NORM/TENORM

HPS INDUSTRY DAY 2016 Sponsored by Dade Moeller An NV5 Company

61st Annual Meeting of the Health Physics Society

July 19, 2016

Held in Spokane, Washington

Welcome!

With increased demand for oil and natural gas, newer technologies based on horizontal drilling and hydraulic fracturing have been deployed in several regions across the United States. Application of these technologies creates potential radiation exposures from NORM/TENORM, environmental protection concerns, and waste management issues. According to the U.S. Environmental Protection Agency, each year the petroleum industry generates about 150,000 cubic meters of waste including produced water, scales, sludge, and equipment that potentially contains NORM/TENORM. NORM/TENORM is present in the initial drilling materials and fluids, produced water, and in process residues such as pipe scale and sludge. NORM/TENORM may also be encountered in other industries, including mining and manufacturing. Many of the industries with NORM are found regionally in the mountains and Gulf States that are rich in mineral resources.

The regulatory authority for radiation protection of diffuse NORM/TENORM lies largely with the states, not the federal government. Currently, there is little consistency among state programs. No federal statute is specifically designated for regulating the materials, and no consistent technical basis for regulating NORM/TENORM has been established. As a result, individual states and industries have to cope with the emerging radiological issues of NORM/TENORM on an ad hoc basis with little scientific support.

The purpose of Industry Day is to provide a forum for individuals and organizations wanting to know more about potential radiation issues in industries with NORM/TENORM. Our goal is to promote the exchange of information among involved stakeholders including state agencies, affected industries and their workers, the general public, and other interested groups.

Founded in 1956, the Health Physics Society is a professional organization whose mission is excellence in the science and practice of radiation safety. This event is an innovative way to accomplish the Society's purpose to promote communication and cooperation among people engaged in radiation protection within functional groups.

Dade Moeller, *an NV5 company*, is leading this event in coordination with the Health Physics Society. We are a full-service radiation protection, environmental, and safety firm founded in 1994 and headquartered in Washington State near the U.S. Department of Energy's Hanford nuclear site. Based on our reputation and expertise, several mining and oil and gas industry clients have relied on us to support them on NORM/TENORM issues.

Sincerely,

W.E. Kennedy, Jr.
Executive Vice President, Dade Moeller/NV5

Dade Moeller®
An NV5 Company

Headquartered in Richland, Washington, near the U.S. Department of Energy's Hanford nuclear site, ***Dade Moeller***, *an NV5 company*, provides a full range of professional and technical services to federal, state, and commercial clients in support of nuclear, radiological, and environmental operations. The company specializes in radiation protection, health physics, worker safety, laboratory services, and training. Founded in 1994, the company bears the name of the late Dr. Dade W. Moeller, a scientist and educator in the fields of health physics and environmental health.

Dade Moeller assists facilities and sites that deal with NORM (Naturally Occurring Radioactive Materials) and TENORM (Technologically Enhanced NORM) issues, including landfills; oil and gas fields; water and waste treatment facilities; natural gas and propane processing facilities; sites that process uranium, radium ore, or thorium; facilities that handle radium illuminated instruments and dials; buildings with radon; and disposal and recycling facilities. We identify the presence and quantity of NORM, train managers and staff, evaluate worker safety, and ensure the safe handling or disposal of NORM.

Dade Moeller joined NV5 in May 2016. NV5 is a provider of engineering and consulting services to public and private sectors, offering solutions through five business verticals: Construction Quality Assurance, Infrastructure, Energy, Program Management, and Environmental. With offices located throughout the United States and the resources for worldwide delivery, NV5 helps clients develop, construct, and operate a wide variety of projects. NV5 performs technical studies necessary to support project planning, design, and permitting of energy, land development, and infrastructure projects for the mining, energy, and natural resources sectors. These services include NORM/TENORM assessments, management, and compliance projects.

Program

Meeting Room 207

7:00–8:00 ***Continuing Education Lecture***

Both health physicists and industry representatives are encouraged to attend!

NORM/TENORM: History + Science + Common Sense = ???
William E. Kennedy, Jr. | Dade Moeller/NV5

Exhibit Hall B

8:15–8:30 ***Welcome***

8:30–9:30 ***Understanding the Basics***

8:30–9:00 **What Is Radiation and How Is It Detected?**
William E. Kennedy, Jr. | Dade Moeller/NV5

9:00–9:30 **What Is NORM/TENORM?**
Alan Fellman, Ph.D., CHP | Dade Moeller/NV5

Exhibit Hall A

9:30–5:00 ***Posters & Exhibits Open***

Poster authors will be available for discussion from 1:00–2:00

The U.S. Abandoned Uranium Mines Project
Darrell Liles | Arcadis

Measurement of Rn-222 Alpha Decay from Barite Pipe Scale
Diana Thompson, CHP, RRPT | Sulas Radiation Safety Consultants, LLC

Performance Assessment Modeling for NORM/TENORM Disposal
William E. Kennedy, Jr. | Dade Moeller/NV5

Survey and Disposition of NORM-Containing Refractory Brick
Tracy Ikenberry, CHP | Dade Moeller/NV5

The Top 10 Things Oil Producers Need to Know About TENORM
Kurt Rhea, General Manager | SECURE Energy Services

Radium Spectral Response through Pipe-Walls
Walter McNeil, Ph.D. | Kansas State University

9:30–10:00 ***Coffee Break, sponsored by US Ecology***

Meeting Room 205

10:00–12:00 ***Oral Presentation Session***

Co-Chairs: Alan Fellman, Ph.D., CHP, and Tracy Ikenberry, CHP | Dade Moeller/NV5

10:00–10:20 **Uranium Mining and NORM: A North American Perspective**
Steven H. Brown, CHP* | SHB, Inc. and Doug B. Chambers | Arcadis Canada

10:20–10:40 **NORM Safety for Oilfield Workers**
Ray Johnson, MS, SE, PE, FHPS, CHP | Radiation Safety Counseling Institute

10:40–11:00 **NORM Radiation Protection for Alum Production and Storage**
Tracy Ikenberry, CHP* and Joel Arana, CHP | Dade Moeller/NV5

11:00–11:20 **TENORM Waste Streams in the Oil and Gas Sector**
Kurt Rhea, General Manager | SECURE Energy Services

11:20–11:40 **Baseline Surveys, Environmental Monitoring, and Assessment for TENORM Facilities**
Philip Egidi, Environmental Scientist | U.S. EPA

11:40–12:00 Presenters will be available for one-on-one questions and discussion.

Exhibit Hall A

12:00 ***Complimentary Buffet Lunch***

Riverside Lobby/Hall D

12:30–3:00 ***Demonstrations:*** Stop by to observe some interesting STEM-related demonstrations presented by Dr. Paul Stansbury (Dade Moeller/NV5)! See page 11 of the program for more information.

3:00–3:30 ***Coffee Break, sponsored by EnergySolutions***

Exhibit Hall B

3:30–4:30 ***Panel Discussion: Current Issues and Topics***

Philip Egidi | U.S. EPA, Ruth McBurney | CRCPD, John Fraizer | Independent Consultant Joe Weismann | US Ecology, and Ray Johnson | Radiation Safety Counseling Institute

4:30–5:00 ***Closing, Contact Exchange, iPad Drawing for Washington STEM***

Grand Terrace Bar

5:00 ***Happy Hour:*** Industry Day participants can have a drink and enjoy reduced price appetizers at the **Grand Terrace Bar**! On the roof of the **Hilton Doubletree**!

Support WASHINGTON STATE STEM EDUCATION FOUNDATION

and

Win an iPad!

The Washington State STEM Education Foundation's mission is to create a **substantial** and **sustainable** impact on the quality of Science, Technology, Engineering, and Mathematics education in the **Mid-Columbia Region**.

We aim to be a **national model** for generating passionate support for STEM in Public Education.

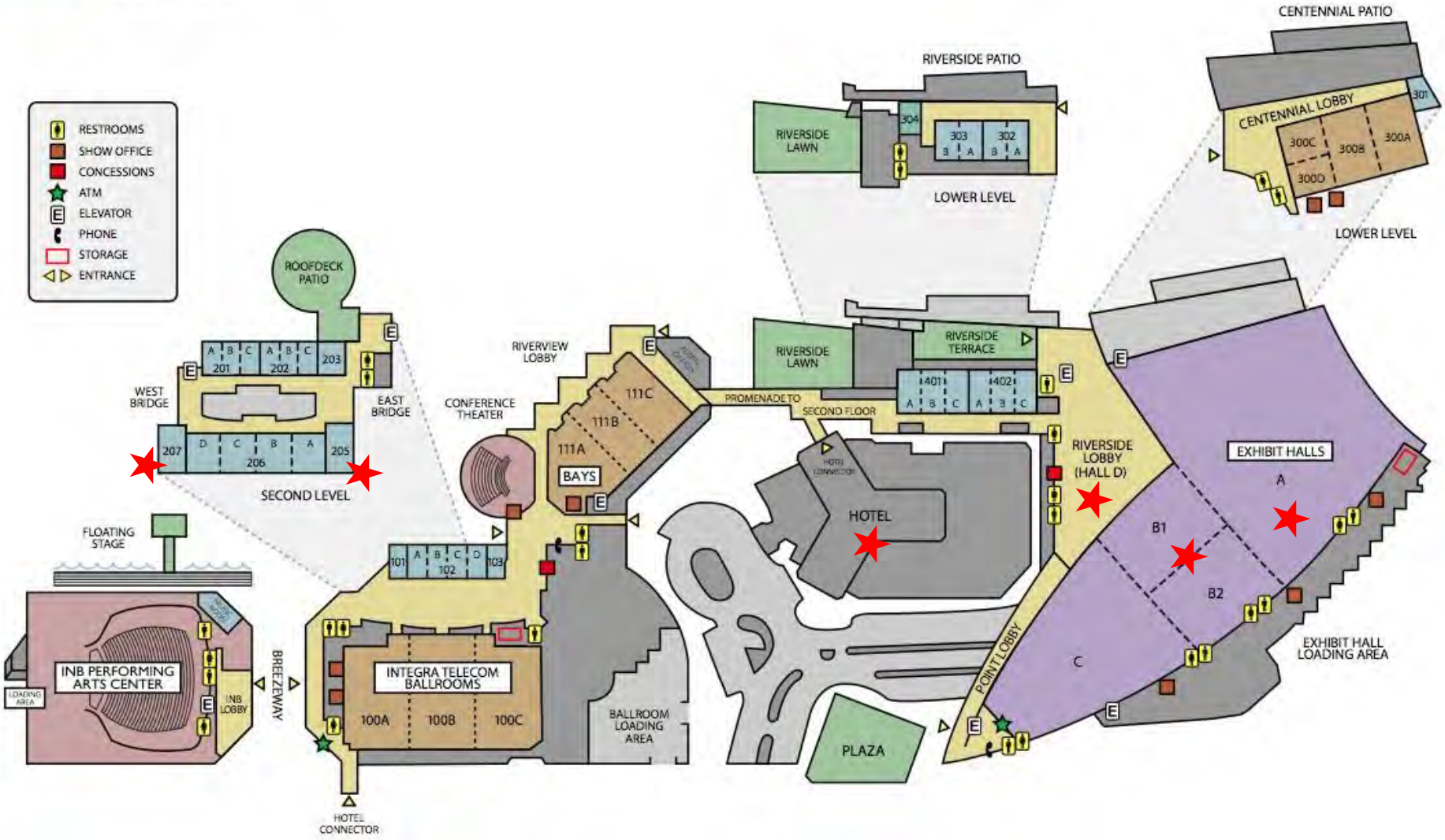
Your $5 donation can help us achieve our goal!

Purchase **tickets** at the

Dade Moeller An NV5 Company

HPS booth!

SPOKANE CONVENTION CENTER



Oral Presentations

Continuing Education Lecture:
NORM/TENORM: History + Science + Common Sense = ???

W. E. Kennedy, Jr. | Dade Moeller, an NV5 Company

Since the early twentieth century, beginning with the search for domestic sources of radium, it has been understood that rock formations contain primordial concentrations of naturally occurring radioactive materials (NORM). NORM includes the radionuclides associated with the uranium or thorium decay chains, and Potassium-40. These sources are all around us to some degree in rocks and soil. They are of primary concern during mineral resource recovery, where human actions modify the NORM concentrations or isotopic distributions, creating technologically enhanced NORM (TENORM). Sources of NORM/TENORM span many human activities, including: using clay for production of bricks or ceramics; mining waste produced by extracting rare earths or other metals such as aluminum; using heavy casting sands which potentially contain thorium; purifying drinking water, which can concentrate radium or uranium in waste; and recovering oil and gas, which can produce large volumes of TENORM waste. Most recently, there have been news reports and concerns about TENORM waste issues associated with application of newer oil and gas recovery technologies, using horizontal drilling coupled with hydraulic fracturing. The major radiation protection concerns of NORM/ TENORM are protecting workers, members of the public, and the environment similar to any activity involving radioactive materials, with one important difference: there is no federal guidance for NORM/TENORM waste management – the regulatory authority lies with the States. Individual States are left to cope with emerging NORM/TENORM radiation protection issues on an ad hoc basis with little scientific support. As a result, state guidance and regulations vary greatly. A harmonized approach would be most beneficial. We are currently at the confluence of history, science, and common sense. This continuing education lecture will provide an overview of NORM/TENORM issues, with an eye to developments which may shape, or reshape, future industrial applications.

Uranium Mining and NORM: A North American Perspective

S. H. Brown, CHP* | SHB, Inc. and D. B. Chambers | Arcadis Canada

This paper is an overview of uranium mining in North America including discussion on the mining methods currently being used, production of NORM materials and wastes associated with these uranium mining methods, the radiological aspects of the NORM materials produced by uranium mining and the regulatory regimes in the United States and in Canada that address and control associated radiological risks to workers and the public. The methods and associated NORM material and wastes produced by both conventional (underground, open pit) and in situ recovery uranium mining are described. The techniques used for the management and exposure control necessary for uranium mine tailings and other associated NORM materials and wastes produced by these current mining methods are also discussed. The radiological aspects of these NORM material and wastes dictate the control methods used to maintain radiological exposures as low as reasonably achievable in accordance with regulatory requirements and internationally accepted best practices. Finally, the paper identifies the responsible government agencies in the US and Canada assigned the authority to regulate and control these NORM materials and summarizes their associated regulatory frameworks.

NORM Safety for Oilfield Workers

R. Johnson, MS, SE, PE, FHPS, CHP | Radiation Safety Counseling Institute

Employers of oilfield workers have a duty, according to OSHA regulations, to provide reasonable protection to workers from all hazards that may occur in oilfield operations. One of the potential hazards is exposure to Naturally Occurring Radioactive Materials (NORM). Such exposures have become a special concern to oilfield workers who are not trained for radiation protection. Consequently, oilfield management and workers tend to be very conservative on the side of safety. Because the media continuously refers to radiation as "Deadly Radiation," most everyone is now conditioned to believe all radiation is deadly and to be avoided at all costs. One oilfield operator responded as follows. When a truck load of scrap pipe was rejected by a metal recycler at 25 u-R/Hr, the company industrial hygienist decided this meant that the load of pipe was "radioactive" and required special handling. Thus, they constructed a secured storage area (posted "Caution Radioactive Materials") to prevent access and radiation exposures from the pipe. To protect pipe handlers, on top of normal fire retardant coveralls, workers donned Tyvek suits with protective gloves over their normal gloves. However, since this was "radioactive" material, they donned a second Tyvek suit and self-contained breathing apparatus while working at summer temperatures up to 115 degrees. The company did not understand that a contamination limit for recycling is to assure the facility does not incorporate NORM into its recycling process (that could lead to public fears of their products) and it should NOT be used to designate limits for worker safety. Even at a surface exposure rate of 50 u-R/hr, workers would have to be in contact with the pipe for 2,000 hours to reach the annual public limit of 100 mrem. Also, measurements were made in contact with exterior pipe surfaces without considering the duration of handling or location of workers. They also did not know that their NaI instruments would not give accurate readings for NORM. They did not understand that count rate measurements with a pancake GM cannot be used to estimate worker exposures (mR/hr), especially since most of the signal will be from beta particles. For inhalation protection, these workers used self-contained breathing apparatus when a throwaway P95, N95 or R95 particulate mask would have been more than adequate.

NORM Radiation Protection for Alum Production and Storage

T. Ikenberry, CHP* and J. Arana, CHP | Dade Moeller, an NV5 Company

Industrial production of aluminum sulfate (alum) involves precursor materials with elevated concentrations of naturally occurring radioactive material (NORM). Concentrations of radionuclides from the Th-232 series are higher than concentrations of the U-238 series radionuclides. For process operations external dose rates are generally low. One location is of interest: near a leaf filter vessel the area dose rates are 2-3 µSv/hr and can approach 50 µSv/hr on contact with the vessel and be 100-150 µSv/hr on contact when the vessel is opened. Because of this, doses from filter cleaning operations were of interest and the subject of a time and motion study. NaI detector response factors for NORM were also determined during this study. Internal dose and surface contamination are of little concern. Process material is wet and non-dispersible, and surface contamination is generally undetectable in all situations. Large volumes of post-process residues may provide a basis for radioactive material licensing, even at low concentrations of NORM, mainly because of total activity and ultimate disposition. Observed exposure rates average about 0.35 µSv/hr on the surface (1-meter) of the impoundment where residues are stored and which is an access-controlled area. Here too there is little concern for internal dose and surface contamination. Estimated annual doses to workers are well below the 1 mSv/year public dose limit, even if conducting all filter cleaning operations. Dose to members of the public during the operating period is even smaller and considered insignificant. Ultimate disposition of residues is the largest challenge for the future.

Oral Presentations *(continued)*

TENORM Waste Streams in the Oil and Gas Sector

K. Rhea, General Manager | SECURE Energy Services

The oil & gas industry generates a variety of technologically enhanced naturally occurring radioactive materials (TENORM) waste streams during exploration and production activities, as well as in pipeline transmission. Understanding where TENORM may be present is critical not only to waste management contractors and disposal facilities, but it is also essential information for regulators and industry health & safety and operations personnel. While regulators understandably grapple with establishing rules and regulations for TENORM based on hypothetical dose rates and RESRAD modeling, it is helpful to start with the end in mind. What waste requires special consideration and handling by the industry and where should regulators focus to ensure compliance? After all, from a regulatory and industry operations perspective, there is effectively no TENORM present if no one looks for it. If surveys have not been done or if samples have not been collected and characterized TENORM may be overlooked. The industry and regulators are much more effective when they target waste streams that are known to be potential sources of TENORM. Then they can focus on the potential employee and public health risks, the potential environmental impacts, and ensure effective/efficient operations. Using actual field surveys and analytical sampling data, specific examples of TENORM-impacted solids, sludge, and surface-contaminated objects are described to provide attendees with a foundational understanding of TENORM sources and activity levels from the oil & gas industry.

Baseline Surveys, Environmental Monitoring, and Assessment for TENORM Facilities

P. Egidi, Environmental Scientist | U.S. EPA

Facilities that handle, dispose, or otherwise process solids and liquids containing naturally occurring radioactive material need to have adequate baseline monitoring prior to start of operations. Many of these facilities are not under a radioactive materials license, and don't have specific requirements for baseline measurements. The purpose of the baseline survey is to be able to evaluate any impacts to the site and local environment from the proposed activity relative to background concentrations. Environmental monitoring during operations is often necessary in order to provide data to meet various effluent limits and public and worker dose limits. Suggestions for baseline monitoring and effluent monitoring are presented.

Demonstrations

Paul Stansbury, Ph.D., CHP

Dade Moeller/NV5

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Paul is a Senior Health Physicist specializing in the assessment and mitigation of human health risks in the workplace and the environment. At the Pacific Northwest National Laboratory, he has contributed to the Radiation Portal Monitoring Project and, more recently, the Rail Test Center Project. Both projects involve installing radiation detectors to mitigate human health and other impacts that would be caused by a "dirty bomb" or an improvised nuclear device made with radiological or nuclear material smuggled into the U.S. Under a cooperative arrangement between Dade Moeller and Washington State University - Tri-Cities, he is leading a project that is establishing a graduate certificate program in radiation protection at WSU. The WSU Faculty Senate approved the certificate. He and other adjunct faculty have developed and taught 3 of the 5 courses that make up the certificate. From 2009 through 2011, Paul served as President-elect, President, and Past President of the American Academy of Health Physics. From 2005 to 2007, he served as Treasurer and member of the Executive Committee of that organization. Paul currently coordinates and instructs in a 56-hour review course given by the Columbia Chapter of the Health Physics Society to professionals in the region preparing for the certification exam.

Industry Day participants are invited to participate in or observe the hands-on activities being presented by Dr. Paul Stansbury in the Riverside Lobby/Hall D.

Penetration Alpha Beta Gamma

Knowing which kind of radiation you're dealing with can help you protect yourself from it.

Fiestaware and Other Natural Radioactivity

Find the (sometimes startling!) amount of natural radioactivity in many common items.

Chart of Nuclides/Binding Energy

Why do nuclear reactions happen and how to read this important source of information.

Half-Life of Barium-137m

Observe the 2.5-minute half-life of this nuclide, going to zero in 25 minutes.

Posters

The U.S. Abandoned Uranium Mines Project

L. Manglass, A. Townsend, D. Liles* | Arcadis

The USEPA has implemented a program for the cleanup of abandoned uranium mines (AUM) in the southwestern United States. By assessing the health and environmental impacts of 521 sites, the USEPA and the Navajo EPA determined priority sites that are being evaluated and remediated currently through the Superfund project. This poster will provide background information on the EPA program and provide examples of current work being completed at sites in the Cameron Area and Eastern Agency Area by Arcadis to support the EPA AUM program.

Measurement of Rn-222 Alpha Decay from Barite Pipe Scale

D. Thompson | Sulas Radiation Safety Consultants, LLC

Radium and radon are selectively segregated from the parent decay chain through traditional oil and gas practices because of radium's enhanced solubility in produced brine water. Radium precipitates with barium in produced water to create barite pipe scale. The radium-226 progeny produce an external exposure risk through gamma-decay emission, and this exposure which is readily detected using traditional exposure rate survey meters. Current alpha spectroscopy methods, endorsed by the Environmental Protection Agency (EPA) which are used to quantify naturally occurring radioactive material contaminants, rely heavily on chemical preparation of the sample (EPA method 903.1). This poster discusses alpha spectroscopy methods of radon gas emanated from a TENORM sample of barite pipe scale not prepared with chemical means. The benefits of using the alpha spectroscopy method described in this poster are: added safety for laboratory staff because the use of harsh acids and other hazardous chemicals is not warranted for sample preparation; no costly reagents required; and faster results.

Survey and Disposition of NORM-Containing Refractory Brick

T. Ikenberry | Dade Moeller, an NV5 Company

As part of the demolition of a former junior high school, a hot water boiler (about 120x150x180 cm) was removed and taken to a steel recycling center; however, the boiler set off the radiation monitors at the recycling center, where it was refused and returned to the demolition site for investigation. A radiation survey was conducted to determine the nature and extent of the radiation, as well as any health risk that might be present. The boiler was observed to have refractory brick present on the left and right sides of the boiler box; some of the brick had been displaced during the demolition process. The survey was conducted using an Exploranium(R) GR-135 Plus "Identifier" which has a 0.065 L sodium iodide (NaI[Tl]) crystal as one of its detectors. Exposure rate measurements were taken at contact on all surfaces. Exposure rates on the outside of the boiler were less than twice background (5 microR/hr) in all cases. Somewhat higher results were noted inside, directly on the refractory brick. Areas where no refractory was present had noticeably lower exposure rates, pointing to the brick as the radiation source. The highest measured net exposure rate was 8 microR per hour. Individual bricks were about 1 microR per hour (net). The instrument identified the radionuclides as "background," indicating presence of NORM in the brick. The State Office of Radiation Protection was contacted about disposition. It was acceptable and recommended that the steel and brick be separated and dealt with separately. It is very important that the history of the boiler and the refractory be fully disclosed to any potential recipient of either the steel or the refractory. In this case, the steel was accepted for recycle, and the brick for disposal at a municipal landfill.

Performance Assessment Modeling for NORM/TENORM Disposal

W. E. Kennedy, Jr. | Dade Moeller, an NV5 Company

Sources of naturally occurring radioactive materials (NORM) and technologically enhanced NORM (TENORM) are encountered during a variety of mineral resource recovery operations. NORM/TENORM is not regulated by the Federal agencies; rather, regulation is left up to the States. When it comes to solid waste disposal, State and local agencies regulate landfills in accordance with the Resource Conservation and Recovery Act (RCRA) using uniform regulations promulgated by the U.S. Environmental Protection Agency. Most RCRA landfills strictly prohibit disposal of radioactive materials. The intent was to ban disposal of radioactive sources and materials licensed by the U.S. Nuclear Regulatory Commission; but disposal of NORM/TENORM implicitly became part of the overall ban. Recently, States such as Pennsylvania have begun to apply low level radioactive waste performance assessment modeling to establish site-specific waste acceptance criteria for NORM/TENORM disposal at specific RCRA landfills. Such assessments can be performed using the RESRAD computer program. The main components of such modeling include: definition of the source term (volume and radionuclide concentrations); description of the waste form; description of the landfill design (size of cells, engineered features, and types of cover materials); selection of radiation exposure scenarios (industrial, residential/garden, or agricultural); selection of exposure pathways (external, inhalation, and/or ingestion); selection of other site-specific data (rainfall, depth to ground water, and regional land use); and interpretation of the results to establish waste acceptance criteria for a specific landfill. A description of these modeling components, an example RESRAD analysis, and an overall observations and conclusions of the modeling process, are provided.

The Top 10 Things Oil Producers Need to Know About TENORM

G. Rhea | SECURE Energy Services

While NORM/TENORM has been a known issue since the 1980s, very few personnel in the oil and gas sector are properly trained to identify, collect, and handle these special waste streams. Even knowledgeable health and safety professionals are often ill-equipped to conduct and document a proper radiation survey or develop a decontamination strategy. Once TENORM waste is identified and collected, field personnel must determine where the waste can safely and legally be disposed of; they must complete a waste manifest, and establish and maintain a chain of custody for confirmatory sampling. In addition, field personnel may not know the Department of Transportation (DOT) requirements for packaging and labeling NORM/TENORM waste that is shipped for waste disposal. What are the top 10 things oil and gas producers need to know about NORM and TENORM waste? What are the radiation safety knowledge gaps that health physicists and radiation safety officers can help fill? Those answers and more will be answered during this poster session.

Radium Gamma-ray Signatures Through Pipe-walls

W. McNeil | Kansas State University

Operations with pipelines in oil production might pose a radiological risk to workers, especially once the pipe has been removed from the functioning system. Thus, it may be useful to determine the level of risk before deconstruction or scale removal begins. In this work, I simulate the signature observed from a spectroscopic gamma-ray detection system for a select few pipe dimensions. This is to better understand the detectability of radium within the pipe and may enable one to assess the level of risk anticipated in future pipe operations, including scale removal, decommissioning, and material disposal. The wall of the pipe and the mass of the materials within the pipe, interfere with gamma-rays emitted from Radium. Thus, the spectrum collected from gamma-ray spectrometers such as NaI scintillators becomes altered from what is observed in databases or source catalogs. Simulations with Geant interfaced by the SWORDS package are employed here to generate the spectral gamma-ray signature outside of some common pipe dimensions considering radium concentrated at various levels within the pipe.

Speakers & Presenters

William E. Kennedy

Dade Moeller/NV5

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William (Bill) E. Kennedy, Jr., is a member of the National Council on Radiation Protection and Measurements (NCRP) Board of Directors and serves as the chair of the NCRP Budget & Finance committee. Bill has extensive experience in a broad range of radiation protection topics and has been instrumental in the development of environmental pathway and radiation dosimetry models used to assess potential health and environmental impacts that resulted from releases of radionuclides to the environment. He has been involved with the development of the technical basis for revised radiation protection standards and regulations, and has participated in evaluations and appraisals at operating nuclear facilities. He is a Fellow of the Health Physics Society and has been the author or coauthor of more than 160 technical publications, presentations, and short courses.

Alan Fellman is a Senior Health Physicist at Dade Moeller in Gaithersburg, Maryland, and is a faculty member of the company's Dade Moeller Training Academy. He has a doctorate degree in Radiation Sciences from New York University, a master's of public health degree in Environmental Sciences from the University of Michigan, and is a Board-certified health physicist. Alan has more than 20 years of experience in Radiation Safety Officer services, sealed source device registration, radioactive material license applications and amendments, safety plan development, program audits, radiation risk assessment, dosimetry analysis and documentation, and decommissioning. At the Dade Moeller Training Academy, Alan leads classes designed to instruct workers how to use radioactive materials safely and in full compliance with State and Federal regulations and license conditions.

Alan Fellman, Ph.D.

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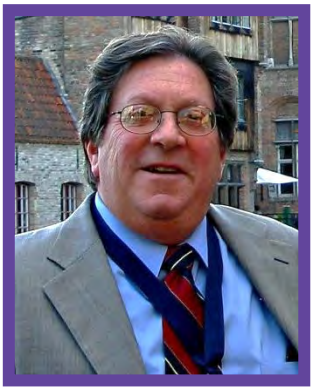

Steven H. Brown, CHP

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Steven has over 40 years of nuclear industry experience. He is currently a member of the Board of Directors of American Academy of Health Physics and has worked extensively with the U.S. Nuclear Regulatory Commission and its Agreement States in the commercial nuclear fuel cycle and at large U.S. Department of Energy nuclear defense and decommissioning/decontamination projects involving nuclides from high level wastes and special nuclear material, transuranic, and low level materials. He is recognized as an expert in environmental, safety, and health aspects of uranium mining, and processing facilities and sites contaminated with uranium fuel cycle and NORM materials. He was the Environmental, Safety, Health and licensing manager and radiation safety officer for five U.S. Nuclear Regulatory Commission licensed uranium mills, including uranium in situ recovery plants. Steven is currently a member of the IAEA working group on occupational radiation protection in uranium mines and processing facilities and has been appointed to the Colorado State Radiation Advisory Committee.

Tracy manages Radiation Consulting for Dade Moeller in its Richland, Washington office. He is a Certified Health Physicist and a Fellow of the Health Physics Society with more than 30 years of technical and project management experience in occupational and environmental health physics, accident analysis, and radiological assessment. He is the Technical Advisory Group Chair of ISO TC85/Subcommittee 2 on Radiological protection, Chair Emeritus and current member of the ANSI Accredited Standards Committee N13 on Radiation Protection, and an Associate Editor of the journal Health Physics and its supplement Operational Radiation Safety. Tracy has been the author or coauthor of more than 60 technical reports, publications, and presentations, as well as an author and technical contributor to numerous environmental impact statements and other technical documents.

Tracy Ikenberry, CHP

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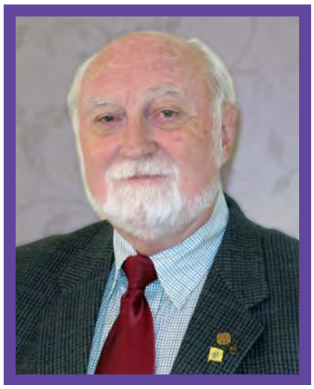

Ray Johnson,
MS, SE, PE, FHPS, CHP

Radiation Safety Counseling Institute

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Ray previously served as a Commissioned Officer in the U.S. Public Health Service on a permanent assignment to the U.S. Environmental Protection Agency from 1970 to 1985, where he served as Chief of the Radiation Surveillance Branch in the Office of Radiation Programs, Washington, D.C. Ray began working on NORM (radon) issues in 1973 when he wrote a report on population health risks from radon in natural gas and a manual on radon dosimetry. In 1981 he published EPA's first estimates of population health risks from radon exposure in homes. In 1986, he was a charter member of the American Association of Radon Scientists and Technologists and served as President from 1995 to 1998. He was also a Founder and President of the Health Physics Society Radon Section in 1995 to 1996 and was the Founder and first President of the National Radon Safety Board from 1997 to 1999. He has taught over 75 radon measurement classes at Rutgers University. Ray is a past President of the Health Physics Society. He has written over 600 book chapters, articles, papers, training manuals, and presentations on radiation safety, measurements, and risk communication. Ray has been a Certified Health Physicist for 33 years and a Licensed Professional Engineer for 50 years.

Phil is an Environmental Scientist in the Office of Radiation and Indoor Air at EPA Headquarters in Washington D.C. He focuses on the risks and regulation of naturally occurring radioactivity in the workplace, the public and the environment, with a focus on uranium recovery and TENORM. In his 30-plus year career, he has worked for various DOE contractors, Oak Ridge National Laboratory, and the Colorado Department of Public Health and Environment (mostly in Colorado). He has been at EPA Headquarters for 4.5 years. Phil spent almost 20 years in the field participating and designing radiological surveys before working for regulatory agencies. He is proficient in speaking various dialects of ICRP, IAEA, NCRP, DOE, NRC, CRCPD, RESRAD, MARSSIM and EPA-speak. He is currently on the Board of the HPS Environment and Radon Section and serves on numerous committees of the above organizations (and others) addressing TENORM.

Philip Egidi

U.S. Environmental Protection Agency

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Speakers & Presenters *(continued)*

Diana Thompson, CHP, RRPT

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Diana has an extensive training background and certifications, as well as a Bachelor of Science in Physics from the University of Wisconsin, Madison. She is currently attaining her M.S. in Physics from the University of Washington, Seattle. She has had extensive field experience (dumpster diving with gusto!), and in dealing with state organizations, federal agencies, and high level industry stakeholders. She has inspected and licensed all medical and industrial modalities of radioactive materials as a state health physicist, conducted internal dosimetry calculations and made hazard assessments after receiving emergency notifications. Diana has also worked as an independent consultant for projects involving risk assessments and disposal of Naturally Occurring Radioactive Material. She is now continuing her professional growth in the clinical setting at Rush University Medical Center in Chicago, Illinois, a 676-bed academic medical center that includes hospital facilities for adults and children.

Kurt Rhea is General Manager for SECURE Energy's U.S. On-Site Services Division. He was founder and CEO of Next Generation Solutions, a radioactive materials management company, which was acquired by SECURE Energy in 2014. As a Certified Radiation Safety Officer, he has years of experience serving the oil and gas industry as well as water treatment facilities across the U.S. He has been an active member and adviser to the North Dakota Petroleum Council as well as other regulatory agencies nationwide. With extensive service offerings including decommissioning and demolition of facilities, decontamination, remediation and reclamation, management, transport and disposal of NORM/TENORM waste streams, tracers, pigging waste, and other radioactive sources, Kurt has seen the gamut of low-level waste across the U.S.

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Walter is an Assistant Professor in the Department of Mechanical and Nuclear Engineering at Kansas State University. He has a doctorate degree in Nuclear Engineering from Kansas State University. Walter equips young engineers with sound techniques that enhance their effectiveness in multidisciplinary design efforts including electrical, computational, mechanical, and software components. His research has included basic radiation transport modeling; radiation detection system performance modeling; alarm algorithm design and evaluation for detection, localization, and isotope identification; software interface design for intuitive operation; and efficient display of complex radiological sensor data. He has developed tools and sensors for oil exploration and holds two patents.

Darrell has over 25 years of experience in the nuclear industry that originated in the U.S. Naval Nuclear Power Program. Subsequently, he worked for the U.S. Geological Survey for 13 years where he held multiple positions as a Reactor Health Physicist, Senior Reactor Operator, and Radiation Safety Officer for a Special Nuclear Material License and a Type A Broad Scope License with locations nationwide. He joined the EPA in 2009 as an emergency responder for radiological incidents and provided expert advice during Fukushima and radiological exercises as a member of the Advisory Team for the Environment, Food, and Health. He initiated efforts to revise the Protective Action Guides and served on the MARSSIM Committee. Mr. Liles has completed remedial projects for the uranium industry, provided advice and training to comply with U.S. Department of Transportation and IATA Regulations, and led a major action to license a conventional uranium mill under the U.S Nuclear Regulatory Commission.

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Ruth is the Executive Director of the Conference of Radiation Control Program Directors. She manages and directs the administrative office for the organization. Prior to taking the position in January 2007, she was the Manager of the Radiation Safety Licensing Branch at the Texas Department of State Health Services, culminating 25 years of service in the Texas Radiation Control Program, most of which involved licensing and standards development. Ruth is currently serving as a Member of Council and the Board of Directors of the National Council on Radiation Protection and Measurements. She is a past President of the Health Physics Society and has also been a U.S. delegate to four International Radiation Protection Association Congresses. Ruth holds a Bachelor of Science in Biology from Henderson State University in Arkansas and a Master of Science in Radiation Sciences from the University of Arkansas for Medical Sciences. She is also certified in comprehensive health physics by the American Board of Health Physics.

John is an independent, health physics consultant with over 35 years of professional experience in a wide range of radiation protection areas. His areas of expertise include external and internal radiation dosimetry, environmental dose assessment, radiation risk assessment, radiation spectroscopy, health physics training, radiation detection and measurement, and radiological site characterization. John is a past-president of the American Academy of Health Physics and a fellow and past-president of the Health Physics Society. John was awarded the 1988 Elda E. Anderson of the Health Physics Society and presented the 2007 John C. Villforth Lecture to the Conference of Radiation Control Program Directors. He has served as an advisor to numerous federal agencies on a wide range of health physics and radiation protection topics from operational health physics program design to environmental radiation dose and risk assessments. John has also served as a consultant to private companies and individuals on numerous health physics issues. He earned his Ph.D. in Physics (with health physics emphasis) from the University of Tennessee in Knoxville.

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Speakers & Presenters *(continued)*

Joseph Weismann, CHP, MBA

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Joe is Vice President of Radiological Programs for US Ecology. He has over 20 years of experience in the areas of Program Management, Radioactive Waste Management, Environmental Remediation, Facility Decommissioning, and Applied Radiation Protection. Joe is responsible for all aspects of US Ecology's radiological programs nationwide; including radioactive waste treatment and disposal operations, compliance, regulatory and public affairs, and supervision of both fixed facility and field services teams. He received his Bachelor of Science of Nuclear Engineering from the Georgia Institute of Technology, MBA from Boise State University, and has a comprehensive certification from the American Board of Health Physics. Prior to joining US Ecology, Joe was the Health Physics Program Manager for Cabrera Services in Goshen, New York and began his career as a Radiological Engineer for Shonka Research Associates in Marietta, GA. Joe has served as technical and management lead on a variety of US EPA CERCLA/Superfund, U.S. Army Corps of Engineers, DOE, and NRC-licensed project sites in over 20 states.

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US Ecology, Inc. is a leading North American provider of environmental services to commercial and government entities. The Company addresses the complex waste management needs of its customers, offering treatment, disposal and recycling of hazardous and radioactive waste, as well as a wide range of complementary field and industrial services. US Ecology's focus on safety, environmental compliance, and customer service, enables us to effectively meet the needs of our customers and to build long-lasting relationships. Headquartered in Boise, Idaho, with operations in the United States, Canada and Mexico, the Company has been protecting the environment since 1952.

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EnergySolutions is an international nuclear services company headquartered in Salt Lake City with operations across the United States, Canada, the United Kingdom and other countries around the world. With over 5,000 world-class professionals, EnergySolutions is a global leader in the safe recycling, processing and disposal of nuclear material. We provide integrated services and solutions to the nuclear industry, the United States Government, the Government of the United Kingdom, along with various medical and research facilities. EnergySolutions offers a full range of services for the decommissioning and remediation of nuclear sites and facilities, management of spent nuclear fuel, the transportation of nuclear material and the environmental cleanup of nuclear legacy sites. We're committed to reasserting America's leadership in the global nuclear industry and helping the United States and the United Kingdom countries achieve energy security in a way that reduces carbon emissions and protects the environment.

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SECURE Energy Services was formed in 2007 by a team of entrepreneurial, forward thinking people. The company has grown into a billion dollar company and it is still focused on providing innovative energy services with an emphasis on exceptional customer service. Our Vision is to be a North American leader in energy services. SECURE operates three divisions: Processing, Recovery and Disposal; Drilling Services and OnSite Services. Over the years, SECURE has grown to find new and innovative ways to help upstream oil and natural gas producers. With a dedication to value and customer service, we continue to build our suite of services with a focus on Environmental and Midstream services. Our goal is to provide integrated solutions throughout the life cycle of oil and gas exploration, to production and final reclamation. We constantly strive to deliver results that exceed expectations.

Thank you for attending!

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