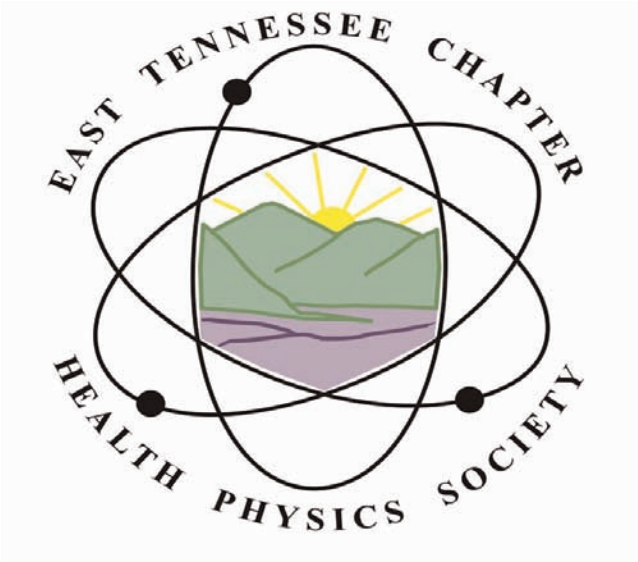
# Health Physics Society
# 2007 Midyear Topical Meeting

The Fortieth Midyear Topical Meeting of the Health Physics Society

Decontamination, Decommissioning, and Environmental Cleanup

In conjunction with the:
American Academy of Health Physics
National Registry of Radiation Protection Technologists (NRRPT)




**Final Program**

**January 21-24, 2007**

**Knoxville Convention Center and Hilton Hotel**

**Knoxville, Tennessee**

# Health Physics Society Committee Meetings

**All Committee Meetings take place at the Hilton Hotel**

## Saturday, January 20, 2007

**FINANCE COMMITTEE**
8:00 am - Noon — Great Smoky C

**AAHP PART 2 PANEL**
8:00 am - 5:00 pm — Tenase

**CONTINUING EDUCATION COMMITTEE**
1:00 - 5:00 pm — Sequoyah 3

## Sunday, January 21, 2007

**AAHP PART 2 PANEL**
8:00 am - 5:00 pm — Tenase

**AAHP EXECUTIVE COMMITTEE**
8:00 am - 5:00 pm — Great Smoky C

**HPS BOARD OF DIRECTORS**
8:00 am - 5:00 pm — Sequoyah 3

**STANDARDS COMMITTEE**
9:00 - 11:00 am — Sequoyah 2

## Monday, January 22, 2007

**EDITORS MEETING**
7:30 - 9:00 am — Sequoyah 2

**ANSI N320**
10:00 am - Noon — Board Room

**HISTORY COMMITTEE**
Noon - 2:00 pm — Great Smoky B

**AWARDS COMMITTEE**
2:30 - 3:30 pm — Board Room

**SCIENTIFIC & PUBLIC ISSUES COMMITTEE**
3:30 - 5:00 pm — Board Room

## Tuesday, January 23, 2007

**LAB ACCREDITATION POLICY**
10:00 am - Noon — Sequoyah 3

**LAB ACCREDITATION ASSESSMENT COMMITTEE**
Noon - 2:00 pm — Sequoyah 3

**PUBLIC INFORMATION COMMITTEE**
Noon - 2:00 pm — Board Room

## Wednesday, January 24, 2007

**RSWB MEETING**
3:00 - 5:00 pm — Great Smoky B

**Thank you to the following Exhibitors for Sponsorship at the 2007 Midyear Meeting:**

**Canberra Industries**

**ORTEC**

## *Table of Contents*



## *Registration Hours*

Monday, January 22.....7:30 AM-3:00 PM
Tuesday, January 23 .....8:00 AM-3:00 PM
Wednesday, January 24.....8:00 AM-Noon

## *Exhibit Hours*

Exhibits are located in Ballroom D-G

| | |
|---|---|
| Monday | 5:15-6:45 PM, Opening Reception |
| Tuesday | 9:30 AM-4:30 PM |
| Tuesday | Noon, Lunch in Exhibit Hall |
| Wednesday | 9:30 AM-Noon |

## *Speaker Ready Room*

Convention Center, 301A

| | |
|---|---|
| Sunday | 2:00-6:00 pm |
| Monday & Tuesday | 8:30 am - 12:00 pm, 2:00-4:00 pm |
| Wednesday | 8:30 am - 11:00 am |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501 West Church Avenue
Knoxville, Tennessee 37902-2591
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## TECHNICAL TOURS

**WEDNESDAY, JANUARY 24**

**SNS and HFIR** $25
1:00-5:30 pm Limited to 80 people
Registrants must be US Citizens

The Spallation Neutron Source (SNS) is an accelerator-based neutron source. When at full power, this one-of-a-kind facility will provide the most intense pulsed neutron beams in the world for scientific research and industrial development. Completed in May 2006, SNS is ramping up to full-power capability of 1.4 MW. Initial users arrived in the Fall of 2006. The High Flux Isotope Reactor (HFIR) is a versatile 85-MW isotope production and test reactor with the capability and facilities for performing a wide variety of irradiation experiments. Since it began full-power operations in 1966, the HFIR has been one of the world's most powerful research reactors. The combination of SNS and HFIR makes Oak Ridge a mecca for neutron-scattering research. Don't miss this rare opportunity to tour these two unique facilities. The van/bus tour will originate and end at the hotel.

**ORISE Historical HP** $25
**Instrument Collection and AMSE**
1:00-5:30 pm Limited to 30 people

This technical tour features two excellent exhibits of great historical interest located in Oak Ridge. One of the exhibits is the comprehensive display of antique and interesting radiation measuring devices maintained at the Oak Ridge Institute for Science and Education. Selected items from this excellent collection are frequently highlighted in Health Physics News. This is your chance to view the entire collection. The second feature is a self-guided visit to the American Museum of Science and Energy. There many interesting and informative historical exhibits await you. One example is a program entitled "The Story of Oak Ridge." This program is a panorama of historical photographs and artifacts explaining the Manhattan Project and the construction of Oak Ridge. This tour will spend approximately 1.5 hours at each of the two featured exhibits. The bus/van tour will originate and end at the hotel.

## SOCIAL EVENTS

**SUNDAY, JANUARY 21**

**Welcome Reception**
6:00-7:00 pm Ballroom, Hilton Hotel

**MONDAY, JANUARY 22**

**Exhibitor Opening Reception**
5:15-6:45 pm Ballroom D-G, Knoxville Convention Center

**TUESDAY, JANUARY 23**

**HPS Night Out at the Foundry**
7:00-10:00 pm $35

The Night Out will begin with a scrumptious buffet dinner at the "Foundry" on the former World's Fair Site. Built in 1865, and listed on the National Historic Register, this restored iron foundry is now a gathering place for special events. Following dinner, the accomplished theatre professional Bill Landry will present his highly acclaimed, one-man performance "Einstein the Man." The play is a scientifically-exact, biographically-correct character study featuring Einstein's scientific work, philosophical ideas, and personal idiosyncrasies. You don't want to miss this opportunity for a very enjoyable evening at a very reasonable price. Although the Foundry is within walking distance of the hotel, transportation will be provided.

## *RECOMMENDED ON-YOUR-OWN EXCURSIONS*

The following are only a few of the sites that you can visit during you stay in Knoxville.

**East Tennessee History Center**

The East Tennessee History Center is located only a few blocks from the meeting hotel. This Center is the Southeast's largest resource for genealogical research. Assistance with your genealogy research is available at the Center. The East Tennessee Historical Society preserves, interprets, and promotes the history of Tennessee, focusing on East Tennessee. The Center includes exhibits describing the history of Tennessee, including larger than life figures, such as David Crockett, Nancy Ward, and Sgt. Alvin C. York, as well as the everyday folks who contributed to the region's reputation for hard work and independence.

**Knoxville Museum of Art**

Dedicated to bringing the fine arts to East Tennessee, the Knoxville Museum of Art features traveling exhibitions from around the world and a permanent collection of contemporary American art. Located one block from the Knoxville Convention Center, the Museum contains five galleries, gardens, museum shop and Exploratory Gallery.

**James White Fort**

Knoxville's most visited historic site, James White Fort is located a few blocks from the Hilton and Knoxville Convention Center. The Fort is named after Knoxville's founder and allows you to experience what life was like in East Tennessee more than 200 years ago.

**Blount Mansion**

Located a few blocks from the Hilton in the center of Knoxville's government district, Blount Mansion offers history that is hard to miss. Located on the bank of the Tennessee River near towers of glass, steel and brick sits this small house - a mansion by frontier standards. Known by the Cherokee Indians as "the house with many eyes", Blount Mansion is one of the oldest homes in Tennessee.

**Women's Basketball Hall of Fame**

The Women's Basketball Hall of Fame opened in 1999 to honor men and women who have contributed to the sport of women's basketball. Located a short walk from the Hilton, the Hall of Fame presents exhibits and displays that describe the history and outstanding players of women's basketball and promotes the future of the sport.

**Knoxville Zoo**

Located a short drive from downtown, the Knoxville Zoo is a treat for young and old. Here you will find animals from all over the world, including elephants, rhinos, lions, cheetahs, gorillas, and chimpanzees from Africa and leopards, tigers, red pandas, gibbons from Asia. From closer to home, you'll meet American black bear, river otter, and the red wolf that once roamed the Smoky Mountains.

**UT Men's Basketball**

Plan to arrive on Saturday in time to attend the SEC men's basketball game between The University of Tennessee and the University of South Carolina - the only teams with two wins over the NCAA Champion Florida Gators last year. The game will be on the UT campus (a short walk from the Hilton) in the 25,000-seat arena on Saturday, January 20.

**UT Lady Vols Basketball**

On Monday evening after the exhibitor opening reception, walk over to the University of Tennessee to see the best of women's college basketball - the UT Lady Vols playing the Duke Blue Devils. This should be one of the best games of the year, with the six-time national champion Lady Vols coached by Pat Summit facing the 2006 NCAA tournament runner-up Duke Blue Devils.

**Museum of Appalachia**

A short drive (15 miles) north of Knoxville in Norris, Tennessee, is the famous Museum of Appalachia. This museum features a 65-acre working rural farm village with animals and gardens. It includes 30 original cabins and buildings from early Appalachian periods and holds over 250,000 items in its historical collection. Locally-made crafts may be purchased at the large gift shop and home-cooked lunches are served daily.

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**Companion/Hospitality Room**

The Hospitality Room is in the Hilton Hotel in the Sequoyah 2 room. Come meet with friends and learn about the available attractions in Knoxville. Local information will be available for planning day trips and restaurant recommendations. On Monday morning from 7 to 8 am, we invite all registered companions to an official welcome from a local representative who will provide an orientation to Knoxville and answer any questions you might have. The Monday breakfast will take place in Sequoyah 2.

Continental breakfast will be available Monday through Wednesday mornings for registered companions, as will afternoon refreshments if attendance warrants.

# *2007 Meeting Exhibitors*

**Exhibits are located in Ballroom D-G, Knoxville Convention Center**

**Thank you to the following Exhibitors for Sponsorship at the 2007 Midyear Meeting:**

**Canberra Industries**

**ORTEC**

**2007 Annual Meeting - Portland, OR** **Booth: Reg Area**
www.hps.org

**2008 Midyear Meeting - Oakland, CA** **Booth: Reg Area**
www.hps.org

**AAHP/ABHP** **Booth: Reg Area**
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Suite 402
McLean, VA 22101
(703)-790-1745; Fax: (703)-790-2672
www.aahp-abhp.org

**Arrow-Tech Inc.** **Booth: 215**
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417 Main Ave West
Rolla, ND 58367
(701)-477-6461; Fax: (701)-477-6464
www.arrowtechinc.com

Arrow-Tech, Inc. is the manufacturer of the Direct-Reading Dosimeter. Arrow-Tech handles a full line of Radiation Detection equipment and maintains customers throughout the world providing quality, reliable, durable products and service. Industries served include the Health Physics, Homeland Security, NDI, Industrial & Medical Radiology and 1st Responders. Arrow-Tech provides calibration services.

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Bartlett has over twenty-six years of experience providing radiation safety, decontamination, maintenance, janitorial, professional and other managed staff augmentation services to nuclear, industrial and government facilities nationwide. Bartlett also offers equipment and technologies including automated monitoring systems, portable ventilation systems and Excel modular scaffolding.

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Canberra is the world's leading supplier of analytical instruments, systems and services for radiation measurement. Applications for Canberra offerings include health physics, nuclear power operations, Radiation Monitoring Systems (RMS), nuclear safeguards, nuclear waste management, environmental radiochemistry and other areas.
The new Canberra has the broadest array of Health Physics capabilities in the industry. HP related products include a full range of gamma and alpha spectroscopy equipment, personnel contamination monitors, hand held survey instruments for alpha, beta, gamma and neutron measurement, whole body counters and area monitors. The company also offers a full range of services including repair and maintenance, training and expert data review.

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The Conference of Radiation Control Program Directors, Inc. (CRCPD) is a nonprofit, non-governmental professional organization, representing state regulatory agencies, that promotes consistency in addressing and resolving radiation protection issues, encourages high standards of quality in radiation protection programs, and provides leadership in radiation safety and education.

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The U.S Department of Homeland Security in coordination with the Department of Energy, the U.S. Navy, and the Health Physics Society is pleased to provide the following update on the Homeland Defense Equipment Reuse (HDER) Program. The HDER Program provides responder agencies across the nation access to a substantial inventory of excess radiological detection instrumentation and other equipment, training and technical support, all at no cost. The equipment available through the program includes: hand-held dose rate meters, electronic pulsers, count rate meters, pocket ionization chambers, instrument probes, personal protective equipment, and miscellaneous safety equipment. The HDER Program is constantly evolving and growing in order to better meet the needs of the first responder community and new equipment items will continue to be available as the program expands and matures.

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Environmental Restoration Group, Inc. (ERG) is a consulting company, incorporated in New Mexico in 1990, with expertise in radiation safety and the management of radioactive wastes. The company provides consulting services primarily to owners and operators of nuclear facilities. These consulting services include environmental monitoring and compliance, employee health and safety, and waste characterization and management. In addition, the company provides environmental monitoring and health and safety equipment to other companies for short-term rental.

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www.nrrpt.org

To encourage and promote the education and training of radiation protection technologists and, by so doing, promote and advance the science of health physics.

**Oak Ridge Associated Universities** **Booth: 213**
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# Final Technical Program

***If a paper is going to be presented by other than the first author, the presenter's name has an asterisk (*)***
***All technical sessions take place at the Knoxville Convention Center***

## Monday, January 22

**7:15-8:15 am** **Ballroom A-C**

**CEL 1**
**A Collector's Guide to Radioactive Dinnerware**
*R. E. Toohey; Oak Ridge Associated Universities*

**8:15-11:45 am** **Ballroom A-C**

### Plenary Session

**8:15 AM** **PL.1**
**Welcome, Announcements, and Introductions**
*B. Dodd, HPS President; J. Frazier, P. Rohwer, Local Co-Chairs*

**8:30 AM** **PL.2**
**Welcoming Remarks and Perspectives on Environmental Cleanup**
*Congressmen Duncan and Wamp, State of Tennessee*

**9:00 AM** **PL.3**
**DOE's Environmental Cleanup Program: Accomplishments and Future**
*Rispoli, J., Assistant Secretary of Energy for Environmental Management*

**9:45 AM** **BREAK**

**10:15 AM** **PL.4**
**Oak Ridge Environmental Cleanup at K-25: Industrial Safety vs. Radiation Safety**
*McCracken, S., ORO Assistant Manager for Environmental Management*

**11:00 AM** **PL.5**
**Cleanup Perspective of D&D from the UK NDA**
*Brazier, P., Director, Region 1 of UK Nuclear Decommissioning Authority - G. William Morgan Lecturer*

**11:45 AM** **LUNCH ON YOUR OWN**

**1:30-4:45 pm** **Ballroom A-C**

### MPM1 Decontamination & Decommissioning - 1

*Co-Chairs: Ken Veinot, Fred Schultz, Fred Haywood*

**1:30 pm** **MPM1.2**
**Trials And Tribulations Of Grouting Low Level Liquid Waste Lines At ORNL**
*Funke, K.*
*Bechtel Jacobs Company LLC*

**1:45 pm** **MPM1.3**
**MARSSIM Applied At Y-12**
*Simanis, A.*
*BWXT Y-12*

**2:00 pm** **MPM1.4**
**Characterizing Hot Cells At ORNL**
*Long, M.*
*Bechtel Jacobs Company LLC*

**2:15 pm** **MPM1.5**
**Evaluation Of Adaya Site Contaminated With Uranium**
*Marouf, B.*
*Ministry of Science & Technology*

**2:30 pm** **MPM1.6**
**Decommissioning A Licensed Facility Having A 60-year History Of Radioactive Materials**
*Marshall, G.*
*Philotechnics*

**2:45 pm** **MPM1.7**
**Decontamination And Decommissioning**
*Graves, M., Dameron, D.**
*BWXT Y-12*

**3:00 pm** **MPM1.8**
**Benefits And Pitfalls Of The Historical Site Assessment**
*Cicotte, G.*
*USAF/AFIOH/SDRH*

**3:15 PM** **BREAK**

**3:45 pm** **MPM1.9**
**Remediation Of An Orphan Vanadium Mill Site**
*Whicker, R., Johnson, J., Meyer, H., Hinds, D., Little, C.*
*MFG, Inc., Frontier Environmental Services*

**4:00 pm** **MPM1.10**
**A Method For Site Characterization At The Austrian Research Centers Seibersdorf**
*Brandl, A., Piniel, R., Steininger, R.*
*Nuclear Engineering Seibersdorf*

**4:15 pm** **MPM1.11**
**Decommissioning The Historical Mallory Pathology Institute**
*Tarzia, J., Martel, C.*
*Radiation Safety & Control Services, Inc., Boston University Medical Center*

**4:30 pm** **MPM1.12**
**Decommissioning Of A Source Manufacturing Facility**
*Palmer, A., Bowers, J., Myers, F., Willis, T.*
*SEC*

**1:30-4:45 pm** **300 A-B**

## MPM2 Safety and ALARA

*Co-Chairs: Martin Davis, Sarah Roberts*

**1:30 pm** **MPM2.1**
**Practical ALARA During Decontamination And Decommissioning And Remediation Activities In Oak Ridge, Tennessee**
*Green, S.*
*Bechtel Jacobs Company LLC*

**1:45 pm** **MPM2.2**
**Dealing With The Unexpected During Removal Of Scrap From K-770**
*Kleinhans, K.*
*Bechtel Jacobs Company LLC*

**2:00 pm** **MPM2.3**
**ALARA Methods For The Retrieval Of Buried Transuranic Waste**
*Hyder, D.*
*Bechtel Jacobs Company LLC*

**2:15 pm** **MPM2.4**
**Integrating RADCON Into Work Planning And Control On Complex And Diverse Accelerated Cleanup/D&D Work In Oak Ridge**
*Stevenson, D.*
*Bechtel Jacobs Company LLC*

**2:30 pm** **MPM2.5**
**An Oversight Inspection Program With Effective Performance Measures**
*Ivey, B.*
*Safety and Ecology Corporation*

**2:45 pm** **MPM2.6**
**Sampling Strategy For The Leaking Underground Storage Tank, Tank W-1a At The Oak Ridge National Laboratory**
*Bauman, R.*
*Bechtel Jacobs Company LLC*

**3:00 PM** **BREAK**

**3:30 pm** **MPM2.7**
**Transuranic Waste Processing Center (TWPC)**
*Littleton, M.*
*Transuranic Waste Processing Center (TWPC)*

**3:45 pm** **MPM2.8**
**Designing For Dose Reduction The Spallation Neutron Source Project**
*Gregory, D.*
*Nuclear and Radiological Protection Division, and the Spallation Neutron Source, ORNL*

**4:00 pm** **MPM2.9**
**Innovative ALARA Tools And Work Practices Used At Hanford**
*Waggoner, L.*
*Fluor Hanford Inc.*

**4:15 pm** **MPM2.11**
**Hanford ALARA Center Support D & D Projects**
*Eby, J.*
*Fluor Hanford Inc.*

**4:30 pm** **MPM2.12**
**How Well It Works When Everybody Talks!**
*McBaugh, D., Priddy, Jr., G.*
*WA Department of Health*

**5:15-6:45 pm**

## Exhibitor Opening Reception

Ballroom D-G, Knoxville Convention Center

# Tuesday, January 23

**7:15-8:15 am** **Room: Ballroom A-C**

**CEL2 A Successful Remediation Project**
*L. Max Scott; Consultant, Baton Rouge, LA*

**8.30 am-Noon** **Ballroom A-C**

## TAM1 New Technologies and Methods

*Co-Chairs: Joe Alvarez, Neil Kiely*

**8:30 am** **TAM1.1**
**The Role Of Modern Positioning Systems In In-situ Survey Techniques For Final Status Surveys**
*Miller, M., Winstead, A., Wrubel, N., Farr, C.*
*Sandia National Laboratories, ERG, Inc.*

**8:45 am** **TAM1.2**
**In-situ Uranium Bioremediation And Stabilization Through FeS Coprecipitation**
*Morie, C., Ilgner, B.*
*Nuclear Fuel Services, Inc., ARCADIS G&M, Inc.*

**9:00 am** **TAM1.3**
**Simultaneous Alpha And Beta Detection: Boon Or Bust**
*Walker, E., Murphy, K.*
*Consultants*

**9:15 am** **TAM1.4**
**Performance Characteristics Of The Three-Dimensional Indoor Survey System Surface Contamination Monitor**
*Baker, K., Wrubel, N., Schierman, M., Farr, C.*
*Environmental Restoration Group, Inc.*

**9:30 am** **TAM1.5**
**Comparisons Of Conventional Counting Methods To A Cerenkov Counting Method For A Rapid Determination Of Sr-90 In Water**
*Ngazimbi, R., Dunker, R., Farfan, E.*
*Idaho State University, Idaho State University - Idaho Accelerator Center*

**9:45 AM** **BREAK IN EXHIBIT HALL**

**10:15 am** **TAM1.6**
**The Use Of Monte Carlo Modeling Of The Volume Weighted Sum Of Fractions For EMWMF**
*Hampshire, G., Redus, K.*
*Bechtel Jacobs Company LLC, Redus and Associates*

**10:30 am** **TAM1.7**
**An Economical & Innovative Approach To Radiological Screening Of ETTP Soils**
*Vinson, R., Skinner, K., McDaniel, D., Salpas, P., Bostic, W.*
*Restoration Services, Inc., Perot Systems Government Services, Salpas Consulting, Materials and Chemistry Laboratory, Inc.*

**10:45 am** **TAM1.8**
**Radiological Capabilities Of A Bulk Soil Screening And Sorting System Evaluated During Pilot Test To Determine Feasibility Of Alternative Remedial Action**
*Lopez, A.*
*MACTEC*

**11:00 am** **TAM1.9**
**Rapid Gamma Spectroscopic Analyses Of TRU/LLW Soil Cores**
*Meyer, K., Stevens, S., Moody, R.*
*Canberra Oak Ridge*

**11:15 am** **TAM1.10**
**A Review And Verification Of The Isotopic Distribution Of Enriched Uranium And The Impact On Decommissioning Considerations**
*Nardi, A., Chance, T., Conant, J.*
*Westinghouse Electric Company, ABB Inc.*

**11:30 am** **TAM1.11**
**MARSAME A Review**
*Petullo, C.*
*USPHS*

**11:45 am** **TAM1.12**
**Balancing Hazards During Research Reactor Decommissioning**
*Ceffalo, G.*
*Bechtel Jacobs Company LLC*

**Noon-1:00 pm** **Exhibit Hall**

## Complimentary Lunch

**9:00-11:45 am** **300 A-B**

## TAM2 Standards and Regulatory Compliance

*Co-Chairs: Alex Boerner, Scott Keithley*

**9:00 am** **TAM2.1**
**U.S. Environmental Protection Agency Superfund Radiation Risk And Dose Assessment Models**
*Walker, S.*
*U.S. Environmental Protection Agency*

**9:15 am** **TAM2.2**
**Alternative Disposal For Low Activity Source Material**
*Downey, H., Majer, T.*
*MACTEC, de maximis*

**9:30 am** **TAM2.3**
**Compliance With Marssim Data Quality Objectives Requirements**
*Duvall, K.*
*N.E. Research*

**9:45 am** **TAM2.4**
**Radiation Risk And Cleanup Standards**
*Rutherford, P.*
*The Boeing Company*

**10:00 AM** **BREAK IN EXHIBIT HALL**

**10:30 am** **TAM2.5**

**Development Of An Alternative Release Limit For A Former Uranium And Thorium Processing Plant In Cushing Oklahoma**

*Thatcher, A.*
*NEXTEP Environmental, Inc.*

**10:45 am** **TAM2.6**

**Completion Of De-Licensing Process For The West Jefferson North Facility**

*Anderson, K.*
*ECC*

**11:00 am** **TAM2.7**

**Community Oversight Of DOE D&D Activities At East Tennessee Technology Park, Oak Ridge, Tennessee**

*Gawarecki, S., Mulvenon, N.*
*Oak Ridge Reservation Local Oversight Committee, Inc.*

**11:15 am** **TAM2.8**

**Sampling Depth Of Decommissioned Concrete Slabs At The U. S. Department Of Energy Savannah River Site**

*Roach, J., Kubilius, W., Roe, B., Lee, P., Jannik, G., Oliver, T.*
*Washington Savannah River Company, Savannah River National Laboratory*

**11:30 am** **TAM2.9**

**How Clean Is Clean? How Fears Drive Cleanup Decisions**

*Johnson, R.*
*Radiation Safety Academy*

**Noon-1:00 pm** **Exhibit Hall**

**Complimentary Lunch**

**1:00-3:00 pm** **Exhibit Hall**

## POSTER

*Co-Chairs: Kyle Kleinhans, Gary Kephart*

**P1.1 3-D Presentation of Radiological Data for Building Surfaces and Components**

*Schierman, M., Farr, C., Wrubel, N., St. Martin, E.*
*Environmental Restoration Group, Cadsultant*

**P1.2 Natural Radionuclides in Surface Soils in Ipoh Malaysia**

*Hedge, H.*
*GeoSyntec Consultants*

**P1.3 Use of GPS-Based Radiation Surveys in a MARSSIM-based Radioactive Soils Cleanup**

*Wrubel, N., Johnston, J., Rademacher, S., Baker, K.*
*Environmental Restoration Group, Inc, AMEC, Inc, USAF*

**P1.4 Characterization Technology Selection for the Core Hole 8 (Tank W-1A) TRU Soil Engineering Study for Completion of Removal Activities at ORNL**

*Rucker, T., Gelinas, R., Pack, S., Mansfield, C.*
*Science Applications International Corporation, Bechtel Jacobs Company LLC*

**P1.5 Development of Web-Based Training to Support NRC Review of Dose Modeling Aspects in License Termination and Decommissioning Plans**

*LePoire, D., Arnish, J., Cheng, J., Kamboj, S., Richmond, P., Chen, S., Barr, C., McKenney, C.*
*Argonne National Laboratory, US Nuclear Regulatory Commission*

**P1.6 Effect of Dust Particle Size on Absorbed Fraction in ET1 Region**

*Moussa, H., Townsend, L., Eckerman, K.*
*University of TN, Oak Ridge National Laboratory*

**P1.8 A Discrete Step Model to Evaluate the Monetary Value of Person-Sievert in Korea**

*Na, S., Kim, S.*
*Center for Nuclear Waste Regulatory Analyses*

**P1.9 Indoor Worker Dose Calculations for Hot Cell Leakage**

*Nes, R., Benke, R.R.*
*Center for Nuclear Waste Regulatory Analyses*

**P1.10 The Resurgence of Nuclear Power from a Local Environmental Health Perspective**

*Sprau, D.*
*East Carolina University*

**P1.11 A Graded Approach to Fate and Transport Modeling to Support Decommissioning Activities at the Savannah River Site, Aiken SC**

*Dixon, K., Flach, G., Lee, P.*
*Savannah River National Laboratory*

**P1.12 Radiological Waste Treatment using Reverse Osmosis, Evaporation and Solidification from Russian Submarines**

*Gilliam, B.*
*Oak Ridge, TN*

**P1.13 An Improved Method for the Analysis of 234U, 235U and 238U in Urine By Inductively Coupled Plasma-Mass Spectrometry**

*Kannamkumarath, S., Gonzalez, B., Tucker, A., Rao, G., Thein, M.*
*Oak Ridge National Laboratory*

**P1.14 A Cost Effective Strategy for Bioassay Monitoring When Dealing with Multiple Transuranic Radionuclides, Mixed Fission Products and Uranium**

*Croslin, S., Stanford, S.*
*Bechtel Jacobs Company*

**P1.15 Summertime Short-term Negative Radon Tests Need to be Retested in Winter**
*McNees, J., Roberts, S.*
*Alabama Department of Public Health, Alabama Cooperative Extension System*

**P1.16 Sio2 Optical Fiber as Optically Stimulated Lumin-escence Material**
*Espinosa, G., Bogard, J.*
*Universidad Nacional Autónoma de México, Oak Ridge National Laboratory*

**P1.17 Double Precision C++ Computer Code for Exact Decision Levels and Errors of the First Kind when the Blank Count Time is an Integer in [1, 20] Times Greater than the Sample Count Time**
*Potter, W.E., Strzelczyk, J.*
*Consultant, University of CO Health Science Center*

**P1.18 Recommendations by the Working Group on Decommissioning of the German Radiation Protection Association**
*Brandl, A.*
*Nuclear Engineering Seibersdorf*

**P1.19 Decommissioning of a Nuclear Fuel Manufacturing Site**
*Downey, H., McDonald, M.*, Conant, J., Knauerhase, K.*
*MACTEC, ABB, ABB*

**P1.20 High-Risk Characterization of the 216-Z-9 Plutonium Waste Crib**
*Landsman, S.*
*Fluor Hanford, Inc*

**P1.21 Comparison of Calculated Versus Measured Uranium Holdup in a Uranium Fuel Fabrication Facility Ventilation System - A Case Study**
*Chance, T., Nardi, A.*, Roth, J.*
*Westinghouse Electric Company, Thor Enterprises*

**P1.22 Subsurface Soil DCGL Method / NRC Approval at Licensee Site**
*Lively, J.*
*MACTEC*

**P1.23 Case Study: the Use of Realistic Future use Scenarios in Decommissioning**
*DeGrazia, J., Gruben, D., Lively, J.**
*MACTEC, MDNR*

**WORKS-IN-PROGRESS**

**P1.24 An Improved Polymer-Based Hydrogel for Decontamination of Hard Assets**
*Gaul, W.C., Davidson, M.S., Edgington, G.J., O'Neill, M.P.*
*Chesapeake Nuclear Services, Cellular Bioengineering, Inc.*

**P1.25 The mobility of radiocesium and plutonium in Roach Lake in southern Nevada**
*Tabriz, M.*
*Oregon State University*

**P1.26 Alternative Decommissioning of a PuBe source**
*Dibblee, M.*
*Retired, Consultant, Portland, OR*

**3:00-4:15 pm Ballroom A-C**

**TPMA Challenges in D&D and Environmental Restoration**
*Co-Chairs: Fred Haywood, Jeff Chapman*

**3:00 pm TPMA.1**
**Ground Water Investigation At Indian Point Energy Center**
*LaVera, R., Mayer, D., Adler, J.*
*Entergy*

**3:15 pm TPMA.2**
**Challenges From D&D Of A Room Contaminated With Extremely High Levels Of Plutonium**
*Rima, S., Smith, K.*
*MACTEC, Inc.*

**3:30 pm TPMA.3**
**Safe Handling And Removal Of Scrap, Shielded Carriers, And Drums With Unknown Contents At The ORNL 7841 Scrap Yard**
*Harris, G.*
*Bechtel Jacobs Company LLC*

**3:45 pm TPMA.4**
**Implementation Of Contamination Area Controls Based On Soil Radium 226 Activity Concentrations**
*McDonald, M., Lively, J.*
*MACTEC*

**4:00 pm TPMA.5**
**Super-Heterogeneity: Discrete Radioactive Nuggets Distributed In The Soil Column**
*Lively, J.*
*MACTEC*

# Wednesday, January 24

**8.30-9:45 am** **Ballroom A-C**

## WAM1A D&D at the DNSC's Curtis Bay and Hammond Depots

*Chair: Eric Abelquist*

**8:30 am** **WAM1A.1**
**Removing The Source Term - Thorium Nitrate Disposal At NTS**
*Hermes, W., Terry, J.**
*ORNL*

**8:45 am** **WAM1A.2**
**RESRAD And RESRAD-BUILD Modeling To Develop Site-Specific DCGLs**
*Chapman, J., Boerner, A., Buchholz, M.*
*ORAU*

**9:00 am** **WAM1A.3**
**Managing The Myriad Of Safety Hazards During D&D**
*Baldwin, M., Underwood, W.*
*Oak Ridge National Laboratory*

**9:15 am** **WAM1A.4**
**Advantages And Lessons Learned Using GPS-Enabled Gamma Scanning For The Characterization Survey Of A Large Thorium/Uranium Site**
*Vitkus, T., Bailey, E.*
*Oak Ridge Associated Universities*

**9:30 am** **WAM1A.5**
**MARSSIM Final Status Survey Design For A Thorium And Uranium Contaminated Site**
*Abelquist, E., Roberts, S.*
*ORAU*

**9:45 AM** **BREAK IN EXHIBIT HALL**

**10:15-11:15 am** **Ballroom A-C**

## WAM2A Homeland Security

*Chair: Don Gregory*

**10:15 am** **WAM2A.1**
**A Low-Cost Radiography System For Non-Intrusive Cargo Container Inspection**
*Ankrah, M., Spaulding, R., Farfan, E., Ozcan, I., Smith, M.*
*Idaho State University - Idaho Accelerator Center*

**10:30 am** **WAM2A.2**
**Dose Characterization For Active, Non-Intrusive Inspection System Using An Electron Accelerator**
*Ozcan, I., Ankrah, M., Farfan, E., Spaulding, R., Smith, M.*
*Idaho State University - Idaho Accelerator Center*

**10:45 am** **WAM2A.3**
**Management And Disposal Of Co-60 Sources From Neely Nuclear Research Center**
*Zakir, N., Burgett, E., Hertel, N., Blaylock, D.*
*Georgia Institute of Technology, Neely Nuclear Research Center, Neely Nuclear Research Center*

**11:00 am** **WAM2A.5**
**The EPA National Decontamination Team**
*Cardarelli II, J., Hudson, S.*
*EPA*

**11:15 AM** **LUNCH ON YOUR OWN**

**8:30-10:00 am** **300 A-B**

## WAM1B Decontamination and Decommissioning - 2

*Chair: Tim Vitkus*

**8:30 am** **WAM1B.1**
**Grouting Liquid Low Level Waste (LLLW) Disposal Trenches At ORNL**
*Geiger, R.*
*Bechtel Jacobs Company LLC*

**8:45 am** **WAM1B.2**
**Activation Study Of The SGHWR In Support Of Its Decommissioning**
*Hertel, N., Blaylock, D., Burgett, E.*
*Georgia Institute of Technology*

**9:00 am** **WAM1B.3**
**Irradiator Decommissioning Project By The University Of Missouri-Columbias Radiation Safety Office**
*Crawford, J., Lewis, G.*
*University of Missouri*

**9:15 am** **WAM1B.4**
**Near-Simultaneous Monitoring And Remediation Of A Tropical Island Contaminated With Plutonium**
*Simon, S.*
*National Institutes of Health*

**9:30 am** **WAM1B.5**
**Remedial Action On The Surface Impoundments Operable Unit At The Oak Ridge National Laboratory, Oak Ridge, Tennessee**
*Haywood, F., Sherrod, T., Coe, R., Goldsmith, W., Chapman, J.*
*URS Group, Inc., Strata-G, LLC, Oak Ridge Associated Universities*

**9:45 am** **WAM1B.6**
**Test Cell A Facility Decontamination And Decommissioning Project: Controlled Explosive Demolition Of Neutron-activated Shield Wall**
*Simonsen, R.*
*Exelon Corporation*

**10:00 AM** **BREAK IN EXHIBIT HALL**

**10:30 am - Noon** **300 A-B**

## WAM2B Uncertainties in Measurement and Analysis

*Chair: Joe Shonka*

**10:30 am** **WAM2B.1**
**Clean by Poisson Distribution**
*Bramlitt, E.*
*New Mexico Commission for the Blind*

**10:45 am** **WAM2B.2**
**Measurement Uncertainty For InSitu Assay Of Containers And For Sampling And Laboratory Assay**
*Bronson, F.*
*Canberra Industries*

**11:00 am** **WAM2B.3**
**Rigorous Application Of Signal Detection Theory To Field Measurements**
*Shonka, J.*
*Shonka Research Associates*

**11:15 am** **WAM2B.4**
**Method For Establishing Contamination Controls For Radiologically Contaminated Soils**
*Landsman, S.*
*Fluor Hanford*

**11:30 am** **WAM2B.5**
**Fractional Sorption Of Plutonium And Americium In Soil From A Particulate Source**
*Gostic, R., Gostic, J., Bias, C.*, Czerwinski, K., Caputo, D.*
*University of Nevada Las Vegas, Cabrera Services, Inc.*

**11:45 am** **WAM2B.6**
**Soil Segregation Technology: Reducing Uncertainty And Increasing Efficiency During Radiological Decommissioning: A Case Study**
*Lombardo, A., Shonka, J., Scott, L., Orthen, R.*
*CEC, Inc., SRA, Inc., LRA*

**NOON** **LUNCH ON YOUR OWN**

**1:00-3:45 pm** **Ballroom A-C**

## WPM1 Computer-Aided Survey Design and Data Analysis

*Chair: Carl Gogolak*

**1:00 pm** **WPM1.1**
**NRC Research Program Related To Subsurface Contamination Evaluation And Operational Environmental Monitoring Programs**
*Powers, G.*
*USNRC*

**1:15 pm** **WPM1.2**
**SADA: A Freeware Decision Support Tool Integrating GIS, Sample Design, Spatial Modeling, And Radiological Assessment**
*Stewart, R.*
*University of Tennessee*

**1:30 pm** **WPM1.3**
**Using SADA For MARSSIM Surveys**
*Gogolak, C., Stewart, R.*
*Consultant, University of Tennessee*

**1:45 pm** **WPM1.4**
**Use Of SADA Software At David Witherspoon Inc. 901 Site**
*Dolislager, F.*
*The University of Tennessee*

**2:00 pm** **WPM1.5**
**BME Methodology In SADA: Theoretical Framework And Application At Chernobyl**
*Christakos, G.*
*San Diego State University*

**2:15 PM** **BREAK**

**2:45 pm** **WPM1.6**
**Computer Based Tools For Decommissioning Characterization And Final Status Survey**
*McGehee, J., Story, H., McGee, D.*
*AREVA NP Inc.*

**3:00 pm** **WPM1.7**
**A Comprehensive Computer Application For Managing Sample Planning And Analytical Laboratory Data In Support Of Decommissioning And Site Clean-Up**
*Darois, E., Tarzia, J., Hollenbeck, P.**
*RSCS, Inc., RSCS, Inc*

**3:15 pm** **WPM1.8**
**Application Of Integrated Database Systems To Decommissioning Of Indoor Survey Units Under MARSSIM**
*Anderson, B.*
*NEXTEP*

**3:30 pm** **WPM1.9**
**Remediation And FSS For A Contaminated Stormwater System**
*Bland, J., Doan, J.*
*Chesapeake Nuc. Srvs.*

**3:45-4:30pm** **Ballroom A-C**

## WPM2 Uncertainties in Measurement and Analysis

*Chair: Joe Shonka*

**3:45 pm** **WPM2.1**
**Operational Limitations For Demolition Of A Highly Alpha-Contaminated Building Modeled Versus Measured Air And Surface Activity Concentrations**
*Droppo, J., Napier, B.*
*PNNL*

**4:00 pm** **WPM2.2**
**Using Shewart Charts, An SPC Technique In Assessing Portable Survey Detector Instrument Health**
*Brown, D.*
*Shaw Environmental, Inc.*

**4:15 pm** **WPM2.3**
**Use Of T-Scores For Data Analysis**
*Stephan, C., Ellis, K., Gonsky, J., Garcia, R.*
*Tetra Tech EC, Independent Consultant*

## NOTE FOR CHPs

**The American Academy of Health Physics has approved the following meeting-related activities for Continuing Education Credits for CHPs:**

- **Meeting attendance is granted 2 CECs per half day of attendance, up to 12 CECs;**
- **AAHP 8 hour courses are granted 16 CECs each;**
- **HPS 2 hour PEP courses are granted 4 CECs each;**
- **HPS 1 hour CELs are granted 2 CECs each.**

# Abstracts

**MPM1.2** Funke, K.; Bechtel Jacobs Company LLC; kcfunke@tds.net

**Trials and Tribulations of Grouting Low Level Liquid Waste Lines at ORNL**

This paper discusses radiological work control methods employed while grouting the Inactive Waste Pipeline System at ORNL. The Inactive Waste Pipeline System consisted of a complex series of buried waste pipelines and appurtenances, e.g., vents, valve pits, pump vaults, etc., historically used to transport liquid process waste and low level waste between generator facilities, storage and disposal sites, and treatment facilities. Locating, uncovering, breaching, and grouting the pipelines was difficult because as-built drawings did not exist, the pipelines were constructed of various materials such as cast iron, carbon steel, and stainless steel, and the radionuclide distribution of the waste in the pipelines varied. Constant evaluation of radiological conditions was required to ensure work controls and methodology used to perform work maintained dose ALARA and prevented the spread of contamination. The results of incorporating job-specific lessons learned into the work control processes meant that the project was completed with significantly less dose to the workers than calculated and the project was able to control contamination while still maintaining efficient work processes.

**MPM1.3** Simanis, A.; BWXT Y-12; a2s@y12.doe.gov

**MARSSIM Applied at Y-12**

Old structures at the Y-12 National Security Complex, potentially contaminated with uranium, are being demolished and the debris removed. Applicable total and removable contamination release limits (alpha and beta-gamma separately), are 83.3 Bq/100 $cm^2$ (5,000 dpm/100 $cm^2$) and 16.7 Bq/100 $cm^2$ (1,000 dpm/100 $cm^2$), respectively. MARSSIM methods have been adapted to ensure objective and defensible radiological information associated with the disposition of the debris is uniformly obtained, assessed, and retained. Modifications were made to avoid costly inefficiencies based on unique end-use criteria and to accommodate the fact that a detailed characterization survey and the MARSSIM-based survey are performed at the same time. Modifications include: (1) direct surface measurements are performed in scanning mode, and (2) the decision rule compares each individual measurement against the limit as well as against investigation levels set below the limit. The survey plan describes measurements needed in each survey unit, including eight direct surface measurements (scan mode) associated with DCGLw in MARSSIM, and the results from scanning a specified percent of the surface. In addition, the survey plan reminds the radiological control technician to perform supplemental characterization surveys to provide confidence that assigned boundaries and class of each survey unit are correct. If each survey result is less than MDA and the survey unit has been assigned the correct class, then the survey unit meets the release criterion. Survey technique MDAs for alpha total and removable contamination are 16.7 Bq/100 $cm^2$ (1,000 dpm/100$cm^2$) and 3.3 Bq/100 $cm^2$ (200 dpm/100$cm^2$), respectively. For beta-gamma total and removable, MDAs are 50 Bq/100 $cm^2$ (3000 dpm/100 $cm^2$) and 10 Bq/100 $cm^2$ (600 dpm/100 $cm^2$).

**MPM1.4** Long, M.; Bechtel Jacobs Company LLC; longmp1@bechteljacobs.org

**Characterizing Hot Cells at ORNL**

Several inactive facilities at Oak Ridge National Laboratory were identified as potential candidates for ventilation isolation. The facilities were constructed over the 1940s, 1950s, and 1960s. Their missions ranged from fission product isolation, purification and source fabrication, to pilot plants for development studies of reactor fuel processing. Isolating the facilities would reduce the risk to workers and eliminate potential release of material into the environment until the facilities can eventually be decontaminated and demolished. Removal of active ventilation meant there will be no negative pressure in the various hot cells, fume hoods, and glove boxes. Thus the removable contamination would need to be reduced to a certain level before the facility could be safely isolated. Each hot cell was designed, constructed, and remodeled based on the available technology of the day and the specific needs of each mission. The variety of hot cell designs and radioactive material inventory created some interesting characterization challenges. A method had to be developed to define a decontamination goal. This goal was a level of contamination within an isolated hot cell that would not be expected to migrate into adjacent general areas after ventilation isolation. Both the derivation of acceptance levels and our experience with remote collection of surface contamination samples will be discussed.

**MPM1.5** Marouf, B.; Ministry of Science & Technology; bahamarouf@yahoo.com

**Evaluation of Adaya Site Contaminated with Uranium**

The Adaya site is located in the northern region of Iraq. It is contaminated with uranium due to past activities and looting that occurred after the fall of the Iraqi government in 2003. Soil contamination with uranium was visible. Surface soil samples were selected from the Adaya site as well as from sites far away from Adaya not contaminated with uranium. The samples were prepared for gamma spectrometric analysis. Gamma spectrometric analyses of the samples have revealed the presence of high concentrations of radionuclides of the uranium-238 series such as Th-234, Pa-234, and Ra-226. While the first and second radionuclides were below the detection limits of the gamma spectrometric system, the Ra-226 concentration ranged between 60 and 70 Bq/kg. The top 5 cm soil layer should be removed and stored in drums for temporary storage. Permanent storage would await a decision about the proper disposal method.

**MPM1.6** Marshall, G.; Philotechnics; grmarshall@philotechnics.com

**Decommissioning a Licensed Facility Having a 60-year History of Radioactive Materials**

Many facilities now being considered for license termination have a long history of work with radioactive materials. Many used radioactive materials in research settings prior to the existence of the Nuclear Regulatory Commission or its predecessor, the Atomic Energy Commission. Such facilities often present unique challenges to those preparing decommissioning plans, as well as to regulatory personnel tasked with reviewing and approving final status surveys. An example is a facility in Pennsylvania that took nearly three years to decommission. The first use of radioactive material was in 1943 in support of the Manhattan Project. It was later licensed under the Atomic Energy Commission, then decommissioned, and then relicensed under Nuclear Regulatory Commission. The regulatory requirement to obtain old records, and the difficulty in doing so, presented unique challenges.

**MPM1.7** Graves, M., Dameron, D.*; BWXT Y-12; gravesmb@y12.doe.gov

**Decontamination and Decommissioning**

While the Y-12 National Security Complex (Y-12) has a defined mission, there have been several Decontamination and Decommissioning (D&D) projects performed in support of infrastructure reduction activities within the complex. Building 9206 was an essentially redundant operation to the primary enriched uranium facility and, as a result, was scheduled for decommissioning to reduce the overall footprint of the Y-12 complex. Incremental funding has required D&D activities to be performed in fragments. Unique radiological control challenges are faced when a portion of a facility is maintained semi-operational and you eliminate a room(s) or essentially take down the facility a bite at a time. Facility utilities such as ventilation, electrical systems, and physical components must be isolated from the building. Control of the radiological hazards at the source of generation requires point source ventilation, extensive physical decontamination, and the use of high grade fixative agents. Because of the legacy of operational activities, the rooms are uniformly contaminated. Y-12 RADCON has successfully performed these activities without any personnel contaminations, upset to the remaining operations, or loss of contamination control.

**MPM1.8** Cicotte, G.; USAF/AFIOH/SDRH; george.cicotte@brooks.af.mil

**Benefits and Pitfalls of the Historical Site Assessment**

The Historical Site Assessment (HSA) is a fundamental tool for survey design under MARSSIM. It provides the assessor with the basic information needed to determine where and how resources should be allocated, what areas or facilities may need remediation or further investigation, and what areas may be determined to be not impacted by radioactive material uses. From the perspective of health physics professional whose resources require that they either contract with an entity engaged in the business of performing HSAs, or do not have time to personally perform such an assessment, reliance on this information can mean the difference between success and failure. Resources, financial and professional, depend on the confidence that can be placed in this function. The reputation of the organization with ownership or custody over the site to be investigated, and the relationship with regulatory agencies, the public, and even the employees of the organization, can be enhanced or harmed by the depth and quality of the HSA. HSAs that do not scrutinize the research phase will contain errors that reduce the value of the assessment, sometimes to such an extent that the HSA might have been better if left undone. Information that is adequately vetted can save relatively large portions of funding on major projects or allow for a more complete remediation with the same funding, speed the process, and provide confidence in the result. This is an examination of several case studies in how discovery of crucial information during or after the HSA significantly altered the result, redirected survey efforts, and demonstrated either no impact on facilities previously believed to have been impacted, or revealed impacts that were previously identified under a Finding of No Significant Impact (FONSI). It is also a call for providers and customers alike to critically examine what is provided to ensure the HSA actually answers the questions that need to be answered.

**MPM1.9** Whicker, R., Johnson, J., Meyer, H., Hinds, D., Little, C.; MFG, Inc., Frontier Environmental Services; randy.whicker@mfgenv.com

**Remediation of an Orphan Vanadium Mill Site**

The Davis Mill in Gateway, Colorado processed vanadium between 1941 and 1944. The mill was used to crush alabaster for a short time in 1947. Between 1955 and 1959, vanadium tailings, containing relatively high concentrations of uranium, were licensed by the Atomic Energy Commission as source material. The property was purchased by a private citizen in 1962 and has since been used for residential and limited agricultural purposes. The Nuclear Regulatory Commission provided a grant to the Colorado Department of Public Health and Environment to fund characterization and remediation of the site. The site was characterized in the fall of 2004. Soil cleanup activities were initiated in May of 2006. A soil cleanup criterion of 96.2 Bq/kg (2.6 pCi/g) Ra-226 above background was established using RESRAD based on an annual dose to a member of the public of 0.25 mSv/y (excluding indoor radon). All uranium decay series radionuclides were assumed to be present in equilibrium concentrations. Areas requiring soil excavation were identified initially based on the site characterization. The radiological status of the site was continually updated as the cleanup proceeded using a GPS-based gamma scanning system. Confirmatory soil samples were analyzed in a temporary on-site laboratory using a 5.08 cm (2 in.) Ludlum NaI detector and a multi-channel analyzer. Excavated soils were transported to the Uravan, Colorado mill site, a distance of approximately 64.4 km (40 miles). A final status survey was

conducted in July 2006. Due to radiological and hydrological conditions that were not identified during the site characterization, financial constraints, and landowner requirements, some areas of the site could not be excavated to meet the 96.2 Bq/kg (2.6 pCi/g) Ra-226 criterion and are likely to be subject to institutional control in the form of deed restrictions.

**MPM1.10** Brandl, A., Piniel, R., Steininger, R.; Nuclear Engineering Seibersdorf; alexander.brandl@arcs.ac.at

**A Method for Site Characterization at the Austrian Research Centers Seibersdorf**

Since 1959, the Austrian Research Centers have been home to a nuclear facility that includes a research reactor, a radiological waste treatment facility, and a hot cell laboratory, which are all now managed by Nuclear Engineering Seibersdorf (NES) as contractor to the Austrian government. With the completion of the decommissioning of the research reactor, the government has tasked NES to perform a complete site survey on all land formerly or presently owned by the Austrian Research Centers. As this land extends over an area of more than 440,000 m□2, an appropriate methodology had to be developed in order to complete this task in an efficient and timely manner. A graded approach has been employed, combining a fast screening method with sufficiently low MDA based on proportional counter technology with in-situ gamma spectrometry and targeted sampling. The methods, detection systems, and results of this large-area site characterization and survey project are presented in this paper.

**MPM1.11** Tarzia, J., Martel, C.; Radiation Safety & Control Services, Inc., Boston University Medical Center; jptarzia@radsafety.com

**Decommissioning the Historical Mallory Pathology Institute**

After serving for many years as the city morgue and a renowned pathology center, the Boston University Medical Center's (BUMC) Mallory Institute of Pathology building was returned to the City of Boston so that it can be used as a clinic and offices for the Boston Health Care for the Homeless Program (BHCHP). Built in 1933, the four-story 7,154 m□2 (77,000 ft□2) Egyptian Revival structure located at the corner of Massachusetts Avenue and Albany Street used both chemicals and radioactive material for many years to support pathology studies. Because of the age of the building, much historical information on the use and storage of radioactive and hazardous material was lost, which added unique challenges to the decommissioning process. Radiological remediation was required in areas where legacy spills containing nuclides such as Sr-90, C-14, and U-238 contaminated cabinets, fume hoods, floors, and areas of the old morgue. Additional complications arose in coordinating the radiological decontamination in areas where biohazard contamination remained. This presentation will discuss the process used to decommission the facility including: the historical site assessment, scoping assessment, remediation activities, and final status survey. It will also present the methods used in the assessment of predecommissioning conditions and lessons learned for future medical center decommissioning activities.

**MPM1.12** Palmer, A., Bowers, J., Myers, F., Willis, T.; SEC; apalmer@sec-tn.com

**Decommissioning of a Source Manufacturing Facility**

This paper discusses the challenges and the resolutions associated with decommissioning a former source manufacturing facility. These included establishing license termination criteria, developing site specific Derived Concentration Guidance Levels (DCGLs), physical decommissioning challenges associated with adjacent facilities in an urban environment, in-process remedial action surveys, and final status survey design and implementation. Physical challenges included demolition, excavation, and remediation adjacent to a recording studio and residential apartments, a very narrow site footprint, and remediation beneath building foundations. The final status survey was designed using both MARSSIM Scenario A and B decision criteria. This paper will also describe the development and application decision rules under MARSSIM scenarios A and B.

**MPM2.1** Green, S.; Bechtel Jacobs Company LLC; gx3@bechteljacobs.org

**Practical ALARA during Decontamination and Decommissioning and Remediation Activities in Oak Ridge, Tennessee**

Decontamination, decommissioning, and remediation of the U.S. Department of Energy sites in Oak Ridge present a diverse set of challenges. K-25 is the site of the first uranium enrichment plant. The site stopped enrichment operations in 1986. The Y-12 original mission was to enrich uranium. The mission currently is to manufacture and refurbish depleted and enriched weapons components. At these sites ALARA hinges on good contamination control and control of airborne radioactivity. Oak Ridge National Laboratory has performed a wide variety of work including operating nuclear research reactors, developing nuclear fuel reprocessing techniques, and performing radioisotope separations for medical use. Radionuclides include fission products, activation products, uranium, thorium, and transuranic elements. High radiation, contamination, and prevention of internal radiation exposure drive the ALARA measures. Demolishing large and small facilities, removing radioactive waste from underground tanks and lines, excavating burial grounds, and characterizing and packaging waste that has been stored for many years present significant and sometimes unique challenges. The challenges to maintain radiation exposures ALARA are also significant and sometimes unique. ALARA, by definition, must balance costs with dose and contamination reductions. ALARA measures are favorably received and implemented when practically employed. This paper presents dose and contamination control techniques for several discrete projects across the DOE Oak Ridge cleanup sites. Measures discussed in this paper range from small, make-shift containments used to cut underground transuranic waste lines to dust suppression systems during

demolition of some of the world's largest structures. This paper is intended to introduce subsequent papers that will provide specific details of these ALARA measures at specific work sites.

**MPM2.2** Kleinhans, K.; Bechtel Jacobs Company LLC; kk2@bjcllc.org

**Dealing with the Unexpected during Removal of Scrap From K-770**

While removing and shipping scrap metal from the K-770 Scrap Yard at the former Oak Ridge Gaseous Diffusion Plant, an anomaly was detected. A loaded dump truck containing scrap metal was found to exhibit 5.2E-5 C/kg-hr (200 mR/hr) on contact. The K-770 Scrap Yard received primarily uranium contaminated scrap metal from the Oak Ridge Gaseous Diffusion Plant; therefore no significant dose rate was anticipated. Upon unloading the dump truck, it was determined that the source of radiation was a damaged shielded cask that was reading up to 1.8E-3 C/kg-hr (7 R/hr) on contact. Later during processing, two additional shielded casks were identified. Efforts were made to determine the origination and contents of these casks. Non-destructive assay (NDA) methods were used to estimate the radioactive content in the casks. Due to the high levels of activity estimated by NDA and potentially high dose rates that would be encountered if a cask were to catastrophically fail, a number of ALARA methods were employed to minimize personnel exposure. The primary ALARA method employed was to work remotely behind a shield wall in the event a cask failed and the source became unshielded.

**MPM2.3** Hyder, D.; Bechtel Jacobs Company LLC; hyderd@bechteljacobs.org

**ALARA Methods for the Retrieval of Buried Transuranic Waste**

Transuranic and other radioactive waste had been buried in 22 trenches in Solid Waste Storage Area 5-North, located in Melton Valley on the Oak Ridge National Laboratory. The waste was originally packaged in 204 concrete casks, 30 drums or wooden boxes, and 540 cubic feet (15.3 cubic meters) of loose debris. The total activity was estimated to be approximately 1.48E+12 Bq (40 curies), with 75% of that being Cm-244, 8% U-233, 8% a mixture of Pu-239/Am-241, and 7% being mixed fission products. The planned activity was to uncover, over pack, and store the waste above ground for future treatment. A HEPA ventilated weather enclosure was erected over the excavation area. Additional ALARA controls included a built-in misting system; a continuous air monitor/air sampler located external to the potential airborne radioactivity area; a cask shield used for cask movement; and the use of long handled tools. Administrative controls were established for entry control and over pack removal and transport. Additionally, the project acquired modern counting instruments for the discrimination of radon and thoron progeny on air samples.

**MPM2.4** Stevenson, D.; Bechtel Jacobs Company LLC; stevensonda@bechteljacobs.org

**Integrating RADCON into Work Planning and Control on Complex and Diverse Accelerated Cleanup/D&D Work in Oak Ridge**

The Oak Ridge Accelerated Cleanup project key objectives are: to safely treat and dispose of legacy low-level and mixed waste stored on the reservation; to decommission surplus facilities and complete hydrologic isolation/capping of major burial grounds in Melton Valley; and to decommission surplus facilities including the K-25 and K-29 gaseous diffusion process buildings and complete the remediation of waste sites at the East Tennessee Technology Park. Effective deployment of radiological control personnel and implementation of consistent radiation safety programs must be integrated with safety and industrial hygiene challenges in work planning, control, and execution activities. This paper reviews the magnitude, complexity, and challenges applicable to radiation safety in managing work in an accelerated clean-up environment. Particular areas to be addressed include staff qualifications and training, integration of RADCON with safety and industrial hygiene in the work planning and control process, assessing radiological program field effectiveness, and emergency response challenges.

**MPM2.5** Ivey, B.; Safety and Ecology Corporation; mivey@sec-tn.com

**An Oversight Inspection Program with Effective Performance Measures**

The Bechtel Jacobs Company LLC (BJC) Radiological Control Program has implemented programmatic ALARA measures in the form of an oversight inspection program. This program, known as the Project Walk Down (PWD) Program, ensures continuous improvement by identifying issues that are contrary to quality, tracking those issues to closure, and analyzing collected data to identify emerging programmatic trends. A checklist is employed containing the critical items of Radiological Work Permit (RWP) content and implementation, work practices, and contamination control and monitoring by which participants report findings, satisfactory and unsatisfactory. All submitted PWD forms are summarized in a monthly report. This report includes trend charts which graphically display each attribute of the PWD form, showing the number of identified unsatisfactory items from the most recent twelve months. With an established definition of a trend, this allows easy identification of emerging programmatic issues. Individual unsatisfactory items are also tracked in the summary report until corrective actions are implemented and notification of closure is received or the item is placed in the BJC Issues/Corrective Action Tracking System.

**MPM2.6** Bauman, R.; Bechtel Jacobs Company LLC; rbauman@knology.net

**Sampling Strategy for the Leaking Underground Storage Tank, Tank W-1a at the Oak Ridge National Laboratory**

Tank W-1A, located at the Oak Ridge National Laboratory (ORNL), was commissioned in 1951 and removed from service in 1986. The primary function of the tank was to collect and store liquid wastes from radiochemical separations and high-radiation analytical facilities at ORNL. During its operation, a transfer line to Tank W-1A was suspected of leaking near the tank intake, causing significant soil and groundwater contamination in the vicinity of the tank and down-gradient plume. In 2001, a remediation project was undertaken to remove the tank and contaminated soils immediately surrounding the tank. However, during soil excavation, higher than expected contamination levels were encountered. Dose rates on excavated dirt ranged up to 60 mSv/hr (6 rem/hr) on contact. The remediation project was subsequently stopped and the area backfilled. Completion of Tank W-1A remediation has since been initiated. To support this effort, additional sampling and characterization of the soils adjacent to the tank have been performed. This presentation provides a review of the radiological safety hazards and subsequent hazard controls applicable to the work performed for the sampling and characterization efforts. Radiological hazards included high radiation dose rate fields, high levels of dispersible contamination, and the generation of airborne radioactivity. Controls included the use of remote handling tools including a soil core transporter, a glove box for cutting and splitting soil core samples, temporary shielding of soil wastes, and strict limiting conditions within the Radiological Work Permit (RWP).

**MPM2.7** Littleton, M.; Transuranic Waste Processing Center (TWPC); mlittleton1022@charter.net

**Transuranic Waste Processing Center (TWPC)**

For over sixty years, defense-related work generated solid and liquid waste stored at the Oak Ridge National Laboratory. The Transuranic Waste Processing Center (TWPC) was constructed in the early 2000s to process this legacy waste. The current mission of TWPC is to characterize approximately 849 cubic meters (30,000 cubic feet) of contact-handled debris waste (CH waste), repackage it to meet disposal requirements, and ship the waste for disposal. CH waste operations began in December 2005. CH waste is packaged in drums and boxes, but TWPC can only characterize waste packed in 208-liter (55-gallon) drums. Waste packed other container types must be opened, examined visually, in most cases size reduced and repackaged in 208-liter drums. The bulk of the CH waste is highly contaminated with transuranic radionuclides. Because of the mobility and toxicity of the contamination, human contact with the waste presents radiological protection challenges. This paper examines the methods to evaluate radiological conditions and control the potential internal exposure during these high risk operations.

**MPM2.8** Gregory, D.; Nuclear and Radiological Protection Division, and the Spallation Neutron Source, ORNL; gregorydc@ornl.gov

**Designing For Dose Reduction The Spallation Neutron Source Project**

The Spallation Neutron Source facility, located at the Oak Ridge National Laboratory in Tennessee, has completed the construction phase and is now operational. Detailed design, construction, and commissioning activities over the last 10 years have placed a high priority on ALARA (As Low As Reasonably Achievable). Design of the linear accelerator, accumulator ring, mercury target, and user-friendly instruments emphasized protection of workers and users from accident-generated dangerous levels of prompt radiation, from chronic elevated general-area radiation levels, and from exposure to activated materials during maintenance. ALARA was "designed-in" to all major systems based on lessons learned from other facilities, detailed radiation source and shielding (Monte Carlo) calculations, and consideration of maintenance during outages. Minimizing both volumes of waste and radiation exposures during the handling of waste were also influential in major design decisions. Examples of radiation-reducing design decisions and the estimated associated dose reductions illustrate the effective design of a major high-energy accelerator facility.

**MPM2.9** Waggoner, L.; Fluor Hanford Inc.; larry_o_waggoner@rl.gov

**Innovative ALARA Tools and Work Practices used at Hanford**

The Hanford DOE site has several nuclear facilities undergoing decontamination, decommissioning, and demolition. Most of these facilities were shut down several years ago and radioactive contamination is still present in the ventilation systems, work spaces, components, gloveboxes, vaults, hot cells, and surrounding soil. In addition, these facilities also contain toxic and hazardous products, and in some cases, fissile material. Hanford personnel have learned that D&D work is different from running or maintaining a facility. Every organization, including managers, engineers, planning personnel and workers, has had to learn new skills. After each facility was characterized, managers had to use this information to develop a plan to accomplish the D&D or determine another use for the facility. There were usually several options, and managers had to determine how much risk they were willing to accept when they made their choice on which option to take. Workers participated in mock-up training and learned how to size-reduce equipment and components, handle large quantities of radioactive and non-radioactive waste, fix contamination, and use remote tooling and robotic equipment. Along with these new skills the workers learned work practices that ensured that contamination was not spread beyond posted boundaries and different methods to keep their dose ALARA. Tools and equipment were selected that minimized contamination spread, could be operated in restricted

areas, and were simple to operate. This presentation will describe the best technologies used to date and the work practices that made them successful.

**MPM2.11** Eby, J.; jerald_l_eby@rl.gov

**Hanford ALARA Center Support D & D Projects**

The Hanford ALARA Center (Center) has provided D&D project support at the DOE Hanford site for the last five-plus years. The Center, with its 371.6 square meters (4,000 square feet) of tools, equipment, and training area, has proven to be a significant resource in the successful D&D of numerous facilities, and it continues to support ongoing projects through finding new tools and equipment applicable to the future tasks on site; demonstrating D&D tools and equipment at the Center to site workers and planners; and facilitating training on D&D processes at the Center's training area. Tools include nibblers, holding fixtures for tools and cutters, special cutting tools, shrouded tools, large shears, and remote operated miniature cameras. Equipment includes water cannons, misters, HEPA filtered exhausters, vacuum cleaners, ventilation systems, temporary enclosures, and system drains. Processes include use of fixatives, foaming enclosures, fogging, and misting. In addition, the Center has continued to acquire new items for heat stress prevention, user-friendly protective clothing, and radiological containments. The Center works in conjunction with other DOE sites, including ALARA Centers at Savannah River and Los Alamos, and DoD and commercial nuclear sites to share lessons learned and new technology in D&D.

**MPM2.12** McBaugh, D., Priddy, Jr., G.; WA Department of Health; Debra.Mcbaugh@doh.wa.gov

**How Well it Works when Everybody Talks!**

While other papers have discussed the function of the Hanford Emergency Decontamination Facility (EDF) and how MARSSIM was used during its decommissioning, no one has yet described the challenges of executing a decommissioning project in unknown regulatory territory. To describe the setting: Shortly after the major reactor accident at SL-1 in Idaho in 1967, the Department of Energy (DOE), then the Atomic Energy Commission, built the EDF on the Hanford Reservation in Richland, Washington. Although Hanford extends over 1,295 square kilometers (500 square miles), DOE preferred to treat contaminated patients at an offsite location. The land selected for the EDF was owned by Kadlec Medical Center (KMC) and was located immediately behind the hospital. KMC leased this land to DOE, who built and operated the EDF for more than 35 years. KMC eventually outgrew its space and requiring expansion onto their adjacent property. Although DOE no longer needed the EDF, decommissioning the facility was not currently funded because of higher priority cleanup projects on the Hanford site. Given these facts, KMC decided they would both fund and contract the decommissioning of the EDF. While all parties recognized and agreed that the KMC expansion would benefit the community, many hurdles remained to be overcome. What those hurdles were, how they were successfully addressed, and how state and federal regulatory requirements were met will be discussed.

**TAM1.1** Miller, M., Winstead, A., Wrubel, N., Farr, C.; Sandia National Laboratories, ERG, Inc., ERG, Inc.; mmiller@sandia.gov

**The Role of Modern Positioning Systems in In-situ Survey Techniques for Final Status Surveys**

The statistical approach to conducting final status surveys, as presented in MARSSIM, was developed with little consideration given to the technological advances commonly used in conducting radiation surveys today. Survey methods incorporating laser positioning systems, ultrasonic positioning systems, and global positioning systems are being used to scan building and soil surfaces for particle and gamma-ray emissions. Surveys performed using these types of systems result in radiological data and associated x, y, z coordinates collected in electronic file format. These data files can then be used to generate maps for visual display or statistical analysis of data using a geographical information system or other computer applications. Particle detector efficiencies and correlations between gamma-ray emission rates and soil concentrations provide a means for converting to units normally specified in the DCGL. While these data are used to estimate the variances required for developing the sampling grid size in the MARSSIM formulation, often it is evident that further sampling might not be necessary, especially when the site survey data indicate that the site contamination levels are far below the DCGLs. Various examples will be presented.

**TAM1.2** Morie, C., Ilgner, B.; Nuclear Fuel Services, Inc., ARCADIS G&M, Inc.; csmorie@nuclearfuelservices.com

**In-situ Uranium Bioremediation and Stabilization through FeS Coprecipitation**

A full-scale remediation system using ARCADIS G&Ms patented in-situ reactive zone (IRZ) technology for the enhanced anaerobic reductive precipitation of uranium and the enhanced reductive dechlorination of tetrachloroethylene and its associated daughter products is being performed at a facility in the Blue Ridge physiographic province. The patented Saunders process is also being implemented to ensure the long-term stability of the precipitated uranium. In addition to long-term stability, the objective of the IRZ system is to reduce existing concentrations of uranium and chlorinated aliphatic hydrocarbons to below remediation goals and prevent or minimize further migration. Prior to and during the implementation of the system, injection and observation wells were sampled for analysis of field parameters, electron acceptors, biodegradation byproducts and products, biogeochemical indicators, volatile organic compounds, and total and dissolved uranium to determine the predominant remedial processes and the effectiveness of the IRZ. Injection and sampling results, hydrogeology, and interpretation of the biodegradation/precipitation will be discussed.

**TAM1.3** Walker, E., Murphy, K.; Consultant; eewjko@msn.com

**Simultaneous Alpha and Beta Detection: Boon or Bust**

The current generation of portable radiation detectors used to assess surface activity includes several types that will respond to both alpha and beta emissions. To take advantage of this characteristic, instrument manufacturers have designed the electronic circuitry to produce an output response to both. The meters employing this circuitry are then coupled to either gas proportional or scintillator detectors, enabling the user to measure beta and alpha activity in the field. The meter-detector combination is calibrated for both alpha and beta response and sent to the field to make the dual measurements. This presentation will describe the characteristics of this dual response and the limitations that must be considered when converting the field measurement to an equivalent source term. Factors to be considered include: response differentiation between lab calibration and field conditions, energy response, and cross-talk between alpha and beta channels. These factors have a significant impact on the value of simultaneous alpha and beta measurements.

**TAM1.4** Baker, K., Wrubel, N., Schierman, M., Farr, C.; Environmental Restoration Group, Inc.; KenBaker@ERGOffice.com

**Performance Characteristics of the Three-Dimensional Indoor Survey System Surface Contamination Monitor**

The Three-Dimensional Indoor Survey System (3-DISS) consists of a fan laser positioning system coupled to a multiple detector array or single handheld radiation detector to accurately record radiation emissions and corresponding x, y, z coordinates. The performance characteristics of the 3-DISS have been evaluated when using alpha and beta detectors. The integrated counts and associated coordinates are recorded at the end of each counting interval and downloaded into ArcView GIS for data processing and presentation. Commercially available digital ratemeter/scalers with RS-232 output capability were modified to provide scaler outputs at user-specified multiples of one-second intervals. A three-second counting interval is used for most scanning surveys because it allows more counts per counting interval while sampling a small enough area for most scan speeds. Because of the short counting time, small sample statistics were used to model the expected output. The statistically derived frequency distributions of counts per counting interval were found to agree well with actual results. The variance of the calculated count rates may be reduced during data processing by nearest-neighbor-averaging techniques, thereby reducing the occurrence of false positives and false negatives. Reducing the variance using nearest-neighbor-averaging techniques also minimizes the spatial distortion of the contaminant distribution on a surface compared to that from surface scans when using traditional survey methods. The statistical model of the 3-DISS was used to provide the minimum detectable activity as a function of background count rate, counting interval, number of nearest neighbors, and the detector detection efficiency.

**TAM1.5** Ngazimbi, R., Dunker, R., Farfan, E.; Idaho State University, Idaho State University - Idaho Accelerator Center; ngazroya@isu.edu

**Comparisons of Conventional Counting Methods to a Cerenkov Counting Method for a Rapid Determination of Sr-90 in Water**

This research project updates previous work for the rapid determination of Sr-90 concentration in water. An experiment is performed to measure Sr-90 through its daughter nuclide Y-90 in water samples using Cerenkov counting and 3M Empore Strontium Rad Disks. This method eliminates the need to wait for two weeks for Y-90 ingrowth and subsequent separation of the Y-90 for beta analysis. By taking advantage of the energetic Y-90 beta particles ability to produce Cerenkov radiation, the need for yttrium separation is eliminated. In addition, utilizing 3M Empore Strontium Rad Disks for separation of Sr-90 from the samples, the process can be further streamlined. Timely measurement of Sr-90 is necessary because Sr-90 might be released to the environment. By eliminating time-consuming preparation procedures, more rapid results can be obtained. A determination of optimum and minimum counting times to achieve a desired minimum detectable activity (MDA) is considered in this study. Additional discussion is also presented on the possibility of expanding the procedure for application in the determination of Sr-90 in soil, vegetation, and milk.

**TAM1.6** Hampshire, G., Redus, K.; Bechtel Jacobs Company LLC, Redus and Associates; o57@bjcllc.org

**The use of Monte Carlo Modeling of the Volume Weighted Sum of Fractions for EMWMF**

Concentration limits for disposal cells are typically applied using a system by which maximum or bounding concentrations are compared to set limits, constraining the sum-of-fractions for the proposed waste to less than unity. This approach usually results in utilizing less than 10% of the risk- or dose-based limits averaged over the entire waste cell contents. The Environmental Management Waste Management Facility in Oak Ridge utilizes a volume-weighted sum-of-fractions approach to accepting waste, and uses a Monte Carlo modeling of expected waste concentrations relative to facility concentration limits to maximize the volume of waste that can be accepted. To date the facility has achieved a 60% utilization of the approved risk limits for the facility, with the capability of approaching more than 90% of the risk limits within the approved waste acceptance structure.

**TAM1.7** Vinson, R., Skinner, K., McDaniel, D., Salpas, P., Bostic, W.; Restoration Services, Inc., Perot Systems Government Services, Salpas Consulting, Materials and Chemistry Laboratory, Inc.; wvl@bechteljacobs.org

**An Economical & Innovative Approach to Radiological Screening of ETTP Soils**

For the past two years, Restoration Services Inc. has been applying an economical and innovative approach to radiological screening of ETTP soils. The Model T counting system combines a portable low energy radiation detector with a

customized shielded counting chamber designed to accommodate the two-inch diameter Geoprobe soil core sample. The shielding allows the radiation detector to distinguish soil sample photon emissions from ambient radiation. The system can detect U-238 at 1.5 Bq/g [80% of Remediation Level (RL)], or less. Soil sample cores are passed through the Model T to: (1) determine whether laboratory analyses are necessary and if so, (2) identify the specific sample interval(s) from which to collect the sample(s). Unnecessary laboratory analyses are reduced by field identification of samples whose results will be below the RL, and characterization is improved by ensuring appropriate interval selection. To date, over 1,172 core samples have been screened, of which only 142 required laboratory analyses. Approximately $500,000 has been saved on laboratory analyses to date, with an expected additional savings of over $250,000 for the duration of the project. Improvements in data collection since October of 2005 have resulted in a computer database with screening results of over 600 core samples and a 50% reduction in screening time.

**TAM1.8** Lopez, A.; MACTEC; aulopez@mactec.com

**Radiological Capabilities of a Bulk Soil Screening and Sorting System Evaluated during Pilot Test to Determine Feasibility of Alternative Remedial Action**

Previous characterization and remedial action events at the former Sumitomo Corporation site located in Teterboro, New Jersey, identified Ra-226 in a combination of diffuse bulk radioactivity and discrete identifiable particles (nuggets) in the soil matrix. A soil screening and sorting system pilot test has been conducted to determine if a conveyor-assisted system can effectively detect and isolate Ra-226 containing nuggets having an activity of at least 3.7 x 10□-3 Bq from bulk soil. Effluent soil streams excavated from the site will be processed through the soil screening/sorting system in a number of varying configurations along with Ra-226 sources of known radioactivity to optimize the operational characteristics of the system. Critical variables include angular response (location of the source in relation to the lateral position of the detector), residence time (speed of the conveyor), attenuation (thickness of soil placed on top of the source), and distance (distance of detector from source). This paper presents analytical data generated during the pilot test, the radiological capabilities of the system, and recommendations for further consideration of the screening method as a viable remedial action alternative.

**TAM1.9** Meyer, K., Stevens, S., Moody, R.; Canberra Oak Ridge; kmeyer@canberra.com

**Rapid Gamma Spectroscopic Analyses of TRU/LLW Soil Cores**

High-resolution field gamma spectroscopy was used to provide rapid analyses of radiological constituents in soil cores taken from the vicinity of Corehole 8 Tank W-1A at ORNL. The purpose of this characterization project was to generate three-dimensional maps of the extent of TRU and LLW contamination in soil around the tank. Geoprobe dual-tube soil sampling was used to collect 2.9 cm diameter soil cores up to 76 cm long. These cores were immediately brought to two adjacent ISOCS gamma spectroscopy stations for measurements. Typically, a 38 cm long core segment was measured for 15 minutes, and the results were reported within 30 minutes. Fast turnaround times were necessary to support the dynamic sampling plan. The primary detected radioactive contaminants were Am-241, Cs-137, Eu-152, Eu-154, and daughters of U-232, U-233, and Th-232. The quantification of Am-241 in the presence of high concentrations of Cs-137 presented special challenges. Using customized counting geometries, lead shielding, and collimators, it was possible to quantify 1.7 x 103 Bq/g of Am-241 in the presence of 7.8 x 105 Bq/g of Cs-137. Detection limits for Am-241 were typically less than 370 Bq/g. The results of ~300 measurements performed at 64 probe locations will be presented.

**TAM1.10** Nardi, A., Chance, T., Conant, J.; Westinghouse Electric Company, ABB Inc.; ajnardi@enercon.com

**A Review and Verification of the Isotopic Distribution of Enriched Uranium and the Impact on Decommissioning Considerations**

The decommissioning of a uranium fuel fabrication facility may involve uranium contamination at various enrichments. At two sites undergoing decommissioning, the range of possible uranium enrichments handled over the historical course of operations included uranium at enrichments ranging from depleted to highly enriched. While gamma spectroscopy measurements of sample media will often provide isotopic information on the U-235 and U-238 activity concentrations, it can not provide information on U-234 or U-236 concentrations. More expensive analytical methods, such as alpha and mass spectrometry, are required to provide such additional isotopic information. This paper presents information on the expected isotopic distribution of uranium over the full range of enrichments based on published public information of the specific activity of enriched uranium. The resulting activity distribution curves were verified by measured data at two different sites undergoing decommissioning. Verification of the activity distribution curves allowed use of gamma spectroscopy measurements for U-235 to predict the concentration of U-234 and total uranium. The activity distribution data were further used to evaluate the impact of varying enrichments on decommissioning criteria (DCGLs) for soils and groundwater. The significance of available U-236 data was also evaluated.

**TAM1.11** Petullo, C.; USPHS; Petullo.Colleen@epamail.epa.gov

**MARSAME a Review**

An overview of the process outlined in the current draft *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME)* and to the current stage of development of the document will be presented. This joint publication from EPA, NRC, DOE and DoD is a supplement to the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).* MARSAME provides information for the design and implementation of technically-defensible sur-

veys to determine proper disposition for materials and equipment (M&E) with potential intrinsic radioactivity or residual radioactive contamination. A graded approach is used to initiate, maintain, remove or transfer control of such M&E based on the selected disposition option, action level, description of the M&E (e.g., size, accessibility, component materials), and description of the radioactivity (e.g., radionuclides, types of radiation, surficial versus volumetric activity). MARSAME is applicable to M&E used or stored at sites and facilities licensed to handle radioactivity, commercial products purposely (e.g., smoke detectors) or incidentally (e.g., phosphate fertilizers) containing radionuclides, and M&E associated with naturally occurring and accelerator-produced radioactive materials (NARM) and technologically enhanced naturally occurring radioactive material (TENORM). Examples of such M&E include heavy equipment, tools, roofing materials, rubble, piping, and sludge as well as gases, liquids, and solids stored in containers. It does not apply to personnel, liquid and gaseous effluent releases, or real property.

**TAM1.12** Ceffalo, G.; Bechtel Jacobs Company LLC; radmonkeyboy@hotmail.com

**Balancing Hazards During Research Reactor Decommissioning**

During the decommissioning of a nearly-unique reactor, many challenges arise that require a creative balance of the radiological, industrial hygiene, and industrial safety disciplines. At the Molten Salt Reactor Experiment (MSRE), these challenges include reheating a mixture of lithium fluoride salts containing uranium, plutonium, thorium, and mixed fission products to a molten state, heat stress, fall protection hazards, fluorine-compound gas mixtures at pressure, contaminants left over from operations in the 1960s, and other hazards. This presentation will cover the decommissioning activity and the continuous balance of the hazards and hazard controls.

**TAM2.1** Walker, S.; U.S. Environmental Protection Agency; walker.stuart@epa.gov

**U.S. Environmental Protection Agency Superfund Radiation Risk and Dose Assessment Models**

This presentation provides a brief overview of the approach used by U.S. EPA to develop risk- and dose-based cleanup levels at radioactively contaminated Superfund sites. This presentation will address the existing EPA Superfund radionuclide calculators for developing (1) risk-based Preliminary Remediation Goals (PRG), and (2) dose-based Dose Compliance Concentration (DCC) levels for radioactively contaminated soil and water; (3) the risk-based calculator for building PRG (BPRG) for radioactive contamination inside buildings (anticipated completion, Fall, 2006); (4) the risk-based calculator for surface PRG (SPRG) for outside hard surfaces such as streets and the outside walls of buildings (anticipated completion, early-2007); and (5) the ecological dose calculator radionuclide ecological benchmark (REB), (anticipated completion, early-2007). The presentation addresses how these calculators fit within the framework EPA Superfund uses to determine cleanup levels. The theme emphasized in this portion of the presentation is that, within the Superfund remediation framework, radioactive contamination is dealt with in a way identical to chemical contamination, except to account for technical differences.

**TAM2.2** Downey, H., Majer, T.; MACTEC, de maximis; htdowney@mactec.com

**Alternative Disposal for Low Activity Source Material**

As part of a remedial investigation at a CERCLA site, soil waste was generated from exploratory soil borings and as part of removal activities at a former drum burial area. Characterization results of these materials indicated very low concentrations of uranium and thorium, at levels less than 0.05% by mass (exempt source material). The site has an Agreement State-issued possession-only radioactive materials license and the source material in the soils is residual from past operations. The soil was evaluated for disposal as exempt radioactive waste at a RCRA landfill, which included dose modeling to workers during transportation and disposal as well as potential dose to members of the public after closure of the disposal facility. These evaluations followed guidance established by the Nuclear Regulatory Commission for transfer and direct disposal of exempt source material in a RCRA landfill. These evaluations determined that the potential dose was very small, and review by the Agreement State indicated that this disposal process should not result in any undue hazard to public health and safety or property. The advantage of this approach is that disposal of this soil waste at a RCRA landfill is estimated to result in a savings of $80,000 as compared to disposal as low-level radioactive waste. Ultimately, the soil was accepted for disposal as exempt radioactive waste at a RCRA landfill, and the process of regulatory acceptance is described.

**TAM2.3** Duvall, K.; N.E. Research; duvall100@verizon.net

**Compliance with Marssim Data Quality Objectives Requirements**

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) describes a process for planning, conducting, and assessing the final status survey (FSS). The sources of data and information that provide input into the process are outside the scope of the manual. However, the manual does provide a means for specifying the quality of data and information that is acceptable as input. It designates the Data Quality Objectives (DQO) process to be utilized for this purpose. Step 3 of the DQO process addresses the need for ensuring that inputs are of an acceptable data quality. This step is incorporated into the manual as explicit DQO requirements (two shall and two should requirements). Full compliance with the manual requires demonstration that these DQO requirements have been met. Appropriate implementation of the DQO process will require the design of data sources in a manner that individual data streams will meet the DQOs for specif-

ic decisions in MARSSIM decision-making, and in other program decision-making as well. The DQO process, therefore, acts as a gatekeeper to the MARSSIM process and allows MARSSIM to take ownership of its data and information inputs. Compliance with MARSSIM DQO requirements is necessary to ensure the integrity of the MARSSIM process and the creditability of its results. The incorporation of DQO requirements in the manual is another key element of the MARSSIM process that strengthens the justification for the release of sites. In many cases, compliance with MARSSIM DQO requirements is either not seriously considered or addressed after-the-fact. The purpose of this paper is to identify these requirements, provide insight on the importance of these requirements in addressing the handling of data and information, and to describe an appropriate approach to MARSSIM implementation that ensures that compliance with these requirements can be demonstrated.

**TAM2.4** Rutherford, P.; The Boeing Company; philip.d.rutherford@boeing.com

**Radiation Risk and Cleanup Standards**

Radiation cleanup standards have traditionally been expressed in terms of contamination levels (e.g. dpm/100 $cm^2$ for surface contamination or Bq/g (pCi/g) for soil contamination or dose limits, e.g., mSv/y (mrem/y). The Atomic Energy Commission (AEC), and later the Nuclear Regulatory Commission (NRC) and the Department of Energy (DOE) established these standards. These standards were promulgated in various regulatory and guidance documents including AEC Regulatory Guide 1.86, 10 CFR 20, and DOE Order 5400.5. The various state radiological control organizations also adopted the same standards. In the mid-1990s, the EPA also embraced the concept of radiation dose-based standards for soil, e.g., 40 CFR 196 (Draft), EPA 402-R-96-011A, OSWER 9200-4.18. Since then, however, the EPA has increasingly distanced itself from radiation dose-based standards and instead adopted radiation risk-based standards. These CERCLA risk goals were originally adopted for chemical cleanup at Superfund sites and were based on a range of 1-in-ten-thousand cancer risk to a 1-in-a-million cancer risk. Adoption of these goals for radiation cleanup by various parties in the EPA, e.g., FGR 13, OSWER No. 9355.01-83A, and by other stakeholders, has forced those in the nuclear industry to address the challenges of these new rules. These challenges include the technical feasibility of measuring down to these "low" risk levels, and the need to accept the "reality" of theoretical radiation risk at low doses. The recent "confirmation" of the linear-no-threshold model of radiation risk at low doses by the BEIR-VII committee has only added to these challenges. Examples of recent DOE cleanup programs at the Energy Technology Engineering Center are used to illustrate how the use of traditional dose-based radiation cleanup goals in the remediation planning process can readily achieve CERCLA risk goals in implementation.

**TAM2.5** Thatcher, A.; NEXTEP Environmental, Inc.; athatcher@nextep.cc

**Development of an Alternative Release Limit for a Former Uranium and Thorium Processing Plant in Cushing Oklahoma**

The purpose of this presentation will be to describe how, through dose modeling and analysis, a complex site was able to obtain an Alternative Release Limit (ARL) that adequately protected the environment, met regulatory approval, and saved money in the process. The Kerr-McGee Refinery Site in Cushing, OK supported an experimental facility that processed nuclear fuel materials from 1963 to 1966. Radiological contaminants at the site as a result of operations consist of natural thorium and isotopes of uranium (Th-228, Th-232, U-234, U-235 and U-238). Site contamination existed in both surface and sub-surface soils and within a shallow aquifer. After the soil was remediated to acceptable regulatory limits, however, the potential existed for residual groundwater contamination to result in exposure to individuals following site closure. Traditional exposure pathway analysis for the resident farmer seemed to indicate that this exposure was excessive. A closer look at the exposure pathways present in this rural location showed that groundwater contamination existed in a shallow aquifer insufficient to support significant irrigation activities and was of sufficiently poor water quality that it could not be used for drinking water. Through the determination of aquifer yield pumping tests, agreement from the Oklahoma Department of Environmental Quality, and sensitivity and uncertainty analysis using Monte Carlo techniques, it was shown that the average member of the critical population was adequately protected in the current site configuration without further remediation. This paper describes the analytical methods and models used to apply the general dose limit of 0.25 mSv/y (25 mrem/y) to the particulars of the Cushing Site, and demonstrates how these methods achieved a much higher ARL for total uranium in groundwater that was accepted by the regulators and achieved significant savings for the Licensee.

**TAM2.6** Anderson, K.; ECC; KAnderson@ecc.net

**Completion of De-Licensing Process for the West Jefferson North Facility**

Demonstrating compliance to decommissioning criteria is a multi-phased process involving extensive data gathering efforts and lengthy negotiations between regulators and property owners. ECC&E2 Closure Services, LLC, under contract to the U.S. Department of Energy has successfully demonstrated compliance to such criteria for the West Jefferson North (WJN) site near West Jefferson, Ohio. The Final Certification of Completion has been drafted and summarizes the performance and results of the final status surveys of the affected and unaffected areas of the WJN site as part of the completion of the Columbus Closure Project (CCP). Final status survey processes adhered to the requirements of the Radiological Characterization and Final Status Plan for Battelle Columbus

Laboratories Decommissioning Project, West Jefferson Site DD-97-02, Rev. 0, as reflecting the requirements of draft NUREG 5849. Surveys were performed throughout the decommissioning and remediation activities performed at the WJN and documented in Final Status Survey Reports (FSSR). Throughout the project, the CCP activity engaged the oversight of the U.S. Department of Energy (DOE), the Battelle Memorial Institute (BMI), and the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE). The ESSAP fulfilled the Independent Verification Contractor (IVC) role for the CCP under contract to the Oak Ridge Office of DOE. The Nuclear Regulatory Commission (NRC) also performed independent review of the in-process final status surveys. The FSSR, in conjunction with the IVC Letter Reports and the NRC inspection reports, document that the endpoint criteria objectives of the NRC-approved Decommissioning Plan have been met for WJN site as covered by the CCP.

**TAM2.7** Gawarecki, S., Mulvenon, N.; Oak Ridge Reservation Local Oversight Committee, Inc.; loc@icx.net

**Community Oversight of DOE D&D Activities at East Tennessee Technology Park, Oak Ridge, Tennessee**

The Oak Ridge Reservation Local Oversight Committee (LOC) oversees DOE environmental and related activities on behalf of eight local governments. DOE undertakes D&D under its Accelerated Cleanup Plan to allow reuse of facilities for industrial purposes or to demolish buildings too contaminated for beneficial reuse. In the latter case, D&D precedes CERCLA remediation of contaminated soil and groundwater. DOE's agreement with EPA allows decommissioning activities to be conducted as non-time-critical removal actions, consequently public input is limited. The LOC monitors D&D at East Tennessee Technology Park where the K-25 building case study demonstrates the challenges encountered at each phase. At project inception the LOC provides input on choice of method and secondary impacts such as waste management and historical preservation. During project execution, concerns include worker safety, non-worker exposures, fugitive emissions, emergency response, and adherence to regulations and plans. When DOE proposes a major change in approach, the LOC examines the rationale and potential consequences. The community is strongly interested in future uses of the site. Facilities to remain must be cleaned up to free-release industrial standards and utilities preserved to support local economic development goals. The LOC ensures that impacted communities have input into DOE D&D decisions throughout the process.

**TAM2.8** Roach, J., Kubilius, W., Roe, B., Lee, P., Jannik, G., Oliver, T.; Washington Savannah River Company, Savannah River National Laboratory; jesse.roach@srs.gov

**Sampling Depth of Decommissioned Concrete Slabs at the U. S. Department of Energy Savannah River Site**

In response to the request for accelerated cleanup at U.S. Department of Energy sites, the Savannah River Site (SRS) has initiated decommissioning through removal of facility structures, leaving concrete slabs and foundations in place. Many of the facilities at SRS have operated since the 1950s and contain residual chemical and radiological contamination. Sampling of the remaining concrete slabs as required for estimating the potential risk to the industrial worker can pose a significant cost in the decommissioning effort. Defining the depth of residual contamination deposited on the concrete surface is necessary to estimate source term and determine that contamination has not migrated to the soil. Existing industry protocols for soil sampling assume a six-inch contamination depth. Samples collected at SRS indicate that the typical contaminants of concern do not migrate beyond two inches in concrete. The sampling processes and analytical methods and results will be presented for several decommissioned facilities at SRS. The data indicate that limiting sampling to the first two inches of depth in concrete slabs is representative in most circumstances. The results provide a basis for the development of cost-effective sampling strategies supportive of the accelerated effort.

**TAM2.9** Johnson, R.; Radiation Safety Academy; rjohnson@radtrain.com

**How Clean Is Clean? How Fears Drive Cleanup Decisions**

While the cleanup of radioactive contamination would seem to be about the technology of risk assessments and radioactivity measurements, it is just as much a matter of fears. We have guidelines for assessing radiological risks outlined in MARRSIM. We have acceptance levels promulgated by the EPA and NRC. When these levels were undergoing debate at an interagency meeting, the author raised the concern that acceptance levels cannot be measured accurately and that the tendency was to strive for zero mrem/year. What drives the effort to go below already conservative acceptance levels by regulatory officials and the public? The answer could be about perceptions of risks, fears of radiation, and other fears. The public often demands zero radiation risks based on a fearful mindset created by over 100 years of media coverage on the terrible effects of radiation. For many people radiation and death are synonymous and the two words could be used interchangeably. The public and media are also reacting to predictions of the LNT hypothesis that indicate risks from radiation all the way down to zero dose. Unfortunately, there is no zero dose. Various populations around the U.S. and around the world may be exposed to natural radiation from 100 mrem/year to more than 100 mSv/y (10,000 mrem/year) without evidence of effects, and yet the public wants zero as the acceptable cleanup level. While public demands can be attributed to fears of radiation, what about the actions of regulatory officials? Many are also fearful of radiation, although many may also be afraid of the consequences of not protecting the public to levels that the public wants. Promulgating less conservative clean up levels could result in loss of public, political, and financial support, and even job security. Perhaps rather than continuing the debate on low-dose effects and striving for

zero cleanup levels, we should be telling people that it is in fact very difficult to harm someone with radiation!

**TPMA.1** LaVera, R., Mayer, D., Adler, J.; Entergy; roninny@optonline.net

**Ground Water Investigation at Indian Point Energy Center**

Small leaks from plant systems and components into the environment surrounding the facility can have dramatic effects on operating and decommissioning planning and funding. Dampness around a concrete shrinkage crack initiated a major investigation program at the Indian Point Energy Center to determine the source and extent of the leakage from a source estimated to be less than 7.6 liters (2 gallons) per day. Tens of millions dollars will be spent, even before decommissioning begins. Groundwater flow patterns were impacted by structures built after the initial studies were completed, resulting in the need for dozens of new wells on site to collect samples and perform tracer tests to determine new flow patterns and rates. Dose and health risks are negligible, but constant management attention has been required to address local, state, and federal concerns. This is now recognized as an industry-wide condition, resulting in changes to the NRC Inspection Manual criteria and NEI guidelines for future monitoring and control of leakage. EPRI has published one groundwater guideline document and is preparing another. Some plants with low activity releases have faced regulatory action by the NRC and state agencies as well as the filing of civil lawsuits. This presentation describes aspects of the groundwater contamination investigation program at the Indian Point Energy Center.

**TPMA.2** Rima, S., Smith, K.; MACTEC, Inc.; sdrima@mactec.com

**Challenges from D&D of a Room Contaminated with Extremely High Levels of Plutonium**

MACTEC was contracted to complete D&D of the Building 771/774 complex at the Rocky Flats site. Building 771 was determined by the DOE and the EPA to be "the most hazardous building in the DOE Complex" due to very high levels of plutonium and other isotopes. The project included demolition of Room 141, which was nicknamed the "Infinity Room" because the plutonium contamination levels could not be measured with any available instrument. After not being entered for several decades, airborne radioactivity levels upon initial entry were measured in excess of one million DAC (Derived Air Concentration) values. Contamination levels exceeded 16.7 MBq/100 $cm^2$ (1 billion dpm/100 $cm^2$); alpha and dose rates were measured up to 0.4 mSv/hr from Am-241 contamination. MACTEC was initially directed to use a demolition method consisting of erecting tents on top of the building, cutting the entire 4.57 m x 9.14 m (15 ft x 30 ft) room into small sections using manual cutting techniques and significant personnel resources, and removing the sections through the ceiling. MACTEC proposed an alternative methodology and a rationale involving encapsulating the wall and floor contamination and grouting the floor with six inches of new concrete, followed by cutting the room into sections to fit into waste containers. The cutting was done using a large diamond wire saw. The unique and successful approach to this difficult project is presented.

**TPMA.3** Harris, G.; Bechtel Jacobs Company LLC; dochar@bellsouth.net

**Safe Handling and Removal of Scrap, Shielded Carriers, and Drums with Unknown Contents at the ORNL 7841 Scrap Yard**

Facility 7841, Contaminated Equipment Storage Yard, commonly referred to as the 7841 Scrap Yard, contained 857 pieces of radioactive equipment collected over the past forty years at the Oak Ridge National Laboratory. The scope of work was to characterize, process, and dispose of contaminated equipment. Characterization data for the items contained within the storage area were limited. Initial characterization data consisted of Non-Destructive Assay (NDA) and passive neutron field measurements, neither of which would quantify beta emitters or most alpha emitters. The majority of shielded carriers and drums were closed to atmosphere, which presented additional radiological and industrial hygiene concerns. A graded approach, based on the associated unknowns and intrusive nature of tasks, was taken with each item to safely process equipment. The primary engineering controls consisted of high-efficiency particulate air (HEPA) filtered enclosures, portable containments, glove bags, localized HEPA filtration, cold tapping, liquid containment systems, shielding, and personal protective equipment (PPE). Administrative controls included daily DAC-h and dose tracking, continuous Radiological Control Technician (RCT) coverage, air analysis during all work activities, utilization of low dose waiting areas, and worker rotation.

**TPMA.4** McDonald, M., Lively, J.; MACTEC; mpmcdonald@mactec.com

**Implementation of Contamination Area Controls Based on Soil Radium 226 Activity Concentrations**

Title 10, Code of Federal Regulations, Part 835 (10 CFR 835) requires the implementation of radiological controls at DOE sites where surface contamination is above established levels. At a DOE decontamination and decommissioning site where soil radioactivity has been well characterized and is of significant concern, soil radioactivity is being used as a trigger to implement surface contamination control requirements. Derivation of the trigger level activity was determined by collecting soil samples from the site where various activity concentrations were identified, blending of soils to obtain a population of samples that were representative of the range of soil activity at the site, and analyzing the soil samples for Ra-226 by an accredited laboratory. Soils from the analyzed samples were then used to contaminate cloth material (test medium) and the material surveyed by hand-held instrumentation with instruments similar to those used for contamination surveys at the site. Contamination survey results of the cloth patches were

plotted against soil activity concentrations and a Ra-226 soil activity concentration was identified as the trigger level for implementation of surface contamination control requirements.

**TPMA.5** Lively, J.; MACTEC; jwlively@mactec.com
**Super-Heterogeneity: Discrete Radioactive Nuggets Distributed in the Soil Column**

In the late 1980s, while assessing the extent of radiological impacts from a FUSRAP site in New Jersey, elevated radiation levels were discovered at a nearby industrial site. Subsequent radiological assessment concluded that the radium radioactivity present at the site was unrelated to the thorium source term at the FUSRAP. Over the next several years, localized remediation events were undertaken in areas where surface gamma surveys revealed elevated gamma radiation levels. During one such remedial event, two stone-like nuggets emitting a strong gamma radiation signal were discovered in an excavation. The discovery of these nuggets prompted a re-evaluation of the available historical radiation survey and characterization data. After reviewing the data, it was hypothesized that what had previously been discounted as anomalous or spurious data might, in fact, indicate the presence of relatively high specific activity nuggets distributed in a relatively clean soil matrix. This paper describes the unique challenges of super-heterogeneity of the soil column and the approach being used to address the soil remediation standards and the potential presence of discrete nuggets containing Ra-226.

**WAM1A.1** Hermes, W., Terry, J.*; ORNL , ORNL; hermeswh@ornl.gov
**Removing The Source Term - Thorium Nitrate Disposal at NTS**

The combined efforts of several federal agencies resulted in the successful retirement of more than seven million pounds of thorium nitrate, a low-level radioactive source material, from three original sources contained in over 21,000 drums. Thorium nitrate was originally acquired during the period 1957 to 1964 by the Department of Energy (DOE) predecessor agency, the Atomic Energy Commission, and later turned over to the National Defense Stockpile. The thorium was acquired because of its potential use as a nuclear reactor fuel; however, a domestic commercial thorium-based fuel cycle application was not developed. Project cooperating agencies included DOE, Oak Ridge National Laboratory, National Nuclear Security Administration, Nuclear Regulatory Commission, and the Defense Logistics Agency/Defense National Stockpile Center (DNSC). Chemical conversion was avoided by special characterization testing, which saved tens of millions of dollars. The paper will present a general summary of the project steps and accomplishments and the execution of the thorium nitrate source term handling and removal from the DNSC depots (primarily Phase 3). At the onset of the project, the DNSC managed the thorium nitrate inventory at two of their depots: approximately five million pounds at Curtis Bay, Md., and another two million pounds at Hammond, Ind. The Phase 3 portion of the project culminated in eleven months of cross country shipments of three to four days duration to the Frenchman Flats area of the DOE site in the Nevada desert, a remote facility slightly larger than the State of Rhode Island, where the containers were placed in specially designated pits and buried under 6.4 m (21 feet) of top cover. Emphasis will be placed on how radiological requirements were defined, met, and optimized during this project.

**WAM1A.2** Chapman, J., Boerner, A., Buchholz, M.; ORAU; chapmanj@orau.gov
**RESRAD and RESRAD-BUILD Modeling to Develop Site-Specific DCGLs**

The Curtis Bay Depot located in Curtis Bay, Maryland, is terminating its source material license issued by the U.S. Nuclear Regulatory Commission (NRC). The NRC license allowed for the storage of naturally-occurring radioactive materials primarily comprised of thorium nitrate and secondarily, of uranium. As a step in the license termination process, Derived Concentration Guideline Levels (DCGLs) were determined to provide clean-up levels that satisfy regulatory requirements. This paper presents the methodologies that were used for calculating site-specific thorium and uranium DCGLs, which were then used for development of the site survey plan for license termination. Radionuclide migration and transport parameters were selected for input into two separate computer models: RESRAD and RESRAD-BUILD. Proposed DCGLs for Th-232 are on the order of 110 Bq/kg (3 pCi/g) and 0.07 Bq/100cm$^2$ (400 dpm/100cm$^2$); and for U-238, on the order of 75 Bq/kg (2 pCi/g) and 0.13 Bq/cm$^2$ (800 dpm/100cm$^2$). These DCGLs account for the dose contribution from decay products in equilibrium.

**WAM1A.3** Baldwin, M., Underwood, W.; Oak Ridge National Laboratory; baldwinme@ornl.gov
**Managing the Myriad of Safety Hazards during D&D**

Radiological surveys were conducted in support of D&D of the Curtis Bay Depot, Curtis Bay, Maryland following removal of a stockpile of thorium nitrate. Execution of the radiological surveys presented a variety of safety challenges requiring careful identification, evaluation, and control. There were two dozen buildings just short of collapse, and field areas potentially containing munitions and explosives of concern at this nearly 500-acre former ordnance depot. Environmental hazards such as rough terrain, wildlife, ticks, poison ivy, and hot outdoor temperatures also added complexity to the task. This paper highlights the myriad of safety challenges and solutions encountered during the course of this project.

**WAM1A.4** Vitkus, T., Bailey, E.; Oak Ridge Associated Universities; vitkust@orau.gov
**Advantages and Lessons Learned using GPS-Enabled Gamma Scanning for the Characterization Survey of a Large Thorium/Uranium Site**

Radiological scoping and characterization survey investigations of a large facility were conducted in order to support

the scheduled termination of the sites U.S. Nuclear Regulatory Commission source material license. The facility stored strategic materials from the late 1950s until recently that included source material consisting of primarily thorium nitrate and lesser quantities of thorium-containing monazite sands. The site consists of 48 storage warehouses and 2 support buildings on 483 acres. Gamma radiation scoping surveys using standard equipment were performed judgmentally over the site land area to provide inputs to the characterization survey planning. The large land area, coupled with logistical issues and future site data documentation requirements, provided the impetus for ensuring position and gamma radiation data were captured and documented during the site characterization. The data quality objectives, procedures, scanning minimum detectable concentrations, process evaluations, and resulting procedural modifications and lessons learned while using this technology will be described.

**WAM1A.5** Abelquist, E., Roberts, S.; ORAU; eric.abelquist@orau.org

**MARSSIM Final Status Survey Design for a Thorium And Uranium Contaminated Site**

The MultiAgency Radiation Survey and Site Assessment Manual (MARSSIM), initially published in December 1997, has been used for designing final status surveys at many D&D sites. The final status survey design is challenging when (1) multiple contaminants are present, (2) both contaminants occur in background, and (3) the derived concentration guideline level (DCGL) for each contaminant is low, i.e., relatively close to background levels. Now consider that the background concentration for each contaminant is highly variable. This paper describes two possible strategies that were considered for the final status survey design of a parcel of land contaminated with thorium and uranium. Scenario A is the standard MARSSIM design that is based on the null hypothesis that the residual radioactivity in the survey unit exceeds the release criterion. Scenario B refers to the alternative design where the null hypothesis is stated as the measurements in the survey unit are indistinguishable from those in the background reference area. Following a thorough site characterization of the land area, the data were used to design final status surveys under both scenarios. The results of both survey designs are discussed.

**WAM1B.1** Geiger, R.; Bechtel Jacobs Company LLC; qgr@bechteljacobs.org

**Grouting Liquid Low Level Waste (LLLW) Disposal Trenches at ORNL**

Trenches 5 and 7 were constructed in the early 1960s and received approximately 2.2 x 104 TBq of liquid low level waste (LLLW) from the Oak Ridge National Laboratory (ORNL). The trenches are located in the Seepage Pits and Trenches Area between Solid Waste Storage Area (SWSA) 5 and SWSA 6 southwest of the ORNL campus. Using a combination of cementitious and polyacrylamide grouting techniques, in situ grouting was performed to stabilize the wastes and prevent their migration from the trenches. Collective dose estimates were anticipated to be 8.38 mSv for all phases of the project and the ALARA goal was set at 6.85 mSv. As the project progressed, it became evident that contamination control was to be more of a challenge than reduction of dose. Consequently, the work process was controlled and modified, as necessary, to reduce or eliminate contamination of workers and the work area. The use of glove bags was one primary contamination reduction method employed by workers.

**WAM1B.2** Hertel, N., Blaylock, D., Burgett, E.; Georgia Institute of Technology; nolan.hertel@me.gatech.edu

**Activation Study of the SGHWR in Support of its Decommissioning**

The Winfrith Steam Generating Heavy Water Reactor (SGHWR) was a 100-MW(e), single-cycle, pressure-tube reactor. The light-water coolant passed through pressure tubes in which the fuel assemblies were suspended. These pressure tubes were passed through larger tubes in a calandria containing the heavy-water moderator. The reactor was commissioned in 1968 and operated at 60-65% utilization until it was closed in 1990. It is scheduled for decommissioning between 2008 and 2012. In order to support the ongoing waste classification and quantification, a neutron activation study of the components within, and including, the calandria as well as the primary system shielding surrounding the reactor was undertaken and is presented in this talk. The study employed a three-dimensional model of the SGHWR. A detailed MCNP5 simulation of the operating reactor was performed to determine the energy- and spatially-dependent fluxes in the system. The fluxes computed with this model were then used with EASY-2003 (European Activation System) to determine the activation product concentrations (Bq/kg) present in the reactor for two dates, January 2006 and January 2009. (This work was performed by the authors as private consultants to MWH, Inc. under a contract from the UKAEA.)

**WAM1B.3** Crawford, J., Lewis, G.; University of Missouri; crawfordw@missouri.edu

**Irradiator Decommissioning Project by the University of Missouri-Columbias Radiation Safety Office**

In May 2006, the University of MissouriColumbias Radiation Safety Office of EHS, completed the decommissioning, moving, and shipping of a J.L. Shepherd s/n 001, GR-12, Co-60 Irradiator. This unit contained radioactive sources that met the NRC Increased Control NRC Order EA-05-90, Isotopes of Concern. The University of Missouri elected to have the sources that met the quantities of concern criteria shipped off campus. This decision was made for the safety of students, staff, and faculty. Additionally, continued storage of the eight sources within the GR-12 Irradiator would have resulted in the University incurring thousands of dollars in costs and man-hours for increased security and continued observation and control. This project involved the coordinated and collaborative efforts of several departments. The planning, flexibility, and coordination on the part of these departments

and groups allowed this project to proceed to conclusion without incident. This project was completed with no lost time accidents, no injuries, no unnecessary exposures, and most notably, with no loss of control or security risk of the sources being used malevolently.

**WAM1B.4** Simon, S.; National Institutes of Health; ssimon@mail.nih.gov

**Near-Simultaneous Monitoring and Remediation of a Tropical Island Contaminated with Plutonium**

Johnston Island, located in the North Pacific Ocean, was contaminated with plutonium in 1962 by an explosive abort of a test missile carrying a nuclear warhead. Today, the island of about 600 acres is used by the U.S. military but is also a national wildlife refuge. A remediation program was carried out in 2000 with support of the Department of Defense. One goal was to locate and remove hot particles near the ground surface that were individually in excess of 5,000 Bq total transuranic (TRU) activity. Design criteria for the environmental radiological survey called for 95% reliability in locating and removing those particles on 300 unpaved acres of the island within nine months. Hot particles of 5,000 Bq TRU contain only about 900 Bq of Am-241, presenting stringent detection requirements for rapid in-situ measurements. A two-step process was implemented using two identical detector systems developed for this project. Each system was a 12-detector linear array of 5 inch diameter FIDLER detectors that was pulled slowly by a tractor. Each array was oriented perpendicular to the direction of travel and would acquire GPS and count-rate data with a 1-second integration time. A pressurized paint system marked the ground at the location of every reading that indicated the likelihood of a particle in excess of the activity limit. The second step, carried out soon after the ground surface scan, verified the activity at each marked location with a longer manual measurement and if necessary, the hot particle was remediated by removing it and a small amount of soil surrounding it. To ensure a 95% detection reliability, a high ratio of false- to true-positives from the surface scan was tolerated, the overall ratio being about 80 to 1. Over 1,000 hot particles, with a median activity of 25,000 Bq, were located and remediated with insignificant environmental disturbance. Detection limits-derived as a function of detector height, background count-rate, and speedwill be discussed.

**WAM1B.5** Haywood, F., Sherrod, T., Coe, R., Goldsmith, W., Chapman, J.; URS Group, Inc., Strata-G, LLC, Oak Ridge Associated Universities; fhaywood@esper.com

**Remedial Action on the Surface Impoundments Operable Unit at the Oak Ridge National Laboratory, Oak Ridge, Tennessee**

This paper discusses the remediation of two wastewater impoundments (ponds) at the Oak Ridge National Laboratory (ORNL), identified as Surface Impoundments Operable Units A and B. The treatment of pond wastes and pond closure was authorized by a Record of Decision signed in September 1997 by representatives of the U.S. Department of Energy (DOE), the Tennessee Department of Environment and Conservation, and the U.S. Environmental Protection Agency, Region 4. An initial Waste Form Analysis project described the distribution of chemical and radioactive constituents in the waste. An analysis of specific radionuclides was used to prepare project safety documentation and to establish a relationship between principal gamma-ray emitters and other radionuclides. Impoundment sediments were removed from the ponds using a suction device and transferred in batches to settling tanks. Following settling and dewatering, the slurry was mixed with Portland cement to form a 6,800 kg (15,000 lb) solidified matrix in a Lift Liner container. Representative samples of slurry were transferred to an on-site lab and analyzed for Am-241 and Cs-137 using a high-resolution gamma-ray spectrometry analyzer. Data from these analyses were essential to estimating the quantity of individual radionuclides in each waste matrix and provided information used to complete the shipping manifests. A total of 984 solidified waste matrices were generated. Each matrix met waste acceptance criteria at two disposal sites used. Most of the matrices (876) were shipped to DOEs Environmental Management Waste Management Facility (EMWMF) in Oak Ridge. The remaining 108 were shipped to Envirocare of Utah, LLC. Once treatment and disposal was complete, the ponds were backfilled with rock and grout, covered with topsoil and prepared for other uses. The waste treatment plant was disassembled; individual items were surveyed for surface contamination, packaged in roll-off containers, and shipped to EMWMF.

**WAM1B.6** Simonsen, R.; Rodney.Simonsen@exelon corp.com

**Test Cell a Facility Decontamination and Decommissioning Project: Controlled Explosive Demolition of Neutron-activated Shield Wall**

Located in Area 25 of the Nevada Test Site, the Test Cell A Facility was used in the 1960s for testing nuclear rocket engines as part of the Nuclear Rocket Development Program. The facility was decontaminated and decommissioned in 2005 using the Streamlined Approach For Environmental Restoration (SAFER) process, under the Federal Facilities Agreement and Consent Order (FFACO). Utilities were verified void of contents and de-energized, hazardous materials were removed, surface radioactive contamination was decontaminated, large sections mechanically demolished, and the remaining thick reinforced neutron-activated concrete shield wall demolished using open-air controlled explosive demolition (CED). CED of the shield wall was closely monitored with actual radiological conditions controlled within planned/modeled conditions.

**WAM2A.1** Ankrah, M., Spaulding, R., Farfan, E., Ozcan, I., Smith, M.; Idaho State University - Idaho Accelerator Center; maxankrah@yahoo.com

**A Low-Cost Radiography System for Non-Intrusive Cargo Container Inspection**

One application of active, non-intrusive inspection technology that has been used for over a century is radiographic imaging. The need to enhance this technology has been accentuated following the September 11, 2001 events in the United States. With a few hundred ports of entry and about 10 million cargo containers being shipped into the United States annually, it has become necessary to inspect these containers efficiently and successfully if we are to detect weapons of mass destruction (WMD, consisting of radioactive, nuclear, explosive, and/or biological components) within different shielding configurations in cargo containers. The Idaho Acceleration Center (IAC) at Idaho State University has constructed a prototype high-density-object detection system to identify nuclear materials in cargo containers using off-the-shelf Geiger Muller tubes. This study characterizes the performance of this system. The project outcomes will lead to the exploration and analyses of other possible low-cost systems such as solid-state detectors and plastic scintillators for the purpose of determining which system provides the best balance of cost and performance.

**WAM2A.2** Ozcan, I., Ankrah, M., Farfan, E., Spaulding, R., Smith, M.; Idaho State University - Idaho Accelerator Center; ozcanibrahim@yahoo.com

**Dose Characterization for Active, Non-Intrusive Inspection System using an Electron Accelerator**

After the terrorist events of September 11, 2001, border security has become one of the most important issues in national security due to the large number of cargo containers entering the country. Screening of all cargo containers for nuclear materials should be performed during border inspections. The technical aspects of inspecting cargo containers using electron accelerators have been studied previously. However, the radiological protection aspects have not been fully considered. The screening process may accidentally harm operators, workers, and bystanders. It might also injure stowaways hiding inside the containers. In this research project, external doses were determined at various locations near the inspection system. The doses were measured inside the container, in the control room, at different positions around the imaging system, and behind the shielding wall to consider skyshine and buildup effects. A 12-MeV linear accelerator (LINAC) was used in the experiment. The relationship between the various locations and doses were determined in this research. Dose values were compared to NCRP standards for maximum allowed exposures.

**WAM2A.3** Zakir, N., Burgett, E., Hertel, N., Blaylock, D.; Georgia Institute of Technology, Neely Nuclear Research Center; nazia.zakir@ors.gatech.edu

**Management and Disposal of Co-60 Sources from Neely Nuclear Research Center**

The packaging and shipment of approximately 60,000 Ci of Co-60 sources from the Hot Cell Facility at the Neely Nuclear Research Center at the Georgia Institute of Technology presented some interesting challenges for the Office of Radiological Safety. From a management viewpoint, issues to be resolved included ownership of the sources, under whose license the loading of the liners and shipment would occur, transfer of ownership of sources, and the agreement letter with the state regulatory agency. The Nevada Test Site agreed to bury the sources; their requirements for exposure rates on the outside of the liner and a water-free liner had to be met. Time constraints such as a busy Institute schedule, manufacturing of the liners, availability of the cask, and upper management project deadlines made for a very tight schedule to package and transport three shipments of sources. From the operational health physics side, MCNP modeling of a raised loaded liner was completed to generate exposure rates to personnel and the general public. The Neely Nuclear Research Center is located in the middle of a busy campus and exposure rates from the loaded liner extended onto a main road. Dry runs of the loading of the liners and transfer of the cask were completed and identified a few problems that had to be quickly remedied. The Georgia Tech police were trained on the project and blocked roads and provided security during the operation. Successful completion of the project required cooperation and coordination between several DOE entities, Duratek, the Institute's project manager, State of Georgia DNR, and the staffs of the NNRC and the Office of Radiological Safety.

**WAM2A.5** Cardarelli II, J., Hudson, S.; EPA; cardarelli.john@epa.gov

**The EPA National Decontamination Team**

The Environmental Protection Agency (EPA) National Decontamination Team (NDT) is a new federal resource of highly skilled and trained professional staff including scientific experts in health physics, industrial hygiene, toxicology, environmental engineering, bio- and analytical chemistry, emergency medicine, and structural and industrial engineering. Its mission is to provide technical and scientific support on issues surrounding the decontamination of buildings, building contents (including evidence), public infrastructure (including waste/drinking water plants, chemical plants, power plants, subways, etc.), indoor environments, and the associated environmental media (air, soil, and water), in the aftermath of an incident of national significance. The NDT provides this support to EPA on-scene coordinators, EPA regions, and other non-EPA special response teams as well as state and local governments in any incident involving chemical, biological, or radiological contamination. It may respond internationally in a technical support role. The history of the team, its response

assets, and recent training activities are described along with examples of its responses for hurricane relief and anthrax threats.

**WAM2B.1** Bramlitt, E.; New Mexico Commission for the Blind; ebramlitt@msn.com

**Clean by Poisson Distribution**

A critical D&D task is radiation measurements to confirm property is clean. The task is exacting because clean counts are defined at levels near background counts, and there are random fluctuations with all counts. Statistical methods are necessary to decide when a count should be designated as due to non-background, and for stating the minimum source large enough to be detected with a specified probability. The paradigm statistical method uses a mean background count and Gaussian distributions to give a decision level count and detection limit mean count for 5 percent alpha and beta error percentiles. The Gaussian function is continuous, so the decision level is a rational number whereas real counts are natural (whole) numbers. The integration for percentile probability is from a rational number count, and that can make the percentile fictitious. A personal computer spreadsheet has been developed to give limits based on Poisson distributions for mean background up to 566 counts, and Gaussian distributions for larger means, but with counts constrained to whole numbers. The user enters a mean background and any desired value for alpha and beta. The spreadsheet gives a realistic decision level count and an allowed alpha that is usually less than the desired alpha. (For example, if 5% alpha is desired perhaps only 3.3% alpha is allowed, and actual false positives will be 1 in 30 rather than 1 in 20.) It gives the allowed bounds for mean +/- sigma and the probability for a count not exceeding those bounds. It accepts background as a count rate, defines a maximum false positive count, plots the count distributions employed, and permits assigning a detection limit. The latter feature is for D&D with an activity acceptable as clean. Examples demonstrate clean by Poisson versus Gaussian distributions. The spreadsheet equations and layout are explained, and a spreadsheet file is made available for presentation attendees.

**WAM2B.2** Bronson, F.; Canberra Industries; fbronson@canberra.com

**Measurement Uncertainty for InSitu Assay of Containers and for Sampling and Laboratory Assay**

During a D&D or ER process, containers of radioactive waste are normally generated. The activity can commonly be determined by gamma spectroscopy, but frequently the contents are not homogeneous. What is the best method to accurately assay these containers: sampling followed by laboratory analysis, or in-situ spectroscopy? To help answer this question, Canberra has developed a tool called ISOCS Uncertainty Estimator [IUE]. With in-situ spectroscopy, the major contribution to the uncertainty is the non-uniform distribution of the radioactivity. The IUE allows this component of the uncertainty to be computed. Among other things in the IUE software, the user can define what percent of the activity is uniformly distributed and what percent is in localized hot spots, as well as the size and number of the hotspots. All variables are sampled randomly, according to the user-defined distribution function, and the results are used to compute the efficiency calibration. The difference between this non-uniform distribution and the reference uniform calibration is computed for a large number of containers. This same software can also simulate the extraction of a sample from the container with the non-uniform radioactivity. The user defines how many individual samples are taken from each container and the size of the sample. The program assumes that the user will combine the individual samples from each container for a composite laboratory analysis, and computes the laboratory sample concentration. The difference between the laboratory sample concentration and the actual container concentration is the sampling error, and is computed for a large number of containers. Several representative containers will be evaluated to compare the in-situ uncertainty compared to the sampling uncertainty. Which will win? I dont know yet. Wait until November when the papers are due to find out.

**WAM2B.3** Shonka, J.; Shonka Research Associates; jjshonka@shonka.com

**Rigorous Application of Signal Detection Theory to Field Measurements**

Field measurements remain the last area in health physics that is not subject to routine performance testing. Unlike many areas such as dosimetry, environmental, and effluent measurements, field measurements are not subject to independent testing, although a partial test may be accomplished by a verification process. One reason that testing has not been required is the difficulty of measuring performance under realistic field conditions. The difficulty is compounded by the legacy attempts to quantify human performance using simple threshold methods such as the Currie criteria, with assumptions of constant human performance. Improper application of the Currie criteria for a threshold is shown. As the use of automated instrumentation increases, a trend to justify field measurement data to partially offset or reduce sampling with subsequent lab analysis has occurred. This paper presents a full implementation of Signal Detection Theory to field measurements. This method includes: (1) a method to establish background from the data and determine acceptable values of its magnitude and variability, (2) a means to threshold data, including combined use of a normalcy test along with an outlier test to fully bound data at a known confidence level, (3) a means to interpret the threshold in terms of what levels and with what frequency non-background conditions would be found, (4) a means to interpret the source geometry of regulatory interest using the detector response as a method to establish the modulation transfer function of the data, (5) the method for establishing receiver operating characteristics, and (6) use of the method to establish the power curve for the survey method. Use of the method to establish the power curve

for a survey is shown, along with examples from actual surveys. If position information is not recorded or used, the new method for threshold and background determination can be used to establish detection for data that is not spatially correlated.

**WAM2B.4** Landsman, S.; Fluor Hanford; Steven_D_Landsman@rl.gov

**Method for Establishing Contamination Controls for Radiologically Contaminated Soils**

Soils present significant challenges for determining the presence of radiological contamination due to inherent self shielding properties of the granular solids present in the soil matrix. This makes implementation of regulatory monitoring requirements difficult in areas with contaminated soils. Once the isotopic distribution of contaminates in the soil is determined, gamma emitters in the matrix can be useful in gauging the magnitude of contamination present through use of gamma instruments such as sodium iodide detectors. It is difficult, however, to compare the results of such measurements to established posting and release values, which are provided in units of activity per unit area. To ensure compliance with regulatory requirements, a study was performed on radiologically contaminated soils typical of Hanford waste sites to determine the relationship between observed gamma measurements and activity per unit area measurements. The study provided data useful in determining the likelihood that radioactive contamination above posting and release values could be transferred from soil surfaces to surrounding areas, items, or individuals through contact or transport of soil from the work areas.

**WAM2B.5** Gostic, R., Gostic, J., Bias, C.*, Czerwinski, K., Caputo, D.; University of Nevada Las Vegas, Cabrera Services, Inc.; biasc2@unlv.nevada.edu

**Fractional Sorption of Plutonium and Americium in Soil from a Particulate Source**

Understanding the behavior of plutonium and americium in the environment is usually limited to laboratory experiments carried out over relatively short time scales. The study of particulate weapons-grade plutonium exposed to environmental conditions provides an opportunity to evaluate plutonium and americium and compare them against models and laboratory experiments. Soil cores obtained from McGuire Air Force Base in New Jersey containing diffuse or homogenously distributed plutonium particulates exposed to environmental conditions for over forty years were analyzed. The vertical profile of plutonium contamination in each of the cores was determined indirectly via gamma spectroscopy of Am-241, the daughter of Pu-241. Discrete plutonium particles were isolated and particle size distributions were obtained. The plutonium particles were characterized by optical microscopy and scanning electron microscopy. Plutonium hot particles were removed from the soil samples, and the soil in the vicinity of the hot particle was analyzed utilizing the NIST standard sequential extraction method. By this technique and a combination of gamma spectroscopy and liquid scintillation counting, relative plutonium and americium distributions in the soil could be determined for water soluble, carbonate, iron/manganese oxides, organic and acid soluble fractions. The results of these studies indicate that after long term environmental exposure the bulk of plutonium remains in the particulate form. Plutonium that is solublized into the surrounding soil is trapped by the organic and carbonate fractions, while americium is more evenly distributed throughout the fractions. The goal of this work is to couple field scale environmental data to laboratory models to facilitate improved modeling of plutonium and americium behavior in the environment.

**WAM2B.6** Lombardo, A., Shonka, J., Scott, L., Orthen, R.; CEC, Inc., SRA, Inc., LRA; alombardo@cecinc.com

**Soil Segregation Technology: Reducing Uncertainty and Increasing Efficiency during Radiological Decommissioning: a Case Study**

During a recent decommissioning project of a site contaminated with thorium, a unique approach to dose modeling and remedial action design was implemented to effectively manage end-point uncertainty. Implementation of a remediation plan and subsequent final surveys to show compliance with conservative criteria often result in excessive remediation due to the large uncertainty. The approach used a dynamic feedback dose model and soil segregation technology to characterize impacted material with precision and accuracy not possible with static control approaches. Utilizing the remedial action goal over excavation and subsequent auto-segregation of excavated material for refill, the end-state (as-left conditions of the refilled excavation) RESRAD input parameters were re-entered to assess the final dose. The segregation process produced separate below- and above-criteria material stockpiles whose volumes were optimized for maximum refill and minimum waste. The below-criteria material was returned to the excavation without further analysis, while the above-criteria material was packaged for offsite disposal. Using the activity concentration data recorded by the segregation system and the as-left configuration of the refilled excavation, the end state model of the site was prepared with substantially reduced uncertainty. The major projected benefits of this approach are reviewed as well as the performance of the segregation system and lessons learned including: (1) total, first-attempt data discovery brought about by simultaneously conducted characterization and final status surveys, (2) lowered project costs stemming from efficient analysis and abstraction of impacted material and reduced offsite waste disposal volume, (3) lowered project costs due to increased remediation/construction efficiency and decreased survey and radioanalytical expenses, and (4) improving the decommissioning experience with new regulatory guidance.

**WPM1.1** Powers, G.; USNRC; gep@nrc.gov

**NRC Research Program Related to Subsurface Contamination Evaluation and Operational Environmental Monitoring Programs**

NRC-sponsored survey design and analytical approaches are under development for volumetric assessments and projected long-term environmental sampling plans. NRC regulations require a routine measurement of radioactive materials in effluent streams and the environment surrounding nuclear facilities during normal operations. The emphasis of the presentation will focus on the evolution of the Multi-Agency Radiation Survey & Site Investigation Manual (MARSSIM) and the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP) toward Geostatistical and Bayesian approaches to surficial and, in particular, volumetric contamination characterization and analysis. This information will be useful to the NRC in developing realistic guidance for implementations requiring subsurface or volumetric knowledge during decommissioning or facility siting issues. Development of licensee and regulatory sampling optimization is being carried out with Spatial Analysis and Decision Assistance (SADA), a freeware environmental software package developed by The Institute for Environmental Modeling at the University of Tennessee and has been sponsored jointly by the NRC, EPA, and DOE. The software is engineered toward environmental cleanup and preoperational activities and assists users with characterizing risk, areas of concern, sample designs, and the ability to permit rapid field analysis utilizing Bayesian-type analytical techniques. NRCs implementation of SADA utilizes automated surveying designs and analytical tools to enhance the demonstration of compliance with criteria for volumetric contaminants and to test and evaluate alternative survey designs. Distributions and total contaminant inventories are sometimes required to assist in determining risk and/or compliance. The inclusion and covariance evaluation of nonradiological information, not previously readily encouraged, can now be included in determining compliance.

**WPM1.2** Stewart, R.; University of Tennessee; stewart@utk.edu

**SADA: a Freeware Decision Support Tool Integrating GIS, Sample Design, Spatial Modeling, and Radiological Assessment**

Spatial Analysis and Decision Assistance (SADA) is a Windows® freeware program that incorporates tools from environmental assessment into an effective problem-solving environment. SADA was developed by the Institute for Environmental Modeling at the University of Tennessee and includes integrated modules for GIS, visualization, geospatial analysis, statistical analysis, MARSSIM analysis, human health and ecological risk assessment, cost/benefit analysis, sampling design, and decision support. SADA began in the middle-1990s as a simple tool for integrating human health risk with spatial modeling tools. Since then, SADA has continued as an evolving freeware product targeted to individuals needing the integration or expansion of existing models into a spatial context. Because of the varied user base, SADA was engineered with an open and highly scaleable environment that in most cases allows additional functionality without an apparent increase in complexity. As a result, applications of SADA have extended into other disciplines that place strong emphasis on the spatial distribution of data. We present such recent developments in SADA that may further support radiological characterization, particularly in the soil. These include methods for the incorporation of soft data and include Markov Bayes analysis as well as the Bayesian Maximum Entropy approach. In this paper, we also provide an overview of the central functions of SADA and a brief discussion of how these can be applied to radiologically contaminated sites.

**WPM1.3** Gogolak, C., Stewart, R.; Consultant, University of Tennessee; carl@gogolak.org

**Using SADA for MARSSIM Surveys**

SADA version 4 includes a Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) module. MARSSIM implements a nonparametric statistical methodology for the design and analysis of final status decommissioning surveys for the Nuclear Regulatory Commission. Nonparametric statistical methods for testing compliance with decommissioning criteria are provided for the case where radionuclides of concern are in background and also for when they are not in background. The tests implemented are the Sign Test and the Wilcoxon Rank Sum Test. The tests are performed in conjunction with an Elevated Measurement Comparison to provide confidence that the radiological criteria specified for license termination are met. Principles and methods from the Data Quality Objectives process are used for the planning of final site surveys. Methods for determining the number of samples for obtaining statistically valid comparisons with the cleanup criteria and the methods for conducting the statistical tests with the collected data are included. A fairly focused approach is used in SADA for MARSSIM. This module was created under the close guidance of the NRC. A detailed example of the use of the MARSSIM module in SADA will be shown.

**WPM1.4** Dolislager, F.; The University of Tennessee; fdolislager@utk.edu

**Use of SADA Software at David Witherspoon Inc. 901 Site**

Spatial Analysis and Decision Assistance (SADA) software was used as the primary risk assessment/spatial assessment tool at the ten-acre David Witherspoon Inc. 901 Maryville Pike Site (DWI 901 Site) in Knoxville, TN. DWI began operation in 1948 in the scrap metal business. Operations at the DWI 901 Site consisted of receiving, processing, storing, and shipping scrap metal, including radiologically and chemically contaminated metal. Operations at the site resulted in widespread radionuclide and other hazardous substances contamination. Beginning in the early 1960s, the Atomic Energy Commission and/or the state of Tennessee licensed DWI to possess and process certain radiological mate-

rial at the DWI 901 Site. Alleged failures to comply with its license and other environmental regulations at the site resulted in a number of administrative and judicial actions to be instituted by the state against owner(s) and operator(s) of the DWI 901 Site. DWI was enjoined from further operations at the site by a 1993 court order. Contamination has been found in soil, sediment, surface water, and groundwater. SADA was used to evaluate sampling routines, model contaminant spatial correlation, perform risk assessments, model risk results, produce area of concern maps, determine removal volumes, and set removal levels of primary contaminants.

**WPM1.5** Christakos, G.; San Diego State University; gchrista@mail.sdsu.edu

**BME Methodology in SADA: Theoretical Framework and Application at Chernobyl**

The BME methodology of interdisciplinary knowledge synthesis and spatiotemporal mapping is being integrated into the SADA framework. We discuss the main theoretical and conceptual elements of BME and outline its application in the case of the Chernobyl fallout in Ukraine (former Soviet Union). The BME mathematics account rigorously for the uncertainty features of the underlying natural system and impose no restriction on the shape of the probability distributions or the form of the predictors (non-Gaussian distributions, multiple-point statistics, and non-linear models are automatically incorporated). BME expresses space-time dependencies and heterogeneous distributions using a multitude of ordinary and generalized covariance models; synthesizes core knowledge bases and various uncertainty sources; and generates a meaningful picture of reality in terms of physical and health attribute maps and the associate risks. The vast territories radioactively contaminated during the 1986 Chernobyl accident provide a substantial dataset of radioactive monitoring data to be used for verification and testing of health risk assessment methods. Furthermore, using this dataset was motivated by its geographical structure (large-scale correlations, short-scale variability, spotty features etc.). BME estimated the extent and magnitude of the radioactive soil contamination by combining exact measurements with secondary local information to assess the uncertainty of soil contamination predictions. BME performed well in terms of both prediction accuracy and adequately reproducing the distribution of the raw repeated measurements available in populated sites.

**WPM1.6** McGehee, J., Story, H., McGee, D.; AREVA NP Inc.; john.mcgehee@areva.com

**Computer Based Tools for Decommissioning Characterization and Final Status Survey**

Several computer based programs have been developed since regulatory agency adoption of the MARSSIM to demonstrate a facility/site is suitable to release for unrestricted use. The programs provide assistance to users during front-end survey planning and back-end reporting process steps including: drawing tools for visualization of survey area spatial boundaries; determining number and location of survey measurements; providing basis documentation for survey design; allowing uploading of measurement results for display on drawings; and creating reports to assist with data evaluation and statistical analysis. With training, the programs are user friendly, perform their purpose well, add credibility to survey results, and are available to users without charge except for training expenses. This paper describes these programs and their application in the survey process. MARSSIM process operational aspects that include data management requirements for long term and/or large decommissioning projects are also discussed. Requirements indicate that an integrated survey data management system, which will work in concert with the specific use programs, is needed to assist with process steps.

**WPM1.7** Darois, E., Tarzia, J., Hollenbeck, P.*; RSCS, Inc.; eldarois@radsafety.com

**A Comprehensive Computer Application for Managing Sample Planning and Analytical Laboratory Data in Support of Decommissioning and Site Clean-Up**

An Analytical Data Management System (ADMS) has been developed to manage analytical laboratory data collected from environmental samples, soils, surface water, groundwater and other media. This system can manage sampling schedules and provide sample status management reports. After the input of sample collection and shipment information, ADMS allows for laboratory data to be imported automatically from electronic files. These files can be in a variety of formats, including, but not limited to, delimited ASCII files. This system performs a variety of quality checks on the imported data including checks of the inventory of results, the achieved MDCs, surrogate radionuclide names, and duplicate and spike sample analysis. Once the data is accepted and reviewed, various statistical analysis and trend reports can be readily generated for any radionuclide for which analysis results are available. This system has been deployed at two nuclear power plants for managing groundwater information and is available for use with three types of databases. This presentation will demonstrate the capabilities of ADMS as an efficient way to save time, reduce costs, and ensure quality data assessments when managing and analyzing large volumes of analytical sample data.

**WPM1.8** Anderson, B.; NEXTEP; banderson@nextep.cc

**Application of Integrated Database Systems to Decommissioning of Indoor Survey Units under MARSSIM**

The advent of MARSSIM has had the effect of transferring a substantial amount of work from field workers taking measurements to analysts who evaluate the data by reducing the amount of measurements needed in the field and increasing the complexity of the survey design process and evaluation of the results. The use of database systems to automate some of these tasks has the potential for significantly increasing productivity for both characterization and final status surveys. This paper outlines how design of the database, standardiza-

tion of the coordinate system, and development of ancillary software scripts can release much of that potential. Although the methods presented can be adapted to either indoor building surveys or outdoor surveys, this paper will limit discussion to the former. A system for identifying the location of a survey measurement in or on a building surface or piece of fixed apparatus anywhere on a given site is presented. Design of a database around such a system is presented, showing how it can be used to create and classify MARSSIM-compliant survey units, plan surveys, record survey measurements, and evaluate and plot the data rapidly using GIS software. Quality controls that can be implemented within the database collection system are also described. A software script is described that reduces the requirements of MARSSIM to five programmable threshold tests and two statistical tests. The script is run against multiple configurations of the data, allowing both pre- and post-remediation datasets to be evaluated and compared. The script output is a summary cover sheet plus a sorted listing of the data, which can be used as the basis for release and can be enclosed within the final report as-is. The advantages of standardized computer analysis and reporting of this type are also discussed.

**WPM1.9** Bland, J., Doan, J.; Chesapeake Nuc. Srvs.; jsbland@chesnuc.com

**Remediation and FSS for a Contaminated Stormwater System**

Following over 50 years of operation, in situ gamma measurements of approximately 200 feet of an off-site underground stormwater system at a thorium processing facility were performed for initial characterization, guiding remediation, and planning the FSS. The surveys consisted of traversing the stormwater line with a 2x2-in. NaI(Tl) detector, which was coupled with a Ludlum 2350-1 and a handheld computer (pda) for recording the gamma readings on a 2-second frequency. This method provided essentually a complete gamma survey of the line for characterizing contamination levels. These surveys identified elevated levels of radioactivity. The lines were cleaned and contaminated sediments were removed; however, elevated levels remained. To evaluate residual contamination levels and the potential for sub-line soil contamination due to line leakage, samples of the storm line were collected and the underlying soils were sampled. Modeling using the MCNP code was performed for correlating the response of a 2x2-in. NaI(Tl) detector to residual contamination levels for both the line and the underlying soil. The results of the modeling were compared with sample data for developing a reasonably conservative approach for guiding additional remediation. Following remediation, a 100% gamma scan was again performed by traversing the length of the line with a 2x2-in. NaI(Tl) detector, again recording the gamma levels every 2 seconds. This scan data, using the MCNP modeling coupled with the sample data, provided the FSS data for demonstrating compliance with the site soil DCGLs. Conservative dose modeling showed that the hypothetical dose to a city worker from routine maintenance of the stormwater lines would be less than 0.02 Sv/y (2 mrem/y) and for removal of the lines and reuse of bricks (contaminated) less than 0.10 mSv/y (10 mrem/y). The systematic approach to the investigation surveys and remediation will be presented along with the modeling used as part of the FSS for demonstrating acceptable levels of residual contamination.

**WPM2.1** Droppo, J., Napier, B.; PNNL; james.droppo@pnl.gov

**Operational Limitations for Demolition of a Highly Alpha-Contaminated Building Modeled Versus Measured Air And Surface Activity Concentrations**

A number of facilities historically used for processing and handling transuranic materials are scheduled for demolition. Those facilities typically have residual alpha-emitting radionuclide contamination that poses an exposure hazard if released to the local environment during the demolition. This paper addresses the effectiveness of current techniques for estimating such potential releases. Atmospheric dispersion modeling was conducted in support of the planning for the demolition of a highly alpha-contaminated building. The frequencies of occurrence of peak air and surface contamination levels were computed using an air dispersion model and local dispersion climatology. During the demolition of the building, four airborne radiation monitors were deployed to record the exposures in the area around the demolition activities. Surface contamination was also monitored throughout the project. A comparison of the monitored and modeled results will be made to evaluate the extent of conservatism in the estimated operational limitations for demolition of a highly alpha-contaminated building. The results of this comparison will prove useful for future modeling efforts from the standpoint of avoiding extreme conservatism in the input parameters.

**WPM2.2** Brown, D.; Shaw Environmental, Inc.; dennis.brown@shawgrp.com

**Using Shewart Charts, an SPC Technique in Assessing Portable Survey Detector Instrument Health**

A variety of chart schemes was evaluated after reviewing a few months of data. One scheme, using an X-bar, moving range chart has been found to be an effective method for control-charting daily instrument performance checks. Also tracked using the same scheme were a couple of years data for common portable alpha and beta and laboratory wipe counters using phoswhich detectors and a smaller sampling of NaI(Tl) 2x2 and 1x1 detectors. The advantages of using this system are that it serves as a robust QC check to verify that the day's source checks are good; long-term trends in instrument response and stability can be performed with a minimal level of effort to assess the reliability and performance of an instrument; and using one daily check for background and source response for each window (alpha and beta) effectively tells a story of instrument performance when plotted. This method enables identifying instruments that are the best of the fleet, increases the value of field measurements, and increases the confidence that a field measurement is above a criterion. The

control chart tool aids in rapid verification that instruments are working properly, i.e., are healthy.

**WPM2.3** Stephan, C., Ellis, K., Gonsky, J., Garcia, R.; Tetra Tech EC, Independent Consultant; cliff.stephan@tteci.com

**Use of T-Scores for Data Analysis**

A difficult task for any radiological safety professional is to disseminate radiological survey data in a manner that is comprehensive and understandable by both laypersons and peers. The data in question frequently involves statistical parameters used as action levels and may be derived from multiple field instruments. A typical scenario encompassing this problem would be to present the results of a gamma scan performed with an array of detectors where the investigation level was set equal to background plus three standard deviations. The data analysis can be simplified by converting the individual detector results to standard scores, a technique frequently used to evaluate data in other scientific disciplines. The use of the standard T score is presented in this work. By using the T score, a value of 50 represents the mean and a sigma of 10 results in values of 20 and 80 for -3 sigma and +3 sigma respectively. The outlined technique effectively allows for data from different detectors or even different types of instruments to be directly compared. In doing so, it also becomes possible to provide a visual data representation in the form of a color-coded map depicting the possible ranges of T scores.

# Poster Abstracts

**P1.1** Schierman, M., Farr, C., Wrubel, N., St. Martin, E.; Environmental Restoration Group, Cadsultant; mikeschierman@ergoffice.com

**3-D Presentation of Radiological Data for Building Surfaces and Components**

Three dimensional (3-D) representations of radiological data from building surfaces and components provide distinct advantages over conventional two dimensional (2-D) methods. Three dimensional presentations give a powerful and immediate visual perspective of the spatial relationship of building surfaces and components, between contamination levels and location within the building, and when high density scanning data are available, provide an effective spatially accurate representation of the radiological condition of the building. This method was used to display field screening and volumetric sampling locations as part of a complex nuclear facility characterization. Spatial information from historical documents, such as as-built drawings and field investigations, was incorporated into commercially available 3-D software applications to create a 3-D image of the radiological condition of building surfaces and components with minimal effort. The use of this method, coupled with indoor autolocating radiation detection systems, could significantly reduce characterization costs while providing a more visually effective and informative format to present information.

**P1.2** Hedge, H.; GeoSyntec Consultants; HHedge@GeoSyntec.com

**Natural Radionuclides in Surface Soils in Ipoh Malaysia**

GeoSyntec Consultants undertook a study to evaluate the background concentrations of natural radioactivity in surface soils of the area around Ipoh (the Kinta Valley) in the central peninsula of Malaysia. Sixty samples were collected and analyzed by a gamma-ray spectroscopy system (GSS) to evaluate the Th-232, U-283, and Ra-226 activity concentrations. Subsamples were sent to the Malaysian Institute for Nuclear Technology Research (MINT) and Eberline Services Laboratories (Oak Ridge, TN) for independent testing. To validate the GeoSyntec laboratory results, MINT analyzed subsamples by neutron activation (NAA) and (GSS); Eberline Services used alpha spectroscopy and GSS. An evaluation of the analytical results of GeoSyntec Consultants, MINT, and Eberline Services is presented for validation of GeoSyntecs-laboratory results. The Kinta Valley study area shows categorically higher activities than those reported for Malaysia in UNSCEAR 2000 report. For the Kinta Valley study, average Th-232, U-238, and Ra-226 activities were 0.210, 0.099, and 1.42 Bq/g, respectively, compared to Malaysia averages of 0.082, 0.066, and 0.067, respectively. This poster summarizes the results of these background measurements and provides a brief comparison between these results and those presented in UNSCEAR 2000.

**P1.3** Wrubel, N., Johnston, J., Rademacher, S., Baker, K.; Environmental Restoration Group, Inc, AMEC, Inc, USAF; neilwrubel@ergoffice.com

**Use of GPS-Based Radiation Surveys in a MARSSIM-based Radioactive Soils Cleanup**

Global Positioning System (GPS)-based radiation surveys have proven to be a powerful tool used in the remediation of radioactively contaminated land areas. Utilization of GPS-based surveys during the remediation of four thorium-impacted sites at Kirtland Air Force Base resulted in significant waste volume reduction and demonstrated compliance with MARSSIM. High density GPS-based surveys, ArcView GIS analysis, gamma radiation-soil radionuclide concentration correlations, and field checks were used to guide soil removal as the remediation progressed. Polygons were drawn around areas on the gamma radiation maps that exceeded the Derived Concentration Guideline Levels (DCGLs). The polygonal areas were field located utilizing GPS and flagged to guide additional excavation. Statistical analysis of the gamma radiation data, including an assessment of the variability of gamma radiation across the site, and correlations between static gamma counts and residual Th-232 concentrations in soil, were used to assess compliance with the elevated measurement comparison test, unity rule, and Wilcoxon rank sum test. These methods facilitated precise excavation control, resulting in a 40% waste volume reduction, and complied with the requirements of the final status survey plan supporting site closure.

**P1.4** Rucker, T., Gelinas, R., Pack, S., Mansfield, C.; Science Applications International Corporation, Bechtel Jacobs Company LLC; ruckert@saic.com

**Characterization Technology Selection for the Core Hole 8 (Tank W-1A) TRU Soil Engineering Study for Completion of Removal Activities at ORNL**

Radiological measurements were required in order to characterize the Tank W-1A site soils at the Oak Ridge National Laboratory with a 3-dimensional map to define the volume and location of Transuranic Waste versus Low Level Waste that must be segregated and disposed. The radiological contamination at the site was assumed to be composed of Am-241 concentrations ranging from approximately 1.8E+03 to 1.1E+04 Bq/g (50 to 300 nCi/g), Pu-239/240 concentrations ranging from 3.7E+02 to 4.6E+04 Bq/g (10 to 1,240 nCi/g) and high levels of gamma emitting isotopes, mainly Cs-137. The use of in-field measurements was desirable in order obtain rapid results that could be used to direct further sampling. The possibilities evaluated included sampling with in-field measurements and in situ (down hole) measurements. That approach initially seemed desirable in order to minimize the amount of sampling-derived waste and exposure to high radiation field and radionuclide contamination. A number of down-hole detector probes and drilling techniques were evaluated. These were abandoned in favor of sampling and in-field measurement because of concerns about detector dead time and saturation from the high radiation environment. Two sampling and in-field measurement techniques were investigated: the TruPro® technique proposed by NMNT, and in-field gamma spectroscopy on soil cores using ISOCS® calibration by Canberra. The latter was eventually chosen due to implementation concerns for the TruPro® technique. Since the in-field gamma spectroscopy technique is not capable of detecting all radionuclides at the levels of concern, in-field measurements were supplemented by sending a subset of samples to a laboratory for complete analysis. However, the in-field measurements were used to guide the sampling based on historical radionuclide ratios. This paper will discuss the capabilities of all characterization techniques considered and the rationale for the final selection. The success of this approach will also be reported.

**P1.5** LePoire, D., Arnish, J., Cheng, J., Kamboj, S., Richmond, P., Chen, S., Barr, C., McKenney, C.; Argonne National Laboratory, U.S. Nuclear Regulatory Commission; dlepoire@anl.gov

**Development of Web-Based Training to Support NRC Review of Dose Modeling Aspects in License Termination and Decommissioning Plans**

A web-based training (WBT) course is being developed for U.S. Nuclear Regulatory Commission (NRC) staff who review License Termination Plans (LTPs) and Decommissioning Plans (DPs). The course is being adapted from an existing classroom training course that targeted specific aspects of the LTP and DP document review process related to dose-based compliance demonstrations made by site licensees. The WBT course is being organized in a modular format with core and advanced modules tailored to various NRC staff with differing responsibilities. The individual modules include topics such as identifying the characteristics of simple and complex sites, identifying when outside expertise or consultation is needed, demonstrating how to conduct acceptance and technical reviews of dose modeling, and providing details regarding the level of justification needed for realistic scenarios for both dose modeling and derivation of derived concentration guideline levels. Various methods of applying probabilistic uncertainty analysis to demonstrate compliance are also presented. Realistic case studies are presented and analyzed, including the abstraction of a realistic site into a conceptual model and computer model. A case history is also used to demonstrate development of review documents such as requests for additional information. To enhance the WBT experience, audio, animation, linked documents, quizzes, and scripts are being integrated into a commercial WBT package that supports simple navigation. The course is also being integrated into both existing and state-of-the-art learning management systems. The WBT offers the advantage of being available at any time for learning or review, whereas the advantage of the classroom-based training is that it facilitates lively discussion of issues and interpretations.

**P1.6** Moussa, H., Townsend, L., Eckerman, K.; University of TN, Oak Ridge National Laboratory; hmoussa@utk.edu

**Effect of Dust Particle Size on Absorbed Fraction in ET1 Region**

The ICRP Publication 30 report, Limits for Intakes of Radionuclides by Workers, was designed to derive secondary limits for adult radiation workers and to retain the simplicity of the ICRP Publication 2 model, while making some improvements. These include accounting for the aerosol diameter size in the deposition model including the nasopharyngeal (N-P) region; however, the only respiratory tract target in Publication 30 is the lung, a 1-kg composite of the trachea, the bronchial tree, the pulmonary parenchyma, and the pulmonary lymph nodes. The extrathoracic region (ET1 and ET2) on the other hand has no counterpart in the Publication 30 model. In ICRP Publication 66, nasal deposition was discussed in regards to thermal and aerodynamic deposition and new equations introduced to calculate the deposition efficiency in the ET1 region. However, the effects of various dust particle sizes on the absorbed fraction in the ET1 region were not addressed in the ICRP 66 report. In this paper the effects of various dust particle sizes on the absorbed fraction in ET1 were studied. Our results indicate that self-absorption in dust particles has a significant effect on the electron absorbed fraction; this effect depends on the dust particle sizes and the energies of the electrons emitted by the radioactive particles that are carried on the dust particles.

**P1.8** Na, S., Kim, S.; shna@kins.re.kr

**A Discrete Step Model to Evaluate the Monetary Value of Person-Sievert in Korea**

Performing a cost-benefit analysis to establish optimum levels of radiation protection under the ALARA principle, a discrete stepwise model has been used to evaluate man-sievert monetary value of Korea. The model formula, which is unique and country-specific, is composed by using the GDP value, the nominal risk coefficient for cancer and hereditary effects, the aversion factor against radiation exposure, and the average life expectancy. Unlike previous researches on alpha-value assessment, it shows different alpha values optimized with respect to the range of individual dose, which would be more realistic and applicable to the radiation protection area. Furthermore, it recommends that the concept of purchasing power parity should be adopted if it needs international comparison of alpha values. Finally, we explain the way that Korean model can be simply generalized to other countries without normalizing country-specific factors.

**P1.9** Nes, R., Benke, R.R.; Center for Nuclear Waste Regulatory Analyses; rnes@swri.org

**Indoor Worker Dose Calculations for Hot Cell Leakage**

**P1.10** Sprau, D.; East Carolina University; spraud@ecu.edu

**The Resurgence of Nuclear Power from a Local Environmental Health Perspective**

Environmental Health Science students and faculty from East Carolina University (ECU) visited the International Atomic Energy Agency (IAEA) headquarters in Vienna and the Chernobyl reactor site near Kiev as part of semester-long special topics course(s) on the Resurgence of Nuclear Power from Local Environmental Health Perspective. The course and the trip were designed to help prepare ECU environmental health students to deal with the new nuclear power plants being planned for North Carolina and other sites around the country. Since no new nuclear power plants have been built in the United States for nearly thirty years, the course dealt with the environmental health/public health aspects of nuclear power generation from a local public health department and local environmental health program perspective. The goals of the course and the trip were to study the potential risks and the possible environmental health impacts of future nuclear power generation along with thier impact on public health. The historical implications of nuclear power plant operations were considered as well as new approaches in designing and building next generation nuclear power plants. The course covered the history of nuclear power, the basics of radiological health, reactor design and operation, environmental health concerns such as air, water and waste contamination, new technologies (including hydrogen production and desalination), and the economics of production. Students obtained a positive and optimistic perspective on the future of nuclear power from their visit to the IAEA as well as an understanding of what went terribly wrong in the Chernobyl incident. Minimization of the consequences of Chernobyl accident, environmental clean up for the current population, and the environmental, medical, and biological consequences of the radiation accident were all examined from the perspective of local environmental health professionals. Development of future course material will be drawn from the student experiences in visiting the contaminated Chernobyl site.

**P1.11** Dixon, K., Flach, G., Lee, P.; Savannah River National Laboratory; kenneth.dixon@srnl.doe.gov

**A Graded Approach to Fate and Transport Modeling to Support Decommissioning Activities at the Savannah River Site, Aiken SC**

The Department of Energy (DOE) Savannah River Site (SRS), located near Aiken, South Carolina, is one of the largest facilities in the DOE complex, with over 1,000 radiological and chemical buildings slated for demolition by 2025. In response to a DOE mandate for accelerated cleanup, most buildings will be demolished, leaving behind only the concrete slab that formed the building foundation. In each case, it is necessary to demonstrate that risk-based criteria have been met for the concrete slab end state. Slabs that pose unacceptable risk are subsequently scabbled or removed entirely to reduce or eliminate the associated risk. Typically, the limiting component of the risk assessment is to determine the potential impacts to groundwater from contaminants leaching from the concrete slabs. SRS has employed a graded approach as a cost effective solution to evaluating potential groundwater impacts. This approach incorporates both simple spreadsheet calculations and complex numerical modeling to cost effectively evaluate the threat to human health posed by potential impact to groundwater. The simple spreadsheet calculations produce generic derived guideline concentration levels (DCGLs) based on U.S. Environmental Protection Agency (USEPA) soil screening guidance protocol for comparison to subsequent end state verification sampling results. In most cases, no further analysis is required. However, when concentrations are found in a concrete slab that exceed the DCGL for a given analyte, a more rigorous modeling effort is undertaken using the PORFLOW code and eliminating the conservatisms inherent in the simple screening calculation. PORFLOW is a numerical model for the simulation of multiphase fluid flow and mass transport in variably saturated porous media. In most cases, the more rigorous modeling exercise using the PORFLOW code shows risk levels to be acceptable, allowing the concrete slab to be left in place. This paper highlights the merits of the graded approach employed at SRS and provides an overview of the screening and rigorous methods used to evaluate potential impacts to groundwater.

**P1.12** Gilliam, B.; bgreat@prodigy.net

**Radiological Waste Treatment using Reverse Osmosis, Evaporation and Solidification from Russian Submarines**

The author, who designed radiological controls and Decontamination treatment processes at the Russian Naval Nuclear shipyard in the Far East near Vladivostok, Russia, will

examine the unique problems associated with nuclear submarine effluent radiological waste treatment. He will analyze Russian radiological control methodologies and regulatory standards, then compare and contrast them with American rad waste regulations and treatments. Drawing from his experience on a commercial multinational venture, as a Radiation Safety Specialist/Consultant in Bolshoi Kamen, he will discuss dosimetry and dose rate calculations on the waste treatment barge. The 2007 Midyear Topical Meeting of the Health Physics Society on Decontamination, Decommissioning and Environmental Cleanup, would be the appropriate forum for the oral presentation, which will be accompanied by slides. The color photos and supplemental graphics would also be suitable for a poster board display. How have the scientists and technological experts faced the Decontamination and Decommissioning environmental challenges of the nuclear shipyard in this Far Eastern region of the former Soviet Union? What are the international implications and applications? This case study will provide a singular insight into Russia's once top-secret program and give an added perspective to the role of American businesses in radiological waste clean-up efforts.

**P1.13** Kannamkumarath, S., Gonzalez, B., Tucker, A., Rao, G., Thein, M.; Oak Ridge National Laboratory; kannamkumass@ornl.gov

**An Improved Method for the Analysis of 234U, 235U and 238U in Urine by Inductively Coupled Plasma-Mass Spectrometry**

An improved method has been developed for the determination of 234U, 235U and 238U in urine by inductively coupled plasma-mass spectrometry(ICP-MS) as an alternative to alpha spectrometry in order to improve the turnaround time and detection limit. The aim of the method was to increase the reliability of the results. To account for matrix effects and variations in sample introduction efficiency, 236U is added to each sample. For 235U and 238U the acidified urine samples are diluted ten-fold prior to analysis. For a 1-L sample, this represented a 10,000-fold dilution. Because the specific activity of 234U is approximately 2000 times higher than that of 238U, this method was not feasible to achieve the desired detection limit for bioassay measurements of 234U. An alternate approach for measuring 234U in urine by ICP-MS has been investigated. The original sample is traced with 236U, and uranium separation chemistry is performed. The resulting eluate is directly analyzed by ICP-MS, thereby eliminating the 10,000-fold dilution. This approach can achieve the desired detection limit for 234U which will be significant for bioassay measurements. Both natural and artificial urine samples were analyzed with this method. Consistent and accurate results were obtained when utilizing 236U as the internal standard. Various applicable internal standards were also investigated. This paper will present the improved method and the results of these investigations.

**P1.14** Croslin, S., Stanford, S.; Bechtel Jacobs Company; sc2@bechteljacobs.org

**A Cost Effective Strategy for Bioassay Monitoring when Dealing with Multiple Transuranic Radionuclides, Mixed Fission Products and Uranium**

The Bechtel Jacobs Company Dosimetry Organization developed several new strategies for bioassay monitoring, designed to be cost effective alternatives to previous monitoring practices. Since radiological workers at company projects are not likely to receive a committed effective dose equivalent of 1mSv (0.1 rem) or more in a year from intakes of radionuclides, part of the new monitoring strategy uses work group monitoring (random sampling), designed to meet the objectives of 10 CFR 835.401 for an internal monitoring program. Other changes include reductions in baseline bioassay sampling, the use of ICP-MS instead of uranium isotopic analysis for routine urine samples when the enrichment of uranium is known, and use of DAC-hour exposures for determining committed effective dose equivalent where a technology shortfall exists for bioassay measurements, as in the case of many transuranic radionuclides. Together, these changes are expected to significantly reduce the total number of bioassay measurements performed by the company.

**P1.15** McNees, J., Roberts, S.; Alabama Department of Public Health, Alabama Cooperative Extension System; jmcnees@adph.state.al.us

**Summertime Short-term Negative Radon Tests Need to be Retested in Winter**

The Alabama Radon Program conducted a study to see if short-term radon tests performed during the summer air-conditioning season, and having results less than the United States Environmental Protection Agency (EPA) action level of 1.48E02 Bq per cubic meter (4.0 pCi/L), were a reliable means in determining whether a house has excessive indoor radon. Using a database of past Alabama Radon Program tests, individuals whose homes had tested less than 1.48E02 Bq per cubic meter (4.0 pCi/L) during the previous air-conditioning seasons of 2003, 2004 and 2005, were offered a free kit to conduct a wintertime retest. The study was done by mail, utilizing an initial contact letter, with participating homeowners being mailed liquid scintillation radon detection kits in January of 2006, performing the test and mailing the completed test vial to the laboratory for analysis. There were 186 valid wintertime retests successfully completed statewide, with 50 of 186 or 26.9% having results greater than or equal to 1.48E02 Bq per cubic meter (4.0 pCi/L). In addition, 43 of 106 or 40.6% valid wintertime retests in the known highest radon incidence areas of Alabama had results greater than 1.48E02 Bq per cubic meter (4.0 pCi/L). This study demonstrates that in the known high radon areas of Alabama there exists approximately a one-in-three chance that a house tested in the summertime and having a radon concentration of less than the action level will have a wintertime retest result of 1.48E02 Bq per cubic meter (4.0 pCi/L) or greater.

**P1.16** Espinosa, G., Bogard, J.; Universidad Nacional Autnoma de Mexico, Oak Ridge National Laboratory; espinosa@fisica.unam.mx

**Sio2 Optical Fiber as Optically Stimulated Luminescence Material**

The use of Optically Stimulated Luminescence (OSL) for radiation dosimetry is based on luminescence emitted from semiconductor materials stimulated with specific wavelengths of light, after being exposed to ionizing radiation. The OSL intensity is a function of the radiation dose absorbed by the material. This work complements previous studies by the authors of the thermoluminescence (TL) response by SiO2 commercial optical fiber exposed to ionizing radiation and provides preliminary results describing some of the OSL material properties. Linear OSL response to beta radiation dose, along with a consistent shape of the photon emission curve with time, were observed using a green/blue OSL excitation laser. The reproducibility of OSL response after repeated irradiations and the change in intensity with time were also examined.

**P1.17** Potter, W.E., Strzelczyk, J.; Consultant, Uniersity. of CO Health Science Center; pspr189729@aol.com

**Double Precision C++ Computer Code for Exact Decision Levels and Errors of the First Kind When the Blank Count Time is an Integer In [1, 20] Times Greater than the Sample Count Time**

In the past, exact computations utilizing modified Bessel functions of integral order have been discussed for decision levels and the associated errors of the first kind in paired counting when the blank count is Poisson distributed with a known expected value. The code of this paper transforms the net count to an integer and assumes that the blank count is Poisson distributed with known expected value. Utilizing the Poisson probability density function, a function in C++ is written to compute the exact probability density function for the transformed net count when it is less than zero, equal to zero and greater than zero. This function sums probabilities to determine the probability of obtaining a specific value for the transformed net count. The validity of the code is then checked by summing probabilities over a wide range of transformed net counts and comparing to 1.0. The decision level is determined by summing the right tail of the probability density function and inverting from a transformed net count to a net count. Double precision arithmetic is utilized and is applicable for smaller expected blank counts in the sample count time. When the ratio of blank count time to the sample count time, R, is less than or equal to 6, the code is valid for expected blank counts, B, not larger than 100.0. When R = 10, 20 the code gives valid results for B not larger than 66.0 and 22.0, respectively. Because the code has the ability to compute errors of the first kind, comparisons can be made with approximate solutions such as those of Brodsky and Currie. The double precision code is found to be adequate for most applications and executes challenging problems in about two minutes or less on a newer home computer. Some results are exhibited.

**P1.18** Brandl, A.; Nuclear Engineering Seibersdorf; alexander.brandl@arcs.ac.at

**Recommendations by the Working Group on Decommissioning of the German Radiation Protection Association**

As decommissioning of nuclear facilities has become a major factor in radiation protection considerations in Germany, Switzerland, and Austria over the past few years, the German-Swiss Radiation Protection Association established a working group on decommissioning within its topical group on incorporation monitoring. This working group serves as an informal platform for the exchange of knowledge gained and lessons learned from decommissioning projects in commercial plants, research reactors, and other nuclear facilities such as fuel cycle or hot cell laboratories. Most importantly, however, the group was tasked with collecting the operational decommissioning experience of its members and drafting recommendations on radiation protection methods and procedures for future projects. The most significant results contained in these recommendations are presented and include considerations such as concerns not only for activity concentration in structures and components and contamination but their dose relevance in case of incorporation of radioactive material. Additional recommendations include the appropriate choice of staff, both operational and radiation protection, as well as their training, and necessary emergency preparedness tranining.

**P1.19** Downey, H., McDonald, M.*, Conant, J., Knauerhase, K.; MACTEC, ABB, ABB; htdowney@mactec.com

**Decommissioning of a Nuclear Fuel Manufacturing Site**

A former nuclear fuel manufacturing facility has been undergoing decommissioning since 2001 with the objective of meeting the criteria for unrestricted use and terminating the license. The site was used for research and development as well as manufacturing of nuclear fuels from 1955 to 2001. In more recent years, some of the facilities were utilized for nuclear plant outage and field operation support. The Decommissioning process has included characterization, a Historical Site Assessment, derivation of site-specific DCGLs, a Decommissioning Plan and Final Status Surveys. This site is regulated by the Nuclear Regulatory Commission, and the State Regulatory Agency has provided significant review of decommissioning documents and activities. Decommissioning activities included decontamination and dismantlement of 12 buildings totaling more than 18,580 square meters (200,000 square feet), removal of paved surfaces and all underground utilities associated with these buildings, and MARSSIM Final Status Surveys covering greater than 56.7 hectares (140 acres). An overview of the decommissioning process at this site will be presented.

**P1.20** Landsman, S.; Fluor Hanford, Inc; Steven_D_Landsman@rl.gov

**HIgh-Risk Characterization of the 216-Z-9 Plutonium Waste Crib**

The 216-Z-9 waste crib was used to dispose of wastes associated with the RECUPLEX process at the Hanford Site Plutonium Finishing Plant. The crib contains approximately 53 kg of plutonium and 100 kg of americium matrixed in the soil column beneath the crib. In addition, high levels of dense non-aqueous phase liquids (DNAPL)such as carbon tetrachloride are also present. A slant borehole was successfully drilled beneath the crib during the spring of 2006 to collect soil samples for characterization of the waste. Soils removed from the borehole contained concentrations of 239-Pu as high as 9.25 kBq/g (0.25 microcuries/gram) and 241-Am as high as 7.4 kBq/g (0.2 microcuries/gram). This presentation is a discussion of the engineered controls and radiological controls implemented to control the radiological and chemical hazards associated with the work, and includes a video presentation of the process used to perform the work.

**P1.21** Chance, T., Nardi, A.*, Roth, J.; Westinghouse Electric Company, Westinghouse Electric Company, Thor Enterprises; ajnardi@enercon.com

**Comparison of Calculated Versus Measured Uranium Holdup in a Uranium Fuel Fabrication Facility Ventilation System - a Case Study**

Uranium holdup in the process equipment ventilation system is an expected condition in uranium fuel fabrication facility. This paper presents a case study for a facility that is undergoing decommissioning and therefore provided the opportunity to directly compare calculated uranium mass holdup in the various ventilation systems against the as found conditions upon dismantling of the ventilation system during the facility decommissioning work. The methods used to obtain radiation measurements on the in place system are described along with the conversion of such measurements into a calculated mass holdup for the ventilation system. The process to collect and account for the actual uranium content of the ductwork as the ventilation system was dismantled is described. The comparison of the expected uranium mass (by calculation) versus measured content of the ventilation system is made. This case study provides useful information for both operating fuel fabrication facilities as well as those undergoing decommissioning.

**P1.22** Lively, J.; MACTEC; jwlively@mactec.com

**Subsurface Soil DCGL Method / NRC Approval at Licensee Site**

A new method to derive and demonstrate compliance with subsurface soil derived concentration guideline levels (SS-DCGLs) has been under development for approximately two years. The method incorporates analogs to the Multi-Agency Radiation Site Survey and Investigation manual (MARSSIM) methodology and addresses each of the conceptual subsurface soil decommissioning criteria itemized in NRC guidance (NUREG-1757). The SS-DCGL method development has recently been advanced to the point that it has been approved for use at a specific, licensed site undergoing decommissioning. This paper provides summary information explaining the concepts incorporated in the SS-DCGL derivation method, the compliance metrics associated with the method, and their analogs to MARSSIM. It further addresses the most recent modifications built into the method in response to the NRCs review of and request for additional information on the request for license amendment incorporating the method into the approved decommissioning plan. The advantages and limitations of the method are explained.

**P1.23** DeGrazia, J., Gruben, D., Lively, J.*; MACTEC, MDNR; jwlively@mactec.com

**Case Study: the Use of Realistic Future use Scenarios in Decommissioning**

The Michigan Department of Natural Resources (MDNR) acquired a parcel of land adjacent to the Tobico Marsh State Game Area and Park from a private landowner. The parcel was subsequently found to have been used to inappropriately dispose of 208-liter (55-gallon) drums containing residues of industrial chemicals and radioactive slag from a nearby magnesium-thorium alloy processing facility. Slurry walls and a clay cap were emplaced around the disposal area to isolate the non-radiological contaminants from the sensitive surrounding environment. The Nuclear Regulatory Commission (USNRC) issued a radioactive materials license to the MDNR and directed that the State appropriately decommission the site. An extensive radiological characterization of the site was undertaken by the MDNR. The characterization surveys and sampling confirmed that the radioactive slag was confined within the installed slurry walls and cap. Early decommissioning plans for the site were being driven by the idea that the cleanup levels must be protective of a resident farmer scenario. However, a number of factors made future development of the site unlikely, and particularly for a resident farmer scenario. In recognition of the unlikely future use of the site for other than recreational uses, the MDNR petitioned the USNRC to reconsider the resident farmer scenario and adopt a more realistic future use scenario consistent with the many detriments to future development of the land. This paper describes the logic presented to, and eventually approved by, the USNRC in support of less restrictive future land use assumptions. By applying more reasonable future land use assumptions, it was shown that leaving the radioactive slag in place complies with the USNRCs decommissioning dose criteria and represented the most environmentally responsible decommissioning option.

## WORKS-IN-PROGRESS

**P1.24** Gaul, W.C., Davidson, M.S., Edgington, G.J., O'Neill, M.P.; Chesapeake Nuclear Services, Cellular Bioengineering, Inc.; mdavidson@chesnuc.com

**An Improved Polymer-Based Hydrogel for Decontamination of Hard Assets**

Strippable coatings have been employed with mixed degrees of ease and efficacy over the last two decades. A new, zero-prep, non-toxic, minimum-odor hydrogel was tested on various material surfaces contaminated with depleted uranium. The gel dries to a durable coating that provides improved ease of removal as compared to other coatings. The gel showed favorable performance on flat and textured surfaces containing grooves, pits, and joints with decontamination factors (DF) up to 50 for surfaces with high levels of alpha contamination. Of particular note was the ability of the gel to penetrate into joints and crevices and maintain its cohesiveness upon removal. The gel was applied on a typical fiber expansion joint in a concrete floor with initial activity of 24,400 cpm/100 cm2. After removal, the residual contamination level was 480 cpm/100 cm2, for a DF of 50 after a single application (98% removal). Materials tested included coated concrete, floor joint filler, painted steel stairs, unpainted wood, oxidized steel, and urethane glass. Loose and fixed surface contamination levels were determined to further evaluate the gel for removal of fixed contamination. Masking tape was applied to surfaces adjacent to the test surfaces. Loose contamination fractions were determined to be negligible, with tape DF values in the 1 to 1.07 range, i.e., essentially no loose contamination. These results indicated that the majority of contamination removed by the gel with high DFs was not simply loose particulate, but fixed in the surface. Some lower DFs were attributed to 90% humidity conditions, damp porous concrete, and incomplete cure time. Testing is planned to further evaluate high-humidity conditions and improved curing.

**P1.25** Tabriz, M.; Oregon State University; nassehzm@onid.orst.edu

**The Mobility of Radiocesium and Plutonium in Roach Lake in Southern Nevada**

The concentrations of several natural and artificial radionuclides were determined in the sediment from a dry lake in southern Nevada. Five sites (designated I through V) were selected in a dry lake called Roach Lake located in Ivanpah Valley about 41 miles west of Las Vegas, Nevada. The samples were analyzed for Cs-137 and other gamma emitting radionuclides using high purity germanium detectors. The plutonium analysis was performed, after chemical separation, by the detection of its alpha particles emissions with surface barrier detectors. Strontium-90 was determined at only one site , after extraction from the samples, by measuring its daughter yttrium-90 with a gas proportional counting instrument.

In all of the locations, the concentrations of the natural radionuclides measured were relatively uniform throughout the core. In contrast, the activity of Cs-137 in site I was determined to be 0.302 pCi/g at the top layer gradually decreasing to to unmeasurable concentrations (less than 0.04 pCi/g) at 5 cm below the surface. Analysis of Pu-239,240 showed an activity of 0.012 pCi/g at the top layer gradually decreasing to an unmeasurable concentration at 8 cm below the surface. A similar concentration-depth profile was observed for Cs-137 and Pu-239,240 in site IV, which was also collected at 1 cm intervals. The strontium-90 analysis, which was performed only on core (I), was found in measurable amounts to 21 cm. Its activity in the top 9 cm was fairly uniform at about 0.06 pCi/g after which it started declining at 9 cm to an activity of about 0.02 pCi/g at the 21st cm layer from the surface.

The Pb-210 dating of samples collected from location IV conclusively demonstrated that all of the excess lead-210 was in the top three to four centimeters - " most in the uppermost 0.3 cm interval. Analysis of Bi-214 suggests constancy in the Ra-226 concentration up to the surface and thus indicates atmospheric origin of the excess Pb-210.

Total activity of Cs-137, 15.5 and 9.4 mCi/km2 for cores I & IV respectively, and a total activity of Pu-239, 0.725 and 0.611 mCi/km2 for cores I & IV respectively compares to the global average inventory of 65± 20 mCi/km2 Cs-137 and 1.8± 0.05 mCi/km2. The lower values in the dry lake are possibly an indication of the loss of these nuclides from the lake bed or lower input due to the dry climate which would limit washout of these nuclides from the atmosphere (low rainout). The comparison of the Pu:Cs activity ratio, 0.049 for core I and 0.062 for core IV, results in much higher values than the global ratio of 0.028± 0.004, which indicates the fact that the Cs-137 may be removed from the dry lake at a higher rate than Pu-239,240 or the original fallout was not typical of the worldwide fallout but had a higher plutonium concentration, possibly due to testing at the Nevada Test Site.

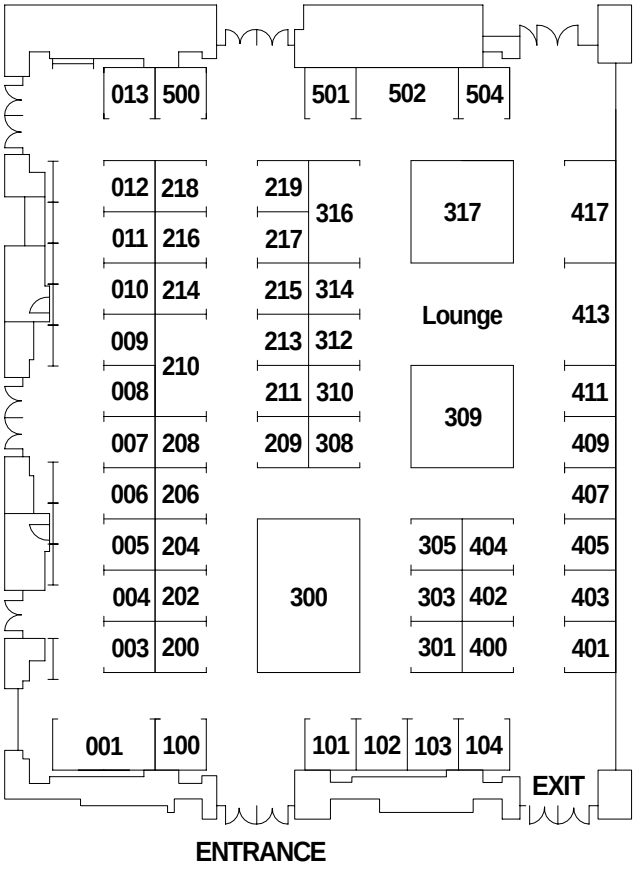
**P1.26** Dibblee, M.; Retired, Consultant, Portland, OR; dibblee@hevanet.com

**Alternative Decommissioning of a PuBe source**

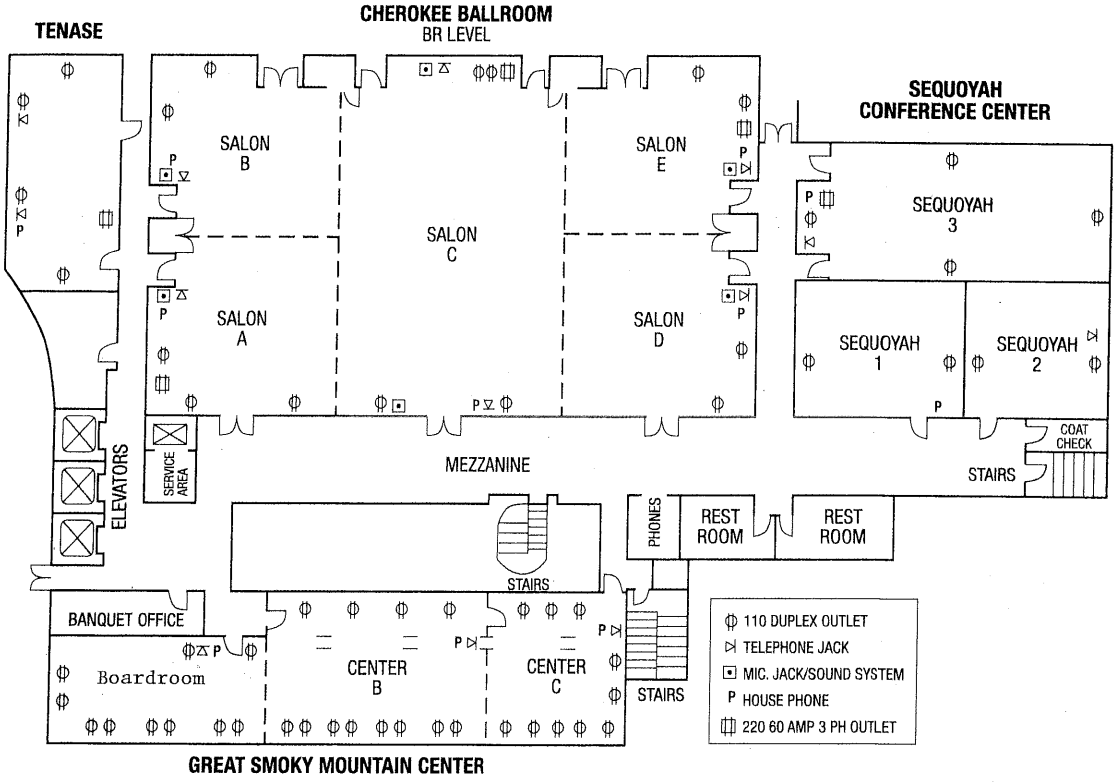
Security considerations require secure storage of those remaining PuBe howitzer sources left over from the post-war "peaceful uses" of material. Although the US Department of Energy has expedited the transfer of a number of PuBe sources to a secure storage and recycling venue, we chose to withdraw from this queue. Rather, we decided to transfer our source for reuse. We struck a deal to move the source 5 miles to its new home. With a team of 4 experienced HPs and one regulator, the source was transported safely and securely to its new location. The entire process took nearly 8 hours but robust procedures made the transport easy. Assembling the team -- including the transport truck and certified driver -- well ahead of the date, using indirect observation to keep dose ALARA, and having many years' combined experience among the team members resulted in a quick source removal from its howitzer to the transport cask, into the transport vehicle, through 5 o'clock traffic, to its new venue. Procedures, practice, and teamwork paid off in little more than one minute of dose. The logistics are discussed in detail to describe the process during those 8 hours.

# Author Index

## Knoxville Convention Center Exhibitor Floorplan




## Knoxville Hilton Floorplan



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