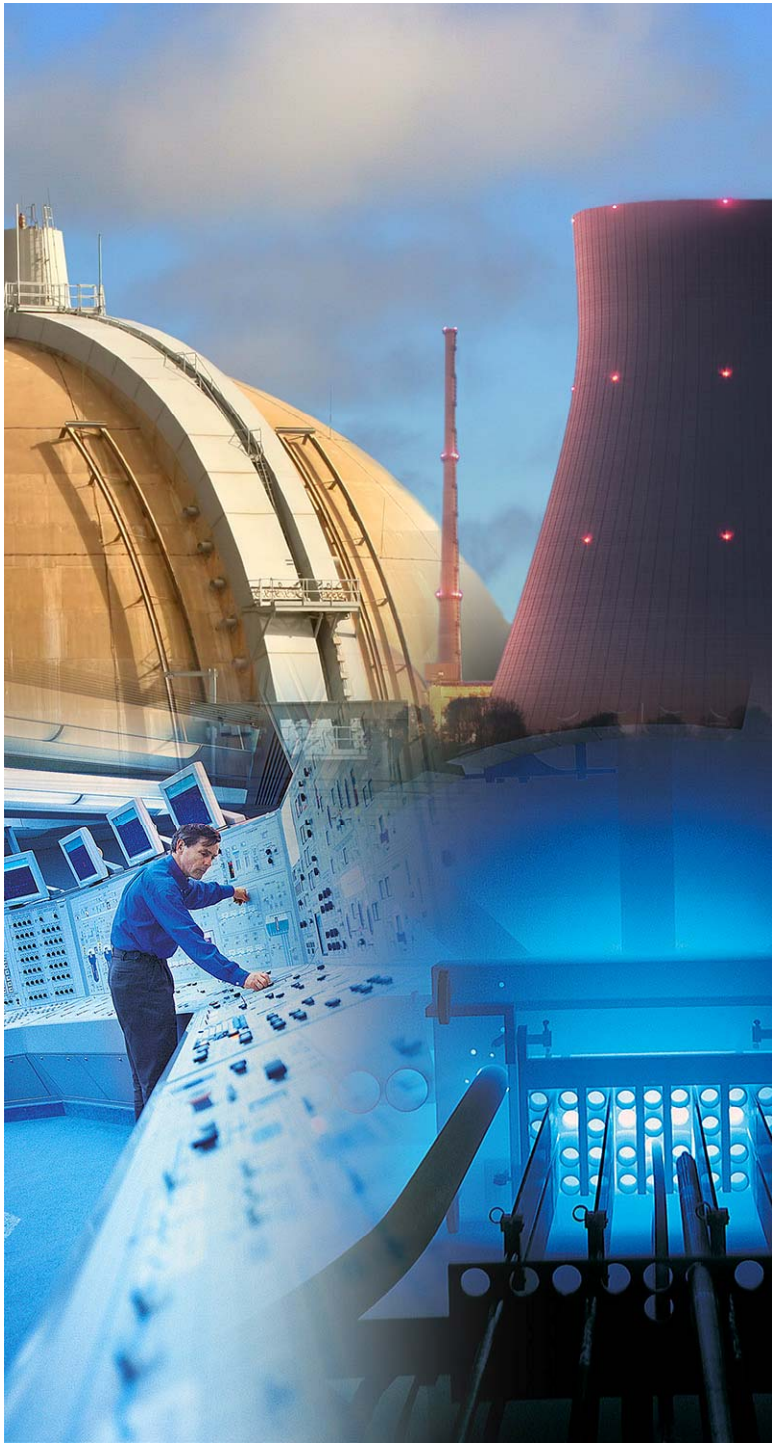

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EPRI Source Term Reduction Program Update

ISOE/EPRI ALARA Symposium
January 13, 2009

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Sr. Project Manager

Presented by

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Sr. Project Manager

Overview

BWR Source Term Reduction Results

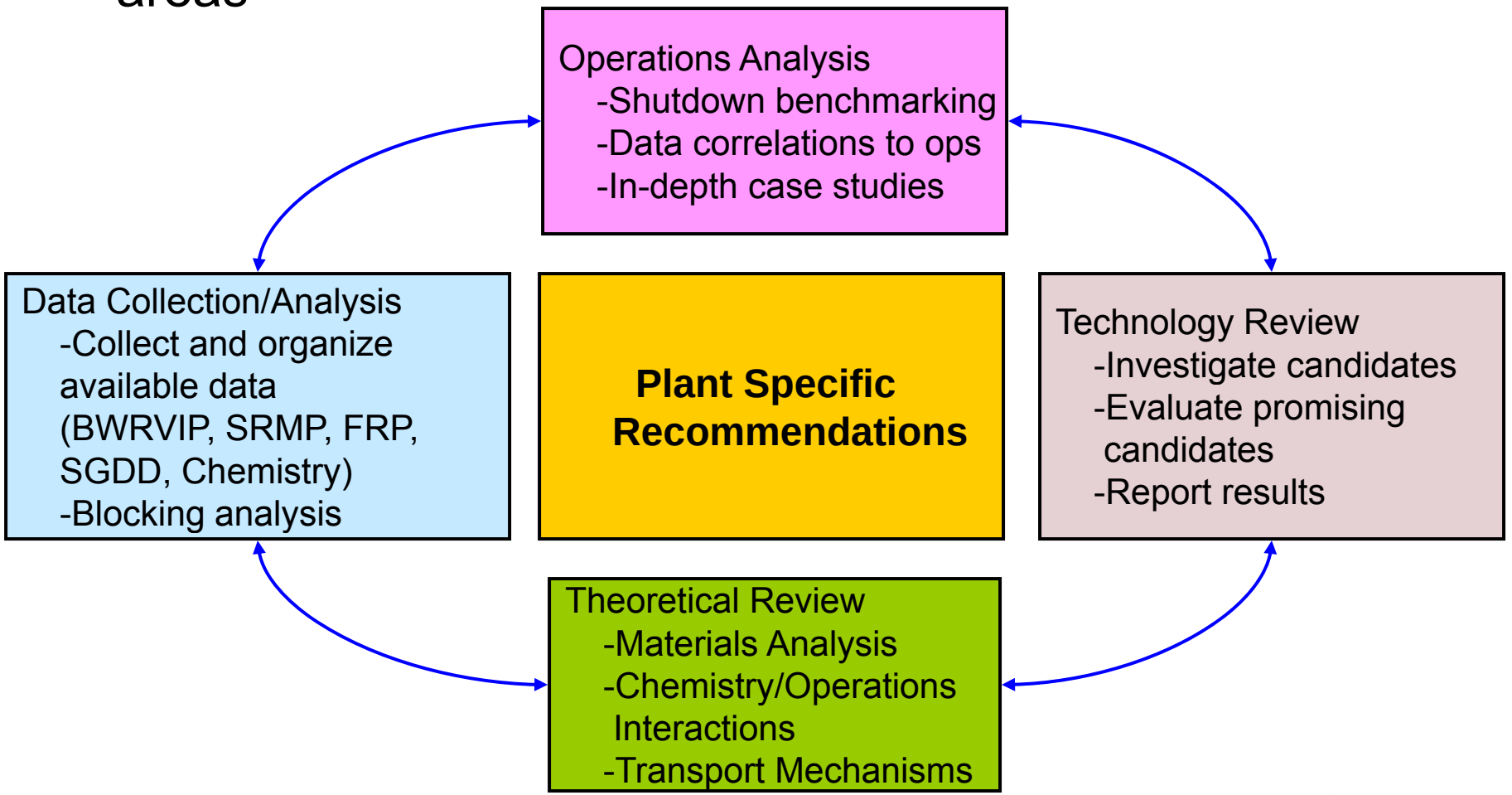
- Cobalt quantification
- BWR shutdown calculations

PWR Source Term Reduction Results

- PWR Source Term Reduction Technology Evaluations

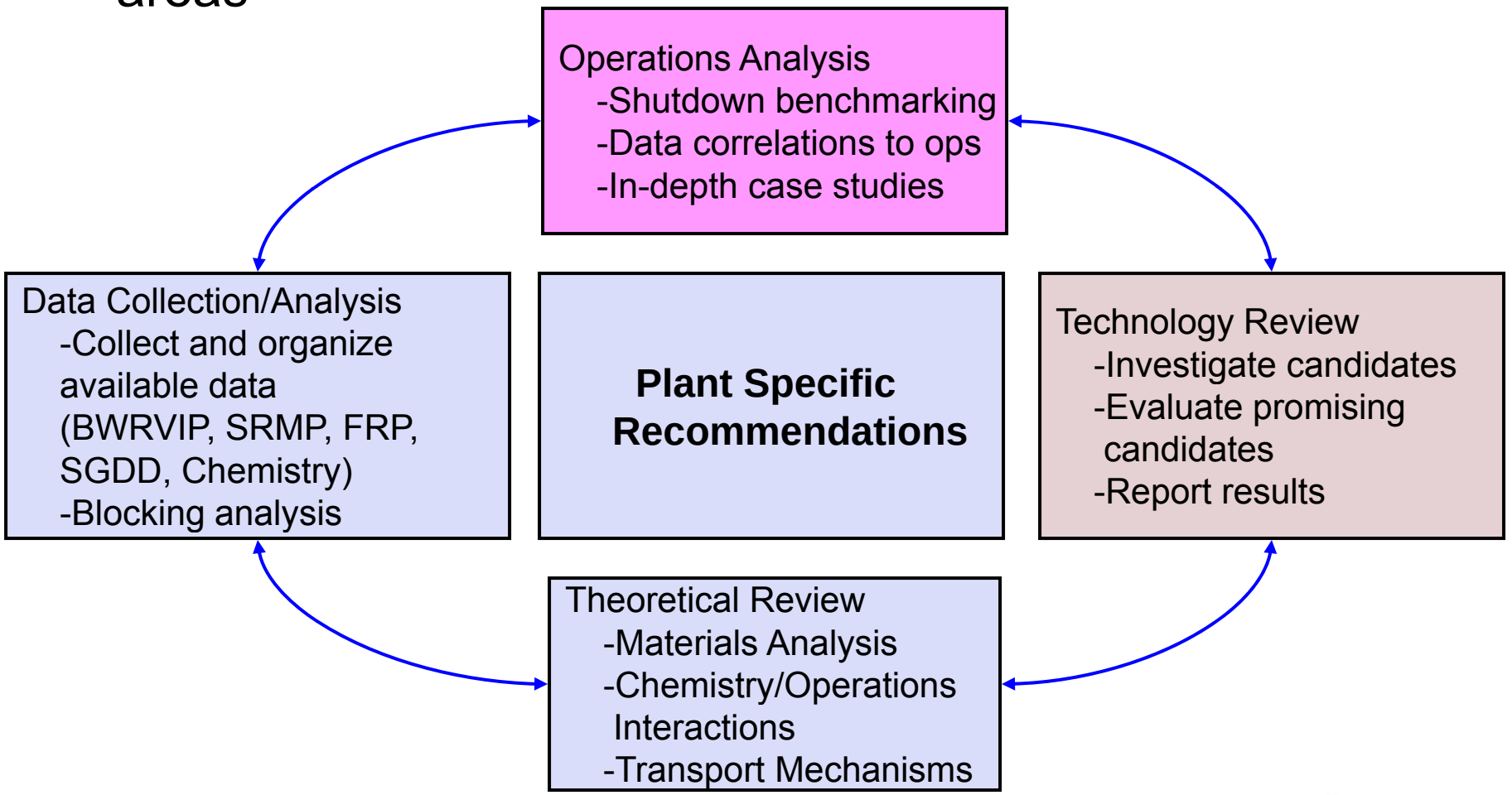
Source Term Reduction Program Strategy

- EPRI Source Term Reduction Program focuses on four areas



Source Term Reduction Program Strategy

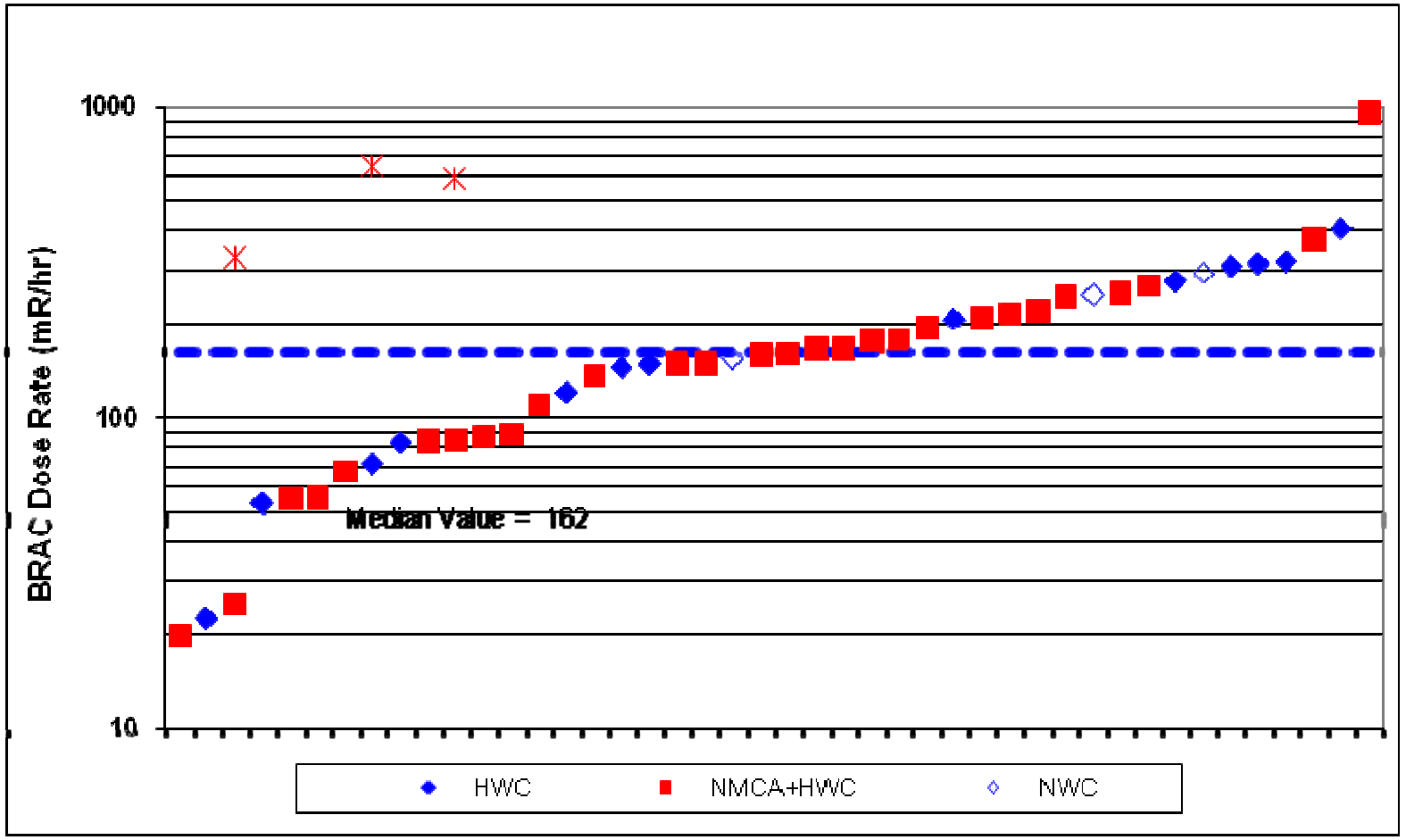
- EPRI Source Term Reduction Program focuses on four areas



BWR Source Term Reduction Project

- BWR Source Term Reduction – Estimating Cobalt Transport to the Reactor (EPRI Report #1018371)
- Goals of Project
  - Identify how plants measure cobalt
  - Target cobalt sources
  - Benchmark cobalt transport to reactor
  - Quantify removal and releases during shutdown and normal operations

BRAC Radiation Field Ranking (June 2008)



BWR Elemental Cobalt Measurements

- 19 plants of the 45 BWRs sample and analyze for elemental cobalt in
  - condensate,
  - feedwater,
  - reactor coolant
- Results vary widely depending upon
  - sample point,
  - sample volume collected (LLD),
  - analytical method (ICP, XRF, ICP-MS),
  - source term

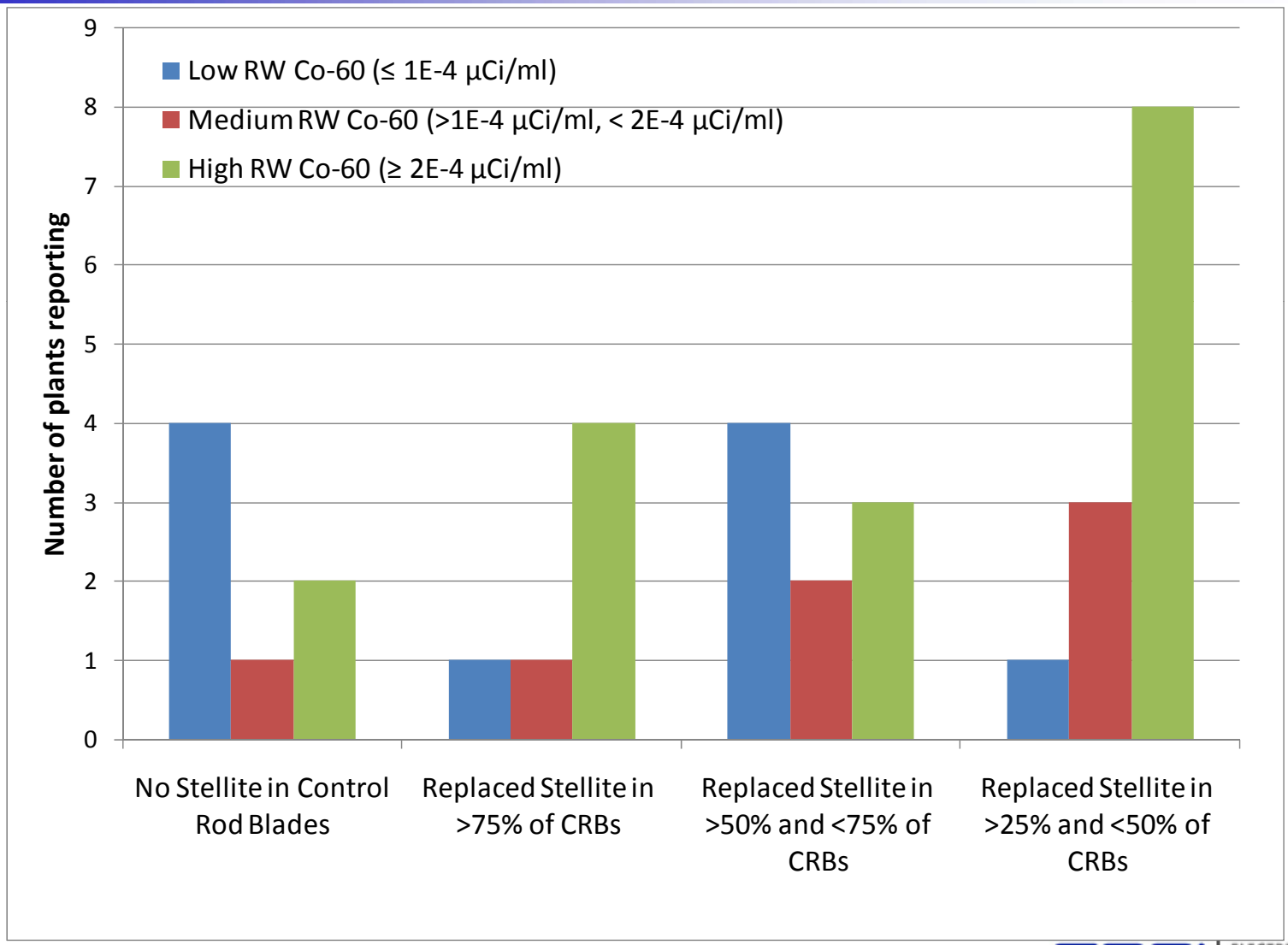
BWR Benchmarking/Source Term Ranking

- Reactor water Co-60 Categories and BRAC Dose Rates

Parameter	Low Co-60 Plants (≤ 1E-4 µCi/ml)	Moderate Co-60 Plants (>1E-4 µCi/ml, < 2E-4 µCi/ml)	High Co-60 Plants (≥ 2E-4 µCi/ml)
Median Co-60; µCi/ml	6.48E-5	1.40E-4	2.79E-4
Co-60 Range; µCi/ml	1.94E-5 to 2.74E-4	5.98E-5 to 3.29E-4	9.42E-5 to 1.83E-3
Median BRAC; mR/hr	89	261	168
BRAC Range; mR/hr	23-406	150-375	20-965

JFG1

Impact of Control Rod Blade Replacement on Reactor Water Cobalt



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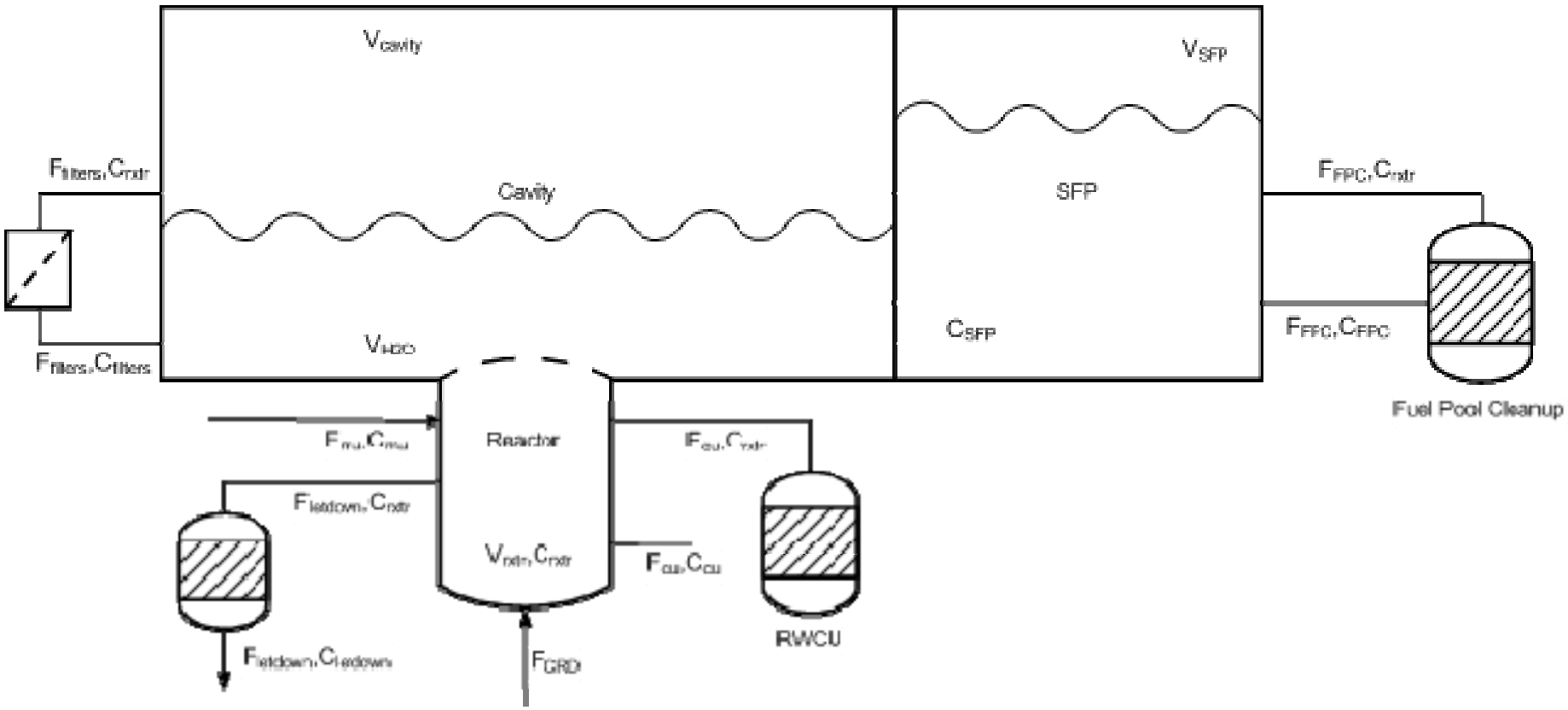
Slide 9

JFG1 Is there a take-away statement from this slide?
Joseph F. Giannelli, 11/8/2008

EPRI BWR Shutdown Calculator

- Shutdown Calculator contains two modules;
  - Shutdown Release Module calculates the activity released and removed during a RFO;
  - Shutdown Analyzer Module estimates the coolant "cleanup" curve from peak activity concentration
- Major data inputs:
  - Outage milestones; activity data; flows, volumes; system status
  - Peach Bottom 2 and Dresden 2 RFOs selected; (completed shutdown data templates available)

BWR Shutdown Calculator



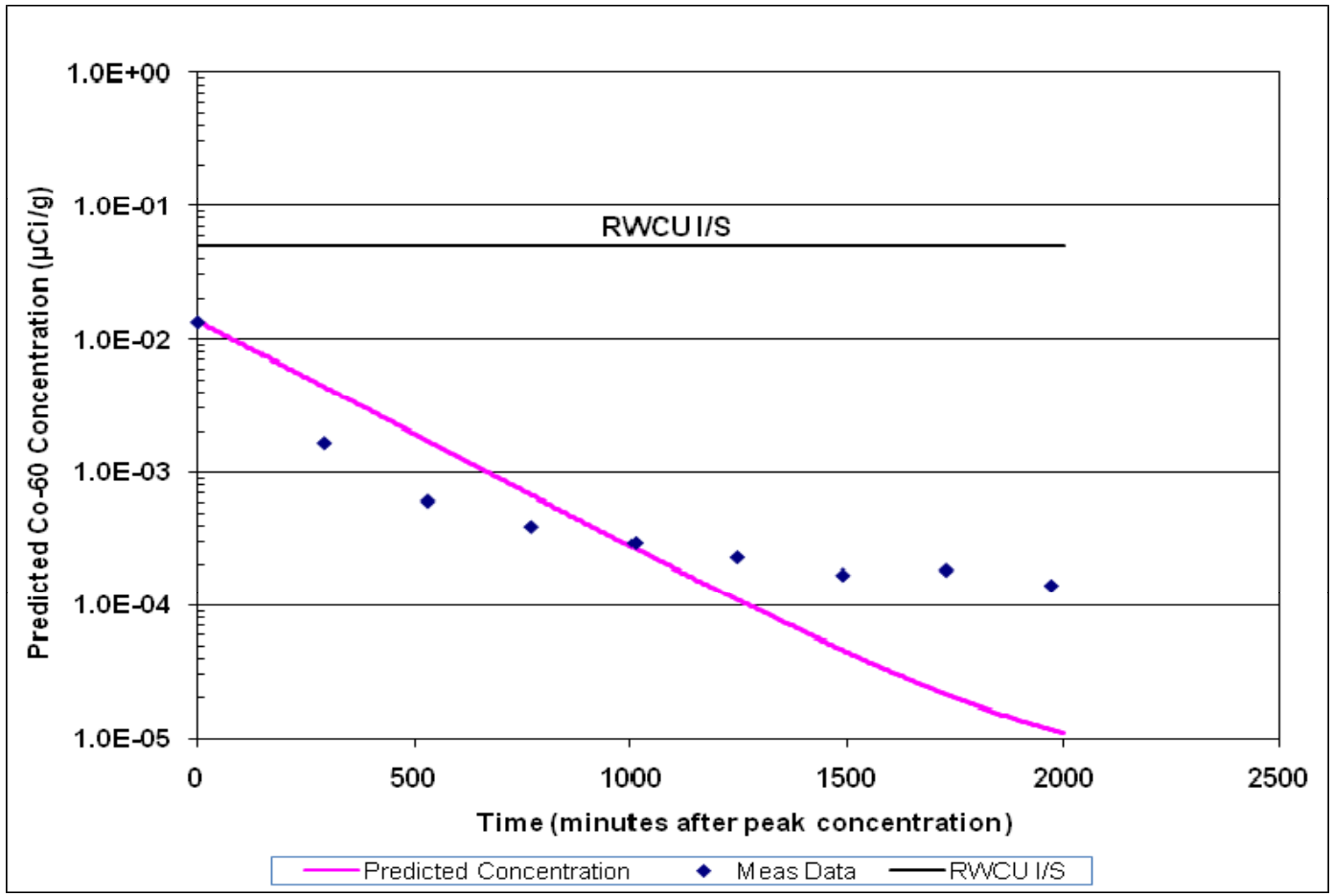
BWR Shutdown Calculator

- PB2 RFO16 Shutdown Release Results for Co-60

	Released (Ci)	Removed, RWCU (Ci)	Removed, Letdown (Ci)	Removed, Filters (Ci)	Removed, FPC (Ci)
Total Activity before flood-up, Ci	7.4	4.2	2.9	0.0	0.0
Total Activity after flood-up and before opening the gates, Ci	4.0	0.5	0.2	1.8	0.0
Total Activity after opening the gates, Ci	319.0	14.9	10.6	108.3	174.0

BWR Shutdown Calculator Results

- PB2 RFO16 Shutdown Analyzer Results for Co-60



BWR Conclusions and Recommendations

- Conclusions
  - Measurement of elemental cobalt provides insight into cobalt contributors
  - Significant variation among BWR plants for cobalt sources
  - High cobalt source does not imply high radiation fields
    - Zinc, NMCA help control fields
  - Stellite in control rod blades is a significant contributor to RW Co-60

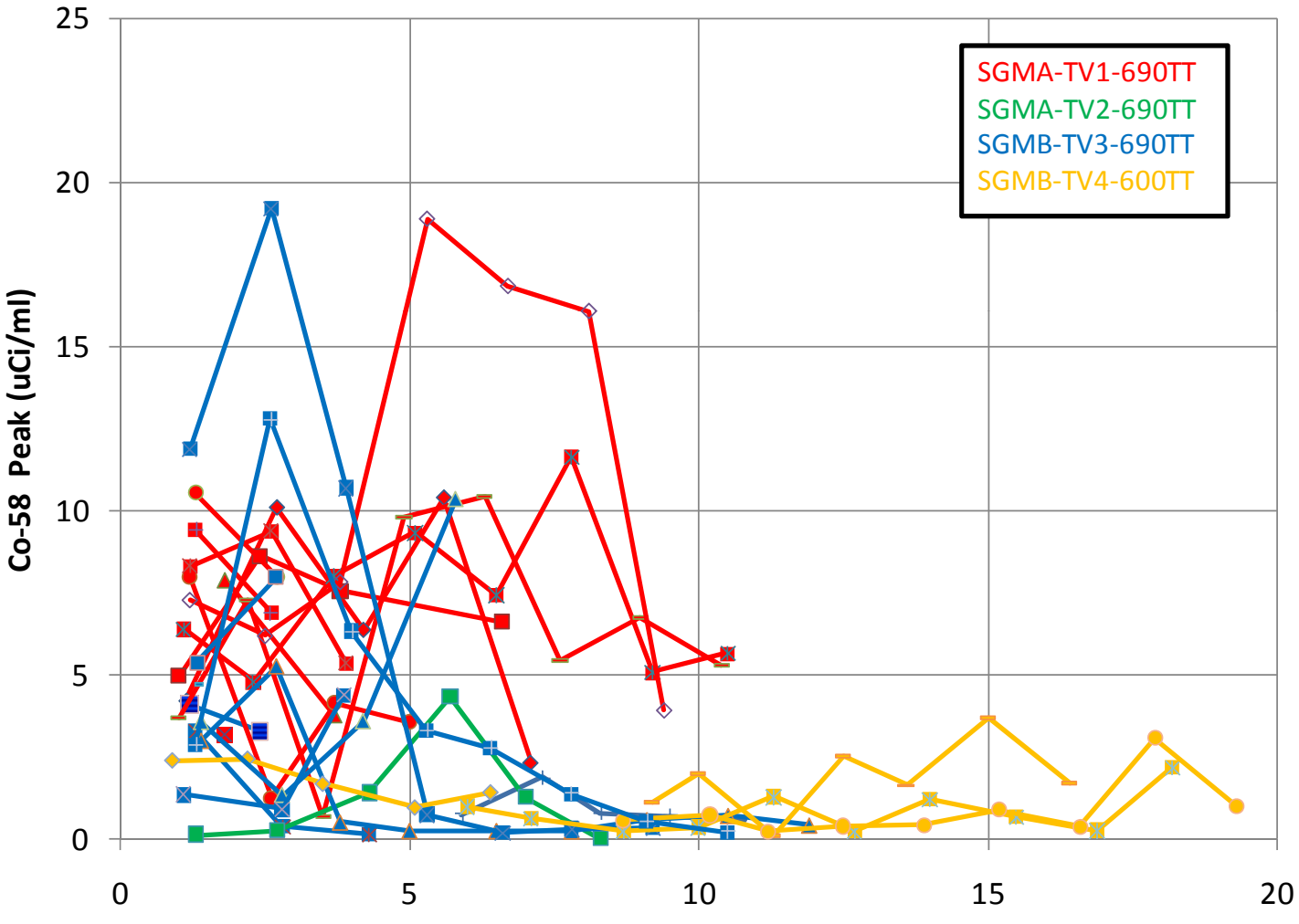
BWR Source Term Recommendations

- Recommendations
  - Plants should update cobalt source term reduction status (CRBs, turbine components, valves, etc.)
  - Conduct industry survey for cobalt source identification evaluations
  - Conduct a further evaluation on elemental cobalt sampling with focus on
    - sample collection
    - preparation
    - analytical methods
  - Apply the EPRI BWR Shutdown Calculator where complete shutdown data are available

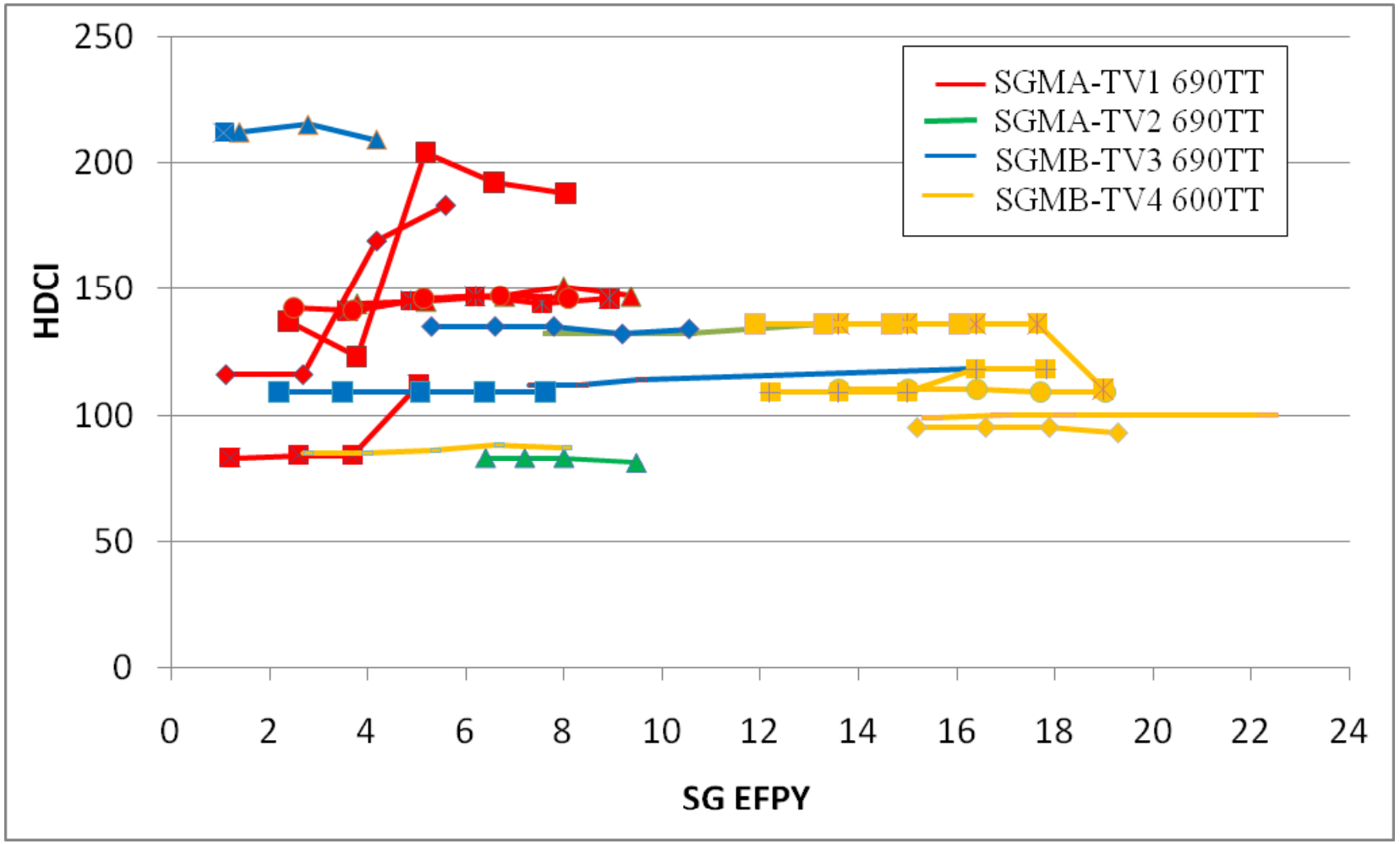
PWR Source Term Reduction
Technology Evaluations

- Report #1016767
- Key Results
  - Activity release magnitude has additional correlation to **core boiling duty** and **tubing surface area**
    - Manufacturing method impact is less clear
  - Zinc continues to show significant radiation benefits
  - pH effects noticed when comparing before and after PWR Primary Guidelines
    - Ringhals, San Onofre show benefits of elevated pH
    - Comanche Peak 1 and 2 do not show clear benefits
  - Long term benefits of electropolishing are noted

PWR Crud Burst Peaks Over Time for Replacement Steam Generators

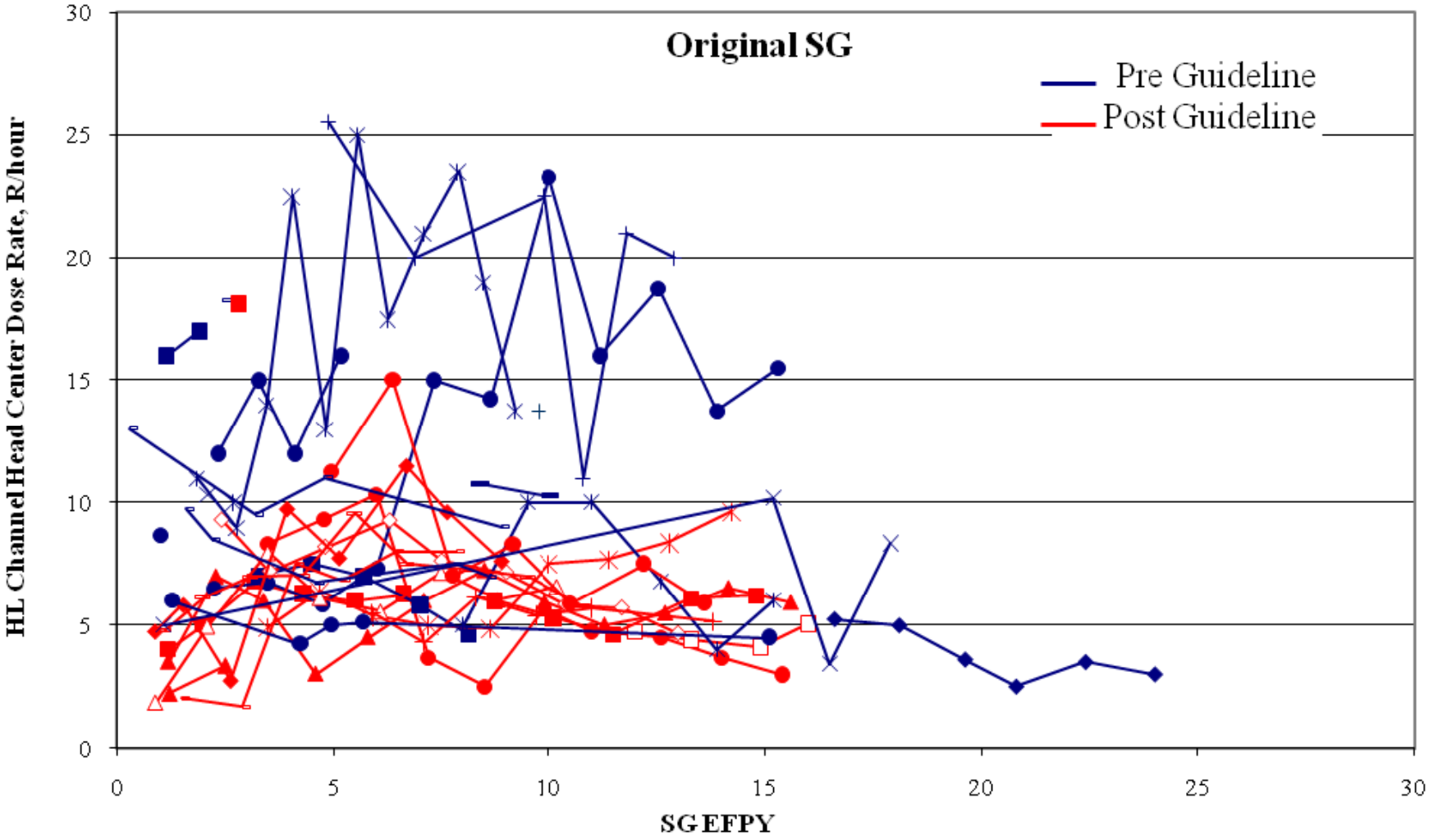


PWR High Duty Core Index Trends for Replacement SG Plants

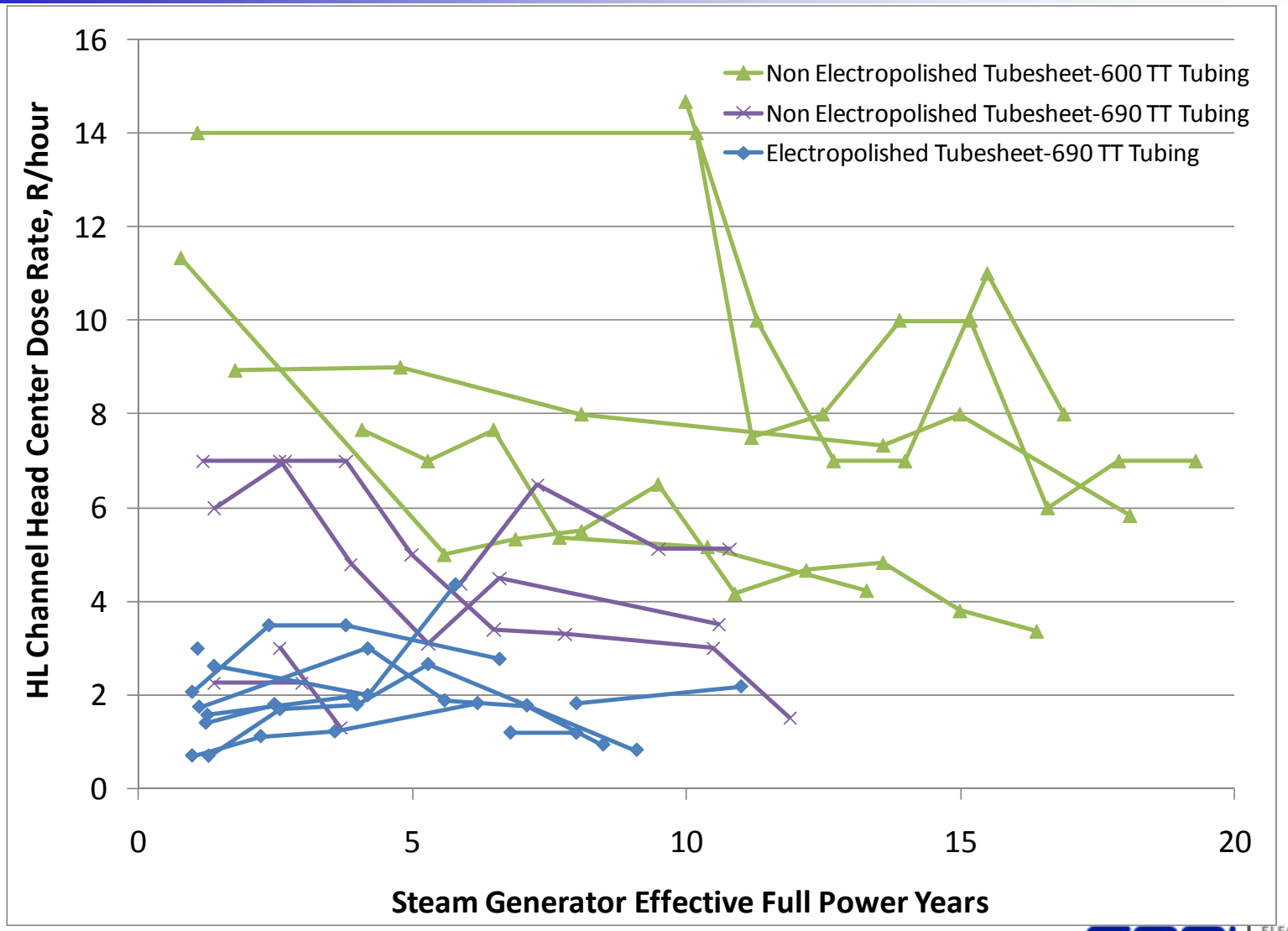


Plants with high HDCI often had larger activity releases

Impacts of PWR Primary Chemistry GL on Channel Head Dose Rates



Impacts of Tubing Material and Electropolishing on Radiation Fields



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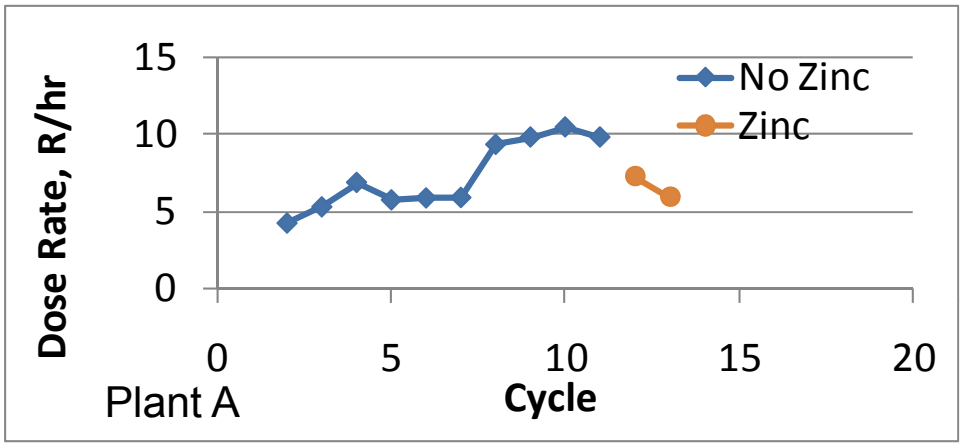
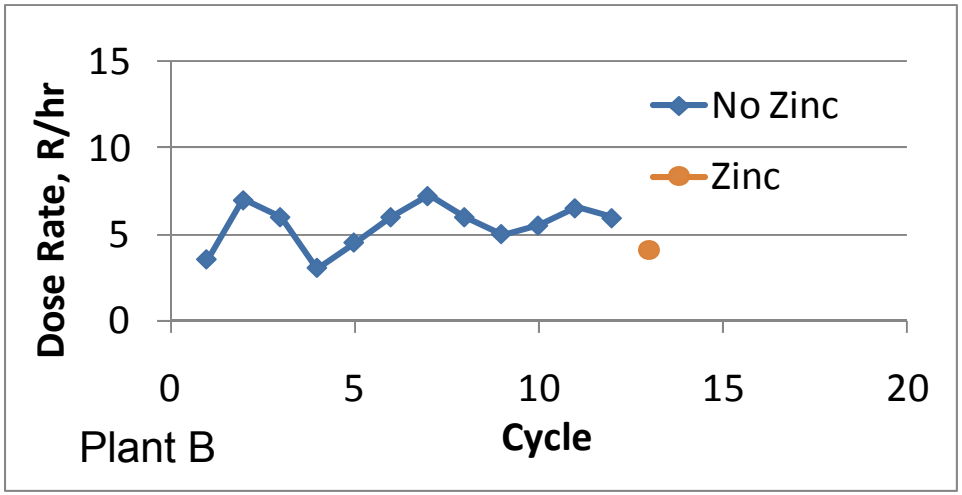
Impacts of Zinc Addition Over Time

- For plants injecting zinc
  - Channel head rates decrease in most cases
  - Observed in several plants
  - No adverse impacts noted





PWR Source Term Technology Conclusions

- Dose rate reduction technology conclusions
  - Crud burst activity level is also correlated to boiling duty and surface area
    - Manufacturing impact is less clear
  - Tubing material has impact on cobalt source
  - Zinc continues to show significant benefits
  - Consistent pH program shows improvement for some plants
  - Electropolishing has continued benefits for channel heads