

Braidwood 2015 Refueling Outages ALARA Successes

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Braidwood

- ✓ Westinghouse 4-Loop PWR
- ✓ Unit 1
 - Began commercial operation July 29, 1988
 - 3645 MWt 1273 MWe
 - 690 S/G tubing
- ✓ Unit 2
 - Began commercial operation October 17, 1988
 - 3645 MWt 1236 MWe
 - Unit 2's have 600 TT SG tubing



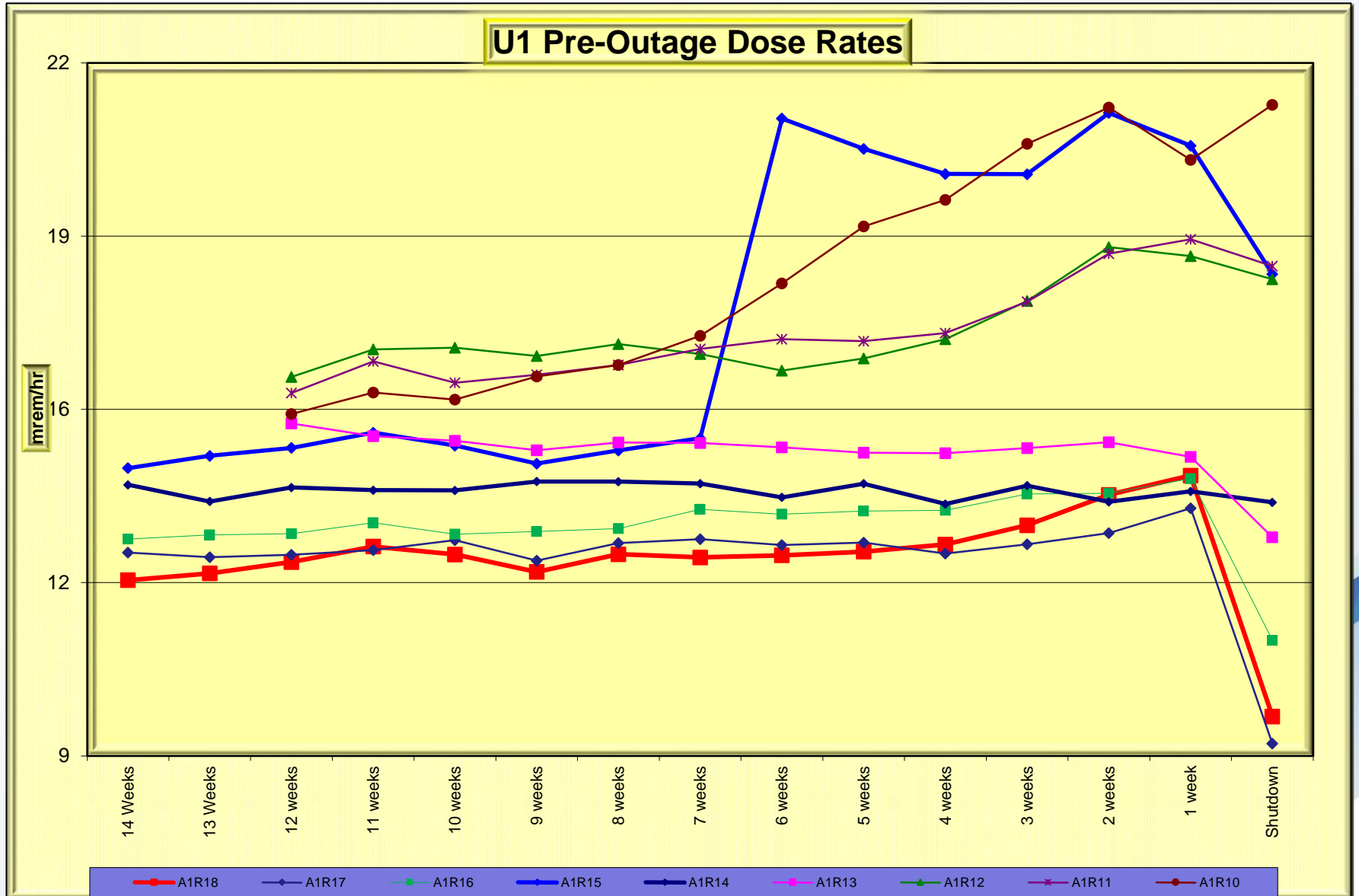
A1R18 Major Work Completed

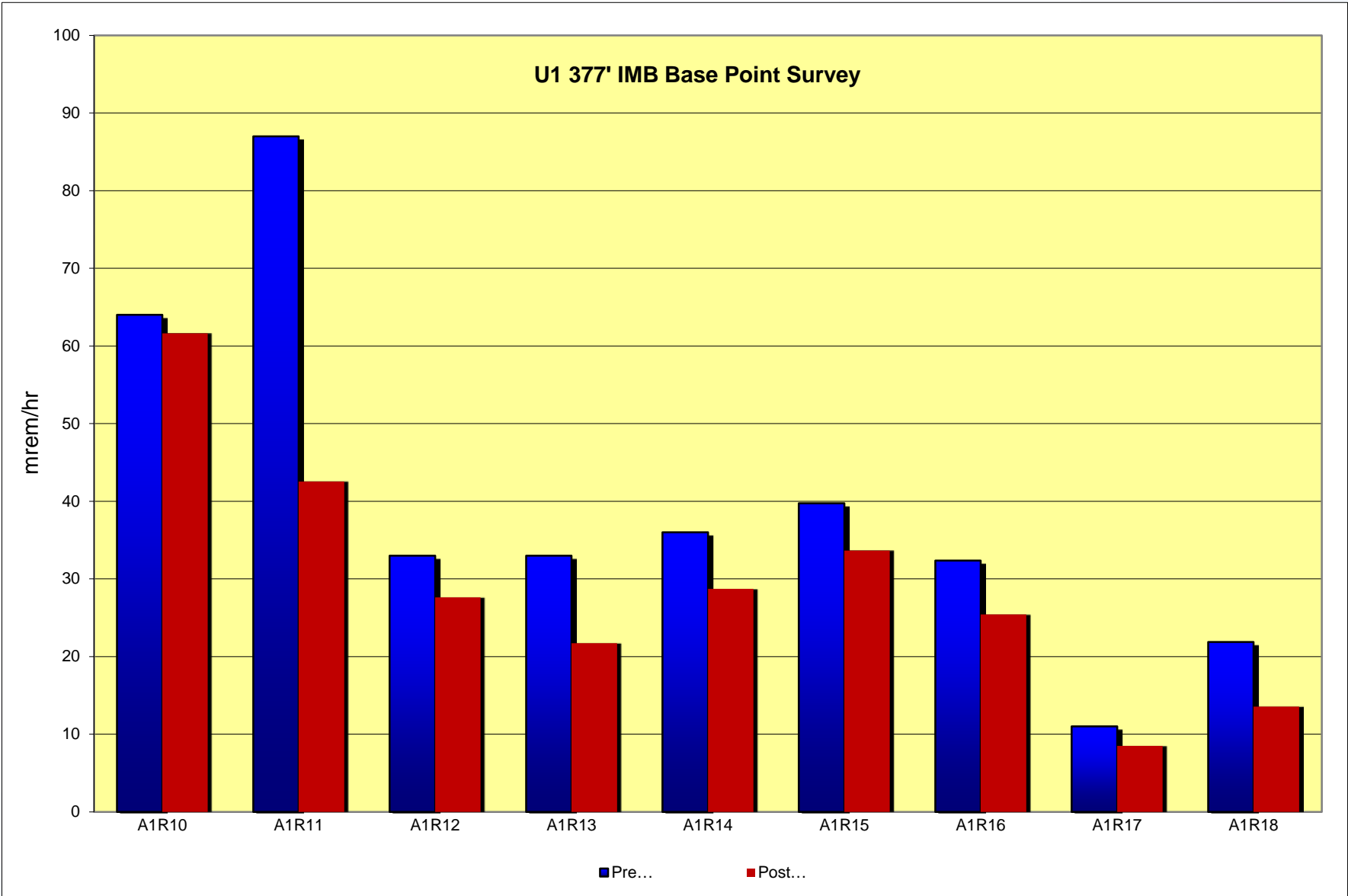
- ✓ (3) RCP Seal replacements
- ✓ 1B CV Pump Seal Replacement
- ✓ Flex Mod to ECCS
- ✓ Flex Mod to AF lines
- ✓ AF Suction Swap Over Mod
- ✓ Reactor Head Inspections and Pen 69 Repair

A1R18

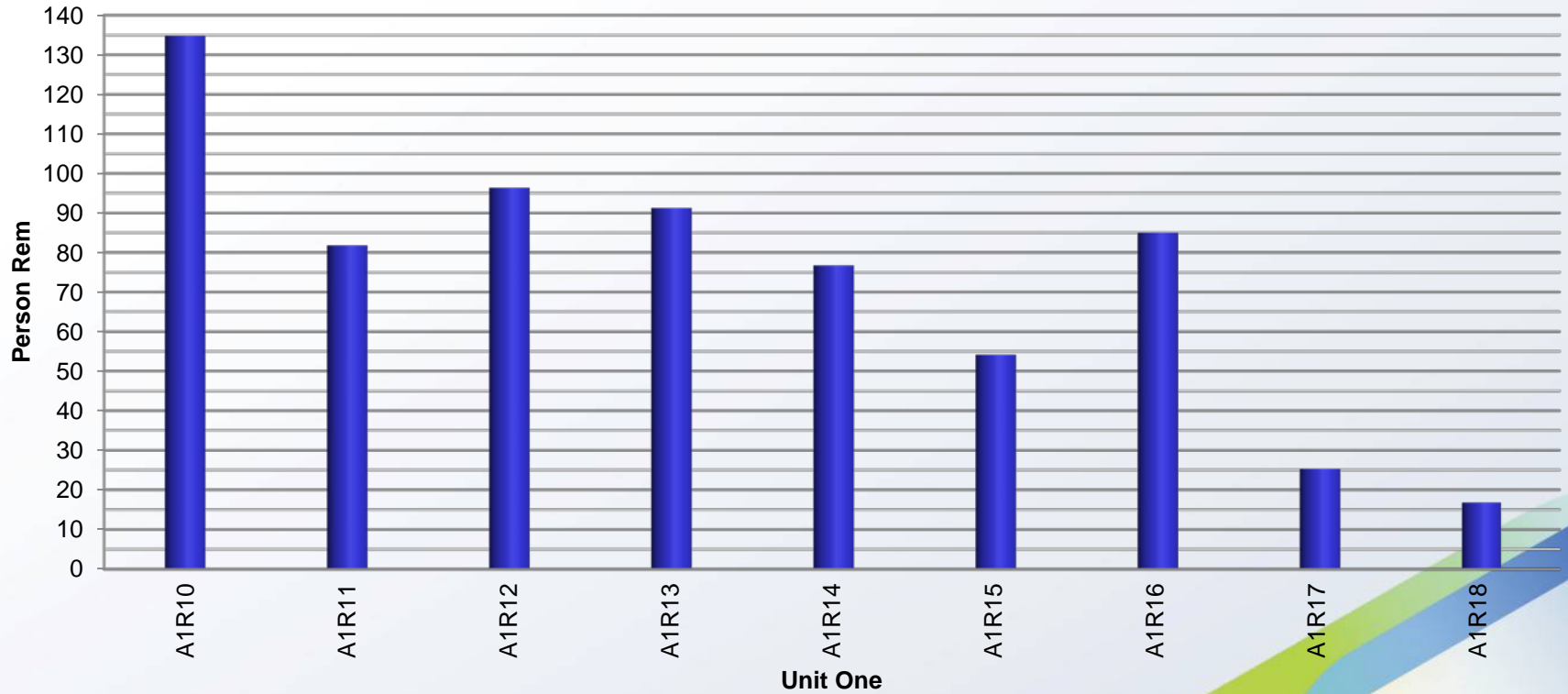
- ✓ 16.766 person-rem
- ✓ No radiological events
- ✓ 19 days 6 hours 21 minutes
- ✓ PCE's: (3) Level 1, (1) Level 2 & (1) Level 3
- ✓ Elevated pH program at 7.4
- ✓ Fourth cycle of Zinc injection
9-month partial @ 5 ppb, last 2 months at 10 ppb
- ✓ Coast down 19 days with EOC Boron @ 10ppm
- ✓ Fourth RFO with PRC-01M overlay
Second online cycle with PRC-01M overlay
- ✓ 9h RCP pump run post peak of 0.788 $\mu\text{Ci/g}$.

Unit One Pre-Outage Dose Rates





Unit One Refueling Outages



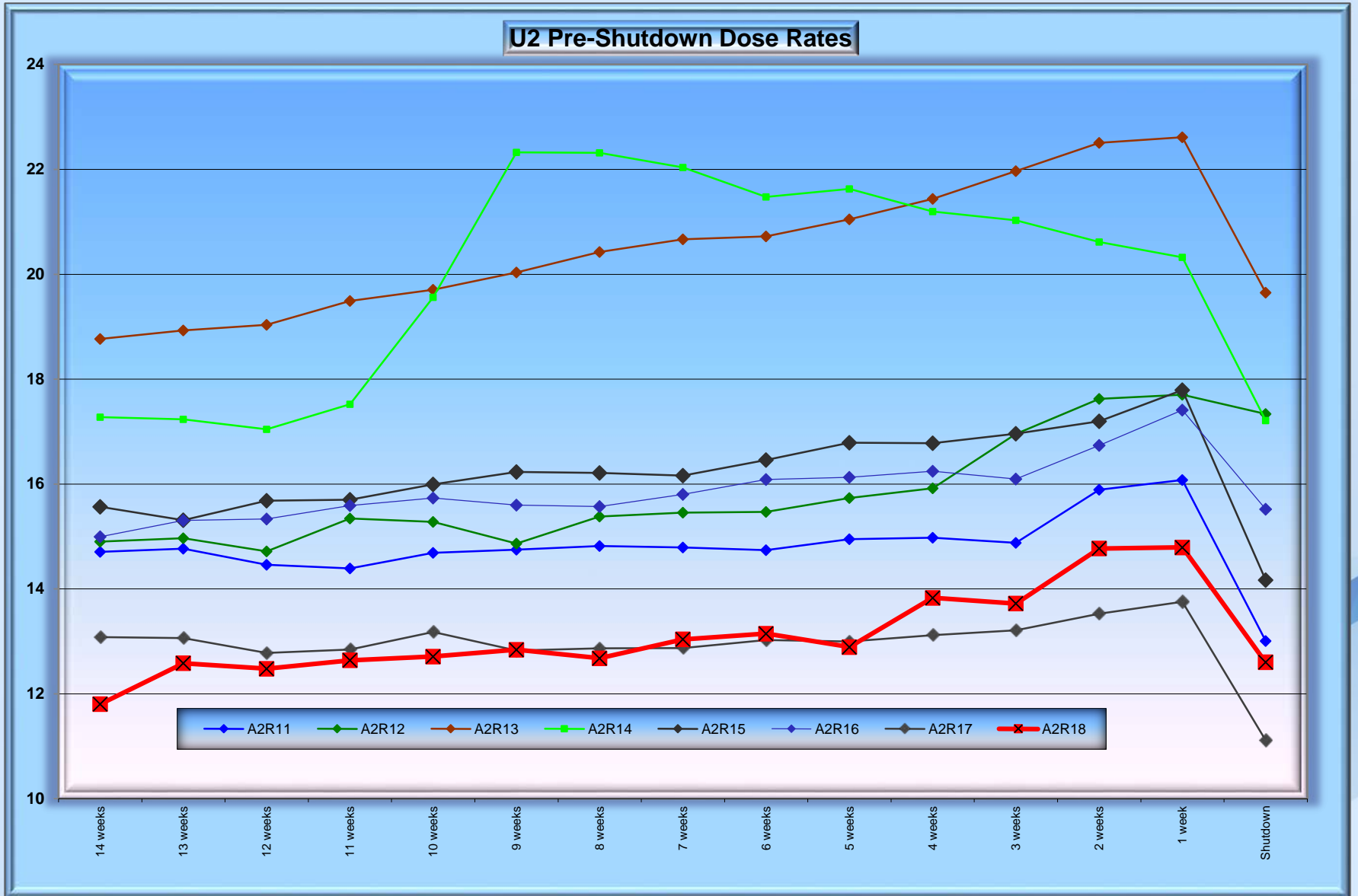
A2R18 Major Work Completed

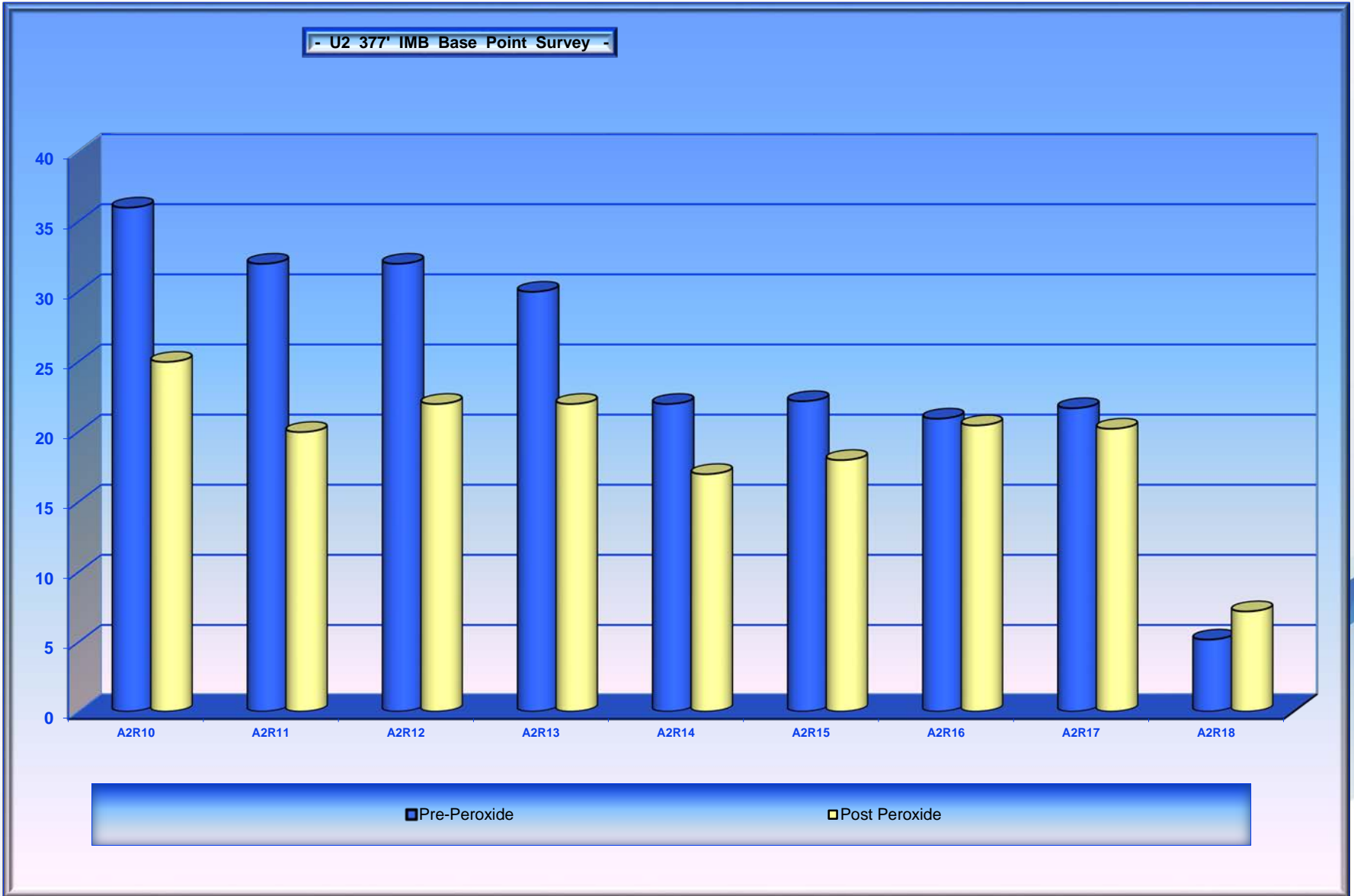
- ✓ N32/N36 Detector Replacement
- ✓ 2A, 2B, 2C, 2D RCP Seal replacements
- ✓ 2A CV Pump Seal Replacement
- ✓ 2SX143B/150B Valve Replacements
- ✓ Flex Mod to ECCS
- ✓ Flex Mod to AF lines
- ✓ AF Suction Swap Over Mod
- ✓ Steam Generator Bowl Drain Mod

A2R18

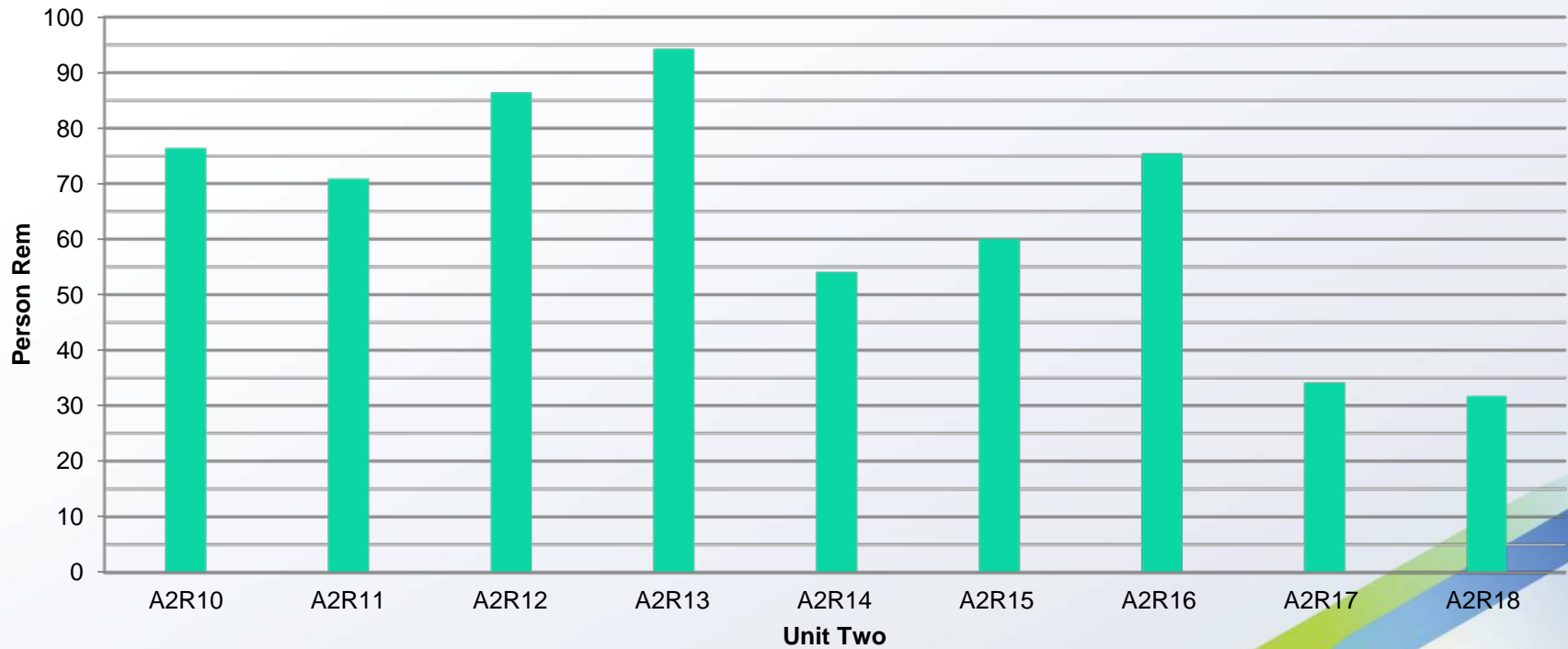
- ✓ 31.718 person-rem
- ✓ No radiological events
- ✓ 18 days 16 hours 26 minutes
- ✓ PCE's: (25) Level 1, (2) Level 2 & (1) Level 3
- ✓ Elevated pH program at 7.4
- ✓ Seventh cycle with Zinc injection
Full Cycle @ 8 ppb, 70 day Curtail
- ✓ Coast down 19 days with EOC Boron @ 10ppm
- ✓ Fourth RFO with PRC-01M overlay
Second online cycle with PRC-01M overlay
- ✓ 21h RCP pump run post oxidation peak of
2.93 μ Ci/g

Unit Two Pre-Outage Dose Rates





Unit Two Refueling Outages



Month by Month

Braidwood Lowest Exposure (ED Readings) by Month in Rem

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2002	1.971	0.859	1.447	65.840	21.563	1.257	0.576	0.490	0.534	0.678	1.053	0.839	97.107
2003	2.571	2.056	2.022	138.826	5.772	5.747	1.715	1.158	2.798	3.768	81.376	1.042	248.851
2004	0.925	1.725	1.348	0.775	0.497	0.491	2.186	1.154	2.802	91.409	1.129	0.924	105.365
2005	1.859	1.523	1.542	73.332	6.134	1.142	1.414	0.964	3.678	2.630	1.338	1.385	96.941
2006	1.014	1.691	2.091	103.713	2.480	1.055	0.638	0.990	1.158	88.808	1.780	1.259	206.677
2007	0.597	0.362	0.679	0.729	0.579	0.594	0.578	0.859	2.108	97.991	1.077	0.395	106.548
2008	1.290	1.646	1.230	52.347	50.737	0.647	0.503	0.784	0.830	0.975	0.733	0.575	112.297
2009	0.853	1.327	1.494	69.700	0.975	0.929	0.918	1.393	1.026	59.362	1.682	1.275	140.934
2010	1.065	0.843	2.316	0.548	0.616	0.851	0.564	1.247	1.872	63.752	3.099	1.596	78.369
2011	1.339	0.966	1.505	51.160	17.588	0.480	1.327	0.788	0.445	0.996	1.251	1.387	79.232
2012	0.855	0.824	0.925	60.438	42.065	0.841	0.611	1.312	0.731	80.658	12.753	0.678	202.691
2013	0.782	0.777	0.603	0.691	0.789	1.970	1.210	0.669	34.027	0.928	0.635	0.517	43.598
2014	1.579	0.340	0.597	1.457	43.436	0.780	0.380	0.380	0.867	0.524	0.295	0.382	51.017
2015	0.583	0.545	4.111	21.792	0.275	0.665	0.353	0.447	0.883	42.355	0.363	0.236	72.608

The All-Time Monthly Exposure Record for Braidwood was achieved in May 2015 with 0.275 Rem

Best year 2013; 43.598 rem (With One RFO)

Best year 2015; 72.608 rem (With Two RFOs)

- Braidwood All-Time Station Monthly Exposure Record
- Denotes lowest collective exposure in a specific month.
- Denotes 2nd lowest collective exposure in a specific month.

Braidwood Implementation of Innovative Ideas

Industry Benchmark Lesson Learned

- ❖ Oskarsham and Forsmark were benchmarked in 2003 and the first lesson learned concerning elemental cobalt and its association with FME in primary system piping that has an unfiltered pathway to the core. Testing and sampling techniques were observed and lessons learned from the Swedish plant.
- ❖ Ft. Calhoun was benchmarked in 2005 and lessons learned concerning:
 - Use of Rx Cavity elevator . The station has since installed cavity elevators in both units.
 - Association of pressurizer back up heater on-line use and reduced dose rates on the pressurizer surge and spray lines during outages were observed. RY Backup Heaters have been used during on-line periods but sparingly. However, when used tasks associated with the pressurizer have been identified so proper dose estimates can be evaluated.
- ❖ San Onofre, St. Lucie and Vogtle were benchmarked in 2005 for use of remote monitoring. The station has since implanted remote monitoring systems and has continually improved performance.
- ❖ Seabrook was benchmarked in 2006 when lesson learned concerning isolation of an RH Train before the addition of hydrazine and starting of 3rd RCP at the end of an outage. This has since been an integral part of outage scheduling.
- ❖ Sizewell B was benchmarked in 2007. It was their experience with End of Cycle (EOC) Boron that led to the station developing a baseline which could be expanded on if circumstances permitted. The results have shown positive influences with collective radiation exposure (CRE) during the final few weeks of the fuel cycle and during the first day of an outage.
- ❖ McGuire was benchmarked in 2007 for an upcoming Pressurizer Weld Overlay. The benchmark lessons learned substantially reduced overall project dose.

Braidwood Implementation of Innovative Ideas

Technology:

- ❖ Rad Guns usage. During U2 Steam Generator Maintenance 500 mrem of personnel exposure is avoided using this tool verses. Also use the tool for high dose rate valves or components when possible.
- ❖ Hydraulic Nuts installed on Pressurizer Safety Relief Valves and Excess Letdown Heat Exchanger. The ELHX has leaked for over 20 years and all engineering attempts to eliminate that leakage were ineffective until hydraulic nuts were installed. Since the installation, no leaks have occurred in over 5 years. Pressurizer Safety Valves used to expend 300-400 mrem to replace. Now they expend 70-80 mrem.
- ❖ Q-Track use during Mock-Up training. MSIP and S/G mock-ups now use simulated dose rates to prepare workers to expected dose rate fields and usage of Alara techniques such as avoiding hot spots, backing away from sources or low dose area usage.
- ❖ Increase use of large area dose rate displays and marquees for worker awareness.
- ❖ Use of Poly-acrylic Acid (PAA) in S/G secondary side has reduced dose to perform Sludge Lancing by 150 mrem/outage.
- ❖ Prior to cavity drain down activities, a total of 24 liters of 30% hydrogen peroxide was added to cavity. Using the peroxide reduced the plate out of particulates on the cavity walls during cavity drain down which helped reduce plate out of contamination on cavity surfaces and minimize decon duration and dose

Braidwood Implementation of Innovative Ideas

Work Processes:

- ❖ Implemented Effective Dose Equivalent (EDE) program. This method of more accurately determining actual dose workers are exposed to reduced overall dose for several projects during a refuel outage.
- ❖ Abandoned Off Gas (OG) 79/80/84 valves. The abandonment eliminated LLRTs and PM program dose associated with these valves.
- ❖ U1/U2 SI 8948 check valve flow scan inspection was relocated from valves to SI Accumulator where they now do flow measurements. This item saves 250 mrem/outage.
- ❖ Containment Access control guards were installed on both U1 & U2 Containment Hatches. This eliminated RPT requirements at 426' cross-town neutron area during containment entries.
- ❖ Installation of a permanent bridge in the lower cavities. The bridge eliminated installation / removal of safety scaffold during outages
- ❖ Use of quick disconnects for ECCS vent/valve surveillance resulted in 200 mrem/year dose savings.
- ❖ Use of Long Life light bulbs in plant.

Braidwood Implementation of Innovative Ideas

Shielding Program:

- ❖ Development and Industry first use of “Smitty Shields” for quick and easy installation of shadow shield racks in the plant. The “Smitty Shield” have become standards at many plants across the industry and received an Exelon CNO innovative design award.
- ❖ Developed and implemented a “Spot” Shielding procedure that has an engineering design change already embedded into the procedure. The procedure is now used throughout the Exelon Fleet. The procedure provides easy use of temporary shielding without stopping work to get an analysis because weight limitations and system configurations are already approved.
- ❖ Installed permanent shielding frames in all 4 RC loops in lower containment. 230 mrem of dose avoided each outage hanging temporary shielding on these loops.
- ❖ Increased amount of shielding permanently stored in Unit 1 and 2 reactor containment building.
- ❖ Industry first use of magnetic shielding under the upper head near CRDM penetrations. Industry personnel said it could not be done but with a collaborative effort with Nuclear Power Outfitters (NPO) the shielding was proven to be effective. Many utilities and vendors in the industry are now pursuing and designing various applications to reduce Rx Head dose rates for CRDM inspections.
- ❖ Steam Generator secondary side water inventory was maintained at 80-90% minimum for work on 401’ pump deck. Historically S/G secondary side levels were 67% which made A1R17 the first time we have increased the level to 90%. Secondary side water inventory levels were monitored by the OCC and Outage Planning to ensure work activities were scheduled and worked at the optimum times.

Braidwood Implementation of Innovative Ideas

Source Term Reduction

- ❖ Braidwood work with PALL filtration to develop industry first 0.05 sub-micron filter for CV Letdown Demin. These filters are now used industry wide in Letdown Demins and Cavity Tri-Nukes
- ❖ A1R17 unit shutdown EOC Boron was 132 ppm. Pre-Outage period saw no substantial dose rate increases, which kept pre-outage dose rates minimized. Shutdown dose rates were the lowest in history which helped minimize collective radiation exposure during pre-outage periods and pre forced oxidation period (day 0) of the outage.
- ❖ A1C17 primary coolant pH program is a modified elevated pH program. Following the cycle boron peak, the at-temperature pH is ramped to 7.4 and maintained through end of cycle. At a pH of 7.4, Braidwood is among the highest RCS pH in the industry.
- ❖ Testing of valves after maintenance for elemental cobalt.
- ❖ During A1C17 DZA was injected for a partial cycle, due to CIPs evaluation, starting 1/23/13 at a target of 5 ppb zinc. Technical evaluation per EC 374189 resulted in allowance to raise the zinc target to 10 ppb during a two month period to allow Braidwood fuel inspection results to reflect Byron's cycle 19 past zinc strategy.

Conclusion

- ❖ Perspective of a new RPM



Thank You!