TWENTY-FIVE-YEAR STUDY OF RADIONUCLIDES IN THE SUSQUEHANNA RIVER VIA PERIPHYTON BIOMONITORS.

Patrick, Ruth; Palms, John; Kreeger, Danielle; Harris, Charles

Abstract—This 25-y study monitored aquatic and terrestrial gamma-ray-emitting radionuclide levels near a nuclear power plant. It is the only known, long-term environmental survey of its kind. It was conducted neither by a utility owner, nor by a government agency, but rather by a private, environmental research institution. Compared to dozens of other flora and fauna, periphyton was found to be the best indicator to biomonitor the Susquehanna River, which runs near PPL Susquehanna's nuclear plant. Sampling began in 1979 before the first plant start-up and continued for the next 24 years. Monitoring began two months after the Three Mile Island accident of 28 March 1979 and includes Three Mile Island area measurements. Ongoing measurements detected fallout from Chernobyl in 1986, as well as ^{131}I not released from PPL Susquehanna. Although this paper concentrates on radionuclides found in periphyton, the scope of the entire environmental program includes a wide variety of aquatic and land-based plants, animals, and inorganic matter. Other species and matter studied were fish, mussels, snails, crayfish, insects, humus, mushrooms, lichens, squirrels, deer, cabbage, tomatoes, coarse and flocculated sediment, and more. Results show periphyton works well for detection of radionuclide activity, even in concentrations less than 100 Bq kg^{-1} (picocuries per gram amounts). Data indicate that PPL Susquehanna's radionuclide releases have had no known environmental or human health impact. Health Phys. 92(1):1–9; 2007

NEI/NIST Measurements Assurance Program for the Nuclear Power Industry

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The Nuclear Energy Institute, NEI, in cooperation with the National Institute of Standards & Technology, NIST, operates a measurement assurance program for radionuclide reference standards -- for the calibration of radioactivity measurement systems utilized in the nuclear power industry. The program began in 1987 and was modeled after a successful measurement assurance program for the radiopharmaceutical industry, which has been in existence since 1974. The program originally consisted of three categories of participants: source suppliers; service laboratories; and utilities. Presently, the program now has one component to service the source manufactures and suppliers, and a second component to service the utilities and their laboratories.

The present cost of the NEI/NIST program for utilities is $15,000 per year for each participant. The source manufactures are paying $30,000 per year. The yearly fee pays for NEI/NIST Research Associates to implement the program, as well as for the cost of materials and other expenses involved in the preparation and distribution of the sources which are sent to the participants, and measurements performed in accordance with NIST requirements. In years past part of the participation fee was used to pay for the development of several new primary NIST standards and calibration of sources in other geometries useful to the nuclear power industry . The participants receive six test sources each year, approximately bimonthly. The sources are prepared and calibrated at NIST and then distributed with the NIST-measured activity undisclosed. The participants measure the source and complete a questionnaire by way of the internet where their measured value is compared to the NIST value. A Report of Traceability is then issued by NIST stating the difference between the participant's value and the NIST value. A Report of Test is also issued, which provides the NIST value and other pertinent information so that the source may then be used as a calibration source by the participant. Additionally, the utilities may receive the same sample at multiple reactor sites and have one sent to the utility's contract laboratory for cross checking, at no additional charge.

Details of the program will be described, along with results of past comparisons.

MARLAP, MARSSIM and RETS-REMP: How is All of this Related…or NOT?

Eric L. Darois, MS, CHP
Robert Litman, Ph.D.

MARLAP and MARSSIM represent documents (NUREGS) developed by multi-agency collaboration. Each of these titles are acronyms with the following full names and publication dates:

MARLAP: Multi-Agency Laboratory Analytical Protocols, July 2004
MARSSIM: Multi-Agency Radiological Site Survey and Investigation Manual, NUREG 1575, 1997 (Revised 2000)

In support of decommissioning final status surveys to demonstrate compliance with 10CFR20 Subpart E, these represent companion documents. Although neither of these documents is required to support license termination, MARSSIM has become the accepted standard to demonstrate a risk-informed (i.e. dose-based) release standard. This document provides a system of classifying impacted areas and implementing a survey scheme based on the severity of the classification, and also provides a rigorous structure of developing data quality objectives (DQOs) and implementing the data quality assessment (DQAs) process once the data is available. The methods of demonstrating compliance with a release standard (or dose) is based upon the development of Derived Concentration Guideline Levels (DCGLs) and the evaluation of data from individual survey units using non-parametric statistical methods in cases where individual data points exceed the DCGL.

MARLAP is a document that is focused on the laboratory analytical process. It includes three volumes. Volume 1 is for project managers and planners and emphasizes the project planning phase, whereas volumes 2 and 3 are specifically directed towards radioanalytical laboratories providing information which can serve as a basis for performance based methodology. Volume 1 provides for the use of the DQO and DQA process as well as for detailed methods to calculate statistical quantities to determine data integrity and defensibility. The principles of MARLAP can be applied to any sampling and analysis process including REMP or RETS. In fact draft Regulatory Guide 4.15 requires compliance with MARLAP for new construction sites.

This paper will discuss the basic elements of both MARSSIM and MARLAP and how these can be applied to the RETS REMP programs.

Reporting Effluents (more/less) Per Reg Guide 1.21 at IPEC

Steve Sandike

This presentation includes a discussion and potential challenges for several inputs to the annual effluent report, as defined by Reg Guide 1.21 - but also as modified by an ever-changing industry standard. After an update on the Indian Point Energy Center Ground Water Monitoring Program (and reported doses as a result of quantified effluent), the presentation includes typical issues of concern with regard to compliance methodologies with the Reg Guide as we evolve into the new generation of nuclear power plants. These issues include calculational and reporting methods for ISFSI, 40CFR190 compliance, and suggested modifications for a new reg guide.

The Processing and Discharge of the Spent Fuel Pool Water from the Decommissioning Yankee Rowe Plant.

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To accommodate progress in the decommissioning of the Yankee Rowe Nuclear Plant, water in the spent fuel pool had to be dispensed with. Due to initial concerns regarding the State of Massachusetts position regarding boron in discharges (the State had communicated 1.5 ppm was the limit they would approve), two alternative methods of dispensing SFP water were being considered. One was the trucking off site of the pool water upon completion of fuel transfer to dry storage (expensive and impractical in regards to public exposure potential) and processing the water through the sites evaporator system. Due to the low throughput, it was projected this would take forty eight months assuming the 20+ year old system did not falter. Ultimately, on site processing and discharge was selected and utilized. This was a very successful undertaking, but not without a number of valuable lessons learned. These are all reviewed in the presentation.

REFUELING WATER TANK VENT RELEASES

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ABSTRACT

The Refueling Water Storage Tank (RWST) for most Pressurized Water reactors is located outside and typically vented to atmosphere. In preparation for Millstone Unit 2 Refueling Outage Number 15 (2R15) it was learned that radioactive water from several sources was scheduled for transferring to the RWST to provide for necessary make-up. The driving forces for recovering this water were to lower both the volume and discharge activity of liquid effluents. These sources included unprocessed reactor coolant water from the Pressurizer and drained reactor coolant that had been processed to the clean waste receiver tanks. Transfer of this water was of concern because the RWST vent is not monitored; consequently, a Condition Report (CR) was generated to evaluate this issue.

The potential releases from the RWST vent included noble gases, iodine and tritium. The noble gas source term was conservatively estimated based on the logical assumption that all of it would be released. Still, noble gas activity released from the RWST vent was insignificant when compared to routine outage releases, such as containment purge and ventilation. Tritium was also estimated by determining the amount of water vapor lost via the vent, which has been modeled at other sites and determined to be negligible. The amount of iodine release was more difficult to estimate, and appeared to carry greater significance relative to overall station annual effluent release. Available guidance on calculating partitioning factors for iodine is dependent on several factors including pH, which were uncertain during the outage planning stages. This lead the station to pursue empirically derived factors from an installed measurement process. Accordingly, a temporary modification (TM) was made to the RWST to measure iodine releases. This TM included modifications necessary to accurately measure and filter the iodine releases via this pathway.

The RWST TM data indicated that the gas-partitioning coefficient is quite variable. Significantly more amounts of iodine were released from the coolant waste fills. The cavity water drain-down fills indicated much lower partitioning, consistent with the original estimates. Preliminary conclusion is that the reason for the significant partitioning differences is pH. Sites need to be aware that in certain situations (RCS and coolant waste transfers and also probably for LOCAs) the partitioning factor may be much higher than expected.

Managing Your Groundwater Program – Do's and Don't

Matthew Daly P.G., John McTigue P.G., LSP, Gregg Demers P.E., LSP, Kenneth Dow and Joseph Lynch, Environmental Resources Management (ERM)

After numerous years of conducting routine REMP monitoring and reporting, plant operators may likely be asked to include groundwater as an additional media to their effluent monitoring program. Unlike surface water, air or edible media, releases to groundwater were not originally planned or accounted for in plant operations and must be addressed much differently than monitoring a permitted release. The subsurface nature of this problem adds certain subtle complexities to environmental monitoring that can be easily missed and have a significant impact on the quality of the data, the reliability of the program, or worst case, make a minor issue a major one through cross-contamination or enhancing subsurface migration of contamination. This paper presents some important considerations on how to approach management of your groundwater monitoring program so that you can both enhance its value and avoid some of the common pitfalls awaiting the unaware.

The release of radioactivity to groundwater is not a permitted action. While this may seem obvious, many managing operating plants are likely positioning to respond to the NEI/EPRI/NRC groundwater monitoring directives as if this was a permitted effluent for which monitoring can be easily transitioned to the REMP program. Nothing could be further from the truth. While the NRC as indicated that "groundwater monitoring will be a normal course of doing business in the Nuclear Power industry" substantial preparation, planning and training will likely be needed to ensure that incorporation of groundwater monitoring into the REMP program will be a seamless, reliable and successful one. While the NEI/EPRI guidance is forthcoming, subtle characteristics of plant operations, subsurface geology and hydrogeology are very site-specific, preventing a universal approach across the industry. Plant management and operations will face significant challenges in evaluating the host of options that exist for addressing this issue and may find it very difficult to differentiate between available choices that could have a substantial impact on the cost of future compliance. This paper will present a number of key aspects of groundwater monitoring to assist plant managers in identifying those critical to designing a reliable groundwater monitoring program including: 1) aspects you should definitely consider including; 2) aspects you should absolutely avoid; 3) what the aspects of the EPRI guidance may be key for your program; 4) what tools and approaches are most beneficial and why; 5) key aspects of data quality, representativeness and management; and 6) general cost-benefit guidelines for tools and technologies available for groundwater monitoring programs.

ABSTRACT

APPLICATION OF ANI GUIDELINE 07-01

"Potential for Unmonitored and Unplanned Off-Site Releases of Radioactive Material"[1]

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This paper presents an overview of American Nuclear Insurers (ANI) experience with application of ANI Guideline 07-01, **Potential for Unmonitored and Unplanned Off-Site Releases of Radioactive Material.** The presentation will provide a background and chronology of guideline development as well as experience to date regarding application.

Experience suggests that achieving compliance with applicable regulations may not always offer protection from future liabilities related to off-site damage to third parties. There is also growing public consciousness of environmental issues. As insurers, ANI looks at the nuclear insurance risk from a broad perspective consisting of several components and strategies. Consideration of these components and strategies can enhance our insured's ability to demonstrate that reasonable actions have been taken to protect the general public. In the aggregate these actions will support the defense of claims from members of the public alleging bodily injury or third party property damage caused by nuclear material emanating from the defined insurance site.

The ANI Guidelines are constructed to address nuclear insurance risk, take into consideration jurisdictional authority requirements as well as other industry standards/guidelines and consider the industry groundwater protection initiative. The ANI Guidelines are not constructed with respect solely to public safety risk or public dose. The ANI guidelines address the broader issue of unmonitored and unplanned off-site releases of plant generated radioactive materials. ANI Guidelines are for insurance purposes only, reflect nuclear liability insurance risk and consequently may differ from other industry guidelines. The ANI guidelines consider any leakage that would contribute to the contamination of groundwater as having a comparatively equal contribution to nuclear liability insurance risk. From a nuclear liability insurance perspective, the term contaminated is generally considered to be any positive results greater than the plant's LLD for plant related radionuclides.

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[1] 17th Annual RETS/REMP Workshop June, 2007, Philadelphia, PA

Guideline for Implementing a Groundwater Protection Program at Nuclear Power Plants

Eric Darois, MS, CHP
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In support of the NEI groundwater protection initiative, EPRI is developing an implementing guideline document with the assistance of many utilites through participation on the guideline development committee. In addition, EPRI has performed assessments of several utilities prior to and following the availability of this draft guide.

This paper will present the major implementation elements of this draft guide and provide insights regarding its implementation. This paper will also discuss a summary of the groundwater assessments performed to date.

Derivation of Dose-Based Detection Limits for Drinking Water and Effluent Compliance

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ABSTRACT

Recent events in the nuclear industry have focused attention on radioactivity contamination in groundwater. Current EPA Safe Drinking Water Standards for radionuclides are specified in 40CFR141, and are derived based on resulting dose. For example, the current limit of 20,000 pCi/liter for tritium is based on an assumed dose commitment of 4 mrem/yr. This presentation will discuss the establishment of dose-based concentration limits for a number of commonly encountered radionuclides, as well as detection limits for demonstrating compliance with these safe drinking water standards. Although such limits only assume drinking water ingestion, this presentation will also provide an assessment of the contribution of other water-borne exposure pathways to the overall committed dose. These factors can become very important considerations when establishing groundwater and effluent monitoring strategies, as well as in determining compliance with the various limits that may be imposed by state and federal regulators.

Paper presented at the 17th Annual RETS/REMP Workshop, June 25-27, 2007, Philadelphia, PA.

Soil Vapor Extraction Technology as an Early Warning Tritium Groundwater Detection System

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An early detection method for identifying unplanned and unmonitored radioactive release to the vadose zone (the unsaturated zone between ground surface and the water table) and subsequent groundwater would reduce the cost of: groundwater site characterization, remediation activities, and the implementation of monitoring programs within the nuclear power industry. A Soil Vapor Extraction System (SVES) capable of collecting soil gas from a large area under plant facilities would enable a utility to monitor the site for early signs of an environmental release by analyzing soil vapor condensate for the presence of tritiated water. This would enhance the utilities response time to an unplanned release resulting in a reduction in the impacted area, and a reduction in clean-up and long term monitoring costs.

In conjunction with EPRI, RSCS is undertaking a research effort to investigate the efficacy of an SVES system for providing an early warning system of tritium groundwater contamination. This project contains the following four phases:

1. Research and identify the most applicable predictive models, techniques and equipment to design, operate and interpret results from a soil gas extraction and monitoring system.
2. Test and refine the predictive model, techniques and equipment in a scaled down bench-test in a controlled laboratory environment.
3. Construct, operate and optimize a soil gas extraction and monitoring system at a site with an existing tritium plume.
4. Design and build a full scale soil gas monitoring system for an operating nuclear power facility.

This paper will provide a description of the mathematical predictive model and the theoretical sensitivity of such a system to various groundwater contamination levels and plume configurations. This paper will also describe each of the four phases, and its implementation schedule.

The Yankee Rowe ISFSI Experience and Resulting Dose Rates

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Yankee transferred it's spent fuel and GTCC waste from the SFP as part of the plant decommissioning and demolition effort completed in the fall of 2006. Initial dose modeling projections identified the 25 mrem/year boundary beyond the industrial area, but within the owner controlled area (265 meters). In 2001, there was little to no empirical data utilized to correlate modeled doses to measured does. Using a vendor, Yankee Atomic attempted to fine tune a three dimensional Monte Carlo based model to account for actual site topography and actual doses and energy spectrums measured with environmental TLDs, neutron TLDs, ion chambers, a portable gamma ray spectroscopy system, REM 500 and HAWK for neutron measurements. This effort was pursued to develop a model that would accurately project direct doses at the Connecticut Yankee (CY) ISFSI, as the CY plant was also decommissioning and approximately one to two years behind Yankee Rowe and Maine Yankee. Ultimately this effort failed due to very low neutron counts, poor counting statistics, and the gamma modeling proved elusive as the original arrangement of canisters on the pad was revised and necessitated additional runs of the 3-D MC model. Funds had been expended, and due to Connecticut Yankee pursuing its own path for ISFSI monitoring, this aspect of the project was abandoned. However, considerable information was collected for one year prior to fuel transfer, during fuel transfer and following completion of fuel transfer. Neutron and gamma TLDs located at various new points through the site, and co-located with existing REMP TLDs close to the site were utilized to accurately characterize the on and off site impact of the fully loaded ISFSI.

Measurement of Tritium at Low Concentrations in Liquid Samples

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Tritiated water is probably the most mobile manmade nuclide found in the environment. The low-energy beta decay produces few health concerns except at extremely high concentrations of tritium. However, because of the ubiquitous nature of tritiated water, when identified in the bionetwork, it can be viewed as a precursor of nuclides with greater health risks. Whether low-concentrations of the tritium or the nuclides that may follow are true health risks is immaterial when viewed from the perspective of the affected public. For this reason alone it becomes desirable to determine tritium concentrations many orders of magnitude below that considered a health concern.
The protocols employed to determine and measure tritium concentrations in the pico-Curies per Liter range are described. The data used to determine the background population are reviewed, as well as a discussion of the equipment-sighting location. Also discussed are the GUM menu items evaluated to calculate the associated uncertainty.

Numerous Opportunities for Chemistry at Decommissioning Nuclear Plants (Bench Testing, New Processes to Support Demolition and Monitor Effluents, Optimizing Sample Flow in support of FSS, etc.)

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Decommissioning plants place a unique demand on the chemistry and effluent programs, requiring rapid adaptation to change, creative problem solving and innovation, close working relationships with other departments, contractors, subcontractors and regulators. It also requires a unique mix of talent within the department, different from that of operating plants. Typically, the contractor mix changes frequently over the course of decommissioning, as does site management and organizational structure, requiring continual adaptation to ensure effective effluent and environmental programs and program execution. In most cases, decommissioning plants have determined that after fuel transfer, the need for a chemistry department and chemistry personnel is dramatically diminished, and the staffing plans will reflect this. In reality, the role for chemistry typically expands, and has in nearly every case for decommissioning commercial nuclear plants. Several examples and lessons learned are provided regarding chemistry opportunities to respond to unique challenges including continually changing effluent pathways, requests for recommendations to deal with contaminants in building materials, the ability to discharge unique liquid and gaseous effluent streams, coordination of analysis and/or back up laboratories for the LTP, FSS, MARSIM, and the non radiological QAPP.

A Proposed Analytical Technique For Tritium In Soil

An Abstract for a Presentation at the RETS-REMP Workshop, 25-Jun-07

By
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Recent industry guidance refers to a potential need for analysis of tritium in soil. Soil from the vadose zone is being analyzed for tritium at various facilities around the country. The sampling methods vary (e.g., solar collector, soil vapor, direct analysis) but the method of detection most commonly used is liquid scintillation counting. The author wanted a rapid analytical technique that had minimal impact on the laboratory chemists. Capability to collect samples from localized areas would be beneficial in addressing the special needs associated with small spills of tritiated, water-borne material. Additionally, it was desirable to measure tritium in activity per unit mass of soil (e.g., pCi/kg). The author presents one method involving direct analysis of soil by distillation. The author discusses the limitations and advantages of the proposed technique, as well as some potential enhancements to the method.

Although there are NRC regulations for control of nuclear material is a general sense, and there are regulations for specific radionuclides in specific media, there are no NRC regulations specifically for tritium in soil. Federal guidance specifies REMP LLDs and REMP reporting levels for tritium in water, but there are no corresponding values for tritium in soil. The author discusses application of the soil analysis results in relation to existing regulations and how the results may assist personnel in potential remediation efforts.

Tracking the Source of I-131 in the Cape Fear River
Greg Barley

In 2006, during routine radiological environmental monitoring of the Cape Fear River water, I-131 was detected at both the control and indicator locations for the Shearon Harris Nuclear Power Plant. The Cape Fear River receives discharges from the Harris Lake, which is the receiving water body for liquid radioactive releases from the Shearon Harris Plant. During the time of the discovery of the I-131 in the Cape Fear River, it was known that the source was not due to plant operation because (1) the I-131 was present at both the control and indicator locations, and (2) due to low rainfall, there was no discharge occurring from the Harris Lake to the Cape Fear River. The investigation focused on determining the source of the I-131 upriver from the control location. In order to accomplish this, it was necessary to institute special sampling from the two main tributaries of the Cape Fear River. While the observed I-131 concentrations were well below any reporting levels, prior to launching the special sampling, Progress Energy personnel consulted with the North Carolina Department of Radiation Protection. Subsequent meetings and updates were provided by Progress Energy personnel to the state personnel. The communication served as an excellent means to ensure that the state personnel were knowledgeable about the findings of the investigation. The investigation was able to narrow the source of the I-131. The likely source was discharges from a public sewage treatment plant upriver of the control location.

Cook Nuclear Plant Experience with Storm Water Tritium Discharges

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and

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In mid-May, 2007, while investigating a leak in the below-grade wall of the Auxiliary Building, tritium was identified in a sample taken from the leak. Investigation of the wall leak led to sampling of various locations on the plant site, including wells and outfalls. Although the various groundwater wells did not indicate the presence of tritium at levels above LLD, tritium was detected in a sample taken from the north outfall.

The purpose of this presentation is to detail the actions taken by Cook Nuclear Plant in analyzing the concentrations and sources of the north outfall tritium. Hypotheses about the sources of the tritium (rainwater and Air conditioning condensate) will be presented along with preliminary results. Finally, dose consequences will be provided and present and future actions taken by the Plant will be discussed. Discussion with the audience will be anticipated as this is an emergent issue.