David J. Allard CHP, Director, Bureau of Radiation Protection
Department of Environmental Protection
on
"Radiation Levels and Tritium at Landfills"
Before the
Senate Environmental Resources & Energy Committee
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Introduction

Thank you Madam Chairman, Senators, good morning. It is an honor and privilege to be before you this morning to present information regarding "Radiation Levels at Landfills." I will also be addressing your expressed concerns related to tritium in landfill leachate.

Before I begin, allow me a moment of introduction. I am a medical health physicist, with nearly 30 years of professional radiation protection experience in biomedical, academic, industrial and government service. Since 1999, I have been the Director of the Bureau of Radiation Protection (BRP) in the Department of Environmental Protection. Prior to joining the Commonwealth, through most of the 1990s, I was a key technical expert for the U.S. Department of Energy (DOE) providing expertise in environmental and occupational radiation protection, performing inspections and independent oversight of DOE's production, weapons, reactor, accelerator, Decontamination and Decommissioning (D&D) and environmental restoration facilities for the Office of Independent Oversight (EH-2). In this capacity, I evaluated some of the most radiologically hazardous and contaminated facilities in the country, such as Rocky Flats, Hanford, Oak Ridge, Savannah River sites, and many others. My formal education includes a B.S. degree in Environmental Sciences and a M.S. in Radiological Sciences and Protection. I am a Certified Health Physicist (CHP), an officer of the Health Physics Society, and active on many national committees. I also serve as Governor Rendell's official liaison to the U.S. Nuclear Regulatory Commission (NRC), and the Department Secretary's alternate member on the Appalachian States Low-Level Radioactive Waste (LLRW) Compact Commission.

As you may be aware, under the state's Radiation Protection Act (Act 147), the BRP has broad programmatic responsibility for independent nuclear safety oversight, emergency response and radiological environmental surveillance with our nine nuclear power plants on five sites in the Commonwealth. We are a relatively small program, but BRP is one of the most respected radiation control programs in the country, and regulates and inspects some 11,000 registered x-ray facilities with 30,000 pieces of equipment, licenses 250 high energy accelerators, licenses 460 radioactive material users, oversees several very complex decommissioning projects, and certifies about 600 radon testers, mitigators and laboratories.

You will no doubt glean from my remarks, that I am very proud to be part of the dedicated and professional team in DEP's Radiation Protection Program, who are

responsible for oversight and regulation of facilities, equipment, materials and radiation sources that can cause grave and acute harm, or potentially increase the risk of cancer. In addition to public, patient and worker protection, we have an important mission to protect the environment. Nevertheless, many of the man-made sources of radiation we deal with on a daily basis are designed to diagnose or treat disease, or otherwise benefit society. Thus, we have the double-edge sword of radiation. The natural sources of radiation in our human environment are many, including uranium and its many decay products. I will touch on some of these points again as we discuss the subject of this hearing.

Background

Radiation is part of our everyday lives. Every day each of us is exposed to naturally occurring quantities of radiation. In fact, radioactivity is in the air we breathe, the soil on which we walk, the buildings we work and live in, and even within our own bodies. The use of radiation in some areas, such as medical and dental practice, plays an important and sometimes vital role in our everyday lives.

Radiation cannot be detected by our human senses, and is invisible energy waves (e.g., gamma or x-rays) or particles (e.g., alpha or beta rays) that originate from natural and man-made radioactive materials, or machine sources. Although natural and man-made radiation are controlled and regulated differently, both sources of radiation behave identically and can be detected with the same instruments.

All material or matter found in nature is made of atoms, which can be either stable or unstable. As unstable atoms change or decay to become stable, they give off their excess energy and eventually become stable. The sun, stars and other cosmic sources constantly emit radiation that enters the atmosphere and expose us on the surface. Natural radiation can also originate from potassium-40 (K-40), which can be found in living cells, and from uranium, a common radioactive element found in soil and rocks and minerals. In fact, Pennsylvania has some of the highest concentrations of uranium in its native rocks and soils.

In addition to radiation originating from natural radioactive sources, artificial or man-made radiation can be produced and originates from high voltage devices such as x-ray equipment. Man-made radioactivity is used in many consumer products (e.g., smoke detectors) and in various medical and research applications. Self-luminescent EXIT signs and watches, welding rods and certain types of glass and ceramic are only a few of the many products that contain or emit low levels of radioactivity and radiation. (Again, I will further discuss these self-luminescent EXIT signs, and the tritium used in them.) Radiation is an essential facet used in cancer treatment, diagnostic x-rays and other medical procedures and research. There are literally tens of thousands of nuclear medicine procedures done annually in the U.S., where patients administered radioactive materials.

Did you know that normal household waste could be radioactive at times? With so many medical uses and applications for radiation available today, it's not surprising that we detect radioactivity in solid waste.

DEP's New Solid Waste Radiation Monitoring Regulations

However, prior to 2000, no solid waste processing or disposal facilities in Pennsylvania, including municipal waste landfills, were permitted to accept any waste containing "radioactivity." That meant that nothing containing detectable radioactive material, even an exempt smoke detector, could be deposited in an individual's trash for disposal. In normal everyday practices, this requirement was almost impossible to achieve. Specifically, we had a situation where patients with relatively large quantities of short-lived nuclear medicine radioactive materials (i.e., 8-day half-life iodine-131) in their body were permitted to leave a hospital or clinic, and their household waste became contaminated. Several landfills in the state had installed portal radiation monitors, and each time one alarmed, BRP staff had to respond. This was very much impacting our program by diverting staff time and resources for materials that were technically exempt when excreted from a patient, and could be safely disposed of in a landfill.

During 2000, BRP and the Bureau of Waste Management (BWM) developed new solid waste regulations and guidance for radioactive material that may be found in waste and disposed in a solid waste processing or disposal facility. These new regulations represent a common-sense approach for identifying, managing and disposing of waste containing certain types of radioactive material that pose no threat to the public or the environment. These regulations do not allow radioactive material regulated under a state or federal license to be disposed at a solid waste disposal facility, unless that material is specifically exempted from disposal restrictions by applicable Pennsylvania or federal law. These regulations were the first in the nation to provide a practical and comprehensive approach to solid waste radiation monitoring, with guidance on how to appropriately disposition various materials.

Most importantly, according to DEP's new regulations, all solid waste facility operators must install equipment at their facilities that will scan incoming waste and sound an alarm if radiation is detected. When the alarm is triggered, the operator must follow specific guidelines to ensure that the radioactive material detected is properly characterized and managed. Approximately 170 solid waste facilities (i.e., landfills, transfer facilities and resource recovery facilities) in Pennsylvania have now installed radiation monitoring devices. The approach they use is also now standardized with respect to alarm set points and calibration. Their experiences so far clearly support DEP's new regulatory approach, and we have prevented many lost or abandoned "orphan" radioactive sources from entering our solid waste disposal and processing facilities.

Reported data from facilities confirmed that over ninety percent of the radiation alarms at solid waste facilities in the state have involved radioactive material that is exempt per NRC and DEP regulations, decays rapidly in place, and does not jeopardize human

health or the environment. This includes household waste contaminated with radioactive material from animals or human patients who have undergone a nuclear medicine treatment. Such material has included contaminated paper products and even kitty litter. It is perfectly legal and safe to discard this type of material in the solid waste stream, and now when an alarm sounds-off at a solid waste facility, facility operators are trained to survey the vehicles, identify the material and properly execute its disposition. The operators also have trigger "action levels" prompting immediate contact with BRP personnel.

Action Level 1 Scenario -

Under an Action Level 1 scenario, an alarm would sound at a solid waste facility indicating the presence of radioactive material in the incoming waste. The facility operator must then determine the cause of the alarm, identify the type of radioactive material present, and the facility's next course of action. If the radioactivity in the solid waste is from the natural environment or contaminated household waste from a medical patient that will decay rapidly, DEP will allow the waste to be disposed or processed at the solid waste facility. Examples of waste containing radioactive material under an Action Level 1 scenario may include solid waste from a patient's home, naturally occurring radioactive material in soil and rocks, or exempt consumer products such as smoke detectors. All radioactive material that is accepted by the solid waste facility for disposal must be managed according to specific DEP regulations, operating permit conditions, and, an approved "Action Plan."

Action Level 2 Scenario -

Although less likely, it is possible that radioactive sources of a more serious nature may become mixed with municipal or residual waste. If the radioactivity detected in the waste is not from the natural environment or from a patient treated with nuclear medicine, or the radiation levels are above those set in the regulations, the facility operator must follow guidelines under an Action Level 2 Scenario. Under this scenario, an operator is not permitted to process or dispose of the solid waste and must contact DEP immediately. A BRP or consultant health physicist will respond to the site and ensure that the radioactive material is properly identified, handled and returned to the point of origin or disposed of at a licensed LLRW disposal facility. If a vehicle is to be rejected to an in-state or out-of-state point of origin, the BRP staff have authority to issue an exemption to federal Department of Transportation (DOT) regulations.

More information on all of the Bureau's programs, including our regulations and guidance documents, can be found on the Department website at www.depweb.state.pa.us, DEP keyword "Radiation Protection".

Tritium in Landfills

One of the main issues you requested to be briefed on was tritium in landfills. As you may be aware, DEP has recently completed a two-year study of over 50 active landfills within the Commonwealth testing for the presence of radioactive materials in landfill liquid effluents, commonly termed "leachate." The study was performed as a follow-up to DEP's new requirements for radiation monitoring at all Commonwealth solid waste facilities. Leachate was screened for radioactivity (i.e., gross alpha, beta, gamma activity, and tritium) and, as expected, naturally occurring uranium, thorium and potassium (K-40) were observed; however, radioactive hydrogen-3 (tritium) above normal background was noted in many samples. Although tritium has been detected in the leachate of most of the permitted landfills, based upon a review of the study and other relevant information, such as receiving stream and river dilution factors, DEP has concluded there is no immediate or long-term threat to the public's health and safety or the environment.

Tritium, a radioactive variation of the chemical element of hydrogen, emits a very low energy beta radiation, is naturally occurring, and is normally present in the environment at higher-than-expected levels as a result of aboveground nuclear weapons testing in the 1960s. Presently, background environmental concentrations of tritium in surface waters run 50 to 150 picocuries per liter (pCi/L). A curie is the unit of measure for radioactivity. It is my professional opinion that the source of the above background tritium in landfills is most likely the improper disposal of self-luminescent tritium 'EXIT' signs commonly used in buildings to identify doorway exits during an emergency or loss of power. There are no other known sources of tritium in industrial or consumer products that would cause these levels of tritium in leachate. Tritium in leachate is an environmental contamination concern, but to cause radiation dose, it must enter the human body. It is not an external radiation hazard. Being chemically hydrogen, tritium readily bonds to oxygen to form tritiated water. The potential pathways into the body are ingestion via drinking water, absorption through the skin, or inhalation of tritiated water vapor.

To assess any possible tritium exposure to on-site workers or the off-site public, we have reviewed the authorized discharges of treated leachate to treatment facilities and streams, locations of public water supply intakes, the use of treated leachate for dust suppression at landfills, evaporation of leachate, the practice of flaring landfill gases, and the use of landfill gas for energy production. Based on the review of many factors including the concentrations of tritium observed, the location of treated liquid effluent discharge points, dilution factors of receiving streams, distance to downstream water supply intakes, results of past air sampling, potential evaporation scenarios, DEP has concluded that there are no threats to the public's health or safety associated with those discharges or practices.

Exposure to tritium is not uncommon, and in the past, levels have been much higher due to atmospheric nuclear weapons testing. The U.S. Environmental Protection Agency (EPA) has established a drinking water standard for tritium of 20,000 pCi/L. This drinking water maximum contaminant limit (MCL) of 20,000 pCi/L is based on the EPA's primary radiation dose limit of 4 millirem (mrem) per year from this exposure

pathway. And, using the assumptions of a person drinking 2 liters of water a day containing 20,000 pCi/L of tritium, for 365 days, a person would get a 4 mrem radiation dose in the year. To put these numbers in perspective, this compares to the 5 mrem one would receive traveling on a jet round trip from New York to Los Angeles, 10 mrem from a chest x-ray, an average dose of 200 mrem per year from indoor radon gas, or the 1,000 to 5,000 mrem from a medical x-ray computed axial tomography "CAT" scan. I would also note that this 20,000 pCi/L EPA drinking water limit is conservative by about a factor of four. The derivation is based on circa 1960 internal dosimetry models and an assumed 20% organically bound fraction of tritium. The reality is that most would be in the form of inorganic tritiated water, and using more up to date models, it would take on the order of 80,000 pCi/L to produce a 4 mrem/yr dose.

Although there are no federal or state surface water quality standards for tritium, the drinking water standard for tritium is helpful in assessing possible risks associated with the tritium in leachate. For instance, the highest level of tritium that we found in leachate was 182,000 pCi/L at the Conestoga Landfill in Berks County. It is my understanding that most of the time treated leachate from this landfill is used onsite by the landfill operator for dust suppression, and is not discharged to the adjacent Conestoga Creek. If treated leachate is discharged, after calculating stream flow dilution between the discharge point and the nearest downstream public water supply intake, the maximum concentration of tritium in the stream at the water supply intake would be well below EPA's drinking water standard of 20,000 pCi/L. Indeed, this is the case for all the landfills in the Commonwealth. With this testimony, I have included a table that provides tritium concentration data in raw leachate for the landfills in our 2004 and 2005 studies.

As an immediate response to the findings of the two-year study, DEP has developed a long-term strategy to monitor and address this issue. First, we will be adding tritium to the standard leachate quarterly testing protocol currently required at all active landfills. Although we have concluded that there is no immediate or long-term threat to the public, we do believe that long-term monitoring and reporting is appropriate in order to ensure the continued protection of the public's health and safety. Based on my recommendation and standards of practice, we have set a 10% threshold on tritium concentration in leachate that would cause a specific down-stream drinking water supply to approach the 20,000 pCi/L drinking water limit. Prospectively, to reduce the potential for future disposal of EXIT signs containing tritium, we are pursuing remedies at both the state and federal levels.

Because these tritium EXIT signs are manufactured and distributed under the authority of the NRC and a "general license," and the concerns related to potential drinking water supply impact, my Deputy Secretary, Tom Fidler, has formally alerted the NRC and EPA to the problem of tritium EXIT signs being improperly disposed and elevated levels of tritium being found in landfill leachate. Our communications to the NRC recommended they evaluate their required labeling and controls of these signs to better alert persons removing signs of the need for proper management and disposal. We will continue to address this matter with the NRC, the federal agency that has ultimate

responsibility in regulating and controlling these tritium containing signs and their disposal. I have also requested the NRC perform a peer review of our calculations and conclusions in this matter, related to worker and public exposure and dose modeling. They have concluded that this is not a public health and safety concern under their regulatory framework. Because the tritium is bound as water, there is no technical means to remove it from treated leachate prior to liquid effluent discharge to the environment. Thus, one must rely on dilution to reduce concentrations. Unfortunately, these tritium EXIT signs cannot be detected by the gamma portal monitors in use at our solid waste facilities, and, it is apparent that the NRC's administrative controls are not adequate.

I have an empty glass tube used in the manufacture of these EXIT signs, and will pass it to the Committee and explain how they work. Basically, the tube is back-filled with tritium gas, and low energy beta particles strike the yellow-green coated surface you see on the inside. The energy of the beta ray is converted to visible light, and you obtain a low-level source of light that may be useful in emergency egress situations (e.g., fire and smoke conditions). These signs are commonly used in commercial aircraft, hotels, shopping malls, etc. Unfortunately, the tritium has a 12-year physical half-life, and after 15 to 25 years, the signs may not provide sufficient illumination. We have also alerted the appropriate federal and national safety standards organizations to this concern. That is, if due to the lack of adequate labeling these signs are not being properly controlled for disposal, are they being monitored for "expiration" and replacement? We don't believe they are.

Nonetheless, these tritium EXIT signs are now widely used under a general license and <u>are not</u> exempt from disposal restrictions. This radioactive device is specifically prohibited from disposal in landfills by the NRC's regulations and our Municipal Waste regulations in Title 25, Chapter 273, Section 273.201(l) and (m). In addition, our DEP guidance (250-3100-001), on page 10 (paragraph C), for the radiation monitoring of solid waste specifically notes: "If a 'generally licensed' tritium EXIT sign is found in any waste stream, it shall be returned to a licensed manufacturer for recycle or shipped for proper low-level radioactive waste disposal." As part of our strategy, and to re-emphasize the regulatory requirements and achieve better compliance, we are providing specific information through permits, fact sheets, and other publications to those businesses involved with building de-construction and demolition. We will also be notifying all tritium EXIT sign licensees in the Commonwealth of their responsibilities, to help ensure tritium EXIT signs are removed and properly managed for transfer or disposal. If one considers a single tritium EXIT sign may have up to 25 curies (Ci), or 25,000,000,000,000 pCi, it would take only one sign in a landfill to generate the tritium concentrations we've observed in leachate.

As referenced above, I have included the summary table of the 2004 and 2005 leachate sampling for tritium at our landfills and the results of DEP's analysis for your reference. The full comprehensive technical report of the two-year study with a summary of testing protocols, analytical methods, quality assurance test results, complete site-specific test results, and conclusions is available on the DEP web site at

www.depweb.state.pa.us, using the DEP Keyword phrase "Radioactive Solid Waste Reports." We have also posted a catalog of radioactive sources detected and prevented from disposal in our landfills.

Conclusions and Long-term Strategy

Other aspects of the Department's long-term strategy for managing this issue of tritium in landfills include: we are actively addressing the regulatory framework with NRC and EPA, we have presented our findings in several government and industry forums (and will continue to do so), we are updating our guidance to further alert the solid waste industry to tritium in leachate monitoring methods, and we have notified all landfills of the new tritium monitoring requirements. This monitoring will include the sampling of groundwater monitoring wells for unlined landfills, or those with documented leachate breakthrough. We are presently working with the EPA to develop web-based training materials for the safe handling of tritium EXIT signs. BRP staff are also assisting EPA with their efforts to find alternative technology for tritium EXIT signs and other generally licensed radioactive sources. All these efforts are beginning to pay-off, for the Association of State and Territorial Solid Waste Management Officials' (ASTSWMO) Radiation Focus Group has recently recommended the Health Physics Society develop an (ANSI N13) national standard protocol for radiation monitoring at landfills. Similarly, ASTSWMO has asked the Conference of Radiation Control Program Directors (CRCPD) to develop a model state regulation on the same subject. In both cases the DEP's regulations and guidance were cited as excellent materials to draft from, for no other state has taken such a comprehensive and rational approach to this regulatory dilemma.

Lastly, our tritium leachate results are similar to those of others who have evaluated the matter (e.g., California and Scotland in the UK). Given the estimated 2-3 million signs in the U.S. alone, and the regular reporting of lost signs in NRC's event database, one would conclude that there is a very high probability that most landfill leachate has tritium contamination. We have asked the EPA to disseminate this information to other states, for we feel site-specific monitoring and dilution factors must be used to assess the potential impact on down-stream drinking water supplies. Again, we don't feel this is a serious public health and safety issue, but the regulatory control and disposal problems need to be addressed by NRC. You have the Department's and my commitment to continue to assess and try to remedy this situation.

Thank you Madam Chairman and Senators. I would be glad to answer any questions you may have, and will remain through the hearing should you wish to call me back to clarify or further explain any issues.

Attachments:

- Table of Landfill Leachate Tritium Results
- Mr. Allard's Resume