INTEGRATION OF RADIOACTIVE AIR EMISSION MONITORING REQUIREMENTS INTO DEVELOPMENT OF A RADIOLOGICAL MATERIAL TRACKING SYSTEM

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ABSTRACT

The Pacific Northwest National Laboratory (Pacific Northwest) has been using an inventory-based method to determine radionuclide air emission monitoring requirements for the research facilities they operate that contain radioactive material. This method requires an annual collection of inventory information for each facility from custodians and from centralized databases developed for other purposes. The data, obtained in various formats, requires reformatting and preprocessing prior to calculating an emission potential based on methods provided in National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. From the time when the original calculations were performed in 1991, the system, which calculates potential emissions from the inventory data, has progressed from spreadsheets to a database. Recent efforts are underway to develop a web-based capability to obtain the inventory information used in the annual assessment. This effort coincides with a Pacific Northwest Lab-wide effort to develop a tool to consolidate radionuclide inventory data to comply with a number of regulatory drivers in addition to radioactive air emissions. This system is being called the Radioactive Material Tracking (RMT) system.

The RMT system will be used to track the radioactive materials inventory within a specified building (or buildings) for the purpose of maintaining a set of information that is needed in order to determine compliance with various requirements. These requirements include facility Technical Safety Requirements (derived from the facility's Safety Analysis Report), Safeguards & Security, and Criticality Safety, in addition to radionuclide air emission monitoring. The various drivers have both unique and overlapping requirements making development of a total system challenging.

A prototype system has been developed using a phased approach. The first phase involves documentation of requirements, and building and testing of a basic database support structure. Testing is being performed on the Pacific Northwest-operated facility with the greatest inventory and the most challenging requirements. In this paper, an overview of the requirements is provided and system capabilities and limitations discussed. The RMT provides a platform to aid custodians in maintaining sufficient inventory information to respond to various compliance program requirements, a tool for facility managers to identify how new operations or movement of materials may affect limiting facility conditions, and a more efficient means to demonstrate compliance.

INTRODUCTION

Requirements for facility air emission sampling at Hanford are promulgated by

- The U.S. Environmental Protection Agency (EPA) in 40 CFR 61, "National Emissions Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities"[1]
- The Washington State Department of Health in Washington Administrative Code 246-247, "Regulation of Radioactive Air Emissions"[2]
- The U. S. Department of Energy (DOE) in regulatory guide DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Monitoring and Environmental Surveillance"[3]

These regulations require that all emission units with the potential to emit radioactivity be evaluated, and that the emission units be continuously sampled if there is the potential for unmitigated releases to cause an offsite dose of greater than or equal to 0.1 mrem/yr to a maximum offsite receptor.

Several methods for projecting potential unmitigated annual emission quantities are prescribed in the 1994 issuance of WAC 246-247:

- Apply an annual release fraction to the radionuclide inventory in the facility.
- Multiply actual measured annual emissions by control system decontamination factors.
- Add actual measured annual emission quantities to actual measured quantities retained by control systems.
- Measure the annual discharge upstream from all control devices.

The inventory-based assessment method has been used by Pacific Northwest since the initial facility assessment in 1991. This method is described in WAC 246-247 as follows:

- Multiply the annual possession quantity of each radionuclide by the release fraction for that radionuclide, depending on its physical state. Use the following release fractions: (i) 1 for gases, (ii) 10^{-3} for liquids or particulate solids, and (iii) 10^{-6} for solids.
- Determine the physical state for each radionuclide by considering its chemical form and the highest temperature to which it is subjected. Use a release fraction of 1 if the radionuclide is subjected to temperatures at or above its boiling point; use a release fraction of 10^{-3} if the radionuclide is subjected to temperatures at or above its melting point but below its boiling point.
- If the chemical form is not known, use a release fraction of 1 for any radionuclide that is heated to a temperature of one hundred degrees Celsius or more, boils at a temperature of one hundred degrees Celsius or less, or is intentionally dispersed into the environment.

Whereas the inventory method yields an assessment based on the current building status (or even the future status if projected future inventory quantities are used in the assessment), the other prescribed methods yield an assessment based on past facility measurements. Thus, the inventory method is deemed to be more appropriate for use at research and development facilities where types and quantities of radionuclides may change from year to year and where historical sampling data may not be a reliable predictor of future emissions. The inventory method, originally used in 1991, determines radionuclide air monitoring requirements for Pacific Northwest facility emission points and continues to be used on an annual basis to confirm these requirements. In addition to the annual determination, Notices of Construction (NOCs) are prepared as needed to permit new projects, moves of radioactive materials, or facility modifications affecting facility emissions or monitoring systems.

An annual NESHAP evaluation is performed using radionuclide inventory information from inventory systems set up for other purposes. Inventory systems have been developed at Pacific Northwest to track materials as required for safeguards and security, to track accountable radioactive sealed sources, and to ensure that materials licensed under a State of Washington Radioactive Materials License meet the license requirements. Because the developed systems do not provide a comprehensive listing of radioactive material or of material characteristics needed for the NESHAP evaluation, the information is supplemented with additional data from custodians. Custodians are contacted to determine annual throughput, physical form, and process information important in determining annual emissions, but not required for other system needs.

Other inventory-based assessments have been performed in conjunction with the annual NESHAP assessment. These include: the need for Facility Effluent Management Plans, Facility Hazard Categorization, and Emergency Planning. Calculations were originally performed on a spreadsheet, but were later upgraded to an Access database. With the availability of web-based tools and increasing demand for radionuclide inventory management, development of a Radioactive Material Tracking (RMT) system was proposed to meet the needs of the inventory-based requirements and reduce the impact on nuclear material custodians in responding to inventory requests. This new tool currently under development is

envisioned to assist radioactive material custodians track their materials and perform calculations (e.g. sum of fractions calculations for facility Hazard Categorization, Emergency Planning; potential-to-emit calculations for NESHAP determination), and will allow facility managers to determine facility or space compliance with inventory-based requirements.

At present, the first phase of the prototype is being developed and tested on the Pacific Northwest-operated facility with the greatest inventory and the most challenging requirements, the Radiochemical Processing Laboratory. This phase maintains the inventory information, but does not yet perform all needed calculations.

SCOPE AND REQUIREMENTS

The RMT will be used to keep track of the inventory of radioactive materials within a specified building (or buildings) for the purpose of maintaining a set of information that is needed in order to comply with the following requirements:

- National Emission Standards for Hazardous Air Pollutants (NESHAP) assessment to determine/confirm radionuclide air monitoring requirements.
- Assessment to determine the need for Facility Effluent Management Plans (FEMPs) based on requirements in DOE Order 5400.1.[4] This assessment is the same as the NESHAPs assessment for Pacific Northwest facilities.
- Facility Hazard Categorization to determine nuclear facility status and safety analysis requirements according to DOE-STD-1027-92.[5]
- Facility Emergency Plan requirements using the method from NRC 10 CFR 30.32.[6]
- Tracking radioactive materials subject to Technical Safety Requirements (TSRs) for Pacific Northwest's only nuclear facility.
- Tracking materials managed in Material Balance Areas (MBAs) as required by Safeguards and Security.
- Maintaining information on sealed sources for which inventorying and leak testing is required.
- Identifying radioactive materials covered under a State of Washington Radioactive Material License to ensure license limits are met. This affects non-DOE radioactive materials.
- Managing radioactive material subject to criticality safety requirements.

As seen by the extensive list above, the NESHAP assessment is just one of the many applications for the RMT system. Compliance with the above requirements is currently being performed through various methods and databases. It becomes a challenging and time-consuming task for laboratory staff with radioactive materials to respond to the various requests for information and difficult for facility managers to ascertain facility compliance.

Radioactive material custodians will maintain all required information on the web-based system keeping track of quantities, forms, locations, containment, and other parameters as needed for compliance purposes. The RMT is expected to be able to generate the required reports on demand and should allow the responsible organization to track the radioactive material at whatever level is required by their operational procedures. In addition, at least some of the information maintained by the RMT will be made available via the Map Information Tool, a web-based software interface.

For the NESHAPs assessment, this tool could eventually replace the database system currently being used. When fully complete, the RMT should be able to calculate the potential-to-emit for a facility with only verification from the radioactive material custodians that the information in the RMT is accurate to the best of their knowledge. The RMT may also be used in the future to determine the potential effects on facility emission point monitoring requirements due to new projects or material transfers between facilities, and thus serve as a preliminary screening tool for facility managers.

ISSUES

A number of issues pertinent to NESHAP that have been noted during the annual inventory evaluation have become increasingly important during the development of the Radioactive Material Tracking system. One of these issues is the activity level at which tracking is needed. For some of the requirements (MBA, sealed source leak testing, criticality safety), there is a limit below which tracking is not required. However, there is currently no de minimus limit for the NESHAP evaluation; and current methods have required custodians to estimate nanocurie and even picocurie quantities of materials, both of which are common in the R&D environment. This task would be even more onerous in a real-time tracking system than the current annual estimates, and would require much labor for little return since it would not significantly affect the potential-to-emit for a facility. Thus, development of an accepted method to account for small quantities of radionuclides must be developed to avoid an excessive burden for the custodians while still providing an acceptable method to demonstrate compliance with the NESHAP requirements.

Another issue is the need to consider facility throughput. Many of the other RMT requirements are based on the risk or vulnerability of materials held at a point in time, whereas, the NESHAP assessment applies to emissions under normal operations over a year. Therefore, the amount of material brought in, processed, and removed during the year must be considered with NESHAP; and the tracking system must be able to store this information, in addition to real-time inventories. The RMT is envisioned to maintain historical records allowing identification of all material resident in the building throughout the year. However, this feature is not likely to be addressed until the final phase.

Additionally, the NESHAP evaluation must consider any potential changes in the physical form of the material during processing. Release fractions increase if a material is heated sufficiently to melt or vaporize and also if a material is intentionally aerosolized during processing. How the material is contained is also important for release fraction selection since it has a direct bearing on the emission potential. For some of the other requirements that consider vulnerability in accidents, container requirements are more restrictive than for NESHAP, which applies to normal operating conditions. However, to take credit for containment under NESHAP, the material must be stored all year. Thus, the RMT must allow for input on processes (potential for material form changes) and containment.

Another issue with regard to NESHAP is that the potential-to-emit is determined for each emission point. For facilities with multiple stacks, ventilation system information is required in addition to inventory information. However, this is not viewed as a major drawback because work with radioactive materials is limited to areas with well-identified emission points. A room identifier with the radioactive material is generally sufficient to associate material with an emission point.

STATUS

A phased approach has been implemented in the development of the RMT. The phases are as follows:

- Develop a requirements document and determine the information needed to respond to radionuclide inventory related requirements. Build a basic support structure for this information and populate RMT with data from existing inventory systems (Safeguards and Security, DOE Accountable Sealed Source, Washington State Licensed Radioactive Material). Perform testing of basic support structure.
- Train Radioactive Material Custodians, have users enter actual data not already provided in existing inventory systems, and test RMT using full actual data from the Radiochemical Processing Laboratory (RPL), Pacific Northwest's only nuclear facility and most complex inventory.
- Build calculational abilities within RMT for compliance with TSR limits and other critical building limits. Develop limit checking capabilities and flags.
- Create reporting capabilities for the most critical reports (e.g. TSR, MBA).
- Develop ability to maintain historical data (needed for throughput information).
- Add features to enhance tool's user-friendliness (e.g. easier ability to modify or clone records).
- Develop modules for ability to calculate compliance with other requirements (e.g. NESHAP, FEMP, Hazard Categorization) and test using RPL inventory.

- Role out RMT for use in all facilities with radioactive materials.

A requirements document was prepared and development work initiated in 1999. The first phase, developing the basic support structure and testing is nearing completion using test data from the RPL. Near-term planning involves training custodians to the RMT and beginning full-scale inventory use for the RPL. At the proposed funding level, the Project plans to complete the first four bullets by the end of FY '01. However, full funding has not been assured.

The RMT will be a valuable tool for managing radioactive materials at Pacific Northwest. Development of this tool is a challenging task due to the number of different inventory-based requirements, each with unique features and all with serious potential safety and environmental compliance consequences. Therefore, development of the RMT is being conducted with sufficient planning, testing, and documentation to meet rigid quality assurance standards for a final product (e.g., RMT is to be under full Configuration Control Management to control, document, and test all changes to the database structure or code). This process is time consuming; however, the end product will be a vital system that meets requirements in an efficient and cost-effective manner.

REFERENCES

1. Environmental Protection Agency, "National Emission Standards for Hazardous Air Pollutants", *Code of Federal Regulations,* 40 CFR 61, (1989).

2. Washington Department of Health, "Radiation Protection – Air Emissions", *Washington Administrative Code*, WAC 246-247, (1994).

3. U. S. Department of Energy, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*, DOE/EH-0173T, U. S. Department of Energy, Washington, D. C.

4. U. S. Department of Energy, *General Environmental Protection Program.* DOE 5400.1, U. S. Department of Energy, Washington, D. C.

5. U. S. Department of Energy, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports.* DOE-STD-1027-92, U. S. Department of Energy, Washington, D. C.

6. U. S. Nuclear Regulatory Commission, "Quantities of Radioactive Materials Requiring Consideration of the Need for an Emergency Plan for Responding to a Release", *Code of Federal Regulations*, 10 CFR 30.72, Schedule C, U. S. Nuclear Regulatory Commission, Washington, D. C.