HEPA Filter Waste Management at Select Department of Energy National Laboratories – 17022

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ABSTRACT

High Efficiency Particulate Air (HEPA) filters are routinely used to filter exhaust air at Department of Energy (DOE) National Laboratory facilities that work with radioactive materials. While the HEPA filter configurations are fairly standardized (such as metal framed with glass microfiber media), the range and concentrations of radioactive and potentially other hazardous materials in the used filters presents for a variety of characterization approaches as well as challenges. This paper will summarize, compare and contrast the current HEPA filter waste management experience at a selection of DOE National Laboratories. Topic areas to be explored include process knowledge collection, characterization methods, characterization results, waste packaging and disposition pathways, and problems and success stories.

INTRODUCTION

HEPA filters are routinely used in DOE National Laboratory building ventilation systems to remove radioactive particles from exhaust air. These include individual HEPA filters for room, fume hood, and glovebox exhaust systems, as well as banks of HEPA filters used to filter the collected exhaust air for an entire building or section of building.

Nuclear grade HEPA filter media is typically made from glass microfiber (boron silicate). Some filter media includes metal separators between the filter pleats. Depending on the specific application, HEPA filters may be either self-contained filtration units or open-face filters that are installed in filter housings.

A number of factors influence HEPA filter performance and impact when HEPAs must be replaced [1]. In general, HEPAs are replaced when the pressure drop across them becomes too high, if they fail particulate challenge testing, or when a HEPA filter system is no longer needed from a given area. When removed from radiologically contaminated ventilation systems they must be characterized, packaged, and disposed as radioactive waste.

While the HEPA filter configurations are fairly standardized (such as metal framed with glass microfiber media), the range and concentrations of radioactive and potentially other hazardous materials in the filters requires a variety of characterization approaches and presents significant challenges. This paper will summarize, compare and contrast the current HEPA filter waste management experience at PNNL, ORNL, LLNL, and SNL. Topic areas to be explored include process knowledge (PK) collection, characterization methods, characterization results, waste packaging and disposition pathways, and challenges and success stories.

HEPA FILTER PK COLLECTION

PNNL PK Collection

At PNNL, PK regarding the specific HEPA filter is collected through use of a HEPA filter checklist, along with the standard radioactive waste inventory sheet completed for each radioactive waste item. The HEPA checklist is completed as part of the HEPA filter removal work package planning.

The HEPA checklist provides opportunity for the laboratory supervisor and research staff to describe the activities performed in the area serviced by the HEPA. Radioactive isotopes of concern, dispersibility, and typical quantities worked with are listed. The checklist requests information about other hazards including biological, nanoscale material, and chemical usage. Based on the information provided in the checklist, a waste operations designator performs a preliminary designation and radiological characterization of the HEPA utilizing PNNL's HEPA filter characterization plan [2].

Programmatic HEPA filter PK is documented in PNNL's HEPA filter characterization plan. This document summarizes data from PNNL's more than 100 core sampled filters since 2004. The majority of the radiological data is gross alpha, gross beta and gamma energy analysis results. Chemical test data is primarily for RCRA metals. Analysis for volatile and semi-volatile organic constituents has also been performed on a small number of HEPA filters where PK indicated potential organic constituents.

After the HEPA filter checklist has been completed, it is returned to the work package where a post-removal section is completed which notes additional info such as if filters appear corroded, heavy particulate loading, etc. This additional information is reevaluated by the designator and may change the waste designation or drive additional characterization.

ORNL PK Collection:

ORNL has several nuclear facilities that routinely generate HEPA filter waste. The facilities include accelerators, research laboratories, hot cells and a high-flux nuclear reactor. The maximum duration that HEPA filters at ORNL can be in service is ten years. Therefore, the generation of routine facility HEPA filter waste can vary significantly from year to year based on the replacement schedule. In addition, facilities change mission based on funding and the generation of HEPA filters from glovebox chains and contaminated hoods can be significant in years preceding a new research mission.

ORNL uses a Data Quality Objective (DQO) process to characterize HEPA filter waste. The characterization of HEPA filters starts with collecting PK about each specific filter and how the filter was used. Typically, some PK exists for the locations where HEPAs are employed and that information is used to estimate the potential contaminants. The collected PK is documented using a form that includes sections for generation activity and location, physical form (i.e., materials), radionuclide identification, RCRA determination, Polychlorinated Biphenyl (PCB) determination, and specific waste attributes (e.g., Accountable Material, Nanomaterials, etc.).

When the PK collection documentation is complete, an evaluation of the PK is performed to determine if the PK data compiled is of sufficient precision and accuracy to ensure safe management and compliance with the waste acceptance requirements of the facility receiving the HEPA filter waste. The evaluation identifies and documents uncertainties, inconsistencies, limitations, and usefulness of the associated data.

In many cases, sampling of the HEPAs filters is determined to be necessary to obtain the missing information. In those cases, the PK evaluation process documents the central sampling design parameters including location and population, type and number of samples, and sample analyses (radiological, chemical, physical, quality control)

Additional parameters are also defined including data deliverables, and data verification and validation requirements.

SNL PK Collection:

At SNL, PK and characterization data for HEPA filters are collected on a disposal request (DR) form. The DR form is a comprehensive set of questions designed to gather information for all types of radioactive and mixed waste generated at SNL. The DR form is completed by the waste generator or delegate and then reviewed by knowledgeable waste management personnel to identify and quantify radiological and hazardous constituents.

LLNL PK Collection:

PK collection on HEPA filters is handled via the same process as other waste streams at LLNL. The Field technician or Characterization point of contact creates an information gathering document (IGD) in the IGD database, with input provided from the generator, and submits it for electronic approval. This document is essentially a waste generation profile, detailing the physical, chemical as well as radiological characteristics, and hazards, of a waste stream. It will typically contain a general, but sometimes detailed, description of the work processes which generated the waste. It will contain PK as well as radiological, and industrial hygiene analytical swipe results, and any other analytical or other supporting knowledge related to characterization. The IGD goes through an electronic approval process to formalize the characterization and to ensure the waste has an appropriate disposal path. The waste generator is responsible for providing initial PK information, and approves the IGD before it routed to chemical and radiological waste characterization professionals. This is the standard characterization process for LLNL generated HEPA Filters.

CHARACTERIZATION METHODS

PNNL Characterization Methods

A graded approach is used to characterize a given HEPA filter or set of filters based on PK regarding use of the filter, the type of radioactive material and anticipated quantity of radioactive material. PNNL leverages its historical sampling data to limit the use of Nondestructive assay (NDA) and sampling and analysis to situations in which the concentration of radioactive material or Resource Conservation and Recovery Act of 1976 (RCRA) constituents may be high.

HEPAs that are considered high activity are those filters that are believed to contain too much radioactive material to sample in a Contamination Area (CA) fume hood as the sampling would probably result in high CA conditions. HEPAs that serviced hot cells or gloveboxes are subjected to NDA, with other isotopes of concern scaled in using specific hot cell or glovebox scaling factors.

HEPAs that filter room air or from locations where minimal radiological contamination is expected are radiologically characterized using PK. PNNL has found that most HEPA filters that have been in service for a significant period accumulate a measureable quantity of radon daughters (Pb-210 , Bi-210, Po-210). These radon daughters are assigned as the primary isotopes using the filter media weight and the 95% Upper Confidence Limit Bq/g values for gross alpha from the HEPA plan PK. Fume hood HEPAs are typically characterized using filter plan PK along with filter weight, and distributed amongst isotopes of concern using information from the checklist.

Fume hood HEPAs may also be radiologically characterized by means of core sampling the media and radiochemical analysis. In this operation, the filter is placed into a fume hood, filter plates removed, and the screen cut open to enable access to the filter media. A core sampling tool is then used to remove an adequate amount of media such that it can be shipped off to offsite commercial lab for radionuclide and/or RCRA analysis.

Chemical characterization of HEPAs is either by PK or through core sampling and RCRA analysis. As with radiological characterization, a graded approach (see Figure 1) is taken with respect to PK and need to sample.

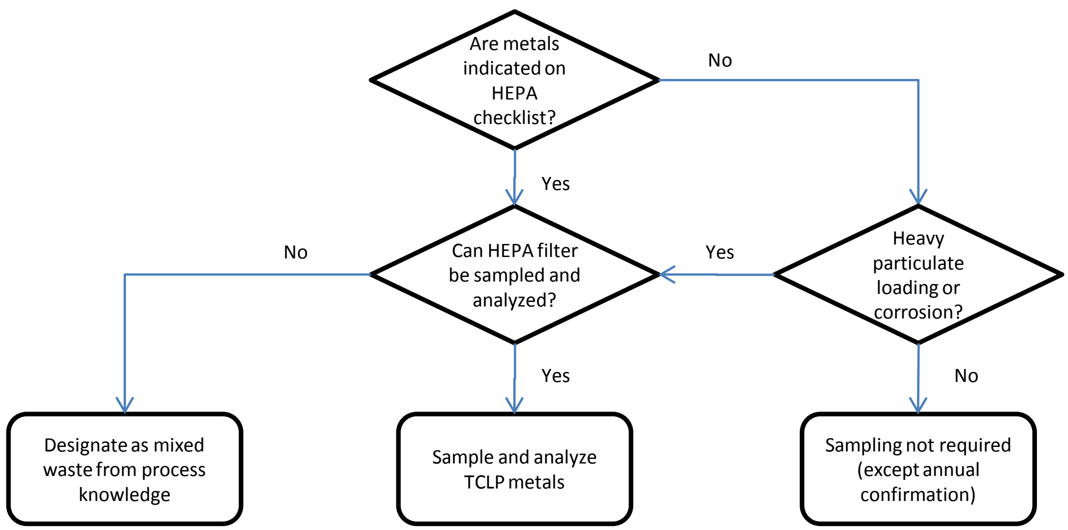

Figure 1, Chemical Characterization Decision Tree

ORNL Characterization Methods:

ORNL uses a variety of methods to characterize HEPA filter waste depending on dose rate, accessibility, expected isotopic and chemical content, anticipated waste disposal facility expectations, and use of graded approach for very low activity HEPA filter waste.

After considering the above, ORNL develops a characterization plan and employs various techniques based on professional judgement to obtain adequate information to develop a defendable suite of characterization data. In some cases, the initial measurements and sample gathering efforts were preliminary and exploratory. By working through a DQO process, the necessary quality aspects are defined and may make the information useful for final characterization.

The techniques to obtain characterization information include

- Obtaining a core or grab sample of the HEPA filter media to determine a radioactivity per mass factor and regulated chemical characteristics
- Obtaining a smear sample from the HEPA filter housing to define the isotope distribution used in a shielding model to derive a dose-to-curie factor
- Gamma spectroscopy measurement
- Neutron activation analysis for HEPA filters located near linear accelerators or reactors
- Multiple surface and distance dose rate survey

SNL Characterization Methods:

To the extent possible, PK is used to determine if hazardous constituents may be present in HEPA filters. If PK is not sufficient to identify the potential for RCRA contaminants, then sampling and analysis is performed. The majority (>95%) of HEPA filters generated at SNL between January 1, 2011 and December 31, 2015 originated at three facilities. The characterization method for each facility is discussed individually.

The Radioactive and Mixed Waste Management Facility (RMWMF) is the primary processing facility for radioactive waste generated at SNL. Emissions from the RMWMF that may be a potential source of chemical or radioactive particulates are filtered prior to discharge. The ventilation exhaust systems at the RMWMF are equipped with pre-filters (rated 85% efficiency) and HEPA filters (rated 99.97% efficiency) for filtering of particulates. Since a variety of waste streams are processed at the RMWMF, sampling and analysis is performed on the pre-filters and HEPA filters. Pinch samples are taken from the filters and analyzed for RCRA Toxicity Characteristic (TC) metals, gross radioactivity (tritium, alpha, and beta), and asbestos. The filters are designed to entrain particulates and are unlikely to collect organic compounds. Therefore, organic analysis is not typically performed for Volatile Organic Compounds (VOCs), Semi-volatile Organic Compounds (SVOCs), and PCBs. Additionally, PK indicates organics are not likely to be present. For the time period of January 1, 2011 to December 31, 2015, the RMWMF generated approximately 10 m^3 of Low-Level Waste (LLW) HEPA filters. No Mixed Waste (MW) filters were generated during this time period.

The Neutron Generator Facility (NGF) consists of several building where HEPA filters are used. The only radionuclide of concern is tritium. Characterization of the tritium content of the HEPA filters is performed by taking pinch samples of waste filters that are then analyzed by liquid scintillation. The tritium results in Bq/g are used in conjunction with the known weight of the filters to calculate a tritium activity. RCRA characterization of NGF filters is typically based on PK. If the process supported by the HEPA filters is known to do any sort of grinding or cutting on RCRA TC metals, such as lead or cadmium, the HEPA filters from this process are conservatively assumed to be mixed waste. Conversely, if the process does not perform any cutting or grinding on RCRA TC metals, the HEPA filters from this process are managed as non-mixed LLW. The NGF is a production facility with very well defined processes that do not vary from year to year. For the time period of January 1, 2011 to December 31, 2015, the NGF generated approximately 11 m^3 of LLW filters and 2 m^3 of MW filters.

The last major group of HEPA filters generated at SNL between January 1, 2011 to December 31, 2015 originated at the accelerator facility. Approximately, 5 m^3 of MW filters were generated in this time frame. PK indicated that only short-lived activation products and potentially Co-60 could be present. Gamma spectroscopy was performed on the filters and only detected natural thorium and Co-60. PK also indicated that lead and silver were potentially present on the filters. The filters were conservatively managed as mixed waste.

LLNL Characterization Methods:

A graded approach is used to characterize a HEPA filter or population of HEPA filters from the same source. PK is used in conjunction with sampling and analysis, to arrive at a final HEPA filter characterization. PK is initially reviewed to determine critical characterization parameters, whether sampling is to be done, and, if so, what type of sampling should occur. It is also used to generate a list of radionuclides which could be present on a HEPA filter from a particular location and activity. Conservative estimates of the activity in the HEPA filter are made when relying primarily on PK. From a hazardous waste standpoint, PK is reviewed to determine the likelihood that the HEPA filters contacted hazardous materials, and whether they have the potential to be considered a federal or state regulated hazardous waste.

In most cases, screening sampling is performed on each unique population of HEPA filters, in the form of tab swipe samples. This consists of inlet swipes for total alpha, beta, and tritium; and in many cases industrial hygiene (IH) metals or SW-846 method 6010 total metals. IH metals consist of those metals (such as beryllium) considered by the LLNL Health & Safety Group to pose particular health threats to workers involved in handling or sampling activities. In addition to radiological and IH metals swipes, where PK suggests that hazardous metals could be present, inlet swipes are taken for total metals. The swipes are typically taken directly from the face of the first HEPA filter in line. The number of samples are determined by the total population of HEPA filters to be disposed of as well as the configuration of the filter array and number of filters in each bank. Barring any anticipated dose risks, swipes will be duplicated across banks to provide an adequate representation for the population of HEPA's in a system.

Where PK indicates that gamma emitting radionuclides could be present, field gamma spectroscopy is applied.

When inlet swipe data, gamma spectroscopy, along with PK, do not provide clear enough information, destructive sampling and analysis will be performed. This sampling consists of cutting some of the filter media out of the inlet side of the HEPA filter. This type of sampling may be performed for radiological as well as hazardous characterization. The final and most intrusive level of sampling on HEPA filters at LLNL, is core sampling. There are provisions for taking core samples of HEPA filters at LLNL, however core sampling is rarely a method used for sampling of HEPA filter media at LLNL.

An effort was made in the mid 1990's, at LLNL, to correlate core sampling of HEPA filters with inlet swipe data. Scores of HEPA filter core samples were taken at the same time swipes were pulled from the inlets of the same filters. The results were widely varied and no correlations were able to be drawn from this activity.

Field gamma spectroscopy, in conjunction with the inlet swipes and PK is the primary method for radiological characterization of HEPA filters at LLNL. Hazardous determinations are primarily made using a conservative PK approach. In many cases, if the PK indicates that processes involving hazardous materials were performed upstream of the HEPA filters, or RCRA metals are detected on inlet swipes, a RCRA hazardous characterization will be applied to the filter.

CHARACTERIZATION RESULTS

PNNL Characterization Results

A large majority of HEPA filters generated at PNNL classify as LLW. During the 1/1/2011 to 12/31/2015 timeframe, HEPAs were generated as shown in Table I. Total waste volume was 120 m^3, which makes up 4 % of PNNL's overall radioactive waste volumes. Dose rates on 92 % of the filters were < 0.005 mSv/hr contact, with 4 % HEPAs between 0.005 and 0.05 at contact, and 4 % greater than 0.05, with a max HEPA dose of 6 mSv/hr.

TABLE I. PNNL HEPA Filter Data 2011-2016

CY	Total HEPAs	LLW	MW	TRU/TRUM
2011	44	36	8	0
2012	47	47	0	0
2013	70	69	0	1
2014	163	162	0	1
2015	62	55	7	0

Regarding DOT classification, 6 % were below the DOT exemption values, 46 % classed as LQ, with 47 % as LSA, and 1% as Type B.

For the filters that designated as hazardous waste, all were regulated for RCRA metals, with lead the most prevalent regulated metal.

ORNL Characterization Results:

The results of a HEPA filter waste characterization effort is documented in a peer-reviewed engineering calculation report. The report has sections describing the calculation purpose and scope, assumptions, references, analysis methods, and conclusions. The results of the characterization calculation are nominal isotopic distributions and correlation factors. For HEPA filter waste, the typical correlation factors relate dose rate to total radioactivity or radioactivity to filter mass. In a few specific cases with limited information, ORNL has developed a bounding characterization case for HEPA filters using a surface contamination value and the estimated “areal density” of the HEPA filter media as compared to the surface area of a stack of cloth wipes.

Table II summarizes the recent HEPA filter waste generated by fiscal year from the ORNL facilities (DOE Office of Science portion only). These HEPA numbers are only those that are used in process systems and do not include HEPA filters utilized in air intake units or non-process general facility air filtration which are disposed of as a special waste or the pre-filters associated with the process gas systems. As expressed in the table, the majority of the HEPA filter waste generated was managed as mixed waste (both Low-Level Mixed Waste (LLMW) and TRUM).

TABLE II. ORNL HEPA Filter Data 2014-2016

FY	Total HEPAs	Mixed (LLW & TRU)	TRU	LLW
2014	139	72	1	66
2015	47	38	6	3
2016	24	20	1	3

SNL Characterization Results:

Approximately 29 m^3 of HEPA filters were generated at SNL during the period from January 1, 2011 to December 31, 2015. The filters consisted of approximately 22 m^3 of LLW and 7 m^3 of MW. Filters from the RMWMF that were sampled for asbestos did not come back with any positive asbestos results. As discussed above, over 95% of the HEPA filters were generated at three facilities. The remaining filters were generated from small pieces of equipment, such as drum compactors, fume hoods, etc. During this period, the RMWMF processed approximately 484 m^3 of waste. HEPA filters made up about 6% of the total waste volume processed.

LLNL Characterization Results:

LLNL's waste tracking database was reviewed from 1/1/2010 to present. Over that time period, one hundred and sixty-seven waste requisitions were generated on HEPA filters identified for disposal. A requisition could represent a single HEPA filter or an entire population of HEPA filters from a buildings exhaust filter bank. Figure 2 illustrates a breakdown of the waste types which HEPA filters were categorized into over that time period. Note that HAZ-CA is waste characterized as hazardous by California waste regulations but does not meet the federal definition of hazardous. CA-COMB is the California only version of Mixed-LLW, and generally includes metals such as nickel, that are not within the Federal toxicity characteristic (i.e., D004-D011 metals). Of the 167 HEPA waste stream requisitions, 147 of those have been characterized, certified for disposal, and shipped to the disposal site. The majority of the HEPA filter requisitions were characterized as low level waste.

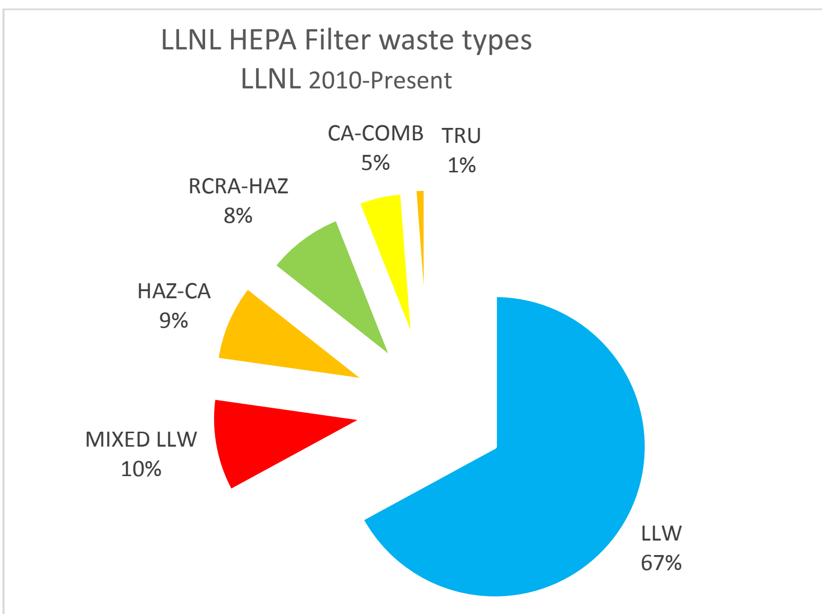

Figure 2, LLNL HEPA Filter Waste Types

WASTE PACKAGING AND DISPOSITION PATHWAYS

PNNL Experience

PNNL LLW HEPAs are packaged into a 36 m^3 foot sealand container and shipped to Perma-Fix Northwest (PFNW) for thermal volume reduction, with the resultant ash shipped to the Hanford site for disposal. MW HEPAs are packaged into 0.91x0.91x0.91 m sized boxes and shipped to PFNW for RCRA treatment. TRU/TRUM HEPAs that are not Remote Handled (RH) are packaged into SWBs are shipped to the Hanford Site.

ORNL Waste Packaging and Disposition Pathways:

ORNL uses conventional disposition outlets for HEPA filter waste such as the Nevada National Security Site (NNSS), Energy Solutions and Perma-Fix. Most of the HEPA filter waste is packaged in metal "B-25" boxes for disposal. For HEPA filter waste that is TRU waste, the ownership is transferred from DOE Oak Ridge Site Office to DOE Oak Ridge Environmental Management (OREM). OREM size reduces and repackages the HEPA filter waste for eventual disposal at the Waste Isolation Pilot Plant.

SNL Waste Packaging and Disposition Pathways:

LLW HEPA filters are usually packaged in 2.1x1.2x 1.2 m metal boxes for final disposition at the NNSS for permanent burial.

MW HEPA filters containing only TCLP metals are treated by macroencapsulation at the RMWMF and disposed at NNSS for permanent burial. Typically, 2.4x1.2x 1.2 m Ultra-Macro Pack[a] boxes are used for MW HEPA filters. These boxes are comprised of high-density/linear low-density polyethylene (PE) macro-liners housed within NNSS Waste Acceptance Criteria compliant packages.

LLNL Waste Packaging and Disposition Pathways:

As there are many sizes and varieties of HEPA filters onsite the packaging will depend on those specifications as well as the radionuclides and the activity it contains. Smaller HEPA filters such as those taken off fume hoods, some glove boxes or small, portable HEPA systems are typically disposed of in drums. Often these types of spent HEPA filters are generated as a result of a specific activity or project and will be disposed of as part of the debris waste stream which is characterized from that activity. Larger HEPA filters such as those found in facility exhaust systems (e.g., 0.3x0.3 x0.29 m metal or wood frame filters) are typically double bagged and packaged into 2.7m^3 or 3.2m^3 boxes for disposal. The majority of LLNL HEPA filters are disposed at NNSS or Energy Solutions.

CHALLENGES AND SUCCESS STORIES

PNNL

PNNL's most significant success with HEPA filters in recent years was a change in the packaging and disposition of LLW HEPAs. Previously PNNL packaged LLW HEPAs in 2.7x1.5x1.5 m or 3x1.8x1.8 m metal waste boxes and shipped directly to the Hanford Site for disposal. Loading and packaging of the HEPAs into these boxes was an arduous process with ergonomic concerns related to lifting and lowering the HEPAs into place. In addition, waste disposal rates at Hanford are volumetrically based and PNNL had no HEPA volume reduction capability.

As a solution to these challenges, PNNL changed to packaging LLW HEPAs into 36 m^3 sealand boxes and shipping these several times a year to PFNW for thermal volume reduction. The waste packaging ergonomics were improved as staff loading the HEPAs can walk into the container, shipment frequency was reduced with the larger container, and the final disposal volume for burial was reduced by a 5:1 factor.

The most challenging HEPA filters PNNL has dealt with are RH-TRU HEPAs. Based on Hanford criteria, RH-TRU is required to be packaged in 208 L drums. Since standard HEPAs will not fit into a 208 L drum and the Hanford site restricted the use of Standard Waste Boxes (SWB's) for RH-TRU, the option for the lab was either to self-perform volume reduction & repack to 208 L drums, or engage an offsite TSD to perform the work. As the lab was not prepared to perform HEPA volume reduction, fortunately, PFNW had capability to size reduce the RH-TRU HEPAs into drums.

In 2016, a Type B quantity RH-TRU HEPA (dose rates of 0.6 mSv/hr contact and 0.15 mSv/hr at 30 cm) was packaged into a 0.75 m^3 container and shipped in a closed transport a distance of 4 km to PFNW. The processing facility completed the size reduction and repackaging with no issues and the repacked waste has been shipped to Hanford.

ORNL Challenges and Success Stories:

ORNL has diverse facilities that use HEPA filters and these may be used in various configurations. Filters may be present as single HEPA filters attached to gloveboxes, HEPA Filters in vacuums, HEPA filters located in labs containing one to several lab hoods, or in large arrays hooked to off-gas or process gas systems handling multiple facilities. Often times in the larger arrays there may be pre-filters of various design located upstream of the credited HEPA filters. These have included normal residential type air filters, bag filters, or non-credited HEPA type filters. These diverse configurations have led to challenges in characterization and packaging of HEPA Filters. ORNL has encountered HEPA filters in large arrays that have multiple HEPA's loaded into frames that are then put into the system. These frames have been too large for standard B-25 boxes and have required procurement of special sized boxes or loading into cargo containers. ORNL has encountered HEPA's that are remote handled and require shielding in order to ship. These diverse configurations and uses of HEPA's make a "one-size fits all" characterization impractical.

ORNL has many systems that use HEPA type filters that are not process gas related. Examples include HEPA type filters installed to filter intake air into the Spallation Neutron Source (SNS) Linac tunnel and in general facility intake air systems. These filters have historically been held for a time to allow decay of radon products or Beryllium-7 and then surveyed for release to the Oak Ridge Operations Industrial Landfill under a Special Waste Permit. In 2016 a Technical Position Paper was issued to allow the disposal of these filters without the requirement to hold to allow the naturally occurring isotopes to decay.

SNL Challenges and Success Stories:

Several years ago SNL started using Ultratech macroencapsulation boxes and drums to treat debris-sized mixed waste contaminated only with TCLP metals. Prior to this, mixed waste was often difficult to treat on-site or expensive to treat at commercial facilities. Over 90% of the mixed LLW generated at SNL can be treated with this technology and sent to NNSS for disposal. Mixed waste HEPA filters contaminated only with TCLP metals are an ideal waste stream for this technology.

LLNL Challenges and Success Stories:

The B513 Shredder Incident [3], stands as an infamous incident in the waste management history of LLNL, and is an important reminder of the importance of good characterization practices for the disposition of waste HEPA filters. From April through July of 1997, Hazardous Waste Management (HWM) personnel were performing shredding operations, using an hydraulic industrial shredder, of debris generated from the cleanup of B-251, the Heavy Element Facility, which was no longer in operation.

Several specific waste streams within this campaign consisted of HEPA filters which were to be shredded for size reduction as well as to facilitate sampling of the filter media. Upon exit from a buffer area, one of the technicians performing the operation, set off a hand and foot counter. Subsequent personnel surveys indicated that all five workers had various levels of contamination on their PPE and the external surface of their respirator cartridges and several of the employees received internal contamination. Following comprehensive bioassay monitoring of all the involved employees, it was initially estimated that that the most effected employee received between 15 and 30 rem of committed effective dose equivalent (CEDE). While the ensuing Type B accident investigation identified a number of contributing causes, mischaracterization and a failure to perform verification of original characterization information were two of the most significant factors. The waste HEPA filters had originally been characterized as building and room HEPA filters containing <1 μCi of Am-241. They were ultimately found to be HEPA filters removed from gloveboxes which were estimated to contain well in excess of 100 mCi of Cm-244. The failure to perform verification of the PK was partly attributed to the fact that this was an ongoing campaign, and HEPA filters from the same building which had previously been shredded, were found to be in line with the characterization information provided. In addition, part of the purpose for the HEPA shredding was in order to facilitate sampling of the filter media, which is typically difficult to obtain otherwise. This brief synopsis of this incident highlights the importance of obtaining good, accurate PK for spent HEPA filters, and following that up with some form of verification sampling and/or surveying.

In contrast to the example listed above, the recent successful characterization and disposal of a specific HEPA filter stream is an example of sound characterization, followed by good verification, which led to the successful, safe disposal of HEPA filters in 2015. In 2013, the Radioactive and Hazardous Waste Management division was chartered with cleaning up a corporate boneyard identified as the IMF WAA (Institutionally Managed Facilities Waste Accumulation Area). One of the largest components in this boneyard consisted of the HEPA filters and housings removed from a building which housed the Atomic Vapor Laser Isotope Separation (AVLIS) project. These filters were removed from building 490, and moved to the IMF WAA, where they were being stored.

Based on good PK regarding the activities in the AVLIS project, the plenum containing the filters was characterized as radioactive low level waste. To verify this and to gain a better idea of the activity contained in the filters, a sampling plan was executed to take a series of radiological swipes from the plenum inlets and interior surfaces, the HEPA filter framing, as well as the front surface of the HEPA filter media. Hazardous constituents were not suspected to be associated with this project, but RCRA metals swipes were taken upstream of the plenum inlet ducts to verify this.

Field gamma spectroscopy of the HEPA filters themselves was also performed. Based on PK, the only radionuclide present in the filters was depleted Uranium. The final activity of the filters was estimated by adding the activity from the swipe results to the activity from direct reading instruments and then applying a conservative safety factor. It was determined that the HEPA plenum with filters met DOT Surface Contaminated Object requirements and this equipment was successfully certified for disposal and shipped to NNSS in August, 2015.

CONCLUSION

HEPA filter waste management at PNNL, ORNL, SNL, and LLNL has a number of common elements and attributes, yet each Lab has tailored an approach to meet site specific requirements and needs. PK data collection typically consists of forms completed by waste generators that are routed to waste management staff who utilize them to make informed decisions about waste characterization, packaging, and disposition. PK is heavily relied upon across the sites for characterization, with varying degree of HEPA sampling and analysis performed to supplement available PK. Filters that are designated as RCRA regulated are primarily due to the presence of RCRA metals. For most labs, the percentage of HEPA waste out of the entire Lab radioactive waste stream is small and there tend to be more LLW filters than LLMW filters. Packaging and disposition vary by site as do the challenges and success stories each lab has experienced with HEPA filters.

FOOTNOTES

[A] Ultra-Macro Pack, UltraTech International, Inc.

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