Hard to Measure Radionuclides in Effluents

Pressurized Water Reactor

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Project Purpose, Scope, and Benefit

- Objective:
  - Identify any hard-to-measure (HTM) radionuclide monitoring gaps in nuclear power plants effluents to ensure accurate accounting of doses to the members of the public.

- Scope:
  - Calculate the generation and release of radionuclides from nuclear power plant operations.
  - Identify any hard-to-measure radionuclides that are not currently analyzed for in nuclear power plant effluents.
  - PWR results published in 2015.

- Benefit:
  - Enhanced understanding of nuclear power operations impacts on the public and the environment.
  - Enhanced stakeholder confidence in nuclear power plant operations.

- Published EPRI Report 3002005563.

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Definition of Hard-to-Measure Radionuclides

- Definition developed for this project.

- Hard to Measure Radionuclides:
  - Those that are not easily measured by nuclear power plant effluent radiation detectors.
  - Radionuclide that is primarily an alpha or beta emitter with minimal photon energy release.
  - Radionuclide whose highest photon energy release is less than 50 keV and its associated abundance is less than 1%.

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Analysis Method and Assumptions

Generation & Release of Radionuclides

- Reference PWR Core Inventory:
  - ORIGEN ARP
  - 3340 MW-th
- Reactor Coolant System (RCS): Concentrations
  - Effective escape rate coefficients generated based on measured RCS concentrations.
  - RCS clean-up and six-hour decay.
- Release of Radionuclides & Resultant Doses
  - ELISA-2 code, GASPAR II, and LADTAP II used to calculate effluent doses.
  - ICRP-26 and ICRP-2 Dose Conversion Factors and Dose Calculation Methods.
  - Maximally exposed individual (MEI) organ doses calculated.

Identification of Monitoring Gaps

1. Relative dose contribution of HTM radionuclides to total dose from all analyzed radionuclides calculated for each pathway and organ.
   - Doses due to carbon-14, tritium, and noble gases not included.
   - >0.1% relative dose contribution used as criteria for potentially significant doses.
2. 2014 Annual Radioactive Effluent Release reports reviewed to tabulate radionuclides that are typically analyzed for in effluents.
3. Gaps between Step 1 and Step 2 above identified.

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PWR Results & Conclusions (1/2)

- **Simple, conservative model.**
- **Excluded tritium, carbon-14, and nobles gases to be able to see impacts of other HTMs.**
- **Hard-to-measure radionuclides with the highest relative dose impacts are:**

Sr-90	**Sr-89**
Fe-55	**Ni-63**

- **Some plants report* these in effluents reports, but not all.**
- Sr-89, Sr-90 (liquid and gas) and Fe-55 (liquid) analysis required per NUREG 1301**.
- ***Ensure these radionuclides are being analyzed for.***

P-32	**Pr-143**	**Sn-123**
Te-127m	**Y-90**	**Y-91**

- **No plants report* these in effluents reports.**
- Y-90 may be included as part of Sr-90.
- Of these, P-32 and Sn-123 have highest relative dose impact (%) for certain pathways (Liquid Releases)

*Note: Plants may analyze for radionuclides but not report if not detected.

**NUREG 1301 “Off-Site Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors” US NRC, 1991.

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PWR Results & Conclusions (2/2)

- Will run analysis with tritium, carbon-14, and noble gases included.
- The scope of this report did not include the full analysis of activated corrosion products, coolant activation products, or additive chemicals.
  - These will be further investigated in 2017 Project “Gap Analysis of Radionuclides and Chemicals Generated from Injected, Added, or New Materials”
- Results could be re-evaluated using updated dosimetry.
  - In the future, understand impacts to results based on new dose conversion factors.
- Boiling Water Reactor (BWR) analysis will be conducted in 2016.

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Low Level Waste TSG Research Project
HTM (e.g. Ni-63 & Fe-55) in Liquid Effluents

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Hard-to-Detect Radionuclides in Liquid Effluents

- Background:
  - Nuclear power plants are reporting hard-to-detect (HTD) such as Ni-63 and Fe-55 in liquid effluents.
  - There exists gaps in knowledge regarding current industry best practices and techniques associated to liquid radwaste HTD analysis and removal.

- Objective:
  - Collate and summarize industry experiences, best practices, and technologies for HTD analysis and removal from liquid radwaste streams.
  - Identify any technical gaps associated to HTD analysis and removal and develop research strategies for closing gaps, as needed.
  - Project will focus on Fe-55 and Ni-63 but will remain open to consider other HTDs as identified through EPRI base research.

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First Step:
Industry Survey to Collect Data/Experiences/Status

- Electronic survey will be sent to LLW TSG members and members of the rad effluents (i.e. RETS/REMP) community.
- Will provide us with baseline information related to Ni-63/Fe-55 in liquid radwaste/effluents and allow us to identify technical gaps.

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Industry Survey to Collect Data/Experiences/Status

- Do you analyze for Fe-55 and/or Ni-63 in your liquid effluents?
- Do you include Fe-55 and/or Ni-63 in Annual Radioactive Effluent Release Reports (e.g. RG 1.21 Reports or international equivalent)?
- Does your utility and/or plant have a Key Performance Indicator (KPI) associated with liquid effluents?
- If you do analyze for Fe-55 and/or Ni-63 in liquid effluents, where (e.g. effluent of which tanks or radwaste process) do you collect the samples that are analyzed for these radionuclides? How do you prepare these samples before they are sent for analysis (e.g. composited)?

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Industry Survey to Collect Data/Experiences/Status

- Do you analyze for Fe-55 and/or Ni-63 at an on-site laboratory (or utility laboratory) or off-site (contract or vendor) laboratory?
- Do you analyze for Fe-55 and/or Ni-63 at an on-site laboratory (or utility laboratory) or off-site (contract or vendor) laboratory?
- Do you have plant system hard-to-detect (Fe-55, Ni-63, others) source term data (e.g. reactor coolant, spent fuel pool, etc.)?
- For Zinc Injection PWRs, what is the impact of zinc injection of Fe-55/Ni-63 source terms to liquid radwaste?

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Industry Survey to Collect Data/Experiences/Status

- Do you have plant system hard-to-detect (Fe-55, Ni-63, others) source term data (e.g. reactor coolant, spent fuel pool, etc.)?
- Do you have influent data (in addition to effluent data) related to Fe-55 and/or Ni-63 to inform how much of these HTDs the liquid radwaste processing is removing?
- Have you implemented any actions or technologies to reduce Fe-55 and/or Ni-63 in liquid effluents? If so, what actions or technologies have you implemented and what were the results?
- Do you have data indicating the impact of radwaste chemistry (e.g. pH) on the processes' performance for removing Fe-55 and Ni-63 and any other HTDs?

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