Health Physics Society Midyear Meeting
Radiation-Generating Devices

2008 Topical Meeting of:
Health Physics Society
(The Forty-First Midyear Topical Meeting of the Health Physics Society)
American Academy of Health Physics

January 27-30, 2008

Final Program

Health Physics Society Committee Meetings

All Committee Meetings take place at the Oakland Marriott (M) and Convention Center (OCC)

Saturday, January 26, 2008

FINANCE COMMITTEE
8:30 - 10:30 am — California (M)

AAHP PART 2 PANEL
8:00 am - 5:00 pm — Oakland (M)

HPS EXECUTIVE COMMITTEE
Noon - 5:00 pm — President's Suite (M)

Sunday, January 27, 2008

AAHP PART 2 PANEL
8:00 am - 5:00 pm — Oakland (M)

AAHP EXECUTIVE COMMITTEE
8:00 am - 5:00 pm — OCC 202

HPS BOARD OF DIRECTORS
8:00 am - 5:00 pm — California (M)

STANDARDS COMMITTEE
9:00 - 11:00 am — OCC 203

TASK FORCE COMMITTEE
Noon-1:30 pm — OCC 201

Monday, January 28, 2008

RSWB MEETING
9:00 am - Noon — OCC 203

SCIENCE SUPPORT COMMITTEE
10:00 am - Noon — OCC 202

HISTORY COMMITTEE
Noon - 2:00 pm — OCC 202

AWARDS COMMITTEE
2:30 - 3:30 pm — President's Suite (M)

SCIENTIFIC & PUBLIC ISSUES COMMITTEE
3:30 - 5:00 pm — President's Suite (M)

ACCELERATOR SECTION BOD MEETING
8:00 - 9:00 pm — OCC 203

Tuesday, January 29, 2008

LAB ACCREDITATION POLICY COMMITTEE
10:00 am - Noon — OCC 202

LAB ACCREDITATION ASSESSMENT COMMITTEE
Noon - 2:00 pm — OCC 202

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Registration Hours

Jewett Ballroom Foyer

Sunday, January 27 ....3:30-7:30 PM
Monday, January 28.................7:30 AM-3:00 PM
Tuesday, January 29 ....7:45 AM-3:00 PM
Wednesday, January 30.................7:45 AM-Noon

Exhibit Hours

Hall C

Monday	5:30-7:00 PM	Opening Reception
Tuesday	9:30 AM-5:00 PM	
Tuesday	Noon	Lunch in Exhibit Hall
Wednesday	9:30 AM-Noon	

Speaker Ready Room

Convention Center, 201

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

Oakland Marriott City Center
1001 Broadway
Oakland, California 94607
Phone: 510-451-4000; Fax: 510-835-3466

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Elsa Nimmo
Kamran Vaziri

And the many NCCHPS members
who are helping during the meeting

TECHNICAL TOURS

WEDNESDAY, JANUARY 30TH

Port of Oakland
9:00 am-Noon
Due to clearance requirements, no onsite registrations are available.

Lawrence Berkeley National Lab
2:00-4:30 PM
Due to clearance requirements, no onsite registrations are available.

SOCIAL EVENTS

SUNDAY, JANUARY 27TH

Livermore Valley Winery Tour
10:30 AM - 4:30 PM

Welcome Reception **AJ Toppers**
6:00 - 8:00 pm - Included in Registration

This year, a local jazz band will complement the opening reception, Sunday, January 27 from 6:00-8:00 pm. The reception will have hors d'oeuvres, passed and in stations, a cash bar, and a "Jazz" band. This will be a great kick-off for the meeting and an opportunity to reconnect with your friends and colleagues.

MONDAY, JANUARY 28TH

Exhibitor Reception **Exhibit Hall**
5:30 - 7:00 PM

TUESDAY, JANUARY 29TH

Saint George's Distillery **CANCELLED**
2:30 - 5:00 PM

2 ½ Annual Radioactive Open Mic Night!
8:00 - 11:00 PM
Looking for a way to end a great time in Oakland with your friends? Looking for something to do on Tuesday night? Come enjoy classic rock 'n roll music at the hotel. In appreciation of the many musicians in the Health Physics Society, the Northern California Chapter will host the 2½ Annual Radioactive Open Mic Night on Tuesday evening. Admission is FREE to all attendees. There will be a cash bar serving beer and wine.

RECOMMENDED ON-YOUR-OWN EXCURSIONS

Family Fun - There is something about a giraffe that brings out the child in everyone. Start the day with coffee at the Oakland Zoo, which has 345 native and exotic animals of 114 species. Shhhh! Don't tell the kids the trip to Chabot Space & Science Center will be educational. They will be thrilled by the hands-on displays and special exhibits. Then head down the hill for activities tailored to children of different ages and interests. Budding artists will enjoy The Museum of Children's Art, which offers art classes and rotating exhibits of art created by children. Young children and their parents will be charmed by Children's Fairyland, a three-dimensional fantasy world where popular nursery rhymes come to life. The website for additional information on the Zoo is:http://www.oaklandzoo.org/

Historic Fun - Oakland's skyline is dotted with gleaming modern high rises, but signs of yesteryear also abound. Historic homes such as Dunsmuir House and Gardens Historic Estate, the Cohen-Bray House, Camron-Stanford House, Pardee Home Museum, and Preservation Park offer fascinating glimpses of how the wealthy lived in the 19th Century. For history made modern, have lunch in the downtown Old Oakland Historic District. A few blocks away, The African American Museum and Library offers exhibits and research archives in splendid surroundings. In the afternoon, head down to Jack London Square for a walk through one of the nation's few floating museums. Affectionately called The Floating White House, the USS Potomac was Franklin Delano Roosevelt's presidential yacht. For an authentic sip of history, there's Jack London's old drinking hole, Heinhold's First and Last Chance Saloon. End the day by enjoying modern dining at one of the many fine waterfront restaurants.

Local Sporting Events - Don't forget that both the San Jose Sharks (ice hockey) and the Golden State Warriors (basketball) are in the SF Bay area! The Golden State Warriors can be just a BART ride away while you will have to drive to San Jose to see the Sharks.

Fortune Cookie Factory - Just a short walk or ride from the hotel. Watch as the batter mixture is injected into a fascinating machine and comes out the other end as round little cookies. These are then quickly picked up, message inserted and folded, before they go hard. Find out how those words of wisdom get inside the cookie, as well as other Chinese culinary secrets. Receive a bag of the fresh-baked treats and write a fortune that will be put into your own personal cookies. (510) 832-5552

Lawrence Hall of Science (LHS) - LHS is the University of California at Berkeley's public science center, fostering understanding and enjoyment of science and mathematics for audiences of all ages. LHS has developed expertise and experience in communicating science to the public through exhibits, school programs, instructional materials, professional development and public programs for more than 35 years. Established in 1968 at the University of California at Berkeley in honor of Ernest O. Lawrence, UC's first Nobel laureate, Lawrence Hall of Science is a national leader in the development of innovative materials and programs for students, teachers, families, and the public at large. Check the website for additional information: //www.lawrencehallofscience.org/

USS Hornet - Docked in Alameda, just a short distance from the hotel is the USS HORNET. The aircraft carrier USS HORNET is a national treasure, having participated in two of the greatest events of the 20th century -- World War II and the Apollo 11 manned space mission.
Now peacefully moored at historic Alameda Point on San Francisco Bay, the USS HORNET is a timeless memorial to those who defended our American values and to those who have pursued America's technological advancements. Whether its mission was projecting military might in times of war or supporting technological achievements in space exploration, the USS HORNET has continually maintained "A Heritage of Excellence." Check out this website for more information: http://www.uss-hornet.org/

Oakland Art Museum - The Oakland Museum of California provides unique collections, exhibitions and educational opportunities designed to generate a broader and deeper understanding of, and interest in, California's environment, history, art and people. Museum programs are responsive, accessible and meaningful to the public, including school children, teachers, scholars, the immediate Oakland community, and an increasingly diverse California population. Check this website for additional information: http://www.museumca.org/global/department.html

Jelly Belly - If you have a car and willing to drive to Fairfield, CA, you have to visit the Jelly belly factory; the sweet-smelling building where "the Original Gourmet Jelly Bean" was born. Elevated walkways inside the factory offer a bird's-eye view of the bright-colored candies as they pass through their life cycle. Jelly Bellies come in 50 official flavors (chocolate pudding and buttered popcorn among them) and by the time they're polished and ready to be packaged, each one sparkles like a jewel.

Napa Valley Wine Train - Daily Gourmet Rail Excursions Year Round. Three Dining Experiences To Choose from. Check out their website for more information: http://www.winetrain.com/

California State Railroad Museum, Sacramento - The California State Railroad Museum complex consists of six original, reconstructed, and new buildings. Throughout the main Railroad History Museum building, 21 meticulously restored locomotives and cars and numerous exhibits illustrate how railroads have shaped people's lives, the economy, and the unique culture of California and the West. Included are a Pullman-style sleeping car, a dining car filled with railroad china, and a Railway Post Office that visitors can actually step aboard. Check out their website for more information: http://www.csrmf.org/default.asp

Skiing - Let it snow! Let it snow!! Let it snow!!!. There are plenty of ski resorts within a 3-4 hour drive from the Bay Area. If you are planning to spend time before or after the meeting, consider spending time skiing on the slopes. Just some of the ski resorts in the area include; Alpine Meadows, Heavenly, Kirkwood, Mt. Rose, Northstar, Sierra-At-Tahoe, Squaw Valley, Boreal, Donner, and Sugar Bowl.

2008 Meeting Exhibitors

Exhibits are located in Hall C

Thank you to the following Exhibitors for Sponsorship at the 2008 Midyear Meeting:
Canberra Industries

Exhibit Hours

Hall C

Monday	5:30-7:00 PM	Opening Reception
Tuesday	9:30 AM-5:00 PM	
Tuesday	Noon	Lunch in Exhibit Hall
Wednesday	9:30 AM-Noon	

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2009 Midyear Meeting - San Antonio **Booth: 121**

AAHP/ABHP **Booth: 220**
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www.aahp-abhp.org

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RSCS is a leader in Radiological Services including Instrument Sales, Calibration, and Repair, HP Training, and Consulting. We specialize in: decommissioning, LTP/FSS support, regulatory compliance, Groundwater Investigations, REMP services, and assessments. Specialty products include Survey Meter Simulators and HP Software.

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XRF Corporation **Booth: 112**

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XRF Corporation provides the finest hand held radionuclide identifiers and sensors available for homeland security, first responder, nuclear power, environmental and medical applications. The rugged and compact ICS-4000 product line utilizes unique Cadmium Zinc Telluride (CZT) detectors providing high-resolution instruments with superior identification capabilities.

Tuesday Panel Discussion
Accelerators and Nanoparticles
6:00 - 8:00 PM; Rooms 210-211

In light of the fact that nanomaterials are becoming a significant issue at materials research accelerators, the Accelerator Section is sponsoring a panel discussion about the hazards of handling and sampling nanomaterials on **Tuesday, January 29, from 6:00 to 8:00 pm**. Panel discussion members will be Peter Lichty from Lawrence Berkeley National Laboratory, Casper Sun of Dade Moeller Associates and Mark Hoover from NIOSH.

Nanomaterials are one of the latest significant materials research initiatives with large potential future uses. Because these materials have huge surface areas, their chemical properties and their action when absorbed into tissue can be significantly altered. These materials are absorbed directly through the skin and in many cases pass directly through cell walls after deposition in the body. Accelerators are being used to analyze these materials and the number of samples at research facilities is rapidly increasing. We need to be aware that many of the elements used in these materials also have significant neutron cross sections and are readily activated. It is important for facilities that may receive nanomaterials to establish a protocol for sample handling and hazard control prior to the sample arrival. Our goal with the Tuesday evening panel discussion is to relay the latest information about nanomaterial hazards to HPS members and allow those who have not dealt with nanomaterial the opportunity to interact with people in the forefront of documenting and establishing safety criteria for nanomaterial use.

Technical Program

If a paper is going to be presented by other than the first author, the presenter's name has an asterisk (*)

Monday, January 28

7:00-8:00 am — Jewett Ballroom

CEL 1 ANSI N43.1 Standard Draft: Radiation Safety for the Design and Operation of Particle Accelerators
James C. Liu, Lawrence S. Walker
Stanford University, Los Alamos National Laboratory

7:00-8:00 am — Rooms 210-211

CEL 2 Site Planning and Design of Diagnostic Imaging Facilities: R/F, CT, and PET
Melissa C. Martin
Therapy Physics Inc.

8:15 am-Noon — Jewett Ballroom

Plenary Session

Chair: Kevin Nelson

8:15 AM — Welcome
Ron Dellums
Mayor of Oakland

8:30 AM — MAM-A.1
The Three B's: Before, Berkeley, and Beyond
Thomas, R.H.
University of California (retired)

9:15 AM — MAM-A.2
Particle Accelerators in Particle Therapy Facilities: The New Wave
Ipe, N.E.
Consultant, Shielding Design, Dosimetry & Radiation Protection

9:45 AM — BREAK

10:15 AM — MAM-A.3
Health Physics Needs for Accelerator Based Homeland Security Cargo Imaging Systems
Braby, L.
Texas A&M University

10:45 AM — MAM-A.4
Recent Radiation Safety Advances at R&D Accelerators and Future Needs
Rokni, S., Liu, J.
Stanford Linear Accelerator Center

11:15 AM — MAM-A.5
Ion Implantation for Fabrication of Semiconductor Materials and Devices
Current, M.I.
Current Scientific

1:30-5:30 pm — Jewett Ballroom

MPM-A New Accelerator Factilities

Co-Chairs: Thomas Otto, Bob Casey

1:30 PM — MPM-A.1
Health Physics Challenges of New Accelerator Initiatives
Otto, T.
CERN

2:00 PM — MPM-A.2
Shielding Requirements For NSLS-II
*Job, P., Casey, R.**
Brookhaven National Laboratory

2:15 PM — MPM-A.3
Radiation Safety Analysis for High Gradient Laser Acceleration Test Facility (E163)
Sanami, T.S, Tran, H.T, Mao, S.M
Stanford Linear Accelerator Center

2:30 PM — MPM-A.4
The Linac Coherent Light Source at SLAC and Its Radiological Considerations
Mao, S., Sanami, T., Satana, M., Fasso, A., Liu, J., Rokni, S.
Stanford Linear Accelerator Center, KEK

2:45 PM — MPM-A.5
Radiation Safety Design for the Materials Test Station
Kelsey, C.T., Muhrer, G., Pitcher, E.J.
Los Alamos National Laboratory

3:00 PM — BREAK

3:30 PM — MPM-A.6
The Compact Light Source: A Miniature Synchrotron, Part 1
Ruth, R.D.
Lyncean Technologies, Inc.

3:45 PM — MPM-A.7
The Compact Light Source: A Miniature Synchrotron, Part 2
Ruth, R.D.
Lyncean Technologies, Inc.

4:00 PM — MPM-A.8
The Compact Light Source: A Miniature Synchrotron, Part 3
Ruth, R.D.
Lyncean Technologies, Inc.

4:15 PM — MPM-A.9
Laser Wakefield Accelerator Research At LBNL
Kestell, D., Donahue, R., Leemans, W.
Lawrence Berkeley National Laboratory

4:30 PM **MPM-A.10**
The Spallation Neutron Source: Overview of Initial Operations
Freeman, D.
Oak Ridge National Laboratory

4:45 PM **MPM-A.11**
A Review of Photo- and Proton-Induced Statistical Neutrons Generated by High-Intensity Laser Matter Interactions
Singh, M.S.
Lawrence Livermore National Laboratory

5:00 PM **MPM-A.12**
Development of the LBNL 88-Inch Cyclotron Neutron Beamline
Bramble, J.R., Fairchild, R.F., Kestell, D.J., Norris, P., Lyneis, C.
Lawrence Berkeley National Laboratory

5:15 PM **MPM-A.13**
Radiological Safety Analysis for SABER, a Proposed New Experimental Facility at SLAC
Bauer, J.M., Mao, X.S.
Stanford Linear Accelerator Center

1:30-5:00 pm **Rooms 210-211**

MPM-B Shielding and Shield Codes

Co-Chairs: Nikolai Mokhov, Lorraine Day

1:30 PM **MPM-B.1**
Challenges, Advances and Future Needs in Shielding Code Developments
Mokhov, N.V. ***(G William Morgan Lecturer)***
Fermilab

2:00 PM **MPM-B.2**
Comparison of Bremsstrahlung Dose Calculations with Al_2O_3 Measurements
Marceau-Day, M.L.
Louisiana State University

2:15 PM **MPM-B.3**
Accelerator Ion Source Shielding Cask Final Design
Baker, S.I., Boettinger, W., Moore, E.F., Pardo, R.C., Savard, G., Wiedmeyer, S.G.
Argonne National Lab

2:30 PM **MPM-B.4**
Skyshine Radiation - An Overview of the Literature
Elder, D.H., Harmon, J.F., Borak, T.B.
Colorado State University

2:45 PM **MPM-B.5**
Radiation Shielding Analysis of Hospital-Based Medical Radiopharmaceutical Cyclotron Facilities
Chen, H.L., Wey, S.P., Li, S.H.
National Tsing Hua University, Chang Gung University

3:00 PM **MPM-B.6**
Monte Carlo Design of Leakage-Reducing Retrofit for Medical Linac Electron Applicator
Sawkey, D., Faddegon, B.
University of California, San Francisco

3:15 PM **MPM-B.7**
A Shielding Design and Post-Installation Verification for a Tomotherapy Radiation Treatment Machine
Guo, F., Wu, C., Purdy, J.
University of California Davis Medical Center, Yale University School of Medicine and Yale New Haven Hospital

3:30 PM **BREAK**

4:00 PM **MPM-B.8**
Is More Pb the Answer in a Changing Medical Environment?
Banghart, D., Kwofie, J.
Stanford University

4:15 PM **MPM-B.10**
Radiation Safety Design of the J-PARC Linac and 3-GeV Synchrotron
Masukawa, F., Nakane, Y., Matsuda, N., Iwamoto, Y., Nakashima, H., Shibata, T.
Japan Atomic Energy Agency

4:30 PM **MPM-B.11**
Design of a Test Vault for Compact Accelerator Sealed Tube Neutron Generator Operations
Chichester, D., Seabury, E., Zabriskie, J., Wharton, J., Caffrey, A.
Idaho National Laboratory

4:45 PM **MPM-B.12**
CINDER'90 Calculations for the Materials Test Station
Kelsey, C.T., Muhrer, G., Pitcher, E.J.
Los Alamos National Laboratory

5:30-7:00 pm **Exhibit Hall**

Exhibits Opening Reception

Tuesday, January 29

7:00-8:00 am — Jewett Ballroom

CEL 3 Environmental Radiation Monitoring at Accelerators
Sam Baker
Argonne National Laboratory

7:00-8:00 am — Rooms 210-211

CEL 4 Linac Radiation Surveys
Nisy Elizabeth Ipe
Consultant, Shielding Design, Dosimetry and Radiation Protection

8:15-11:45 am — Jewett Ballroom

TAM-A Radiation Detection Instrumentation Selection and Calibration

Co-Chairs: Tom McLean, Dick Olsher

8:15 AM — TAM-A.1
Field Evaluation of a Portable High-Energy Neutron (En>20 MeV) Dose Meter
McLean, T., Olsher, R., Walker, L.S., Duran, M.
Los Alamos National Laboratory

8:45 AM — TAM-A.2
Impact of 10CFR835 Neutron Radiation Weighting Factors on Neutron Reference Fields and Calibration
*Elick, D., Murphy, M., Piper, K., Rolph, J.**
Pacific Northwest National Laboratory

9:00 AM — TAM-A.4
Using Shewhart Charts, an SPC Technique in Assessing Portable Survey Detector Instrument Health
Brown, D.
Shaw E&I

9:15 AM — TAM-A.5
Two Potentially Significant Sources of Neutron RGD Dose Rate Bias: Cf-250 Component in Cf-252 Sources and Fluctuating Survey Meter Sensitivity
Murphy, M., Piper, R.
Pacific Northwest National Laboratory

9:30 AM — TAM-A.6
Stanford Linear Accelerator Center Radioanalysis Laboratory Operations
Brogonia, H., Liu, J., Tran, H., Kerimbaev, M.
Stanford Linear Accelerator Center

9:45 AM — TAM-A.7
Advances in Automation in Instrument Calibration
Rushton, R.O., Pritchett, H.W., Sullivan, P.
Hopewell Designs, Inc.

10:00 AM — BREAK IN EXHIBIT HALL

10:30 AM — TAM-A.8
NACLA Recognition for the HPS Lab Accreditation Program
Keith, L., Slowey, T., Schwahn, S., Swinth, K., Rathbone, B., Gogolak, C., Bakhtiar, S., Bosworth, L.
ATSDR, K&S Associates, US Department of Energy, Consultant, Pacific Northwest National Laboratory

10:45 AM — TAM-A.9
Dose Response of Several Standard Neutron Meters at Various Energies
Radev, R., Singh, M., Moran, M.
Lawrence Livermore National Laboratory

11:00 AM — TAM-A.10
Intercomparison of Selected Rem Meters and Dosimeters in High-Energy Neutron Fields
McLean, T., Olsher, R., Walker, L., Duran, M.
Los Alamos National Laboratory, RP2

11:15 AM — TAM-A.11
Alpha/Beta Counting System, w/Radon-thoron Compensation
Grasseschi, J., Homann, S., Hume, R., Smith, T., Wong, C.
Lawrence Livermore National Laboratory

11:30 AM — TAM-A.12
Monte Carlo Simulation of a GEM-based TEPC for Its Response to High Energy Neutrons
Wang, C., Mandapaka, A., Burgett, E.
Georgia Tech

Noon-1:15 pm — Exhibit Hall

Complimentary Lunch

8:15-9:45 am — Rooms 210-211

TAM-B Regulatory, Legal and Public Concern

Co-Chairs: Ruth McBurney, Jeffrey Chapman

8:15 AM — TAM-B.1
Regulation of Radiation Generating Devices: Challenges and Approaches for State Radiation Control Programs
McBurney, R.E.
Conference of Radiation Control Program Directors

8:45 AM — TAM-B.2
Status Update for Implementation of NRC Regulatory Authority of NARM
White, D.
US Nuclear Regulatory Commission

9:00 AM **TAM-B.4**

An Overview of International Activities in Instrument Calibration

Rushton, R.O.

Hopewell Designs, Inc.

9:15 AM **TAM-B.5**

IEC International Standards under Development on Radiation-Generating Devices

Voytchev, M., Radev, R., Chiaro, P., Thomson, I., Dray, C., Li, J.

Institute for Radiation Protection and Nuclear Safety, France, Lawrence Livermore National Laboratory, Oak Ridge National Laboratory, Tsinghua University, China

9:30 AM **TAM-B.6**

Implication of the Amended 10CFR835 Neutron Weighting Factors on Detector Calibration and Design

Chapman, J.A., Miller, L.F., Croft, S.

Canberra, University of Tennessee

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

10:15 am-12:15 pm **Rooms 210-211**

TAM-C Environmental and D&D Issues

Co-Chairs: Pavel Degtiarenko, Donald Cossairt

10:15 AM **TAM-C.1**

Managing Environmental Radiation at CEBAF: Lessons Learned

Degtiarenko, P., May, R.

Thomas Jefferson National Accelerator Facilty

10:45 AM **TAM-C.2**

Measurement of Pre-Operational Radiation Exposure Level at the Linac Centre of the Lagos University Teaching Hospital, Nigeria

Aweda, M.A.

University of Lagos

11:00 AM **TAM-C.3**

Decontamination of Medical Radioisotopes from Hard Surfaces using Peelable Polymer-Based Decontamination Agents

Draine, A.E., Walter, K.J., O'Neill, M.P., Edgington, G.J., Johnson, T.E.

Colorado State University, Cellular Bioengineering, Inc.

11:15 AM **TAM-C.4**

Diffusion Properties of Tritium in The NuMI Decay Pipe Concrete

Vaziri, K.

Fermi National Laboratory

11:30 AM **TAM-C.5**

Gross Alpha Monitoring at the Hanford Site: Historical Perspectives

Moeller, M.

Dade Moeller & Associates

11:45 AM **TAM-C.6**

A Model for Estimating Radionuclide Concentrations in the Fermilab Industrial Cooling Water System

Cossairt, J.D.

Fermi National Accelerator Laboratory

NOON **TAM-C.7**

Methodology to Evaluate the Public Dose Due to Radioactive Airborne Releases (NESHAPs) from Various Facilities of the Stanford Linear Accelerator Center (SLAC)

Tran, H., Liu, J.

Stanford Linear Accelerator Center

Noon-1:15 pm **Exhibit Hall**

Complimentary Lunch

1:15-3:15 pm **Exhibit Hall**

POSTER SESSION

P.2 Shielding and Internal Scattering in a Digital Radiography Cabinet

Velarde, S., Berry, P.

Los Alamos National Laboratory

P.4 Comparison of Long Double Precision Computer Solution for Decision Levels and Detection Limits with the Poisson-Normal Approximation when the Ratio of the Blank Count Time to the Sample Count Time is an Integer

Potter, W.E., Strzelczyk, J.

Consultant, Sacramento, CA, University of Colorado Health Science Center, Denver, CO

P.5 What an RSO Needs to Know about Portable XRF Analyzers

Blute, J.

Thermo Fisher Scientific

P.6 Body Radioactivity and Radiation Dose from K-40 in Bangladeshi Subjects Measured with a Whole-Body Counter

Rahman, M.S., Mollah, A. S., Begum, A., Zaman, M. A., Islam, M., Cho, G.

Bangladesh Atomic Energy Commission, Jahangirnagar University, Korea Advanced Institute of Science and Technology

P.7 Performance Evaluation of Whole Body Count Measurements by the Marshall Islands Radiological Surveillance Program (2002-2005)

Jue, T., Kehl, S., Hamilton, T., Hickman, D.

Lawrence Livermore National Laboratory

P.8 A New Radiation Monitoring System for the High Intensity Proton Accelator Facility, J-PARC

*Yamamura, S., Fujimoto, T., Itou, K., Ishikura, T., Sakamaki, T., Miyairi, T., Tanaka, E., Nunomiya, T.**

Fuji Electric Co, Ltd.

P.9 Dose Measurements at the Pre-Accelerator Section of the GSI Unilac
Grosam, S., Festag, J.G., Fehrenbacher, G., Vogt, K.*
GSI

P.11 Health Physics Challenges Involving Active, Non-Intrusive Inspection Systems
Ozcan, I., Farfan, E., LaBone, E., Chandler, K., Donnelly, E.
Lawrence Berkeley National Laboratory, Savannah River National Laboratory, University of South Carolina, Idaho Accelerator Center - Idaho State University, Centers for Disease Control and Prevention

P.12 Update of Electron Accelerator Be-7 Production, Associated Problems, and Proposed Remedy
May, R., Murla, J.
Jefferson Lab, Norfolk Naval Shipyard

P.13 Practical RCT Energized Worker Electrical Training
Walker, L., Martinez, T., Johnson, J., Fanning, M., Gordon, L.
Los Alamos National Laboratory

P.14 The Response Change of Radiation Detection Instrumentation to a Magnetic Field Update
Walker, L., Justus, A.
Los Alamos National Laboratory

3:15-5:15 pm Jewett Ballroom

TPM-A Homeland Security Human and Cargo Imaging

Co-Chairs: Chris Morris, Radoslav Radev

3:15 PM TPM-A.1
Tomographic Imaging with Cosmic Ray Muons
Morris, C., Borozdin, K., Fraser, A., Green, J., Hogan, G., Makela, M., McGaughey, P., Priedhorsky, W., Schultz, L., Sossong, M.
Los Alamos National Laboratory

3:45 PM TPM-A.2
ANSI N42.37 The Department of Homeland Security Training Standard
Cox, M.
National Institutes of Standards and Technology/DHS

4:00 PM TPM-A.3
A Mobile Truck Monitoring System
Chiaro, P., Rushton, R.O., Hancock, R., Sullivan, P.*
Oak Ridge National Laboratory, Hopewell Designs, Inc.

4:15 PM TPM-A.4
Use of Californium-252 Neutron Sources for a Continuous Monitoring of Uranium-235 Mass Flow
Uckan, T., March-Leuba, J., Powell, D., Radev, R., Nelson, D.
Oak Ridge National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratory

4:30 PM TPM-A.5
Reducing Radiation Exposures when Operating Active, Non-Intrusive Inspection Systems
Ozcan, I., Farfan, E., Chandler, K., Donnelly, E., LaBone, E.
Lawrence Berkeley National Laboratory, Savannah River National Laboratory, Idaho Accelerator Center - Idaho State University, Centers for Disease Control and Prevention, University of South Carolina

4:45 PM TPM-A.7
Shielding Modeling, Design and Validation Around an 10-MV X-Ray Cargo Container Inspector
Burgett, E., Hertel, N., Starns V.M., Falconer, D., Ferderer, M.*
Georgia Institute of Technology, ScanTech Holdings LLC

5:00 PM TPM-A.8
Air Cargo Explosives Detection Pilot Program (ACEDPP)
Doshi, A.P., Dobie, D.
Lawrence Livermore National Laboratory

3:15-5:30 pm Rooms 210-211

TPM-B Medical Therapy and Imaging

Co-Chairs: Fred Mettler Jr., Cal Huntzinger

3:15 PM TPM-B.1
Medical Radiation Exposure in the United States: 2006
Mettler, F. ***(G William Morgan Lecturer)***
University of New Mexico School of Medicine

3:45 PM TPM-B.2
The Diagnostic and Therapeutic Uses of Ionizing Radiation at the Colorado State University Veterinary Medical Center
Elder, D.H., Harmon, J.F., Borak, T.B., LaRue, S.M.
Colorado State University

4:00 PM TPM-B.3
Epi-Rad90 Epiretinal Delivery Device
Vermeere, W.
NeoVista, Inc.

4:15 PM TPM-B.4
Review of the Radiation Safety Aspects of a Handheld X-ray System for Use in the Healing Arts, Part 1
Turner, C., Harding, D.
Aribex, Inc.

4:30 PM TPM-B.5
Review of the Radiation Safety Aspects of a Handheld X-ray System for Use in the Healing Arts, Part 2
Turner C., Harding D.
Aribex, Inc

4:45 PM **TPM-B.7**

Production of Impurities in a C-12 Ion Beam Traversing an Energy Degrader

Stichelbaut, F., Jongen, Y.
IBA

5:00 PM **TPM-B.8**

Radiation Safety Aspects of the Cyberknife Stereotactic Radiosurgery System

Sorensen, T.
Accuray, Inc.

5:15 PM **TPM-B.9**

Developments in External Beam Radiation Therapy & Radiosurgery

Huntzinger, C.
Varian Medical Systems

6:00-8:00 pm **Rooms 210-211**

Panel Discussion: Accelerators and Nanoparticles

Panel Discussants:
Peter Lichty; Lawrence Berkeley National Laboratory
Casper Sun; Dade Moeller Associates
Mark Hoover; NIOSH

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.**

Wednesday, January 30

8:00-9:15 am — Jewett Ballroom

WAM-A Interlocks and Safety Devices

Co-Chairs: John Anderson Jr., Kelly Mahoney

8:00 AM — WAM-A.1
Accelerator Safety Interlock Systems - Past, Present and Future
Anderson Jr., J.E.
Fermi National Accelerator Laboratory

8:30 AM — WAM-A.4
LANSCE Experimental Personnel Access Control System (EPACS)
Hall, M., Sturrock, J., Gallegos, F., Martinez, M., Henderson, D.*
Los Alamos National Laboratory

8:45 AM — WAM-A.5
Radiological Studies for the LCLS Beam Abort System
Santana Leitner, M., Mao, S., Bauer, J., Rokni, S.
Stanford Linear Accelerator Center

9:00 AM — WAM-A.6
Programmable Safety PLCs and Their Use in Accelerator Safety Applications
Mahoney, K.
Thomas Jefferson National Accelerator Facility

9:15 AM — BREAK IN EXHIBIT HALL

9:45-11:45 am — Jewett Ballroom

WAM-B Radiation Spectroscopy

Co-Chairs: Takashi Nakamura, Allen Brodsky

9:45 AM — WAM-B.1
Challenges and Advances in Neutron Spectroscopy
Nakamura, T.
Tohoku University

10:15 AM — WAM-B.2
Performance Comparison between NaI and HPGe Gamma Spectroscopy Systems for the Purpose of Radioactive Waste Drum Characterization at SLAC
Kerimbaev, M., Liu, J., Sprenger, P., Brogonia, H.
Stanford Linear Accelerator Center, Colorado State University

10:30 AM — WAM-B.3
Simulation versus Reality: An Activation Experiment at SLAC
Bauer, J.M.
Stanford Linear Accelerator Center

10:45 AM — WAM-B.4
Optimizing Detector Designs for Fast Neutron Dosimetry
Brodsky, A.
Georgetown University

11:00 AM — WAM-B.5
High-Energy Neutron Dose Measurement: A 20-Year Perspective, Part 1
Olsher, R.H., McLean, T.D.
Los Alamos National Laboratory

11:15 AM — WAM-B.6
High-Energy Neutron Dose Measurement: A 20-Year Perspective, Part 2
Olsher, R.H., McLean, T.D.
Los Alamos National Laboratory

11:30 AM — WAM-B.7
High Energy Activation Foil Neutron Spectral Unfolding
Walker, L., James, M., Oostens, J., Freeman, D., Nakao, N.
Los Alamos National Laboratory, Campbellsville University, Oak Ridge National Laboratory, Fermi National Accelerator

8:30 am-Noon — Rooms 210-211

WAM-C Radiation Dosimetry

Co-Chairs: Nolan Hertel, Tony Sorenson

8:30 AM — WAM-C.1
Accelerator Dosimetry: Past, Present and Future Needs
Hertel, N.
Georgia Institute of Technology

9:00 AM — WAM-C.2
Testing Recognition of Protective Action Guidance by Emergency Responder
Desrosiers, A.E.
Dade Moeller & Associates

9:15 AM — WAM-C.3
An Approach to Dosimetry for High-Energy Bremsstrahlung Systems Operating in Outdoor Environments
Shannon, M., Hertel, N., Norman, D., Jones, J., Haskell, K.
Georgia Institute of Technology, Idaho National Laboratory

9:30 AM — WAM-C.4
The Usefulness of Accelerator Mass Spectrometry in Retrospective Dosimetry Studies
Hickman, D.P., Bogen, K.T., Hamilton, T.F., Brown, T.A., Cox, C.C., Marchetti, A.A., Martinelli, R.E.
Lawrence Livermore National Laboratory

9:45 AM **WAM-C.5**

Reduction in Personnel Dosimetry Requirements at Argonne APS

Butala, S., Vacca, J.

Argonne

10:00 AM **WAM-C.6**

Utilization of Accelerator Mass Spectrometry in a Real Time Occupational Internal Dosimetry Program

Wood-Zika, A.R., Hamilton, T.F., Mansfield, W.G., Brown, T.A., Langston, R.L., Martinelli, R.E., Cox, C.C., Hickman, D.P., Wong, C.T.

Lawrence Livermore National Laboratory

10:15 AM **WAM-C.7**

Synchrotron Radiation - A Potential Tool for Radiation Biology Studies

Day, D.F., Marceau-Day, M.L., Kim, D.

Louisiana State University Agriculture Center, Louisiana State University-CAMD, Chonnam University

10:30 AM **BREAK IN EXHIBIT HALL**

11:00 AM **WAM-C.8**

Urinary Excretion of Plutonium Isotopes Based on Accelerator Mass Spectrometry: Baseline Measurements from the Marshall Islands

Hamilton, T.F., Brown, T.A., Martinelli, R.E., Tumey, S.J., Kehl, S.R., Bogen, K.T., Buchholz, B.A., Hickman, D.P., Wood-zika, A.R., Langston, R.G.

Lawrence Livermore National Laboratory

11:15 AM **WAM-C.9**

Improved Methodology for Assessing Workplace Uranium Intakes Based on Accelerator Mass Spectrometric Measurements of Uranium-236 (U-236)

Hamilton, T.F., Brown, T.A., Wood-zika, A.R., Tumey, S.J., Martinelli, R.E., Kehl, S.R., Mansfield, W.

Lawrence Livermore National Laboratory

11:30 AM **WAM-C.10**

Evaluation of Aluminum-oxide (Al_2O_3:C) Optically Stimulated Luminescence (OSL) Dosimeters as a Potential Alternative to Thermoluminescent Dosimeters (TLDs) for Remote Dosimetry Services

Homnick, J., Ibbott, G., Springer, A., Aguirre, F.

MD Anderson

11:45 AM **WAM-C.11**

Dosimetry of the Axxent™ Electronic Brachytherapy System

Axelrod, S.

Xoft Inc.

1:30-5:30 pm **Jewett Ballroom**

WPM-A Operational Health Physics

Co-Chairs: Steve Frey, Carter Ficklen

1:30 PM **WPM-A.1**

Operational Health Physics Session Welcome

Frey, S.

Stanford Linear Accelerator Center

2:00 PM **WPM-A.2**

Associated Non-Radiological Hazards from Accelerator Operations

Ficklen, C.

Jefferson Lab

2:15 PM **WPM-A.3**

Radiological Safety Evaluation of RGDs at Oak Ridge National Laboratory

Mei, G., Gillespie, T., Hamley, S.

Oak Ridge National Laboratory

2:30 PM **WPM-A.4**

Failed Gamma Beam Irradiator

Penland, S.L., Wagoner, D.A.

Francis Marion University, Savannah River Site

2:45 PM **WPM-A.5**

Can One Size Fit All? An Integrated Approach to Radiation Generating Device Safety Training UCRL-ABS-233183

*Sprague, D., Barron, D.**

Lawrence Livermore National Laboratory

3:00 PM **WPM-A.6**

Microfabrication Beamlines at the Center for Advanced Microstructures and Devices (CAMD)

*Goettert, J., Marceau-Day, M.L.**

Louisiana State University/CAMD

3:15 PM **BREAK**

3:45 PM **WPM-A.7**

Operational Health Physics of a Medical Radionuclide Production Facility

*Lovato, L., Walker, L.**

Los Alamos National Laboratory

4:00 PM **WPM-A.8**

Elevated Dose Rate Condition at LANSCE Ultra Cold Neutron Facility

Duran, M., Fanning, M., Mansfield, B., Salazar, J., Kelsey, C.

Los Alamos National Laboratory

4:15 PM **WPM-A.9**

The Process of Repairing a Highly Activated NuMI Horn

Lautenschlager, G.

Fermilab

4:30 PM **WPM-A.10**

Radiation Safety and other Aspects of the Gamma Knife Reload

Jacob, N.

Rhode Island Hospital

4:45 PM **WPM-A.11**

Extremity Exposure While Working with Cladding Samples

Torres, M., Ridenour, M., Burtseva, T., Billone, M.*

Argonne National Laboratory

5:00 PM **WPM-A.12**

Health Physics Challenges of Maintaining a Cyclotron with Light and Heavy Ion Beams in the Modern Regulatory Climate

Allen, J., Norris, P., Kestell, D., Lyneis, C.

University of California, Berkeley, Lawrence Berkeley National Laboratory

5:15 PM **WPM-A.13**

Development and Management of an X-ray Safety Program

Fairchild II, R.F., Donahue, C.A.

Lawrence Berkeley National Laboratory

1:45-3:00 pm **Rooms 210-211**

WPM-B Industrial Radiation-Generating Machines

Co-Chairs: Frederic Stichelbaut, Donal Day

1:45 PM **WPM-B.1**

Design of High Performance X-Ray Irradiation Systems

Stichelbaut, F., Bol, J., Cleland, M.R., Herer, A., Mullier, B.

IBA

2:15 PM **WPM-B.2**

Portable X-ray Radiography at a Nuclear Power Plant

Gumnick, J., Simonsen, R.

Exelon Nuclear

2:30 PM **WPM-B.3**

Microfocus X-Ray Tube using Carbon Nanotube Point Electron Emitters

Heo, S., Ihsan, A., Cho, S.

KAIST

2:45 PM **WPM-B.5**

What an RSO Needs to Know about Portable XRF Analyzers

Blute, J.

Thermo Fisher Scientific

3:00 PM **BREAK**

3:30-5:00 pm **Rooms 210-211**

WPM-C Health Physics of Research Facilities

Co-Chairs: Robert May, James Liu

3:30 PM **WPM-C.1**

The Morphology of a Research Accelerator

*May, R., Ferguson, C.**

Thomas Jefferson National Accelerator Facility

4:00 PM **WPM-C.2**

Accelerator Production of Superheavy Elements

Stoyer, N.J., Henderson, R.A., Kenneally, J.M., Moody, K.J., Shaughnessy, D.A., Stoyer, M.A., Wild, J.F., Wilk, P.A., Oganessian, Y.T., Utyonkov, V.K.

Lawrence Livermore National Laboratory, Joint Institute for Nuclear Research

4:15 PM **WPM-C.4**

Advancing the Advanced Light Source (ALS) Through Top-off Operations

Donahue, R., Kestell, D., Heinzelman, K., Donahue, C.

Lawrence Berkeley National Laboratory

4:30 PM **WPM-C.5**

Implications of Accelerator Based Nano-Particle Material Research

Day, L., Walker, L.

Lousiana State University, Los Alamos National Laboratory

4:45 PM **WPM-C.6**

High Energy Radiation Facility using Electron Linac and its Applications at PAL

Lee, H.S., Chung, C.W., Oh, Y.D., Kang, H.S.

Pohang Accelerator Lab./POSTECH

Abstracts

MAM-A.1 Thomas, R. H.; University of California (retired); keblecal@comcast.net

The Three B's: Before, Berkeley, and Beyond

Accelerator radiological protection was born in 1895 concurrently with the discovery of X-rays. For the next sixty years its focus of attention was almost entirely devoted to external photon irradiation. Events which led to the much broader interest in radiations, energies and stopping powers that typify the interest of our profession today are the:
• Annus Mirabilis of 1932; • Manhattan Project (1941-1946);
• Post war period (1945-1965) to which the Berkeley campus of the University of California contributed in a significant way under the leadership of Burton Moyer;
• Understanding of high-energy accelerator radiation environments brought about by experimental studies and computer simulations for the design of high-energy particle accelerators. In the future accelerators will be increasingly used, inevitably leading to increased exposures to neutrons that generate high-LET radiations within body-tissues. Much work remains to place protection standards for high-LET radiations in general and for neutrons in particular on a logical basis.

MAM-A.2 Ipe, N.E.; Consultant, Shielding Design, Dosimetry & Radiation Protection; nisy@comcast.net

Particle Accelerators in Particle Therapy Facilities: The New Wave

In 1930 E.O. Lawrence invented the cyclotron at the University of California at Berkeley. Several years later, his student Robert Wilson while investigating the shielding requirements for the 184 inch cyclotron made an important discovery that the copious amount of protons and ions that were produced had enough energy to penetrate the human body. The large amount of dose in the Bragg peak could be used for the treatment of deep seated cancers while sparing normal tissue. This led to the use of particle accelerators in radiation therapy. We are now witnessing a new wave of these facilities. There are currently about thirty operational particle therapy (PT) facilities worldwide. with another 20 facilities or so are in the planning, design or construction stage. Particle accelerators are capable of accelerating protons and various ions such as helium, lithium, carbon, oxygen and neon to energies that allow the penetration of 30 cm or more in tissue. A typical particle therapy (PT) facility may consist of an injector, a cyclotron or a synchrotron, a high energy transport beam line, several treatment rooms including fixed beam and gantry rooms, and even a research area. During the operation of these facilities, radiation is produced with neutrons being the dominant component outside the shielding. At these facilities maximum proton energies typically range from about 230 to 250 MeV, while carbon ions may have maximum energies of 320 MeV/u to 430 MeV/u. Several vendors provide turnkey designs. The pitfalls of using cookie cutter shielding designs are pointed out. The importance of considering the patient workload, the beam parameters for treatment, the country/state specific regulatory requirements, and the occupancies in the adjacent areas is stressed. Shielding considerations including angular dose profile, spectrum, transmission of various shielding materials (concrete, high density concrete and composite materials) are discussed. Activation is briefly addressed.

MAM-A.3 Braby L.; Texas A&M University; labraby@tamu.edu

Health Physics Needs for Accelerator Based Homeland Security Cargo Imaging Systems

Both transmission and back scatter radiography systems are currently used to inspect the contents of trucks and cargo containers entering this country. Because of reluctance to increase the number of radioactive sources which might be diverted by terrorists there is a preference for the use of radiation generating machines rather than radioisotopes in new imaging systems. Since simple radiography can not recognize some important threat materials new approaches are being developed. A pulsed fast neutron imaging system was developed to detect explosives and some other materials. Homeland Security is currently working with vendors to develop systems which can detect high z items such as special nuclear materials and shielding, when they are concealed among much larger amounts of materials like steel. Plans currently call for utilizing electron accelerators in the 6 to 10 MeV range to produce photon spectra for this purpose. Narrow beams of high energy photons produced by pulsed electron beams create several dosimetry problems. The specifications for most inspection systems intended for routine use require that the annual exposure to individuals operating the system is less than 1.0 mSv. There is also concern about the safety of individuals who may be in the container, or another part of the truck. The allowable dose to these inadvertently exposed individuals determines the maximum dose that can be used for inspection. The operation of accelerators for inspection purposes quickly becomes a very routine task. Individuals operating the systems may be tempted to "streamline" procedures or bypass interlocks in order to make their jobs easier or more efficient. Careful attention to the design of interlocks, operating procedures, and operator training is necessary to maintain radiation exposures as low as reasonably achievable.

MAM-A.4 Rokni, S., Liu, J.; SLAC; james@slac.stanford.edu

Recent Radiation Safety Advances at R&D Accelerators and Future Needs

The development and use of accelerators has been expanded into many areas in the last few decades. The research and development (R&D) type of accelerators cover a large spectrum from large and complex accelerators in national laboratories to those small room-size or tabletop accelerators that are used widely in a dynamic manner in industry. The application of R&D type of accelerators also varies widely. For example, very-high-power accelerators are replacing reactors to produce neutrons for R&D. In addition to high-power, high-energy accelerators for particle and nuclear physics research, many electron accelerators are being built in the world to generate low-energy synchrotron radiation or free electron laser for basic science, or applied research. The development and operations of these different types of accelerators for various applications present opportunities and challenges for radiation safety. Advances in the last decade in the area of radiation safety for the R&D type accelerators are reviewed and summarized in this presentation. Specific areas of interest include calculation tools (e.g., Monte Carlo codes), radiation measurements and instrumentation (e.g., high-energy neutron spectrometry), shielding design for personnel and environmental protection, dosimetry, and safety interlocked systems. Challenges and future needs to address some of the current issues are also discussed.

MAM-A.5 Current, M.I.; Current Scientific; currentsci@aol.com

Ion Implantation for Fabrication of Semiconductor Materials and Devices

Accelerator and plasma-based ion implantation continues to be the dominant means for doping of semiconductor materials for fabrication of microelectronics. In recent years ion implantation has also been increasingly used for fabrication advanced forms of semiconductor materials, in particular, various types of silicon-on-insulator (SOI) substrates for high-performance logic and memories and photonic waveguides and detectors. Materials fabrication can take the form of direct chemical layer formation (by implantation of oxygen to form buried oxide layers) or through formation of splitting plane layers for lamination of heterogeneous materials (by implantation of hydrogen). The requirements for doping of semiconductor device layers continue to push the boundaries of accelerator operations, for example with the use of >5 MeV energies for fabrication of optical sensory arrays. The proliferation of ion types used for doping, in particular the commercialization of large dopant-containing molecules containing 10 to several thousand dopants has extended the useful dose range of ion implantation at the high end and seems to offer dramatically reduced lattice damage mechanisms. All of these developments have led to new ion implantation systems designs that will be examined in terms of the new challenges for radiation and toxic materials exposures.

MPM-A.1 Otto, T.; CERN; thomas.otto@cern.ch

Health Physics Challenges of New Accelerator Initiatives

Today's and tomorrow's flagship particle accelerators are found in research centres, where they are used for fundamental investigations. Scientists wish to explore more and more "exotic" realms of their field and they require higher particle energies, higher particle beam intensities or a combination of both. With beam powers in the megawatt range, radiation protection at future facilities becomes an increasingly complex and demanding task. Shielding against prompt beam loss, and the management of releases of radioactive air are key elements for the protection of the public. High dose rates from activated material will make today's "hands-on maintenance" approach impossible. Future, world-wide unique research facilities will have a rapidly fluctuating, international user community, with needs for safety training and personal dosimetry. Finally, at the end of the accelerator's life time, large volumes of radioactive waste need to be characterised and eliminated. These factors will have a growing impact on the total cost of future high energy/high intensity accelerators. It will be essential to address them as early as possible in the lifecycle of the projects, in collaboration with accelerator scientists, civil engineers and the prospective user community.

MPM-A.2 Job, P., Casey, R.*; BNL; casey@bnl.gov

Shielding Requirements For NSLS-II

Brookhaven National Laboratory has prepared a conceptual design for a new electron synchrotron for scientific research using synchrotron radiation. The project is funded by the Department of Energy. This facility, called the "National Synchrotron Light Source II" (NSLS-II), will provide ultra-high brightness and flux and exceptional stability in the photon beam lines. It will also provide advanced insertion devices, optics, detectors, and robotics, and a suite of scientific instruments designed to maximize the scientific output of the facility. The project scope includes the design, construction, installation, and commissioning of the following accelerators: a 200 MeV linac, a booster accelerator operating from 200 MeV to 3 GeV, and the main ring which stores 500 mA current of electrons at an energy of 3 GeV. It is planned to operate the facility primarily in a top-off mode, thereby maintaining the maximum variation in stored beam current to < 1%. Because of the very demanding requirements for beam emittance and synchrotron radiation brilliance, the beam life-time is expected to be quite low, on the order of 2 hours. Radiation protection requirements for operating this facility are discussed. The characteristics of each of the accelerators and their operating modes are summarized and their impact on shielding assumptions reviewed. The results of the preliminary shielding calculations and the design criteria are discussed for each of the accelerator bulk shield walls.

MPM-A.3 Sanami, T.S., Tran, H.T., Mao, S.M.; SLAC; sanami@slac.stanford.edu

Radiation Safety Analysis for High Gradient Laser Acceleration Test Facility (E163)

The E163, which starts operation in February 2007, is the first high gradient laser acceleration test facility in Stanford Linear Accelerator Center (SLAC). The facility utilizes well focused 70 MeV, 600 mW electron beam provided from existing x-band structure acceleration unit (Next Linear Collider Test Accelerator - NLCTA) for testing various type of laser acceleration unit. After passing through the unit, beam energy is analyzed using a spectrometer magnet. Because the thickness of the E163 enclosure wall is 2 ft and the beam line dose not have any beam containment device, dose rate around the enclosure are calculated for all envisioned beam losses using Monte Calro calculation code, MARS with MCNP option. The beam losses are categorized normal operation, mis-steering condition (likely happen) and mis-steering condition which have design goals of 0.5 mrem/h, 10 mrem/h and 400 mrem/h, respectively. The calculated dose rate results are in good agreement with one by measured which are taken in commissioning survey. The presentation will describe the radiation safety analysis for the E163 facility with beam line components, details of shielding structure, calculation method and survey results.

MPM-A.4 Mao, S., Sanami, T., Satana, M., Fasso, A., Liu, J., Rokni, S.; SLAC, KEK; mao@slac.stanford.edu

The Linac Coherent Light Source at SLAC and Its Radiological Considerations

The Linac Coherent Light Source (LCLS) at SLAC will be the world's first x-ray free electron laser when it becomes operational in 2009. Pulses of x-ray laser light from LCLS will be many orders of magnitude brighter and several orders of magnitude shorter than what can be produced by other x-ray sources available in the world. These characteristics will enable frontier new science in many areas. This paper describes the LCLS beam parameters and its lay-out. The radiological considerations and the shielding design criteria are presented. The specific radiation protection issues, for example, shielding for the Experimental Hall in 0-degree line downstream of electron line, protection for main dump line which used DC magnets, collimator systems in Front End Enclosure and Experimental Hall, are discussed.

This work was supported by Department of Energy contract DE-AC02-76SF00515.

MPM-A.5 Kelsey, C.T., Muhrer, G., Pitcher, E.J.; Los Alamos National Laboratory; ckelsey@lanl.gov

Radiation Safety Design for the Materials Test Station

The Materials Test Station (MTS) is a spallation source facility being designed to irradiate reactor fuels and materials in a fast neutron spectrum for the United States Department of Energy's Global Nuclear Energy Partnership. 800 MeV proton beam at 1.25 mA from the Los Alamos Neutron Science Center (LANSCE) accelerator will be delivered to the MTS target modules yielding a peak fast flux in the fuel module of 10^15 neutrons per cm^2*s. The resulting prompt and residual radiation hazards have been quantified. Conceptual design for required shielding and active protection has been developed to ensure compliance with LANSCE's shielding policy.

MPM-A.6/7/8 Ruth, R.D.; Lyncean Technologies, Inc.; ronald_ruth@lynceantech.com

The Compact Light Source: A Miniature Synchrotron, Parts 1, 2, 3

Past research at Stanford Linear Accelerator Center introduced a new x-ray source concept, a miniature synchrotron light source [1]. This early research led later to the formation of a corporation, Lyncean Technologies, Inc., which has recently completed development of the Compact Light Source (CLS) [2]. The CLS is a near-monochromatic, tunable, homelab-size x-ray source with up to three beamlines that can be used like the x-ray beamlines at the synchrotrons—but it is about 200 times smaller than a synchrotron light source. The compact size is achieved using a laser undulator and a miniature electron-beam storage ring, in other words—inverse Compton scattering from an electron beam in a miniature storage ring. The CLS is designed to produce a photon flux on sample that is comparable to the flux of highly-productive synchrotron beamlines. This presentation will first introduce the basic principles of the Compact Light Source and show how the quality, tunability and flux of a synchrotron beam line can be brought to an x-ray scientist's local laboratory. The construction of the production-prototype CLS, funded by the NIGMS Protein Structure Initiative, is now complete, and the commissioning and testing phase of the CLS prototype is well advanced. The second CLS is under construction as part of the second round of the Protein Structure Initiative [3] The presentation will show details of the storage ring, laser system and x-ray optics and will conclude with initial results of using the prototype CLS to test new imaging techniques.

References [1] Z. Huang and R. D. Ruth, "Laser-Electron Storage Ring", Phys. Rev. Lett., 80:976-979, 1998. [2] Supported by the National Institute of General Medical Sciences, the National Institutes of Health, R44 GM66511 and R44 GM074437. [3] The Accelerated Technology Center for Gene to 3D Structure (ATCG3D) supported by PSI II, the National Institute of General Medical Sciences and the National Center for Research Resources, NIH, U54 GM074961.

MPM-A.9 Kestell, D., Donahue, R., Leemans, W.; Lawrence Berkeley National Laboratory; DJKestell@lbl.gov

Laser Wakefield Accelerator Research at LBNL

The Lasers, Optical Accelerator Systems Integrated Studies (LOASIS) is a core program at Lawrence Berkeley National Laboratory. Headed by Dr. Wim Leemans, the research in the program is centered around a state-of-the-art short pulse, high intensity Ti:sapphire laser system (50 fs, 10 Hz, 100 TW). The laser pulse is focused into a plasma-filled sapphire capillary to accelerate bunches of tightly focused electrons to energies in excess of 1GeV over 3.3cm on the wake of the laser pulse. Thus for the first time a laser-driven accelerator has reached the beam energies typically found in conventional synchrotrons, such as the Advanced Light

Source at LBNL. The program is housed in the building that was used by the Heavy Ion Linear Accelerator (HILAC) to discover a number of heavy elements during the 1950's to 1970's and utilizes existing in-situ HILAC shielding. As the LOASIS program advances beyond 1GeV and develops additional capabilities, such as injecting energetic beams into accelerating cavities, health physics staff at LBNL must ensure that doses to staff remain as low as reasonably achievable (ALARA). Methods to ensure that doses to personnel working in LOASIS are kept ALARA while allowing research and development to continue will be discussed.

MPM-A.10 Freeman, D.; Oak Ridge National Laboratory; freemandw@ornl.gov

The Spallation Neutron Source: Overview of Initial Operations

The Spallation Neutron Source (SNS) provided first beam to target in April of 2006. Since that time, power on target has steadily increased. On August 11, SNS achieved a power of 180 kW, the highest power of any pulsed source in the world. As power levels have increased, induced radioactivity has also increased in various parts of the machine. Several interesting studies have been conducted characterizing radiation levels and radionuclide production. Radiation levels associated with the target system have been measured and analyzed. This paper presents some of the findings of interest. As expected, with sustained proton beam on target, the target mercury shows an exponential rise in activity and an accompanying exponential decay upon beam shutdown. The behavior has been well characterized. Additionally, we were able to characterize the radiation levels associated with other target process systems including various cooling water loops.

MPM-A.11 Singh, M. S.; Lawrence Livermore National Laboratory; singh1@llnl.gov

A Review of Photo- and Proton-Induced Statistical Neutrons Generated by High-Intensity Laser Matter Interactions

Statistical neutrons generated by the high-intensity laser matter interactions were measured for a variety of targets under various irradiation conditions. These measurements were part of the experimental and theoretical efforts to assess the feasibility of fast ignition for achieving higher fusion-energy gain at less total driver energy. The average laser intensity on targets ranged from 10^18 watts/cm^2 to 3 x 10^20 watts/cm2. At these intensities, electrons were generated up to 100 MeV, and protons up to 55 MeV. In this paper we summarize our experimental results and discuss laser-matter interaction physics relevant for generating particle source term for performing radiation shielding calculations. In the near future, Lawrence Livermore National Laboratory (LLNL) will have a facility that will achieve 10^23 watts/cm^2 with a capability to generate GeV energy particles.

(This work was performed under the auspices of the U. S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.)

MPM-A.12 Bramble, J.R., Fairchild, R.F., Kestell, D.J., Norris, P., Lyneis, C.; Lawrence Berkeley National Laboratory; JRBramble@lbl.gov

Development of the LBNL 88-Inch Cyclotron Neutron Beamline

The 88-Inch Cyclotron is a K=140 sector-focused cyclotron with both light- and heavy-ion capabilities operated by the Department of Energy's Office of Science. Protons and other light-ions at high intensities (10-20 (e) microAmp) are accelerated up to maximum energies of 55 MeV (protons), 65 MeV (deuterons), 135 MeV (3He) and 140 MeV (4He). Most heavy ions through uranium can be accelerated to maximum energies that vary with the mass and charge state. To advance the capabilities of the cyclotron, a novel neutron source is under development at one of the five available beamlines. The development of this source presents unique challenges to the physicists, engineers and health physicists involved in the project. Initial runs of the neutron-generating beamline have produced 10E5 neutrons per microAmp per second, with a maximum current of 10 (e) microAmp. These intensities will generate dose rates in excess of 100 mrem/h at 30cm outside the installed beamline shielding. Methods to ensure that doses to personnel working at the cyclotron are kept as low as reasonably achievable while allowing research and development to continue will be discussed.

MPM-A.13 Bauer, J.M., Mao, X.S.; Stanford Linear Accelerator Center; bauerj@slac.stanford.edu

Radiological Safety Analysis for SABER, a Proposed New Experimental Facility at SLAC

The South Arc Beam Experimental Region (SABER) is proposed to be the successor to the now dismantled Final Focus Test Beam (FFTB) area of the Stanford Linear Accelerator Center (SLAC). SABER would be located at the front end of the South Arc, formerly part of the Stanford Linear Collider. Electron beams with energy of 28.5 GeV and power up to 3 kW would permit a variety of experiments and be especially suited for certain beam-physics experiments. The presentation will discuss the radiological safety aspects of this proposed facility. The design for a shielding maze at an entrance way will be introduced. The prompt dose at several penetrations are considered, and air activation and various residual activations estimated. Also, the shielding required for the beam dump to be used during the first year of operation will be described, including results from simulations of the dump with the Monte Carlo program FLUKA.

MPM-B.1 Mokhov, N.V. (**G. William Morgan Lecturer**); Fermilab; mokhov@fnal.gov

Challenges, Advances and Future Needs in Shielding Code Developments

The growing needs of new accelerator and space projects with their respective experiments stimulate new developments of Monte-Carlo codes geared towards enhanced modeling of elementary particle and heavy-ion interactions during transport in realistic micro and macro systems. The challenges arise from extremely high beam energy (up to many TeV) and beam power (up to many MW) which put unprecedented requirements on capability and reliability of simulations codes used in design of radiation shielding for accelerator and detector components, personnel and environment. Space radiation protection is one of five critical enabling technologies identified in the NASA Strategic Plan for human space exploration. That induced new research activities for radiation shielding technologies and code developments. Recent advances in transport codes are described which are impressive in physics, geometry, reliability and user-friendliness aspects. The status of the widely used simulation codes is reviewed. The applications that are motivating new developments in the codes, needs for better nuclear and macroscopic data, recent benchmarking, and future physics improvements are described.

MPM-B.2 Marceau-Day, M.L.; LSU; day@lsu.edu

Comparison of Bremsstrahlung Dose Calculations with Al_2O_3 Measurements

This paper reports on the numerical evaluation of Bremsstrahlung dose characteristics and compares these assessments with experimental measurements using passive integrating devices based on aluminum trioxide for the CAMD 1.3 GeV Storage Ring and 0.2 GeV Linac. All magnets were modeled as Bremsstrahlung dose sources, including all magnets in the horizontal transport line [at 0.2 GeV] and all Storage Ring magnets, including Bending Magnets [1.7T], focusing and defocusing quadrupoles and sextupoles. Particular attention was paid to those elements with limiting apertures. The facility also contains a superconducting wave-length shifter [7T] that was separately modeled. The model was constructed based known predicted values. Due to the forward-directed peak of Bremsstrahlung radiation, this numerical evaluation was predicated on line-source evaluation. The length of the line source was determined as the distance between 2 shielding elements and the dose was assumed to be distributed. All models were calculated with local shielding in place and compared with passive integrating devices both inside and outside the CAMD facility. The results indicate that the present shielding is sufficient to meet all regulatory standards for site boundary dose.

MPM-B.3 Baker, S.I., Boettinger, W., Moore, E.F., Pardo, R.C., Savard, G., Wiedmeyer, S.G.; Argonne National Lab; sambaker@anl.gov

Accelerator Ion Source Shielding Cask Final Design

The Californium Rare Ion Breeder Upgrade (CARIBU) project at the Argonne National Laboratory ATLAS accelerator utilizes fission fragments from a Californium-252 spontaneous fission source as accelerated neutron-rich projectiles for research in nuclear and astrophysics. To obtain a sufficient number of particles on target requires a 37 GBq 252Cf fission source and, consequently, a novel shielding cask. The dual-purpose cask provides shielding for the source during on-site transport, storage, and use. Borated polyethylene is chosen as the cask shielding material to reduce the neutron exposure rate from 46 rem/hour at 30 cm to 0.001 rem/hour. The source is delivered to Argonne from Oak Ridge National Laboratory in a certified shipping cask. It is transferred from the certified cask to the CARIBU shielding cask using manipulators in a hot cell. After on-site transport to ATLAS, the source is transferred from the cask to a gas catcher for fission fragment collection and subsequent acceleration in ATLAS for physics research. A single vertically-opening door allows the source holder with its source to be manually pushed out of the cask into the gas catcher. In order for the gas catcher to operate properly, high gas purity has to be maintained. Use of borated water extended polyester (WEP) in the source holder permits bakeout at 100 degrees C. to avoid excessive outgassing. WEP has superior high temperature properties but provides poorer neutron shielding than polyethylene. We explain in detail how these considerations and others, primarily safety concerns, are addressed in the final design.

MPM-B.4 Elder, D.H., Harmon, J.F., Borak, T.B.; Colorado State University; delder@colostate.edu

Skyshine Radiation - An Overview of the Literature

Skyshine is the term used for radiation that originates near the surface of the earth with an upward velocity and then is scattered back by the molecules in the atmosphere. Skyshine radiation is of concern because it can contribute dose to the public in areas beyond the boundary of the radiation production facility, even in areas which are not in the line of sight of the source. When the Brookhaven Cosmotron and the Lawrence Berkeley Bevatron became operational in 1953 and 1954, the radiation levels in the vicinity of the accelerator facilities were much higher than predicted. This was due to neutrons that had been scattered back to earth. Also, the radiation doses around "hot cells" used to store large quantities of radioactive materials were reported to be high as early as 1957 due to photon scattering. Both of these phenomena were referred to as skyshine radiation. These observations led to a large number of empirical and theoretical studies of radiation propagation and skyshine radiation. The earliest work on neutron skyshine was done by Lindenbaum, and Price was the first to present an analytical approach to photon skyshine.

More recently, computer simulations using Monte Carlo methods and integral-line-beam methods have been applied to both photon and neutron skyshine. These computer simulations have resulted in predicted exposure levels that are in agreement with measurements.

MPM-B.5 Chen, H.L., Wey, S.P., Li, S.H.; National Tsing Hua University, Chang Gung University; alvin.chen@feynman.com.tw

Radiation Shielding Analysis of Hospital-Based Medical Radiopharmaceutical Cyclotron Facilities

The neutron and gamma dose (dose rate) leaking from the self-shielded Sumitomo HM-12S cyclotron for PET radiopharmaceutical production was calculated by FLUKA Monte Carlo code and measured by using commerical Thermo Eberline FHT-751 proportional neutron detector and TLD-100/600/700 which embedded in different layers of cylindrical polyethylene phantom inside the vault of Chang Gung Memorial Hospital. The neutron detector and TLD was calibrated by national lab Cf-252 neutron source and Cs-137 gamma source, the response of neutron detector also calculated by MCNP Monte Carlo code. Three-dimensional distribution of measured dose (dose rate)showed heavy radiation leakages through the interlocks of self shieldings and the gaps between the shieldings and floor. Some designed deficiency also found. Modifications and improvements are evaluated to eliminate the leakages.

MPM-B.6 Sawkey, D., Faddegon, B.; UCSF; daren@sawkey.net

Monte Carlo Design of Leakage-Reducing Retrofit for Medical Linac Electron Applicator

Currently available electron applicators used with Siemens medical linear accelerators may exceed leakage values specified by IEC. It is desirable for customers to be able to retrofit their existing applicators without needing to recommission their treatment beams. We use Monte Carlo simulation (EGSnrc, BEAM) and measurement to determine the source of the leakage; determine the approximate thickness, location, and material of shielding necessary to reduce the leakage to acceptable levels; determine the effect of this shielding on the treatment field; and propose a design concept to meet the dual objectives of reducing leakage while minimizing effect on the treatment beam. Leakage is primarily electrons scattered from the upper scraper, but also from the top of the sidewall. Measurements and simulations show that extra Al shielding, placed on the outside of the sidewall in the region of the upper scraper, and below the upper scraper, of thickness less than or about 1.5 cm, is enough to reduce leakage below IEC specifications while having negligible effect on the treatment beam. A preliminary design shows a worst-case effect on the treatment beam of 1.1%, at the highest energy (21 MeV) and largest field size (25 cm). It is not necessary to shield the lower air gap (used for patient alignment, etc.), because few particles pass through this gap without first scattering from the applicator body.

MPM-B.7 Guo, F., Wu, C., Purdy, J.; University of California Davis Medical Center, Yale University School of Medicine and Yale New Haven Hospital; fanqing.guo@yale.edu

A Shielding Design and Post-Installation Verification for a Tomotherapy Radiation Treatment Machine

Helical TomoTherapy (TomoTherapy Inc., Madison, WI, USA) is a new type of radiotherapy machine. Similar to CT, while the treatment couch is moving into the gantry, the patient gets treated from the rotating gantry. A shielding design was performed before a new TomoTherapy was installed at UC Davis in an existing Varian 600C treatment room. After careful calculations of the primary radiation and secondary ones (including leakage and scatter), an extra layer of 18 cm of concrete equivalent was suggested to be added to a small region by the therapist„3…4s console. While the assumption for design was just a best estimation of the future situation, it is necessary to do post-installation radiation survey and re-calculation under real treatment set-up. Both the survey and re-calculation based on real patient treatment arrangement confirm the rationales of the design. For example, the surveyed doses for all Points of Interest under worst situation are under the recommended national and state permissible levels. One of the critical assumptions, the patient beam-on time, was assumed 6 minute; the actual is 5.9 minutes. The successful experience of UC Davis suggested that extra caution should be taken to deal with the shielding design of new type radiotherapy devices, especially when utilizing old treatment rooms. It also shows that the data from several literatures for TomoTherapy shielding designs are close enough to the real situations.

MPM-B.8 Banghart, D., Kwofie, J.; Stanford Univsersity; dawnb@stanford.edu

Is More Pb the Answer in a Changing Medical Environment?

A rapidly changing medical environment includes upgraded diagnostic machines such as moble CT units, increasing PET/CT demands, on-site cyclotrons and facility retrotfits, all requiring the health physicist to weigh shielding calculations and recommendations against the backdrop of budget issues, existing space and pressures to increase patient load. This paper will discuss the changing landscape of Stanford University’s medical machines and facilities in the past 10 years and the shielding approaches used to meet regulatory requirements and goals.

MPM-B.10 Masukawa, F., Nakane, Y., Matsuda, N., Iwamoto, Y., Nakashima, H., Shibata, T.; Japan Atomic Energy Agency; masukawa.fumihiro@jaea.go.jp

Radiation Safety Design of the J-PARC Linac and 3-GeV Synchrotron

The J-PARC (Japan Proton Accelerator Research Complex) project is in progress, aiming at studies on the latest basic science and the advancing nuclear technology. In the project, the high-energy proton accelerator complex of the world's highest intensity is under construction. The J-PARC consists of three accelerators and three target facilities in the Phase 1 of the project. The accelerators are a 400-MeV Linac for an injector, a 3-GeV synchrotron which provides proton beams of 333 micro-A (1MW), and a 50-GeV synchrotron which provides proton beams of 15 micro-A (0.75MW). The operation of the Linac has already been started with energy of 181-MeV since January 2007, and the beam commissioning of the 3-GeV synchrotron is coming soon. In order to overcome many problems on the shielding design for J-PARC, various shielding design methods were applied with estimating the accuracy of the shielding design method by experimental benchmark analyses. In this paper, we briefly report the methods used for the radiation shielding calculation and their application to the J-PARC Linac and 3-GeV synchrotron.

MPM-B.11 Chichester, D., Seabury, E., Zabriskie, J., Wharton, J., Caffrey, A.; Idaho National Laboratory; david.chichester@inl.gov

Design of a Test Vault for Compact Accelerator Sealed Tube Neutron Generator Operations

A new research and development laboratory has been commissioned at Idaho National Laboratory for operating compact accelerator sealed tube neutron generators. The facility is designed to provide radiation shielding for DT (14.1 MeV) neutron sources with intensities of up to 2 x 10^8 neutrons per second. Shielding at the laboratory is comprised of modular concrete shield blocks with tongue-in-groove features to prevent radiation streaming and includes an entrance maze and a fully integrated electrical interlock system. Analytical calculations and numerical simulations were used in the design process for the building to assess the performance of the shielding walls at achieving sufficient radiation attenuation and external radiation levels. Using Monte Carlo modeling, dose rate contour plots have been generated for the facility to visualize the effectiveness of the shield wall and entrance maze, and to illustrate the spatial profile of the radiation dose field above the facility. Benchmark dosimetry measurements have been taken at the facility using a portable neutron generator and high sensitivity health physics instrumentation which show good agreement between the design calculations and the facility's as-built shielding.

MPM-B.12 Kelsey, C.T., Muhrer, G., Pitcher, E.J.; Los Alamos National Laboratory; ckelsey@lanl.gov

CINDER'90 Calculations for the Materials Test Station

CINDER'90 is a transmutation code that allows nuclide inventories to be calculated with input from MCNPX radiation transport calculations. It is currently being prepared for release through the Radiation Safety Information Computational Center (RSICC). The Materials Test Station (MTS) is a spallation source facility being designed to irradiate reactor fuels and materials in a fast neutron spectrum for the United States Department of Energy's Global Nuclear Energy Partnership. 800 MeV proton beam at 1.25 mA from the Los Alamos Neutron Science Center (LANSCE) accelerator will be delivered to the MTS target modules yielding a peak fast flux in the fuel module of 10^15 neutrons per cm^2*s. Resulting radionuclide inventories have been calculated using CINDER'90 to quantify residual radiation hazards. Code results include the inventories used for accident release source terms, decay photon spectra used for hot cell shielding design, and decay heat profiles used for cooling system design.

TAM-A.1 McLean, T., Olsher, R., Walker, L. Scott, Duran, M.; Los Alamos National Laboratory; tmclean@lanl.gov

Field Evaluation of a Portable High-Energy Neutron (En>20 MeV) Dose Meter

CHELSI is a portable neutron dose equivalent meter designed at LANL for use in leakage fields around high-energy particle accelerators. The instrument uses a digital signal processor to distinguish, in real time, neutron-induced spallation products from external gammas based on the pulse shape discrimination properties of CsI(Tl). In field use, pulse shape information in conjunction with signal pulse height, is used to assign a count-to-dose conversion factor to calculate neutron dose equivalent. The appropriate conversion factors were calculated using the G-value or spectrum-weighted method. A PDA is used to display integrated neutron dose and dose rate to the user. In addition, an estimation of gamma dose rate is also displayed. The shape and energy data can be logged and analyzed off-line using deconvolution routines for a determination of neutron fluence and a more accurate calculation of dose. A description of CHELSI and an outline of the data analysis techniques are followed by a presentation of data obtained in the field including an intercomparison with survey instruments in current use at the Los Alamos Neutron Science Center (LANSCE). The talk concludes with an assessment of CHELSI performance to date and the outlook for the future.

TAM-A.2 Elick, D., Murphy, M., Piper, K., Rolph, J.*; Pacific Northwest National Laboratory; james.rolph@pnl.gov

Impact of 10CFR835 Neutron Radiation Weighting Factors on Neutron Reference Fields and Calibration

The Department of Energy issued an amendment to 10 CFR part 835, the Occupational Radiation Protection requirements effective July 9, 2007. Part 835 of title 10 of the CFR provides the nuclear safety requirements that provide radiological protection for DOE workers and members of the public in a DOE facility controlled area. In this amendment the dosimetric models and dose terms where changed to be consistent with the newer recommendations from ICRP publications 60 and 68. The effect of these changes on the neutron reference fields and calibration will be evaluated and assessed. Review will include ICRU Report 51, Quantities and Units in Radiation Protection Dosimetry and ICRP

Publication 74, Conversion Coefficients for Use in Radiation Protection Against External Radiation of the operational external exposure quantities. This presentation will summarize the review and conclusions made during an assessment of the impact of these changes on neutron reference field and calibration of neutron instruments in use at the Hanford Site. The proposed implementation plan for the Hanford Site will be included in the presentation.

TAM-A.4 Brown, D.; Shaw E&I; dennis.brown@shawgrp.com

Using Shewhart 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 (Shewart Charts) 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. While this work focused on performing all work in Excel the author has reviewed three statistical programs that perform the same functions, some better, and others not as flexibly.

TAM-A.5 Murphy, M., Piper, R.; Pacific Northwest National Laboratory; mk.murphy@pnl.gov

Two Potentially Significant Sources of Neutron RGD Dose Rate Bias: Cf-250 Component in Cf-252 Sources and Fluctuating Survey Meter Sensitivity

There are numerous Cf-252 sources in both the DOE complex and private sector being implemented as Radiation Generating Devices (RGD). Calibration staff at the Pacific Northwest National Laboratory (PNNL) have assessed or identified two potentially significant biases when utilizing RGDs consisting of these sources. Some users and custodians of Cf-252 sources may not be aware of the potentially large influence of the Cf-250 isotope. With its 13.1 year half-life, the influence of spontaneous fission neutrons from Cf-250 effectively slows the decay rate of these sources as they age. Relying on a simple decay of a source using the standard Cf-252 half-life of 966 days can lead to a large discrepancy between the assumed and actual neutron emission rate. If relatively pure Cf-252 sources are implemented initially, this presents primarily a calibration issue and not a significant impact on the management of the RGD. However, it behooves vigilant RGD users, custodians, and qualified experts to be knowledgeable of the relative isotopic content, purification date and assay date of their high activity californium sources. The second issue involves the change in sensitivity versus integrated neutron dose for proportional counter-based neutron survey meters. For the relatively high dose rates that are associated with neutron RGDs in particular, the sensitivity of proportional counter-based instruments can increase significantly over a short time period in a field, and this effect is proportional to the total integrated neutron dose received by the detector. A low percentage of such detectors can show a decrease in sensitivity versus integrated dose. The vigilant RGD user and custodian should be aware of this potential, both in the use and calibration of facility related neutron survey instruments, and whether it may impact the initial RGD characterization/acceptance testing, evaluation of shielding and routine monitoring of the facility. Experiences and the results of measurements performed at PNNL will be related as well as ways to mitigate their influence.

TAM-A.6 Brogonia, H., Liu, J., Tran, H., Kerimbaev, M.; Stanford Linear Accelerator Center; brogonia@slac.stanford.edu

Stanford Linear Accelerator Center Radioanalysis Laboratory Operations

The Stanford Linear Accelerator Center (SLAC) is a research facility that includes a two mile linear accelerator. SLAC operations have the potential to activate the air, accelerator components, shielding, and the soil in and around the accelerator. It is important to detect and monitor these materials in order to minimize the radiological and environmental impacts. The SLAC Radioanalysis Laboratory accomplishes this by providing services to support the SLAC mission and operations. Services include characterizing tritium and other radionuclides in accelerator cooling systems, detecting radionuclides in environmental samples, and characterizing radioactive waste. Details about the Radioanalysis Laboratory operations are described to provide insight into the type of radioactive materials found at SLAC. Information about the counting process, equipment inventory, instrument capabilities, customer profile, and the quality assurance are also included.

TAM-A.7 Rushton, R.O., Pritchett, H.W., Sullivan, P.; Hopewell Designs, Inc.; rorushton@hopewelldesigns.com

Advances in Automation in Instrument Calibration

Within the last several years, the number of radiation instruments that require calibration has increased dramatically due to Homeland Security monitoring. Workload at calibration labs is increasing. To help increase throughput and improve accuracy and record keeping, automation is being applied to irradiators and control systems at calibration laboratories. Part of this effort involves the use of automated software to perform a comprehensive calibration of the irradiator itself. The results of this calibration are incorporated into the automation software so that an exposure rate can be input and the irradiator is configured to produce this rate. For calibration of radiation instruments, the calibration steps for an instrument are recorded in a database. The automated software can then configure the irradiator for each step via a "one-button setup" control on the computer screen. Many new radiation detection instruments come equipped with a computer interface that allows the instrument to be calibrated via computer instead of having to adjust potentiometers. When this program is used in conjunction with the automated irradiator software, the entire calibration process can be streamlined with the result of better production and increased accuracy.

TAM-A.8 Keith, L., Slowey, T., Schwahn, S., Swinth, K., Rathbone, B., Gogolak, C., Bakhtiar, S., Bosworth, L.; ATSDR, K&S Associates, US Department of Energy, Consultant, PNL; skeith@cdc.gov

NACLA Recognition for the HPS Lab Accreditation Program

The Health Physics Society (HPS) is seeking recognition for its Laboratory Accreditation Program (LAP) from the National Cooperation for Laboratory Accreditation (NACLA). The goal is for the HPS LAP to become a nationally recognized accreditating body. Currently, HPS can accredit laboratories that calibrate radiation survey meters or those that produce NIST-traceable radioactive sources. Obtaining NACLA recognition postures HPS for expanding this program to support a broader cross-section of the health physics community. Several significant steps have been completed, and those that remain are being actively engaged.

TAM-A.9 Radev, R., Singh, M., Moran, M.; Lawrence Livermore National Laboratory; radev1@llnl.gov

Dose Response of Several Standard Neutron Meters at Various Energies

The ambient neutron dose response of NRD 9-inch Bonner sphere, Anderson-Braun type neutron rem meter, wide energy range neutron detection instrument (SWENDI-II), neutron personal electronic dosimeters (EPD) and bubble neutron dosimeters were measured at the LLNL's Radiation Calibration Laboratory and D-T neutron generating facility. Two neutron sources with different energy distributions were used: 252Cf fission-neutrons and 14 MeV neutrons generated by a D-T neutron generator. The relative responses of the five neutron dose meters and detectors are compared. The experimental results are also compared with Monte Carlo radiation transport calculations. *(This work was performed under the auspices of the U. S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48. UCRL-ABS-234064)

TAM-A.10 McLean, T., Olsher, R., Walker, L., Duran, M.; Los Alamos National Laboratory, RP2; tmclean@lanl.gov

Intercomparison of Selected Rem Meters and Dosimeters in High-Energy Neutron Fields

This work concerns an intercomparison of neutron rem meters and dosimeters commonly used at the Los Alamos Neutron Science Center (LANSCE). This proton accelerator-based facility consists of 4 experimental areas including the Lujan Center, Proton Radiography (PRAD), Weapons Neutron Research (WNR) and Ultra-Cold neutron target. Each of these facilities utilizes 800 MeV protons on various targets. The facility also has a medical isotope production area. Each of these areas must be routinely surveyed for the neutron component of the occupational dose. Several different rem meters and automated spectroscopy systems are now available for these surveys. Quite often the dose equivalent readings displayed by the survey instruments are not in agreement. To properly interpret these findings, it is necessary that the respective instrument energy responses be known. Unfortunately, this is not always the case. Though some instruments have been modeled using Monte Carlo techniques, the calculations often rely on physics models to provide vital but missing cross-section data. Hence, even the response of modeled instruments must be experimentally validated using well-characterized fields. In this study, the dose response of the Albatross, Eagle, SWENDI, PRESCILA and Thermo NRD rem meters have been investigated in a variety of high-energy fields at the WNR facility. Incident dose was calculated from neutron spectral data obtained using time-of-flight information in conjunction with a U-238 fission chamber. As part of this work, the response of various dosimeters including the LANL track etch detector (PN3) and superheated droplet dosimeters was also investigated. In some cases, it has been possible to combine the WNR data with quasi-monoenergetic neutron data previously obtained at other facilities to get a more complete understanding of instrument response.

TAM-A.11 Grasseschi, J., Homann, S., Hume, R., Smith, T., Wong, C.; Lawrence Livermore National Laboratory; Grasseschi1@llnl.gov

Alpha/Beta Counting System, w/Radon-thoron Compensation

Air sampling is used as a workplace indicator for possible exposures to individuals working in facilities where radioactive materials such as plutonium and americium are handled. It is important that results for these air samples are reported as soon as possible after sample collection, precluding the typical four day delay prior to counting. New solid state silicon alpha/beta detectors are ideally suited to perform this analysis since the alpha results can be compensated for the presence of radon and thoron. Output from these detectors is a multichannel spectrum similar to that of an alpha spectroscopy system. This allows one to compensate the results for the lower energy alpha-particle emitters for spill-down from the higher energy radon and thoron daughters. It also allows for identification of alpha-particle emitting radionuclides present in the sample. This combination provides a unique ability to identify the presence of uranium, plutonium and americium on air filter samples in the presence of radon and thoron soon after sample collection. Real world examples of spectra produced from these detectors are presented and results are compared to LLNL's current alpha/beta ratio algorithm for determining the presence of plutonium and americium on an air filter sample without waiting four days for decay of the radon and thoron daughters. This presentation provides information on using these detectors as standard alpha/beta counters for the analysis of swipe samples. Information on the alpha and beta detection efficiencies is presented and compared to those of traditional gas-flow proportional counters and field scalers with scintillation detectors. The advantage of using a solid state silicon detector for the analysis of swipe samples is the elimination of the need for P-10 counting gas and the potential for identification of alpha-particle emitting radionuclides.

TAM-A.12 Wang, C., Mandapaka, A., Burgett, E.; Georgia Tech; chris.wang@nre.gatech.edu

Monte Carlo Simulation of a GEM-based TEPC for Its Response to High Energy Neutrons

A new neutron rem meter has been under development at Georgia Tech. This new detector is a tissue equivalent proportional counter (TEPC) that has a shape of a square plate. The current design consists of four components - the cathode, the Rexolite sheet, the gas electron multiplier (GEM) foil, and the anode. The cathode is made of conducting plastic, A-150. The anode is made of a copper-coated printed circuit board. The Rexolite sheet is sandwiched between the cathode and the GEM foil, and it has a large number of holes that serve as gas cavities. Each hole (or cavity) is 3 mm (dia.) x 4 mm (height) and is filled with propane-based tissue equivalent gas. During operation the A-150 cathode is held at the ground potential and the anode is held at the positive voltage. A gas gain between 10 and 100 can be obtained by operating the GEM foil with voltages between 490 volts and 550 volts. A neutron event is produced via a recoil proton that enters the gas cavity from A-150. Previous studies showed that such a GEM-based TEPC can have a neutron response curve (i.e. counts cm^2/n) that resembles the shape of the neutron fluence-to effective dose conversion factors (Sv cm^2/n) for neutrons with energies between thermal (0.025 eV) to 10 MeV. In the present study, we use Monte Carlo code MCNP-X version 2.6 to obtain and extend the detector's response to neutrons with energies up to 250 MeV. The goal is to find out if the GEM-based TEPC can be used as a neutron rem meter at proton therapy facilities and other accelerator facilities that produce high energy neutrons.

TAM-B.1 McBurney, R. E.; Conference of Radiation Control Program Directors; rmcburney@crcpd.org

Regulation of Radiation Generating Devices: Challenges and Approaches for State Radiation Control Programs

Since the radiation safety and quality assurance aspects of the use of radiation machines in non-federal facilities is not regulated under federal law (except for mammography), this responsibility has traditionally been assumed by most state and some local governments. In order to provide a uniform and consistent approach to the regulation of radiation throughout the country, the Conference of Radiation Control Program Directors develops suggested regulations and regulatory guidance. The constantly changing technologies involved with radiation machines create radiation safety and other regulatory challenges. Devices such as electronic brachytherapy, hand-held portable x-ray units, and the increased use of machine-based replacements for radiation sources that could pose security risks in medical, industrial, and research facilities pose unique regulatory issues and may not fit into the established regulatory scheme. Most of the replacement technologies involve the use of accelerators, many with highly advanced computer and robotic systems. New approaches to the regulation of emerging technologies are being addressed by CRCPD in concert with other professional organizations and will be discussed in the presentation.

TAM-B.2 White, D.; NRC; dew2@nrc.gov

Status Update for Implementation of NRC Regulatory Authority of NARM

The purpose for this presentation is to provide an update on NRC's efforts to implement the requirements of Section 651(e) of the Energy Policy Act of 2005 for certain naturally-occurring and accelerator-produced radioactive material or NARM. Topics of discussion will include: NRC's final regulations, associated guidance in support of the regulations, and the transition plan to facilitate an orderly transition of regulatory authority.

TAM-B.4 Rushton, R.O.; Hopewell Designs, Inc.; rorushton@hopewelldesigns.com

An Overview of International Activities in Instrument Calibration

In many third world and poor countries, medical imaging and therapy equipment is being introduced at a rapid pace. Calibration programs to support this equipment are being implemented and/or enhanced in many of these countries. This presentation gives an overview of the international calibration programs that support these new standards laboratories. A network of national primary and secondary standards laboratories ensures world-wide uniformity of measurements and traceability to the International System of Measurements. Programs for intercomparison measurements, calibration, and training are coordinated through the French Bureau International des Poids et Mesures (BIPM) that serves as the 1st link in the chain of international measurement systems. Other international organizations provide additional support, training, and standardization. New radiation generating devices are being installed at both new & existing standards calibration labs. A short tour of several of these labs and their radiation generating devices is given to illustrate how they are supporting their national medical and industrial programs. New programs are being established in such countries as Croatia, Kenya, and Moldova. Existing programs are being upgraded in Argentina, Romania, and Albania, amongst others.

TAM-B.5 Voytchev, M., Radev, R., Chiaro, P., Thomson, I., Dray, C., Li, J.; Institute for Radiation Protection and Nuclear Safety, France, Lawrence Livermore National Laboratory, Oak Ridge National Laboratory, Tsinghua University, China; miroslav.voytchev@irsn.fr

IEC International Standards under Development on Radiation-Generating Devices

The International Electrotechnical Commission (IEC) is the leading and oldest global organization with over 100 years history of developing and publishing international standards for all electrical, electronic and related technologies, including radiation detection instrumentation. Subcommittee 45B "Radiation Protection Instrumentation" of the IEC has recently started the development of two standards on radiation-generating devices. IEC 62463 "Radiation protection instrumentation X-ray systems for personnel security screening" is applicable to X-ray systems designed for screening people to detect if they are carrying objects as weapons, explosives, chemical and biological agents and other concealed items that could be used for criminal purposes, e.g. terrorist use, drug smuggling, etc. IEC 62523 "Radiation protection instrumentation Cargo/Vehicle radiographic inspection systems" applies to cargo/vehicle imaging inspection systems using accelerator produced X-ray or gamma radiation to obtain images of the screened objects (e.g. cargo containers, transport and passenger vehicles and railroad cars). The objective of both standards is to specify standard requirements and general characteristics and test procedures, as well as, radiation, electrical, environmental, mechanical, and safety requirements and to provide examples of acceptable methods to test these requirements. In particular the standards address the design requirements as they relate to the radiation protection of the people being screened, people who are in the vicinity of the equipment and the operators. The standards do not deal with the performance requirements for the quality of the object detection. Compliance with the standards requirements will provide the manufacturers with internationally acceptable specifications and the device users with assurance of the rigorous quality and accuracy of the measurements. The main characteristics of IEC 62463 and IEC 62523 standards are presented and as well as the IEC methodology of standard development and approval.

TAM-B.6 Chapman, J.A., Miller, L.F., Croft, S.; Canberra, University of Tennessee; jchapman@canberra.com

Implication of the Amended 10CFR835 Neutron Weighting Factors on Detector Calibration and Design

Neutron dose equivalent is often estimated by direct measurement using a thermal neutron detector encapsulated by a polyethylene moderator. The industry norm in the United States was driven more by neutron fields generated by fission neutrons than by considerations of accelerator-produced neutrons which have the potential to create harder spectra. For accelerator-produced neutrons, the "standard instrument design" for measuring neutron dose equivalent has pragmatically been augmented by a suite of experiments to measure the differential energy spectrum and fold these experimental measurements with the energy dependent behavior of the instrument to create a site-specific correction factor, to be applied to the direct reading which is based on a calibration in a dissimilar spectrum. In more elaborate schemes, the experimental differential spectra are used to modify the instrument moderator assembly such that, in the minds of the site radiation protection staff, the instrument is calibrated by physical compensation directly for that neutron field. In reality whatever the origin of the fast neutrons the energy distribution is highly degraded at reasonable distances from the source due to skyshine, room and other scatter. The spectrum can typically be described by a "degraded" high energy feature with a thermal component the two being connected by a slowing down continuum. This makes the "correction factor" sensitive to the location. In this paper we will examine the potential impact of spectral weighting and whether physical compensation is to be preferred. The backdrop of the discussion is the periodic revision to the energy dependent fluence-to-dose-equivalent conversion factors which in large part stem from revision to the neutron quality factors. To illustrate these issues, we will use neutron spectrum measurements collected from a cyclotron: 10.5 MeV proton beam on O-18 for production of F-18.

TAM-C.1 Degtiarenko, P., May, R.; Thomas Jefferson National Accelerator Facility; pavel@jlab.org

Managing Environmental Radiation at CEBAF: Lessons Learned

The Continuous Electron Beam Accelerator Facility at Jefferson Lab has started into the second decade of successful operation, delivering powerful electron beams with energies up to 6 GeV for use by the Physics community. Major upgrade project is under way with plans to double the accelerator energy and build new experimental facilities. We present the history of the environmental radiation protection program at CEBAF as it was developed, implemented, and routinely operated. Overcoming unique radiation protection challenges at JLab required corresponding unique efforts in our ability to model and calculate radiation fields, measure low level environmental neutron and photon radiation, and work together with the Laboratory Management and users on executing the program. Coming changes in environmental regulations and techniques and ways of their implementation are considered.

TAM-C.2 Aweda, M.A.; University of Lagos; awedama@yahoo.com

Measurement of Pre-Operational Radiation Exposure Level at the Linac Centre of the Lagos University Teaching Hospital, Nigeria

Following the acquisition of a 6 15 MeV ELEKTA LINAC for teletherapy by the Lagos University Teaching Hospital, Nigeria, a pre-operational assessment of the radiological conditions of the new LINAC Center and its environments has been conducted. Exposure levels in the control and supervised areas and offices in the LINAC locality were measured. The environmental radiation survey around the Center was also conducted according to the requirements prescribed by the NCRP and IAEA Basic Safety Standards etc. The 15 MeV is sufficient energy to activate (hí, n) and (hí, p) interactions in some materials found within the locality, thereby enhancing the background exposure level. Radioactivity levels were determined in some samples of the building materials, soils and flowers using a well gamma counter in order to generate baseline data for future assessment of the environmental impact of the use of the LINAC. Statistics of world major cases of radiation accidents show that although the probability of accident with LINAC is low, the consequences when it occurs, constitute serious harms to victims. Such database is very useful in the assessment of long- and short-term environmental impacts of eventual LINAC accidents. 10 samples of the concrete materials, 10 samples of flowers, 10 samples of grasses and 20 samples of soil carefully selected from all over the LINAC Center and its environments were processed and radioactivity counted. The mean exposure level in the control area was 3.4 ± 1.0 ìSv the mean value in the supervised area was 3.7 ± 1.0 ìSv while the mean for adjacent offices was 3.5 ± 1.0 ìSv. The mean of the measured specific activities in the concrete, flowers, plants and soil samples were 664.7 Bq/kg, 214.4 Bq/kg, 205.8 Bq/kg and 410.3 Bq/kg respectively.

TAM-C.3 Draine, A.E., Walter, K.J., O'Neill, M.P., Edgington, G.J., Johnson, T.E.; Colorado State University, Cellular Bioengineering, Inc.; Amanda.Draine @ColoState.edu

Decontamination of Medical Radioisotopes from Hard Surfaces using Peelable Polymer-Based Decontamination Agents

Medical radioisotopes are typically short-lived and decay within a matter of days or weeks. However, down time in a medical facility related to radioisotope contamination is costly and can impact patient care. Although liquid decontamination agents can be used to address this problem, they often require multiple applications with attendant scrubbing and wiping which produces large volumes of low-level radioactive waste. Therefore, research was conducted on the use of low-volume peelable decontamination agents. Testing was performed on hard surfaces, such as vinyl composition floor tiles, which are found in many hospitals, research laboratories, and universities. The tiles were contaminated with Tc-99m, Tl-201, and I-131. Quantitative and qualitative data were obtained for each of three different peelable decontamination agent formulations. Quantitative data included environmental temperature and relative humidity, application thickness, dry time, contact time, and decontamination efficacy on various surfaces and geospatial planes. Qualitative factors included ease of application and peelability, as well as sag resistance and odor of each agent. Initial studies showed that under standard conditions there were reproducible differences in the decontamination efficacies among the three different decontamination formulations.

TAM-C.4 Vaziri, K.; Fermi National Laboratory; Vaziri@fnal.gov

Diffusion Properties Of Tritium In The NuMI Decay Pipe Concrete

Neutrinos at the Main Injector (NuMI), is an experiment to measure the mass and other parameters associated with the neutrino oscillation. The NuMI beam line is located in a 3 degree sloped, one kilometer long tunnel, which crosses several geological strata including the one containing the aquifer. The tunnel acts as a large well. Hydrogeological modeling of the surrounding rock and activation calculations predicted that the activation of the water, all of which flows into the tunnel, was well below the drinking standards. The discovery of larger than expected tritium concentrations in the sump pump at the far end of the tunnel started an extensive investigation. This presentation describes the different measurements of air tritium concentrations, direct production in water and concentration of tritium in the under-drains. The results will described what was learned about the different forms of water in concrete, interaction of the tritiated air moisture with the concrete surface, adsorption of tritium on concrete and measurements of diffusion of tritium through concrete.

TAM-C.5 Moeller, M.; Dade Moeller & Associates; mmoeller@moellerinc.com

Gross Alpha Monitoring at the Hanford Site Historical Perspectives

As part of the Hanford Downwinders Litigation, weekly gross alpha monitoring data for the Hanford Site in southeastern Washington state was tabulated and analyzed for a period of more than 50 years. These data, which were part of a site environmental monitoring program, provide historical perspectives of both operations at the site and of events worldwide. Taken in total, they provide a fascinating record of the activities at the site and the evolution of environmental protection. Specifically, the Hanford perspectives include definitive correlation between the monitoring data and variations in emissions as a result of increased site production, the design and use of emissions control technologies, and operations under upset or accident conditions. Perhaps unexpectedly, the Hanford data also chronicle distant nuclear weapons detonations and the environmental transport of radioactive fallout on a global scale. The worldwide perspectives address the role of Hanford monitoring in determining that the former Soviet Union had detonated their first atomic bomb in late August 1949, and in documenting the levels of radioactive fallout at Hanford from above ground nuclear weapons detonations in Nevada, the Pacific and elsewhere.

TAM-C.6 Cossairt, J.D.; Fermi National Accelerator Laboratory; cossairt@fnal.gov

A Model for Estimating Radionuclide Concentrations in the Fermilab Industrial Cooling Water System

Large particle accelerators, especially those with high power beams of protons and ions, unavoidably produce radionuclides in their bulk shielding and also require large volume process cooling water systems to handle the associated heat loads. This is true at the Fermi National Accelerator Laboratory (Fermilab). As described elsewhere, the Neutrinos at the Main Injector (NuMI) beam facility came on line during 2005. This beamline, including a target, a large decay pipe, and a high power hadron absorber, is located in an underground cavern and, to date, utilizes 200-400 kW of 120 GeV protons. By design, this beamline produces radionuclides in its shielding materials, both natural and engineered, that unavoidably become co-mingled with a high volume discharge to the Fermilab industrial cooling water (ICW) system in the course of the necessarily continual process of tunnel dewatering. Following several months of initial operation of this facility, measurable concentrations of H-3 in the form of tritiated water were identified throughout the ICW system; in both underground piping systems and surface water ponds. It was quickly recognized that the dominant source of the tritiated water among other possibilities at Fermilab is, indeed, the NuMI target station. This was the first identification of measurable concentrations of a radionuclide in the ICW system, an event that motivated an extensive effort to understand these discharges in order to minimize environmental releases. One component of this effort is the development of the mathematical model of radionuclide concentrations in this system discussed here. Both the details of the model are described and its possible future application to water management on the Fermilab site discussed.

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TAM-C.7 Tran, H., Liu, J.; SLAC; hhtran@slac.stanford.edu

Methodology to Evaluate the Public Dose due to Radioactive Airborne Releases (NESHAPs) from various Facilities of the Stanford Linear Accelerator Center (SLAC)

Per the Clean Air Act, the EPA issues the National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities (NESHAPs) requirements to govern radioactive airborne effluents. These regulations prescribe a dose limit of 10 mrem/y (0.1 mSv/y) to the MEI (Maximally Exposed Individual) of general public and a requirement for a continuous monitoring system if a release point can cause > 0.1 mrem/y to the MEI. This paper discusses the methodology for establishing and maintaining a NESHAPs program at SLAC that will comply with the Department of Energy (DOE) requirements. In brief, this paper assesses the types and quantities of airborne radioactivity produced and released by the Stanford Linear Accelerator Center (SLAC) during Calendar Year 2006 (CY06). The resulting dose to the Maximally Exposed Individual (MEI) of the off-site general public from CY06 releases of airborne radioactivity was 0.12 mrem (1.2E-3 mSv). This is well below the regulatory standard. In addition, there is no individual release point within SLAC facilities exceeding the 0.1 mrem/y (0.001 mSv) limit for the continuous monitoring requirement.

TPM-A.1 Morris, C., Borozdin, K., Fraser, A., Green, J., Hogan, G., Makela, M., McGaughey, P., Priedhorsky, W., Schultz, L., Sossong, M.; Los Alamos National Laboratory; cmorris@lanl.gov

Tomographic Imaging with Cosmic Ray Muons

Over 120 million vehicles enter the U.S each year. Many are capable of transporting hidden nuclear weapons or nuclear material. Currently deployed x-ray radiography systems are limited because they cannot be used on occupied vehicles and the energy and dose are too low to penetrate many cargos. We present a new technique that overcomes these limitations by obtaining tomographic images using the multiple scattering of cosmic radiation as it transits each vehicle. When coupled with passive radiation detection, muon interrogation can provide safe and robust border protection against nuclear devices or material in occupied vehicles and containers.

TPM-A.2 Cox, M.; NIST/DHS; morgancx@swcp.com

ANSI N42.37 the Department of Homeland Security Training Standard

In May of 2004 this project was initiated to develop a standard designated ANSI N42.37 for training DHS related personnel to use specific radiation detectors for interdiction and prevention. The relevant types of radiation detectors are specified in 4 ANSI N42 standards: ANSI N42.32 for personal detectors, ANSI N42.33 for portable survey meters. ANSI N42.34 for radionuclide identifiers and ANSI N42.35 for portal radiation monitors. This presentation covers the chronology of the development of the standard, lists some of the major issues discussed and resolved within the standard, names the diverse spectrum of contributing experts, reviews an outline of the content, and describes the evolutionary process used to reach the delivered product. The standard was basically completed in about two years and was published in late 2006. It is now available from ANSI. The standard is entitled "American National Standard Training Requirements for Homeland Security Purposes Using Radiation Detection Instrumentation for Interdiction and Prevention."

TPM-A.3 Chiaro, P., Rushton, R.O.*, Hancock, R., Sullivan, P.; Oak Ridge National Laboratory, Hopewell Designs, Inc.; rorushton@hopewelldesigns.com

A Mobile Truck Monitoring System

Portal monitors are being established at all major entry points to the United States. Within the US borders, there are fixed monitoring points, but relatively few mobile systems. The Transportation Security Administration worked with the Oak Ridge National Laboratory to develop a Transportable Radiation Monitoring System (TRMS). The TRMS consists of two small trailers that can be quickly deployed to a designated location and set up within minutes. Each trailer is 6ft by 12ft long and is designed to be towed by a pickup truck or car. The trailers are positioned on either side of a road such as an interstate rest area or truck stop. As vehicles pass between the trailers, gamma and neutron radiation is monitored by plastic scintillators, sodium iodide detectors, and He-3 neutron detectors. The two trailers work as one system through a wireless interface from the secondary to the master trailer removing the need to run cables across roads. Multiple radionuclides can be identified and screened for medical or suspect isotopes. The TRMS is equipped with generators and solar powered battery back up to operate for days without external power.

TPM-A.4 Uckan, T., March-Leuba, J., Powell, D., Radev, R., Nelson, D.*; Oak Ridge National Laboratory, Lawrence Livermore National Laboratory, SNL; radev1@llnl.gov

Use of Californium-252 Neutron Sources for a Continuous Monitoring of Uranium-235 Mass Flow

The U.S. Department of Energy Fissile Mass Flow Monitor (FMFM) equipment, developed by Oak Ridge National Laboratory, utilizes californium-252 (Cf-252) neutron sources to measure continuously the mass flow of uranium-235 (U-235) in the uranium hexafluoride (UF6) gas streams in uranium-processing facilities. The FMFM uses moderated neutrons emitted by the Cf-252 neutron sources for fission activation of the UF6 gas. The FMFM operating principle relies on the measurement of the gamma rays emitted by the neutron-induced fission products in the stream. The optimal performance of the FMFM is achieved by the use of four Cf-252 sources of 3-4 μg (~7 to 9 * 10 -6 neutrons/s) each. Each neutron source is mounted into a special source plug made of polyethylene. The source plugs are placed in an annular sleeve filled with moderator material (high-density polyethylene) that surrounds the process pipe. The four source plugs with their respective neutron sources are spaced 90^{o} apart around the circumference of the process pipe. The source radiation (gamma rays and neutrons) is shielded with lead and lithiated (5 wt %) polyethylene to meet the applicable radiation safety requirements. The sources are replaced every 2-3 years, before their thermal neutron production degrades to ~60% of their output when they were installed. During installation and handling of the new FMFM sources the source identity and the neutronic characteristics provided by the manufacturer are verified by the use of remotely controlled instruments (a neutron detector system and a remote-control TV camera). These instruments also allow remote monitoring of the source replacement process and eliminate unnecessary radiation exposure. Thus exposure is maintained at "as low as reasonably achievable" levels. Details of the FMFM equipment and operation, the sources, and the radiation shielding, as well as a description of the source replacement and verification methodology and the related instruments are presented.

TPM-A.5 Ozcan, I., Farfan, E., Chandler, K., Donnelly, E., LaBone, E.; Lawrence Berkeley National Laboratory, Savannah River National Laboratory, Idaho Accelerator Center - Idaho State University, Centers for Disease Control and Prevention, University of South Carolina; IOzcan@lbl.gov

Reducing Radiation Exposures When Operating Active, Non-Intrusive Inspection Systems

The United States is working to improve the border security system to readily detect and report attempts to import nuclear material, devices, contraband, and stowaways. About seven million cargo containers reach the 360 active United States ports every year, and, over the next 20 years, this is expected to increase to as many as 30 million per year. However, the current inspection system involves only a fraction of the total number of cargo containers entering the country (about 2 percent). One way that the challenge to improve border security is being addressed is by employing various creative technologies such as active, non-intrusive linear accelerator inspection systems. Of course, as health physicists we have to be concerned about the radiation safety of workers, bystanders, and any possible stowaways (persons attempting to enter the U.S. illegally by hiding in one of these containers). However, few dosimetric studies of these inspection systems have been completed and implemented to evaluate the radiation safety. Recently, researchers at Idaho Accelerator Center of Idaho State University have performed dosimetric evaluations of an active, non-intrusive inspection system. These studies have suggested specific engineering designs to reduce exposures, such as: 1) properly locating the detection system relative to the container, 2) employing fences, locks, warning signs and lights, and 3) conducting a low-dose pre-scan of each container to identify and retrieve any possible stowaways prior to conducting a higher dose scan.

TPM-A.7 Burgett, E., Hertel, N.*, Starns V.M., Falconer, D., Ferderer, M.; Georgia Institute of Technology, ScanTech Holdings LLC; eric.burgett@ors.gatech.edu

Shielding Modeling, Design and Validation Around an 10-MV X-Ray Cargo Container Inspector

ScanTech Holdings is in the process of commissioning an 10-MV fixed target electron accelerator testing facility for inspection of sea-land cargo containers. This testing facility is located in Perry, Georgia and will be used for preliminary testing of the inspection system to direct any design modifications. This high energy cargo inspection system was designed to interrogate and image cargo containers for the presence of illicit nuclear material. Several scoping models were used to arrive at a preliminary shielding design for a generic test facility. Several different cargo container loadings were studied in this set of scoping studies. A former missile refurbishing facility in Perry, Georgia was selected for the actual testing site. The facility was modeled in detail to determine the downfield dose rates from the accelerator using MCNP5. Mesh tallies were used to determine the spatial dose rate profile out to 500 meters from the accelerator. Validation measurements will be conducted once the accelerator is in place. The downfield dose rates will be presented.

TPM-A.8 Doshi, A.P., Dobie, D.; Lawrence Livermore National Laboratory; doshi1@llnl.gov

Air Cargo Explosives Detection Pilot Program (ACEDPP)

At San Francisco International Airport (SFO), DHS is installing and operating dedicated cargo screening capabilities in several airline cargo facilities. These screening checkpoints will be operated by dedicated, TSA-certified screeners. Technology to be deployed in the selected air cargo facilities includes x-ray systems, explosive trace detectors, and automated explosives detection systems. Canine teams also may be used. In the ACEDPP, DHS will test screening technology that has a proven track record in the checked baggage environment. Although cargo is expected to have different challenges than checked baggage, it is important to understand technical and operational issues associated with enhanced cargo screening in different environments. Field data gathered by the ACEDPP will be complemented by modeling and simulation efforts that will allow DHS to understand how the experience gathered at SFO can be applied to other airports. In addition, this data set will be available to researchers developing new technology, and will provide valuable insights for future research, development, deployment and maintenance. Congress directed DHS/S&T in the Department of Homeland Security Appropriations Act of 2006 to conduct a series of pilot programs at three airports to test new concepts for enhancing the screening of air cargo. Air cargo is considered a potential vector for threats to aviation safety, particularly cargo that is transported on passenger aircraft. DHS/S&T is the lead federal agency for this pilot program. Working closely with TSA, DHS/S&T has tasked Lawrence Livermore National Laboratory (LLNL) to serve as the ACEDPP project performer. At SFO, DHS has partnered with SFO management, several airline organizations, and the local TSA staff. LLNL serves as the prime integrator for the ACEDPP work at SFO; additional support is provided by the Transportation Security Laboratory, Pacific Northwest National Laboratory, and Oak Ridge National Laboratory.

TPM-B.1 Mettler, F. **(G. William Morgan Lecturer)**; University of New Mexico School of Medicine; fmettler@salud.unm.edu

Medical Radiation Exposure in the United States: 2006

Medical radiation exposure of the U.S. population has not been systematically evaluated for almost 25 years. In 1982, the per capita dose was estimated to be 0.54 mSv and the collective dose 124,000 person-Sv. The preliminary estimates of the NCRP Scientific Committee 6-2 medical subgroup are that in 2006 the per capita dose from medical exposure (not including radiotherapy) had increased almost 600 percent to about 3.2 mSv and the collective dose had increased over 750 percent to about 970,000 person-Sv. The largest contributions and increases have come primarily from CT scanning and nuclear medicine. The 67 million CT scans accounted for 12 percent of the total procedures and about almost half of the collective dose. Nuclear medicine accounted for about 3 percent of all procedures but 23 percent of the total collective dose. Medical exposure has equaled or exceeded natural background and is now the largest source of radiation exposure to the U.S. population.

TPM-B.2 Elder, D.H., Harmon, J.F., Borak, T.B., LaRue, S.M.; Colorado State University; delder@colostate.edu

The Diagnostic and Therapeutic Uses of Ionizing Radiation at the Colorado State University Veterinary Medical Center

Ionizing radiation plays an important role in the diagnosis and treatment of a variety of diseases. The impact of radiation was almost immediate, with the first report of a medical radiograph appearing within months of Roentgen's discovery of x-rays. Physicians rushed to use radiation for the treatment of a wide range of diseases. Radiation was also implemented by the veterinary profession, and Colorado State University played an important role. In 1915, a veterinarian from Colorado Agricultural College, which later became Colorado State University, published the first paper on diagnostic radiology in veterinary medicine in the United States. Radiation therapy was first performed on companion animals at Colorado State in 1957 using an orthovoltage unit. A cobalt machine was installed in the early 1970s, and the first linear accelerator was installed in 1980. In the fall of

2007 the newest accelerator, a Varian Trilogy, was commissioned. Today, the Diagnostic Radiology Section provides state-of-the-art x-ray, CT and MRI capability to both large and small animal patients. The purchase of a PET/CT machine is on the horizon.

TPM-B.3 Vermeere, W.; NeoVista, Inc.; bvermeere@neovistainc.com

Epi-Rad90 Epiretinal Delivery Device

The Epi-Rad90 Epiretinal Delivery Device is an intraocular administered hand piece intended for the treatment of neovascularization by means of focal delivery of radiation to target tissues. Following a core vitrectomy, the sealed 555MBq Sr-90/Y-90 radiation source is temporarily placed over the lesion by means of a proprietary hand piece. Radiation shielding is an obvious safety concern considered throughout the hand piece design. When in the storage (retracted) position, the radiation source is surrounded by an aluminum inner shield and Densimet outer shield that effectively protects the surgeon and patient during handling and initial positioning. During treatment (source engaged), the source is located within the stainless steel cannula that allows penetration of the beta radiation directly to the site of the proliferative, neovascular tissue. Because the radiation source is primarily beta particles, with a very short range in water and body tissues, very little radiation reaches other tissues. Thus, the well-established side effects of external beam radiation therapy and plaque therapy, i.e., retinal photoreceptor toxicity, radiation retinopathy, cataract formation, and scleral necrosis are minimized or eliminated.

TPM-B.4, TPM-B.5 Turner, C., Harding, D.; Aribex, Inc.; dharding@aribex.com

Review of the Radiation Safety Aspects of a Handheld X-ray System for Use in the Healing Arts, Parts 1 & 2

The NOMAD handheld x-ray system has been in use in dental practices and forensics applications for the last 2 years. It is a first of its kind in the healing arts. During this time the NOMAD has been extensively studied. Many academic studies reviewing the performance and safety of this device are now completed and being submitted for publication and peer review. This paper will present a review of the available studies and will compare the results of these studies to explore the safety and effectiveness of the handheld x-ray. The focus of these studies include, Leakage radiation; Operator exposure from both leakage and scattered radiation; Patient exposure; Image quality; Motion artifacts; Time savings; and clinical inputs. Data will be presented to show that the diagnostic utility is comparable to stationary x-ray systems, potential radiation exposure is well below regulatory limits, image quality is excellent and there are no observable motion artifacts.

TPM-B.7 Stichelbaut, F., Jongen, Y.; IBA; frederic.stichelbaut@iba-group.com

Production of Impurities in a C-12 Ion Beam Traversing an Energy Degrader

The IBA Company develops a Carbon therapy system that is complementary to its proton therapy systems. This system is based on a K=1600 superconducting cyclotron delivering C-12(6+) ion beams at a fixed energy of 400 MeV/u. An energy degrader consisting of a graphite wheel with varying thickness achieves the modulation of C-12 beam energy needed to treat tumors located at various depths. The fragmentation of C-12 ions interacting with this energy degrader produces a large variety of ion species with different mass M and charge Q. Charged particles with the same magnetic rigidity as the C-12 will be transported along the beam line and have the possibility to reach the patient. The PHITS Monte Carlo simulation code has been used to study the transmission of C-12 ions through the graphite degrader and the generation of other ion species such as H-2, He-4, Li-6 and B-10. That study demonstrates that, given the beam line acceptance limits in emitttance and energy, the C-12 transmission efficiency remains acceptable down to 100 MeV/u while the yield of transmitted impurities is below 10-4 per initial ion and is thus negligible.

TPM-B.8 Sorensen, T.; Accuray, Inc.; tsorensen@accuray.com

Radiation Safety Aspects of the Cyberknife Stereotactic Radiosurgery System

Provide a short talk on the radiation safety aspects of the Cyberknife stereotactic radiosurgery system. Include a description of radiosurgery versus radiotherapy, describe the device and its operation. Include a description of a typical facility and describe how the device is used.

TPM-B.9 Huntzinger, C.; Varian Medical Systems; cal.huntzinger@varian.com

Developments in External Beam Radiation Therapy & Radiosurgery

Though traditional radiation therapy and radiosurgery (non-invasive brain surgery) both make use of external radiation beams, the equipment used and treatment modes have developed independently of one another and have generally been used by different groups of medical practitioners. At present, we are seeing a convergence in these two therapeutic methods. This convergence has a number of implications, including increased in-room patient imaging prior to treatment, the need for machines capable of delivering extremely high dose rates, and a growing number of treatments involving much higher total patient doses. As a result, health and medical physicists are encountering new types of equipment, new treatment room shielding requirements, and the possibility of higher staff doses. This paper will provide an overview of these developments and some of their implications for health and medical physicists.

WAM-A.1 Anderson Jr., J.E.; Fermi National Accelerator Laboratory; jea@fnal.gov

Accelerator Safety Interlock Systems - Past, Present and Future

The Accelerator Safety Interlock System (SIS) evolved as a means to protect personnel from the radiological hazards created by the operation of particle beam accelerators. The original system designs primarily utilized relay logic. As the size and complexity of accelerators grew, so did the complexity of the interlock systems. To increase the system reliability, i.e. the probability of the system performing successfully, redundant configurations were used. Although the redundant configurations increased the safety of the systems, the number of components necessary for interlocking large-scale accelerators caused a decrease in the SIS availability and an increase in the mean time to repair. Solid state systems began to replace the complex relay logic systems providing enhanced diagnostics and reduced repair times. The introduction of the Programmable Logic Controller (PLC) took interlock system design into a new era. However, the flexibility provided by the PLC based systems created the new challenge of avoiding common mode programming errors in the design of redundant systems. As the development of the next generation of accelerators progresses, the SIS designer will again be challenged to provide highly reliability, available, and fault tolerant systems.

WAM-A.4 Hall, M., Sturrock, J., Gallegos, F., Martinez, M., Henderson, D.; Los Alamos National Laboratory; sturrock@lanl.gov

LANSCE Experimental Personnel Access Control System (EPACS)

The Radiation Security System (RSS) at the Los Alamos Neutron Science Center (LANSCE) provides personnel protection from prompt radiation due to accelerated beam. The Experimental Personnel Access Control System (EPACS) is a component of the RSS that is designed to be used in experimental beam lines areas to prevent personnel access to hazardous prompt radiation. EPACS was modeled after the primary beam line Personnel Access Control System (PACS) used at LANSCE. It was designed to replace several older personnel safety systems (PSS) with a single modern unified design. Lessons learned from the design of PACS and from the operation over the last 20 years were incorporated into a the design of a redundant sensor, single-point failure safe, fault tolerant, and tamper-resistant system that prevents access to the experimental beam areas by controlling the access keys and beam stoppers. EPACS incorporates beam stopper controls that allow experimenters to insert secondary (local) beam stoppers and thereby gain access to their experimental area. If problems arise with the secondary beam stoppers, access control can be passed to the central control room (CCR) and they can insert primary beam stoppers and release the keys that control access to the experimental area. The design philosophy, lessons learned, hardware design, operation, and limitations of the device are described.

WAM-A.5 Santana Leitner, M., Mao, S., Bauer, J., Rokni, S.; SLAC; msantana@slac.stanford.edu

Radiological Studies for the LCLS Beam Abort System

The Linac Coherent Light Source (LCLS), a pioneer hard x-ray free electron laser is currently under construction at the Stanford Linear Accelerator Center. It is expected that by 2009 LCLS will deliver laser pulses of unprecedented brightness and short length, which will be used in several forefront research applications. This ambitious project encompasses major design challenges to the radiation protection like the numerous sources and the number of surveyed objects. In order to sort those, the showers from various loss sources have been tracked along a detailed model covering 1/2 mile of LCLS accelerator by means of the Monte Carlo intra nuclear cascade codes FLUKA and MARS15. This article covers the FLUKA studies of heat load, prompt and residual dose and environmental impact for the LCLS beam abort system (single beam dump, SBD).

WAM-A.6 Mahoney, K.; Thomas Jefferson National Accelerator Facility; mahoney@jlab.org

Programmable Safety PLCs and Their Use in Accelerator Safety Applications

Programmable Logic Controllers (PLCs) are special purpose commercial off the shelf industrial computers designed for highly reliable monitoring and control. Robust general industrial PLCs have been used with great success in accelerator safety applications for over 15 years. In the intervening time period a new class of PLC, tested and ITL certified for use in safety applications, is developed. Several of the new D.O.E. accelerator projects plan to use this new class of PLC. What distinguishes a Safety PLC from other types? How must the system be managed? Is redundancy still required? How is a safety PLC integrated in to an overall safety management program? In this paper we shall discuss recent work with Safety PLCs and their application to accelerator interlocks and safety systems.

WAM-B.1 Nakamura, T.; Tohoku University; nakamura@cyric.tohoku.ac.jp

Challenges and Advances in Neutron Spectroscopy

High-energy and high-intensity particle accelerators are increasingly used for various purposes. Radiation environment around these accelerator facilities is dominated by high-energy radiation, especially high-energy neutrons, of strong penetrability. Radiation spectroscopy, especially neutron spectroscopy is a very challenging work. Here in this kick-off talk, the recent development of various new sophisticated neutron spectrometers is described. For neutrons of energies beyond 100 MeV, the self-TOF detector using the NE102A plastic scintillators, large-scale NE213 organic liquid scintillator, and spallation detectors of C and Bi have recently been developed by our group, especially for use in neutron target and shielding experiments. Inorganic scintillators such as BaF2, NaI(Tl) and CsI(Tl) are also used for neutron spectroscopy of energy above 20 MeV. For use in the charged particle and neutron mixed field, the following detectors are realized: 1) Phoswich detector which combines the NE115 plastic scintillator and the NE213 scintillator, or the CWO and CsI(Tl) scintillators, 2) Anti-coincidence detector system using DE and E counters. Bonner sphere spectrometer (multi-moderator detector) mounted 3He counter, 6LiI(Eu) scintillator, In activation detector and so on, have been widely used for neutron spectroscopy in the wide energy range from thermal up to 1 GeV. But it is still very difficult to measure neutrons having much higher energy beyond GeV and the detector development for such very high-energy neutron measurement will be a future challenging work. In the neutrino beam facility, muon spectroscopy will be also needed, especially in the forward direction.

WAM-B.2 Kerimbaev, M., Liu, J., Sprenger, P., Brogonia, H.; SLAC, CSU; kerimbae@slac.stanford.edu

Performance Comparison between NaI and HPGe Gamma Spectroscopy Systems for the Purpose of Radioactive Waste Drum Characterization at SLAC

This paper describes study that was conducted for the purpose of determining radionuclide identification capabilities and operational parameters of two portable gamma spectroscopy systems for the characterization of the radioactive waste drums. These two systems are the BNC (Berkeley Nucleonics Corporation) Surveillance and Measurement System (SAM) with NaI detector and the ORTEC system with High Purity Germanium Solid State Detector (HPGe). Activated radioactive waste can be generated at the Stanford Linear Accelerator Center (SLAC). Activation occurs when accelerator parts are exposed to the high energy, generally, above 10 MeV beam. There is variety of the activated radionuclides Co-60, Mn-54, Na-22 etc. The activated materials must be characterized to identify and quantify radionuclides to meet requirements for shipping, storage and ultimate disposal. The current waste drum characterization method utilizes the SAM developed by to locate the hot spot on the drum surface, acquire dose rate and spectra, and identify isotopes. The purpose of this report is to compare the performance of the SAM to that of a portable High Purity Germanium (HPGe) detector, in characterizing of waste drums, taking into consideration usage, efficiency, sensitivity, isotope identification and complexity of operations.

WAM-B.3 Bauer, J.M.; Stanford Linear Accelerator Center; bauerj@slac.stanford.edu

Simulation versus Reality: An Activation Experiment at SLAC

As Monte Carlo particle transport programs allow increasingly detailed predictions for both prompt and residual radiation, new experiments are warranted to test the accuracy of these results. One such experiment was performed recently at the Stanford Linear Accelerator Center (SLAC) in collaboration with CERN. It irradiated various samples under controlled conditions by placing them next to a copper dump hit by 20 W of 28.5 GeV electrons. The samples were placed to the side or downstream of the dump, were removed after a few hours to a few days in the radiation field, and were measured over several weeks with a gamma spectrometer and dose rate meter to identify the types and amounts of radioactive isotopes created and to measure the dose rates over time. The presentation will describe the experiment, the gamma spectroscopy and dose rate measurements, the simulations, and how the real measurements compare to the Monte Carlo predictions.

WAM-B.4 Brodsky, A.; Georgetown University; Albrodsky@aol.com

Optimizing Detector Designs for Fast Neutron Dosimetry

Solid hydrogenous compounds can be used to infer a fast neutron spectrum N(E) and dose from a proton recoil spectrum P(E) by the equation derived previously: N(E) = -(E/s(E)D) dP(E)/dE, where E is the variable energy on the proton or neutron scale, s(E) is the neutron-proton scattering cross-section, and D is the density of protons in the solid detector material. This equation is valid regardless of the directional distribution of the incident neutrons. Therefore, optimization of detection and dosimetry may be obtained by: selecting the appropriate solid angles to be subtended by the detector at the points on the neutron source of interest; shielding parts of the detector volume to minimize the need for "end effect" spectrum corrections from loss of protons from the field of view at edges of the finite detector; and designing light piping for scintillation detectors, or viewing geometries for measuring tracks, so that proton energies can be viewed outside the exposed parts of the detector for minimum spectral distortion.

WAM-B.5, WAM-B.6 Olsher, R.H., McLean, T.D.; Los Alamos National Laboratory; dick@lanl.gov

High-Energy Neutron Dose Measurement: A 20-Year Perspective, Parts 1 & 2

High-energy (>20MeV) real-time neutron dose measurements have traditionally presented a challenge around particle accelerators. Conventional rem meters such as the Andersson-Braun (AB) and Hankins designs feature a pure polyethylene moderator and neutron absorber surrounding a thermal detector. Such designs provide a reasonable rem like response over a limited energy range from thermal to about 7 MeV. Over the past two decades, considerable effort has been directed at enhancing and extending the high-energy response of conventional rem meters through the use of a "heavy metal" insert. The purpose of the heavy metal is to generate additional neutrons via evaporation and spallation reactions. Two examples are LINUS, a modified AB rem meter with a 1-cm thick cylindrical lead insert, and WENDI, a Los Alamos rem meter design with a tungsten powder insert. In the late 1990s, a lightweight rem meter

(PRESCILA) was developed at Los Alamos which features an extended energy response to several hundred MeV. An array of four proton-recoil scintillators surrounds a Lucite (TM) light guide, and a single thermal element is located within the light guide. The inherent pulse height advantage of proton recoils over electron tracks in the phosphor grains eliminates the need for pulse shape discrimination and facilitates operation with off-the-shelf health physics counters. Over the past five years, CHELSI, a portable high-energy (>20 MeV) neutron spectrometer has been developed at Los Alamos. Based on the inherent pulse shape discrimination properties of CsI(Tl), the instrument flags charged particle events produced via neutron-induced spallation events. Scintillation events are processed in real time using digital signal processing. Pulse height and pulse shape information is used to infer the underlying neutron spectrum and calculate the corresponding dose equivalent. An overview of the design and performance capabilities of the above instruments will be presented.

WAM-B.7 Walker, L., James, M., Oostens, J., Freeman, D., Nakao, N.; Los Alamos National Laboratory, Campbellsville University, Oak Ridge National Laboratory, Fermi National Accelerator; swalker@lanl.gov

High Energy Activation Foil Neutron Spectral Unfolding

Experiments used to identify the radionuclides of interest in the high energy foil activation analysis are now complete. A suite of radionuclides peculiar to each activation foil have been identified, and in addition, our latest experiment identified nobium (Nb) as new foil with ideal properties. A new set of MCNPX cross section calculations were completed this fall. After the cross section matrixes are input into Mathmatica, we will have the first opportunity to attempt unfolding neutron spectra. The foil set now includes: As, In, Tb, Ho, Ta, Ir, Au, Bi and Nb. The first set of cross section calculations were based upon a foil set modeled inside of a five inch Bonner sphere and used the Bertini model in the Monte Carlo N-Particle Transport Code, High Energy Version (MCNPX). We now believe that it the Cascade Exciton Model (CEM) may be more appropriate for this case. CEM more properly models the low (<1 GeV) energy processes. It is hoped that the new (n, xp, yn) cross section functions will expand the energy range of this new neutron spectral unfolding system. The first cross section calculations only included the (n, xn) reactions and thus left out a great deal of the information available to complete the unfolding process. Recent experiments have shown that at higher neutron energies, the (n, xp, yn) reactions begin to dominate the radionuclide production and thus must be included in the unfolding process. The initial calculations indicated that covering the foils with lead would change the response of the foils and might enhance the unfolding process. Experiments have also been conducted with covered and uncovered activation foils to clarify that hypothesis.

WAM-C.1 Hertel, N.; Georgia Institute of Technology; Nolan.hertel@me.gatech.edu

Accelerator Dosimetry: Past, Present and Future Needs

The techniques used in accelerator radiation dosimetry in the past and currently will be reviewed. The present techniques will be discussed in light of the complexity of dose equivalent quantities since neutrons are one of the radiations that need to be considered at many accelerator facilities. The impact of changes to the internationally recommended quantities on current techniques will be addressed. Advances in dosimeters and dosimetry techniques will be reviewed.

WAM-C.2 Desrosiers, A.E.; Dade Moeller & Associates; radcorder@verizon.net

Testing Recognition of Protective Action Guidance by Emergency Responder

Now that weapons of mass destruction are in the planning basis for radiological events, the response efforts will involve large numbers of relatively untrained personnel who must provide fire, rescue and response efforts. The personnel who must function prior to the arrival of the radiological experts must be able to independently detect radiation fields, quantify their doses, and decide protective action guidance. To support this decision requirement, a visual radiation dosimeter was designed to integrate dose measurement and action guidance. This paper relates lessons learned in developing methods to test the ability of emergency responders to use radiation detectors to accurately quantify dose and determine the associated protective action guidance. In this process, we have leaned that methods suitable for highly trained technical personnel must be modified in order to suit the needs of the broader emergency response community. In the new paradigm, radiological instrumentation will be operated by personnel whose major function is not radiation protection, but firefighting, security, or emergency medical services. The instrumentation must be designed for operation by users with minimal training and the training must be adapted to this new class of users. This paper will report actual testing results for a new class of colorimetric radiation detector intended for emergency response personnel.

WAM-C.3 Shannon, M., Hertel, N., Norman, D., Jones, J., Haskell, K.; Georgia Institute of Technology, Idaho National Laboratory; mshannon3@gatech.edu

An Approach to Dosimetry for High-Energy Bremsstrahlung Systems Operating in Outdoor Environments

The Idaho National Laboratory (INL) is engaged in ongoing research to develop technologies for homeland defense and national security applications. These technologies rely on accelerator-based (currently 20 MeV electron beams) bremsstrahlung sources which interact with suspect materials and cause photonuclear reactions. Recently, this research was moved from an indoor laboratory setting to an outdoor environment. These new operating conditions bring many challenges from operating an accelerator outdoors to performing dosimetry assessments and measurements. The INL team has partnered with a team from Georgia Tech to perform research relative to conducting the aformentioned dosimetry assessments and measurements. The current focus is on the gamma-ray contribution to the total dose although neutron assessments and measurements are also underway. The research involves numerical modeling, in-beam and out-of-beam realtime measurements, as well as determining the response of various detectors in this pulsed environment. Several detectors have been used to characterize the beam including gas-filled ion chambers, air-filled ion chambers and parallel plate ion chambers. Additionally, optically stimulated luminescent (OSL) dosimeters and thermoluminescent dosimeters (TLDs) are being used to measure relative dose both in and out of the beam. This paper will provide a current status of this ongoing research and present data from various measurements and MCNP models.

WAM-C.4 Hickman, D.P., Bogen, K.T., Hamilton, T.F., Brown, T.A., Cox, C.C., Marchetti, A.A., Martinelli, R.E.; Lawrence Livermore National Laboratory; dhickman@llnl.gov

The Usefulness of Accelerator Mass Spectrometry in Retrospective Dosimetry Studies

In 2001 Lawrence Livermore National Laboratory initiated a Laboratory Directed Research and Development project to evaluate the application of accelerator mass spectrometry to analyze Pu-239 in archived bioassay samples collected for routine occupational worker monitoring. This project successfully applied accelerator mass spectrometry (AMS) to recover previously inaccessible information concerning short- and long-term urinary excretion patterns of Pu-239 for a set of eleven personnel, who were periodically monitored at LLNL via urine sampling over multiple decades. AMS analysis was performed on residue that was removed from archived alpha spectrometry discs that were originally generated as an end product of processing routinely collected urine samples. AMS methods are substantially more sensitive (50- to 300-fold) than alpha spectrometry and it was possible to reconstruct detailed patterns of historical Pu-239 excretion and compare these patterns with known or potential intake situations in the work environment. The sensitivity of the technique is sufficient to detect low-level exposures 20 or more years post exposure. Results of this research facilitate application of ultra-sensitive Pu-detection technology to occupational safety, nuclear security goals, and retrospective dosimetry. This presentation will review the methods and results of the study and will present some of the observed excretion patterns relative to known exposure and sample processing issues.

This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

WAM-C.5 Butala, S., Vacca, J.; Argonne; sbutala@anl.gov

Reduction in Personnel Dosimetry Requirements at Argonne APS

The Advanced Photon Source at Argonne National Laboratory uses 7 GeV electrons to produce high intensity X ray beams for experiments located on 50 separate beamlines. The original shielding design basis was to reduce prompt radiation levels to less than 0.25 mrem/hour at accessible locations adjacent to the storage ring and experiment hutches. This implies a maximum annual radiation dose of 500 mrem to a person who spends 2000 hours in the operating facility. A retrospective analysis of shielding validation active radiation surveys, personnel radiation dosimeter reports, and area monitor dosimeter results was performed in 2007. This review was done with respect to the DOE 10 CFR 835 monitoring requirement for persons “likely to exceed” 100 mrem in a year. The data examined spans a twelve year operating period, and evaluates data from 66,000 personnel dosimeters, 3,000 TLD area monitors, and hundreds of prompt radiation validation surveys. As a result, the experiment hall was able to be de-posted from its radiological Controlled Area status and the requirement for radiation dosimetry on the floor of the experiment hall was rescinded. This talk will present a summary of the analysis and discuss other factors which allowed this decision to be made.

WAM-C.6 Wood-Zika, A.R., Hamilton, T.F., Mansfield, W.G., Brown, T.A., Langston, R.L., Martinelli, R.E., Cox, C.C., Hickman, D.P., Wong, C.T.; Lawrence Livermore National Laboratory; woodzika1@llnl.gov

Utilization of Accelerator Mass Spectrometry in a Real Time Occupational Internal Dosimetry Program

In 2003 Lawrence Livermore National Laboratory (LLNL) began utilizing accelerator mass spectrometry (AMS) to analyze Pu-239 and Pu-240 as a supplemental technique to its routine DOELAP accredited alpha spectroscopy analytical method. The AMS analysis has been applied to over 250 samples, including both reprocessed alpha spectroscopy disc material and investigatory urine samples. The AMS technique reliably provides detection levels of less than 1 microbecquerel, typically on the order of about 0.2 microbecquerels. This detection capability is greater than 100 times more sensitive than the routine alpha spectroscopy technique. The sensitivity of the AMS technique has enabled the LLNL Internal Dosimetry Program to confirm the presence of low-level intakes not initially identified by workplace monitoring or alpha spectroscopy analysis, resolve excretion patterns for Pu-in-urine levels well below the alpha spectroscopy detection levels, investigate sporadic or barely detectable alpha spectroscopy results, estimate intake time frames and solubility information from retrospective analysis of historical routine samples, and determine source terms based on the Pu-240 to Pu-239 ratio. Use of AMS has the benefit of identifying previously unrecognized low-level Pu impurities/contaminants within the routine Pu-in-urine bioassay chemical processing methods. This presentation will review the AMS technique used at LLNL, review significant achievements, and provide a plan for continued use of AMS as part of LLNL's Internal Dosimetry Program. This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

WAM-C.7 Day, D.F., Marceau-Day, M.L., Kim, D.; LSU Ag. Center, LSU-CAMD, Chonnam University; dday@agctr.lsu.edu

Synchrotron Radiation - A Potential Tool for Radiation Biology Studies

X-rays produce photolysis of water, giving rise to reactive oxygen species, including, but not limited to hydroxyl radicals [OH], peroxide radicals and singlet oxygen. Studies on the effects of X-rays on biological materials is complicated by the peripheral damage caused by these radicals, and the biological repair mechanisms triggered by their presence. A tunable X-ray source, using synchrotron radiation, offers a method of assessing specific radiation damage to biological systems. A micromachining beamline equipped with a Jenoptik scanner was used to expose eukaryotic and prokaryotic cells, in a dried state, with a specific X-ray spectrum and damage to DNA was monitored using genetic manipulation techniques. The spectrum was hardened and the overall flux diminished by modulating with various thicknesses of Aluminum. Kill curves were generated for live cells. In addition to the radio-biology effects, these experiments were designed to select for mutations in microorganisms that could then be used in the development of alternative bio-based fuels. The DNA sequences of many industrially important micro-organisms have not been elucidated. This precludes the use of site-directed mutagenesis techniques for these organisms. Results indicate that isolated DNA could be fragmented by this process leading to non revertible characteristics when transformed back into the host. The authors believe this is the first report of mutations in isolated DNA as a consequence of exposure to synchrotron radiation. The high incidence of double stranded breaks with X-rays found with synchrotron radiation as opposed to the dimerization seen with UV mutagenesis, suggests that synchrotron radiation may be valuable for the production of mutants and the use of the dry cell technique may aid in the elucidation of biological effects of radiation on living systems.

WAM-C.8 Hamilton, T.F., Brown, T.A., Martinelli, R.E., Tumey, S.J., Kehl, S.R., Bogen, K.T., Buchholz, B.A., Hickman, D.P., Wood-zika, A.R., Langston, R.G.; LLNL; hamilton18@llnl.gov

Urinary Excretion of Plutonium Isotopes Based on Accelerator Mass Spectrometry: Baseline Measurements from the Marshall Islands

Assessments of plutonium exposure and uptake are most commonly assessed using urinalysis based on alpha-spectrometric measurements of Pu-239+240. These measurements fail to meet basic performance criteria for radio-bioassay and internal dosimetry as established under the United States Department of Energy (DOE), Code of Federal Regulations, Part 835 (10 CFR 835). Many internal dosimetry programs exploit a clause in the regulations which tolerates non-compliance through existence of a 'technological shortfall'. Accelerator Mass Spectrometry (AMS) and other competing 'atom counting' technologies provide much improved detection sensitivities for long-lived radionuclides such as Pu-239 and Pu-240. The Center for Accelerator Mass Spectrometry (CAMS) heavy element measurement system at the Lawrence Livermore National Laboratory (LLNL) is considered to be the cutting edge technology for this stated purpose, far exceeding the requirements of the United States Department of Energy (DOE) regulation stated in 10 CFR 835 for in-vitro bioassay monitoring of plutonium isotopes. In recent years, we have utilized this new measurement capability as part of a radiological surveillance monitoring program at former nuclear test sites in the Marshall Islands. High quality plutonium bioassay data developed under this program appear to re-define the baseline for urinary excretion of plutonium from people living in the Northern Hemisphere, and challenges previous assumptions about residual systemic burdens of plutonium acquired from previous exposures to world-wide fallout contamination. We will present an overview of AMS applications at LLNL as well as some interesting findings on age-related trends in urinary excretion of plutonium at the sub-microbecquerel level from baseline cohort populations in the Marshall Islands. Work was performed under the auspices of the U.S. Department of Energy at Lawrence Livermore National Laboratory under contract W-7405-Eng-48.

WAM-C.9 Hamilton, T.F., Brown, T.A., Wood-zika, A.R., Tumey, S.J., Martinelli, R.E., Kehl, S.R., Mansfield, W.; Lawrence Livermore National Laboratory; hamilton18@llnl.gov

Improved Methodology for Assessing Workplace Uranium Intakes Based on Accelerator Mass Spectrometric Measurements of Uranium-236 (U-236)

Heavy-element accelerator mass spectrometry (AMS) provides a highly sensitive, accurate, and robust technique for measuring actinide elements at ultra-low concentrations. The development of heavy element AMS at the Lawrence Livermore National Laboratory (LLNL) has centered on plutonium and uranium isotope applications in human health and exposure, long-term environmental stewardship, and source-term characterization. These studies have shown that AMS has a sufficiently high abundance sensitivity to measure low abundance isotopes in the presence of mass m*f*{1 and m*f*y1 ions generated from principal isotopes of the element of interest. In many cases, the isotopic signature ratios of the low-abundance isotopes provide more sensitive and accurate fingerprint information for assessing sources of contamination in either the workplace or the environment. This is especially true of uranium where the high abundance isotopes associated with an anthropogenic source will be rapidly diluted by the natural uranium background. Uranium-236 (U-236) (half-life = 2.34E7 years) does occur in nature but at ultra-low concentrations. U-236 is also produced in nuclear reactors from neutron capture on uranium-235 (U-235) and may enter the workplace as reprocessed uranium containing elevated levels of U-236. Consequently, industrial sources of uranium including materials used in nuclear weapons production potentially carry U-236/U-238 or U-236/U-235 signature ratios that are distinguishable from natural background uranium. Here we report on the results of initial studies showing the presence of U-236 in bioassay samples collected from LLNL workers potentially exposed to uranium. Advances in U-236 detection and measurement clearly provide a basis for improving on methodologies used to assess workplace intakes of uranium as well as in related fields such as nuclear forensics and counterterrorism.

Work was performed under the auspices of the U.S. Department of Energy at Lawrence Livermore National Laboratory under contract W-7405-Eng-48.

WAM-C.10 Homnick, J., Ibbott, G., Springer, A., Aguirre, F.; MD Anderson; jhomnick@mdanderson.org

Evaluation of Aluminum-oxide (Al_2O_3:C) Optically Stimulated Luminescence (OSL) Dosimeters as a Potential Alternative to Thermoluminescent Dosimeters (TLDs) for Remote Dosimetry Services

Purpose: To evaluate aluminum-oxide ($Al_2 0_3$:C) optically stimulated luminescence (OSL) dosimeters as a potential alternative to thermoluminescent dosimeters (TLDs) for remote dosimetry services provided by the Radiological Physics Center at the University of Texas M. D. Anderson Cancer Center. The goals included evaluation of reproducibility and the dependence of response on factors such as dose, modality, field size, environmental conditions, fading, and multiple readings. Method and Materials: OSL dosimeters were placed equidistant (< 1 cm) from the center of a 20 cm x 20 cm Solid Water (SW) phantom which provided backscatter and build-up. For modality measurements, dosimeters were irradiated to doses of either 100 or 300 cGy with either 6 or 15 MV photons or 8 or 15 MeV electrons. All other irradiations were performed with a Co-60 unit. A Landauer microStar reader, with readout time set to 7 seconds, was used to measure the dosimeter responses.

Results: The calculated standard deviation of the reproducibility readings was less than 1.4% for doses of 50 cGy and 300 cGy, and less than 0.9% for a dose of 1000 cGy. The measured dose response was linear at doses less than 600 cGy, and independent of modality. Field-size output factors measured with OSL dosimeters agreed to those measured with an ion chamber within 1.5%. Heat, cold and humidity had no effect on the dosimeters, but exposure to light significantly decreased their response. Measurements of fading demonstrated that a 5% loss of signal occurs over the first ten days after irradiation, after which the response changes less than 1%. The dosimeters lost about 0.2% of their signal with each successive reading. Conclusion: These results demonstrated that the precision of OSL dosimeters is comparable to that provided by TLDs used for remote dosimetry and therefore warrants further investigation. This work was supported in part by Landauer Corporation and by PHS grant CA10953 from the NCI, DHHS.

WAM-C.11 Axelrod, S.; Xoft Inc.; saxelrod@Xoftinc.com

Dosimetry of the Axxent™ Electronic Brachytherapy System

The Axxent electronic brachytherapy system is a new method for delivering therapeutic high dose radiation in a brachytherapy (internal) mode. Initial indications are in post-lumpectomy breast and endometrial cancer treatments. The Axxent device is a miniature x-ray source operating at 50 kVp, and takes the place of high activity, highly penetrating radioactive sources such as Ir-192. Like Ir-192, the source dosimetry is characterized within the AAPM TG43 formalism. Measurements of the spatial distribution of the delivered dose, source stability, and treatment plan validation measurements will be presented.

WPM-A.1 Frey, S.; SLAC; Sfreyohp@SLAC.Stanford.EDU

Operational Health Physics Session Welcome

Participants will be welcomed to the Operational Health Physics Session in this opening set of remarks. The theme of the Session, the history and future of radiation-generating devices (RGDs), will be explored. We will start by examining the history of RGD operational health physics, moving to important developments in the practice, and on to its current state. This exploration will then take the participant forward to the state of RGD technology today, and how health physics can meet the challenges of the RGDs of tomorrow to help ensure that they will continue to be safely used. The introduction will conclude with a showing how Oakland is a natural location for this conference on RGDs as the San Francisco Bay Area is a world center of RGD technology development and major RGD-based research facilities.

WPM-A.2 Ficklen, C.; Jefferson Lab; Ficklen@jlab.org
Associated Non-Radiological Hazards From Accelerator Operations

The two principal accelerator ionizing radiation hazards, prompt radiation during operation and induced radiation from activation processes, are well documented in the professional literature. Other accelerator-related radiological and non-radiological hazards have received less attention but they still pose significant personnel risks. Ionizing radiation from accelerator operations can produce several toxic gases. Ozone (O_3) is the gas of greatest concern. Ozone may be produced at levels presenting personnel health hazards in an accelerator or experimental equipment enclosure. Also oxides of nitrogen generation are of concern. Detection methods and control measures for these gases will be covered. Accelerator operations present a broad range of normal and special non-radiological hazards. Normal industrial safety hazards (electricity, pressurized systems, mechanical systems, and noise) exist along with a number of special accelerator safety and health hazards. These special hazards include the use of cryogenic gases, chemicals, and non-ionizing radiation (such as radiofrequency, microwave, and lasers). Recently introduced accelerator non-radiological hazards are biosafety and nanotechnology concerns. This paper emphasizes these newer special non-radiological accelerator hazards.

WPM-A.3 Mei, G., Gillespie, T., Hamley, S.; Oak Ridge National Laboratory; meigt@ornl.gov
Radiological Safety Evaluation of RGDs at ORNL

There are approximately 70 radiation-generating devices (RGDs) at the Oak Ridge National Laboratory (ORNL) that are used in a variety of areas for X-ray diffraction and fluorescence studies, radiography, tomography, and irradiation operations. Radiological safety oversight and support are provided by the ORNL Nuclear and Radiological Support Group, with much of the field work conducted by the RGD users. The radiological safety management of normal operations has been historically quite successful. An incident involving a stuck X-ray powder diffractometer shutter occurred in September 2006. Investigation of the incident revealed that the safety features for the X-ray powder diffractometer operated in an unexpected manner that was neither "fail-safe" nor tolerant of a stuck shutter fault. As a follow-on action of the investigation, ORNL conducted a safety features and programmatic compliance assessment of all RGDs that are in use to evaluate similar issues.

This paper discusses the RGD incident in 2006 and the related investigation and assessment. Different technical and programmatic issues will be presented and the methods to help improve radiation safety management will also be discussed.

WPM-A.4 Penland, S.L., Wagoner, D.A.; Francis Marion University, Savannah River Site; samanthapenland@hotmail.com
Failed Gamma Beam Irradiator

The Health Physics Calibration Facility at the Savannah River Site houses numerous radiation-generating devices used for calibration and research. Among these irradiators is a 7-source gamma beam irradiator. The irradiators were designed and manufactured by Hopewell Designs, Inc. During my 2007 summer internship at the Savannah River Site, my project consisted of a characterization of the gamma beam using routine operation of the irradiator. On June 12, 2007, after repetitive exposures of the 1 Curie Cobalt-60 source, the aluminum rabbit containing the stainless steel source capsule underwent a mechanical failure. The source could not successfully be exposed. During an attempt to rotate the carousel back to the "dummy" source, it was found that the carousel was jammed and would not rotate. The purpose of this paper is to discuss the recovery of the 1 Curie Cobalt-60 source and the return of the gamma beam irradiator to full operation.

WPM-A.5 Sprague, D., Barron, D.*; Lawrence Livermore National Laboratory; barron5@llnl.gov
Can One Size Fit All? An Integrated Approach to Radiation Generating Device Safety Training UCRL-ABS-233183

Until recently, LLNL Radiation Generating Device (RGD) safety training was divided into separate courses for particle accelerators, x-ray machines and electron-beam devices. This device specialization inadvertently resulted in redundant training for those clients using multiple categories of RGDs. In an attempt to streamline training requirements and increase training efficiency, a new integrated lecture course on RGD Safety was developed to try to meet the needs of all LLNL RGD users. In this paper we discuss the safety training philosophy behind the development of the new course, as well as describe course content and overall training goals. Finally, we discuss the operational challenges and experience associated with teaching this 4-hour lecture course approximately 30 times each year.

This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

WPM-A.6 Goettert, J., Marceau-Day, M.L.*; LSU/CAMD; day@lsu.edu
Microfabrication Beamlines at the Center for Advanced Microstructures and Devices {CAMD}

The use of synchrotron radiation to pattern very precise, tall microstructures is practiced at a number of synchrotron radiation facilities worldwide. These beamlines are typically equipped with so-called scanners, which move the samples periodically across the synchrotron radiation beam thereby accumulating sufficient dose to modify the resist.

The CAMD facility operates four microfabrication beamlines, including three bending magnet beamlines and a high power beamline attached to the 7T super-conducting wavelength shifter. All beamlines are terminated with beryllium windows separating the ultra-high vacuum section connected to the storage ring from the scanner, which operates typically at 100mbar He atmosphere during exposure. Some of the Health Physics concerns are related to the observation that these microfabrication beamlines typically use 'white light' and a beam fan of up to 10mrad wide. This translates into ~100mm wide beams at the end of a 10m long beamline requiring large beam pipes and also beamsize limiting apertures mounted in the front end section of the beamline. In addition, access to the beamline and scanner during exposure must be restricted by using a radiation safety hutch as radiation is scattered from materials placed into the beam including the Be vacuum windows and low Z filters such as graphite and aluminum, which are required to adapt the radiation spectrum to the resist height.This paper will briefly describe beamline layouts and design criteria that allow a radiation safe operation, and will then focus on microstructure fabrication and potential applications currently explored at CAMD and other facilities.

WPM-A.7 Lovato, L., Walker, L.*; Los Alamos National Laboratory; lil@lanl.gov

Operational Health Physics of a Medical Radionuclide Production Facility

The Isotope Production Facility (IPF) is located just down stream of the end of the Alveraz Tanks (drift tube linear accelerator) at the Los Alamos Neutron Science Center (LANSCE) accelerator facility. A100 MeV proton beam (H+) is used to produce neutrons which are then interact with a target to produce medical radionuclides used for medical treatments all across North America. The facility was dedicated on January 12, 2004. IPF has been producing medical radionuclides since that time. Health Physics support of the IPF facility has been in transition since the IPF dedication. The facility was completed with several design deficiencies (electronics subject to radiation damage, cooling skid design etc.). As the operations team has worked through these problems, IPF has reconfigured equipment, implemented operational changes and worked to change procedures to deal with the system weaknesses. During the past year, the IPF facility has moved into a more consistent operations mode. (Those things subject to failure have failed etc.). HP has completed a procedure to insure a consistent health physics program and recognition of IPF needs in regard to cooling system leaks, contamination control, area access requirements and sample packaging/shipment requirements. Safety controls brought about by changes in IPF operations requirements are now captured through tighter HP routine monitoring requirements, better knowledge of system weaknesses and consistent application of radiological principles. This evolution has resulted in a strong well founded structure designed to insure a safe and compliant work environment.

WPM-A.8 Duran, M., Fanning, M., Mansfield, B., Salazar, J., Kelsey, C.; Los Alamos National Laboratory; duranma@lanl.gov

Elevated Dose Rate Condition at LANSCE Ultra Cold Neutron Facility

Beam development tuning operations at the 'Ultra Cold Neutron Facility' at the Los Alamos Neutron Science Center (LANSCE) created a beam spill condition. RCT's responded to a reported Albatross 2080 neutron (ND) alarm by operations personnel. The UCN facility had been evacuated and a well-collimated beam spill was located. The area is posted as a Controlled Area and there are postings at all entrances to evacuate the area if the ND alarms. Per the fact-finding following the incident, no radiation control policies were violated by this incidence. The ND's performed their intended function.

WPM-A.9 Lautenschlager, G.; Fermilab; glauten@fnal.gov

The Process of Repairing a Highly Activated NuMI Horn

Fermi National Accelerator Laboratory (Fermilab) is a high-energy particle accelerator laboratory operated by Fermi Research Alliance in Batavia, Illinois for the DOE. NuMI is a beam line used for neutrino production from an intense 120 GeV proton beam. Protons from the Main Injector beam line interact with a target to produce neutrinos, which are then used for the MINOS experiment to determine if neutrinos have mass. A horn is a magnetic focusing device that helps to focus the pions resulting from target interactions. Horns produce toroidal magnetic fields that bend the secondary particles in the desired direction. The approximate cost to build and test a new horn is about $750,000. Two horns are in use in the NuMI beam line. Horns use high voltages and currents in order to produce the strong magnetic fields needed to focus the secondary beam. They are also exposed to very high radiation. As a result, they become very hot thermally. They need to be cooled to minimize the adverse effects of thermal heating. The water that is sprayed onto the horns is collected underneath the horns in catch basins, which collects the water and returns it to the cooling system to be recycled. On two occasions the water cooling lines have broken, resulting in failed water cooling of the horn. Replacement horns were not ready; therefore it was necessary to repair the leaks on the horns. ALARA principles were closely observed in planning the repair of the water lines. Additionally, mock ups were constructed using lumber and workers spent many days practicing their assigned steps. Most of the steps were planned in numbers of seconds to complete. Typical dose rates were 1 mrem per second. The two repairs that have occurred to date were completed for 371 person-mrem for Horn #1 distributed among 19 workers, and 244 person-mrem for Horn #2 distributed among 9 workers. The allotted repair time in the high dose rate field was about 2 minutes for each of the horns. It was estimated that about 2 person-rem was saved for each of the horn repair jobs.

WPM-A.10 Jacob, N.; Rhode Island Hospital; njacob@lifespan.org

Radiation Safety and other Aspects of the Gamma Knife Reload

The Gamma Knife contains 201 Co-60 sources that have to be reloaded every five years or so. This involves a lot of pre-planning and coordination between various entities, including the manufacturer, shipper, regulatory agencies and local law enforcement and all participating departments of the licensee. Funding, notifications and license amendments have to be completed on a timely basis. Compliance with Nuclear Regulatory Commission, Agreement State and Homeland Security requirements can be a challenge. License requirements of shielding, leak testing, radiation surveys, and documentation have to be addressed. The movement of the heavy shield may require construction changes to the facility and closing off of corridors and rooms including patient areas. This paper will describe the experience of our institution during a recent reload.

WPM-A.11 Torres, M., Ridenour, M.*, Burtseva, T., Billone, M.; Argonne National Laboratory, Argonne National Laboratory; mridenour@anl.gov

Extremity Exposure While Working with Cladding Samples

This work involves radiological characterization of irradiated zirconium cladding (alloy) samples (100 mm long or less). The samples were irradiated in a nuclear reactor in Sweden and sent to Argonne National Laboratory for structural and chemical analysis. A series of measurements were made using TLD chips and an ion chamber to estimate the exposure to the extremities of a worker. Gamma and beta-gamma exposure rate measurements were performed which recorded rates over 300 R/hr on contact with the samples. A number of lead and tungsten gloves were tested in search of the best material to minimize the worker's extremity exposure. Included in this experiment is the installation of the sample into the cutting machine inside a glovebox. Measurements were made by inserting the chips and ion chamber into the gloves of the glovebox with the reactor sample present. Then a series of dry runs were performed by the workers to optimize the tasks and remove unnecessary steps in the process. Based on the radiological characterization of the samples,workers were authorized to perform the cuts and exposures were kept ALARA. Overall, this experience could benefit other facilities that perform work with extremely "hot" samples where exposures to extremity can be more than 300R/h beta-gamma at contact.

WPM-A.12 Allen, J., Norris, P., Kestell, D., Lyneis, C.; University of California, Berkeley, Lawrence Berkeley National Laboratory; P_McMahan@lbl.gov

Health Physics Challenges of Maintaining a Cyclotron with Light and Heavy Ion Beams in the Modern Regulatory Climate

The LBNL 88-Inch cyclotron first accelerated particles in 1961 for nuclear chemistry. The machine now supports research programs in nuclear structure, astrophysics, heavy element studies, fundamental interactions, symmetries, and technology R&D by LBNL and U.C. Berkeley. It is home to the Berkeley Accelerator Space Effects (BASE) facility, which provides well-characterized beams of protons, heavy ions and other medium energy particles which simulate the space environment. The National Security Space community and researchers from other government, university, commercial and international institutions use these beams to understand the effect of radiation on microelectronics, optics, materials, and cells. Routine maintenance is performed on the cyclotron following approximately 250 hours of operation. Major maintenance on activated internal components is typically performed twice a year. Some internal components of the cyclotron become activated by bombardment and emit dose rates in excess of 100 mrem/h at 30cm when removed from the cyclotron envelope. In particular, at the exit to the cyclotron, the deflector rails made of inconel steel have many long-lived activation products. With careful work planning and attention while setting the running schedule, doses to maintenance staff are kept as low as reasonably achievable, between ~100 to 200 mrem/yr over the past 10 years. Dose calculations using PHITS, DCHAIN and MCNP have been performed to predict expected doses, as well as to plan a possible future upgrades to the deflector rails. Advances in electronic dosimetry and in computational tools will continue to assist health physicists minimize dose as cyclotron operations evolve.

WPM-A.13 Fairchild II, R.F., Donahue, C.A.; Lawrence Berkeley National Laboratory; rffairchild@lbl.gov

Development and Management of an X-ray Safety Program

The Lawrence Berkeley National Laboratory (LBNL) X-ray safety program consists of a variety of X-ray diffraction units, cabinet irradiators, and computerized tomography scanners used for analytical purposes. These X-ray machines come from a variety of manufacturers and many enclosures were designed and installed more than 15-years ago. The X-ray machines are used by a wide variety of personnel, including LBNL research staff and students. Such an X-ray program requires robust engineering and administrative controls to ensure that personnel exposures are maintained as low as reasonably achievable (ALARA) while at the same time providing simple and timely access to the X-ray machines. The challenges of developing and managing the LBNL X-ray safety program to ensure that all X-ray machine enclosures are fully interlocked, failsafe, and properly shielded, while at the same time ensuring that all personnel using an X-ray machine are trained commensurate with the hazards and maintain their exposures ALARA will be discussed.

WPM-B.1 Stichelbaut, F., Bol, J., Cleland, M.R., Herer, A., Mullier, B.; IBA; frederic.stichelbaut@iba-group.com

Design of High Performance X-Ray Irradiation Systems

The IBA Company is actively involved in the design of new industrial irradiation systems based on high-energy X-Rays. These systems make use of 5 MeV to 7 MeV electron accelerators able to deliver beam currents as high as 100 mA. The X-rays are produced by sending the electron beams on a Tantalum target. To optimize these X-ray irradiation systems, use is made of Monte Carlo simulation codes such as GEANT3 and MCNPX. These simulations tools reveal invaluable to design the best irradiation methods as a function of product size and product density, and to determine their performance figures. The MC predictions have been verified by irradiating homogeneous products with densities ranging from 0.035 to 0.25 g/cm3 at an industrial X-ray facility located in Germany. The various configurations will be presented, together with the results of the experimental tests.

WPM-B.2 Gumnick, J., Simonsen, R.; Exelon Nuclear; john.gumnick@exeloncorp.com

Portable X-ray Radiography at a Nuclear Power Plant

During a recent refueling outage, a process for performing non-destructive examination (NDE) radiography was successfully implemented at a Nuclear Generating Station using a battery-powered portable x-ray generator rather than a traditional gamma radiography source. Radiological safety risks were reduced and efficiencies gained while still producing acceptable NDE results. The radiation hazard exists only during x-ray machine operation. Eliminated is the risk of using radioactive sources for radiography, such as radiation overexposures, source disconnects and stolen or lost sources. Large High Radiation Area exclusion boundaries are no longer required, reducing the impact on refueling outage activities when radiography is in progress. Personnel resources were greatly reduced by eliminating the need for posting extensive radiological boundaries, and posting boundary guards. Because the x-ray generator works in a nanosecond pulse mode, special precautions were necessary in the choice of radiation protection instrumentation. Radiation survey and dosimetry instrumentation were tested to verify adequate monitoring of dose rates and accumulated dose from operating the x-ray machine.

WPM-B.3 Heo, S., Ihsan, A., Cho, S.*; Korea Advanced Institute of Science and Technology; socho@kaist.ac.kr

Microfocus X-Ray Tube using Carbon Nanotube Point Electron Emitters

A microfocus x-ray tube has been demonstrated using carbon nanotube (CNT) point electron emitters. The CNT emitter was coated on an etched tungsten nanotip using the dielectrophoresis method. A triode-shaped electron gun and a magnetic solenoid lens, and a transmission x-ray target were adopted for the field emission electron beam with transmission ratio higher than 90% and the focal size of x rays smaller than 3 micrometer. The transmission x-ray target was fabricated by sputter coating of tungsten (W) on Beryllium (Be) x-ray window material. The thickness of the tungsten was optimized based on the calculations of the highest x-ray intensity at incident electron beam energy using a particle transport code (MCNPX). Due to the design characteristics and the operation performances of the microfocus x-ray tube, clear x-ray radiographic images of micro metal meshes with the magnification factor of higher than 300 and a phase contrast images of an inhomogeneous light material were obtained.

WPM-B.5 Blute, J.; Thermo Fisher Scientific; jim.blute@thermofisher.com

What an RSO Needs to Know about Portable XRF Analyzers

The technology for x-ray tube based portable XRF is changing rapidly and the use of these devices has risen sharply in the past 5 years. Portable XRF analyzers using miniature x-ray tubes are now extensively used in various industries. An overview of portable X-Ray fluorescence (XRF) Analyzers will be provided. Questions are often raised by end-users and regulatory authorities regarding regulatory requirements, dose, risk, training, and safe use procedures. These end-use questions are discussed from a manufacturer's experience and point of view. Specific topics to be presented include: the basic theory of operation, applicable ionizing radiation regulations, implications of the open-beam configuration, implications of localized dose and dose from very low energy x-rays (e.g., in the 5 to 50 keV range), evolution of safety features, and typical radiation safety program elements.

WPM-C.1 May, R., Ferguson, C.*; Thomas Jefferson National Accelerator Facility; may@jlab.org

The Morphology of a Research Accelerator

Research accelerators, usually designed with a specific mission in mind, often begin to struggle with changes in technology and changes regulatory environment by the time they are under construction. By the time a research accelerator has been commissioned, new law and regulations can affect operations from a cost and schedule standpoint. In some cases, the mission of the facility can change based on increased capability not envisioned by the designers. It is a challenge to successfully plan, construct, maintain, or operate a research accelerator amidst this backdrop. This presentation covers the initial design of the Continuous Electron Beam Accelerator Facility and considers the changes in technological advancements and regulatory framework through its first decade of post-commissioning operations. It describes the essential features of the morphology of one modern research accelerator.

WPM-C.2 Stoyer, N.J., Henderson, R.A., Kenneally, J.M., Moody, K.J., Shaughnessy, D. A., Stoyer, M.A., Wild, J.F., Wilk, P.A., Oganessian, Y.T., Utyonkov, V.K.; Lawrence Livermore National Laboratory, Joint Institute for Nuclear Research; stoyer2@llnl.gov

Accelerator Production of Superheavy Elements

Since about 1997, we have been collaborating with Russian scientists at the Flerov Laboratory of Nuclear Reactions (FLNR), Joint Institute for Nuclear Research, Dubna, Russian Federation to produce superheavy elements using high-intensity Ca-48 beams on a variety of radioactive actinide targets, including U-233, U-238, Np-237, Pu-242, Pu-244, Am-243, Cm-245, Cm-248, and Cf-249, for physics and chemistry experiments. The results of these experiments, which include discovery of five new elements (113, 114, 115, 116, and 118), determination of the nuclear decay properties of nearly 40 new isotopes, determination of the chemical properties of several elements, and preliminary mapping of the "Island of Stability", will be summarized. We will describe the experimental setups used for this body of work at the U-400 accelerator FLNR. We will highlight specific aspects that require health physics considerations while preparing for and performing these experiments, most notably the chemical purification of target materials at LLNL and the production and usage of targets at FLNR.

WPM-C.4 Donahue, R., Kestell, D., Heinzelman, K., Donahue, C.; Lawrence Berkeley National Laboratory; RJDonahue@lbl.gov

Advancing the Advanced Light Source (ALS) Through Top-off Operations

The ALS is a 3rd generation synchrotron light source operating at 1.9 GeV and 400 mA. The brightness and thermal stability of the ALS is limited by electron beam lifetime. Narrow gap insertion devices, higher beam currents and smaller emittance coupling all result in shorter electron beam lifetimes. To mitigate these effects on the lifetime many synchrotron light user facilities are operating, or are planning to operate, in a mode referred to as Top-off. In Top-off mode there is a quasi-continuous filling (topping-off) the storage ring in order to maintain constant beam current. Prior to Top-off operations the facility must ensure that there is no possibility of accidentally injecting the electron beam out through the accelerator shield wall following the path of a user's synchrotron beamline. This paper describes the various tracking studies conducted, the design changes and interlock systems enhancements, as well as a summary of the numerous safety reviews conducted. Recent results from the first Top-off operations at the ALS will also be briefly summarized.

WPM-C.5 Day, L., Walker, L.; Lousiana State University, Los Alamos National Laboratory; day@lsu.edu

Implications of Accelerator based Nano-Particle Material Research

Why should health physicists be concerned with the nano-particle (NP) technology revolution? Accelerator devices are used to evaluate NP material properties. As part of this research NPs may also become activated. Recent research has shown that not only size matters, but also shape and particle coating. NP production and application is exploding. Iron Oxide particles < 10 nanometers have been shown to stunt the growth of nerve cells. Work at NIST has found that single-walled carbon nanotubes (SWCT's) < 200 nanometers readily enter the human lung causing toxicity or death in the affected lung cells. TiO_2 nanoparticles are normally considered of low toxicity. However, coating these particles increased pulmonary inflammation. These responses complicate the perception of toxicity of nanoparticles. NP's may freely enter the body through all possible routes including inhalation, skin absorption, ingestion and injection. HP, efforts should be directed toward developing air sampling techniques, contamination analysis, engineering controls to insure complete containment and internal dosimetry research to determine the fate and toxicity of such materials in-vivo. Once they are out in the environment, they are freely mobile. As with much of the technology developed and applied in the present day, researchers and those applying this technology are very quick to find applications without completely understanding the implications of the hazard posed to humans. Materials with nanometer dimensions are so small, they will easily cross cellular barriers, pass directly through the skin, deposit deeply in lungs with no biological mechanism for removal and provide a huge surface area for bio/chemical interactions that are different from their bulk-counterparts. Five nanometer UO_2 particles have been developed. One gram of these nanoparticles has 1 x e18 particles and a surface area for chemical/bio interaction of 144 square meters. Particles of this size have no shelf shielding and the potential to rapidly distribute throughout the body. It is already known the certain nanoparticles pose a significant biological hazard as nanoparticles because of size and shape. Do these hazards (size/shape) also translate into synergistic hazards when the chemical and radiological hazards are added to the particle size hazard? Health Physicists need to formulate methods for hazard mitigation and control of dissemination of nanoparticles and to be cognizant of the potential hazards of such new technology, be they radioactive or not.

WPM-C.6 Lee, H.S., Chung, C.W., Oh, Y.D., Kang, H.S.; Pohang Accelerator Lab. / POSTECH, Pohang Accelerator Lab./ POSTECH; lee@postech.ac.kr

High Energy Radiation Facility using Electron Linac and its Applications at PAL

High energy radiation source and neutron source based electron accelerator were developed at Pohang Accelerator Laboratory. The PHERF(Pohang High Energy Radiation Facility) is the radiation source using 2.5 GeV electron linac which is a injector of Pohang Light Source. Several combinations of radiation field are available depending on the position before and behind shield. The radiation field was generated by interaction of 2.5 GeV electrons (10 Hz, 1 nsec of beam width) with thick and thin targets. The direct irradiation of incident electron is used for the damage study of accelerator components and the detector developments. The PNF(Pohang Neuton Source), which has been mainly used for total neutron measurements at a range less than a few eV, is the source using 80 MeV electron (15 Hz, 1 usec of beam width). In this paper, the overall scheme of two radiation facilities is presented and the application study such as photoneutron measurements, damage analysis to permanent magnet and Nb superconducting material, detection technique developments of explosive or nuclear materials, and the detector development, are introduced.

P.2 Velarde, S., Berry, P.; Los Alamos National Laboratory; skvelarde@lanl.gov

Shielding and Internal Scattering in a Digital Radiography Cabinet

With more Non-Destructive Evaluation (NDE) departments converting to both Digital Radiography (DR) and Computed Tomography (CT), special consideration has to be given to the design of the shielding and the internal design associated with the radiography cabinet. Due to increased throughput associated with digital operations, the radiography cabinets of the future must accommodate a significantly increased radiation dose. The physical design and associated shielding must minimize radiation scatter and adequately protect the operator as well as the public from x-rays created as a result of the operations. To be commercially viable, the cabinet configuration must also be capable of accommodating the inspection of very large objects. In this presentation, we will examine the digital radiography cabinet. Design considerations for the radiography cabinet, including methods to reduce radiation scatter inside of the cabinet and methods to reduce the cabinet wall thickness and weight, will be discussed. We will look at various designs and measure the scattered radiation using both TLDs and ion chambers. Comparison will be made to the MCNPX simulation results.

P.4 Potter, W.E., Strzelczyk, J.; Consultant, Sacramento, CA, University of Colorado Health Science Center; pspr189729@aol.com

Comparison of Long Double Precision Computer Solution for Decision Levels and Detection Limits with the Poisson-Normal Approximation when the Ratio of the Blank Count Time to the Sample Count Time is an Integer

The presented approach assumes that the blank count is Poisson distributed with known expected value. The net count is transformed into an integer. A code written in C++ allows computation of the exact probability density function for the transformed net count both when there is no activity in the sample and when there is activity in the sample. The validity of the computations is verified by checking that the sum of probabilities is close to 1.0 both when there is no activity in the sample, and when there is the maximum predicted activity in the sample. The decision level is determined by summation of the right tail of the probability density function when there is no activity in the sample and inverting from a transformed net count to a net count. The detection limit is determined by summation of the right tail of the probability density function when there is activity in the sample. A simple search is utilized to determine the number with two decimal places having error of the second kind closest in absolute value to the desired error of the second kind. To seek detection limits with no more than two decimal places reduces execution times. Experimentation showed the necessity for restrictions on the expected blank count, B, and the ratio of blank count time to sample count time N. If the errors of both types are in [0.01, 0.1], then the following restrictions apply: for $N <= 5$, $B <= 1000.0$; for $N = 10$, $B <= 400.0$; for $N = 20$, $B <= 90.0$. These restrictions are for errors of both types equal to 0.01. It is expected that for larger errors the code will work for larger B. Also the code will work for $N > 20$, if B is taken sufficiently small. Straightforward modifications to the code enable confidence intervals for the both the expected value of the Poisson distribution and the expected net count to be determined.

P.5 Blute, J.; Thermo Fisher Scientific; jim.blute@thermofisher.com

What an RSO Needs to Know about Portable XRF Analyzers

The technology for x-ray tube based portable XRF is changing rapidly and the use of these devices has risen sharply in the past 5 years. Portable XRF analyzers using miniature x-ray tubes are now extensively used in various industries. An overview of portable X-Ray fluorescence (XRF) Analyzers will be provided. Questions are often raised by end-users and regulatory authorities regarding regulatory requirements, dose, risk, training, and safe use procedures. These end-use questions are discussed from a manufacturer's experience and point of view. Specific topics to be presented include: the basic theory of operation, applicable ionizing radiation regulations, implications of the open-beam configuration, implications of localized dose and dose from very low energy x-rays (e.g., in the 5 to 50 keV range), evolution of safety features, and typical radiation safety program elements.

P.6 Rahman, M.S., Mollah, A.S., Begum, A., Zaman, M.A., Islam, M., Cho, G.; Bangladesh Atomic Energy Commission, Jahangirnagar University, Korea Advanced Institute of Science and Technology; msrahman1974@yahoo.com

Body Radioactivity and Radiation Dose from K-40 in Bangladeshi Subjects Measured with a Whole-Body Counter

A group of subjects of Bangladeshi adults from both sexes were studied for internal radioactivity and absorbed dose by measuring the whole-body activity of naturally occurring K-40 using a whole-body counter. Naturally occurring K-40 was determined by a whole-body counter employing a single detector in chair geometry, which is installed at the Institute of Nuclear Science and Technology (INST), Savar, Dhaka, Bangladesh. Subjects were selected randomly from among those assumed to be free of internal contamination by radionuclides. The mean activity and absorbed dose due to naturally occurring K-40 for the average male were found to be 1977.20 plus minus 424.85 Bq and 97.37 plus minus 25.75 micro-Gy/y respectively and those for the average female were 1665.00 plus minus 332.11 Bq and 96.12 plus minus 20.06 micro-Gy/y respectively. The average activity and absorbed dose for both sexes were 1901.51 plus minus 425.89 Bq and 97.07 plus minus 24.49 micro-Gy/y respectively. The K-40 activity per unit body weight varied inversely with slenderness. Both K-40 activity per unit body weight and annual dose from K-40 for subjects are below the values reported by the UNSCEAR.

P.7 Jue, T., Kehl, S., Hamilton, T., Hickman, D.; Lawrence Livermore National Laboratory; jue5@llnl.gov

Performance Evaluation of Whole Body Count Measurements by the Marshall Islands Radiological Surveillance Program (2002-2005)

Under the auspices of the United States Department of Energy, scientists from the Lawrence Livermore National Laboratory (LLNL) have developed a number of initiatives to address long term radiological surveillance needs at the former U.S. Nuclear test sites in the Marshall Islands. The Marshall Islands Radiological Surveillance Program operates three permanent whole body counting facilities at remote locations in Marshall Islands. These facilities are used to assess doses delivered to resettled and resettling atoll populations in the Marshall Islands from internally deposited Cesium-137(137Cs). The whole body counting facilities all participate in the Oak Ridge National Laboratory 5 bottle phantom Intercomparision Studies Program (ISP). This presentation provides a general overview of the Marshall Islands Radiological Surveillance Program with respect to quality assurance assessments of the whole body counting facilities operated by the Marshall Islands Radiological Surveillance Program from 2002 2005.

This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48. UCRL-ABS-233782

P.8 Yamamura, S., Fujimoto, T., Itou, K., Ishikura, T., Sakamaki, T., Miyairi, T., Tanaka, E., Nunomiya, T.*; Fuji Electric Co,Ltd.; shimoji-norio@fesys.co.jp

A New Radiation Monitoring System for the High Intensity Proton Accelator Facility, J-PARC

We developed a new radiation monitoring system, specially designed for high- intensity and high-energy proton accelerator facility, J-PARC (Japan Proton Accelerator Research Complex). The J-PARC has a injection linac, 3 GeV and 50 GeV synchrotrons with high beam powers of 200kW, 1MW and 0.75MW, respectively. This system is composed of wide-energy range neutron and photon monitors to measure ambient dose-equivalent rates without counting loss under the condition of high dose rates around the J-PARC area. To realize this characteristics, the monitoring system was designed to have fast pulse counting circuits. The neutron monitor is composed of a 5.08 cm diameter spherical proportional counter filled with 5 atom 3He gas and is surrounded with polyethylene and lead moderators in order to fit the detector response to the fluence-to-ambient dose equivalent conversion coefficients given by ICRP-74 up to 150 MeV. This monitor can measure neutron ambient dose equivalent from thermal to 150-MeV energy. The ·Á ray monitor is composed of a 35.0 cm diameter spherical ionization chamber filled with 8 atom Ar gas. The current which is output from the chamber in a few micloseconds is integrated and converted into the voltage by an amplifier. Then the voltage is converted into block pulses. Both monitors enable to measure dose rates from back ground level of 10-2·ÊSv./h up to ~105·ÊSv/h without counting loss using fast pulse counting circuits. Detector amplifier and pulse-shaping circuit are put in one shield case in order to reslize good electromagnetic compatibility.

P.9 Grosam, S., Festag, J.G., Fehrenbacher, G.*, Vogt, K.; GSI; g.fehrenbacher@gsi.de

Dose Measurements at the Pre-Accelerator Section of the GSI Unilac

At the UNILAC (UNIversal Linear ACcelerator) of the GSI (Gesellschaft fuer Schwerionenforschung, facility for the research with heavy ions) two different pre-stripper sections deliver ions for further acceleration. One of these consists of an ECR ion source, a RFQ and an IH accelerating structure. After leaving the IH structure the ions have a specific energy of 1.4 MeV/nucleon. The ion source and the accelerating structures produce x-rays during operation. The aim of this work is to improve the knowledge of the radiation fields near the ion source and the sections of the pre-accelerator. Measurements have been made by means of various passive and active dosemeter systems. In the vicinity of the ECR ion source the doses are measured by dosemeters con-sisting of TLD cards inside a polyethylene cylinder during the production of Li-7, C-12 and Ca-48 ion beams. A x-ray spectrum measured with a HPGe-detector near the ECR ion source together with the dosemeter readings gives hints on the fraction of the dose caused by x-rays with energies less than about 300 keV. Spatial dose distributions of the radiation fields around the RFQ and IH structures have been measured during their opera-tion with different accelerating voltages (the produced radiation depends strongly on the accelerating voltage; the amount of the radiation increases with a power of 3 or higher of the voltage). Accelerators for the treatment of cancer with protons and/or heavier ions use ECR ion sources and IH accelerating structures. Therefore the results of these measurements are interesting for the planning of such facilities.

P.11 Ozcan, I., Farfan, E., LaBone, E., Chandler, K., Donnelly, E.; Lawrence Berkeley National Laboratory, Savannah River National Laboratory, University of South Carolina, Idaho Accelerator Center - Idaho State University, Centers for Disease Control and Prevention; IOzcan@lbl.gov

Health Physics Challenges Involving Active, Non-Intrusive Inspection Systems

The cargo container transport system at ports in the United States is vulnerable. About 90 percent of consumer products imported by the United States (from food to car tires) arrive in cargo containers. Twelve million cargo containers move from port to port throughout the world and, on a daily basis, about 21,000 cargo containers arrive in the over 360 active United States ports (more than 7 million a year). However, only 2 or 3 percent of those containers are currently inspected. In addition, the U.S. Department of Commerce estimates that container cargo will quadruple over the next 20 years. The challenge of how to adequately inspect containers for contraband or possible terrorist threats is being addressed by various organizations and agencies in the United States. New devices are being developed to detect contraband, nuclear materials, or stowaways in cargo containers. These devices involve a variety of technologies, some of which include particle accelerators in active, non-intrusive inspection systems. The ideal time limit to inspect a 40-foot (12.2 m) cargo container is 60 seconds. Longer times would drastically interfere with commerce and impede port operations. Moreover, the U.S. Food and Drug Administration has set a limit of 10 MeV for irradiating foodstuff. These factors must all be considered when designing an inspection system. It is also important to include dosimetric studies to assess potential radiation exposures to workers, bystanders, and stowaways. Preliminary dosimetric studies have been conducted at the Idaho Accelerator Center of Idaho State University, which have highlighted these and many other challenges faced when using active, non-intrusive inspection systems.

P.12 May, R., Murla, J.; Jefferson Lab, Norfolk Naval Shipyard; may@jlab.org

Update of Electron Accelerator Be-7 Production, Associated Problems, and Proposed Remedy

This is an update of a presentation at the 48th Annual (2003 San Diego) Meeting of the Health Physics Society entitled, "Electron Accelerator Be-7 Production, Associated Problems, and Proposed Remedy. R.T. May, K.B. Welch..." The original presentation discussed mechanism for Be-7 attachment to dust based on electrostatic conditions in air due to ionizing radiation interaction. The original presentation also evaluated several standard industrial applications for collection of Be-7 contaminated dust. The update corrects original assumptions by incorporating aerosol kinetics and discusses possible additional associated techniques for collection.

P.13 Walker, L., Martinez, T., Johnson, J., Fanning, M., Gordon, L.; Los Alamos National Laboratory; swalker@lanl.gov

Practical RCT Energized Worker Electrical Training

Radiation Protection 1 (RP-1), at the LANSCE accelerator, is in the process of preparing a special RCT (Radiological Control Technician) training class for RCT energized electrical workers. Information for this class was obtained primarily by going into the work areas and taking digital photos of the electrical hazards RCTs must work around, and reviewing the work to be performed by the RCT's in these areas. Most of the electrical hazards RCTs are exposed to are low voltage, high current hazards. However, the hazards in the beam tunnels at the down stream end of the accelerator are classed as High Voltage/High Current DC hazards. Calculations have shown that ark flash hazards from DC magnets are not a concern until measurements must be taken within1 cm of the exposed magnet busses. The Radiation Protection Division at LANL (Los Alamos National Laboratory) made the decision that unless maintenance personnel require dose rate measurements on contact, all dose rate measurements will be taken at one foot (approximately 30 cm) and thus mitigate the ark flash hazard. Contact measurements would require that the magnets be de-energized and the power locked out and tagged in an electrically safe work condition. RCTs to not have the background to verify that the equipment is properly locked out and tagged out and in a zero energy state. Thus, RP management will let the electrically qualified individuals (not RCTs) who have locked out the equipment take a contact reading under their personal LOTO and verbally tell the RCT what the contact reading is rather than the RCT making the measurement themselves. The RCT will ensure that the instrument is properly calibrated, and set to the appropriate scale for the reading, before handing the instrument to the individual who will take the reading.

P.14 Walker, L., Justus, A.*; Los Alamos National Laboratory; swalker@lanl.gov

The Response Change of Radiation Detection Instrumentation to a Magnetic Field Update

The radiation response of ten different radiation detection instrument models were observed as magnetic field intensity was varied. In the initial experiment, a dipole magnet with a magnetic field intensity of up to 750 gauss was used. The following instrument types were exposed to a 137Cs check source while in (or being inserted or removed from) the magnetic field: RO-2, RO-3, RO-20, Mini Radiac, Tele-tector, GM pancake probe, E-600 with a SPA-3 Probe, Victoreen RF, and Eberline SHP 450. The instruments were inserted into the magnetic field directly between the dipoles and observed under both the static (within the field) and dynamic (while being inserted or removed from the field) conditions. Overall, GM instrument types proved to be most stable. Instruments with internal magnetic or reed switches as well as meter movements for displays proved to be most unstable. The magnetic field of the dipole magnet was mapped utilizing a hall effect probe and the fields determined at the instrument testing locations. Some instrument types do very poorly. This should be considered as a very necessary facility-specific type test. Another set of measurements were completed with a larger magnet in which the magnetic fields exceeded 2000 gauss. Previous test results with the 750 gauss field are folded in with the new results. Magnetic fields around the largest accelerator beam line magnets were measured with a hall effect probe. Large dipole magnets have consistent external magnetic fields around 30 gauss and a few were observed with external fields over 60 gauss. The RO-20 is insensitive to the effects magnetic fields up to 270 gauss and provides a more accurate, less energy dependant reading than GM tubes. Thus, (of the instruments we analyzed) the RO-20 is the instrument of choice for completing dose rate measurements around magnetic fields.

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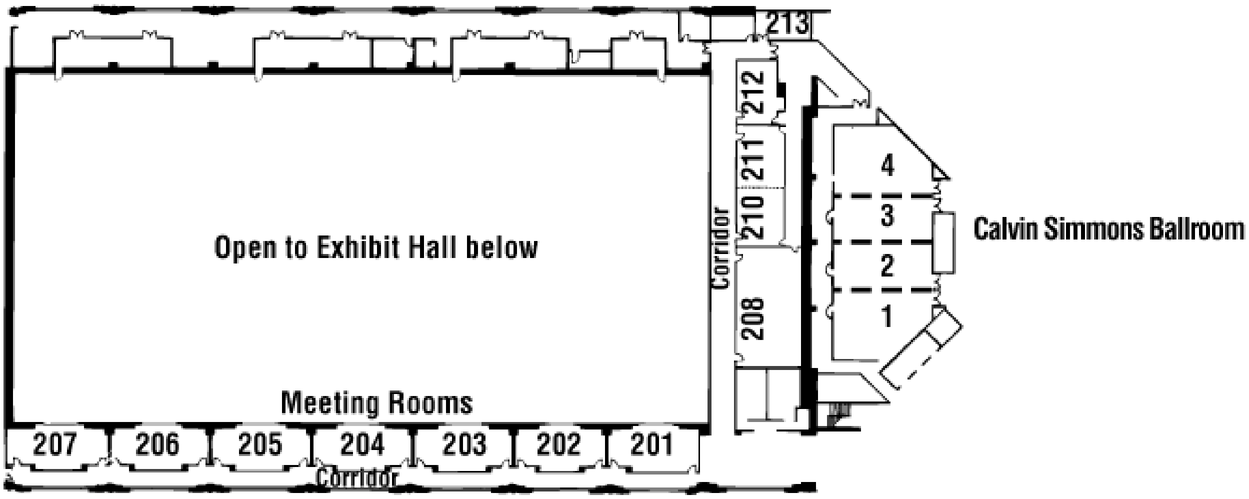

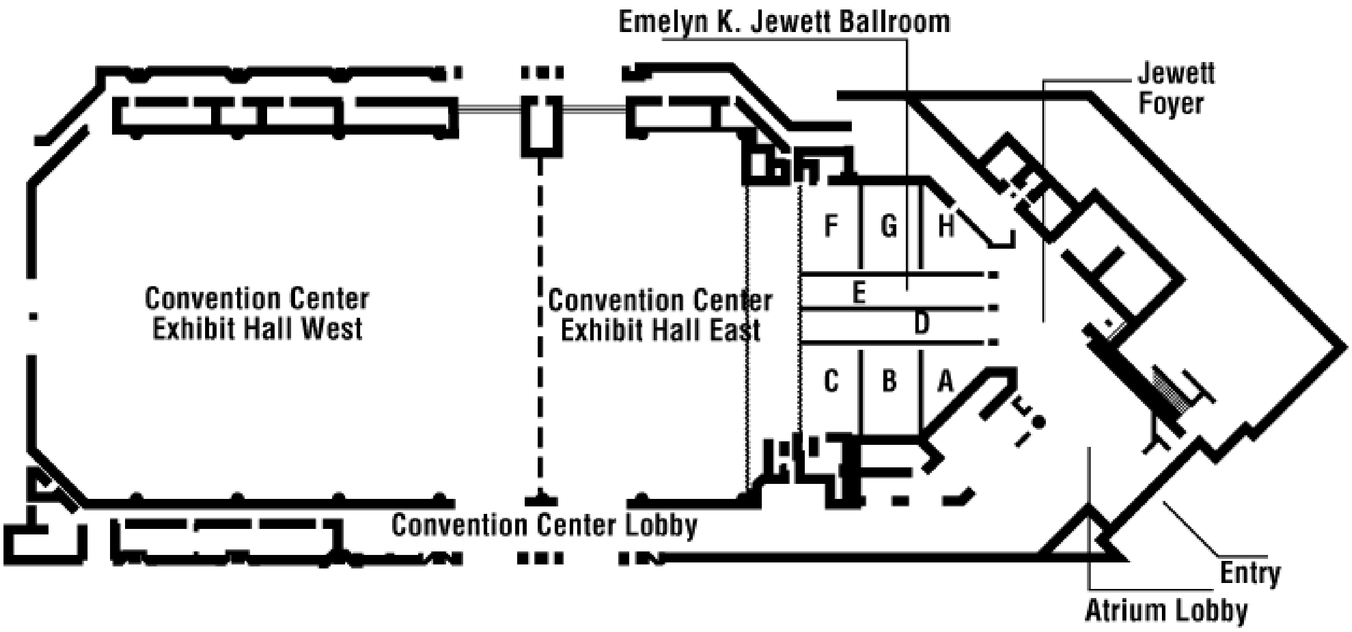

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