

Beaver Valley Power Station Source Term Reduction Strategy, Struggles and Success

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Presentation Outline

- **Plant History and Radiological Conditions**
- **Benchmark Most Improved**
- **Unit 1 and 2 Source Term Reduction**
 - ❖ Strategy
 - ❖ Struggles
 - ❖ Successes
- **RP Metrics & Measures**
 - ❖ What's Not Improved
 - ❖ What is Improved
- **Future Plans**
 - ❖ We Know What to Fix

Beaver Valley



- **Westinghouse 3 Loop PWR**
 - ❖ Unit 1 892 MW(e)
Commercial 10/1/76
 - ❖ Unit 2 846 MW(e)
Commercial 11/17/1987
- **Number of employees: ~ 700**

Beaver Valley U2

Radiological History

Outage	Dose Goal (rem)	TLD Dose (rem)	RWP-hrs. (x1,000)	Effective Dose Rate (mrem/hr)	Effective Dose Rate (rem/day)	Duration (days)
2R01	---	369.862	---	---	4.803	77
2R02	---	290.805	---	---	3.635	80
2R03	260	245.060	---	---	4.154	59
2R04	240	198.818	---	---	2.455	81
2R05	147	171.022	152.271	1.12	3.800	45
2R06	140	168.736	243.023	0.69	1.577	107
2R07	105	81.181	135.248	0.60	1.845	44
2R08	125	105.719	143.505	0.74	3.304	32
2R09	97	63.591	98.552	0.65	2.765	23
2R10	74	97.279	153.659	0.63	4.248	28
2R11	80	75.053	101.910	0.74	3.127	24
2R12	137	174.637	167.631	1.04	4.259	41
2R13	88	79.662	139.736	0.57	2.096	38

Beaver Valley U1

Radiological History- Refueling Outages

Outage	Dose Goal (rem)	TLD Dose (rem)	RWP-hrs. (x1,000)	Effective Dose Rate (mrem/hr)	Effective Dose Rate (rem/day)	Duration (days)
1R01	---	538.076	---	---	1.516	355
1R02	---	610.16	---	---	3.113	196
1R03	---	688.449	---	---	6.495	106
1R04	---	450.3	---	---	5.298	85
1R05	---	605.185	---	---	5.933	102
1R06	---	622.56	---	---	7.592	82
1R07	---	980.094	---	---	8.449	116
1R08	450	407.729	---	---	4.118	99
1R09	390	379.677	---	---	4.574	83
1R10	275	250	240.004	1.04	3.906	64
1R11	235	249.864	223.459	1.12	5.099	49
1R12	---	223.885	270.575	0.83	1.947	115
1R13	270	208.923	226.728	0.92	4.018	52
1R14	166	151.267	192.517	1.12	3.981	38
1R15	132	185.872	211.182	0.88	3.549	52
1R16	152	141.307	158.367	0.89	5.234	27
1R17-SGR Uprate	260	207.385	450899	0.46	3.152	64
1R18	98	85.177	151.557	0.56	2.757	30
1R19	60	57.303	116.39	0.49	1.91	30

Benchmarking Goal: “Clone” Practices & Technologies to Exactly Replicate Results

- **Which Westinghouse Plants Have Shown Big Improvements in Source Term over past 8 to 10 years?**
 - ❖ Similar in Design, Age, Operating History or Huge Change
 - ❖ Looked at Dose Rates- (Published OE Results)
 - Not Outage CRE: Impacted by Emergent Work, 10 Yr ISI, etc.
- **Selected Significantly Improved Plants in Past 8 Years**
(Significantly Contaminated to Cleanest)
 - ❖ VC Summer
 - ❖ Turkey Point-3,4
 - ❖ DC Cook 1,2
- **What are they doing that we are not?**
- **Can we “Clone” their practices and technology use into Beaver Valley?**

Benchmarking: What was Common?

“CLONE” Practices & Technologies to Exactly Replicate Results

- Shutdown Practice
 - ❖ Acid Reducing Chemistry + 12-16 HRS
 - ❖ RCP Operation for Forced Oxygenation: 1 RCP or None
 - ❖ Maximize Clean-Up Flow Rates $T_{1/2} = 4-8$ hours
- Technology- Clean-up in CVCS
 - ❖ Advanced Electrostatic Resin Specifically Engineered for Extremely Small, Surface Charged, Particle Removal Used PRC-01
 - Shutdown, I/S $T = 2$ hrs
 - New Charge & Used for Start-Up
 - Single Vessel I/S for Shutdown
 - ❖ No Zinc
- Results
 - ❖ Declining Dose Rates and Contamination Levels
 - ❖ Sustained Dose Rate Reductions, -30% to -35% for 7 cycles

Benchmarking: How Good are they Today?

Snapshot

- DC Cook-2
 - ❖ ~ 110 to 150 REM 30 Day RFOs 4 cycles ago
 - ❖ 32.3 REM, 30 day U2C18

- Turkey Point 3, 4
 - ❖ ~ 150 to 190 REM RFOs 7 Cycles Ago
 - ❖ 4R24 2009: 75.617 REM, 40 Days

- VC Summer
 - ❖ ~150 to 170 REM 7 cycles ago
 - ❖ R18: 59.442 REM ED, Est. TLD 49 REM
 - ❖ 30 PCE's
 - ❖ 0.052 uCi/cc Co-58 H2O2 Peak (Yes Peak)
 - ❖ SG Bowl Dose Rate Change: R12 to R18= -57%, R18 SG Avg 1.174 R/hr

Selected Initiatives for Beaver Valley Source Term Reduction

- **Our Strategy: “Clone” Plants with Greatest Change**
- **Beaver Valley U1 U2 Shutdown Chemistry Strategy**
 1. Rapid RCS Cooldown
 2. Reduced Inventory Crud Burst
 3. Maximized Letdown Purification Flowrate
 4. EPRI Clean-Up Goal $\leq 0.05\mu\text{Ci/ml}$ Prior to Rx Cavity Flood-up
 5. U1 U2 PRC-01M Speciality Media Technology:
 - Prototyped PRC-01 U1R14 2001
 - Second Generation PRC-01M, Advanced Technology Now In Use
 - Application in SFP and CVCS
 6. U1 Zinc Injection 6 cycles
 - U2 SGR & Uprate 1R18 -No Zinc

BVPS Shutdown Plan Execution:

- **Very Rapid Cooldown Rate**
 - ❖ 1R19: Mode 5 in 6.3 hrs
 - ❖ 2R14: Mode 5 RCS 200°F in 5.3 hrs - (record)
- **Reduced Oxidation RCS Inventory**
 - ❖ Typically 2 of 3 Loop Stop Valves
 - ❖ A & B Loop Closed Prior to Peroxide Injection
- **Time to Peroxide Injection (Most Recent Outages)**
 - ❖ 1R19 = 21 Hrs
 - ❖ 2R14 = 22 Hrs
- **Shutdown CVCS Clean-Up Bed In Service**
 - ❖ 1R19: T= ~ 1 hr as Planned, RCS Temperature 494° F
 - ❖ 2R14: T= +4 hrs vs ~1 hour as Planned, 281° F
 - Failure of Reach Rod 2R12, 2R13 and 2R14

Shutdown Plan Execution:

- **Time to Clean-Up from Oxidation to 0.05 uC/cc Goal,**
 - ❖ 1R19: Actual 57 hrs. (1 Loop Isolated)
 - ❖ 2R14: Actual 43 hrs. (1 Loop Isolated)

RP Source Term Metrics

- **Components**
 - ❖ RV Head
 - ❖ Steam Generator - HL CL Averages
 - ❖ Bowl Dose Rates Unit 2
- **PCE's Lower**
- **Effective Dose Rate**

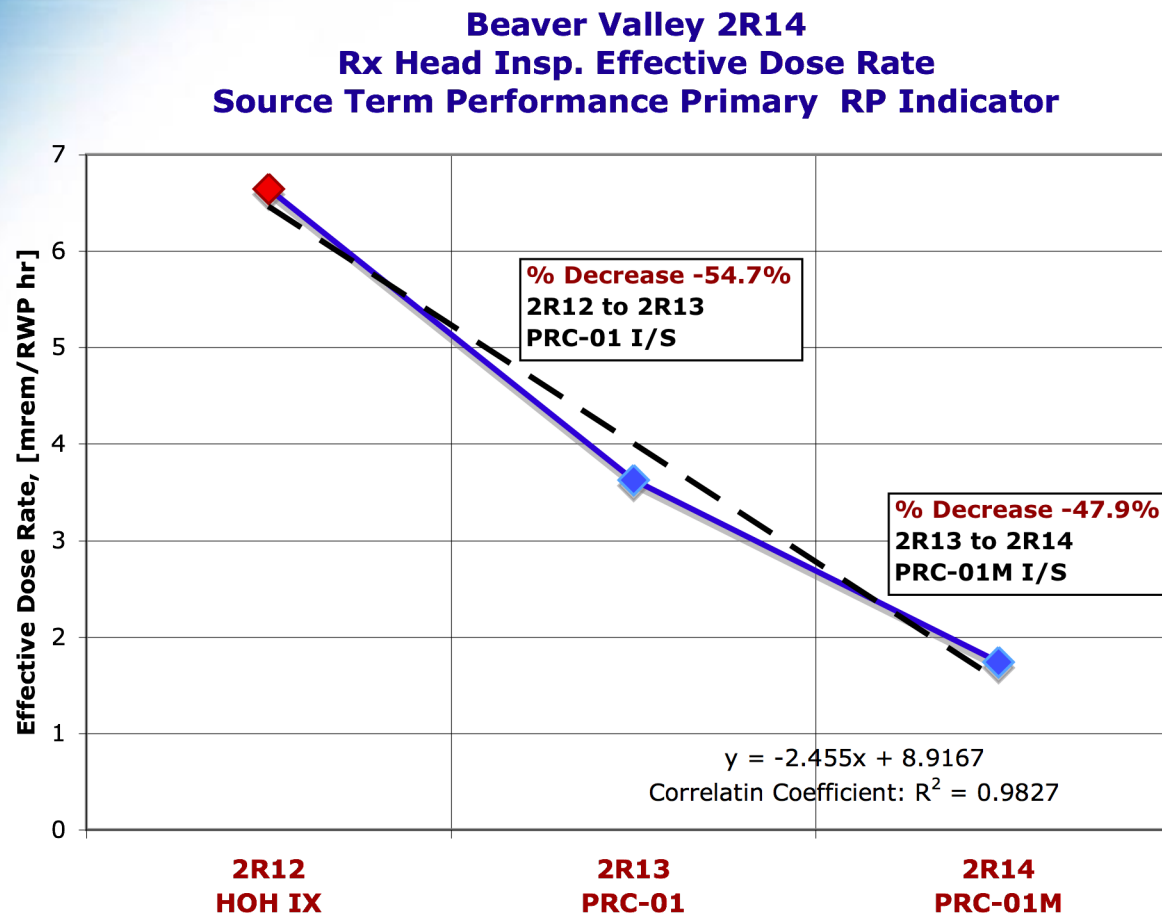
Outage Struggles 2R14

➤ U2R14

- ❖ Loop B Higher Dose Rates
 - No Letdown Purification During First 4 Hours of RCS Cooldown
 - RCS at 281°F when PRC-01M Bed placed I/S
- ❖ Emergent Work
 - Extensive Alloy 600 Weld Repair Issues
- ❖ CVCS Purification Demin Not Available on Start-Up
 - Demineralizer Valve Reach Rod Failure
 - 5 Days of No RCS Clean-Up at Start-Up

2R14: What's Evidence of Lower Source Term?

Components: Rx Vessel Head Effective Dose Rate



Outage Struggles 1R19

➤ U1R19

- ❖ Emergent Work
- ❖ CVCS Purification
 - 2 Vessels Loaded with 2 Different Media
 - Operated in Parallel MB Bias flow Away from Specialty Resin Bed
 - 110 GPM to 140 GPM
 - Specialty Resin Demin Not Available on Start-Up for 5 days
- ❖ SFP Demin Not Configured with Specialty Resin

1R19 PCE Performance

- The Station ALARA Managers Committee established a top-quartile goal of 30 events with a stretch goal of 25
- The probable causes and locations

CATEGORY	TOTAL NUMBER	PERCENT OF TOTAL	AREA	TOTAL NUMBER	PERCENT OF TOTAL
Equipment/material uses	13	39%	Leg / knee	22	67%
Workers preparation practices	10	30%	Torso	7	21%
Equipment condition	5	15%	Arm	2	6%
Workmanship	4	12%	Foot	1	3%
Environmental conditions	1	3%	Face	1	3%

- Twenty-seven of the thirty-three or 81.8% of the events are attributed to Human Performance (HuP) error

Post Outage Issues

- **1R 18: Difficulty Sluicing Specialty Resin Bed**
 - ❖ Weak Acid Macroporous Substrate
 - ❖ Modified Surface Chemistry
 - ❖ Radiation Degradation Probable Cause

- **Corrective Action 1R19:
Changed to Second Generation Technology,
PRC-01M (Modified)**
 - ❖ Changed to Turkey Point 3,4 Use of PRC-01M- No Sluicing Issues
 - ❖ Strong Acid Cation Gel Resin Substrate
 - ❖ Modified Surface Chemistry

2010 Plan for Improvements

- **Extending Use of Specialty Resin**
 - ❖ Start-Up and On-Line Use
 - ❖ Continuing Shutdown Use
- **Strengthen Source Term Monitoring Program**
 - ❖ Correlation with Chemistry
 - ❖ Electronic Dosimeters Used as Constant Radiation Monitors on Components
 - ❖ Evaluating Use of EdF Method Source Term Monitoring
 - CZT Detectors
 - Measuring Deposited Activity, uCi/dm²
 - Standardized EdF Method
- **Outage Pre-Planning and Maintenance**
 - ❖ Reach Rod Repairs at U2 - Problem in Past 3 Outages

Thank You!

Questions