

Cook Units 1 & 2

Source Term Reduction

4th Quartile to Top Decline

for Outage Exposure

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Cook Nuclear Plant

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Presentation Outline



- **Success Approach**
- **Retrospective**
 - What the Team DID to Capture Such Success?
- **How Do you Duplicate Success**
 - **Benchmark and Exactly Mimic What We Did????**
 - **Removal Biases and Obstacles with Data !!!!!**
- **Brief Highlights of Results for DC Cook**
 - **Co-58 Peak**
 - **SG Dose Rates**
- **Future - sustainability???**



NRC 2010 PWR Quartile Improvement -44% Three CRE



- 1st Quartile
- Improving Every Period

2010 PWR Quartile Data

	Plant Name	Three-Year Coll. TEDE per Reactor Year 2008-2010	Percent Change From 2007-2009	2007-2009 Quartile (if changed)
1st Quartile	INDIAN POINT 3	25.049	-57% ▼	2
	COOK 1,2	33.291	-44% ▼	2
	FARLEY 1,2	34.000	-8% ▼	
	SUMMER 1	35.757	-1% ▼	
	CALLAWAY 1	36.431	-12% ▼	
	PRAIRIE ISLAND 1,2	39.208	26% ▲	
	PALO VERDE 1,2,3	41.159	-9% ▼	
	HARRIS	44.778	15% ▲	

Success Started This Way...

And Sustained Commitment...



- **Start at the Top- Senior Leadership Team**
 - Must be First Communication
 - Management Commitment to Change Process
- **Benchmarked and Mimic Successful Solution**
 - Exactly - **well, at least try**
- **Engaged a Collaborative Team Process**
 - AEP DC Cook - Los Alamos Scientists - (n,p) Energy, Inc.
 - Key Contributors: Bob Heathcote, Dave Kozin, Dave Faulkner, Terry Brown, Carl Moeller, Dave Miller, Joe Beer, Chuck Vanderswag
- **Senior Leadership Team Made Decision to Implement**
 - RP In Lead Role- Very Important (We own Performance Metrics)
 - Operations and Outage Management Interfaces Required
 - Chemistry Directed to Support Initiative - **what does this mean??**

Prerequisites for Low Dose Outages



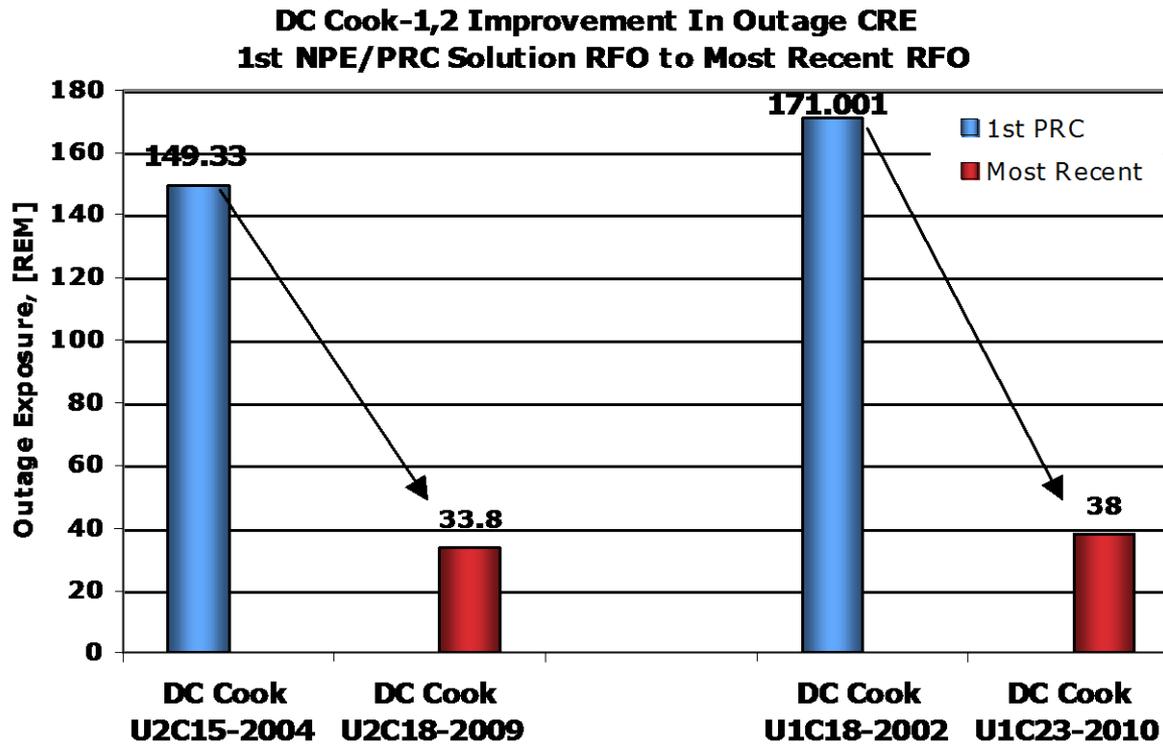
- **Leadership Team Accountability** - RP can't be the only bagholder
- **Good ALARA Program**
 - Not all plant exposure is from transport, deposition of colloids
 - Irradiated components
- **Good Enough At Power Chemistry**
 - PWRs - Chemistry is Good Stable Most All Plants
 - BWRs –Chemistry more Complex???, NMC, HWC, DZO, Fe Inj.
- **Excellent Foreign Material Exclusion Program** - micro stuff!!
 - PWRs – Most OK, want perfection
 - BWRs – Good
- **Clean-Up Systems in Good Shape** - **this is important!!!**
 - F/D Septa

DC Cook-1,2

Most Recent Refueling Outage Collective Radiation Exposure



- DC Cook-1,2
 - 2C18: 33.8 REM US Record 4 Loop IC Low Dose
 - 1C23: 37.0 REM 35 day
- 5 Year ALARA Plan- 2010-2015
 - Goal: 20 to 25 REM, 30 day RFOs



Key to Success Benchmark +++

Understand Differences, and Implement Exactly
Implement What Worked

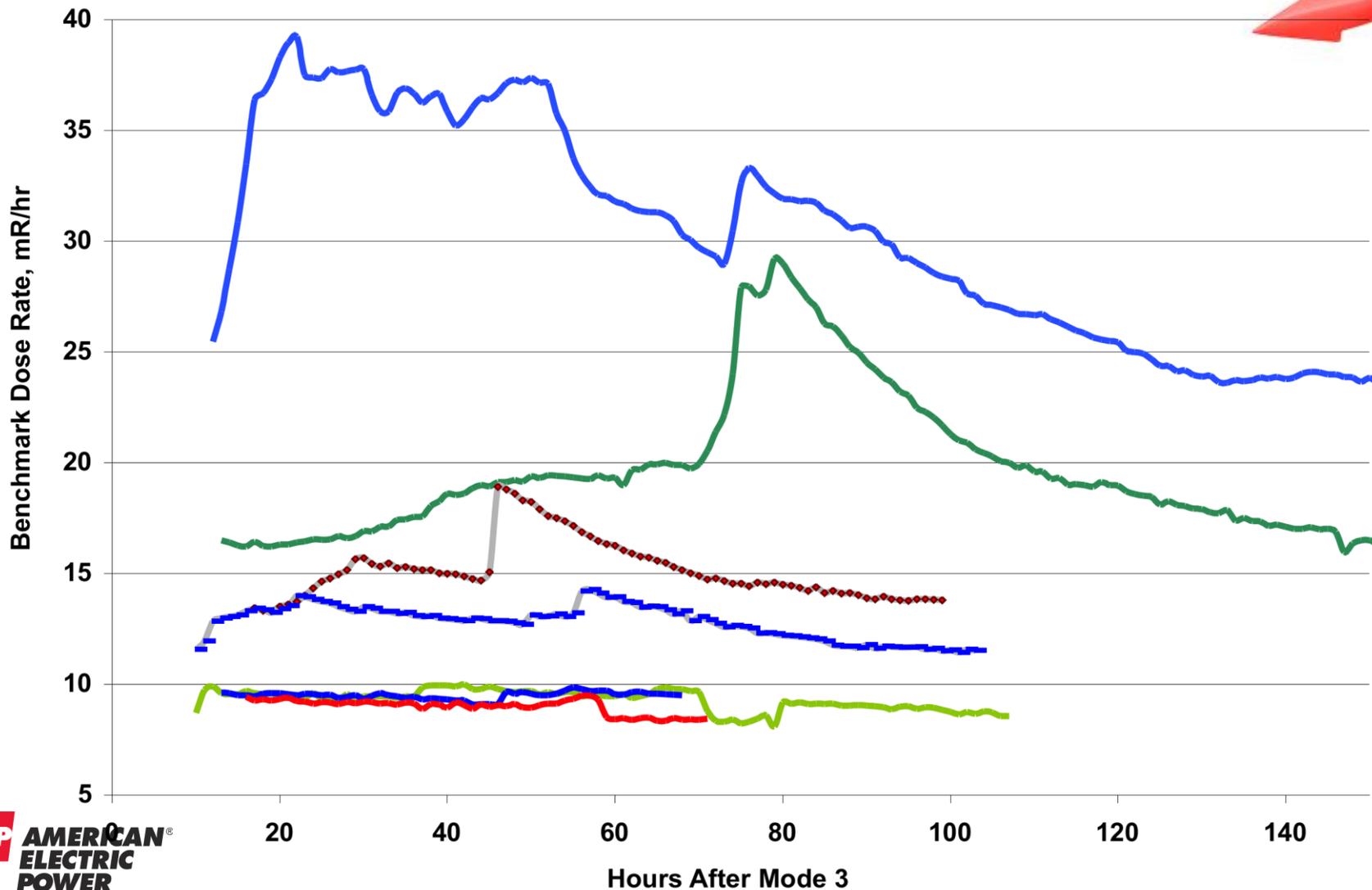


Benchmarked Other Stations for Cost Effective Solution

- **VC Summer, Turkey Point 3,4**
- **What did and didn't they do that was Different?**
 - Did not use Zinc Injection
 - Did not use Ortho-macroporous resin
 - Did Not have RTD Lines
 - Did Not Use Any Fuel Cleaning or Decon
 - **Did... Use Good Shutdown and Start-Up Operations**
 - **Did... Use PRC-01M Resin in CVCS and SFP, Sustained for 4+ cycles**
 - **Did... Retain External Experts to Optimized Shutdown/Start-Up Protocol**
- **So Cook Started a Program to Exactly Duplicate What Other Successful Plants did to Every Detail !**

Benchmark: Impressive VC Summer Results: Electronic Dosimeters as Process Monitors

VC Summer RF 12 to 18 Baseline
ED Dose Rates During Cooldown

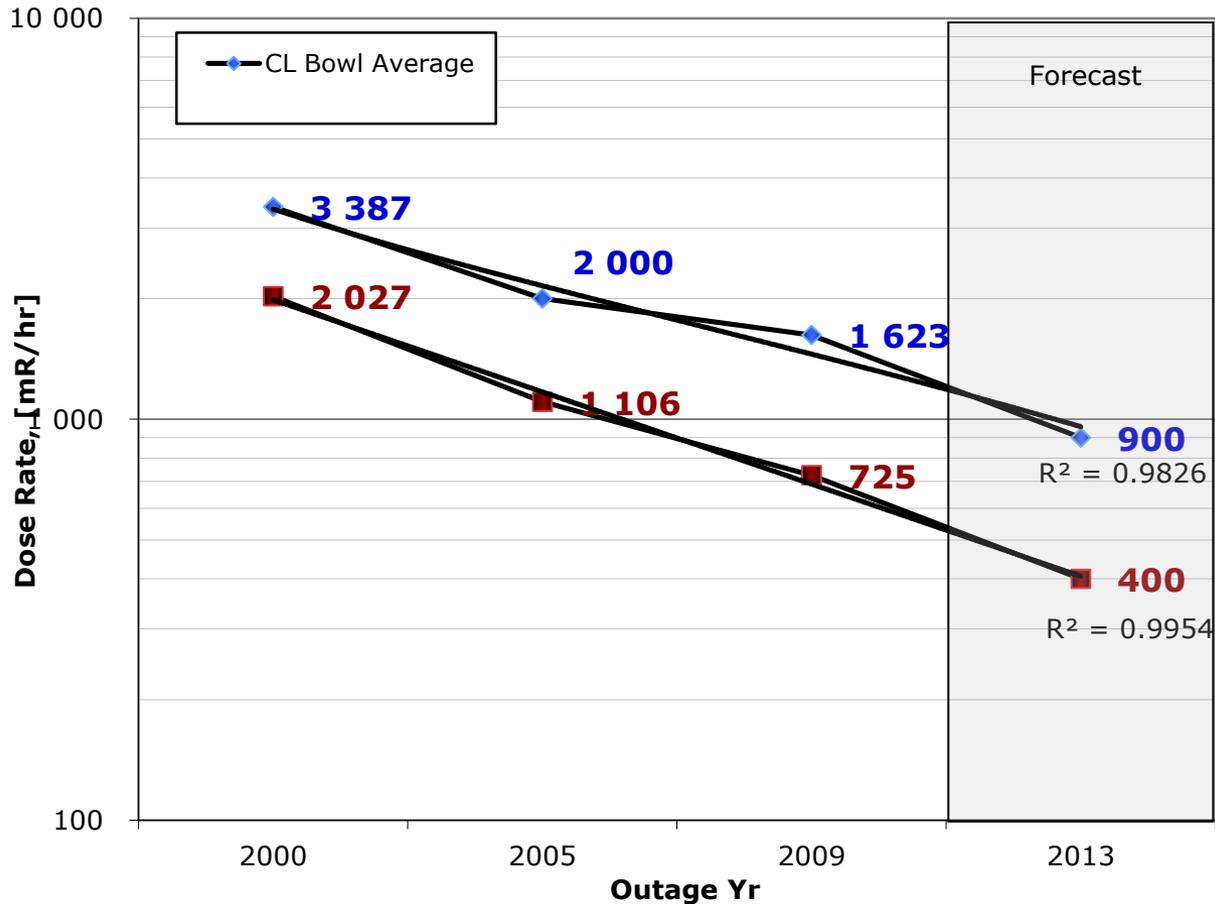


Benchmark: Impressive Results

VC Summer SG Dose Rates on Co-60 Decay Rate

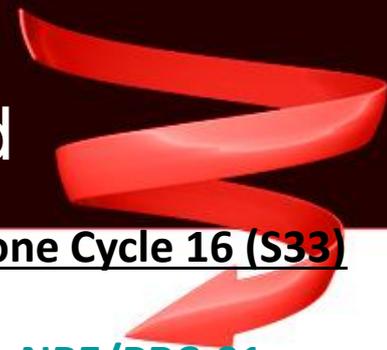


**VC Summer SG Bowl Dose Rate Change
2000, 2005, 2009, Forecast 2013
All RFO PRC Solutions I/S**



Benchmark: Results

VC Summer Impact of Reducing Core Crud

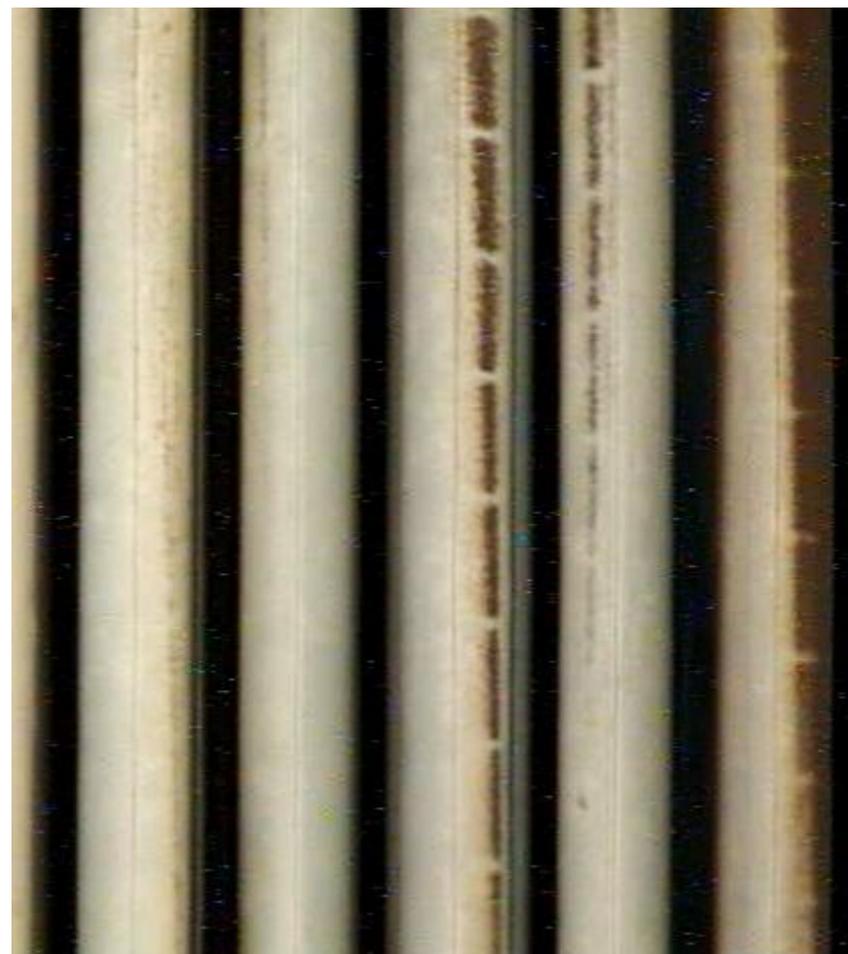


2003 Highest Power Zone Cycle 14 (grid 6)

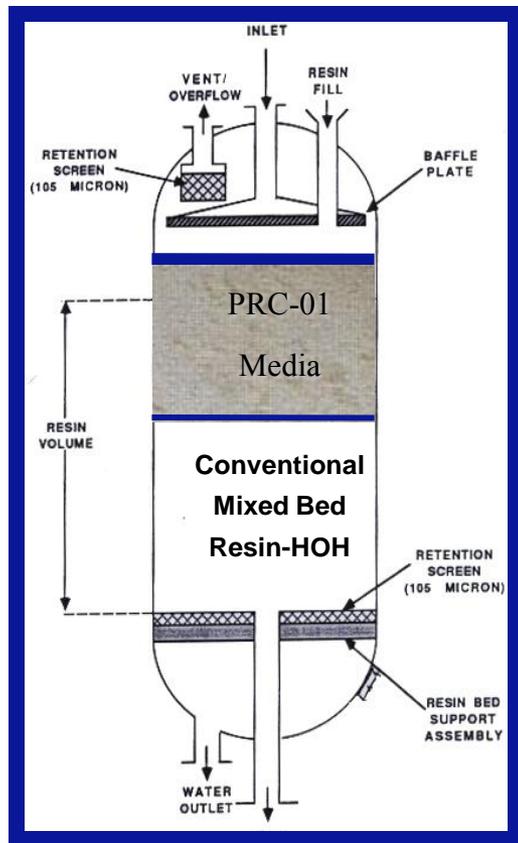
2006 Highest Power Zone Cycle 16 (S33)

3rd RFO with NPE/PRC-01 Solution

After 6th RFO with NPE/PRC-01



Benchmark: Technology Used Correctly, Key to Success



PWR

Deep Bed Vessel

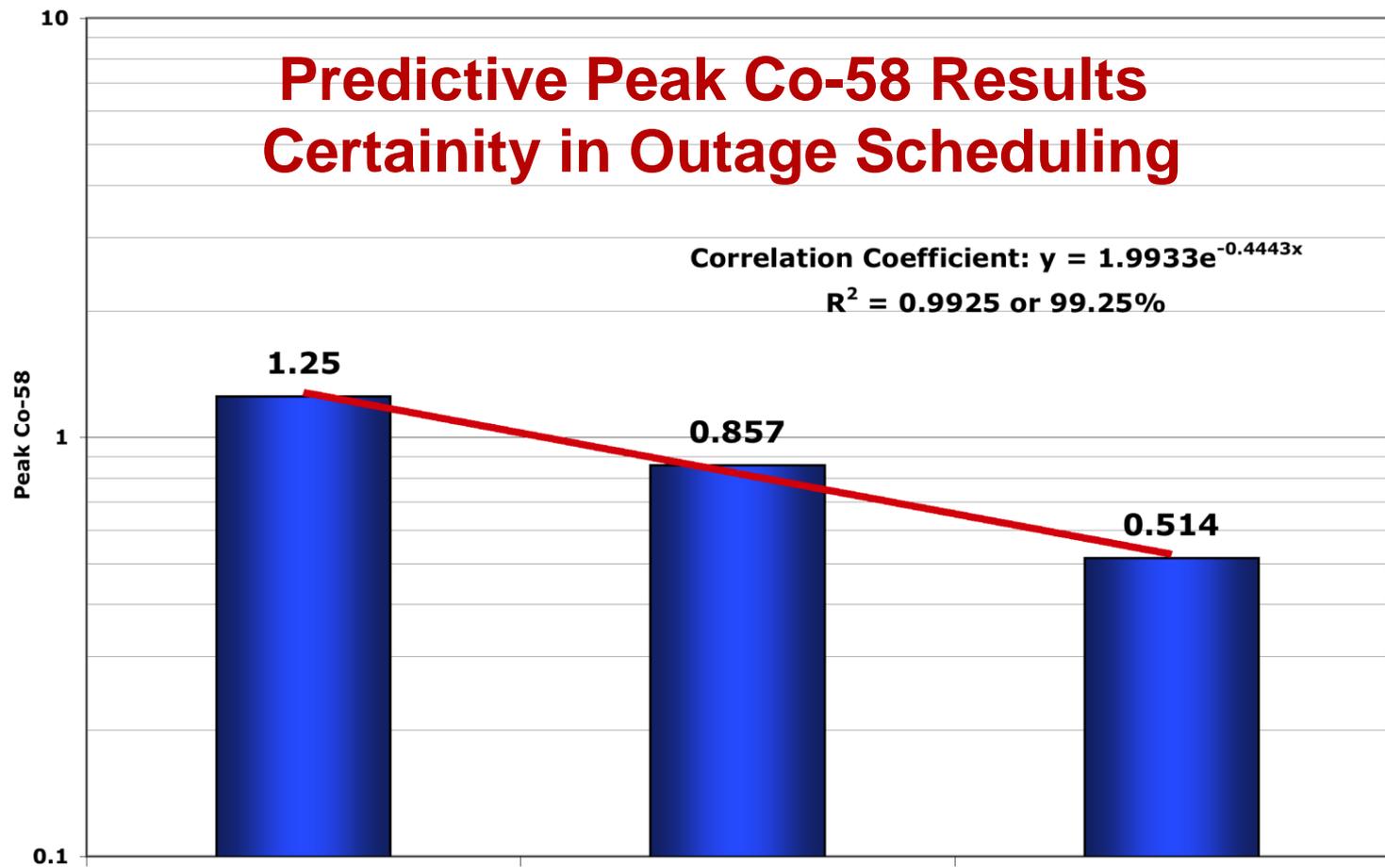
- **Two Part Engineered Solution:**
 - Shutdown/Start-Up Improvements
- **Implementation:**
 - 1 um RCS Filter Placed I/S
 - PRC-01M Overlay On top of Conventional Resin
 - Shutdown Bed Discharged and Re-Loaded for Start-Up
 - Spent Fuel Pool

Cook Unit 2: Co-58 Peak Decline with NPE/PRC

Correlating Coefficient: 99.25%



DC Cook U2C17-C19
Peak Co-58



**Predictive Peak Co-58 Results
Certainty in Outage Scheduling**

Correlation Coefficient: $y = 1.9933e^{-0.4443x}$
 $R^2 = 0.9925$ or 99.25%

U2C17
3rd NPE/PRC

U2C18
4th NPE/PRC

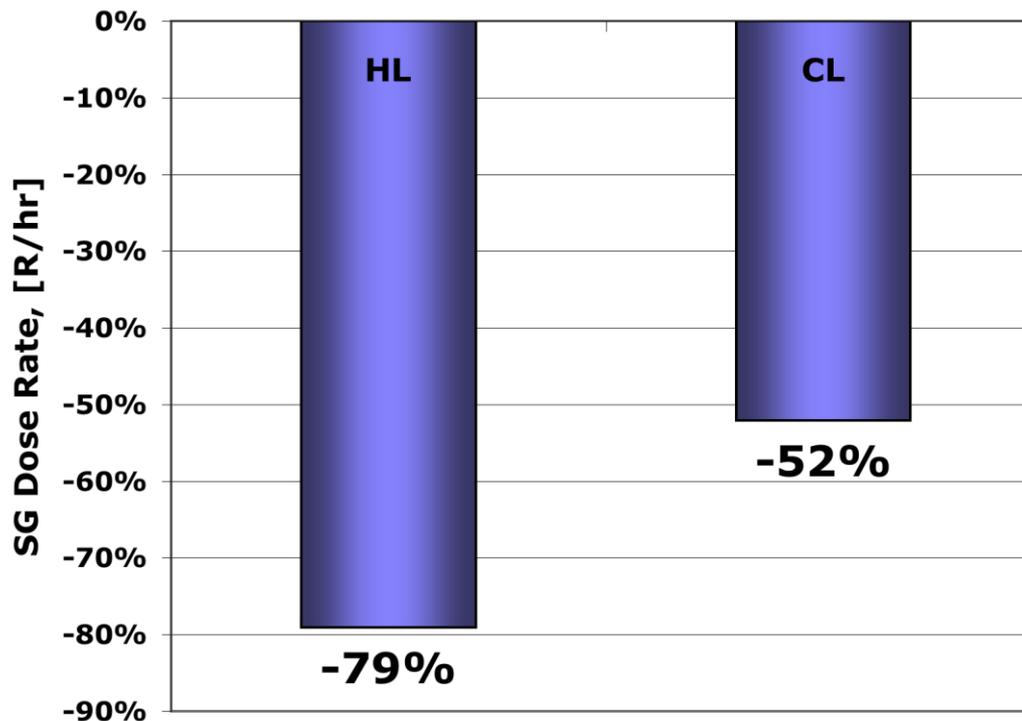
U2C19
5th NPE/PRC

DC Cook Unit 2 SG Performance

Last 3 RFOs, 2007 to 2010 (no RTDs)



**DC Cook Unit 2 Average SG Dose Rate Decline
Since NPE/PRC Solution I/S (no RTGs)**



Using New Tools: What is CZT?

Cadmium Zinc Telluride (CZT) Gamma Spectroscopy

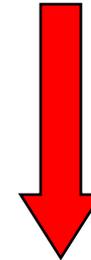


- **New Gamma Spectroscopy Technology** - **important when mix is changing**
 - Identifies Isotopes in Energies between 100 keV to 1800 keV
 - Isotopes ID for NPP:
 - Co-58, Co-60, Ag-110m, Cs-137, Sb-124 & 122, Cr-51, Fe-59, Mn-54, Zn-65
- **Small and Lightweight**
- **Portable**
- **Cost Effective**
- **No Cooling Required**
- **Refueling Outages**
 - 2 day Measurement
 - 2 day Analysis



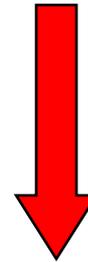
CZT Results - Benchmarks

Co-58 SG Hot Leg Piping Deposited Activity



CZT Results - Benchmarks

Co-60 SG Hot Leg Piping Deposited Activity



How do we Continue to Improve?

Co-60 Controls Dose Now



- **Shutdown/ Start-up Practices**
 - Solid PZR Ops to Permit Early Peroxide Add, +18 vs +30 Hr
 - Stability to Schedule, Shorter Time with High Activity RCS Less Dose, Work Window Opens
 - Change Nothing Else!
- **ALARA Stays Aggressive**
 - Resist Temptation to Reduce High Standards of ALARA Program as Dose Rates Continue to Drop
 - Identify Local Challenge Areas- Involve Experts
 - CZT Technology Provides DATA to Guide us to New Opportunities for Improvement

What does Future Source Term Look Like?



- **Co-58 Peaks will continue Decline**
- **SG Dose Rates will continue decline**
 - Co-60 Decay Rate
- **General Area Dose rates will Decline**
 - 25% to 35% in Stainless Steel RCS
- **Opportunity**
 - Faster Outage
 - US Low Dose Record RFO at Cook
 - World Record Low dose at within Grasp by 2015
 - (Depending on Work Scope)
- **5 Yr Plan-**
 - DC Cook-U1 and U2
 - **Near Future: > 15 to <25 REM RFO**



Questions?