₂ZrF₆

Soluble by-products
No Solid Waste
New Generation Coatings Properties

- Substrate Electrogalvanized
- Conversion coating thickness: 30 to 50 nm
- Zirconium as oxide/hydroxide is main deposit, with additives and ions from the substrate

Conversion Coating
Substrate

X-ray Photoelectron Spectroscopy (XPS)
**New Generation Coatings Properties**

- **Zinc Phosphating**
  - Coating Weight: 1 - 4 g/m²
  - Thickness: ~ 600 mg/m²

- **Iron Phosphating**
  - Coating Weight: ~ 600 mg/m²

- **Chromating**
  - Coating Weight: ~ 20 - 300 mg/m²

- **New Generation Ctg.**
  - Coating Weight: 20 - 300 mg/m²
### Traditional Vs Next Generation Coating and Operational Comparison

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Iron Phosphate</th>
<th>Zinc Phosphate</th>
<th>Next Generation Coatings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. pH</strong></td>
<td>4.5 - 5.5</td>
<td>2.8 - 3.5</td>
<td>3.5 – 6.0</td>
</tr>
<tr>
<td><strong>2. Composition</strong></td>
<td>Iron oxide/ phosphate</td>
<td>Phosphate of Zn, Fe, Mn, Ni, Co</td>
<td>Nanostructured particles, Ti, V, Zr, Silanes, polymers, or combinations</td>
</tr>
<tr>
<td><strong>3. Coating weight (g/m²)</strong></td>
<td>0.20 – 0.90</td>
<td>1.5 – 4.0</td>
<td>0.06 – 0.10</td>
</tr>
<tr>
<td><strong>4. Temperature (°F)</strong></td>
<td>100 - 140</td>
<td>105 - 135</td>
<td>Ambient</td>
</tr>
<tr>
<td><strong>5. Conditioning step</strong></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>6. Sludge</strong></td>
<td>Moderate</td>
<td>High</td>
<td>Very minimal</td>
</tr>
<tr>
<td><strong>7. Accelerator impact</strong></td>
<td>Increase CW</td>
<td>Decrease CW</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>8. Post treatment</strong></td>
<td>Very important</td>
<td>Optional</td>
<td>Not necessary</td>
</tr>
<tr>
<td><strong>9. Corrosion protection</strong></td>
<td>Worse than Zn₃(PO₄)₂</td>
<td>Standard for High Quality</td>
<td>Meet Performance Specifications</td>
</tr>
</tbody>
</table>

US Army Corrosion Summit 2009
### Next Generation Coatings

**Performance on Various Paint Systems**

#### 504 hr Neutral Salt Spray

<table>
<thead>
<tr>
<th>Paint System</th>
<th>Corrosion Resistance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyester Powder</td>
<td>0.3 mm</td>
</tr>
<tr>
<td>Cathodic E-Coat</td>
<td>0.2 mm</td>
</tr>
<tr>
<td>Epoxy Ester Powder</td>
<td>2.3 mm</td>
</tr>
<tr>
<td>Urethane Ester Powder</td>
<td>3.9 mm</td>
</tr>
<tr>
<td>Polyester Powder</td>
<td>2.2 mm</td>
</tr>
<tr>
<td>Polyester Powder</td>
<td>2.4 mm</td>
</tr>
<tr>
<td>Polyester Powder</td>
<td>2.8 mm</td>
</tr>
<tr>
<td>Acrylic High Solids</td>
<td>2.3 mm</td>
</tr>
</tbody>
</table>

![Paint Samples](image)
**New Generation Coatings Performance To-Date**

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Iron Phosphate</th>
<th>Bi-cationic ((\text{Zn}_3\text{P}_4)_2)</th>
<th>Tri-cationic ((\text{Zn}_3\text{P}_4)_2)</th>
<th>New Conversion Coatings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al</td>
<td>n/a</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>EG</td>
<td>3</td>
<td>8</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>HDG</td>
<td>3</td>
<td>6</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Galvannealed</td>
<td>3</td>
<td>8</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>CRS</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>7</td>
</tr>
</tbody>
</table>

**Ranking:** 1 = very poor, 3 = poor, 5 = acceptable, 8 = good, 10 = excellent  
All applications are done **wet-in-wet** using a standard automotive e-coat  
Test results are based upon GM 9540P, APGE, VDA, CCT, CASS, NSS, and EFC Test.
Potential Process Layout

Traditional Iron Phosphate Process

- Cleaning
- Rinse
- Phosphate
- Rinse
- Post Rinse
- DI Rinse

Next Generation Process

- Cleaning
- Rinse
- Next Generation
- DI Rinse
- Optional Rinses

Potential Savings: Energy, Water, Waste Treatment

Unheated Stage

Heated Stage
New Generation Coating

Greenfield Process Layout Option

Zinc Phosphating Process

1. Deluge or Hot Water
2. Cleaning
3. Water Rinses
4. Surface Conditioner
5. Zinc Phosphate
6. Water Rinses
7. Post Rinse
8. DI Water Rinses
9. Recirc./Fresh

Water Rinses TecTalis

New Generation Coating Process

1. Deluge or Hot Water
2. Cleaning
3. Water Rinses
4. TecTalis
5. Amb
6. DI Water Rinses
7. Recirc./Fresh
8. 600 feet

800 feet
New Conversion Coatings Potential Cost Savings

1. Energy Savings
   - Reduction in the number of heated stages

2. Water Savings
   - Reduction in number of stages, reduced water requirements

3. Man Power – Labor and Maintenance costs
   - Reduction in sludge generation
   - Reduction of waste disposal costs
   - Less Clean-outs of the system

4. Reduction in Floor Space – Greenfield Construction
   - Reduction in number of stages
Next Generation Coatings

Industries Served

- Appliance
- Manufacturing Jobbers
- Office Furniture
- Electrical Equipment
- Maintenance Equipment
- Heating & Cooling
- Agricultural Equipment
- General Manufacturing
- Automotive Assembly
- Automotive Components
New Generation Coatings
Military Specification MIL-Std-171

Current Approved under MIL-Std-171
5.1 - Phosphate Paint Base Coatings
  5.1.1 Zinc Phosphate base – TTC 490 Type I, Spray and Immersion
  5.1.2 Iron Phosphate base – TTC 490, type II or IV
  5.2 Pretreatment coating, TTC 490, type III (wash primer)
  5.3 Heavy Phosphate Coatings
  5.3.1 Manganese Phosphate base, DOD-P-16232, type M.

Proposed under MIL-Std-171
5.1 - Phosphate Paint Base Coatings
  5.1.1 Zinc Phosphate base – TTC 490 Type I, Spray and Immersion
  5.1.2 Iron Phosphate base – TTC 490, type II or IV
  5.1.3 Heavy Zinc base – TTC 490, type V
  5.1.4 New Generation Coatings (Nano), TTC 490, type IV
  5.2 Pretreatment coating, TTC 490, type III (wash primer)
  5.3 Heavy Phosphate Coatings
What is the requirement (callout) on the drawings?

3.2.1 Submit proposed written procedure per contract. Type I and V

3.2.2 Submit test panels processed to the proposed procedure

1. Define the process change with the new coating complete with process controls.

2. Rewrite written procedure an process panels to the revision

3. Test New System – 3 sets of 3 panels per set

   1. Pretreatment for visual appearance

   2. Pretreatment/primer panels check film thickness and Salt Spray

   3. Pretreatment, primer and topcoat.

4. Submit written procedure/panels to contracting officer for approval.
Next Generation Coatings

Benefits Summary

• No heat required – *cuts energy costs!*
• Significantly reduce inner-stage rusting - *improve adhesion & reduce reject rates!*
• Less reaction with metal surface - *generate very little sludge!*
• Shorter treatment time – *increase production throughput!*
• No post treatment required – *decrease chemical handling & costs!*
• No hazardous waste disposal – *reduce labor / chemical costs!*
• Performance – *Meeting Industry Specifications!*
Thank You