CONTAINMENT COATINGS ADHESION DATA COLLECTION

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BACKGROUND

- EPRI/NUCC initiated a program in 2005 to evaluate coating failures and the potential influence of aging
  - Five-phase effort:
    - Task 1: Coatings Degradation Utility Survey
    - Task 2: Coatings Degradation Research
    - Task 3: Containment Coatings Adhesion Testing
    - Task 4: Coatings Aging Research
    - Task 5: Long-term Performance Integrity of Inorganic Coatings
    - Task 6: Overall Summary

Background

- Task 3 of EPRI/NUCC program collects coatings adhesion data for coatings systems, which:
  - Provides baseline correlation to original qualification
  - Provides confirmatory support for ASTM coating inspection methods that rely upon visual inspection as initial step

BACKGROUND

- As part of the EPRI/NUCC effort, containment coating adhesion and visual inspection data has been collected by a team of three Industry coatings experts:
  - Jon R. Cavallo, CCC&L Inc.
  - Daniel Cox, SCE – SONGS
  - Garth Dolderer –FPL
- Testing has been performed on coatings on both concrete and steel substrates

BACKGROUND

- The volunteer plants were selected to include a variety of containment coating systems
- Testing performed at four volunteer plants:
  - San Onofre Nuclear Generating Station (SONGS) Unit 3
  - Waterford Unit 3
  - McGuire Unit 1
  - Oconee Unit 2

BACKGROUND

- Adhesion data was collected using two standard adhesion test methods:
  - Pull-off testing per ASTM D 4541-02
  - Knife test per ASTM D 6677-01
- Testing was performed on coatings at multiple locations and conditions on both concrete and steel substrates:
  - On visually sound coatings
  - Adjacent to degraded coating areas

Background

- The 200 psi pull-off adhesion minimum contained in ASTM D5144-00 was used as screening criterion
- The Elcometer Model 106 Adhesion Tester used in the testing and available up to 40 years ago reads out in “pounds per square inch” rather than “pounds.” The reference to adhesion in units of “pounds” in Section 6.4 of ANSI N5.12-1972 is erroneous; the units of adhesion should have been stated as “pounds per square inch” as measured by the Elcometer adhesion tester.

COATING SYSTEMS TESTED

- SONGS Unit 3
  - Steel Substrate Coating System – 2 coats Mobil 78-W-3
  - Concrete Substrate Coating System – Mobil 46-X-29 surfacer with Mobil 84-W-9 topcoat on floors and equipment pads; Mobil 84-V-2 thin film sealer on walls

COATING SYSTEMS TESTED

- Waterford Unit 3
  - Steel substrate – Carboline CZ-11 primer, Phenoline 305 topcoat
  - Steel substrate – Ameron Dimetcote D-6 primer, Amercoat 90 topcoat
  - Steel substrate (repair) – Ameron Amerlock 400NT (2 coats)
  - Concrete substrate – Ameron 110AA surfacer, Amercoat 66 topcoat

COATING SYSTEMS TESTED

- McGuire Unit 1
  - Steel substrate – Mobil Mobil-Zinc 7 primer, 89 topcoat
  - Concrete substrate (wall) – Mobil 46-X-29 surfacer, 89 topcoat
  - Concrete substrate (floor) – Mobil 46-X-29 surfacer, 76 topcoat

COATING SYSTEMS TESTED

- Oconee Unit 2
  - Steel substrate – Carboline CZ-11 primer, Phenoline 305 topcoat
  - Concrete substrate (wall) – Carboline 195 Surfacer, Phenoline 305 topcoat
  - Concrete substrate (floor) – Carboline 2011S surfacer, Phenoline 305 topcoat

PULL-OFF (AND KNIFE) ADHESION TEST RESULTS ON VISUALLY SOUND COATINGS – SONGS UNIT 3

Sound Concrete Floor (46-X-29 / 84-W-9)	300 psi (10)	300 psi (10)	700 psi (10)
Sound Concrete Wall (84-V-2)	500 psi (10)	500 psi (10)	>1000 psi (10)
Sound Structural Steel 78-W-3)	>1000 psi (8)	700 psi (10)	>1000 psi (10)
Degraded Structural Steel (78-W-3)	300 psi (none)	300 psi (8)	250 psi (8)
Sound Liner Steel (78-W-3)	500 psi (10)	500 psi (10)	>1000 psi (10)

PULL-OFF (AND KNIFE) ADHESION TEST RESULTS ON VISUALLY SOUND COATINGS – WATERFORD UNIT 3

Sound Concrete Wall (110AA / 66)	400 psi (10)	550 psi (8)	320 psi (8)
Sound Liner Steel (CZ-11 / 305)	290 psi (10)	330 psi (10)	310 psi (10)
Sound Structural Steel (D-6 / 90))	>1000 psi (8)	625 psi (6)	410 psi (4)
Degraded Liner Steel (Repair 400 NT)	600 psi (10)	750 psi (10)	700 psi (10)
Degraded Liner Steel (CZ-11 / 305)	300 psi (8)	200 psi (6)	200 psi (4)

PULL-OFF (AND KNIFE) ADHESION TEST RESULTS ON VISUALLY SOUND COATINGS – MCGUIRE UNIT 1

Sound Concrete Floor (46-X-29, 76)	>1000 psi (10)	300 psi (10)	400 psi (8)
Degraded Concrete Floor (46-X-29, 76)	200 psi (6)	200 psi (6)	200 psi (6)
Sound Concrete Wall (46-X-29, 89)	500 psi (10)	200 psi (10)	300 psi (10)
Degraded Concrete Wall (46-X-29, 89)	400 psi (10)	400 psi (10)	400 psi (10)
Sound Liner Steel (MZ-7, 89)	700 psi (10)	>1000 psi (10)	800 psi (10)
Degraded Liner Steel (MZ-7, 89)	600 psi (10)	700 psi (8)	500 psi (10)

PULL-OFF (AND KNIFE) ADHESION TEST RESULTS ON VISUALLY SOUND COATINGS – OCONEE UNIT 2

Sound Concrete Floor (2011S, 305)	200 psi (4)	320 psi (4)	250 psi (8)
Sound Concrete Wall (195, 305)	300 psi (6)	290 psi (6)	410 psi (6)
Degraded Concrete Wall (195, 305)	410 psi (8)	270 psi (6)	380 psi (6)
Sound Liner Steel (CZ-11, 305)	370 psi (10)	600 psi (10)	440 psi (10)
Degraded Liner Steel (CZ-11, 305)	400 psi (10)	840 psi (10)	450 psi (10)

FINAL CONCLUSIONS

- Aged, visually intact DBA-qualified coatings for various manufacturers, exhibiting no visual anomalies, continue to exhibit system pull-off adhesion at or in excess of the originally specified (ANSI N5.12 and ASTM D5144) minimum value of 200 psi
- Results provide confirmatory support for ASTM coating inspection methods that rely upon visual inspection as an initial step

FINAL REPORT

- Detailed information concerning the containment coating adhesion and visual inspection will be published mid-2007 as EPRI PSE Report No. 1014883 entitled:
  - **Plant Support Engineering; Adhesion Testing of Nuclear Service Level I Coatings**