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Air Permit Compliance for Hanford Waste Retrieval Operations Involving Multi-Unit Emissions

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ABSTRACT

Since 1970, approximately 38,000 suspect-transuranic and transuranic waste containers have been placed in retrievable storage on the Hanford Site in the 200 Areas burial grounds. Hanford's Waste Retrieval Project is retrieving these buried containers and processing them for safe storage and disposition. Container retrieval activities require an air emissions permit to account for potential emissions of radionuclides. The air permit covers the excavation activities as well as activities associated with assaying containers and installing filters in the retrieved transuranic containers lacking proper venting devices.

Fluor Hanford, Inc. is required to track radioactive emissions resulting from the retrieval activities. Air, soil, and debris media contribute to the emissions and enabling assumptions allow for calculation of emissions. Each of these activities is limited to an allowed annual emission (per calendar year) and contributes to the overall total emissions allowed for waste retrieval operations. Tracking these emissions is required to ensure a permit exceedance does not occur.

A tracking tool was developed to calculate potential emissions in real time sense. Logic evaluations are established within the tracking system to compare real time data against license limits to ensure values are not exceeded for either an individual activity or the total limit. Data input are based on field survey and workplace air monitoring activities.

This tracking tool is used monthly and quarterly to verify compliance to the license limits. Use of this tool has allowed Fluor Hanford, Inc. to successfully retrieve a significant number of containers in a safe manner without any exceedance of emission limits.

INTRODUCTION

In 1970, the U.S. Atomic Energy Commission (AEC) defined transuranic (TRU) waste as a separate waste category and declared that TRU waste must be retrievably stored. In 1973, the AEC determined that waste containing plutonium might be associated with increased hazards and should be disposed of in facilities that provide a greater level of containment than the type of shallow land burial typically used for low-level waste (LLW). Beginning at that point, suspect-TRU waste (identified at that time as waste likely to contain greater than 3.7E-01M Bq per kg [10 nanocuries per gram] of transuranic radionuclides) was separated from other LLW and retrievably stored in designated areas in burial ground facilities of the 200 Areas. The definition of TRU waste was changed in 1984 to specify only waste containing greater than 3.7 MBq per kg (100 nanocuries per gram) of transuranics; therefore, some of the suspect TRU waste initially placed in storage would now be LLW.

Since 1970, approximately 38,000 TRU and suspect-TRU waste containers have been placed in retrievable storage on the Hanford Site in the 200 Areas burial grounds. The majority of TRU waste containers on the Hanford Site are located in outdoor trenches in these burial grounds, where the containers had been stacked upright on asphalt pads and then covered with earth as shown in Figure 1.

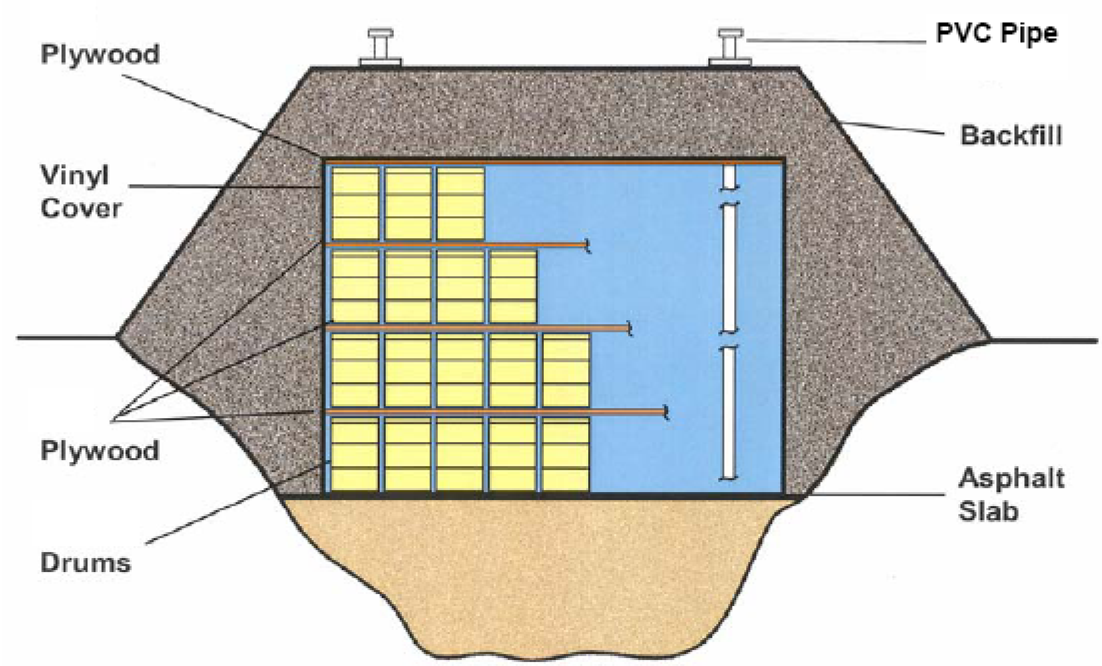

Fig. 1. Side view of a typical post-1970 transuranic waste interim storage trench configuration.

Other trenches are configured with drums placed horizontally in a V-notched trench, with soil used to fill the void spaces between containers and no asphalt pads as shown in Figure 2.

Fig. 2. V Notched trench drum emplacement shown from the early 1970s.

Hanford's Waste Retrieval Project is retrieving these buried containers and processing them for safe storage and disposition.

These containers are retrieved, visually inspected for structural integrity, and, if necessary, placed in an overpack container. Waste is categorized as TRU (including mixed waste) or LLW (including mixed waste) through a records review or nondestructive assay. Unvented and inadequately vented containers containing TRU material are vented. Retrieved TRU containers are transported from the burial grounds to existing storage units having a *Resource Conservation and Recovery Act of 1976* (RCRA) permit. After retrieval, the containers will be stored for certification activities to support disposal at the Waste Isolation Pilot Plant (WIPP). The containers determined to be LLW will be disposed at a RCRA-permitted landfill or other approved facility.

RADIOACTIVE AIR EMISSION LICENSE AND EMISSION UNITS

A Notice of Construction [1] was prepared to obtain approval for radioactive air emissions associated with excavation activities associated with retrieving waste containers as well as activities associated with assaying containers and installing filters in retrieved containers that lack proper venting devices. The associated approval from the Washington State Department of Health (WDOH), which is the regulating agency for radioactive air emissions, is separated into five distinct emission units for the overall Waste Retrieval Project. The total abated emission limit for this Notice of Construction is limited to 1.1E-02 aSv/s (3.44E-08 millirem/year) to the Maximally Exposed Individual. The potential to emit for this project is 2.9E-02 pSv/s (9.01 E-02 millirem/year).

Diffuse and Fugitive Emissions – Excavation and Dart Venting

The specific steps or approach to uncovering the containers will vary according to the configuration of the trench to be uncovered, the proximity of nearby trenches or fences, the designated location of the spoils pile, the planned extent of the soil removal, and other similar considerations. Excavation is performed "open-air" and emissions are not from a point source. The exposed containers are inspected and surveyed for contamination. Abnormal drum conditions will be managed as follows: Contaminated containers are decontaminated or overpacked as needed. Retrieval activities include appropriate disposition of small amounts of incidental contaminated soil (e.g., containerized or fixed in place). Larger areas of contamination can be fixed and the area posted as required by the project radiological control organization for later disposition. Bulk transfer of contaminated soils for disposal in another trench can also occur. A maximum of 12,000 vented containers of waste are approved to be retrieved per year. Once vented, the containers are allowed to be staged with the other retrieved containers for further handling, resulting in the staging/storage of a maximum of 12,000 vented containers per year for the project. Using a release fraction of 2.00E-09 for fugitive emissions from vented containers, the potential unabated release rate from the staging of vented containers is 3.6E-02 Bq/s (3.0E-05 Curies/year) alpha (based on Am-241) and .53 Bq/s (4.5E-04 Curies/year) beta (based on Cs-137).

The Dart System is a portable unit that clamps directly onto a drum, using a pneumatic driver remotely activated by wire or radio transmitter. This system penetrates the drum lid with minimal risk of contamination release to install a filter with an aluminum bronze housing to prevent the possibility of sparking. Although each filter is essentially a point source, the collective potential emissions from these operations are considered diffuse and fugitive. A maximum of 1,000 containers per year are approved to have installation of filters using the Dart System. The potential unabated release rate from using the Dart System is .16 Bq/s (1.4E-4 Curies/year) alpha (Am-241) and 2.5 Bq/s (2.1E-3 Curies/year) beta (Cs-137). This is based on a release fraction of 1.0E-3 and a pressure release time of 1 hour. All of the emissions from a pressurized container are routed through the high-efficiency particulate air (HEPA)-type filter; therefore, the abated release rate is 56 μBq/s (4.8E-8 Curies/year) Am-241 and .83 mBq/s (7.1E-7 Curies/year) Cs-137.

High-Efficiency Particulate Air Filtered Vacuum

HEPA-filtered vacuums can be used for soil excavation, and spot contamination. Within the V Notched trenches, it is more likely that the use of a vacuum will be employed to remove larger quantities of soil from the top surface of buried containers and soil materials in the interstices surrounding containers. The HEPA-filtered vacuums have potential unabated release rates of 3.5 Bq/s (2.97E-3 Curies/year) alpha (Am-241) and 20.3 Bq/s (1.73E-2 Curies/year) beta (Cs-137) is based on a release fraction of 1.

Mobile Drum Venting System (MDVS)

The MDVS is a pneumatic drilling device enclosed in a trailer containing system equipment allowing an operator to sample or vent a drum and install a filter. Potential emissions from MDVS operations are point source emissions.

The MDVS has a testable HEPA-type filter for all emissions resulting from drilling and headspace sampling. The test compartment is ventilated with a passive HEPA-type filter and is designed to withstand a deflagration as described in the performance specification for this venting system.

The average annual flow for the exhaust port for the venting and head-space gas sampling operations is approximately 1E-4 m^3/s (consisting of a continuous flow in the milliliter per second range, with intermittent spikes in the liter per second range).

Drum Venting System 2 (DVS2)

The DVS2 is a venting system utilizing a pneumatic drill that is remotely actuated to vent the drum as shown in Figure 3.

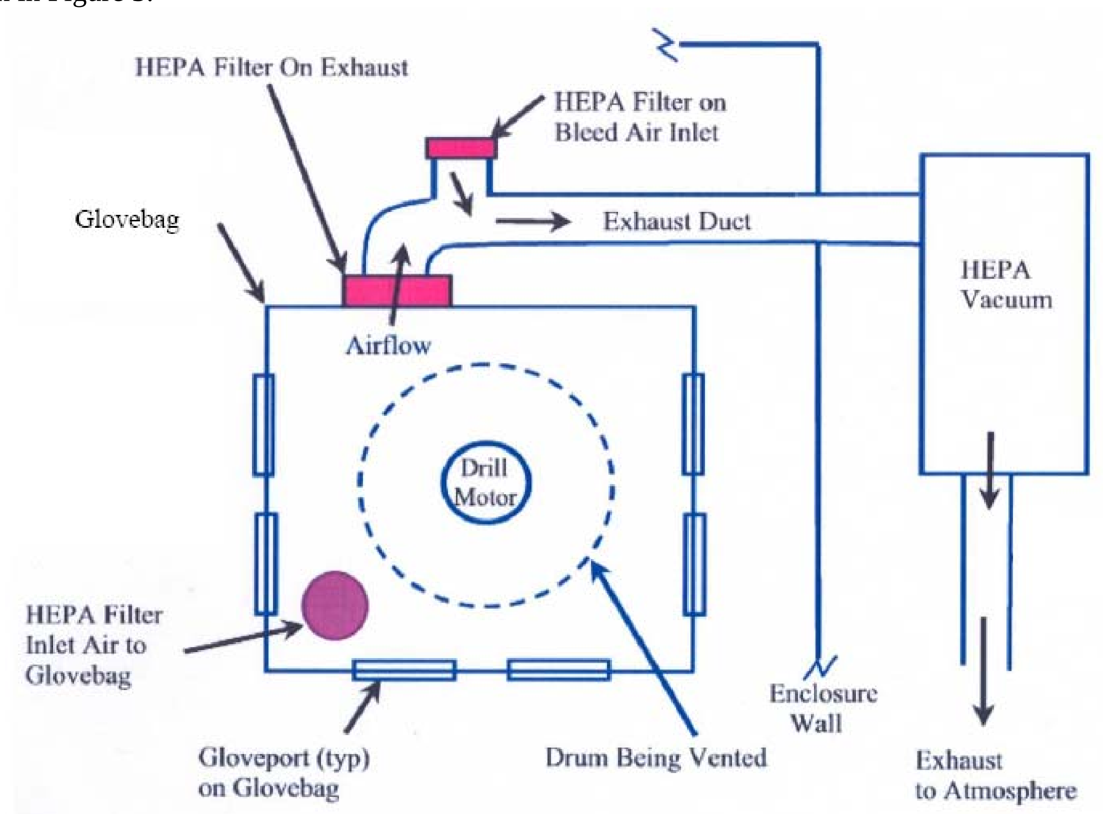

Fig. 3. Top view schematic of the DVS2 process flow.

After the drum is vented, a filter is hand-installed, the head-space of the drum is sampled and the drum is staged in a designated area for diffusion.

Glovebags are used to contain potential contamination. A portable HEPA vacuum with variable speed is connected to the HEPA filter on the glovebag and is used for exhausting the glovebag. The vacuum is operated during venting and for a short time following venting at a low flow. Glovebags also have ports to check for contamination or hazardous gases. The DVS2 is installed in an improved container, which contains electrical service and a head space gas sampling station.

A maximum of 9,000 containers of waste are approved to be processed per year using the MDVS or the DVS2 (combined total). The processing rate is designed to be 3,600 s (60 minutes) per container. Using the release fraction of 1.0E-3 for particulates and a time factor of 1.03 (60 minutes per container multiplied by 9,000 containers and divided by 526,000 minutes per year) the potential unabated release rates using the MDVS is 1.5 Bq/s (1.28E-3 Curies/year) alpha (Am-241) and 22.5 Bq/s (1.92E-2 Curies/year) beta (Cs-137).

TECHNICAL APPROACH

Required Monitoring

The potential unabated offsite dose associated with this activity for normal operations is calculated to be less than .032 pSv/s (0.1 millirem per year). Therefore, in accordance with 40 Code of Federal Regulations 61, Subpart H, periodic confirmatory measurements will be made to verify the low emissions. The 200 Area diffuse/fugitive emission unit is considered by WDOH as a major, non-point emission source. A network system of site air monitors is used to verify low emissions during TRU waste retrieval.

Additional monitoring for the diffuse and fugitive emissions consists of radiological surveys from the soil excavation activities. The survey methods for monitoring are not a direct measurement of effluent emissions. The methods are intended to demonstrate compliance by showing that by being under the contamination levels by which work is controlled, the actual emissions inherently would be below the estimated emissions, which are based on (calculated from) the same contamination levels.

Radiological smears of the active exhaust port of the MDVS and the DVS2 are performed at the end of each shift of operation of use to verify low emissions from point sources.

Tracking Tool

Because waste retrieval is a combination of point source and diffuse/fugitive emissions, and does not have a monitoring system to provide real time data, a tracking tool was developed to calculate potential emissions in real time sense. This innovative approach allows compliance to the license, real time evaluation at any given time window, and planning work for the remaining year. Logic evaluations are established within the tracking system to compare real time data against license limits to ensure values are not exceeded for either an individual activity or the aggregate total limit. Data input are based on field survey and workplace air monitoring activities. The tracking tool consists of a spreadsheet with embedded logic evaluations.

Due to the multi-faceted operations, which are covered under this permit, the allowable limit for each emission source is tracked and compared against the total permit limit. Permit limits are based on throughput throughout the calendar year, so the calculations are performed quarterly and the values are accumulated to year end. On January 1 of each year, the accumulation values are refreshed and the cycle is repeated. The facility is only required to certify that the total permit limit is met or complied with at the end of each year. Because the source terms are additive, it is possible to have a high value in one area without exceeding the overall limit due to the averaging effect of all values. The logic is set up such that it provides a value of yes, no, or evaluate for compliance of each check point. Evaluation is required if a high value is obtained for one emission area that could potentially result in exceeding the permit limit. If an evaluation flag shows up, then a check is made to confirm that the associated values are all within the required limits. This will be discussed in greater detail later on in this paper.

The spreadsheet is set up with a series of sheets for each emission source. For example the activity of staging and handling of drums is considered an emission source. There is a sheet for data input, a separate calculation sheet, and a separate assumption sheet for this emission source. The calculation and assumption sheets are actually for convenience only and provide backup support to the data input sheet. It is helpful since the data are only entered on a monthly or quarterly basis and it may be needful to review the assumptions and calculations to ensure the data are entered correctly.

The radionuclides of concern exist as particulates. Even though many radionuclides are potentially contained, all radionuclides in the drums and containers are assumed to be conservatively represented by either Am-241 or Cs-137. This assumption provides a conservative estimate of dose because these isotopes have the highest unit dose factor that when applied provides an overestimation of emissions. Dose factors were derived for the Hanford Site [2] by converting Hanford-specific meteorological data from a .44gs (14-year) period into dose per unit release factors. These dose factors are used to determine the effective dose equivalent to a maximum public receptor (MPR) either on or off the Hanford Site. This method simplifies dose calculations by eliminating the need to run the CAP88-PC(TM) computer model [3]. The CAP88-PC computer model is a risk based model which calculates the dose based on modeling of ingestion, inhalation, and exposure to a public receptor. Dose factors have been established for specific sections on the Hanford Site. The dose factors used were for the 200 West Area on the Hanford Site. Representing the alpha and beta isotopes as either Am-241 or Cs-137 simplifies the spreadsheet so that a check need be done for only two isotopes rather than several. This assumption holds for each type of emission: staging/handling, active venting, passive venting, darting, excavating, or vacuuming.

Since the annual inventory is the key factor in determining compliance, the curie throughput must be known. Due to the large number of containers that will be retrieved on the Hanford Site, an average curie per container was determined to simplify the annual inventory tracking requirement. It has been determined that the average curie content of a container on the Hanford Site is .74 TBq (20 curies). The alpha curies average 46.3 GBq (1.25 curies) per container. The beta curies average .69 TBq (18.75 curies) per container. Since Am-241 and Cs-137 have the highest dose factors, these isotopes are assigned as the curies for alpha and beta and the annual inventory can be determined via the number of containers processed per year. These averages apply to those activities involving container operations such as staging, venting, and darting. They also apply to excavation and vacuuming the interstitial soil around and between the containers since the source of contamination of these matrices is from the containers.

Emissions Evaluation

Both diffuse/fugitive and point source emissions are permitted for the Waste Retrieval Project. Diffuse/fugitive emissions include:

- Staging/handling of vented containers
- Installation of venting systems using the dart method
- Excavation.

Point source emissions include:

- Installation of venting systems with active exhaust
- Installation of venting systems with passive exhaust
- Soil removal with HEPA vacuum
- Spot contamination with HEPA vacuum.

Diffuse/Fugitive Emissions

Tracking the emission limits for each of these types of activities requires knowledge of the underlying assumptions that were made in the permit application. Release fractions and dose factors are required in order to calculate the emissions. The standard values used for release fractions are as follows:

- 1 for gases
- 10-3 for liquids or particulate solids;
- 10-6 for solids.

If a release fraction other than these is used, it must be approved by the regulator. For staging/handling activities, all the containers are vented through NucFil®[1] filters placed in the container. Samples were taken of containers with the NucFil® filters in place to determine if the release factor was less than 10-6. Subsequent analysis showed an efficiency factor of 2E-14 for the filters and agreement was made with the regulator that a release factor of 2E-09 could be applied to NucFil® vented containers that are stored/handled at the project based on this information. Since the release factor can be applied to each container, the algorithm simply allows for keeping track of the number of containers that are stored/handled each year and verifying the cumulative emissions are less than that allowed for 12,000 containers.

Calculating emissions for venting using the dart method is done differently because credit cannot be taken for a filter. The release factor of 1E-03 applies, so a timed release was used. The regulator approved the use of applying the release factor to a 3,600-s (60-minute) release that is annualized for each calendar year. Once these factors are applied, the algorithm allows for tracking the number of containers that are vented using the dart method each calendar year.

Tracking emissions associated with excavation requires tracking volumes of soil, surface contamination, and associated airborne emissions. The contaminated soil volumes are further divided into three levels of contamination. Figure 4 shows the logic used to develop the algorithms used in the spreadsheet.

[1] NucFil® is a registered trademark of Nuclear Filter Technology, Inc., Lakewood, Colorado.

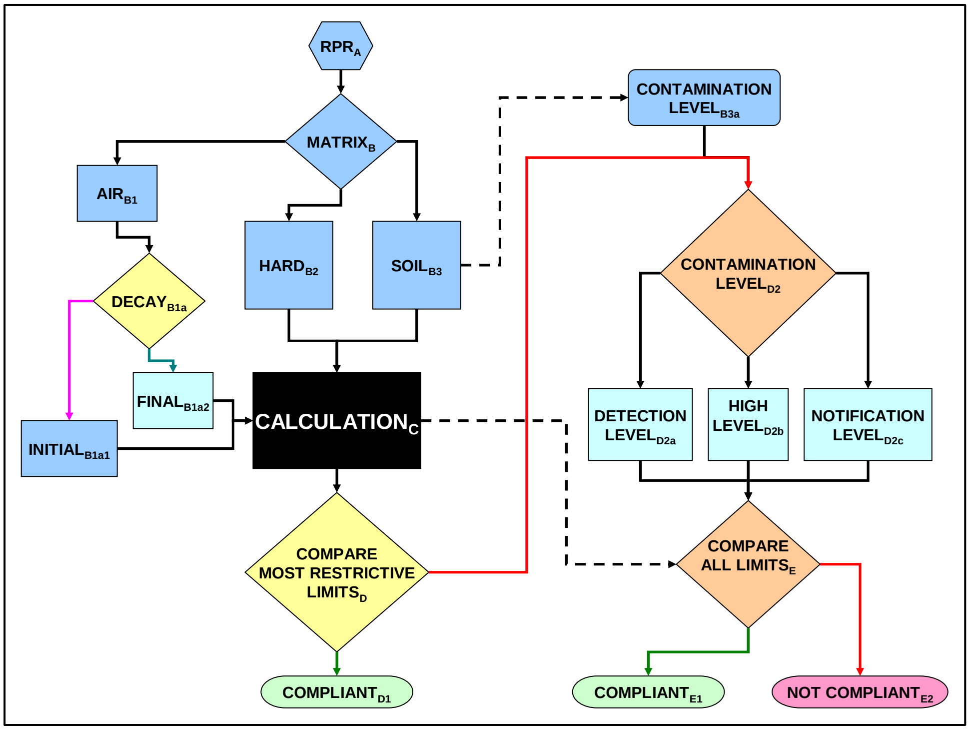

Fig. 4. Logic diagram used for determining compliance of excavation activities.

Samples taken during operational activities provide the data for surface contamination and airborne emissions. Data from these samples are then entered into the spreadsheet based on the matrix, i.e., air, hard surface, or soil. If the matrix is air, a bubble configuration is assumed. The bubble is assumed to be a bubble over the work area that is 4,000 m^3. A flow rate through the bubble is calculated by assuming one air exchange every 5 minutes multiplied by the time work is done within the assumed bubble. Data for air can either account for decay time for radon, or if the radon values are known to be low, the initial reading can be used. If the matrix is for a hard surface, such as a plywood platform or container surface, the contamination levels are multiplied by the appropriate conversion factors and area of contamination encountered. If the matrix is soil, three additional categories must be considered. The soil in contact with the containers is assumed to be contaminated at detectable levels (100 dpm/.01 m^2 alpha and 5,000 dpm/.01 m^2 beta/gamma direct readings based on past operations and the pilot dig). A smaller percentage (1%) of the contaminated soil (i.e., 3 m^3), is assumed to be contaminated at higher levels (2,000 dpm/.01 m^2 alpha and 100,000 dpm/.01 m^2 beta/gamma). Contamination at notification levels is not expected. However, as a contingency planning estimate, 0.1% of the contaminated soil (i.e., 0.3 m^3) is assumed to be contaminated at notification levels (28,000 dpm/.01 m^2 alpha and 500,000 dpm/.01 m^2 beta). To determine the corresponding soil concentration in picocuries per grams of individual radionuclides, conversion factors were used, as developed in *Soil Contamination Standards for Protection of Personnel* [4]. The average soil density was assumed to be 1.3kg/m^3 (98 pounds per cubic foot).

The notice of construction limits for soil in the detection level category is the most restrictive, so if that limit is not exceeded, all of the categories are met. Only if those limits are exceeded will it be necessary to evaluate individual limits for the three soil categories (detection, high, and notification).

Point Source Emissions

The release fraction used for staging/handling drums is not applicable to active venting operations. Instead a timed release is used in combination with the standard 1E-03 release fraction. A 60-minute time period was established for installating a drum vent. This 3,600-s time is annualized over 3.15E+07 seconds in a year and then multiplied by the release fraction to determine emissions for venting operations. The algorithm simply allows for keeping track of the number of containers that are actively vented each year and verifying the cumulative emissions are less than that allowed for 9,000 containers.

The passive venting exhausts potential emissions from using the HEPA vacuum (HVU) mounted in the gloved chamber to collect metal filings after installation of a NucFil® filter. During filter installation, the equipment is shrouded in a boot that mates with the top of the container. A very conservative estimate of release rates is calculated by assuming the surface area of the boot that covers the drum lid during the filter installation process (5.3E-3 m^2) multiplied by 9,000 drums with an average contamination level of 10,000 dpm/ .01 m^2 beta/gamma and 200 dpm/.01 m^2 alpha. This allows for an algorithm that tracks the number of containers (9,000) that are vented in this manner.

Soil is removed either as interstitial material between the containers or from the surface of the containers using HEPA vacuums. Each of these activities is permitted separately. Interstitial soil removal is assumed to remove up to 2% of the curies in the soil. A release fraction of 1.0 is used for HEPA vacuums instead of the 1E-3 release fraction used for manual excavation, therefore the dose associated with the HEPA vacuuming process is not directly 2% of the soil matrix dose. Spot contamination removal is permitted under a categorical permit, but must be accounted for. Since HVU use includes both soil and spot removal, the algorithm tracks both the soil volumes and surface area that are vacuumed and compares the results for each matrix against the permit limits of both permits to ensure compliance.

BENEFITS

Use of this tracking tool allows the facility to show compliance to the license at any point in time during the calendar year, not only for the overall limit, but for each limit allowed for individual processes. In addition it facilitates completing the semi-annual and annual certification report that must be submitted to the regulator each year. It also serves as a best management practice in maintaining compliance since the emissions are not large enough to be subject to the annual inspections performed by the regulators.

CONCLUSION

This tracking tool is used monthly and quarterly to verify compliance to the license limits. Using of this tool has allowed Fluor Hanford, Inc. to successfully retrieve a significant number of containers in a safe manner without any exceedance of emission limits. This tool simulates real time monitoring similar to the requirements for major emission units that require continuous monitoring and subsequent sample analysis. It also allows for planning of future work based on how close real time emissions are to the existing limits.

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