Regulations and Guidance for Dealing With Radioactivity in Solid Waste in Pennsylvania

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Abstract. The Pennsylvania Department of Environmental Protection (PA DEP) has the responsibility for protecting the health and safety of the citizens in the Commonwealth, and protection of the environment from hazardous material contaminants. This includes sources of radiation such as medical and non-medical radiation generating devices, radioactive materials, radioactive waste, and independent oversight for nuclear power plants within the state. This paper and meeting poster summarizes the regulations and guidance for dealing with radioactivity often detected in solid waste in Pennsylvania.

Keywords: radiation monitoring, solid waste, Pennsylvania regulations and guidance.

1. Introduction

As with any industrial society and consumer-oriented economy, the United States generates significant volumes of solid waste. The U.S. Environmental Protection Agency (EPA) regulates the solid waste (SW) processing and disposal facilities under the federal Resource Conservation and Recovery Act (RCRA). Such facilities include landfills and resource recovery facilities (RRF), also known as incinerators or energy recovery facilities. EPA’s regulations cover “RCRA Subtitle C” hazardous material processing and disposal sites and “RCRA Subtitle D” household or municipal waste landfills. However, if they have equivalent regulations, states are often delegated the authority to regulate these SW facilities by EPA. Pennsylvania has the authority to regulate SW facilities. In fact, the state is one of the few that uses hazardous material design standards for our municipal waste landfills. The PA DEP Bureau of Waste Management (BWM) regulates some 6 RRFs, 54 landfills, and 110 transfer facilities. In addition to the SW generated by residents of the state, approximately 10 million tons of out-of-state SW is imported and disposed of in Pennsylvania each year. Similarly, the U.S. Nuclear Regulatory Commission (NRC) regulates radioactive materials, but has a provision within the federal Atomic Energy Act (AEA) that allows it to enter into “agreements” with states. Pennsylvania is one of 35 Agreement States and regulates radioactive material (RAM), i.e., byproduct material, source material and small quantities of special nuclear material, in various medical, academic and industrial settings. The PA DEP Bureau of Radiation Protection (BRP) regulates about 900 specific licenses of various type, 1,300 general licensed (GL) sealed sources at 400 facilities, and 55,000 GL tritium exit signs at 3,500 facilities within the Commonwealth. However, there is one area that neither the NRC nor the PA DEP directly regulate, and that is the possession and/or generation of SW with naturally occurring SW with naturally occurring radioactive material (NORM) or technologically enhanced NORM (or TENORM). Nonetheless, within the state’s SW regulatory framework, the PA DEP does regulate disposal of NORM or TENORM containing wastes at SW landfills.

2. Discussion

In the late 1990s, with increasing frequency RAM was being detected in municipal and industrial “residual” solid waste by radiation monitors installed at processing and disposal facilities. The vast majority of the detection events were due to short-lived nuclear medicine radionuclides (e.g., I-131, Tc-99m, Tl-201, etc.). However, often NORM or TENORM, consumer products with RAM, or more dangerous lost sealed sources (e.g., Am-241, Ra-226, Cs-137, etc.) were detected. A regulatory analysis performed in 1999 showed the radioactive materials that set off facility radiation alarms may be regulated
through specific or general license, but more likely are deregulated, exempt or unregulated. Additionally, it was evident there were no federal or state regulatory requirements to have radiation monitors at solid waste facilities, nor where there standards for: alarm set point, system background limit, gamma energy discrimination level or protocols for response. Regardless of the probable type of RAM in the solid waste (i.e., short-lived medical radionuclides), BRP staff promptly responded to numerous alarms on a weekly basis. This caused a measurable impact on other program activities, such as x-ray equipment and RAM user inspections. Further, despite the lack of specific regulatory requirements to have radiation monitors, many SW facilities installed them because of ill-defined operating conditions prohibiting “processing or disposal of radioactivity.”

With the potential for serious impact on human health, safety and the environment from some types of RAM found in the solid waste stream, the PA DEP BWM and BRP jointly developed regulations requiring monitoring for radiation and radioactive materials at all municipal and residual solid waste facilities in Pennsylvania. These regulations were codified in 2000, and became effective in 2001. Appendix A are the regulations applicable to municipal landfills. Other SW facilities (i.e., RRFs and transfer facilities) have the same applicable radiation monitoring regulations. A comprehensive guidance document was also developed for the regulated community to assist with implementation during a 2-year transition phase. [1] During this period all SW facilities were required to install radiation monitoring equipment and, develop an Action Plan for responding to alarms. This poster describes the nature of the problem, the new regulatory framework and radiation monitoring requirements, alarm set points and background limits, equipment standards, and program experience. Also outlined are the requirements for a facility Action Plan, instrumentation performance checks, training and records, and the public dose limits that will be applied to operations and effluents. A graded response to alarms involving two radiation Action Levels with appropriate onsite RAM characterization has allowed facilities and the PA DEP to more effectively manage the radioactive materials that might be discovered in municipal and residual solid waste.

Our experiences since developing and implementing these regulations have been many. We believe these regulations to be a rational and practical approach to a multi-faceted regulatory quagmire. For example, in the case of radionuclides used for diagnostic and therapeutic nuclear medicine, the RAM received at a licensed medical clinic or hospital is highly regulated until it is administered to the patient. Once in the patient, it may be excreted to the sanitary sewer without control, and, the patient may be sent home to contaminate household articles, which can in turn be disposed of as solid waste. This accounts for the vast majority of radiation alarms at SW facilities. Investigations and tracking over the years have determined that I-131, Tc-99m and Tl-201 to be the most common materials causing alarms. Measured and calculated activity levels are very low, but enough to trigger an alarm. Through the SW facility Action Plan review and approval process, the PA DEP allows processing and disposal of SW contaminated with these radionuclides without any specific controls. NORM and TENORM is the next largest category of RAM to cause SW facility alarms. These disposals require an evaluation of the concentration of uranium and thorium and/or decay series (i.e., Ra-226), total volume of waste, with an appropriate and conservative “resident farmer” public dose evaluation and DEP approval prior to disposal. If the calculated dose is below 25 mrem/yr, the disposal may be allowed if other physical and chemical characteristics are deemed acceptable. Each year numerous generally or specifically licensed sealed sources, or materials that should be licensed, are detected and prevented from improper disposal in PA landfills. These discrete byproduct materials sources (many with Ra-226) make up the third major category of RAM causing radiation alarms at Commonwealth SW facilities. There are about 2,000 alarms at our 170 SW facilities each year. Typically, 80-90% of the alarms are short-lived patient contaminated SW, 10-20% of the alarms are NORM or TENORM, and 1-3% are discrete sources.

As noted in the regulations outlined in Appendix A, the focus of our SW radiation monitoring is on the front end, that is, we are trying to prevent and control the inappropriate RAM entering our landfills or
being processed at a transfer facility or RRF. Again, we feel this is important to protect the public, workers at these facilities, environment, and, to prevent contamination of valuable assets in the case of RRFs. There are numerous documented cases where GL sources have been lost or abandoned, melted in metal recycle foundries, and have caused millions of dollars in facility clean-up cost. Early on with this new program we had a near miss with four Cs-137 sources, 111 MBq (3 mCi) each, accidentally incinerated at a RRF in PA or MD. Fortunately the sources remained intact. Once the PA DEP finished implementing these new regulations in 2004, with the approval of about 170 SW facility Action Plans, based on the sources we had prevented from entering SW facilities, we felt it was important to evaluate the leachate from our landfills for radioactivity. This was an obvious gap in our regulations. Thus, investigations were done in 2004 at our 54 landfills, and leachate samples were evaluated for gross alpha / beta activity, gamma spec and tritium. High gross alpha levels prompted further alpha spec analysis.

Results confirmed our suspicions, that the gross alpha / beta activity was all due to U / Th series, except for beta activity when run via liquid scintillation. In particular, the observation of tritium up to a thousand times normal background was not uncommon. The landfill leachate study was repeated in 2005, but just for tritium. Results were similar. The DEP believes the cause of this tritium contamination of leachate is due to improper disposal of GL tritium exit signs. These tritium in leachate investigations are ongoing, with quarterly sampling and analysis being performed from 2007 through 2008. Surface water background levels of tritium in N. America are about 18.5-55.5 Bq/L (50-150 pCi/L); however, leachate was found to be from background levels in 10% of the landfills, up to a high concentration of about 129.5 kBq (350,000 pCi/L). The EPA’s drinking water standard for tritium is 7.4 kBq (20,000 pCi/L), and over 50% of our landfills exceeded this concentration. Leachate is obviously not a source of drinking water, but the DEP has examined the potential impact of treated (but still tritiated) leachate being discharged to the stream or river. Considering initial concentrations at discharge points, downstream dilution factors based on mean stream flows, we evaluated the possible impact on all downstream water supplies. We have found no case where 10% of the EPA drinking water standard might be exceeded at a drinking water intake. Should this threshold be exceeded, the DEP would have to required routine tritium analysis of the finished drinking water. Quarterly monitoring of tritium in landfill leachate continues in the Commonwealth, and the DEP is currently evaluating the need for continued long-term monitoring. Current landfill leachate tritium concentration data will be presented in this poster.

3. Conclusion

The Commonwealth of Pennsylvania has developed a rational and comprehensive regulatory framework and requires radiation monitoring at its approximately 170 solid waste facilities. Low hazard short-lived patient contaminated radioactive materials are allowed to be processed or disposed of at transfer facilities, landfills or incinerators. However, solid waste with levels of NORM or TENORM mandates an evaluation prior to processing or disposal. Orphan or abandoned sealed sources are recovered for disposal at licensed low-level radioactive waste (LLRW) facilities. However, due to the nature of tritium, it is not possible to detect improper disposal of GL tritium exit signs. Thus, efforts are now being focused at the state and national level for better tritium exit sign control, with appropriate transfer back to the manufacturer or disposal of these signs at a licensed LLRW facility. [2] All the above noted regulations, guidance, fact sheets, and leachate studies can be found on the PA DEP BRP web page for solid waste radiation monitoring. The link is below in the reference section. [3]

REFERENCES

Appendix A

PA DEP MUNICIPAL WASTE RADIATION MONITORING AND RESPONSE REGULATIONS FOR MUNICIPAL LANDFILLS

Title 25. Environmental Protection

Chapter 273 – Municipal Waste Landfills

§ 273.133 MAP AND GRID REQUIREMENTS
§ 273.140a RADIATION PROTECTION ACTION PLAN
§ 273.201 BASIC LIMITATIONS
§ 273.223 RADIATION MONITORING AND RESPONSE
§ 273.311 DAILY OPERATIONAL RECORDS
§ 273.313 ANNUAL OPERATION REPORT

§ 273.133. Map and grid requirements.

(a) An application shall contain a topographic map of the proposed permit and adjacent areas showing the following:

(14) A designated area for vehicles for use in the event of the detection of waste containing radioactive material. The designated area shall, by location or shielding, protect the environment, facility staff and public from radiation originating in the vehicle. The Department’s Guidance Document on “Radioactivity Monitoring at Solid Waste Processing and Disposal Facilities,” Document Number 250-3100-001, describes various factors to consider in determining an appropriate designated area.

§ 273.140a. Radiation protection action plan.

(a) An application shall contain an action plan specifying procedures for monitoring and responding to radioactive material entering the facility, as well as related procedures for training, notification, recordkeeping and reporting.

(b) The action plan shall be prepared in accordance with the Department’s Guidance Document on “Radioactivity Monitoring at Solid Waste Processing and Disposal Facilities,” Document Number 250-3100-001, or in a manner at least as protective of the environment, facility staff, and public health and safety, and which meets all statutory and regulatory requirements.

(c) The action plan shall be incorporated into the landfill’s approved waste analysis plan, under § 271.613 (relating to waste analysis plan).
§ 273.201. Basic limitations.

(l) The following radioactive material controlled under specific or general license or order authorized by any Federal, State or other government agency may not be disposed at the facility, unless specifically exempted from disposal restrictions by an applicable Pennsylvania or federal statute or regulation:

1. Naturally occurring and accelerator produced radioactive material.
2. Byproduct material.
3. Source material.
4. Special nuclear material.
5. Transuranic radioactive material.

(m) The following radioactive material may not be disposed at the facility, unless approved in writing by the Department, and the disposal does not endanger the environment, facility staff or public health and safety:

1. Short-lived radioactive material from a patient having undergone a medical procedure.
2. TENORM.
3. Consumer products containing radioactive material.

(n) The limitations in subsections (l) and (m) do not apply to radioactive material as found in the undisturbed natural environment of the Commonwealth.

§ 273.223. Radiation monitoring and response.

(a) An operator shall implement the action plan approved under § 273.140a (relating to radiation protection action plan).

(b) An operator shall monitor incoming waste in accordance with the Department’s Guidance Document on “Radioactivity Monitoring at Solid Waste Processing and Disposal Facilities,” Document Number 250-3100-001, or in a manner at least as protective of the environment, facility staff and public health and safety. Monitoring shall meet the requirements of this section and the facility’s approved radiation protection action plan.

(c) Radiation detector elements shall be as close as practical to the waste load and in an appropriate geometry to monitor the waste. The radiation monitoring system shall be set to alarm at a level no higher than 10 microroentgen per hour (µR/hr)* above the average background at the facility when any of the radiation detector elements is exposed to a cesium-137 gamma radiation field. Radiation detector elements shall be shielded to maintain the average background below 10 µR/hr. If capable of energy discrimination, the radiation monitoring system shall be set to detect gamma rays of a 50 kiloelectron volt (keV) energy and higher.
(d) An operator shall have portable radiation monitors capable of determining the radiation dose rate and presence of contamination on a vehicle that has caused an alarm. Upon a confirmed exceedance of the alarm level in subsection (c), a radiological survey of the vehicle shall be performed.

(e) An operator shall notify the Department immediately and isolate the vehicle when radiation dose rates of 20 µSv/hr (2 mrem/hr) or greater are detected in the cab of a vehicle, 500 µSv/hr (50 mrem/hr) or greater are detected from any other surface, or contamination is detected on the outside of the vehicle.

(f) Monitoring equipment shall be calibrated at a frequency specified by the manufacturer, but not less than once a year.

(g) If radioactive material is detected, the vehicle containing the radioactive material may not leave the facility without written Department approval and an authorized United States Department of Transportation exemption form.

§ 273.311. Daily operational records.

(b) The daily operational record shall include the following:

(10) A record of each incident in which radioactive material is detected in waste loads. The record shall include:

(i) The date, time and location of the occurrence.

(ii) A brief narrative description of the occurrence.

(iii) Specific information on the origin of the material, if known.

(iv) A description of the radioactive material involved, if known.

(v) The name, address and telephone numbers of the supplier or handler of the radioactive material and the name of the driver.

(vi) The final disposition of the material.

§ 273.313. Annual operation report.

(b) The annual operation report, which shall be submitted on a form supplied by the department, shall include the following:

(9) A record of detected radioactive materials.

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*Note:* To reduce confusion with radiation monitoring system calibrations, the PA DEP regulations currently do not state the SI units for the 10 µR/hr alarm set point (using Cs-137) above background, and 10 µR/hr background limit. Nonetheless, this would be equivalent to an approximate absorbed dose rate to air of 87 nGy/hr.