



BRAC and SRMP Revision

2012 – 2013 EPRI Project

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Improved BRAC and SRMP

Value Statement:

Identify and standardize an improved set of radiation monitoring points improving quality and comparability while expanding the type of data available for analysis.

Overview

- EPRI Standard Radiation Monitoring Programs
 - BRAC – BWR Radiation Level Assessment and Control
 - Overview and Impact
 - SRMP – PWR Standard Radiation Monitoring Program
 - Overview and Impact
- 2012-2013 Project – Improved SRMP and BRAC

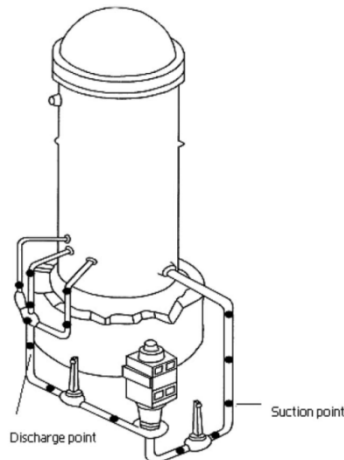
Standard Radiation Monitoring Programs

BRAC and SRMP

Dose rates representative of activity incorporation into piping oxide films during operating cycle.

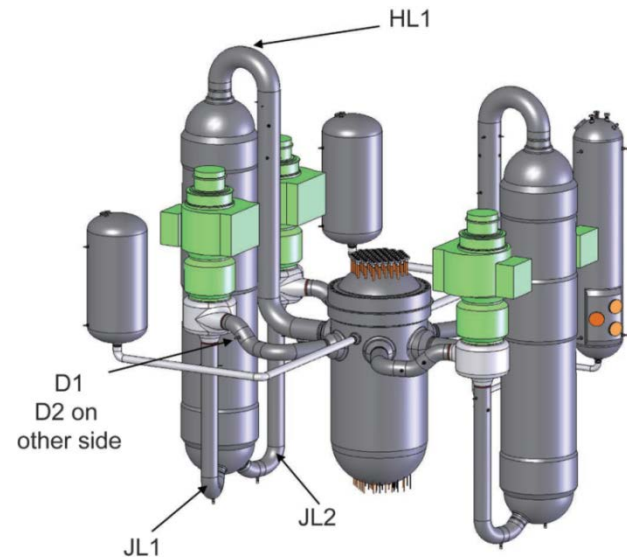
BWR Radiation Level Assessment and Control

- 1977 – current
- Long running data collection program
- 2011 Report (1023028)



PWR – Standard Radiation Monitoring Program

- 1978 to 1996, 2005 – current
- 2011 Report (1023020)



BWR Radiation Level Assessment and Control Program (BRAC)

- GE Water Chemistry Program Extension
 - GE Document NEDC-13361-01 (1973)
- BRAC program jointly funded by EPRI and GE
- GE Document NEDC 12688 (1977)
- Documented a standard systematic approach to dose rate monitoring
 - Systems/Instrumentation/Timing
- Goal of developing a predictive BWR radiation buildup model
- Material/Operational changes to reduce occupational exposure

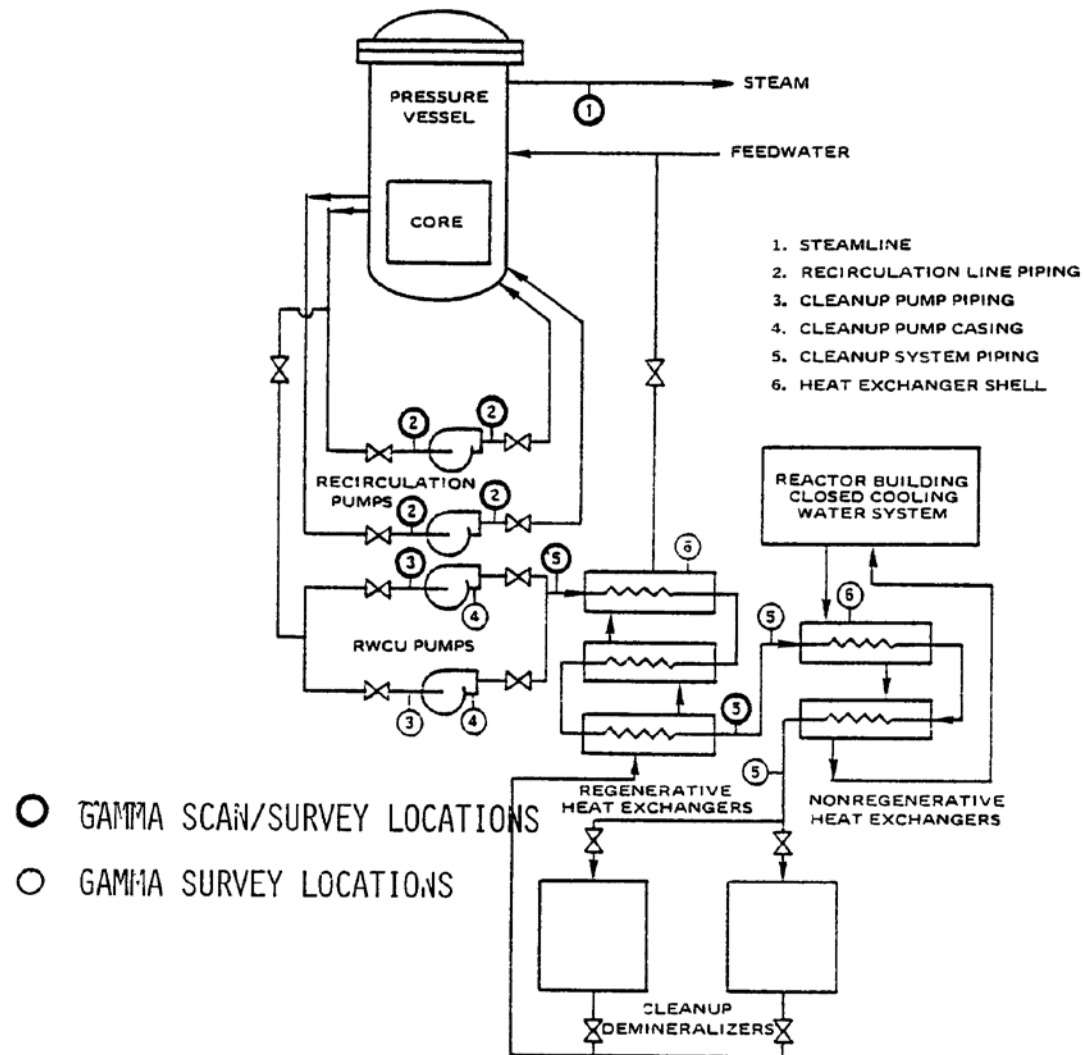
BRAC Survey Locations and Timing

Survey Locations

- RWCU System
- Recirc System
- Main steam lines
- Moisture separator reheater
- Undervessel

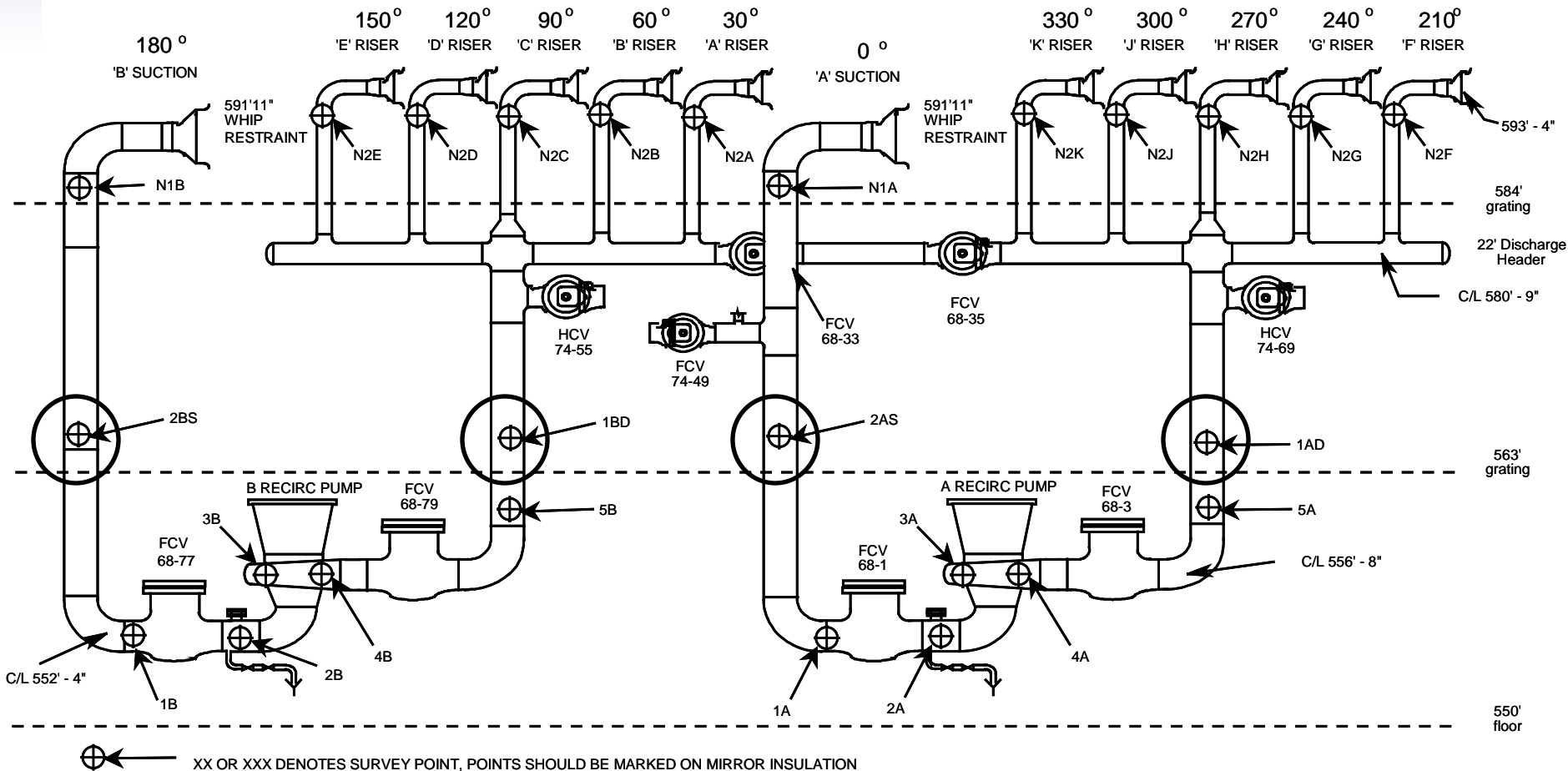
Timing of Surveys

- Every refueling outage (minimum)
- Extended mid-cycle forced or maintenance outages
- 7-14 days after shutdown



Standard BRAC Points

Majority of Data



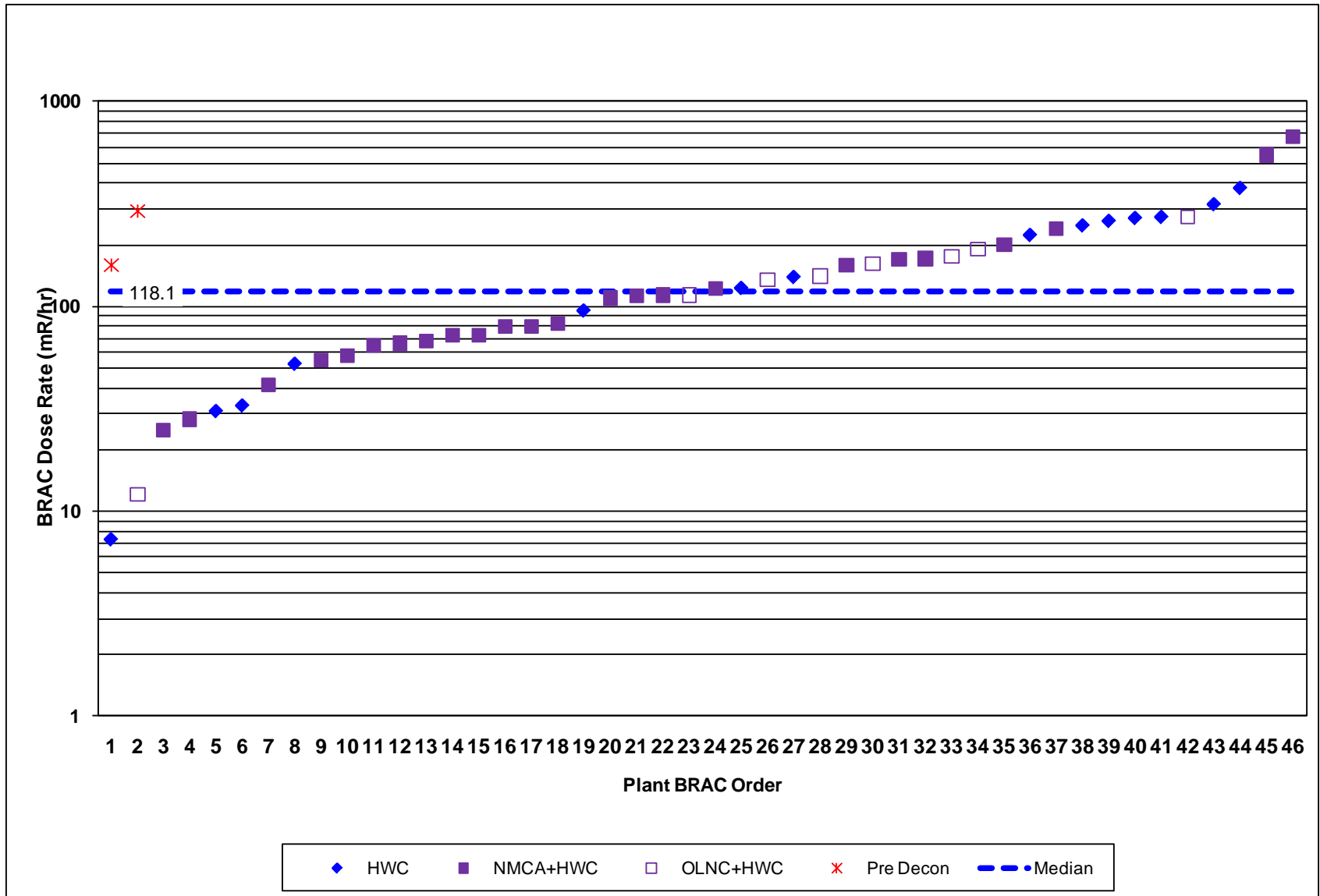
BWR-BRAC Benchmarking Report

2011 Results 1023028

- **2011 report includes data from 46 of 49 participating units**
 - 37 operating North American, 5 European, and 4 Taiwanese BWRs
- **Average of reactor recirculation suction and discharge contact dose rates**
 - Measured with shielded directional probe
- **Annual Benchmarking Reports**
 - Published in last half of the year
 - Utilities receive a report with their plant identified

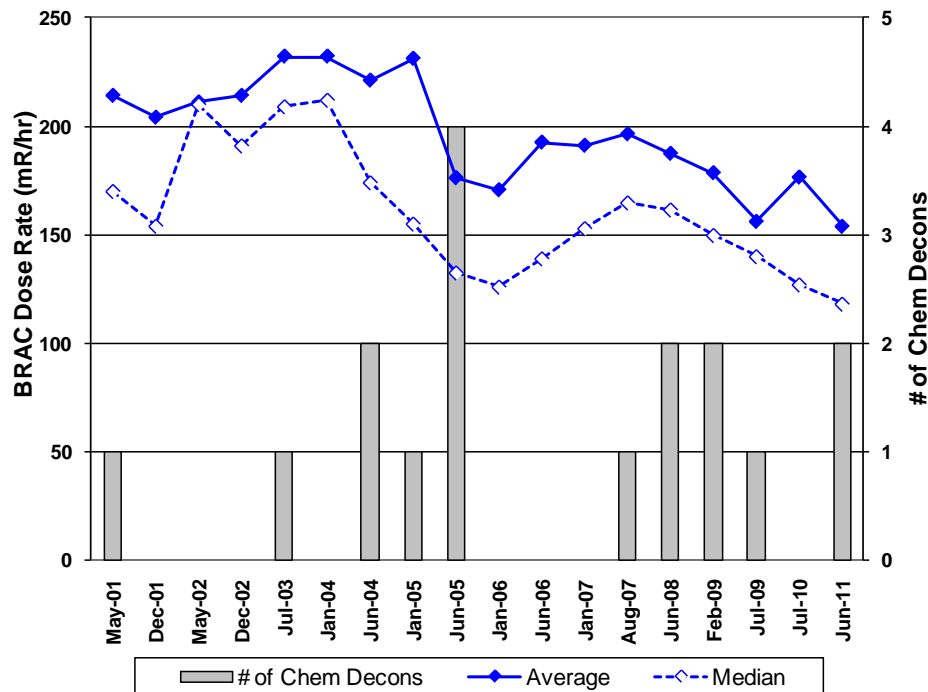
BWR-BRAC (1023028)

Dose Rates by Chemistry Regime

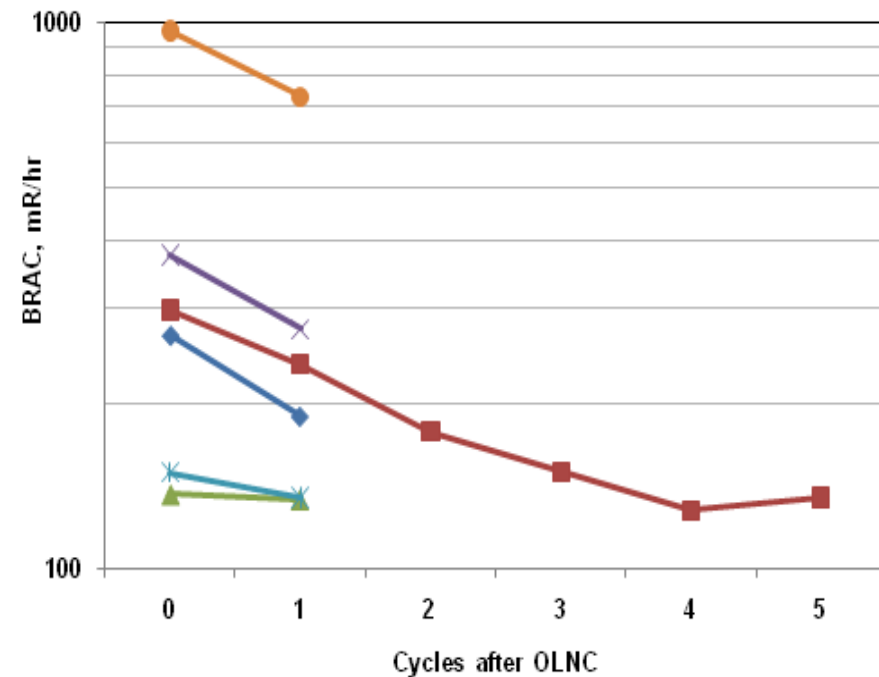


Impact of BRAC Program

Historic BRAC Average and Median 2001 – 2011



BRAC Dose Rate and OLNC Applications*



*Trend complicated with more recent data.

PWR Standard Radiation Monitoring Program (SRMP)

- Instituted in 1978, designed to capture Westinghouse plant dose rate data
- Goals stated in 1978
 - Provide meaningful, consistent and systematic approach to dose rate measurements
 - Provide reliable data for comparisons to other plants
 - Monitor plant parameters that affect radiation fields
 - To use the data to identify plant features, materials, and operational techniques that help control fields
- In 1996, lack of industry interest and reduced funding limited the SRMP scope
- Reinstated 2007 (RP 2020 Initiative)

Standard Radiation Monitoring Program

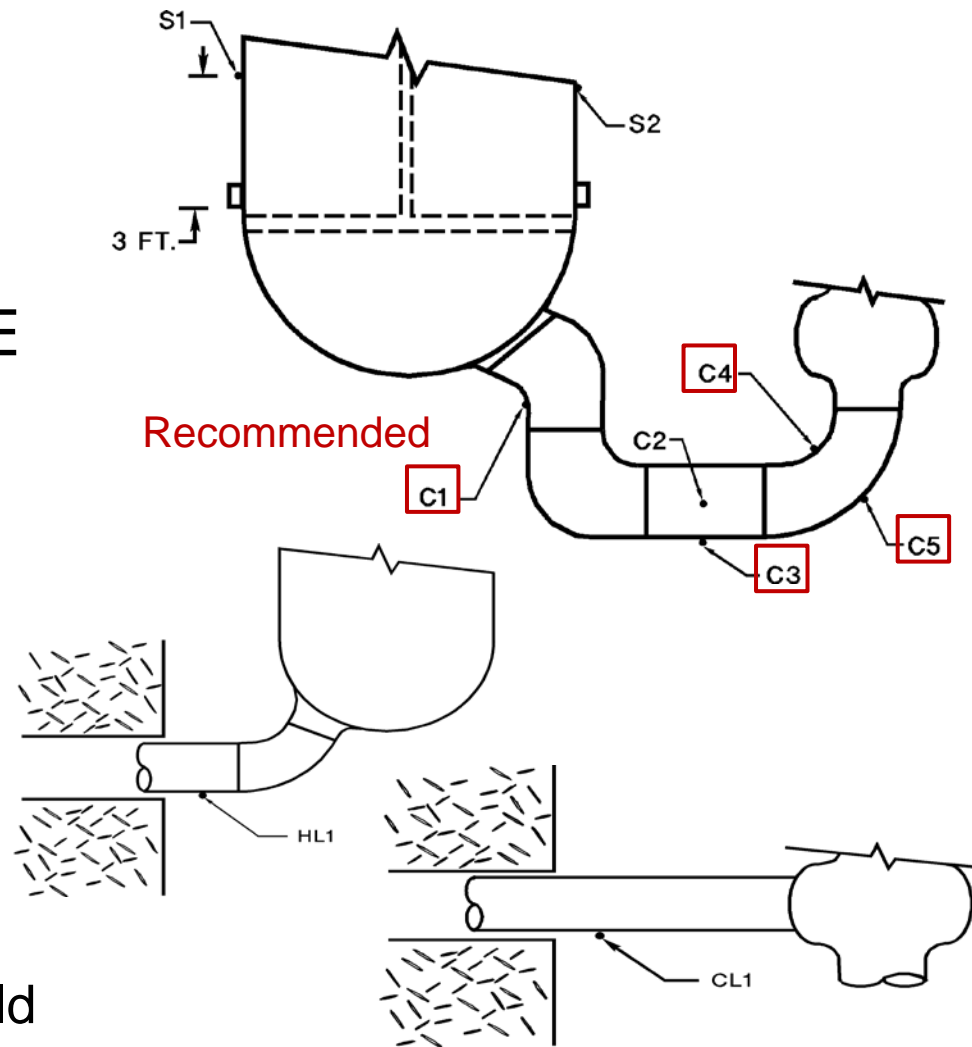
2007 Version (Current)

- Procedures available for all three western PWR designs, Westinghouse, Combustion Engineering, and Babcock & Wilcox
- Procedures include 'Required Points,' 'Recommended Points,' and 'Optional Information.'
- Data should be collected within 24 hours after completion of forced oxidation cleanup
 - Data collected prior to forced oxidation also submitted if available
- Majority of data collected by conventional (unshielded) probe

Required SRMP Points

Loop Piping

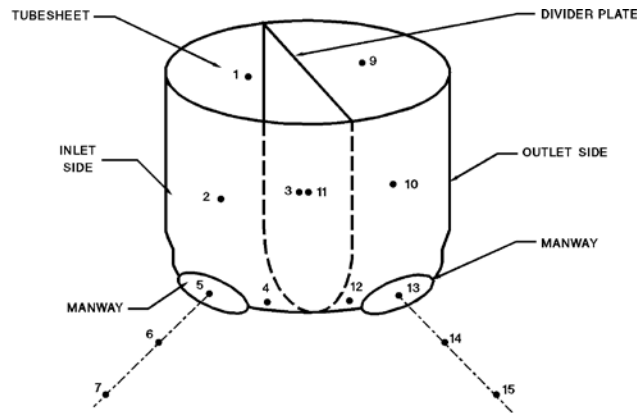
- Required for All Designs
 - Straight section of crossover/crossunder piping, side of pipe
- Required only for W and CE
 - Bottom of hot leg piping between SG inlet and reactor vessel shield
 - Bottom of cold leg piping between RCP and reactor vessel shield
- Required only if previously collected
 - Outside of SG, hot leg and cold leg sides



Required SRMP Points

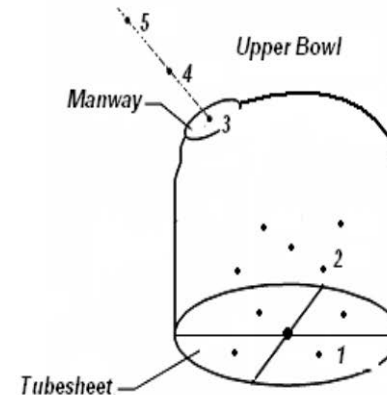
Channel Head

Westinghouse



- Required for W and CE
 - Midpoint of tubesheets
 - Channel Head Centers
 - Center of Divider Plate (W), Stay Cylinder (CE)
 - Bottom of Channel Head

Babcock & Wilcox



- Required for B&W
 - Highest general area dose rate and contact with the center of the tubesheet (upper & lower bowls)
 - 30 cm above highest dose rate tubesheet point of upper/lower bowl

Optional Information

- Generation (nonspecific) locations
- Westinghouse and CE Points
 - Letdown piping
 - CVCS heat exchanger (on the shell)
 - RHR piping
 - RHR heat exchangers (on the shell)
 - Refueling water surface
- Babcock and Wilcox Points
 - Decay heat piping
 - Cooler inlet piping
 - Decay heat pump suction

RHR Piping

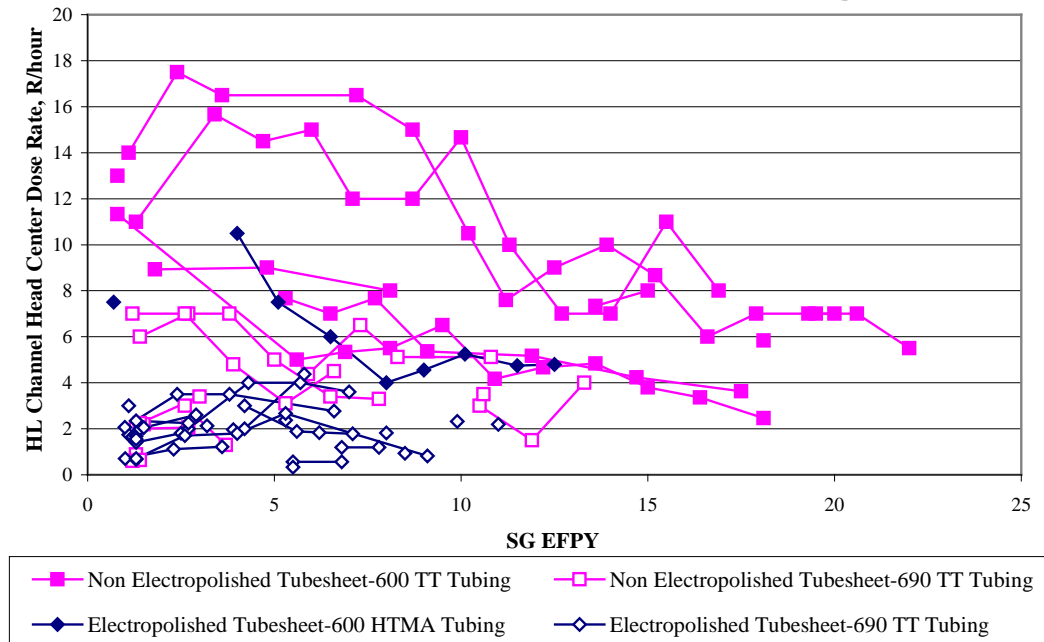


Impact of Reinstated SRMP Program

- Enhanced evaluations of source term reduction technology

- *Source Term Reduction: Impact of Plant Design and Chemistry on PWR Shutdown Releases and Dose Rates (2006, 1013507)*
- *Technology Evaluation and Operations Strategies for PWR Radiation Source Term Reduction (2008, 1016767)*
- *Plant Specific Recommendations for PWR Radiation Source Term Reduction (2009, 1019225)*
- *Cobalt Reduction Sourcebook (2010, 1021103)*

SRMP Channel Head Dose Rate reductions with SG tube electropolishing



PWR-SRMP Benchmarking Report

2011 Results 1023020

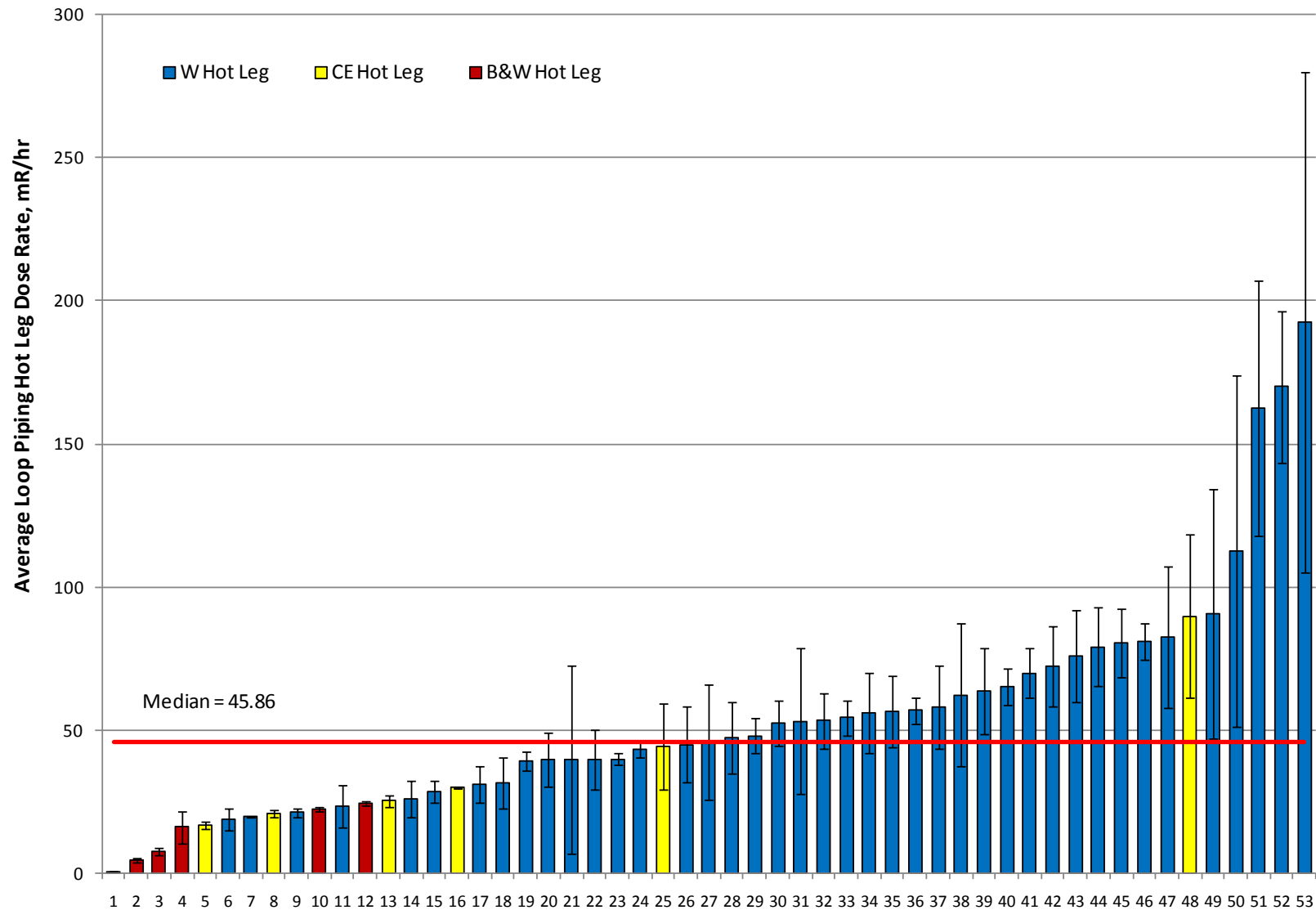
- 2011 report includes data from 134 units
- Majority of data from cycles ending 2006 to 2009

	Cycles of Loop Data	EOC Range	Cycles of CH Data	EOC Range
Non-EDF	56	10/2003 – 8/2010	64	3/2000 – 8/2010
EDF	54	6/2006 – 7/2007	0	None

- Continuing Benchmarking Reports
 - Published in first half of the year

PWR-SRMP (1023020)

Hot Leg Loop Piping Dose Rates by NSSS Vendor



Radiation Surveys

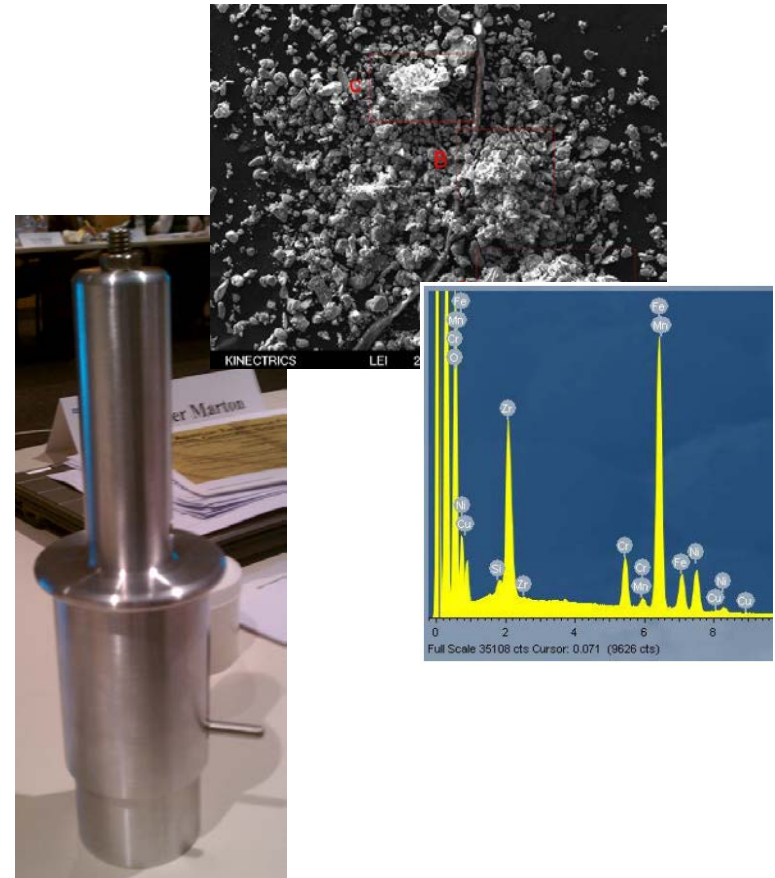
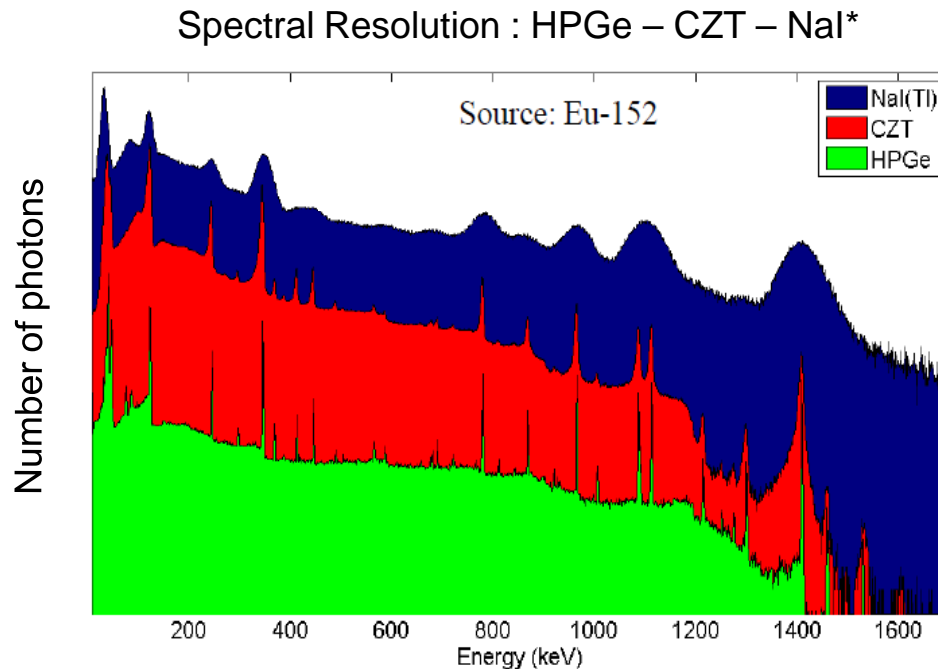
Key Link to Source Term Management Efforts

- BRAC and SRMP are representative of activity incorporation into piping oxide films during operating cycle
- BUT BRAC/SRMP dose rate measurements do not always correlate with cumulative radiation exposure (CRE) at many plants (complicated by time in field)
 - Chemical source term management technologies may not be uniformly effective
 - Across all plant systems (data collection locations)
 - For all dose important nuclides (isotopic data)
 - Numerous work locations exist beyond the recirculation piping

Considerations for Revision (1/2)

Type of Data to Collect

- Isotopic (High Purity Germanium and/or CZT)
- Time Dependent Data (ED)
- Standardized Smear Samples

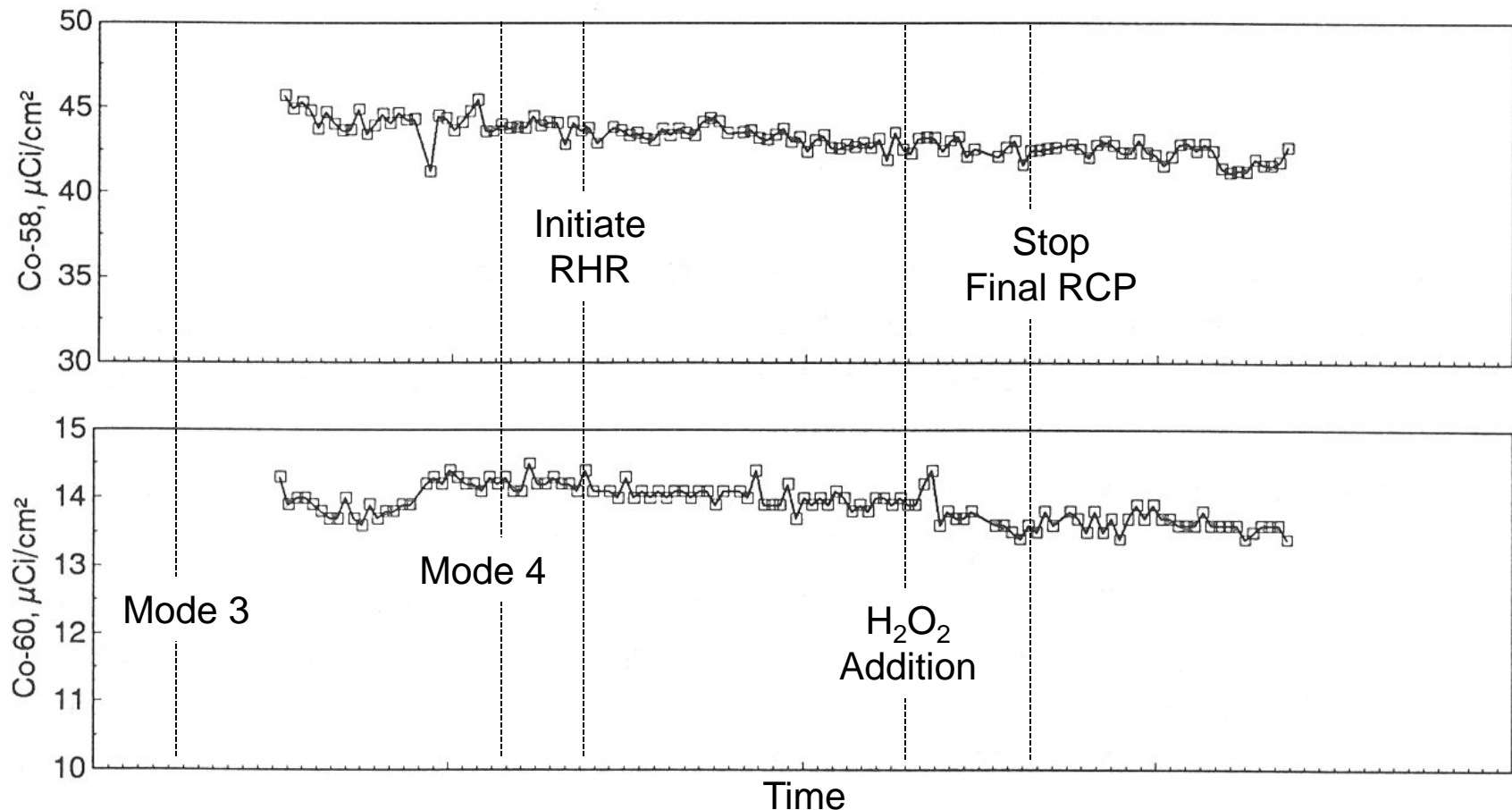


*A. Rocher, ISOE Expert Group on Water Chemistry Meeting, June 2011

Gamma Spectroscopy

Soluble Activity Incorporation

Westinghouse PWR Crossover Piping Activity Shutdown Transient



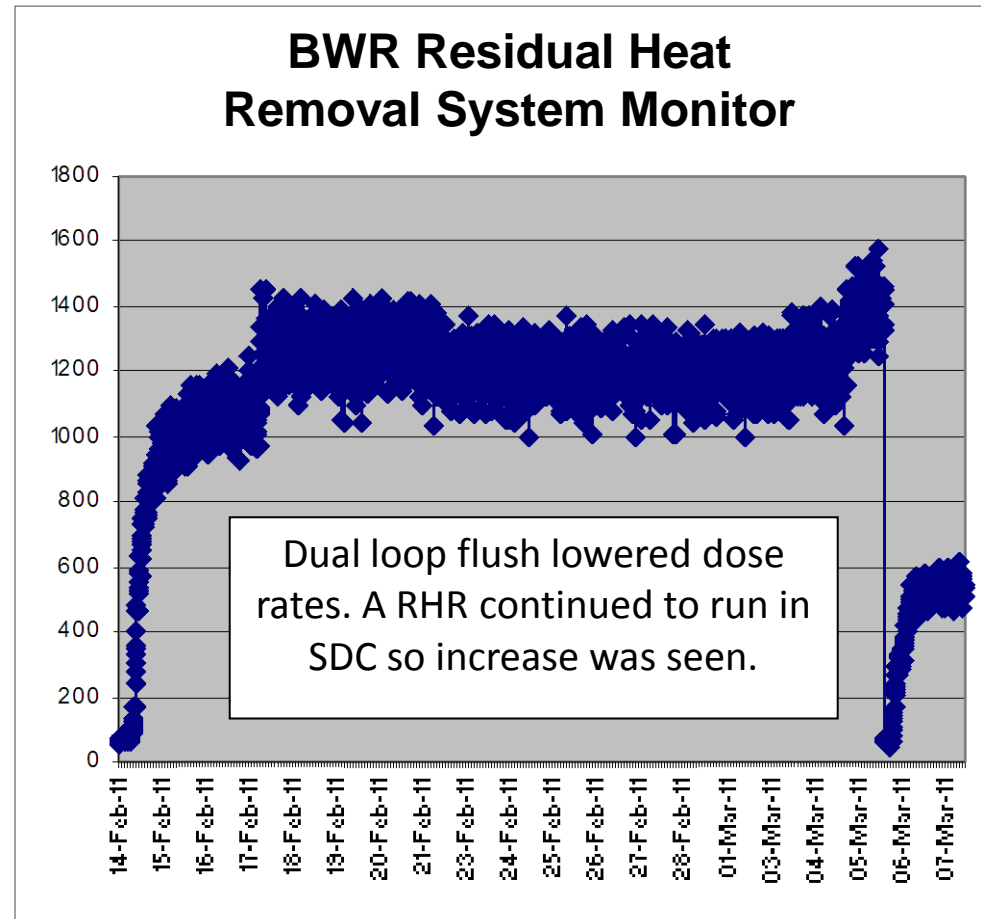
Pressurized Water Reactor Activity Transport and Source Term Assessment: Surface Activity Concentrations by Gamma Scanning. EPRI Palo Alto, CA: 2011. 1023027.

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Installed Remote Technology (EDs)

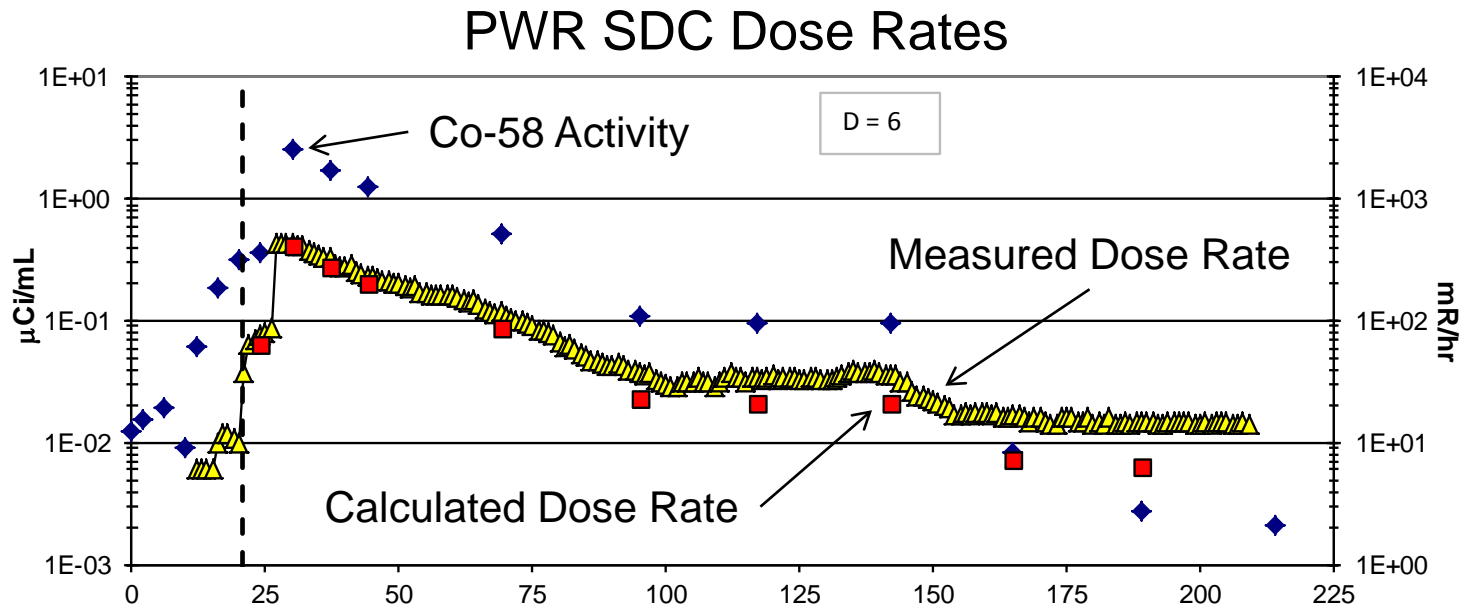
Improved Understanding of Operational Maneuvers

- Provides time dependent information about changes in dose rate
- Expands understanding of impact of operations and corrective actions



Installed Remote Technology (EDs)

Improved Understanding of Particulate Transport

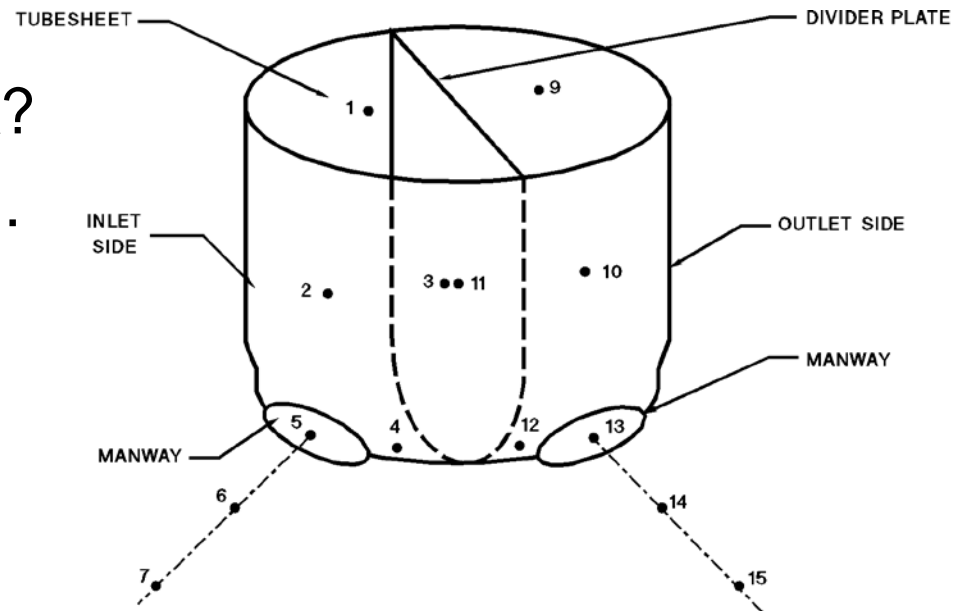
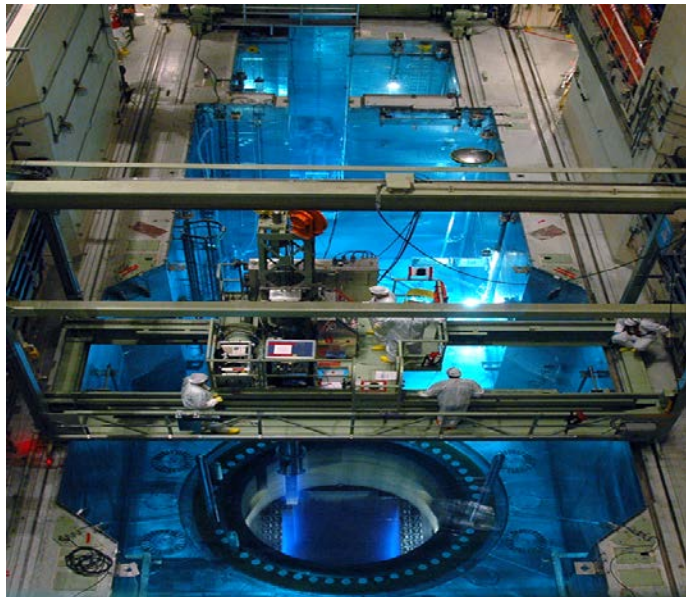


- Measured data corrected for activity of the coolant
- Calculated data shows impact of particulate transport
 - Observed to calculated delta demonstrates impact of particulate dropout

Considerations for Revision (2/2)

Plant Locations Where Data is Collected

- High flow regions – current BRAC & SRMP points
- Low flow regions – expanded BRAC and informational SRMP
- Other areas of outage work?
 - Fuel pool, Refuel floor, ...



Improved SRMP and BRAC

2012 – 2013 Project

- **Tasks**

- Evaluate current database of radiation field data for utility response
- Establish improved set of plant locations (retained and additional) for standard radiation field data collection
 - Consider overlapping points from CANDU and VVER designs
- Develop procedures for data collection (gross dose rate, electronic dosimetry, and isotopic gamma scans)
- Collect available data at new program locations (current and historic)

- **Deliverables**

- 2012 Technical Meeting: Utility Standardization of Radiation Field Data
- 2013 Technical Report: *Application of Updated Standard Radiation Field Analysis*

To Participate Contact **Dan Wells**, dwells@epri.com, 650-855-8630

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