



# OEM Unqualified Coatings Testing

Washington D.C. / Rockville  
April 12-13, 2005

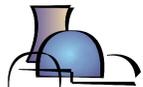
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*704 547-6058*



**EPRI**

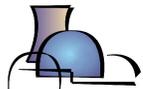
# Background

- The US Nuclear Regulatory Commission currently holds the position that 100% of DBA unqualified coatings in PWR containments will fail during a loss of coolant accident (LOCA) and thus be available for transport to the Emergency Core Cooling Systems' (ECCS) sump.
- The objective of this EPRI/NUCC project is to obtain real data concerning the performance of OEM coatings under DBA conditions.
- Typical OEM Components
  - electrical cabinets / junction boxes
  - small cranes
  - RCP (and other) motors
  - pipe support components



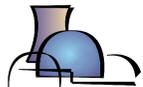
## OEM Coatings

- Many OEM coatings are applied by production line, automated processes (such as electrostatic spray) in a repetitive fashion.
- The generic type of OEM coating on a particular power plant component (such as an electrical junction box) varies little from vendor to vendor.
- Most (if not all) OEM coatings are unqualified



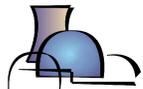
# Tasks Performed in Phase 1

- Conducted an industry wide survey.
- Obtained “Unqualified Coating Lists” from 27 PWR plants. Most common OEM unqualified coating types:
  - Alkyd (25 plants)
  - Epoxy (10 plants)
  - Acrylics (6 plants)
  - High temperature aluminum (5 plants)
  - Inorganic zinc primer and/or epoxy phenolic topcoat (4 plants)
  - Polyester enamel (4 plants)



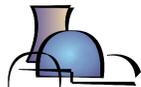
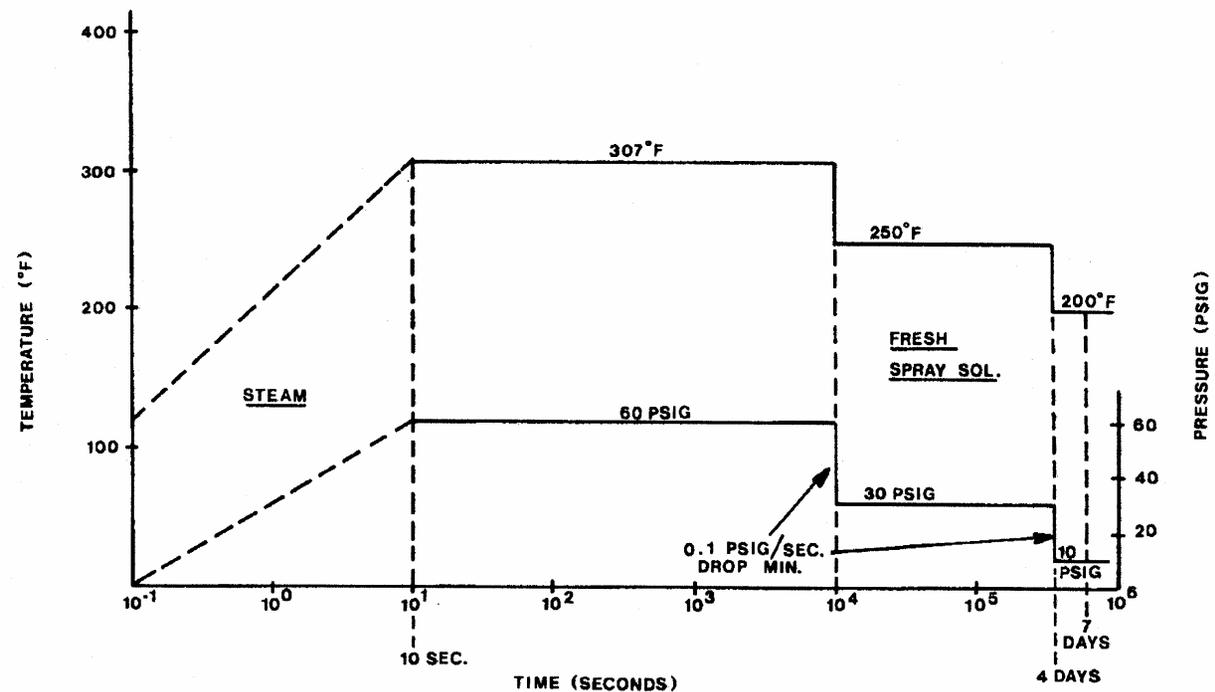
# Tasks Performed in Phase 1

- Obtained 37 samples of OEM coating components with OEM coatings.
- Performed FTIR (Fourier Transform Infrared Spectroscopy) to determine generic coating type of each sample.
  - Alkyd - 14 samples
  - Epoxy - 9 samples
  - Acrylics - 2 samples
  - Others
- Samples are representative of Industry.
- 1009750, *Analysis of PWR Unqualified OEM Coatings* was issued on 03/31/2005.



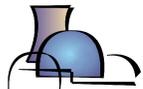
# Phase 2 Test Design

- Perform coatings DBA qualification testing per ANSI N101.2 and ASTM D3911 on 2"x 4" coupons from OEM painted components
  - $3.2 \times 10^8$  Rads
  - 307 F DBA curve
  - Borated water spray solution
  - 7 day test



## Phase 2 Testing

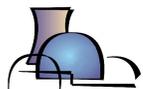
- Sample preparation and testing performed under QA program
- Radiation exposure at UMass Lowell.
- Autoclave testing at Keeler&Long/PPG.
- Delamination results use definition consistent with Coating PIRT panel
- Preliminary results follow



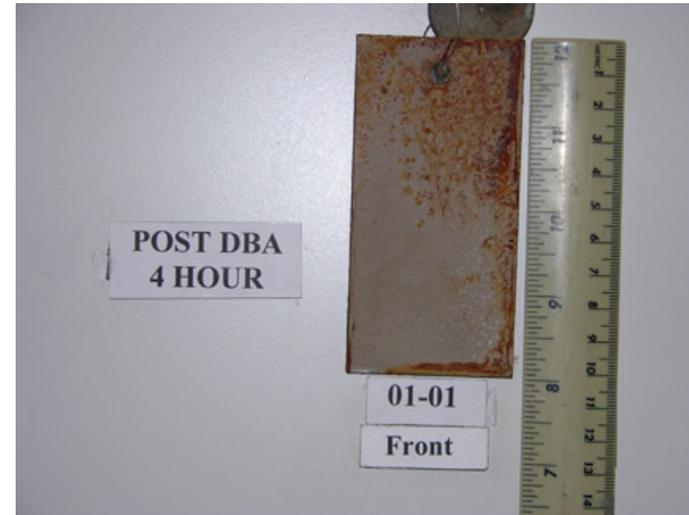
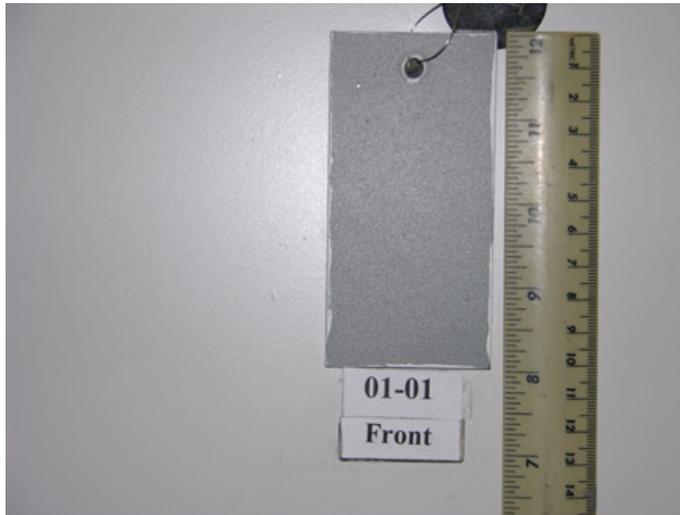
# Autoclave Testing at Keeler & Long/PPG



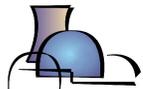
- Picture shows typical loading of many samples in each autoclave run. Device holds samples in spray region.
- DBA test is ~ 7 days duration.
- Following pictures show sample before testing and 4 hours after removal from DBA autoclave (Post DBA, 4 hour.)



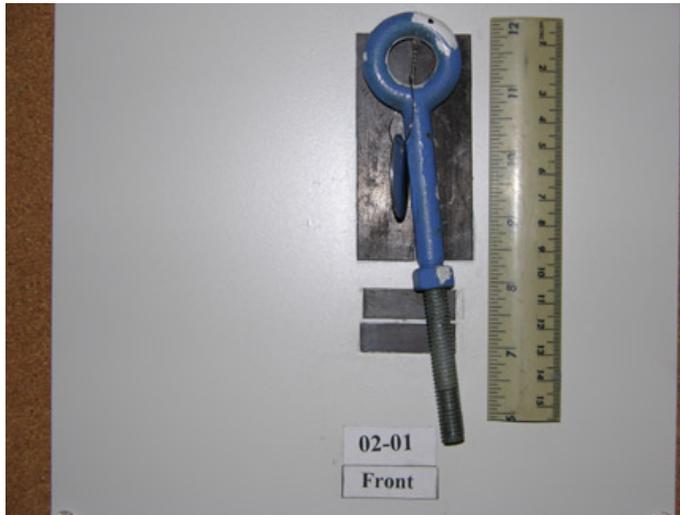
# OEM Unqualified Coating Sample# 01



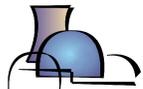
- OEM Coats # 01; Panel from a transformer; Alkyd; No. 8 medium dense blistering on upper half with some broken and rust/rust stain Lower right half has some flaking Approximately 5% Delamination of Coating



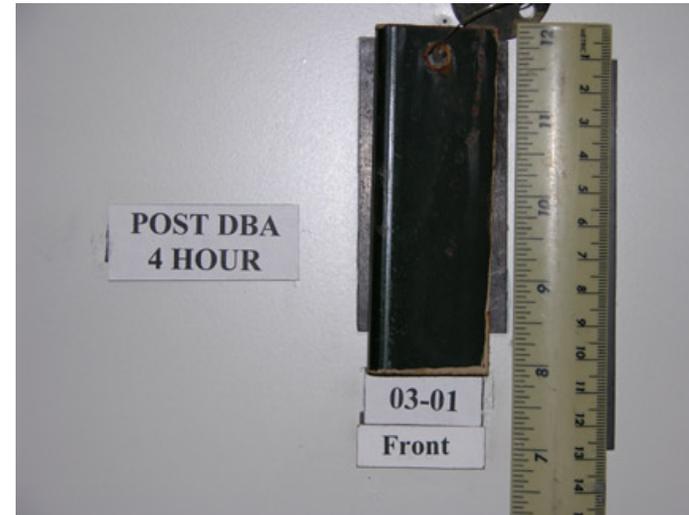
## OEM Unqualified Coating Sample# 02



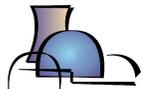
- OEM Coats # 02; Blue eye bolt from Limitorque operator; Coating type not available; Coating bubbled and delaminated from substrate What remains is loosely attached Approximately 60% Delamination of Coating



## OEM Unqualified Coating Sample# 03



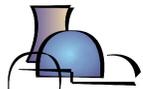
- OEM Coats # 03; Piece of green unistrut; Styrenated acrylic; Minor rust upper right corner, from mechanical damage. Coating intact, no other defects 0% Delamination of Coating



## OEM Unqualified Coating Sample# 04



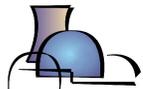
- OEM Coats # 04; White light fixture; Urethane; Localized areas of No. 6-8 medium dense to dense blisters. Several blisters have broken and delaminated, causing rust to form <5% Delamination of Coating



## OEM Unqualified Coating Sample# 05



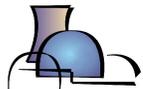
- OEM Coats # 05; Cap from a Foxboro transmitter; Epoxy; No. 6-8 medium dense intact blistering over entire panel. Curved surface has >#2 dense. Some pinpoint rusting from broken blisters <5% Delamination of Coating



## OEM Unqualified Coating Sample# 06



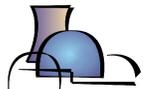
- OEM Coats # 06; Cap from a Foxboro transmitter; Epoxy Ester; No. 4-8 dense blistering entire panel. > No. 2 medium, some broken and delaminated. Oxide formation on exposed surface. Approximately 5% Delamination of Coating



## OEM Unqualified Coating Sample# 07



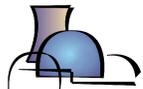
- OEM Coats # 07; Cover from an electrical j-box; Epoxy; No. 4 dense blistering entire panel. When viewed under magnification blisters have a spotted black appearance. 3 rust spots located on bottom curved surface. Coating intact, no other defects. <5% Delamination of Coating



## OEM Unqualified Coating Sample# 08



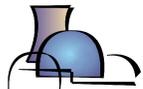
- OEM Coats # 08; Blue/purple (damaged) bearing housing from a Limitorque operator; Epoxy; No. 2-8 dense blistering entire surface. Coating is attached but dis-bonded. Approximately 10% Delamination of Coating



## OEM Unqualified Coating Sample# 09



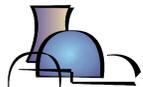
- OEM Coats # 09; Piece of gray zinc primed strut body; Appears to be a residue, not a coating – possibly rusted galvanizing; Oxide formation on surface, some pinpoint rusting. No other defects. 0% Delamination of Coating



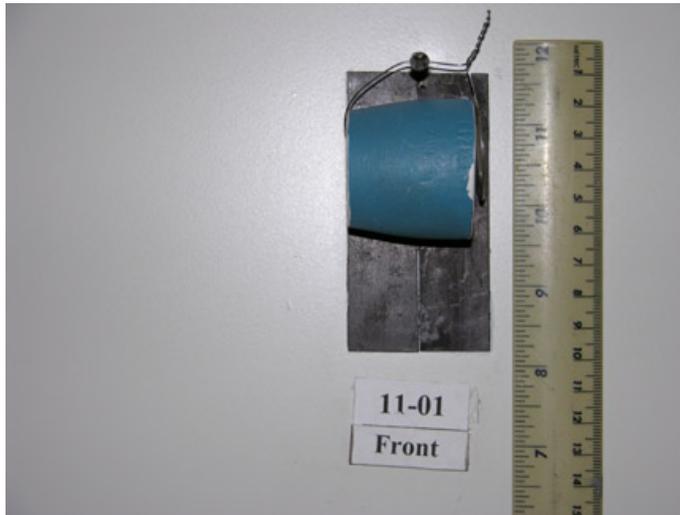
# OEM Unqualified Coating Sample# 10



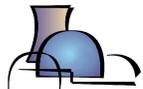
- OEM Coats # 10; Piece of gray strut body; Inorganic zinc rich; Some rusting. Coating intact, no other defects. <1% Delamination of Coating



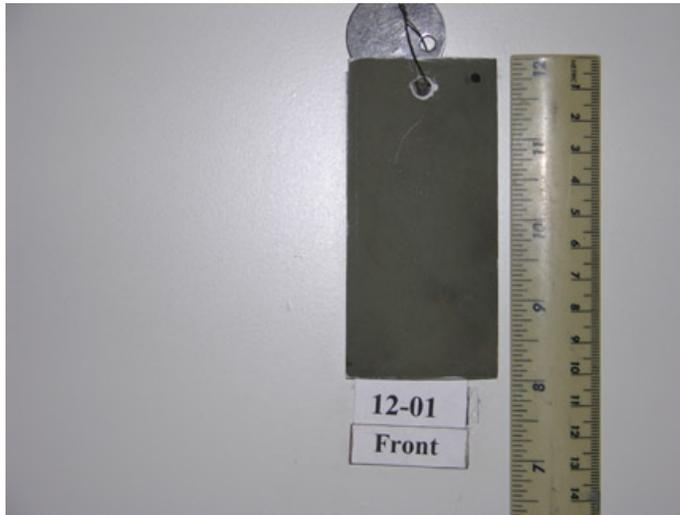
# OEM Unqualified Coating Sample# 11



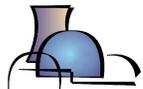
- OEM Coats # 11; Piece of blue strut body; Moisture-cured urethane; 1 rust spot from delaminated coating. Coating intact, no other defects. <5% Delamination of Coating.



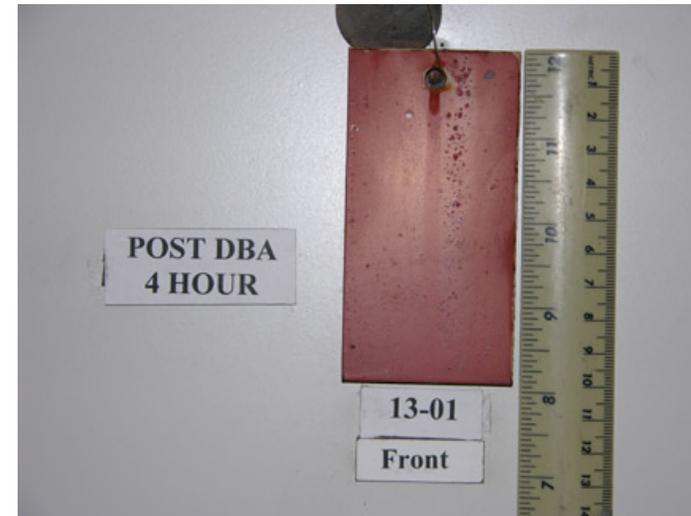
## OEM Unqualified Coating Sample# 12



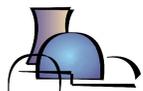
- OEM Coats # 12; Limitorque motor; Inorganic zinc rich; Near complete coating failure, heavy rust. 95% Delamination of Coating.



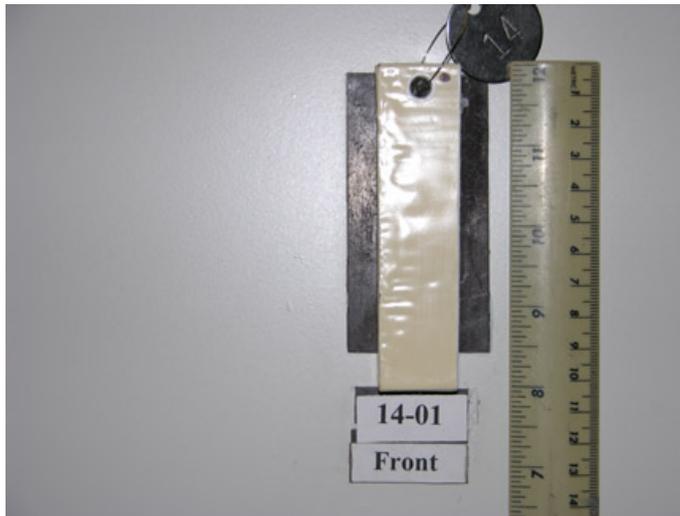
## OEM Unqualified Coating Sample# 13



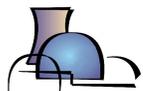
- OEM Coats # 13; Piece of orange plate from a crane; Urethane; No. 6-8 few blisters. Coating intact, no other defects. 0% Delamination of Coating.



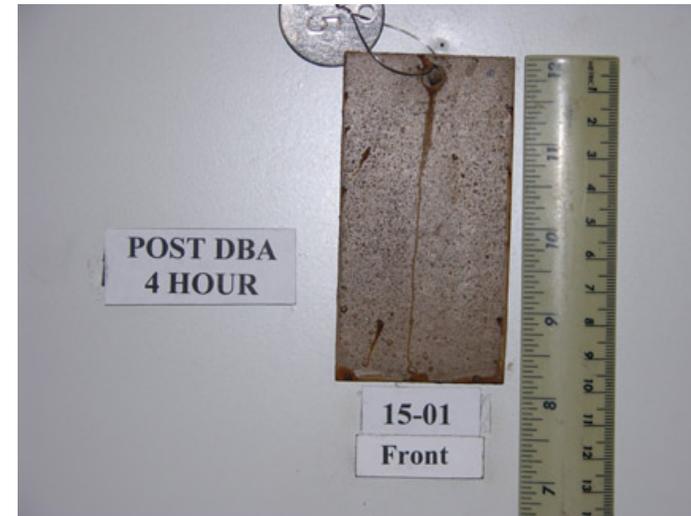
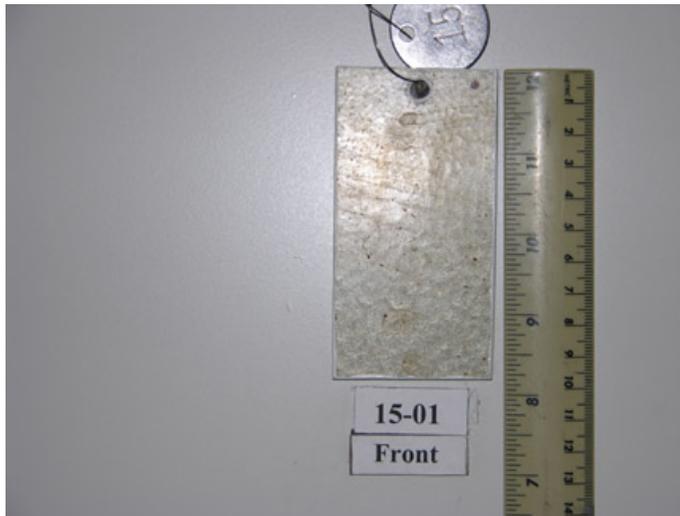
## OEM Unqualified Coating Sample# 14



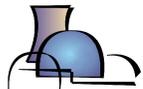
- OEM Coats # 14; Piece of yellow steel. Repair paint from W RCP motor shop; Epoxy ester; No. 6 few blisters, 1 crack right side with rusting Coating intact, no other defects. 0% Delamination of Coating.



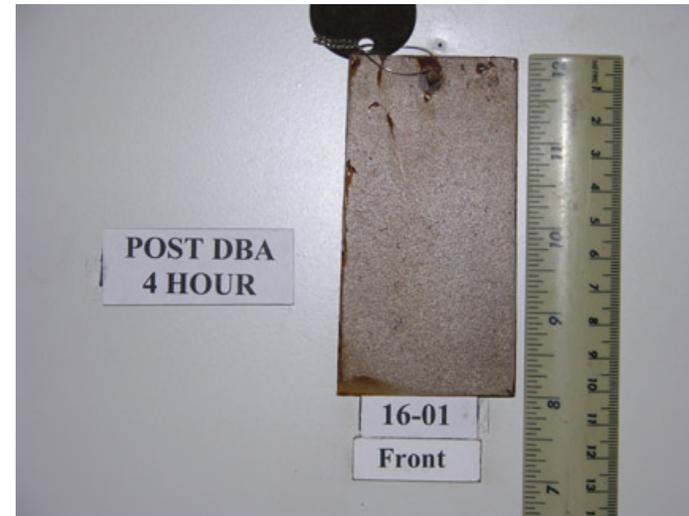
# OEM Unqualified Coating Sample# 15



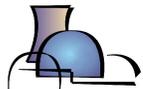
- OEM Coats # 15; “Austin brand” electrical junction box, gray; Vinyl toluene modified alkyd; No. 8 dense blisters entire panel, localized #2-4 medium dense, few rust spots Coating intact, no other defects. <1% Delamination of Coating.



## OEM Unqualified Coating Sample# 16



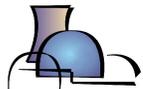
- OEM Coats # 16; “Austin brand” electrical junction box, gray Vinyl toluene modified alkyd; Coating cracked, few rust spots, some flaking <5% Delamination of Coating.



# OEM Unqualified Coating Sample# 17



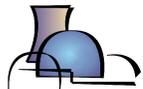
- OEM Coats # 17; “Austin brand” electrical junction box, gray; Vinyl toluene modified alkyd; No. 8 dense, few rust spots Coating intact, no other defects <1% Delamination of Coating.



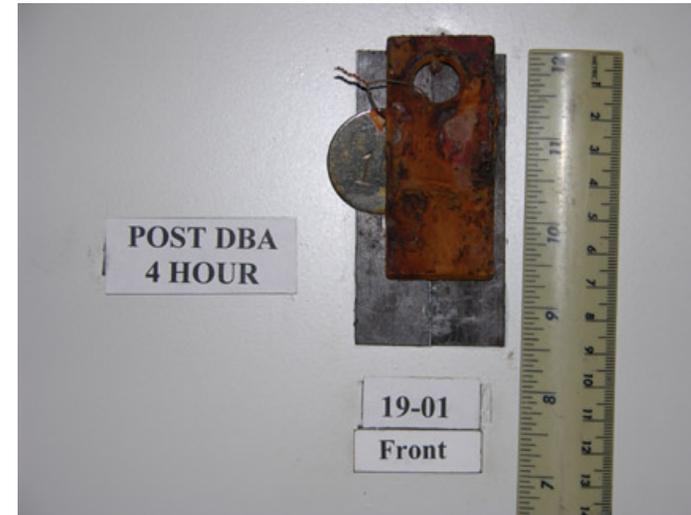
## OEM Unqualified Coating Sample# 18



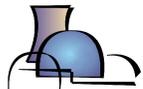
- OEM Coats # 18; Pipe hanger, silver; Alkyd; Few rust spots <1% Delamination of Coating.



## OEM Unqualified Coating Sample# 19



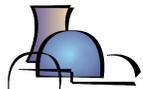
- OEM Coats # 19; Small pipe hanger, red; Alkyd; Heavy rust, delamination. Approximately 95% Delamination of Coating.



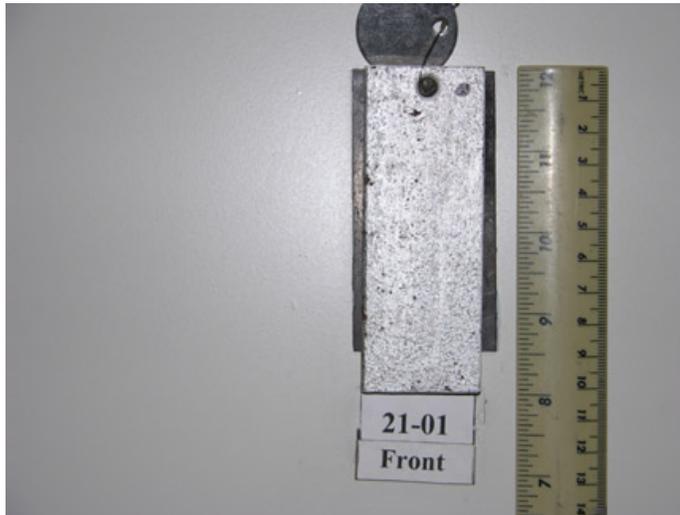
## OEM Unqualified Coating Sample# 20



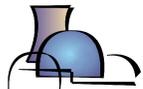
- OEM Coats # 20; Pipe hanger, yellow; Alkyd; 100% of topcoat delaminated, primer intact. 5% of panel rusted. Approximately 55% Delamination of Coating 50% topcoat, 5% primer.



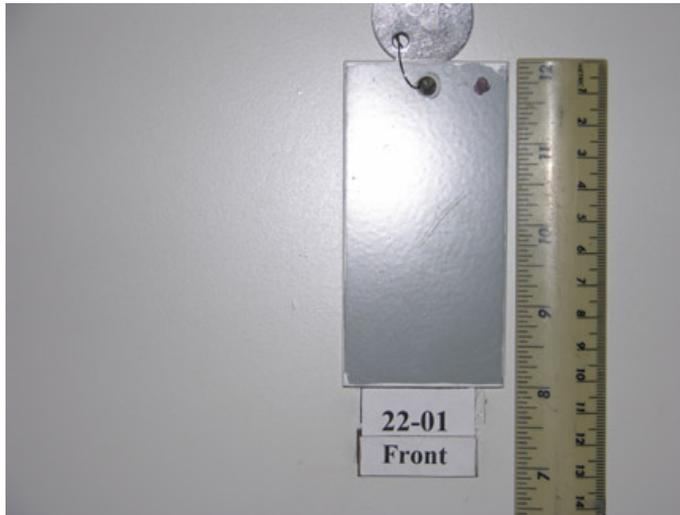
# OEM Unqualified Coating Sample# 21



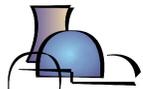
- OEM Coats # 21; Piece of angle iron, silver; Alkyd; No. 6-8 medium blisters, some broken with rust. Rust stain on 100% of panel. <5% Delamination of topcoat.



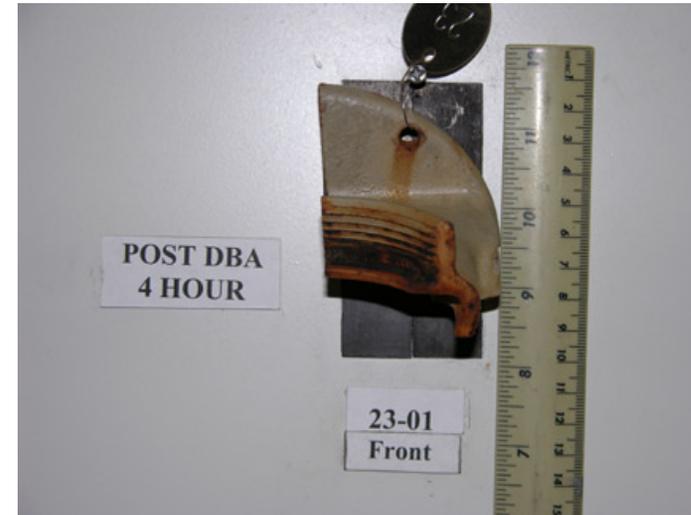
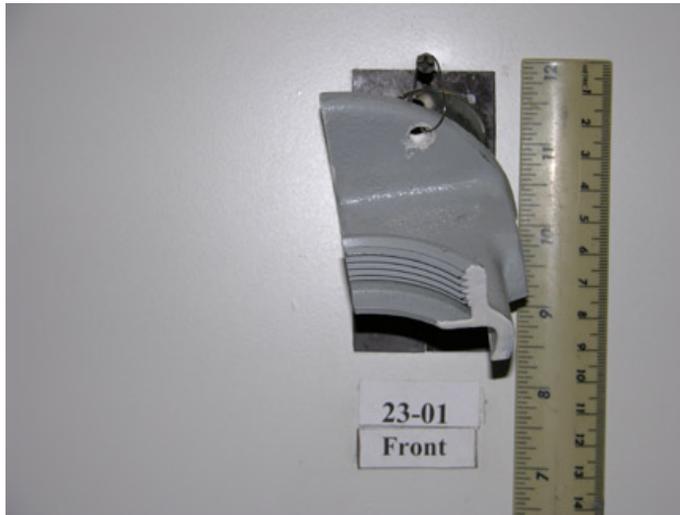
## OEM Unqualified Coating Sample# 22



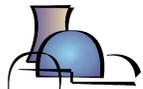
- OEM Coats # 22; “Hoffman brand” electrical j-box, gray; Alkyd; No. 6-8 few blisters, some broken Coating intact, no other defects <1% Delamination of coating.



## OEM Unqualified Coating Sample# 23



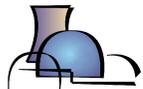
- OEM Coats # 23; Electrical lamp fixture, gray; Epoxy; Several rust spots causing. Approximately 1% delamination. Coating intact, no other defects.



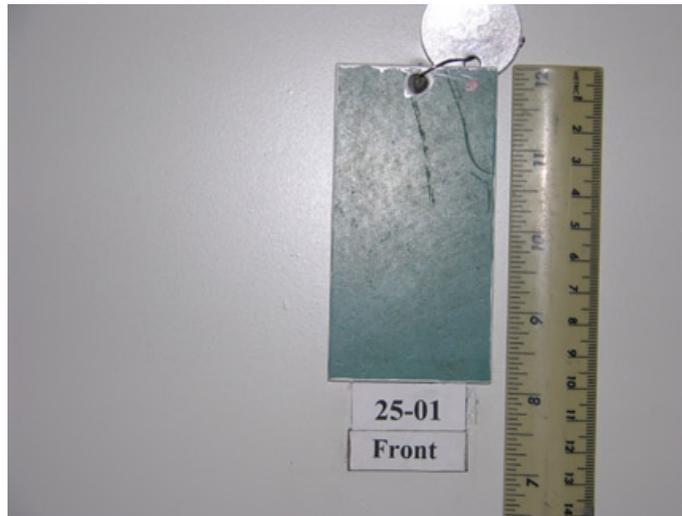
## OEM Unqualified Coating Sample# 24



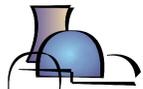
- OEM Coats # 24; Electrical j-box cover, gray; Moisture cured urethane; #8 dense blisters entire panel, >#2 Few blisters. Approximately 5% delamination from broken blisters. Note: Tag stuck to top of panel causing heavy rust.



## OEM Unqualified Coating Sample# 25



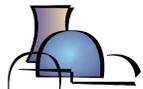
- OEM Coats # 25; Shaft coupling guard, blue-green; Alkyd; Heavy rust on entire panel. Approximately 80% delamination.



## OEM Unqualified Coating Sample# 26



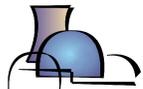
- OEM Coats # 26; “Westinghouse brand” conduit box cover, gray; Styrenated alkyd; No.2-8 dense blistering, some broken. Approximately 20% delamination.



## OEM Unqualified Coating Sample# 27



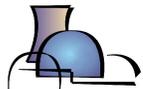
- OEM Coats # 27; “Grinnel brand” hand wheel, light blue; Epoxy; No. 8 medium dense blistering, some broken. Approximately 20% delamination.



## OEM Unqualified Coating Sample# 28



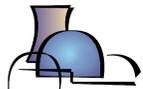
- OEM Coats # 28; “Fisher brand” round cover, black; Styrenated acrylic; Coating break-down causing heavy oxidation in powder form over approximately 50% of the panel.



## OEM Unqualified Coating Sample# 29



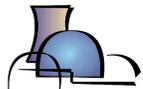
- OEM Coats # 29; “Victoreen brand” instrument cover, gray; Epoxy; No. 8 dense blistering, some broken causing rust. When viewed under magnification there is a possibility of intracoat delamination. Approximately 50% intracoat delamination.



## OEM Unqualified Coating Sample# 30



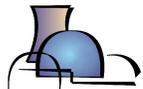
- OEM Coats # 30; Top of diaphragm operator, blue-green; Moisture cured urethane; No. 2 dense blistering, all intact with the exception of a single blister located bottom center of panel. <1% delamination.



# OEM Unqualified Coating Sample# 31



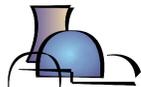
- OEM Coats # 31; Gaitronics j-box, gray; Alkyd; Heavy rust and deterioration of coating. Approximately 98% delamination.



## OEM Unqualified Coating Sample# 32



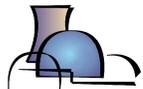
- OEM Coats # 32; Top of an ITT diaphragm operator, blue-green; Alkyd; No. 8 dense blistering with oxidation in powder form coming through broken blisters. Approximately 40% delamination.



## OEM Unqualified Coating Sample# 33



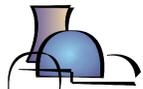
- OEM Coats # 33; Manifold for air lines, gray; Epoxy ester; No. 4-6 medium dense blistering with oxidation in powder form coming through broken blisters. Approximately 5% delamination.



# OEM Unqualified Coating Sample# 34



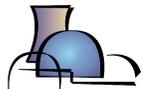
- OEM Coats # 34; Motor end bell, blue; Alkyd; Coating break-down causing heavy oxidation in powder form. Approximately 95% oxidized/delaminated.



## OEM Unqualified Coating Sample# 35



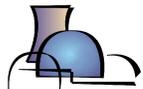
- OEM Coats # 35; Limitorque cover, blue; Alkyd; No. 6-8 dense blistering, some rust from broken blisters. Approximately 5% delamination



## OEM Unqualified Coating Sample# 36



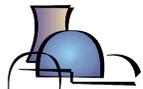
- OEM Coats # 36; Motor/pump end piece, blue; Alkyd; No. 2-8 dense blistering, some broken. Approximately 5% delamination



## OEM Unqualified Coating Sample# 37



- OEM Coats # 37; Electrical enclosure, gray; Alkyd; No. 8 dense blistering, When viewed under magnification there is a possibility of intracoat delamination. Approximately 50% intracoat delamination



## Summary

- Phase 1 survey identified OEM coatings to be tested
- Representative OEM samples were obtained and tested
- General observations:
  - Coating failures generally significantly less than 100% failure assumption currently in use
  - Majority of samples show failure less than 5%
  - Delamination is dominant failure mode
- Phase 2 test report (1011753, *DBA Testing of PWR Unqualified OEM Coatings*) to be completed in June 2005

