

## Midyear Meeting NCRP NORM/TENORM Workshop Summary

Bill Kennedy

Photos courtesy of Phil Egidi

The National Council on Radiation Protection and Measurements (NCRP) held a workshop on naturally occurring radioactive materials (NORM) and technologically enhanced NORM (TENORM) at the 2016 Health Physics Society (HPS) Midyear Meeting in Austin, Texas, in February. As cochair of the NCRP scientific committee on this topic (SC 5-2), I'm going to summarize the workshop sessions as best I can. My comments are from my own personal notes and do not necessarily reflect the speakers' intentions or the messages that SC 5-2 members will take back to our committee deliberations.

First off, it's been a lot of fun for me (you don't hear that often) to meet colleagues working in this area and to help put together this portion of the HPS midyear meeting. I thank SC 5-2 members (who identified the speakers and reached out to them) and the speakers (who graciously provided top-quality presentations on relatively short notice). As a committee, we appreciate the speakers' assistance, and I hope the audience and other participants appreciate it as well. Thank you to John Frazier for being my fellow cochair of SC 5-2 (although he's reluctant to admit it) and for doing a yeoman's job with the session chair activities.



**Masoud Beitollahi**

In the first session of the workshop, Masoud Beitollahi reminded us of the importance of geology: it's all about the source term, and the source term starts with geology. He reminded us of the relationship between the [222Rn map that the Environmental Protection Agency](#) (EPA) has put together and the locations of shale formations that produce oil and gas in this country. It's interesting how well they coincide. The chemistry of rock formations is also important in that it determines what can be mobilized. This is something we often forget, but it is central to the source term. Conventional and unconventional types of rock formations and the different technologies applied to them all have an impact on the wastes generated and ultimately how the wastes are handled and disposed of.

In the second paper, John Frazier talked about a lot of issues. Mostly what I took away was that many issues call for a reality check. If you're forced to conduct modeling instead of taking measurements to make a decision, then you need to look at how you do that modeling. What are the appropriate transfer factors? What are the release fractions of radon from pipe scale vs. other types of wastes? Sampling numbers from the literature typically are biased high. They're very conservative since health physicists have the tendency to sample where the external dose rate is highest; however, such sampling is not necessarily characteristic of what's there. It's characteristic of one spot and one location, and unless you do a more comprehensive survey program, you don't really know how those values relate to the mean or average concentration of the material.



**John Frazier**

John also discussed exposure durations. We tend to be conservative when we run scenarios, but if a worker performs maintenance an hour a month, we over-predict his dose if we run the exposure scenario for 40 hours a week at the location of highest activity dose rate. In addition, John stressed the realities of time-dependent mixtures when dealing with TENORM. Although a material comes out of the ground at one concentration, after a few hours, a few days, or a few weeks, you may have a completely different problem on your hands because of the radioactive decay-chain reactions.

Jared Thompson provided a very interesting overview of many activities that the Conference of Radiation Control Program Directors (CRCPD) has sponsored over time. Among CRCPD's activities of interest to SC 5-2 is the development of trigger levels. Such levels are in fact consistent with the philosophies of the International Commission on Radiological Protection and the International Atomic Energy Agency. At what point do you cross the line: when are further radiation protection efforts required or further characterization efforts needed to determine if you have a problem? When do you decide that you do have a problem? The role of subjective judgment is central to



Jared Thompson

understanding all of this. He reminded us that regulators may wear one hat as regulators, another as advisors, and a third when interacting with public interest groups. You have to consider the entire audience when you make subjective judgments so that you can communicate your decisions successfully across all issues and to all stakeholders.

Jared also said that we need to look at TENORM more broadly—beyond the oil and gas industry. If we have compartmentalized our thinking too finely, we may miss problems in some areas and may in fact make life worse for some industries. He stressed the need for training so that people know what they're dealing with and what they're looking for.



Dan Shank

In the second session, we had two papers on litigation. Dan Shank gave us a history of NORM litigation starting with pipe scale and its associated issues. Dan explained that after many years of litigation and appeals, the jury verdict was upheld and damages of over \$112 million were affirmed, which opened the floodgates for further litigation. Everybody sees a successful lawsuit and wants to be part of it. He stressed that the points of law are not always clear. It's not that somebody got cancer—it's that somebody was afraid they might get cancer, and this becomes a valid legal argument. The compensation may be based on fear and not reality.



Maricio Escobar

Maricio Escobar gave the second talk on litigation issues. He discussed the 15 states that have regulations on NORM and TENORM. We learned that most state regulations converged on operational and public limits that are largely consistent with [10 CFR 20](#) and with the 0.25/0.75 mSv (EPA's 25/75 mrem) criteria in terms of public protection. But we also learned that states vary widely in their concentration and dose limits, resulting in much confusion. While each state has a rationale for its limits, the differences are again something SC 5-2 is taking to heart. Is there a scientific basis that can unify and create harmony among these disparate regulations in different states? Such unity would not just improve public health regulation, but would also improve how industry handles NORM/TENORM in this country.



Dave Allard

Dave Allard's study in Pennsylvania covered TENORM from soup to nuts, and the SC 5-2 members will have to break down all the steps that Dave took and review all of the results that Dave got. His study started with defining measurement and monitoring schemes, developing basic data quality objectives, deciding how they're implemented, and ensuring data control and ended up with performing statewide surveys to collect the data, obtaining modeling support, and making decisions on how to use the data, how to interpret them, and ultimately how they might feed the regulatory process. Dave is immersed in these processes daily, as will be SC 5-2. It's a benchmark study that I think will be a cornerstone consideration for SC 5-2 going forward.



Janet Johnson

In the third session, Janet Johnson talked about the Colorado experience. Colorado is a unique state in that it allows disposal of NORM in Resource Conservation and Recovery Act (RCRA) landfills, but limits the concentrations of NORM and where it can go. The issue of generators determining waste concentrations is paramount in this industry. The credibility of the whole disposal system depends on how much rigor the generator uses to define the waste. Another big issue is decay to equilibrium. Use of grab samples compared to other means of characterizing waste streams is a concern. Health physicists often struggle to communicate the difficulties of using portable or handheld dose-rate instruments to characterize waste, especially when the measurement nomenclature varies.

Art Rood talked about his experience looking at waste-disposal issues and reviewed several fundamental principles. He provided overviews of concentration ranges from different types of waste and reminded us that, again, single-point measurements may not be very useful in overall characterization of waste streams, considering the potential variability of those streams. Radon emanation rates from pipe scale have been measured and are known to be roughly a factor of 10 less than emanation rates from other waste forms like uranium mill tailings or other mine tailing waste. This is a sobering thought because we accept the fact that radon is important but, depending on the waste form, we have to remember that emanation rates may be different and the magnitude of that problem may vary.



Art Rood

Art also discussed exposure pathway analysis. He gave a very good overview of how it's done, why it's done, when it should be done, and how the results should be interpreted. He reviewed some of Andy Lombardo's and Dave Allard's work in Pennsylvania, highlighting the significant conclusions with respect to who's exposed by which pathway when and how important those exposures are to making waste-disposal decisions. He reminded us again that while it's necessary to meet waste acceptance criteria developed in terms of dose rates to workers and people, we need also to understand the waste volume as well as concentration when doing postclosure and siting analysis for any waste-disposal facility. If you have an industrial or sanitary landfill that has only 10% of the waste coming from a NORM source, it's really not legitimate to do a bounding calculation that has a million cubic meters of waste with a very thin cap. You need to tailor and understand the kinds of siting analyses that are realistic.



Allen McArthur

Next up, Allen McArthur taught us an outstanding history lesson. NORM discovery, NORM action—he included everything from the early 1980s through present day. Numerous countries were involved; this isn't just a problem in the United States—it's global. I found it interesting that there were similar responses around the world as people discovered they had a problem. They identified  $^{210}\text{Pb}$  and other radionuclides as the important contributors, looked internationally for guidance, and found that they needed a radiation specialist to help them sort through, measure, and understand the situation. Oftentimes the situation was resolved by getting a radiation professional involved, either on staff or through a consultation program, to make sure procedures, records, and operations were maintained with public safety as the goal.



Joe Weismann

In the fourth and final session, Joe Weismann started off looking at waste acceptance criteria. His company supports facilities across the United States. As we saw, they have a variety of waste acceptance criteria depending on the type of facility, the state it's in, how the facility is operated, and the types of waste NORM they receive. Idaho was a very interesting test case that laid out possibilities for other states and how we might look at disposal. I think Joe made the statement that there's plenty of disposal capacity in the country today, but that's true only if all of the waste has been identified for disposal.



Andy Lombardo

We all give Andy Lombardo kudos for his role in the comprehensive study that was conducted in Pennsylvania: collecting data, analyzing the data, and understanding and interpreting those data. As a pathway modeler for over 40 years and one of the individuals who developed the mathematical formulations for [RESRAD](#) (a computer model that estimates radiation doses and risks from residual radioactive materials), I took delight in everything Andy said because it was exactly my experience over the years. Andy advised us to consider not running just one simulation, but running multiple simulations, asking questions, and using Monte Carlo analyses to try to understand results and the potential variability of the results. So many of Andy's statements resonated with me. For example, if you run a 1,000-year analysis and the answer is zero, it could be because the peak is at 1,010 years or 1,100 years. In reviewing previous per-

formance estimates for low-level waste, we always asked “what’s the next shoe to drop?” Is 1,000 years or 10,000 years the right time frame? Given the uncertainties of the data, parameters, and modeling, if the peak is at 1,100 years you’re probably doing a disservice to say it’s zero for the first 1,000 because it has an upward tendency. And that’s where we should focus our modeling and assessment: what is our understanding of the mechanics, what are the limitations of our knowledge today, and what is the role of uncertainty in assessment? It all comes back to the importance of the source term on the analysis, which relates back to basic geology: understanding what’s there, knowing when it’s there, and deciding how to analyze it.



**Mel Hebert**

Mel Hebert did a great job on deep-well injection and options that most of us haven’t considered. Some of them are very Texas-specific, but Mel laid great groundwork for understanding the different types of deep-well injections that are possible, what his company is doing, and what Texas is doing. We heard about the seismicity in Oklahoma, which might be related to some form of deep-well injection, and we know this is on the public’s mind. So if the SC 5-2 members are going to look at the overall issues, we need to understand how waste is generated, how it’s dealt with, and what the possibilities are.

In closing, I would like to thank HPS President Nancy Kirner and the Society for allowing us to hold this meeting essentially at the last minute and to invent these workshop sessions. For me, it was a very powerful and fun experience, both professionally and personally. I got to see so many long-time friends in the audience, and I hope that the meeting was as rewarding for others as it was for us SC 5-2 members.