

Radiation Field Source Term Control – Review of US Experiences

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Radiation Management and Source Term Technical Strategy Group

2015 Members	
Arizona Public Service (Palo Verde)	FirstEnergy Corp.
AXPO	<i>Korean Hydro Nuclear Power</i>
<i>Comision Federal de Electricidad</i>	Luminant
Detroit Edison	Omaha Public Power District
Dominion	Nebraska Public Power District
Duke Energy	NA-SA
<i>Electricite de France</i>	Public Service Electric and Gas
Energy Northwest*	Southern Company
Entergy	Tennessee Valley Authority
Exelon	Xcel

* New Member

Example of Activities:

•Topical Webcasts

•Workshops:

- Scaffold, Shielding, and Insulation (June 23-25, 2015)
- Source Term Reduction (July 15-17, 2015)
- Remote Monitoring (August 11-13, 2015 with Southern Company)

•R&D and Benchmarking:

- Finish update to RMT Field Implementation report
- Kick start activity transport & finish BWR HE UFC
- Support quick industry benchmarking (zinc at high-duty plants, chemical decontamination)

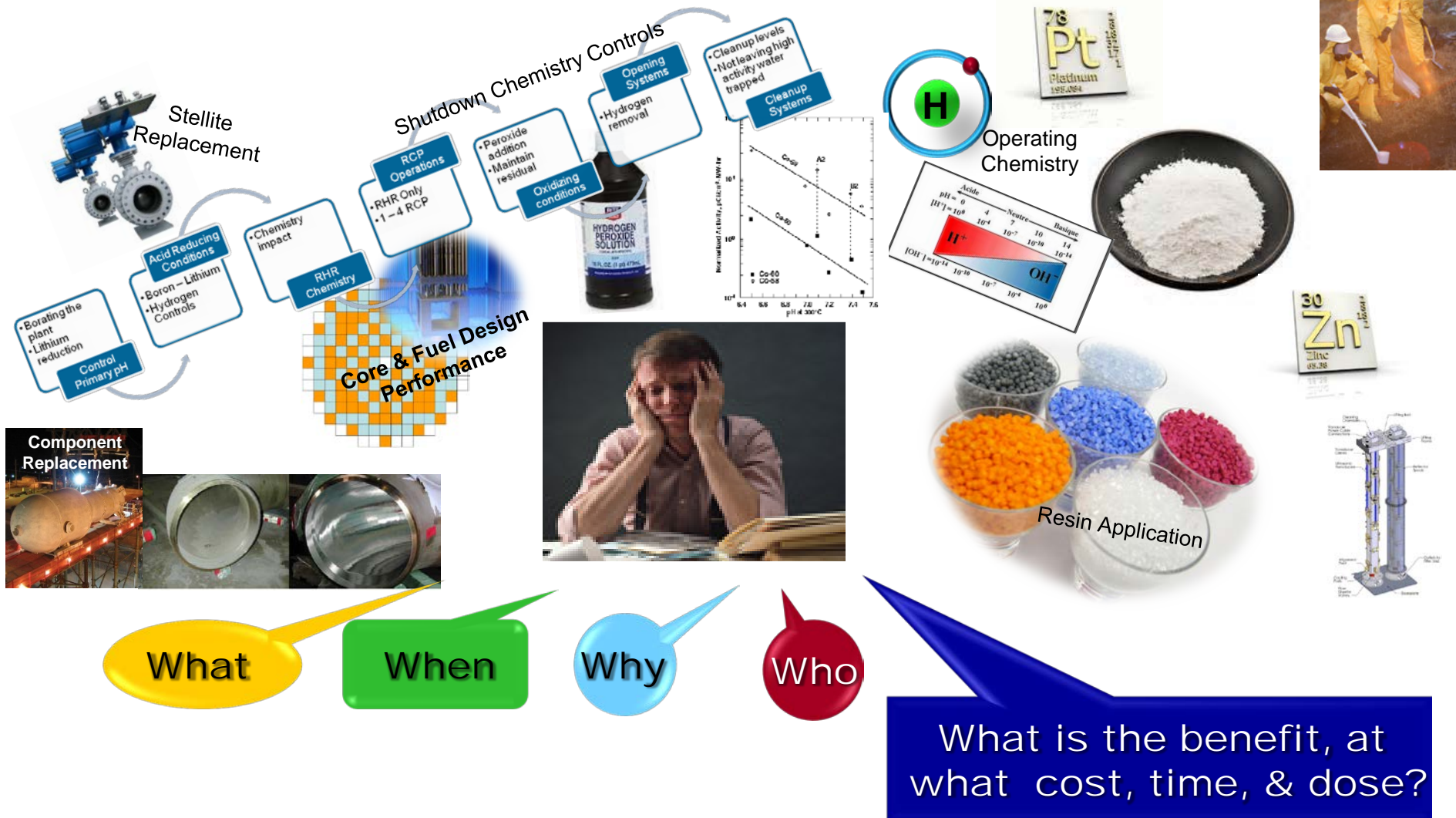
•Publications (examples):

- Shielding Program Optimization (3002003165)
- Radiological Hot Spot Experiences (3002003158)
- Recent Chemical Decontamination Experience (3002000555)

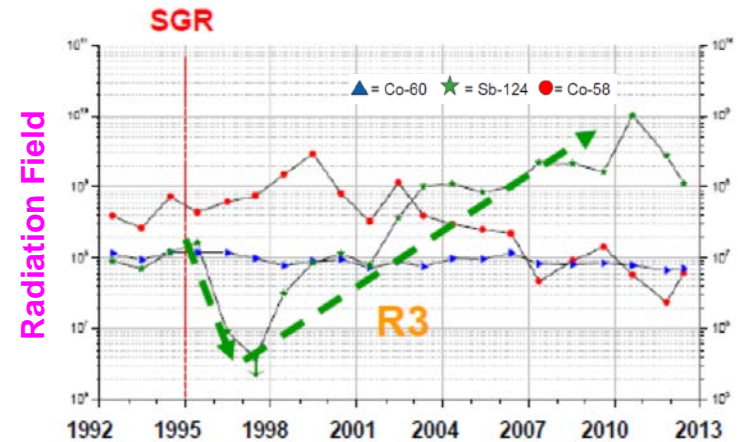
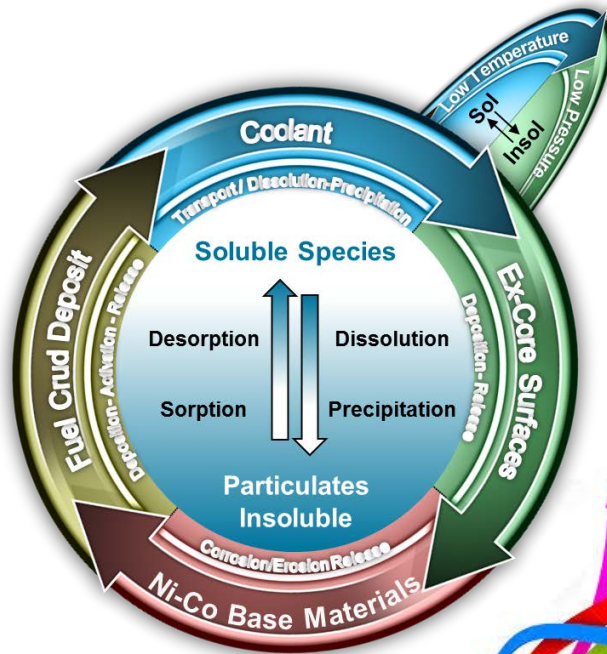
3 yr membership includes one of the following assessment options:

- ALARA, Source Term, Scaffold, RMT, Alpha, Other

Ever felt like this?



EPRI's Source Term Assessment Approach



Operational Changes

Utilized Source Term Mitigation –
Stellite Reduction, Zn, pH, Pt, HWC

Detailed review of plant design, performance, and monitoring data
is benchmarked against fleet operating experience
to derive feasible and practical source term control opportunities

Assessment Statistics

- 21 assessments assisted sites/plants since 2007 – one currently in progress & one pending to start
- Initially, 1 - 2 assessments per year, currently we are performing 3 – 5 per year
- Site/plant breakdown
 - **14 BWR assessments**
 - 4 repeat assessments with focused scope
 - 7 PWR assessments
 - 1 international plant

Assessment Triggers

- Dose

- Collective Radiation Exposure performance (INPO CRE quartile)
- Outage goals exceeded (significantly or repeatedly)

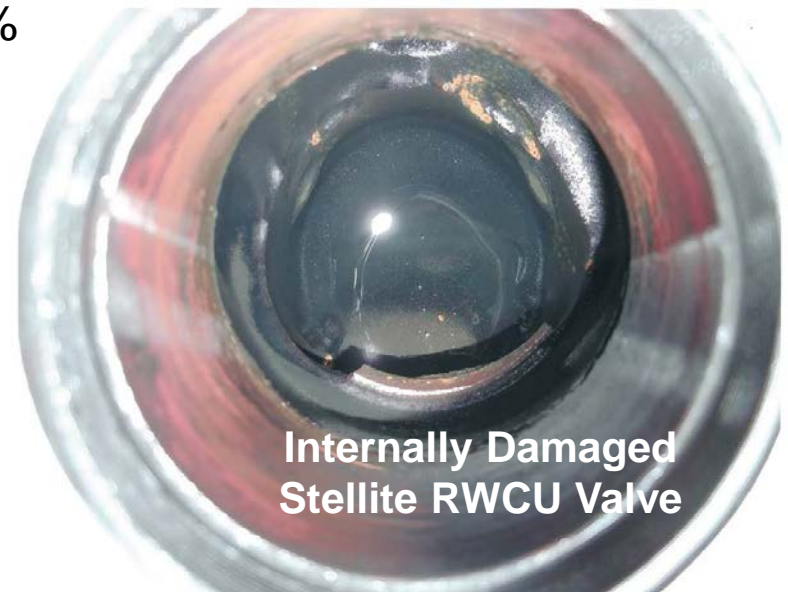
- Radiation fields

- Increase despite active source term reduction
- Stagnant despite active source term reduction
- Unexpected releases

BWR – Common Assessment Findings

■ Materials

- Stellite®-containing control rod blades in core (8/14)
- Stellite®-containing valves with wear indications (8/14)
- Stellite® jet pump wedges with wear indications (7/14)
- Stellite® turbine components (4/14)
- Replacement component material specifications
 - Specified cobalt content, i.e. ppm/wt.-%
 - Receipt verification



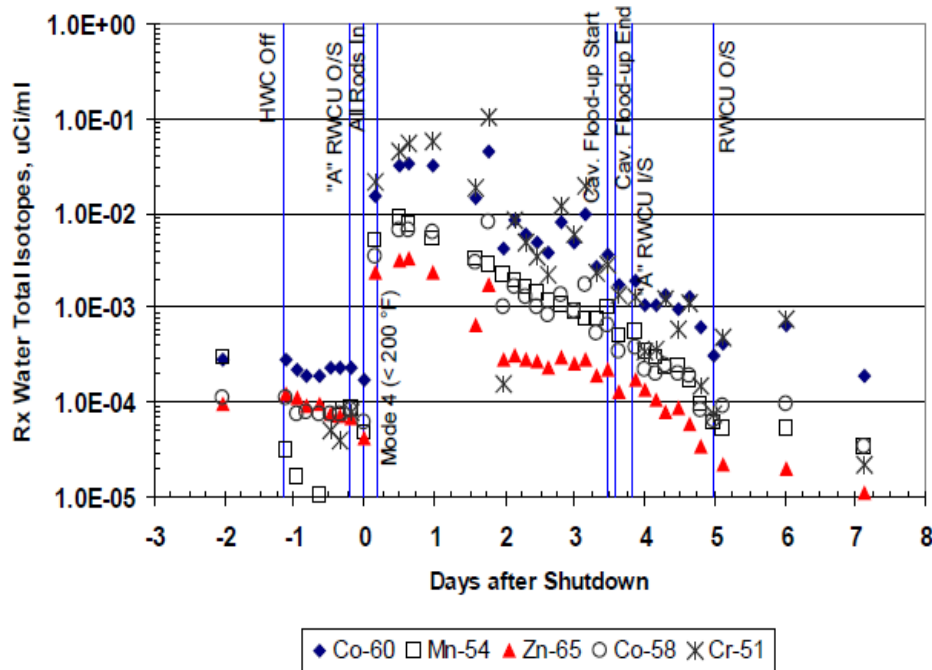
BWR – Common Assessment Findings

- Fuel failure
- FW iron
- Condenser inleakage
- Cleanup systems performance and reliability
- Change in core and/or fuel design
- Sequencing in chemical decontamination and/or OLNC application
- Increasing impact of Cr-51 on outage activity releases

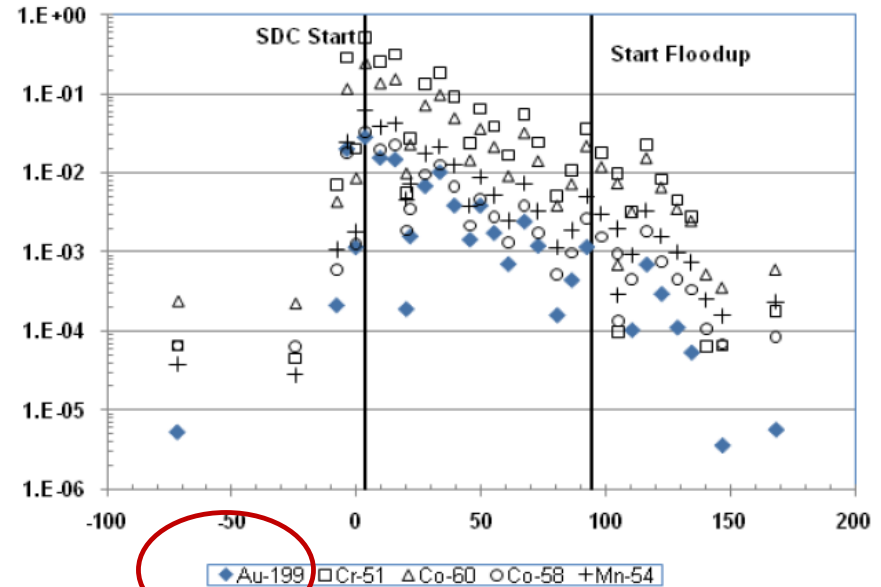
Plant-specific and localized micro-environments strongly influence corrosion, activation, and generation of radiation fields

Is Cr-51 too much neglected?

HWC + NMCA
Plant A, Cycle N



HWC + NMCA + 2 OLNC's
Plant A, Cycle N+1



Au-199, ~3 day, β^- & γ emitter

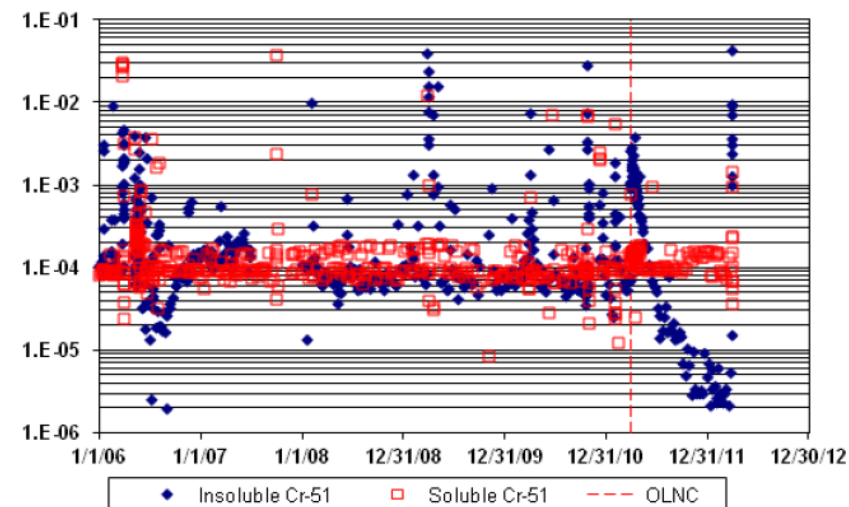
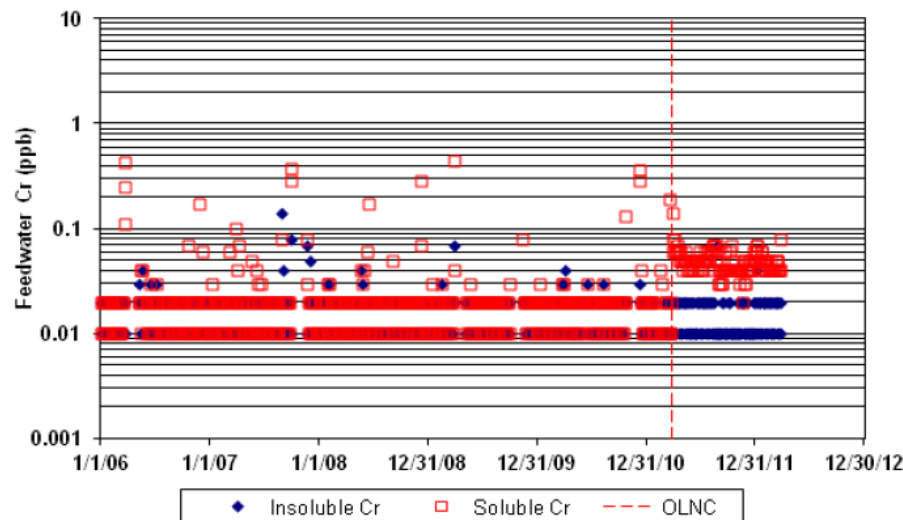
Common Recommendations for BWRs

- Reduction of cobalt-containing material (14/14)
- Improving performance and availability of cleanup systems during outage evolutions, especially (14/14)
 - RWCU
 - Spent fuel pool cleanup
 - Submersible demineralizers and filters
- Continuation/implementation/sequencing of platinum injection (9/14)
- System chemical decontamination w/focus on addressing loss of platinum coverage (8/14)

- ALARA Assessments

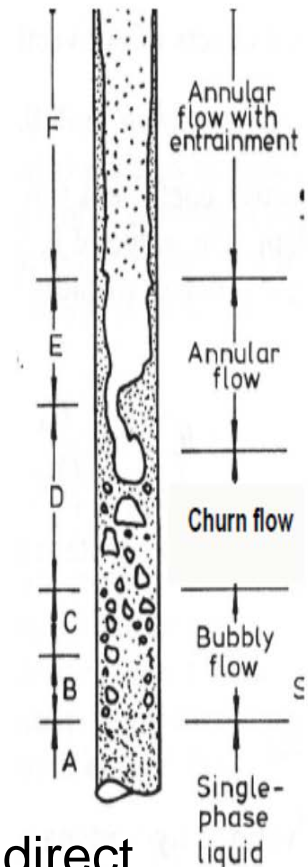
Common Recommendations for BWRs

- Reduce FW Fe ingress to reactor
- Maximize FW Zn (within guidance)
- Implement BWRVIP-225 recommended shutdown practices
 - Soft shutdown
 - Floodup of reactor cavity through condensate/feedwater
- Effective chemistry monitoring and establishing of mass balances



Fine Tuning

- Hotspot – flushing, tracking
- Corrosion product mass balances
 - Elemental and activities
 - Soluble & insoluble fractions
 - At-power & at critical outage points
 - Fuel cladding & ex-core surfaces
- Core and fuel design
 - Low leakage core and moisture carry-over
 - Change in enrichment, neutron spectra, and activation
 - Use of stainless steel and Inconel components exposed to direct neutron field
- Core Operation and fuel failure
 - Core flow and its changes impact corrosion product deposition and mobilization
 - Failure suppression changes local flow condition and neutron spectra



Gaps

- Admiralty brass condenser replacement impact – removing
 - Copper source – ECP effect
 - Source for Zn-65, a 1115-keV gamma emitter – effect on dose rates
- Behavior and impact of chromium and Cr-51 under OLNC, low hydrogen, and low iron condition
- Impact of fuel design, core design, and core operation on corrosion product activation and transport
- Targeted analysis of corrosion products during outage evolutions and unique conditions
- Uncommon nuclides – a forensic tool
 - Au-199 release at shutdown = release from core
 - W-187 – indicative of Stellite[®] wear
 - Sb-125 – indicative of tin activation in Zircaloy and spallation

Path of Driving Cobalt toward Zero – New Roadmap

■ Continue tools and technology development

- Effect of microclimates on radiation fields
- Surface passivation
- Silver and antimony behavior
- Hydrophobic coatings

New 2015 Project

New 2015 Project

2016 Proposed Project

2016 Proposed Project

■ Continue, improve and extend data collection

- Chemistry Monitoring and Assessment Databases
- Standard Radiation Monitoring Program Databases

Continuing Effort

Continuing Effort

■ Leverage new computational tools to make our data work smarter

New in 2015

■ Develop plant-specific implementation decision logic

2016 Proposed Project



2015 EPRI Radiation Field & Source Term Reduction Workshop

Charlotte, North Carolina
July 15 – 17, 2015

Topics:

Radiation Field Generation, Monitoring &
Modeling

BRAC & SRMP Gamma Measurements



**You are
cordially invited
please join us**



Together...Shaping the Future of Electricity