PANEL SESSION 87: Characterization & Survey for Decommissioning and Waste Management

Co-Chairs: **Rateb (Boby) Abu Eid**, *US NRC*
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Panelists:

1. **Andrew Szilagyi**, *Director, Office of D&D and Facility Engineering, US DOE*
2. **Karen Kim**, *Project Manager, Electric Power Research Institute, EPRI*
3. **Robert Stewart**, *Professor, Oak Ridge National Laboratory (ORNL) & University of Tennessee (UT)*
4. **Arne Larsson**, *General Manager , Consultancy Services, Radioactive Waste Processing, Studsvik (Sweden)*
5. **Yvon Desnoyers**, *Principal Consultant, Geostatistical Radiological Characterization, GEOVARIANCES (France*)

About 50 participants from several countries all over the world, attended this panel session which focused on innovative and emerging characterization technologies and methods for decommissioning and waste management of nuclear facilities. The main theme was efficient subsurface characterization and sampling using advanced methods and technologies to minimize costs and enhance risk-informed performance-based approach. The session co-chairs summarized the main theme and topics of the session and introduced each panel member. The five panelists presented updates of national and international approaches, methods, and techniques developed or applied by their institutions, or companies. The presentations covered a wide scope of application reflecting knowledge and experience of: governments and regulators, academic and research and development institutions, as well as industry and consultant sectors. The presentation session was followed by a questions and answers session which included questions regarding the process to expedite adoption and application of new technologies, status of EPRI's reports on subsurface approaches to gamma-bore hole characterization, cost-effectiveness of subsurface characterization, and application of 3D statistical approaches.

Summary of Presentations

Andrew Szilagyi explained how characterization technology innovation and development at DOE resulted in: improved worker safety, reduced technical risk, accelerated cleanup, resolved complex technical challenges, and enhanced lifecycle savings. He explained the following techniques applied by DOE activities: (a) RadBall technique as a radiation detection device which provides 3D visualization; (b) GrayQBTM a 3D radiation mapping device used to locate, identify, and generate a 3D map of radioactive contamination; and (c) DeconGel, a DOE-EM commercial transition technology used for decontamination of surfaces. Mr. Szilagyi then described in-situ decommissioning and long-term monitoring technologies at the Savannah River Site (SRS) by using a systems engineering approach and in-situ decommissioning sensor network (ISDSN) Meso-Scale Test Bed (MSTB). He demonstrated usefulness of ISDSN-MSTB in assessment of cementitious material durability, moisture-fluid flow and transport, and contaminant mobility at a decommissioning nuclear facility. Subsequently, he outlined D&D

technology development accomplishments at Idaho National Laboratory (IDL) particularly sodium treatment and long-reach tools. Finally, he presented an outline of the advanced simulation modeling capability for environmental management (ASCEM), the advanced fogging technologies at IDL, and the scintillation phosphor spray and paint system for detection of Tc-99 at Oak-Ridge National Laboratory.

Karen Kim summarized EPRI's decommissioning and groundwater protection programs focusing on site characterization for decommissioning optimization strategies using the following steps: (a) historical site assessment; (b) preliminary characterization; (c) use of investigation wells; (d) development of site conceptual models particularly subsurface modeling; and (d) use of long-term monitoring. In this context, she described, as an example, the subsurface multi-spectral contamination monitoring at Rancho Seco. Ms. Kim described in-situ gamma scanning technologies applied during nuclear power plants decommissioning. In this regard she discussed aspects of large scale initial characterization, survey during remediation, subsurface borehole investigation, underwater surveys, and surveys of buildings and bulk materials. Subsequently, Ms. Kim described innovative developing technologies studied by EPRI, including "geophysical subsurface investigations particularly the use of electric properties of subsurface geology and water to identify leaks and spills. She also described EPRI's soil vapor extraction and monitoring system from concept, bench-top testing, pilot test, to implementation. She indicated that this technique is less invasive and easier to install than groundwater wells and can be effective as an early detection tool for leaks and spills under buildings or tanks. Ms. Kim closed her presentation with conclusions that subsurface monitoring programs can be optimized through planning and initial investigation, and through use of innovative technologies

Robert Stewart provided an outline of the Spatial Analysis & Decision Assistance (SADA) code application for 3D subsurface characterization and approaches for volumetric compliance with the decommissioning dose criteria. SADA is a freeware desktop which integrates environmental risk analytics, spatial modeling, and decision sciences. It was developed through collaboration of UT and ORNL via support of EPA, NRC, and DOE. Dr. Stewart described SADA capabilities in support of: initial sample design; data collection and management; risk-based screening and integration of spatial modeling with risk; quantifying uncertainties in the final decision-making; providing probabilities of exceeding risk limits and cost-benefit analysis (e.g.; remedial actions *vs.* risk). Dr. Stewart addressed subsurface challenges including (a) derivation of derived concentration guideline levels (DCGLs); (b) establishing survey units in 3D; (c) limitations due to less accessible subsurface media; and (d) geospatial extension to MARSSIM (GEM) surface approach. He described his proposed 3D regulatory limit rule (RLR) using a continuous function specifying acceptable limit as a function of geometry, volume, and depth. Dr. Stewart described the conceptual model envisaged for subsurface which essentially embraces correlation and integration of variety of data types and use of best practices rather than hard coded steps. He subsequently described geostatistical simulation which produces multiple realizations of contamination and generation of PDFs describing concentration uncertainty which can be used to produce probability of exceedance. This approach represents the Stochastic Compliance Site Model which is usually evolved based on investigation of the life cycle of the contaminated facility. Finally, he discussed multi-scale sampling and remedial design based on identification of set of remedial units that move the site into compliance and identification of locations (units) that move the site into non-compliance. Dr. Stewart concluded his presentation by addressing difficult challenges in development of a regulatory guidance for subsurface characterization and survey.

Arne Larsson presented strategies for selection of key activities in radiological characterization covering the entire lifecycle of a nuclear facility. He emphasized the role and significance of characterization during siting, operation, after shutdown, and during dismantling and decommissioning for site release. He added that clear objectives are crucial to optimize characterization efforts and minimize costs based on a structured judgment of data quality and quantity to support decision-making. He illustrated using graphics how to build an information management structure including waste management and clearance. He exemplified robust and reliable processes developed by Studsvik for NPP decommissioning and waste management. Mr. Larsson also addressed knowledge management for D&D including documenting historical data and anecdotal information. He subsequently described the key steps in the characterization process including: (a) initiation phase (e.g.; define objectives and boundary conditions), (b) planning (e.g.; evaluation of historical information, categorization of objects, methodology and sampling strategy, equipment selection, sampling plan and validation of nuclide vectors), (c) implementation (e.g.; staff training and qualification, in-situ measurements, laboratory analysis, assessment of results, and evaluation of the need for additional measurements), (d) data assessment (e.g.; evaluation of data and calculated results *vs.* measured data, comparison of measurements with historical information and initial categorization, re-categorization of objects, and assessment of the need for additional measurements); (e) judgment and reporting (e.g.; judgment and data analysis), evaluation of data against goals and initial problem statement, QA/QC reporting, and post-project review and audit.

Yvon Desnoyers provided a global perspective regarding geo-statistics for radiological characterization and sampling optimization. In this regard he emphasized the corner stones of characterization including data collection and processing, sampling design, and analysis/evaluation for decision-making. For sampling design he discussed probability-based design (e.g.; systematic and random) and judgmental design. He added that a mix of these designs may be used to fulfill evaluation objectives and in using an iterative approach. Dr. Desnoyers discussed geo-statistical methodology through use of variograms (e.g.; when on average the difference between two close measurements is LOW and the difference between two distant measurements is HIGH). In other words, the way the variogram increases with distance is linked to the spatial variability. He showed characterization of three spatial structures using regular sampling grids and described data analysis and modeling using a geostatistical multi-variant approach and uncertainty reduction. He demonstrated risk analysis and estimation support tools through development of probability maps for LLW management support. He described in detail decision-making tools for the decontamination process including waste segregation according to activity levels and risks, average activity per decontamination unit, and accumulated total activity. He also demonstrated sampling optimization and how to deal with hot spots, averaging dose rates, and waste zoning. Further, he showed maps for sampling optimization (e.g.; maps of false negative risk) using integration of geostatistical analyses to optimize number and location of data points. Finally, Dr. Desnoyers provided a 3D example of a deep contamination case study using four drilling campaigns in 1999, 2007, 2009, and 2010 and an outline of the added value of geostatistics in support of characterization for decommissioning and waste management.

Questions and Answers

Andrew Szilagyi was asked if there was room for more innovation, or if DOE reached an ultimate investigation level of remediation technology development. Mr. Szilagyi replied the DOE optimized and demonstrated cleanup and decommissioning new technologies at its facilities. Nevertheless, there is a lot more room for innovation; we have not even asked the right questions about certain technologies and their application to decommissioning and decontamination such as nanotechnology, laser, etc.

Karen Kim was asked about the status of EPRI's reports on subsurface approaches to gamma-bore hole characterization and underwater characterization and monitoring. She replied that these reports are available through EPRI at a cost.

All Panelists: A question was raised to all panel members about cost-effectiveness of the 3D subsurface characterization and process and examples of application to minimize waste and reduce volumes of contamination. The panelists provided examples for soil and groundwater contamination sites and facilities.

Robert Stewart responded to a question regarding application of 3D statistical approach he replied that based on SADA code users' list and number of publications and reports issued using SADA code there appear to have an increase in use of 3D statistical approach in subsurface radiological decontamination.