PWR RP/ALARA

ASSOCIATION

2016 Winter Meeting
Key West, FL
January 26-28, 2016

PWR RP/ALARA
ASSOCIATION

2016 Board of Directors

Chairman
2015-2017 Term
Dana Page (803-701-3596) dana.page@duke-energy.com – Catawba Nuclear Station

Vice-Chairman
2015-2017 Term
2017-2019 Term as Chairman
Steve Lisi (704-875-5124) stephen.lisi@duke-energy.com – McGuire Nuclear Station

Secretary
2015-2017 Term
To be filled at Winter 2016 meeting

Treasurer
2015-2017 Term
Kinsey Boehl (603-773-7638) kinsey.boehl@fpl.com – Seabrook

Steering Committee "At Large" Members
2015-2017 Term
Abby Fields (706-826-3432) acfields@southernco.com – Vogtle
Jeff Fontaine (724-462-3423) fontainej@firstenergycorp.com – Beaver Valley
Glen Toft (856-339-1009) glen.toft@pseg.com – Salem

Steering Committee "At Large" Members
2015-2016 Term
Rick Rogers (805-545-3246) rwr2@pge.com – Diablo Canyon
One Position open

Past-Chairman / Advisor
2015-2017 Term
Steve Edelman (717-948-8516) steven.edelman@exeloncorp.com – Three Mile Island

**** Terms begin/end after the Summer Meeting of the year indicated ****

Key West
June 26-28, 2016

MEETING BOOK INDEX

PWR RP/ALARA Association Meeting Agenda
Key West, FL - January 2016

Monday, January 25

4:00 – 6:00 pm Steering Board Meeting & Appetizers

Note To all the PWR RP ALARA Association Representatives:

This is to inform you that PWR RP/ALARA Association Meeting has been granted 1 Continuing Education Credit (CEC) per contact hour to a maximum of 15 CEC and assigned ID 2015-01-007.

Please be advised that contact hours do not include meals or business meetings without technical content.

As credit was requested for all participants, this assignment will be posted to the AAHP website.

Tuesday, January 26

2:00 – 3:00 pm Meeting Registration – Salon Foyer

3:00 – 4:00 pm Opening Ceremonies & Introduction in Salon C:

- Welcome – Opening Remarks (Dana Page)
- Safety Review – Building escape routes (Steve Lisi)
- Safety Message – (Steve Lisi)
- Introduction of NSA Representative – (Rick McCormick)
- Introductions of Board Members (Dana Page)
- Introduction of Association Members
- Association Secretary Report (Abby Fields)
- Association Treasury Report (Kinsey Boehl)
- Establish Meeting Expectations (Dana Page)
- Bench Mark question solicitation (Rick Rogers)
- High Interest Topic Sheets/Program (Glenn Toft)
- Nominations for "At Large" Board Member (1 Position) (Steve Lisi)
- Presentations Overview (Dana Page)

4:30 – 5:00 pm Steering Committee Meeting

5:00 – 6:30 pm Opening Reception & Vendor Displays in Salon A & B

Wednesday, January 27

07:00 – 08:00 Breakfast with Vendors in Salon A & B

08:00 – 08:05 Meeting Overview (Dana Page)

08:05 – 08:10 Safety Message (Rick Rogers)

08:10 – 08:20 ALARA Association Group Picture

08:20 – 09:40	Breakout Sessions by Plant Type (Document Successes & Challenges and a Golden Nugget) Grand Pacific E-G, Executive Boardroom, Harbor Room, Seaport and Maritime Room. • 2 Loop Westinghouse • 3 Loop Westinghouse • 4 Loop Westinghouse • 4 Loop ICE • B & W, CE and Decommissioning Units
09:40 – 10:00	**Break / Vendor Interface (Report to Break out Rooms after break)**
10:00 – 11:30	Breakout Session by Plant Type (Document Successes & Challenges and a Golden Nugget) • 2 Loop Westinghouse • 3 Loop Westinghouse • 4 Loop Westinghouse • 4 Loop ICE • B & W, CE and Decommissioning Units
11:30 - 11:40	**10 Minute Break (Report to Salon C after break)**
11:40 – 12:30	Vendor Presentations
12:30 – 1:30	Lunch
1:30 – 2:30	Presentation - Source Term Reduction & Radiation Field Characterization (Carola A Gregorich, Dr. - Electric Power Research Institute)
2:30 – 2:40	**10 Minute Break**
2:40 – 3:30	Vendor Presentations (Remaining vendors)
3:30 – 3:40	Vote for New Board Member
3:40 – 3:50	End of Day Comments / Adjourn Day 2
4:00 – 4:30	Steering Committee Meeting
5:00 – 6:30	Vendor Reception

Thursday, January 28

08:00 – 09:00	Breakfast with Vendors in Salon A & B
09:00 – 09:03	Safety Message (Abby Fields)
09:03 – 09:05	Voting Results for New Board Member (Abby Fields)
09:05 – 09:35	Presentation - What to Expect with Decommissioning (Bill Lehmbeck -Kewaunee Power Station)
09:35 – 10:30	Breakout Session Review (Successes, Challenges and Golden Nuggets) • B & W, CE and Decommissioning Units
10:30 – 11:00	**Break / Vendor Interface**
11:00 – 12:30	Breakout Session Review (Successes, Challenges and Golden Nuggets) • 2 Loop Westinghouse • 3 Loop Westinghouse
12:30 – 1:15	**Lunch / Passport Drawing**
1:15 – 2:15	Breakout Session Review (Successes, Challenges and Golden Nuggets) • 4 Loop Westinghouse • 4 Loop ICE
2:15 – 3:00	Round Table Discussions
3:00 – 3:15	Closing Remarks and Update on 2016 Summer Meeting (San Diego, CA; June 13-15, 2016)

June 13-15, 2016

3:30 – 4:30	Steering Committee Meeting • Opening Remarks • Nomination/Election of Secretary • Review Meeting Critique Sheets • New Business

PWR RP/ALARA ASSOCIATION

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MEETING NOTES

PWR RP/ALARA Committee Meeting
January 26-28, 2016
Key West, FL
Attendee List by Plant

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PWR RP/ALARA Committee Meeting
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Key West, FL
Attendee List by Professional Association

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Key West, FL
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Radiation Field Control through Source Term

Overview of EPRI Research & Industry Support Activities

Carola Gregorich
Senior Technical Leader

PWR RP/ALARA Winter Meeting
January 26-28, 2016

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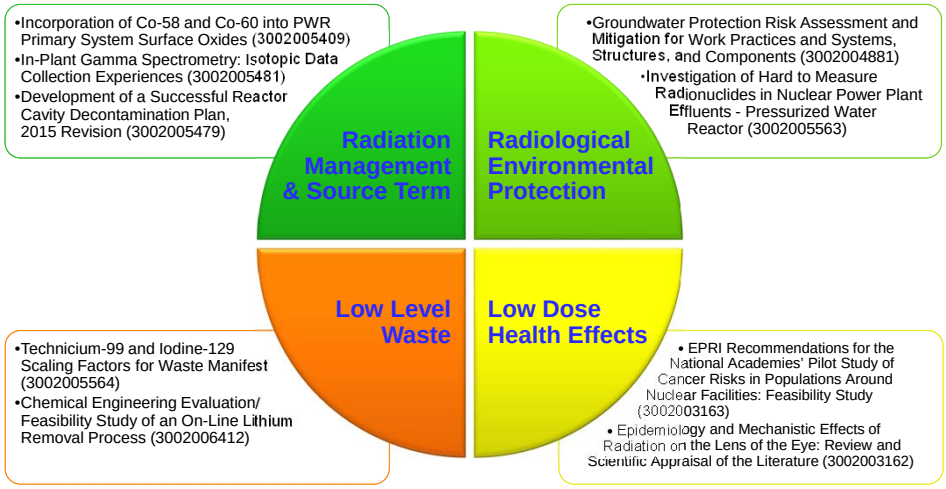
EPRI Radiation Safety Program



Enhance Radiation Safety for Workers and the Public

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EPRI Radiation Safety – Research Focus Areas

ALARA Strategies and Technologies
- Combines source term reduction technologies with typical dose reduction tools and work planning improvements to provide a comprehensive strategy for reducing dose to workers.

Radioactivity Generation and Control (Source Term Reduction)
- Understanding radioactivity and radiation field generation and transport processes and tools/technologies for improved control of radioactivity for reducing radiation fields and effluents

Radiation Safety Guidance
- Development and maintenance of guidelines, guides and sourcebooks for radiation protection, source term reduction, radiological environmental protection (which includes groundwater), and low level waste.

Accurate Dose Reporting for Workers and Public
- Provide more accurate dose assessment methodologies for determining worker dose and public dose due to effluents.

Benchmarking and Trending (Fundamental)
- Maintenance of databases for the Standard Radiation Monitoring Programs (SRMP/BRAC) and the industry low level waste benchmarking database, RadBench™.

Integration of Industrial and Radiological Safety
- Includes research related to the development of technologies and strategies that better meet the needs for an integrated approach for addressing worker protection, addressing both radiological and industrial hazards.

Optimized Worker Protection

Radiation Detection and Measurements
- Includes the evaluation and use of new measurement technologies for radiation detection and isotopic measurements.

Environmental Monitoring and Remediation
- Includes all research related to environmental monitoring and remediation of groundwater and soil.

EPRI Membership Suggests and Prioritizes Research, in addition …

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EPRI ELECTRIC POWER RESEARCH INSTITUTE

ERPI Radiation Safety – Technical Strategy Groups

Radiation Managements and Source Term (RMST TSG)

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Groundwater (GW TSG)

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Low Level Waste (LLW TSG)

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TSG Membership
- 3-Yr Commitment Basis (in addition to RS Base)

Offers
- Knowledge transfer
- Influence on research direction
- Benchmark of emergent issues
- Surveys of practices
- Independent assessment one (1) pre membership period
- Access to
  - Deliverables
  - Collaboration SharePoint
  - Webcasts
  - Workshops

Highly Interactive & Collaborative Peer Groups

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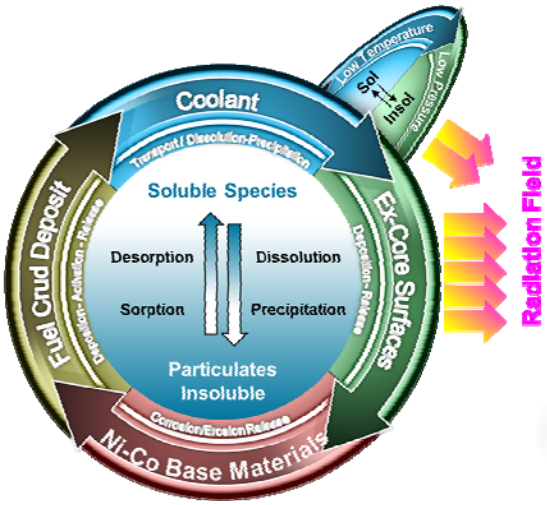
Radiation Field & Source Term Reduction



is a Team Sport

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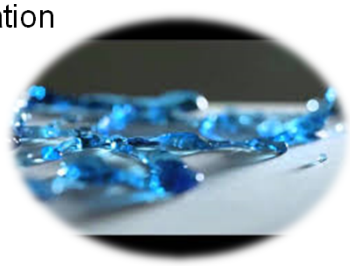
EPRI's Radiation Field and Source Term Research - 2016

- Fundamental
  - Standard Monitoring of Utility Radiation Fields Program [BRAC + SRMP = SMURF]
  - Chemistry Monitoring and Assessment Program [CMA]
- Base
  - Surface Passivation to Reduce Radiation Fields
  - Micro-Environments Influence on Radiation Field Generation
  - Silver and Antimony Impact on Radiation Fields
  - Hydrophobic Coatings as Dose and PCE Control Tool
  - Top Ten ALARA Tools for New Builds
- RMST TSG
  - Review of Activity Transport Modeling State-of-the-Art
  - OSCAR Benchmarking
  - NitroXX testing



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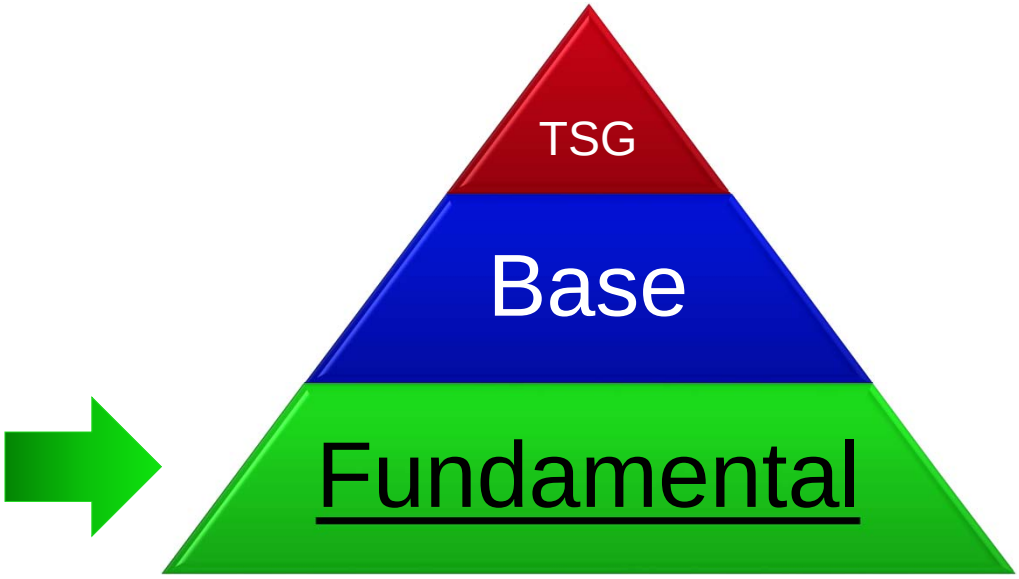
EPRI's Radiation Field & Source Term Efforts



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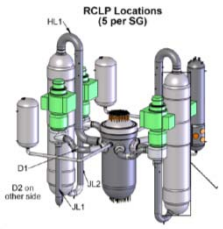
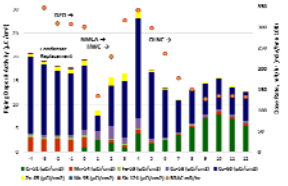
Fundamental: Standard Monitoring of Utility Radiation Fields (SMURF)





- Objective:
  - Establish standard practices for radiation field monitoring
  - Collect, house, and make accessible radiation field data
- Scope:
  - Curate data to support cause and effect analysis
    - Organize information and manage data
  - Assist plants in implementing the SMURF programs
- Benefit:

  Access to reliable and validated plant radiation field data taken following a standardized protocol is crucial for the successful execution of utility benchmarking, plant support, plant assessments, and EPRI research

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2014 Revisions of Standard Radiation Field Monitoring Programs 'Highly Recommended' to Implement Gamma Isotopic Monitoring

Purpose:

Obtain reliable data of the isotopic composition of plant radiation fields

To:

Improve our understanding of plants' radiation field generation and their responses to plant changes

Go-To Resources: 3002003155 & 3002003157

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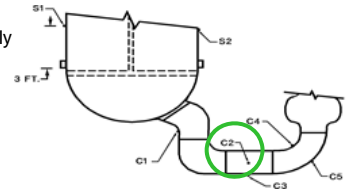
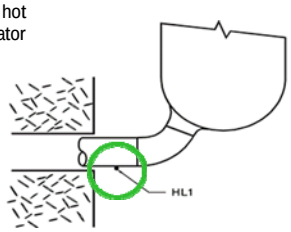
EPRI ELECTRIC POWER RESEARCH INSTITUTE

PWR Standardized Location for Highly Recommended Isotopic Characterization on Primary Circuit Loop Piping

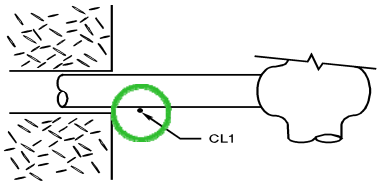
Crossover Piping (C2) - Straight section of crossover (crossunder) piping between Steam Generator outlet and Reactor Coolant Pump, side of pipe (generally away from primary concrete shield)



Hot Leg Piping (HL1) - Bottom of hot leg piping between Steam Generator inlet and Reactor Vessel Shield



Cold Leg Piping (CL1) - Bottom of cold leg piping between Reactor Coolant Pump and Reactor Vessel Shield



Dose Rate Measurements Are Essential – Isotopic Data Greatly Enhance Data Value

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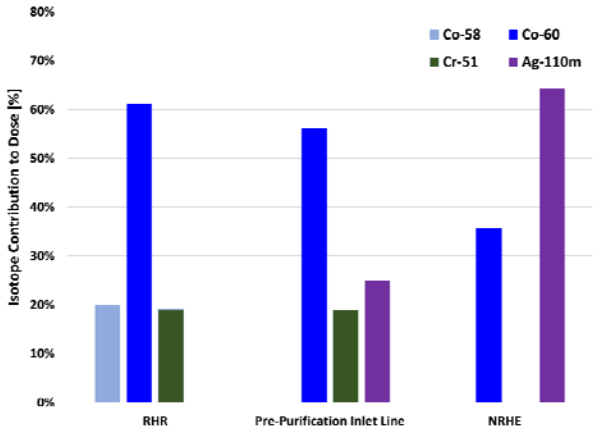
PWR Standardized Location for Highly Recommended Isotopic Characterization on Auxiliary System Locations

- Letdown and Return Line
  - Chemical and Volume Control / Make-up and Purification
  - Residual Heat Removal (RHR) System / Decay Heat / Shutdown Cooling (SDC)



More than Co-58

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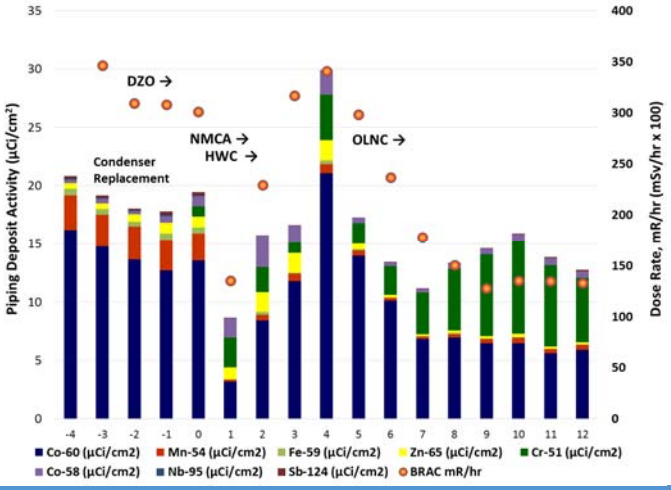
BWR Standardized Location for Highly Recommended Isotopic Characterization on Primary Circuit Loop Piping

- Reactor Recirculation System Piping



More than Co-60

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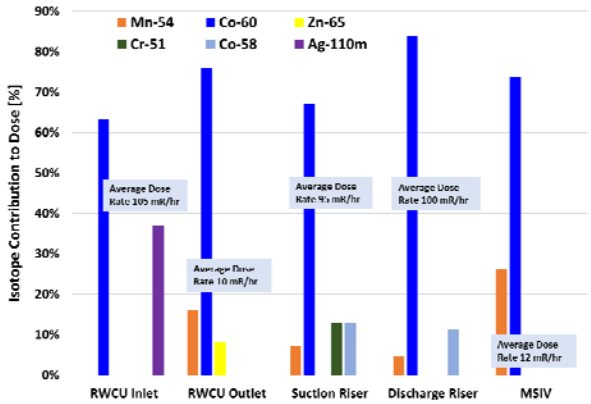
BWR Standardized Location for Highly Recommended Isotopic Characterization on Auxiliary System Locations

- RWCU Inlet Piping
- RHR Shutdown Cooling (SDC) Header



Isotopic Data Change Our Understanding

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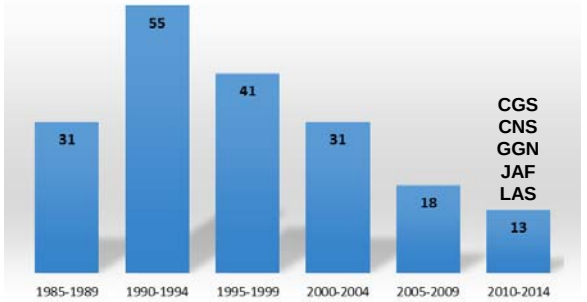
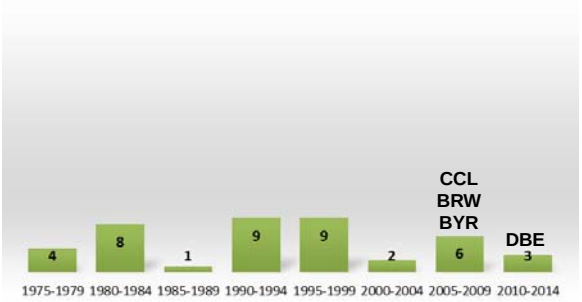
Available In-Plant Gamma Data

- As of May 2015, the BRAC database houses gamma spectrometric data from 37 BWRs taken during 320 respective outages.
- Isotopic characterization data are less prevalent in the U.S. PWR fleet than in the BWR fleet.



BWR at BRAC Points



PWR at SRMP Points

5-Year Frequency Distribution of Gamma Spectrometric Measurements performed in U.S. Fleet

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Standard Monitoring of Utility Radiation Fields (SMURF) Deliverables

In-Plant Gamma Spectrometry: Isotopic Data Collection Experiences.
EPRI, Palo Alto, CA: 2015. 3002005481.

- Collates and reviews available measurement practices and data sets.
- Identifies options for standardizing measurement protocol.
- Illustrate insights and value derived from the analysis of the data collected by in-plant gamma spectrometry.
- Describes lessons learned and identifies gaps.

In-Plant Gamma Isotopic Radiation Field Monitoring – Fundamentals 101
Sep 15, 2016 Charlotte, NC
(in conjunction with the 2016 Source Term and Radiation Field Reduction Workshop)

In-Plant Gamma Spectrometry Go-To Resource for the Practitioner

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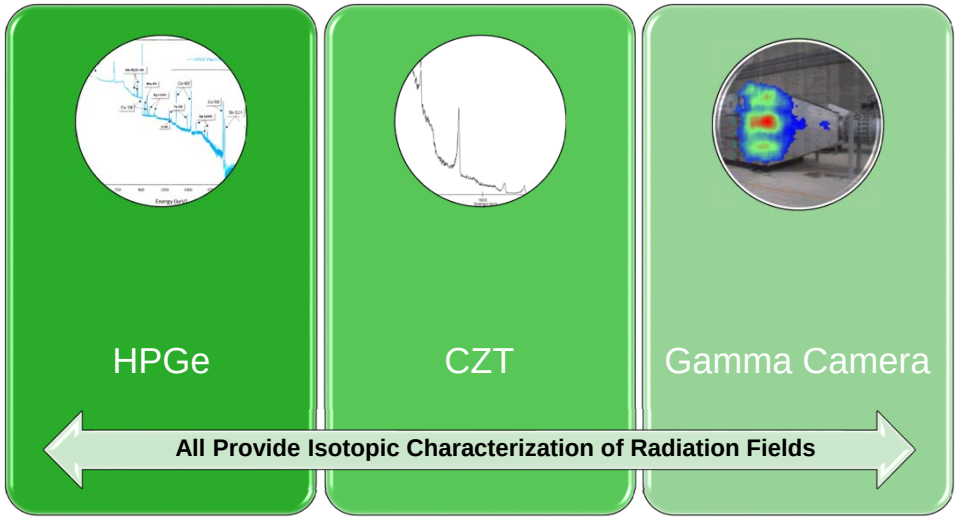
Current Measurement Equipment Options



Check Out the Tool Selection Flow Chart

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Data Collected and Submitted to EPRI

Now What?

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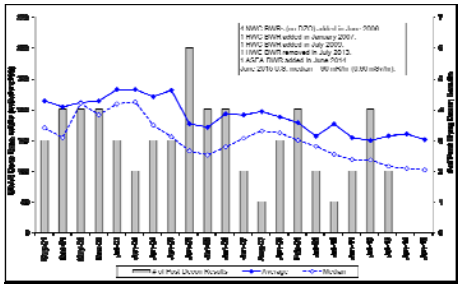
Data in SMURF & CMA Enable

- **Benchmarking**
  - Boiling Water Reactor Shutdown Chemistry and Dose Summary (3002005162)
  - Plant Source Term Assessments (Columbia, Nine Mile Point, and Laguna Verde)
  - Plant Requests (Duke, Dominion, Exelon)
- **Research Projects**
  - PWR Shutdown Activity and Corrosion Product Release Analysis
  - Micro-Environment Effect on Activity Transport and Radiation Fields
  - High-Efficiency Ultrasonic Fuel Cleaning as a Source Term Reduction Tool in Boiling Water Reactors
  - Flexible Operations



BRAC Dose Rate History

Data Availability Increases Research Efficiency

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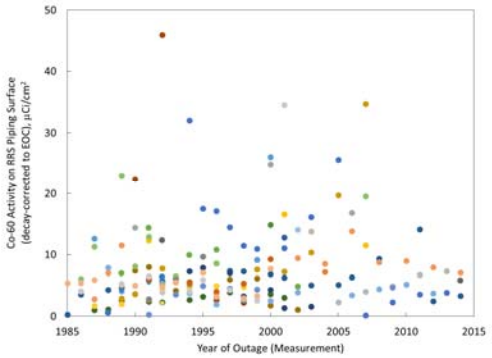
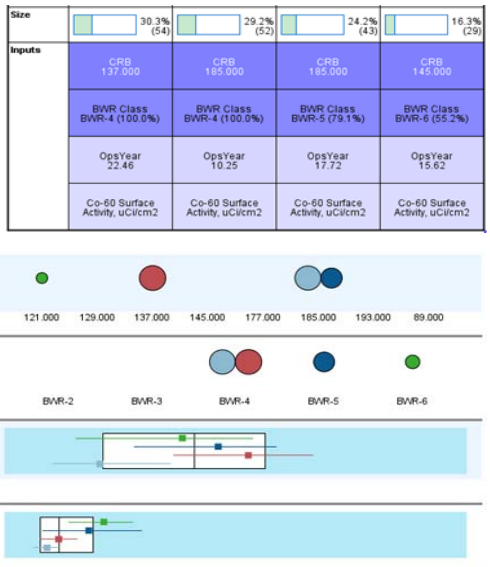
Enhanced Data Analysis – BWR Isotopic Radiation Field Data



Initial Test Cluster Analysis



BWR 5 & 6 have above average Co-60 surface activities

- At about similar times in operating life
- No. of CRBs unlikely a contributor (low/high)

→ Additional investigations needed into design and operations differences

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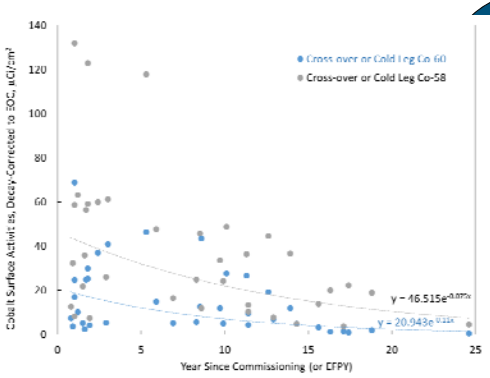
Enhanced Data Analysis – PWR Isotopic Radiation Field Data



Initial Test Cluster Analysis

Work in Progress

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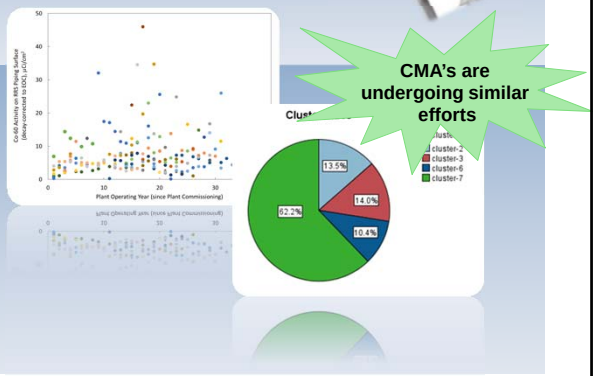
SMURF's Path Forward

- Short Term Actions
  - Merge databases: BRAC + SRMP = SMURF
  - Enhance data collection and database infrastructure
  - Improve data validation tool
- Long Term Vision
  - Make data accessible
  - Create a standard user web interface
  - Improve data upload
    - Outage data
    - Online radiation field monitoring data



CMA's are undergoing similar efforts

Monitoring Data are a Fundamental Asset

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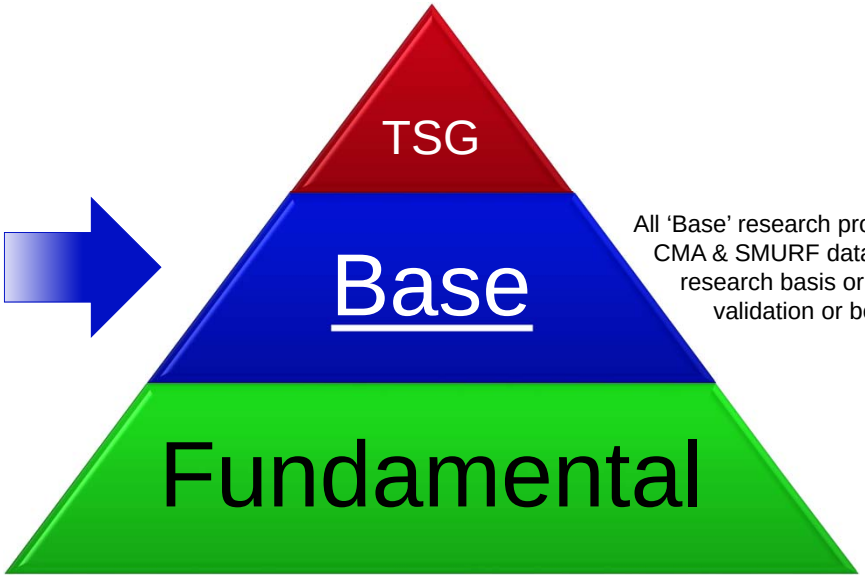
EPRI's Radiation Field & Source Term Efforts



All 'Base' research projects rely on CMA & SMURF data, either as research basis or as source for validation or benchmarking.

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Stable Surfaces – Key to Sustainable Low Radiation Fields

- Wetted component surfaces are metal release **source** and activity incorporation **sink**
- Options for surface stabilization
  - In-situ processes – HFT
  - Surface modification during component manufacturing
- 3002005377 summarizes State-of-the-Art

Stopping Metal Release is Most Effective Course of Action

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Effect of Micro-Environments on Activity Transport and Radiation Fields (2015 – 2017)

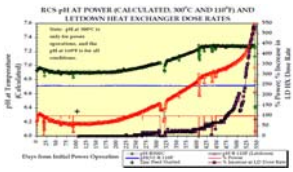
Background/Need

- Source term mitigation strategies have shown side effects, sometimes adverse to their intent
  - Zinc – potential impact in low temperature regions
  - Platinum/Hydrogen – crud bursts
- Local (interface/surface) chemistry differs from bulk coolant chemistry
- Multiple, simultaneous changes implemented do not allow to deduce a true cause-response relation

Project Objectives

- Investigate impact of global chemistry strategies on radiation field generation under localized environments in primary circuit
- Probe variations of local responses to the same parameter and their potential influences on unanticipated effects

Deposit formed on test CRDM (MRP-284)



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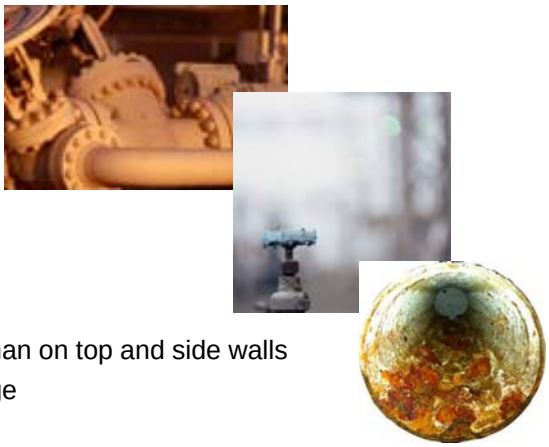
Phase 1: Characterizing Micro-Environments



- Known Locations:
  - Flow **restrictions** such as valves and pipe bends
  - **Heat** exchanging surfaces
  - Coolant **cleanup** units
  - **Stagnant** flow, crevice, and dead-end piping
- Common Observations
  - Repeated **hot spot** formation
  - Higher dose rates on bottom of **horizontal** piping than on top and side walls
  - **Deposit** formation in region of coolant phase change
  - Dose rate gradient along **temperature** gradients
  - Piping of different materials – dose rates on **carbon steel** piping tends to be higher than on SS
  - High dose rates on **control rod** housings and drives

Plant Radiation Fields = Sum of Micro-Environments

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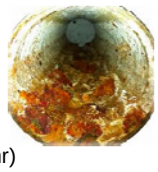
Phase1: Collecting Operational Experiences



- **Horizontal** piping
  - Plant A entered unplanned its outage with a full power scram (BWRVIP-225, Rev.1):
    - 6-inch vertical RWCU piping exhibited expected dose rates (150 – 300 mR/hr; 1.5 – 3 mSv/hr)
    - 2.5- and 4-inch bottom head drain piping feeding RWCU piping exhibited significantly above normal radiation fields of 10 R/hr (100 mSv/hr)
    - **Apparent cause**: Crud released from core settling out in horizontal piping sections concluded based on coolant isotopic data, no isotopic piping data are available
    - ***Mitigation:*** Extensive flushing operations
- Piping **Material**
  - Plant B experienced high dose rates on RWCU **carbon steel** piping and replaced piping in-kind.

Dose rates after one cycle were again up to avg. 760 mR/hr (7.6 mSv/hr), increasing to 3.2 R/hr (32 mSv/hr) after second cycle and 4.3 R/hr (43 mSv/hr) with max of 7 R/hr (70 mSv/hr) after 3 cycles, at which time another in-kind replacement was performed.

Translate Lessons Learned into Proactive Strategies

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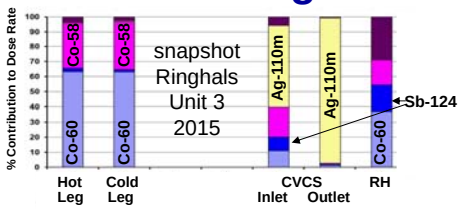
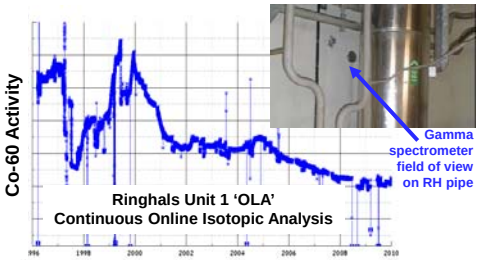
Phase 1: Translating OE into Hypothesis for Testing

- **To-date** working with limited to 'outage **snapshots**', and lessons learned



- **Going forward**, we need to evaluate available **time-function** data to understand
  - The effect of **pH** changes in letdown systems and its influence on Zn, Ag, Co, and other actors
  - The effect of **redox**-changing players as caused by
    - Introduction of oxygenated makeup water
    - Trapped air in PWR control rod housings
    - Collapse of unvented, high-hydrogen content pressurizer bubble
  - Activated **species** behavior
    - Co-58 solubility differs from Co-60 solubility, several PWRs observed in non-filterable to filterable ratios
    - Ag and Sb behavior



Monitoring Continuously Deciphers Generation

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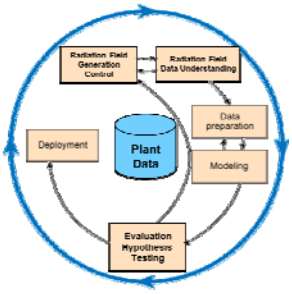
Phase 1: Building Test Cases

- Sources
  - EPRI report library
  - INPO OE database
  - Chemistry [CMA] and Radiation Field Monitoring [SMURF] Databases
  - Plant operating experiences including best possible event characterization including isotopic monitoring



- Assessment Approaches
  - Detailed analysis of specific event or observed trending - ongoing
  - Following specific evolution at plants and collecting data specific to event evolutions – forthcoming
  - Laboratory simulation to verify developed hypothesis – forthcoming

Snapshots are Good – Time Evolutions are more Insightful.

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Effect of Micro-Environments on Activity Transport and Radiation Fields (2015 – 2017)

Work Scope

Phase 1 – in progress, summary report 2016

- Survey and evaluate literature on colloid formation under LWR conditions.
- Survey industry data to identify situations and collate experiences

Phase 2 – in planning stages

- Design experimental program to investigate the effect of
  - radiation on local chemistry environments
  - colloid formation and behavior on local chemistry and transport phenomena
- Perform experimental program to validate formulated hypothesis

Benefits

Expands fundamental knowledge of radiation field generation in multivariate systems in response to implemented chemistry mitigation strategies for asset protection, radiation field and source term reduction

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If you'd be ask

What would be your top choices of ALARA tool or activities that every RP at a New Build should consider?

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Top Ten Project – Why, Why Now, & What

Today - 67 units are under construction globally

- New Builds – Okiluoto, Flamanville, Angra, Barakah, Summer, Vogtle, 24 in China
- Designs – AP1000™, APR1400, AREVA EPR™, US-APWR – what about ABWR, ESBWR

Objective

- Develop a high-level primer to guide new-build plant personnel in minimizing radiation exposure
  - Based on plant experience, and EPRI research
  - Collate lessons learned
  - Integrate knowledge and technologies available today

Experience, Science, and Technology Centered – Not Cost-Benefit

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Top 10 Activities to a Sustainable ALARA in New Builds

1. Create and foster strong interdisciplinary plant ALARA and Source Term platform to sustain low radiation fields
2. Avoid materials of high cobalt* content
3. Create corrosion-resistance stable surface
4. Install permanent shielding and work platforms
5. Install infrastructure for and utilize remote monitoring
6. Establish and maintain ALARA planning tools
7. Ensure accessible and functioning sampling, monitoring, & operational stations
8. Automate and implement remote operations as much as possible
9. Optimize coolant chemistry regime (hydrogen, platinum, zinc)
10. Maximize coolant cleanup and component flushing capabilities

Applicable for Operating Fleet, too.

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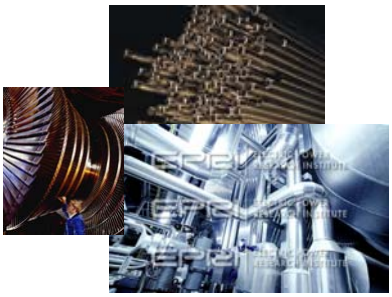
2. Avoid Materials of High Cobalt* Content

- **Need** is for resistance against corrosion and wear
- **Options** are:
  - Special materials
  - Surface treatment (electropolishing, SCrP, passivation during hot functional testing)
- **Be aware** of 'hidden' content, for example,
  - Any nickel bearing metal may contain cobalt unless specified and verified
  - Impurity in alloy 690 steam generator tubing be limited to 0.014% average for the tube bundle with no heat to exceed 0.020%
  - In, or near, the core where neutron flux is high, and for components expected to release significant quantities to reactor coolant stream, cobalt content targets (mean values) lower than 0.05% should be considered.

*** Other dose contributing elements need to be managed, too, such as nickel, silver, & antimony**



Unintended Ingress Affects Dose Rates

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3. Create Corrosion-Resistance Stable Surface

- Use of advanced modern materials, e.g., Alloy 800
- Establish metal surface passivation prior to operations
  - Electropolishing, - plating
  - Stabilized Chromium Process (SCrP)
  - Effective passivation during hot functional testing – include hydrogen and zinc
- Maintain during operations
  - Zinc injection
  - HWC
  - Pt injection in boiling water reactors

Stop Metal Releases to Stop Activation

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3a. Improved Surface Passivation during HFT

General Observation

- Advantage: Surface passivation of all-wetted surfaces occurs in-situ
- Drawbacks: Duration needed and multitude of materials involved

Beneficial Practices

- Sizewell B – two step process
  (a) passivation – Li + H_2,
  (b) HFT^2 – B + Li + H_2 followed by shutdown with H_2O_2 injection
- Tomari 3 – zinc application
  7ppb Zn during HFT (Li + H_2)

Lessons Learned

- Traditional HFT preconditioning
  - Resulted in unstable corrosion films that continue to release metals at high rates
  - In lithiated coolant without hydrogen may intensify nickel release during operation
- Japanese testing shows:
  - A stable nickel-enriched corrosion film is formed during initial exposure at high pH
    (Li without H2)
  - This Ni-enriched films dissolves upon exposure to normal PWR operating conditions
- **Hydrogen is crucial for developing stable corrosion file during HFT, Li is not**

Next ANT Steps: Develop HFT Guidance and HFT Monitoring

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6. Establish and Maintain ALARA Planning Tools

- Establish ALARA planning tools, such as:
  - Surrogate tour mapping,
  - Laser scanning,
  - Constructing a photo library of high radiation areas prior to operation, and
  - Taking videos of equipment internals
- Develop data warehousing enabling access to data from ALARA planning tools
  - Integrate online and outage radiation field and remote monitoring of work activities
  - Cross link to standardized radiation work permits and task packages
  - Define key descriptors & metrics for success
- Create change capabilities to enable adaptation of emergent technologies
  - Data management and analysis
  - Robotics

Isotopic Radiation Field 3D Real-time Visualization – No Longer a Dream.

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10. Maximize Coolant Cleanup & Component Flushing Capabilities

- Only tools to remove activated corrosion products from coolant
- Maximize coolant cleanup
  - Select optimal resin and enhance system performance plus availability
  - Optimize coolant flowrate through cleanup
  - Augment during outage with submersible filter/demineralizers
  - Dedicated cleanup system for cavity cleanup in draindown line during refuel activities to effectively remove high-particulate source term
- Install component flushing ports and ensure shortest possible, shielded route to waste management system
- Implement remote online monitoring of performance and remote change out capabilities

Clean Coolant Equals Low Radiation Fields.

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Top EPRI Must Have's on CY/RP Bookshelves

Chemistry

3002002922 - ANT: Preliminary Guidance for Chemistry Control in Advanced Pressurized Water Reactor Designs
3002000505 - Pressurized Water Reactor Primary Water Chemistry Guidelines: Revision 7
3002002623 - BWRVIP-190 Revision 1: BWR Water Chemistry Guidelines
3002001796 - Boiling Water Reactor Zinc Addition Sourcebook
3002001942 - BWRVIP-225 Revision 1: BWR Shutdown and Startup Chemistry Experience and Application Sourcebook
1025316 - Pressurized Water Reactor Primary Zinc Application Sourcebook Revision 1
1021112 - Corrosion Product Transport during Boiling Water Reactor and Pressurized Water Reactor Startups

Radiation Safety/ALARA

3002005480 - Remote Monitoring Technology Guide for Radiation Protection: Field Implementation of Remote Monitoring
3002003165 - Guidance for Optimal Performance of Shielding Programs
3002000268 - Evaluating Indoor Location Tracking Systems in a Nuclear Facility: Experimentation with Different Techniques in an Industrial Environment
3002000032 - 3D Radiation Field Estimation Algorithm v1.0
1025309 - Dose Reduction Options for Refueling Tasks
1021101 - Evaluation of an Advanced Radiation Shielding Material for Permanent Installation at an Operating Nuclear Reactor
1021102 - Scaffold Program Optimization and Dose Reduction Guide

Source Term

1021103 - Cobalt Reduction Sourcebook
1003390 - Radiation Field Control Manual
3002005377 - LWR Ex-Core Surface Conditioning for Radiation Field Reduction
3002005479 - Reactor Cavity Decontamination Sourcebook
3002005484 - EPRI Plant Source Term Assessments--2015 Review
3002005481 - In-Plant Gamma Spectrometry: Isotopic Data Collection Experiences
3002003157 - EPRI BWR Radiation Level Assessment and Control (BRAC) Program: 2014 Revision
3002003155 - EPRI Pressurized Water Reactor Standard Radiation Monitoring Program: 2014 Revision
1025305 - Impacts of PWR Operational Events on Particulate Transport and Radiation Fields
1016766 - High Activity Crud Burst Impacts and Responses

Knowledge Transfer and Retention is Key to Sustainable ALARA

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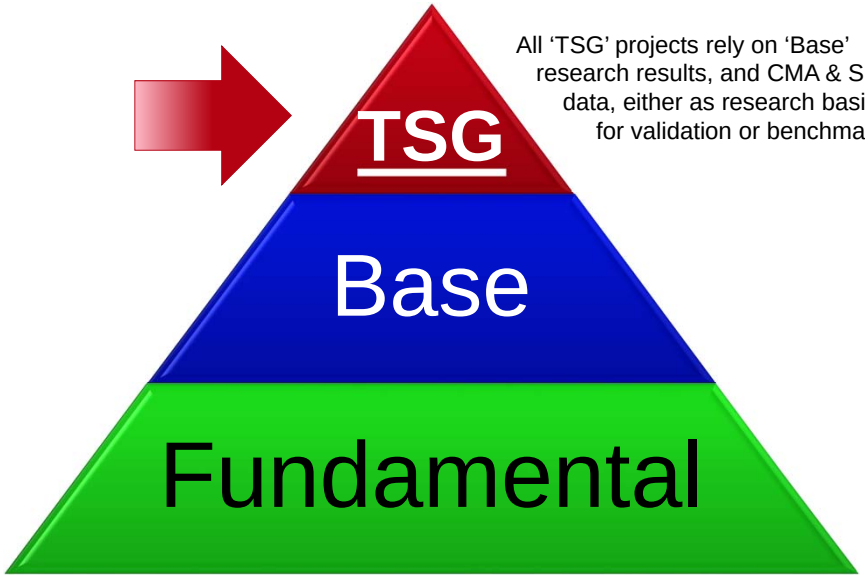
EPRI's Radiation Field & Source Term Efforts



All 'TSG' projects rely on 'Base' research results, and CMA & SMURF data, either as research basis or as source for validation or benchmarking.

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RMST TSG – Global Industry Peer Group

Global experience base of 20 utilities with 74 sites and 166 units (~40% of global fleet) for:

- Benchmarking
  - **Quick surveys to emergent issues**
  - Deeper looks at topics of general interest
    Hot spot practices (3002003158), chemical decontamination (3002000555)
- **Independent objective technical assessments** (3002005484)
  - Topical –
    Source term, alpha, ALARA, remote monitoring, scaffold & shielding
  - Individual –
    Vendor's first-of-a-kind decontamination, fleet-wide practices
- Answering **tactical research** questions
  - PWR shutdown releases (3002005483)
  - BWR ultrasonic fuel cleaning as radiation field reduction strategy (3002005482)
  - Radiation Field modeling – OSCAR
  - Radiation Monitoring Technology Implementation Guidance (3002005480)
- Knowledge Transfer
  - Annual Workshops (with associated learning opportunities)
    June - Shielding & Scaffolding; August - Remote Monitoring; September - Radiation Field & Source Term Reduction

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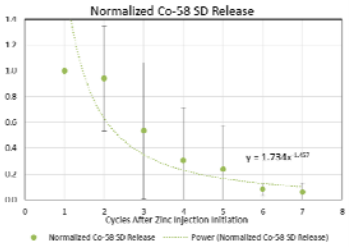
RMST TSG – 2015 Quick Benchmarks

- Zinc effectiveness at high-duty PWRs
  - Similar benefit to radiation fields at SRMP location as in not high-duty plants
  - Six of the seven benchmarked high-duty plants perform UFC each outage
- BWR Shutdown Particulate Release:
  - Follow BWR VIP-225 guidance
  - Implement soft shutdown
  - Ensure cleanup system availability
  - HWC-OLNC chemistry influences chromium chemistry in coolant, which is mostly insoluble



Six High Duty, Alloy 690 SGs, UFC, & RCS Zinc of 5-12 ppb started Early in Cycle

- BWR Chemical Decontamination:
  - Short-term benefits may not measure up
  - Ensure adequate flushing plans and passivation steps are executed to avoid unexpected consequences
  - Ensure loss of platinum is counteracted for adequate asset protection

For more information visit the Radiation Safety Collaboration site

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Review of Industry Source Term Reduction Efforts

- Objective:
  - Identify best practices & lessons learned
  - Identify knowledge gaps and technology needs
- General Observation:

Do not expect Quick Fixes – Source Term Reduction manifests successes after several cycles

- Basis:
  - Past EPRI Source Term Assessments
    More than 20 assessments performed globally
    - ~ 2/3 BWR and ~ 1/3 PWR
    - several repeat assessments

TSG report 3002005484 - October 2015

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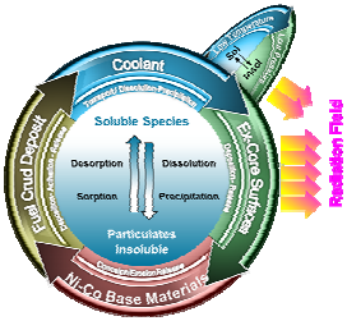
Source Term Reduction - Ownership and Drivers



Source Term is controlled and affected by all departments

Source Term reduction is most effectively achieved, when all department have the same objective:

Producing power, cost efficient, while source term conscious

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Source Term Reduction in Pressurized Water Reactors

- Beneficial source term strategies identified are:
  - Fuel cleaning
  - Zinc chemistry
  - Elevated lithium control programs
  - Crud mitigation
  - End-of-cycle chemistry control strategies

- Gaps – future research
  - Develop better understanding and guidance on
    - Optimum time to terminate zinc feed prior to EOC considering Zn ions impact on ex-core surface deposition
    - Changing lithium/pH_T during the latter portion of a cycle (within Guideline limits) to stabilize fuel deposits (and minimize deposition on ex-core surfaces)

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Source Term Reduction in Boiling Water Reactors

- Common issues found
  - Materials (Stellite™ replacements and material specification/verification)
  - RWCU and RHR materials – carbon steel surfaces generally cause higher radiation fields than stainless steel surfaces
  - Cleanup system performance and availability

- Factors contributing to source term mobility include
  - Fuel failures
  - Change in core design
  - Condenser inleakage
  - Transients affecting hydrogen-oxygen balance in coolant
  - Sequencing of platinum injection
  - Noble metal application close to outage

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Source Term Reduction in Boiling Water Reactors

- Beneficial Source Term reduction strategies
  - Reduction of cobalt-containing materials such as Stellite™ (OEM blades, valves…)
  - Excellency in cleanup system performance and availability
  - Optimum chemistry program (HWC, Pt, Zn)
  - Minimize FW iron ingress
  - BWRVIP-225 recommended shutdown practices

- Beneficial outage operational practices
  - Flood up through the condensate treatment system
  - Using submersible filters and demineralizers to supplement cavity cleanup
  - Applying fresh precoats to RWCU F/Ds and fuel pool cooling system F/Ds shortly prior to outage start
  - Maintaining RWCU in service until after cavity floodup is complete, fuel gates are open, and water clarity has been established

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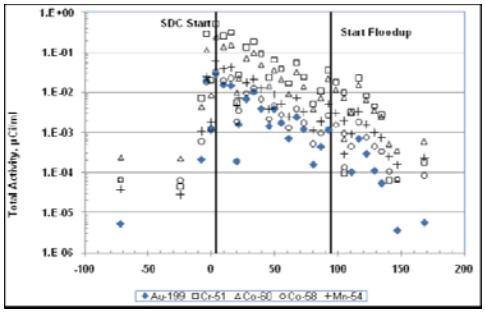
Source Term Reduction in Boiling Water Reactors

Gaps – future research

- Chemistry
  - Behavior of chromium and Cr-51 under OLNC, low hydrogen and low iron conditions
  - Impact of OLNC, low iron, and high zinc chemistry on radiation fields
  - Chemical decontamination – sequencing of noble metal application
  - Behavior of reported Zn-65 and Zn-69m relative to elemental zinc levels needs better understanding
- Materials
  - Impact of removal of admiralty brass condensers on copper source – ECP effect and reduction of natural zinc caused radiation field
  - Impact of in-vessel cobalt sources on cobalt mass balance
  - Cr-51 particulate releases
  - Transition to Inconel® grids will this cause an increased contribution from Co-58
- Operations
  - Impact of shutdown practices on hotspots and associated CRE
  - Cleanup of forward pumped drains
- Fuels
  - Influence of core and/or fuel design on source term and its mobility
  - Control rod sequencing impact of activity transport
- RP
  - Chemical decontamination benefit relative to asset protect and recontamination rates
  - Remote monitoring as part of ALARA program



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Review of Industry Source Term Reduction Efforts

- **Do**
  - **Component replacement:**
    - **Eliminate high cobalt content materials (Stellite™ etc.)**
    - **Enforce material specifications in regards to cobalt content**
    - **Enhance surface finishes**
  - **Optimize reactor coolant cleanup efficiency and performance**
  - **Limit core crud buildup and carry-over**
  - **Optimize chemistry program**
  - **Use any additional coolant cleanup system during outage**

- Don't
  - Replace non-Stellite™ with Stellite™
  - Ignore degrading cleanup system performance
  - Ignore chemistry and radiation field monitoring
  - Expect quick fixes

Achieve a Sustainable Low Source Term

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RMST TSG – 2015 Tactical Research

- BWR Ultrasonic Fuel Cleaning (3002005482)
  - Feasible
  - Benefit is expected long term if applied to reload fuel
  - Needs further qualification by fuel reliability/fuel vendors
- PWR Shutdown Release (3002005483)
  - Evaluation of various factors impacting releases and release rates
    - Steam generator design, materials, manufacturing process, and life time
    - Plant design, operating temperature, pH_T
    - Case studies – UFC and shutdown practices
  - Multivariate system requires long-term, continuing monitoring and analysis
  - This is an ongoing effort – apparent inconclusiveness may be indicative of plant specificity
  - Status update publication in 2016
- Radiation Field Modeling
  - Review in progress – publication 2016
  - PWR – **OSCAR** is considered for sensitivity and validation studies to aid industry in implementation of radiation field reduction strategies
- Radiation Monitoring Technology Implementation Guide (3002005483)

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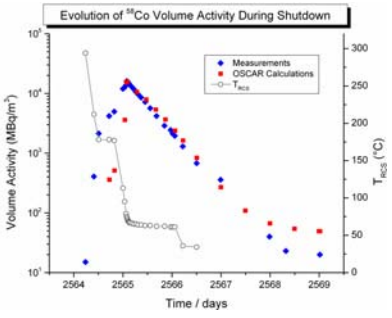
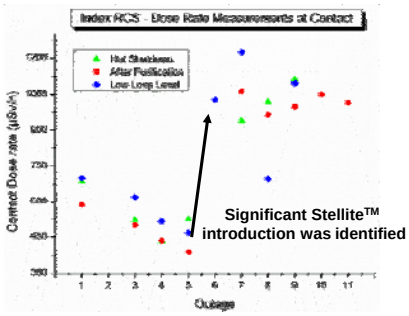
OSCAR – a PWR Radiation Field Modeling Tool

- RMST TSG currently working to bring to EPRI members
- Focus on research, sensitivity, and validation studies
- EPRI and Southern are working on validating OSCARs capabilities in 2016 (pending)

Predictive



Explorative



Mathieu Corbineau, *OSCAR – Modeling Tool for Source Term Management and Dose Reduction: AREVA Use*, 2015 EPRI Source Term and Radiation Field Reduction Workshop, 15 July 2015, Charlotte, NC.

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RMST TSG – Tactical Research Topics under Consideration

- PWR zinc guidance
  - EOC termination
  - Zn target concentration
- BWR
  - Cr-51, Co-58 contributions & activity transport under ultra-low iron, hydrogen, and platinum
  - Decontamination, when and how to assure asset protection
- Coupling radiation field generation modeling with ALARA planning

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RMST TSG Meetings in 2016 & knowledge transfer opportunities

- **Dose Reduction for Scaffolding, Insulation, and Shielding Workshop**
  - June 14-16, 2016 in Charlotte, NC at EPRI Offices
- **Radiation Monitoring Technology Workshop**
  - August 2016 – details TBD
- **Radiation Field and Source Term Reduction Workshop**
  - Sept. 12 - 14, 2016 in Charlotte, NC at EPRI Offices
  - Monday afternoon – Utility only – Source Term 101
  - Tue/Wed – open workshop
  - In conjunction with PWR Chemistry TSG – Wed pm joint session
- **In-Plant Gamma Isotopic Radiation Field Monitoring – Fundamentals 101**
  - Sept 15, 2016 at EPRI Charlotte offices
  - open to EPRI members - please email interest to cgregorich@epri.com

For more information, email cgregorich@epri.com

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RMST TSG – 2016 Membership

Utility - Membership period		2014-2016	2015-2017	2016-2018
Dominion Resources Inc.	Dominion			TBF
AXPO	NOK	x		
Comision Federal de Electricidad	CFE	x		
Detroit Edison	DTE Energy	x		
Electricite de France	EDF	x		
FirstEnergy Service Company	FENOC	x		
Korean Hydro Nuclear Power	KHNP	x		
Luminant	Luminant	x		
NA-SA	NA-SA	x		
Nebraska Public Power District	NPPD	x		
Public Service Electric and Gas	PSE&G	x		
Southern Company		x		
Tennessee Valley Authority	TVA	x		
Xcel		x		
Arizona Public Service (Palo Verde)	APS		x	
Energy Northwest			x	
Entergy Services, Inc.	Entergy		x	
Duke Energy	Duke			x
Exelon Corporation	Exelon			x
Omaha Public Power District	OPPD			x

Does RMST TSG Offer Value? – Speak to your NMETT to Join/Renew.

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PWR RP ALARA ASSOCIATION

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PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Arkansas Nuclear One UTILITY: Entergy

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	B&W	26	High	5.573 rem	Third	4
UNIT 2:	CE	24	Medium*	6.063 rem	Fourth	5
UNIT 3:						

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	60.471/ 59.9 rem	25/ 35.5	52,697 lbs	26
UNIT 2:	65.295/ 65.906 rem	29/ 55	43,403 lbs	37
UNIT 3:				

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	✓		**UNIT 1:**	✓	
Ultrasonic Fuel Clean		✓	**UNIT 2:**	✓	
Reduced Inventory Shutdown Chemistry	✓		**UNIT 3:**		

SPECIALTY RESINS		**MACROPOROUS**	✓	**PCR-01**		**OTHER:**		**ONLINE**	

CONSTANT MODIFIED Ph	**YES** ✓	**NO**	**IF YES, REVISED TO:** Modified pH 7.2
PERM. SCAFFOLD	**YES**	**NO** ✓	**LOCATION:**
PERM. SHIELDING	**YES** ✓	**NO**	**LOCATION:** Containment and Auxiliary Buildings

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	356 mr	5	Holtec	HI Storm C

Additional information: * Per Reactor Engineering

Prepared By: Melody Gibson **Date:** 01/19/2016

Contact Info: mgibson@entergy.com

PWR RP ALARA ASSOCIATION

PWR RP/ALARA ASSOCIATION

PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Beaver Valley UTILITY: First Energy

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE TO DATE	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	Westinghouse	24	H	2125	1	1
UNIT 2:	Westinghouse	19	H	651	3	2
UNIT 3:						

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	37,000/30,519	30/29	32,008	6
UNIT 2:	73,176/73,472	37/34	83,194	11
UNIT 3:				

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	☑	☐	**UNIT 1:**	☑	☐
Ultrasonic Fuel Clean	☐	☑	**UNIT 2:**	☐	☑
Reduced Inventory Shutdown Chemistry	☐	☑	**UNIT 3:**	☐	☐

SPECIALTY RESINS	☐	**MACROPOROUS**	☐	**PCR-01**	☑	**OTHER:**		**ONLINE** ☐

CONSTANT MODIFIED Ph	**YES** ☑	**NO** ☐	**IF YES, REVISED TO:**
PERM. SCAFFOLD	**YES** ☐	**NO** ☐	**LOCATION:** Drains Tanks, Pressurizer lines, S/G cubicles in RBC
PERM. SHIELDING	**YES** ☐	**NO** ☑	**LOCATION:**

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	425	4	Transco	NUHOMS 37PTH

Additional information:

Prepared By: Jeff Fontaine **Date:** 1/19/16

Contact Info: Cell: 724-462-3423

PWR RP ALARA ASSOCIATION

PWR RP/ALARA ASSOCIATION

PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Byron UTILITY: Exelon

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:		20	H	7.937	2	1
UNIT 2:		19	H	3.601	2	1
UNIT 3:						

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	41.7 / 40.746 (Secondary)	18 days / 18 days	67,592	7
UNIT 2:	44.0 / 63.081 (Secondary)	25 days / 25 days	71,390	1
UNIT 3:				

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	✓		**UNIT 1:**	✓	
Ultrasonic Fuel Clean		✓	**UNIT 2:**		✓
Reduced Inventory Shutdown Chemistry		✓	**UNIT 3:**		

SPECIALTY RESINS	✓	**MACROPOROUS**		**PCR-01**	✓	**OTHER:**	PRC-01M used for Outage, FC and On-line	**ONLINE**	✓

CONSTANT MODIFIED Ph	**YES** ✓	**NO**	**IF YES, REVISED TO:** 7.4
PERM. SCAFFOLD	**YES** ✓	**NO**	**LOCATION:** Aux Bldg., Unit 1 and Unit 2 Containment
PERM. SHIELDING	**YES** ✓	**NO**	**LOCATION:** Aux Building

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	112 mrem	20	Holtech	Hi-Storm

Additional information: Byron achieved the best site monthly exposure(162 mrem) in November 2015

Additional dose during Unit 2 outage was due to emergent repairs to CRDM Pen - 6. Additional dose for repairs was 16.439 P-Rem (Secondary)

Prepared By: Scott Leach **Date:** 1/12/16

Contact Info: scott.leach@exeloncorp.cor

PWR RP ALARA ASSOCIATION

PWR RP/ALARA ASSOCIATION

PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Catawba UTILITY: Duke Energy

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	Westinghouse	23	H	9.960 Total both Units	2nd	1
UNIT 2:	Westinghouse	21	H		3rd	1
UNIT 3:						

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	39.370/35.355	28/27	43,000	1
UNIT 2:	92.570/83.558	39/45	73,300	12
UNIT 3:				

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	✓		**UNIT 1:**	✓	
Ultrasonic Fuel Clean	✓		**UNIT 2:**		✓
Reduced Inventory Shutdown Chemistry		✓	**UNIT 3:**		

SPECIALTY RESINS ✓	**MACROPOROUS**	**PCR-01**	**OTHER:**		**ONLINE**

CONSTANT MODIFIED Ph	**YES**	**NO**	**IF YES, REVISED TO:**
PERM. SCAFFOLD	**YES**	**NO** ✓	**LOCATION:**
PERM. SHIELDING	**YES** ✓	**NO**	**LOCATION:** Aux Bldg

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	62/300	24/6	N/A	NAC-UMS/Magnastor

Additional information:

Prepared By: Fletcher Wilson **Date:** 1/14/2016

Contact Info: Dana Page

PWR RP ALARA ASSOCIATION

PWR RP/ALARA ASSOCIATION

PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Davis- Besse UTILITY: FirstEnergy

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	B&W	19	High	~950 millirem TLD	4th	0
UNIT 2:						
UNIT 3:						

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	233.5 R / 214.6 R	76 Days / 97 Days	218,726 lbs.	28
UNIT 2:				
UNIT 3:				

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	✓		**UNIT 1:** Replaced Original S/G's	✓	
Ultrasonic Fuel Clean	✓		**UNIT 2:**		
Reduced Inventory Shutdown Chemistry			**UNIT 3:**		

SPECIALTY RESINS		MACROPOROUS	✓	PCR-01	✓	OTHER:		ONLINE	✓

CONSTANT MODIFIED Ph	**YES** ✓	**NO**	**IF YES, REVISED TO:** 7.2 (researching increase to 7.4)
PERM. SCAFFOLD	**YES** ✓	**NO**	**LOCATION:** Shielding Scaffold
PERM. SHIELDING	**YES**	**NO** ✓	**LOCATION:**

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	430	3	Areva	NUHOMS - 24P

Additional information: TLD dose is 848 mrem for 3 quarters. Expecting ~ 100 mrem for 4th Quarter once TLD results are published.
The PCE's were 10 for Refuel and 18 for S/G Replacement.
Dry Fuel Storage was in 1996.

Prepared By: Marc Sidoti **Date:** 01/12/2016

Contact Info: Cell 419-265-1053

PWR RP ALARA ASSOCIATION

PWR RP/ALARA ASSOCIATION

PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Diablo Canyon UTILITY: Pacific Gas & Electric Co.

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE TO DATE	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	4 loop W	19	L	2015 = 5.1*	3	6
UNIT 2:	4 loop W	18	L	2015 = 3.3*	1	4
UNIT 3:						

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	43 / 56	33 / 34	71,000lbs.	7
UNIT 2:	30 / 30	33 / 32	88,000lbs.	14
UNIT 3:				

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	✓		**UNIT 1:**	✓	
Ultrasonic Fuel Clean		✓	**UNIT 2:**	✓	
Reduced Inventory Shutdown Chemistry		✓	**UNIT 3:**		

SPECIALTY RESINS	✓	**MACROPOROUS**	✓	**PCR-01**		**OTHER:**		**ONLINE** ✓

CONSTANT MODIFIED Ph	**YES** ✓	**NO**	**IF YES, REVISED TO:** pHt 7.2
PERM. SCAFFOLD	**YES**	**NO** ✓	**LOCATION:**
PERM. SHIELDING	**YES** ✓	**NO**	**LOCATION:** RCDT

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	0.077 mrem	32	Holtec	MPC-32

Additional information: Rx head replaced on both units w/ integrated shield package.
*Online dose includes significant firewater piping replacement project in both units and ISFSI campaign of 9 total cans.

Prepared By: Rick Rogers **Date:** 1/19/16

Contact Info: Killian Fischer 8050-545-39

PWR RP ALARA ASSOCIATION

PWR RP/ALARA ASSOCIATION

PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Ginna Station UTILITY: Exelon Corp.

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	Westinghouse	39	H	4.5 Rem	1st	1
UNIT 2:	NA					
UNIT 3:	NA					

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	35 Rem/27.492 Rem	19 days/18.6 days	20	2
UNIT 2:	NA			
UNIT 3:	NA			

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	☐	☑	**UNIT 1:** 1996	☑	☐
Ultrasonic Fuel Clean	☐	☑	**UNIT 2:**	☐	☐
Reduced Inventory Shutdown Chemistry	☑	☐	**UNIT 3:**	☐	☐

SPECIALTY RESINS	MACROPOROUS	PCR-01	OTHER:	ONLINE
☑	☑	☑	LiOH, anion, cation	☑

CONSTANT MODIFIED Ph	YES ☑	NO ☐	**IF YES, REVISED TO:** 7.2 from 7.0
PERM. SCAFFOLD	YES ☑	NO ☐	**LOCATION:** Containment Purge Exhaust, Spray Line, RHR suction line
PERM. SHIELDING	YES ☑	NO ☐	**LOCATION:** Regen HX, Spray Line, RHR suction line, RHR intake line

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	0.478 rem	4	site personnel	NUHOMS with 32PT dry shielded

Additional information: Ginna has only done two ISFSI campaigns 2010 (4 canisters) and 2011(2 canisters). This year 2016, we will be doing our third campaign 4 canisters.

Prepared By: Chris Singley **Date:** 01/14/16

Contact Info: christian.singley@exeloncor

PWR RP ALARA ASSOCIATION

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PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: McGuire UTILITY: Duke Energy

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	Westinghouse	EOC24	H	9.820	4	4
UNIT 2:	Westinghouse	EOC23	H	8.028	2	5
UNIT 3:	N/A	N/A	N/A	N/A	N/A	N/A

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	41.9/36.4	24/27	50,000	20
UNIT 2:	N/A	N/A	N/A	N/A
UNIT 3:	N/A	N/A	N/A	N/A

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	☑	☐	**UNIT 1:** YES	☑	☐
Ultrasonic Fuel Clean	☑	☐	**UNIT 2:** YES	☑	☐
Reduced Inventory Shutdown Chemistry	☑	☑	**UNIT 3:** N/A	☑	☐

SPECIALTY RESINS	MACROPOROUS	PCR-01	OTHER:	ONLINE
☑	☑	☐		☑

CONSTANT MODIFIED Ph	**YES** ☑	**NO** ☐	**IF YES, REVISED TO:** 6.9 - 7.15
PERM. SCAFFOLD	**YES** ☐	**NO** ☑	**LOCATION:**
PERM. SHIELDING	**YES** ☑	**NO** ☐	**LOCATION:** U-1 Letdown line Auxiliary bldg.

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	.219 rem	5	NAC	Magnastor

Additional information:

Prepared By: Stephen Lisi **Date:** 1/12/2016

Contact Info: stephen.lisi@duke-energy.c

PWR RP ALARA ASSOCIATION

PWR RP/ALARA ASSOCIATION

PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Millstone UTILITY: Dominion

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:		NA	NA	NA	NA	N
UNIT 2:		23	H	4.850	3rd	7
UNIT 3:		17	H	0.833	3rd	2

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	NA	NA	NA	NA
UNIT 2:	59.891	30/35	50,000	12
UNIT 3:	66.045	28/35	75,000	16

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	☐	☑	**UNIT 1:**	☐	☐
Ultrasonic Fuel Clean	☑	☐	**UNIT 2:**	☑	☐
Reduced Inventory Shutdown Chemistry	☐	☑	**UNIT 3:**	☐	☑

SPECIALTY RESINS		MACROPOROUS	☑	PCR-01		OTHER:		ONLINE	

CONSTANT MODIFIED Ph	**YES** ☑	**NO** ☐	**IF YES, REVISED TO:**
PERM. SCAFFOLD	**YES** ☑	**NO** ☐	**LOCATION:** Very little
PERM. SHIELDING	**YES** ☑	**NO** ☐	**LOCATION:** Pressurizer Spray Piping

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	34 mrem	9	NA	NUHOMES

Additional information: Unit 1 permanently shutdown. Fuel cleaning at Unit 3 only.

Prepared By: Donald DelCore **Date:** 01/14/2016

Contact Info: Donald.W.Del.Core@Dom.c

PWR RP ALARA ASSOCIATION

PWR RP/ALARA ASSOCIATION

PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Oconee UTILITY: Duke Energy

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	B&W	29	H	5.241 Rem	1	1
UNIT 2:	B&W	28	H	5.403 Rem	2	1
UNIT 3:	B&W	28	H	3.635 Rem	2	1

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	47.4 Rem / 33.9 Rem	35 days		7
UNIT 2:	63 Rem / 58.8 Rem	26 days		14
UNIT 3:	58.9 Rem / 51.2 Rem	29 days		6

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	☐	☑	**UNIT 1:**	☑	☐
Ultrasonic Fuel Clean	☑	☐	**UNIT 2:**	☑	☐
Reduced Inventory Shutdown Chemistry	☑	☐	**UNIT 3:**	☑	☐

SPECIALTY RESINS ☐	MACROPOROUS ☑	PCR-01 ☐	OTHER:		ONLINE ☐

CONSTANT MODIFIED Ph	**YES** ☑	**NO** ☐	**IF YES, REVISED TO:** 6.9 - 7.15
PERM. SCAFFOLD	**YES** ☐	**NO** ☐	**LOCATION:**
PERM. SHIELDING	**YES** ☑	**NO** ☐	**LOCATION:** Seal Supply Filter Housings

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	0.455 Rem	4	Transnuclear	Nuhoms 24-PTB

Additional information:

Prepared By: Jill R. Smith **Date:** 1/15/16

Contact Info: 864-873-5551

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PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Palo Verde Nuclear Generating Station UTILITY: Arizona Public Service Company

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	CE	19	High	3.124 rem *	1	2
UNIT 2:	CE	20	High	2.209 rem	1	4
UNIT 3:	CE	19	High	1.908 rem	1	2

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	21.825 / 24.915 rem	30 days / 31.8 days	79,380 #	11
UNIT 2:	20.529 / 20.999 rem	30 days / 36.0 days	79,180 #	3
UNIT 3:	28.172 / 29.636 rem	30 days / 29.8 days	80,580 #	16

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	☐	☑	**UNIT 1:** Fall RFO 2005, 1R12	☑	☐
Ultrasonic Fuel Clean	☐	☑	**UNIT 2:** Fall RFO 2003, 2R11	☑	☐
Reduced Inventory Shutdown Chemistry	☑	☐	**UNIT 3:** Fall RFO 2007, 3R13	☑	☐

SPECIALTY RESINS		MACROPOROUS	☑	PCR-01		OTHER:	0.05 micron RCS filtration	ONLINE	☑

CONSTANT MODIFIED Ph	**YES** ☑	**NO** ☐	**IF YES, REVISED TO:** Modified pH 7.2
PERM. SCAFFOLD	**YES** ☑	**NO** ☐	**LOCATION:** Containment and Auxiliary Buildings
PERM. SHIELDING	**YES** ☑	**NO** ☐	**LOCATION:** Reactor Vessel Closure Head

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	0.032 rem	131	NAC	UMS

Additional information: * 3.124 rem online in Unit 1 includes Decontamination Facility, Dry Active Waste Processing and Storage (DAWPS) Facility, Low Level Radioactive Material Storage Facility (LLRMSF) and Outage Support Facility (OSF). Dose associated with Dry Fuel Storage is included in the applicable unit.
PRC01 Resin to be used prior to Refueling Outage (RFO) 3R19, fall 2016.
Permanent Shielding Modifications for Containment and other locations are in development.
RCS Deborating Ion Exchangers utilize macroporous resin layered over gel-type resin.
Dry Fuel Storage: Best Dose 32 mrem was associated with an 8.4 kW canister. 56 mrem for a 13.0 kW canister.

Prepared By: James Bungard **Date:** 1/19/2016

Contact Info: James.Bungard@aps.com

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PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Robinson Unit 2 (single unit) UTILITY: Duke Energy Progress

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:						
UNIT 2:	Westinghouse	30	L	3.926 (pending TLD results for 2nd half of 2015)	3	1
UNIT 3:						

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:				
UNIT 2:	50/52.663	25/44	45,470	11
UNIT 3:				

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	✓		UNIT 1:		
Ultrasonic Fuel Clean	✓		UNIT 2:	✓	
Reduced Inventory Shutdown Chemistry		✓	UNIT 3:		

SPECIALTY RESINS		MACROPOROUS	✓	PCR-01		OTHER:		ONLINE	✓

CONSTANT MODIFIED Ph	YES ✓	NO	IF YES, REVISED TO: 7.1
PERM. SCAFFOLD	YES ✓	NO	LOCATION: Loops (around S/G)
PERM. SHIELDING	YES ✓	NO	LOCATION: various

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	161 mREM	4	NUHOMS	24P

Additional information: Use of NeverWet for DFS campaign - 1st time in industry - TIP Award
Dose savings yielded lowest per cannister dose at RNP.

Prepared By: Wade Miller **Date:** 01/20/2016

Contact Info: wade.miller@duke-energy.c

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PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Salem UTILITY: PSEG Nuclear, LLC

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	Westinghouse	24	High	3.607 rem	1st (1)	5
UNIT 2:	Westinghouse	22	High	1.689 rem	1st (1)	1
UNIT 3:	N/A	N/A	N/A	N/A	N/A	N/A

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	46.5 / 46.7 rem	25 / 35 days	4800 lbs	14
UNIT 2:	37.2 / 30.4 rem	25 / 39 days	3415 lbs	11
UNIT 3:	N/A	N/A	N/A	N/A

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	☑	☐	**UNIT 1:** 1996	☑	☐
Ultrasonic Fuel Clean	☐	☑	**UNIT 2:** 2008	☑	☐
Reduced Inventory Shutdown Chemistry	☐	☑	**UNIT 3:** N/A	☐	☐

SPECIALTY RESINS	MACROPOROUS	PCR-01	OTHER:	ONLINE
☑	☑	☐		☑

CONSTANT MODIFIED Ph	**YES** ☐	**NO** ☑	**IF YES, REVISED TO:** N/A
PERM. SCAFFOLD	**YES** ☐	**NO** ☐	**LOCATION:** Unknown
PERM. SHIELDING	**YES** ☐	**NO** ☑	**LOCATION:** N/A

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	1.151 rem (2)	7	Holtec	100

Additional information: (1) Operating Rad Exposure viewed on 01/21/2016
(2) Average: 25 kW/cask, 164 mR/cask

Prepared By: Glenn Toft **Date:** 01/21/2016

Contact Info: glen.toft@pseg.com

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PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Seabrook Station UTILITY: NextEra Energy

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE TO DATE	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	West 4L	18	H	1.684 rem (2015)	4	3
UNIT 2:						
UNIT 3:						

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	96.615 rem/99.696 rem	35 days/44 days	120,000	18
UNIT 2:				
UNIT 3:				

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	✓		**UNIT 1:**		✓
Ultrasonic Fuel Clean	✓		**UNIT 2:**		
Reduced Inventory Shutdown Chemistry			**UNIT 3:**		

SPECIALTY RESINS ✓	MACROPOROUS ✓	PCR-01	OTHER: Submersible Demins	ONLINE

CONSTANT MODIFIED Ph	YES ✓	NO	IF YES, REVISED TO: 7.3
PERM. SCAFFOLD	YES	NO ✓	LOCATION:
PERM. SHIELDING	YES	NO ✓	LOCATION:

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	0.6234 rem	8 (avg kw: 27.5)	TransNuclear	NUHOMS HD-32PTH

Additional information: High dose in OR17 from MSIP on 7 RV Nozzles

Prepared By: Kinsey Boehl **Date:** 1/14/16

Contact Info: 603-773-7638

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PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Sequoyah Nuclear Plant UTILITY: Tennessee Valley Authority

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:		20		6.122 Rem ED dose	3rd	4
UNIT 2:		20		3.742 Rem ED dose	2nd	3
UNIT 3:						

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	55.653 / 73.357 Rem	29 days / 34 days	approx. 280k lbs	20
UNIT 2:	74.752 / 57.467 Rem	28 days / 31 days	approx. 280k lbs	6
UNIT 3:				

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	✓		**UNIT 1:** 2003	✓	
Ultrasonic Fuel Clean	✓		**UNIT 2:** 2012	✓	
Reduced Inventory Shutdown Chemistry			**UNIT 3:**		

SPECIALTY RESINS		**MACROPOROUS**		**PCR-01**		**OTHER:**	**ONLINE**

CONSTANT MODIFIED Ph	**YES**	**NO**	**IF YES, REVISED TO:**
PERM. SCAFFOLD	**YES**	**NO** ✓	**LOCATION:**
PERM. SHIELDING	**YES**	**NO** ✓	**LOCATION:**

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	174 mRem avg	8	Holtec	HI STORM 100

Additional information: U1R20 dose delta attributed to Loose Parts retrieval and recovery; U2R20 dose delta attributed to SQN Soft Shutdown

Prepared By: Michael Harrison **Date:** 01/14/16

Contact Info: cell: 702-496-4743

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PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: South Texas Project UTILITY: STPNOC

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	WESTINGHOUSE	19	HIGH	1.71 rem	2	12
UNIT 2:	WESTINGHOUSE	17	HIGH	1.73 rem	1	6
UNIT 3:						

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	59 rem / 53 rem	30 / 64	25,000	52
UNIT 2:	38 rem / 33 rem	29 / 41	17,000	48
UNIT 3:				

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	✓		UNIT 1:	✓	
Ultrasonic Fuel Clean	✓		UNIT 2:	✓	
Reduced Inventory Shutdown Chemistry	✓		UNIT 3:		

SPECIALTY RESINS		MACROPOROUS	✓	PCR-01		OTHER:		ONLINE	

CONSTANT MODIFIED Ph	YES ✓	NO	IF YES, REVISED TO: 7.2
PERM. SCAFFOLD	YES ✓	NO	LOCATION: Reactor Containment Building - various locations
PERM. SHIELDING	YES ✓	NO	LOCATION: Reactor Containment Building - Letdown Line, PZR Spray Lines

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE				

Additional information:
- RCS cleanup makes use of layered macroporous resin
- Fuel ultrasonic cleaning each third cycle
- H/L & CL nozzle MSIP for Unit 1 - 2017
- Dry fuel storage project launch in 2017

Prepared By: G. Neil Keeney **Date:** 01/14/2016

Contact Info: keeneygn@stpegs.com

PWR RP ALARA ASSOCIATION

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PLANT STATUS REPORT QUESTIONAIRE – WINTER 2016

STATION: Three Mile Island UTILITY: Exelon

	NSSS	CYCLE #	CORE DUTY (H/L)	PWR OP'S ONLINE DOSE LAST YEAR	INPO QUARTILE	ONLINE PCE'S
UNIT 1:	B&W	21	L	8.758	4	2
UNIT 2:						
UNIT 3:						

	LAST REFUEL OUTAGE EXP. EST./ACTUAL	DURATION EST./ ACTUAL	LEAD INSTALLED #	PCE's
UNIT 1:	164.175	26	~20k	9
UNIT 2:				
UNIT 3:				

	Yes	No	STEAM GENERATORS REPLACED	Yes	No
Zinc:	✓		UNIT 1: 2009	✓	
Ultrasonic Fuel Clean			UNIT 2:		
Reduced Inventory Shutdown Chemistry			UNIT 3:		

SPECIALTY RESINS ✓	MACROPOROUS	PCR-01 ✓	OTHER:		ONLINE

CONSTANT MODIFIED Ph	YES	NO	IF YES, REVISED TO:
PERM. SCAFFOLD	YES	NO ✓	LOCATION:
PERM. SHIELDING	YES	NO ✓	LOCATION:

	BEST DOSE	# CANISTERS	VENDOR	CANISTER TYPE
DRY FUEL STORAGE	na	na	na	na

Additional information:

Prepared By: Steve Edelman **Date:** 01-12-2016

Contact Info:

HIGH INTEREST TOPIC AND QUESTIONNAIRE

PWR ALARA Association Key West, FL January 26-28, 2016

Topic:

Contact (Name)	Plant	NSSS	Comments
	Ginna	2LW	
	Kewaunee	2LW	
	Point Beach 1,2	2LW	
	Prairie Island 1,2	2LW	
	Ringhals 2,3,4	2LW 3LW	
	Beaver Valley 1,2	3LW	
	Farley 1,2	3LW	
	Harris	3LW	
	North Anna 1,2	3LW	
	Robinson	3LW	
	Surry 1,2	3LW	
	Turkey Point 1,2	3LW	
	VC Summer	3LW	
	Braidwood 1,2	4LW	
	Byron 1,2	4LW	
	Callaway	4LW	
	Catawba 1,2	4LW	
	Comanche Peak 1,2	4LW	
	Cook 1,2	4LW	
	Diablo Canyon 1,2	4LW	
	Indian Point 2,3	4LW	
	McGuire 1,2	4LW	
	Salem 1,2	4LW	

Return completed form to the Committee Secretary prior to the end of the meeting so that it may be included in the meeting report.

HIGH INTEREST TOPIC AND QUESTIONNAIRE

PWR ALARA Association Key West, FL January 26-28, 2016

Topic:

Contact (Name)	Plant	NSSS	Comments
	Seabrook	4LW	
	Sequoyah 1,2	4LW	
	Sizewell B	4LW	
	South Texas 1,2	4LW	
	Vogtle 1,2	4LW	
	Watts Bar	4LW	
	Wolf Creek	4LW	
	Millstone 3,2	4LW, CE	
	Calvert Cliffs	CE	
	Ft. Calhoun	CE	
	Palisades	CE	
	Palo Verde 1,2,3	CE	
	San Onofre 2,3	CE	
	St.Lucie 1,2	CE	
	Waterford	CE	
	ANO 2,1	CE, B&W	
	Crystal River	B&W	
	Davis Besse	B&W	
	Oconee 1,2,3	B&W	
	TMI	B&W	
	Areva		
	EDF		
	Westing-house		

Return completed form to the Committee Secretary prior to the end of the meeting so that it may be included in the meeting report.

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Optional
Name:_____
Utility: _____

Winter 2016 Key West, FL January 26-28, 2016

MEETING CRITIQUE

The goal is to meet your expectations regarding this meeting. Please help us by providing your comments and suggestions regarding the following:

Plant Status Report: Only collected at the Winter meetings

Technical Content:_____
_____
_____

Vendor Participation:_____
_____

Meeting Format (Breakout Session vs. Presentation, etc.):_____
_____
_____

Facilities (Meeting Room, Hotel Facilities, Location, etc.):_____
_____
_____

Please list any topics you would like to see the Board address in the future. Also include specific recommendations relative to the suggested presentation format, where possible (e.g. breakout session, technology presentation, survey, etc.):_____
_____
_____
_____

Please provide suggestions for Board activities or actions which would help justify your company's continued participation in the PWR/ALARA Association:_____
_____
_____
_____

Other Comments:_____
_____
_____

Do you anticipate your plant being represented by you or another representative at the Summer 2016 Meeting in San Diego, CA? _____ If not, why?
_____
_____

Return completed form to the Committee Secretary prior to the end of the meeting.