# *Next Generation Coatings presented to US Army Corrosion Summit February 4, 2009*

Henkel

Adhesive Technologies

US Army Corrosion Summit 2009

Terrence R. Giles
Business Development Mgr
Henkel Adhesive Technologies

# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **04 FEB 2009** | | **00-00-2009 to 00-00-2009** |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **Next Generation Coatings presented to US Army Corrosion Summit** | 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) **Henkel Adhesive Technologies,Dusseldorf, Germany ,** | 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
**Approved for public release; distribution unlimited**

13. SUPPLEMENTARY NOTES
**2009 U.S. Army Corrosion Summit, 3-5 Feb, Clearwater Beach, FL**

14. ABSTRACT

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT **unclassified** | b. ABSTRACT **unclassified** | c. THIS PAGE **unclassified** | **Same as Report (SAR)** | **20** | |

# A Historical Perspective on Metal Pretreatment

US Army Corrosion Summit 2009

1906, 1st $FePO_4$ T. Coslett

1910 Zinc Phosphate Introduction

1943 Introduction of Jernstadt "Salt"

1986 Tri-Cationic Zinc Phosphate Today's Standard

1998 First Work on Next Generation Coatings

2002 Replacement for Zinc Phosphate Begins

2001 Replacement for Iron Phosphate Begins

1900 1950 2000

# Historical Perspective of Metal Pretreatment

US Army Corrosion Summit 2009

December 2006
1st OEM trial to replace Zinc Phosphate

November, 2007
1st N. American OEM Conversion

4 Qtr 2008 - 2009
Global Roll Outs Automotive

2005 2006 2007 2008 2009

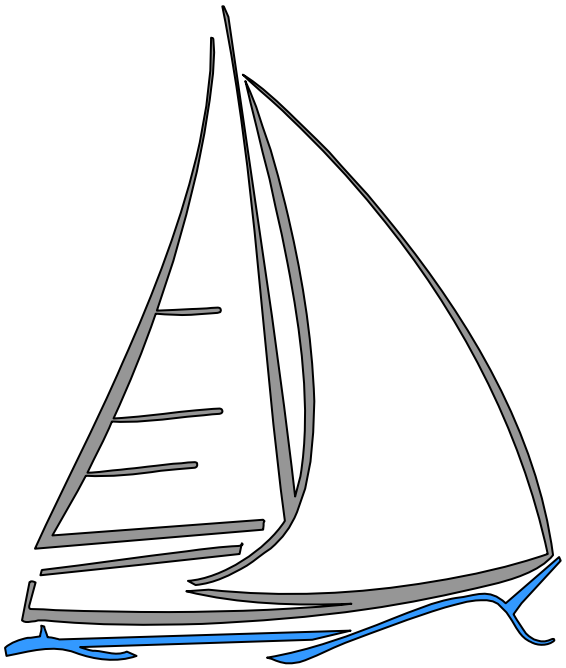
January 2007
1st Auto Parts Conversion

March 2007
2nd OEM Trial

February 2008
1st S. American OEM Conversion

# Why the trend to Change?
# Significantly Strong Headwinds

US Army Corrosion Summit 2009



**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**

US Army Corrosion Summit 2009

***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

US Army Corrosion Summit 2009

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

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

**Performance**
- Meet Customer Specifications

# Research & Development

## Reaction Chemistry

US Army Corrosion Summit 2009

**Zinc Phosphate Solution**
**~50% Efficient in the use of Zn**

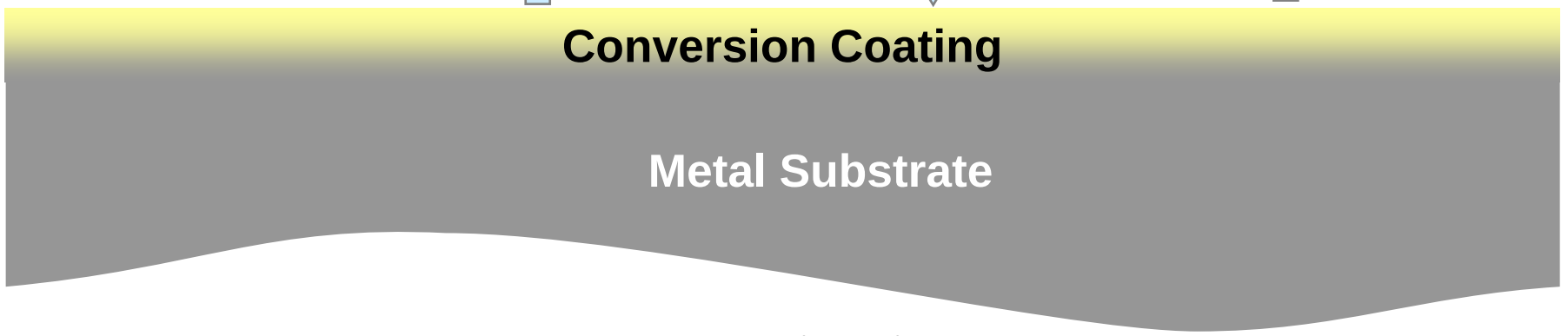
**Solid by-products**
Solid Waste!

$Zn(H_2PO_4)_2$ $Zn_3(PO_4)_2 + FePO_4$

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

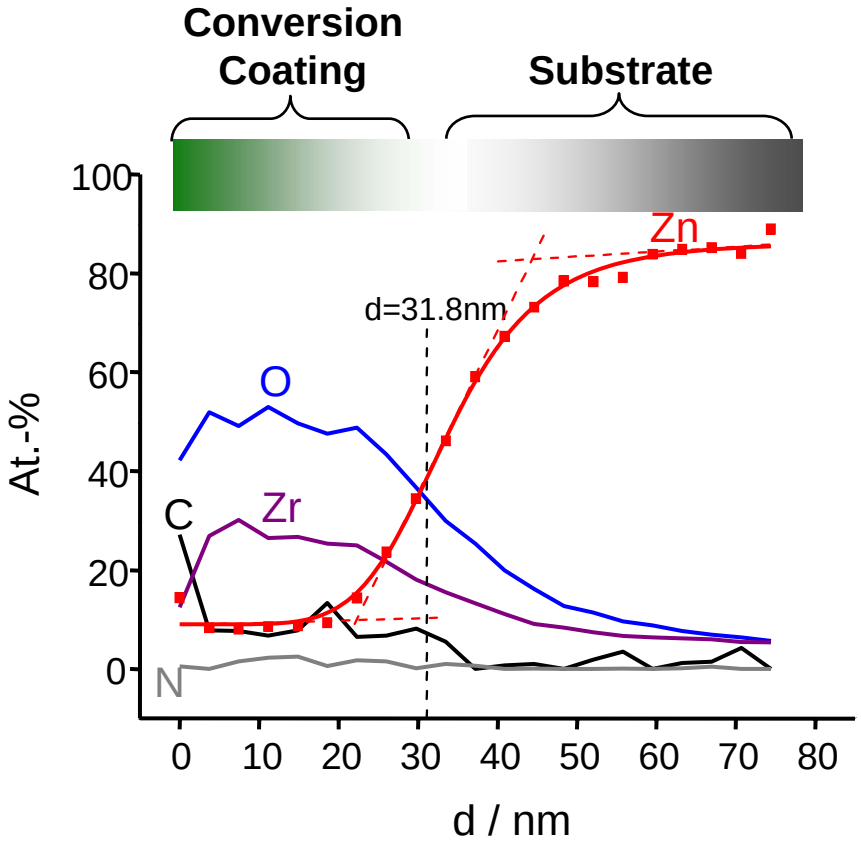
**Soluble by-products**
No Solid Waste

$H_2ZrF_6$ $Zn^{+2} + F^-$

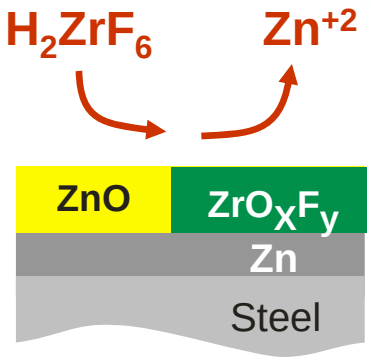


# New Generation Coatings Properties

US Army Corrosion Summit 2009



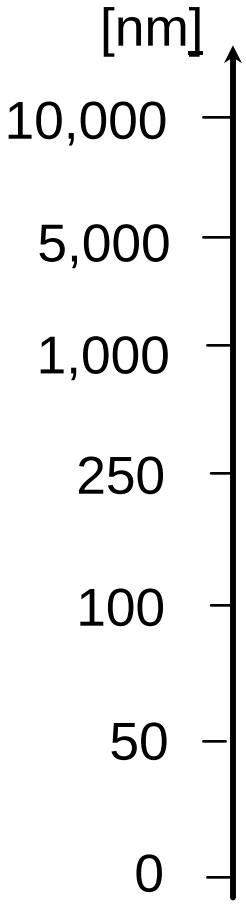

X-ray Photoelectron Spectroscopy (XPS)




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

# New Generation Coatings Properties

US Army Corrosion Summit 2009



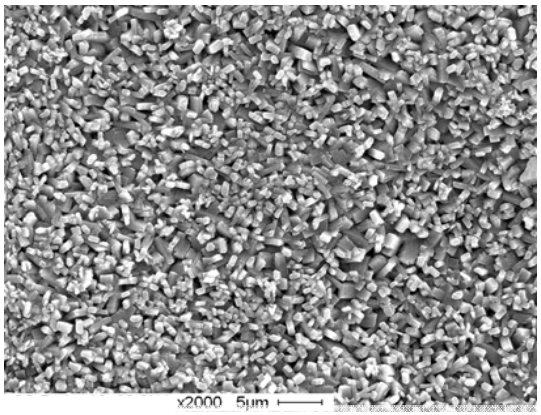

Zinc Phosphating — **1 - 4 g/m²**

Iron Phosphating — **~ 600 mg/m²**

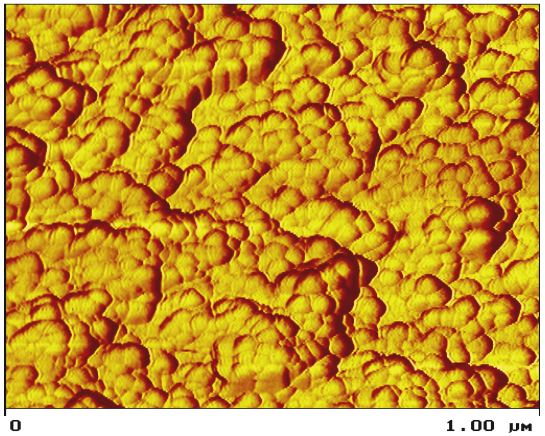
Chromating

**New Generation Ctg.** — **20 - 300 mg/m²**

**Coating Weight**




**SEM - Zinc Phosphate**




**AFM – New Generation Ctg.**

# Traditional Vs Next Generation Coating and Operational Comparison

US Army Corrosion Summit 2009

| Characteristic | Iron Phosphate | Zinc Phosphate | Next Generation Coatings |
|---|---|---|---|
| 1. pH | 4.5 - 5.5 | 2.8 - 3.5 | 3.5 – 6.0 |
| 2. Composition | Iron oxide/ phosphate | Phosphate of Zn, Fe, Mn, Ni, Co | Nanostructured particles, Ti, V, Zr, Silanes, polymers, or combinations |
| 3. Coating weight ($g/m^2$) | 0.20 – 0.90 | 1.5 – 4.0 | 0.06 – 0.10 |
| 4. Temperature (°F) | 100 - 140 | 105 - 135 | Ambient |
| 5. Conditioning step | No | Yes | No |
| 6. Sludge | Moderate | High | Very minimal |
| 7. Accelerator impact | Increase CW | Decrease CW | N/A |
| 8. Post treatment | Very important | Optional | Not necessary |
| 9. Corrosion protection | Worse than $Zn_3(PO_4)_2$ | Standard for High Quality | Meet Performance Specifications |

# Next Generation Coatings

## Performance on Various Paint Systems

US Army Corrosion Summit 2009

### 504 hr Neutral Salt Spray

| Polyester Powder | | Cathodic E-Coat | Epoxy Ester Powder | Urethane Ester Powder | Polyester Powder | Polyester Powder | Acrylic High Solids |
|---|---|---|---|---|---|---|---|
| 0.3 mm | 0.2 mm | 2.3 mm | 3.9 mm | 2.2 mm | 2.4 mm | 2.8 mm | 2.3 mm |

# New Generation Coatings Performance To-Date

US Army Corrosion Summit 2009

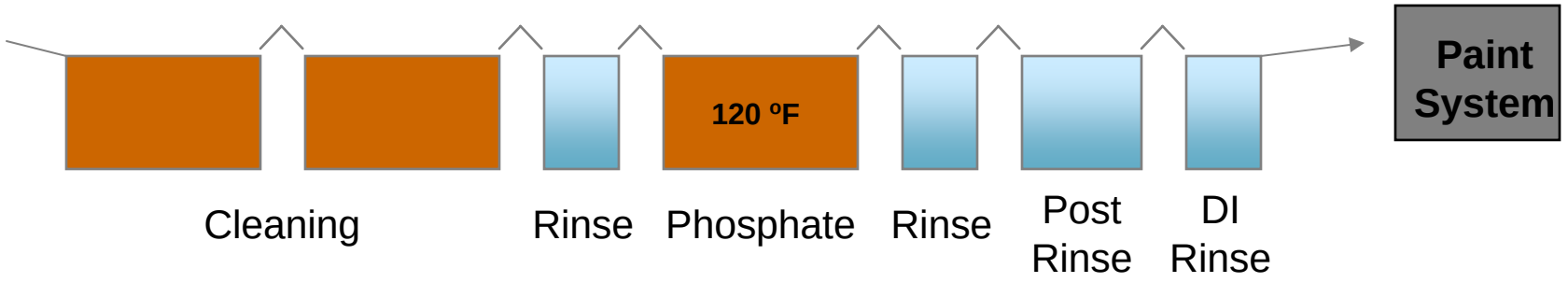
| Substrate | Process: Iron Phosphate | Process: Bi-cationic ($Zn_3(P0_4)_2$) | Process: Tri-cationic ($Zn_3(P0_4)_2$) | Process: New Conversion Coatings |
|---|---|---|---|---|
| Al | n/a | 8 | 9 | 10 |
| EG | 3 | 8 | 10 | 9 |
| HDG | 3 | 6 | 10 | 8 |
| Galvannealed | 3 | 8 | 10 | 9 |
| CRS | 1 | 5 | 10 | 7 |

**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 FFC Test.

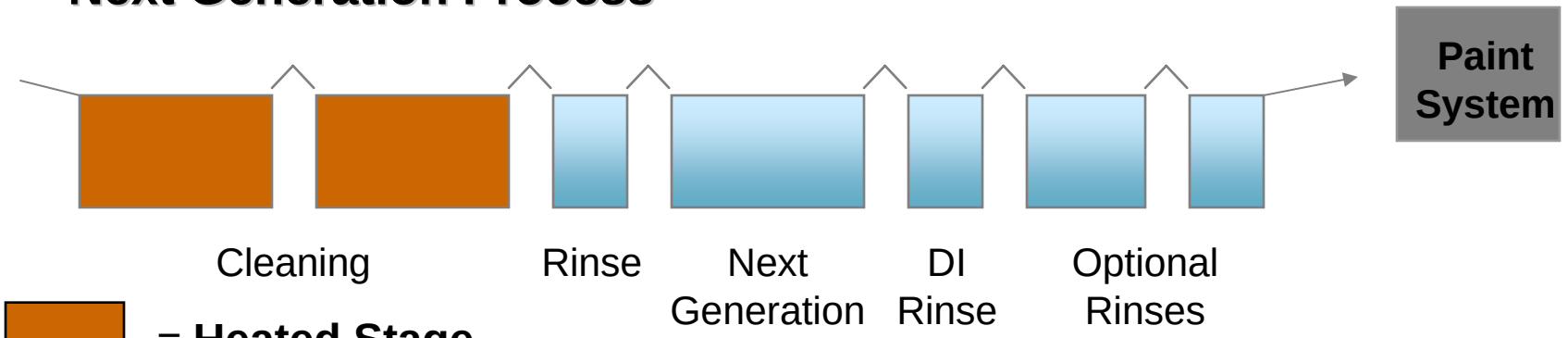
# Potential Process Layout

US Army Corrosion Summit 2009

## Traditional Iron Phosphate Process




## Next Generation Process




= **Heated Stage**

= **Unheated Stage**

**Potential Savings: Energy**

**Water**

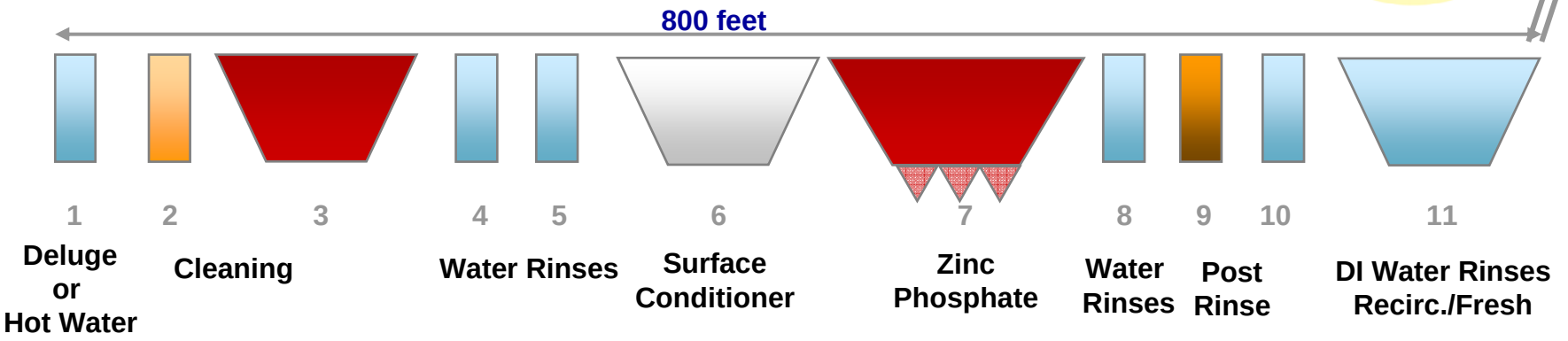
**Waste Treatment**

# New Generation Coating

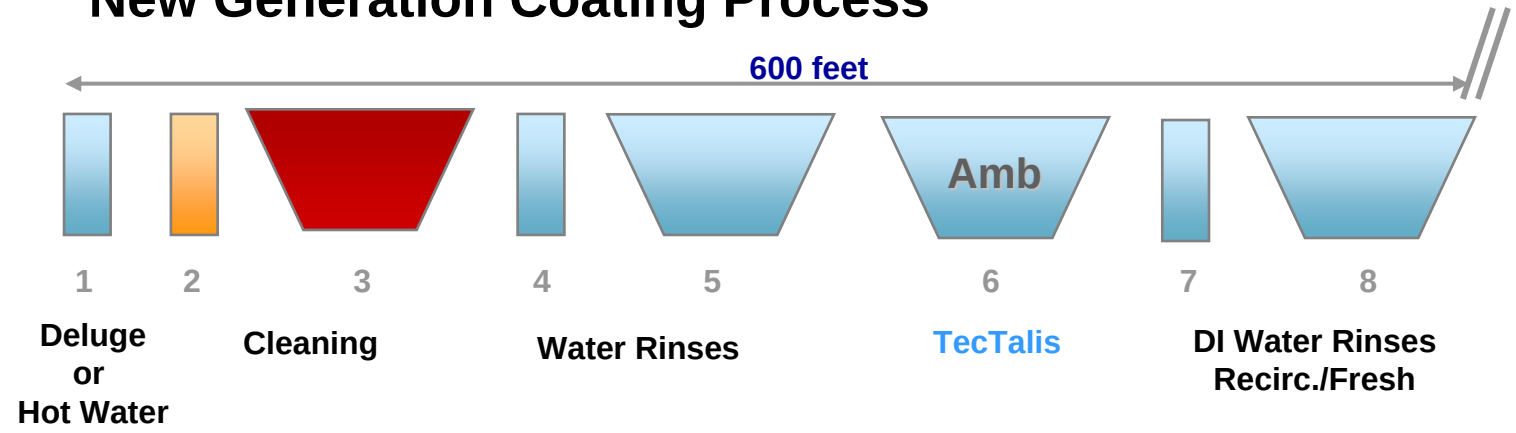
*Greenfield Process Layout Option*

US Army Corrosion Summit 2009

## Zinc Phosphating Process




## New Generation Coating Process



# New Conversion Coatings Potential Cost Savings

US Army Corrosion Summit 2009

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

US Army
Corrosion Summit
2009

- 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

US Army Corrosion Summit 2009

### 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

# New Generation Coatings

## use under TTC 490 Proposed Changes

US Army Corrosion Summit 2009

**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

US Army Corrosion Summit 2009

- 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!*

Henkel

Adhesive Technologies

US Army Corrosion Summit 2009

# Thank You