SOLVING SAMPLING PROBLEMS

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ABSTRACT

The implementation of 10CFR61 and the adoption of the International Atomic Energy Agency's (IAEA) "Regulation for the Transport of Radioactive Materials" by the D.O.T. require that extensive analysis be performed on the waste products that are generated by facilities which produce or utilize by-product materials. Specifically, the waste products must be analyzed to determine the presence and concentration of by-product materials. Representative samples of the waste products are necessary to perform this analysis. Most waste streams are sampled with some difficulty; however, obtaining representative samples from volume reduced waste product streams is even more difficult. Mathematical correlation models can be used to analyze these waste products, but representative sampling is still needed periodically to verify the correlations.

The purpose of this paper is to share how Duke Power Company has solved the problems we have encountered in obtaining representative samples from items such as cartridge filters, resin slurries, and volume reduced dry product. Some of the problems we have encountered include minimizing personnel exposure, obtaining representative samples from heterogenous waste forms, transporting samples from high-rad areas to low-rad areas for retrieval and analysis, controlling the spread of contamination, adaptability to variations in process parameters (e.g., flowrate, density, concentration, chemistry, etc.) and sampling new waste forms such as dry product from volume reduction equipment.

Solving the problems of sampling volume reduction (VR) dry products was very challenging. Since it is basically a new waste stream, we were unable to locate a sampling device specifically designed for VR dry product. Consequently, we developed one. Our goal was to come up with a simple design that had few moving parts, required low maintenance, solved the problems listed above and was inexpensive. The details of this device are discussed in this paper.

The methods and equipment outlined in this paper and used by Duke Power Company to solve our sampling problems can be used to solve similar sampling problems that other by-product utilizers or generators may encounter.

BACKGROUND

The implementation of 10CFR61 and the adoption of IAEA regulations by the D.O.T. require that extensive analysis be performed on the waste products that are generated by facilities that produce or utilize by-product materials. "10CFR61-Licensing Requirements for Land Disposal of Radioactive Waste," requires each waste generator to classify their waste streams for burial at a near-surface burial facility. The waste is classified as either Class A, B, or C. These classifications are based upon the concentrations of certain radionuclides which are important at the burial site. IAEA regulations as well as 10CFR20.311 require each waste shipment to list the presence and concentration of each nuclide on the shipping manifest.

Several methods of assaying the waste are acceptable to the NRC. Four of these methods are:

1) Materials Accountability

2) Classification by Source

3) Gross Radiation Measurement

4) Direct Measurement[1]

Of these four methods, only items 3), and 4) can be effectively used by a nuclear station with multiple units and shared waste systems. Both of these methods involve using scaling factors to determine the distribution and concentration of radionuclides. Scaling factors are used to correlate between radionuclides which can be routinely measured by direct methods (e.g., gamma spectral analysis), and others which require more sophisticated and costly methods (e.g., alpha/beta analysis). Samples of the major waste streams must be analyzed on a periodic basis to establish the scaling factors between the two groups of nuclides. Once the scaling factors have been determined, a mathematical model can be developed to predict the quantity and distribution of the nuclides in a given waste stream. In order to verify that the math models are accurately predicting the quantities and distribution of the nuclides, it is recommended that the waste streams by reanalyzed annually for Class B and C waste if the Direct Measurement Method is utilized[2].

PROBLEMS AND SOLUTIONS

The problems associated with obtaining samples from the various waste streams at a nuclear station include: minimizing personnel exposure, obtaining representative samples from heterogenous waste forms, transporting samples from high-rad areas to low-rad areas for retrieval and analysis, controlling the spread of contamination, adaptability to variations in process parameters (e.g., flowrate, density, concentration, chemistry, etc.), and sampling new waste forms such as dry product from volume reduction equipment.

Contaminated Trash

Contaminated trash, dry active waste (DAW), is difficult to sample due to the large volumes and the diversity of the material. At Duke Power Company, operating experience shows that all DAW packages are

Class A waste. We are able to make this conclusion because we have developed a math model which allows us to measure the gamma radiation level of the DAW containers and predict the presence and concentration of the various nuclides in the container using scaling factors. This method of dose to curie conversion takes into account waste package and detector geometry, shielding and attenuation effects, the effective gamma energies of the emitted photons, and the number of photons per decay.[3] Smear samples are taken from various locations within the station, consolidated, and then analyzed. The results of the analyses are used to establish radionuclide distribution and to verify and update our scaling factors.

Cartridge Filters

The radiation levels of cartridge filters used in the "clean-up" of the primary system and Spent Fuel Pool complicate the 10CFR61 classification analysis. Because these filters are radioactively hot, they need to be analyzed with a math model. Either a mass balance or direct measurement/scaling factor model should be used. We predominately use the Direct Measurement Method and scaling factors to classify our cartridge filters because we do not have the capability to routinely sample inlet and outlet feed streams on all our filters. Unfortunately, as has already been mentioned, periodic verification of the math model is necessary to assure conformance with 10CFR61. The radiation levels of these filters often are 5-50 R/hr. at one meter, which makes physical contact with these filters very undesirable. The problem we face is how to sample a filter without exposing personnel to excessive levels of radiation.

When we remove a filter or filter housing from service, it is placed in a container and moved to a temporary storage area and allowed to drain. When we are ready to make a shipment, the filters are loaded into either a HIC or into 55-gallon drums. An idea we are considering is to allow the filters to drain in the shipping container and then to pump the liquid out prior to shipment to the burial site. Therefore, the ideal time to sample a filter is when it is being removed from service. However, sampling cartridge filters is not an easy task at any time.

At Oconee Nuclear Station we use wound cartridge filters, which are designed for flow from the outside to the inside of the filter. At McGuire and Catawba, we use both pleated paper and wound cartridge filters and the flow is normally from the inside to the outside of the filter. The most important difference between the filters at Oconee and those at McGuire and Catawba is the filters at Oconee have metal cores whereas the other filters have metal housings.

At McGuire Nuclear Station, when a filter must be sampled, tin snips and a pair of scissors have been used to cut through the metal housing and then to obtain a piece of the filter. At Oconee, a butcher knife has been used to cut a plug out of the filter. Not only do these techniques employ extremely poor ALARA methods, but we believe that a sample of the filter should contain a representative cross section. Furthermore, the lab received a much larger sample than was needed.

A method of solving these problems at Oconee is to replace the butcher knife with the device shown in Fig. 1.

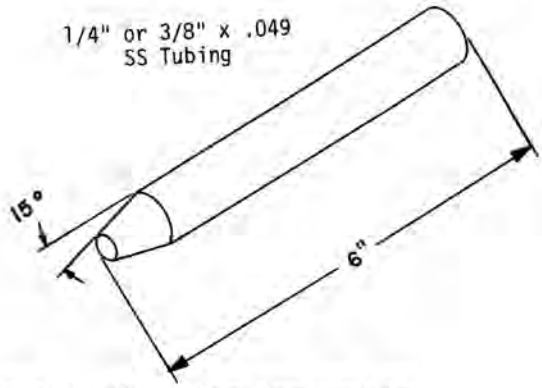

Fig. 1. Filter Core Sampling Tube.

As you can see, this device is merely a piece of 1/4" to 3/8" stainless tubing sharpened to a knife edge on one end. The other end is attached to an extension on an electric drill. When a filter or filter assembly is removed, the technician simply drills into the filter media. A core is trapped in the tube then the tube is placed in a shielded container and sent to the lab for analysis. Given the geometry of the tube, gamma spectral analysis can be performed without removing the filter media. If alpha/beta type analysis is necessary, the sample can be pushed out of the tube with a small metal rod. Using this sampling device reduces the number of times the filter cartridge is handled, eliminates the need to physically handle the filter, provides a cross sectional sample, and provides the lab with only the amount of filter media necessary to perform the analysis; thus, reducing exposure of personnel to potentially highly radioactive sources.

The solution to McGuire's problems is very similar. The sharpened piece of tubing can be replaced or used in conjunction with a small hole saw attached to the electric drill. Another option would be to replace the metal housing and core with plastic. This would not only allow the sample coring device to be used, but it would also facilitate filter shredding.

Resin Slurries and VR Dry Product

Although these two waste streams vary in the problems they present in sampling, they are being discussed together in this paper because the solution we are presenting for each waste stream is basically the same.

The problems associated with sampling resin slurries, particularly primary system deborating and purification demineralizer resin, are minimizing personnel exposure and obtaining a representative sample. Volume reduction equipment such as incinerators and dryers produce dry, free-flowing ash and salts. Resin slurries and dry product can be highly radioactive. Additionally, VR dry product is a potential airborne contaminant. Therefore, extra care must be taken when sampling these two waste streams.

At Duke Power Company, sampling resin is accomplished by two basic methods. A sample can be taken from the recirculation line of the resin storage tank or a grab sample of the resin can be taken as it is being transferred into a dewatering liner. The first method is preferred; however, if the recirculation line does not exist or is out of service, the resin must be sampled as it is being transferred.

The key to sampling any material is getting a representative sample. Ideally, resin tanks should have mechanical mixers and recirculation lines. The next major concern is radiation exposure to the personnel who must retrieve the sample. The optimum location to take a sample is usually not in an area that you want to send personnel to retrieve the sample. This is a problem we have noted with the samplers we are presently using. In order to retrieve the sample, technicians have to enter high-rad areas. This is particularly true when the sampler is installed as a backfit to an existing system. A sampling device is needed which can transport the collected sample to a remote low-rad area for either retrieval or analysis. We have developed and have a patent pending on a device which will collect and transport, to a remote location, a representative resin sample from either a recirculation or transfer line.

A schematic of the sampler installed in a typical resin sampling situation is shown in Fig. 2. Since a patent has not yet been issued, specific details of the sampler can not be given at this time.

The sampler we developed, collects and pneumatically transfers a representative sample to a remote location. It is specifically designed to handle multi-phase fluids (e.g., solids in air, solids in liquid). The total quantity collected, the frequency and the period of the sampler operation are all controlled by the operator. The sample collection container can be located as much as thirty feet from the sampler location. This allows the sample to be transported to a remote location or directly to the lab. The collection container is designed to allow the transport air to be returned to the process stream or to be filtered and then exhausted (Fig. 3).

This sampler provides the user with flexibility so that he can easily use it in a manner which best fits his needs. It can be used to sample resin slurries or dry product slurries. The total amount of material collected can be controlled. The amount of each grab for a sample can be varied as well as the frequency and duration of each grab. This flexibility also allows the operator to adjust to changes in process parameters such as flowrate and density or concentration, and also provides the user with the ability to retrieve a sample from a low-rad area or eliminate the need to provide the shielding necessary to allow personnel to retrieve a sample from a high-rad area.

While we plan to use this device to sample resin slurries, we developed it to solve the problems we were facing with the introduction of a new waste stream at Duke Power - dry product from our volume reduction equipment. We are currently installing, at our Oconee Nuclear Station, a fluid bed incinerator and a fluid bed dryer. The material resulting from the use of these two processes will be a free-flowing mixture of ash and salt. The inputs to this equipment will consist of DAW, oil, low activity resin, and evaporator concentrates. We are in the process of developing a mass balance program which will calculate the distribution and quantity of nuclides present in the final product based on input feed stream characteristics. During the startup of this equipment, we will verify our model calculations. Once the equipment is placed into operation, we will use the sampler to take periodic samples of the final product to verify our math model.

CONCLUSION

10CFR61 and other regulations require the producers and utilizers of by-product material to identify and quantify the radionuclides present in their waste if it is going to be buried in a near-surface disposal facility. Even if mathematical models are used to identify the nuclides, sampling of the waste streams is needed periodically to verify the models. The sampling operation should be such that representative samples can be obtained in accordance with ALARA exposure guidelines. In some cases it is necessary to employ special techniques and equipment to accomplish this goal. We have given a brief glimpse of what Duke Power Company is doing to overcome some of the problems associated with this task. We feel the methods and equipment we have used can be utilized by other utilities and related industries to solve similar problems.

REFERENCES

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2. ibid.

3. Changfuh Lan, Rodney D. Kinard, Elizabeth G. Hough, "A Method for Standardization of Methodologies for the Determination of the Curie Content for Low-Level Radioactive Waste Packages", Waste Management '83, 1, 115 (1983).

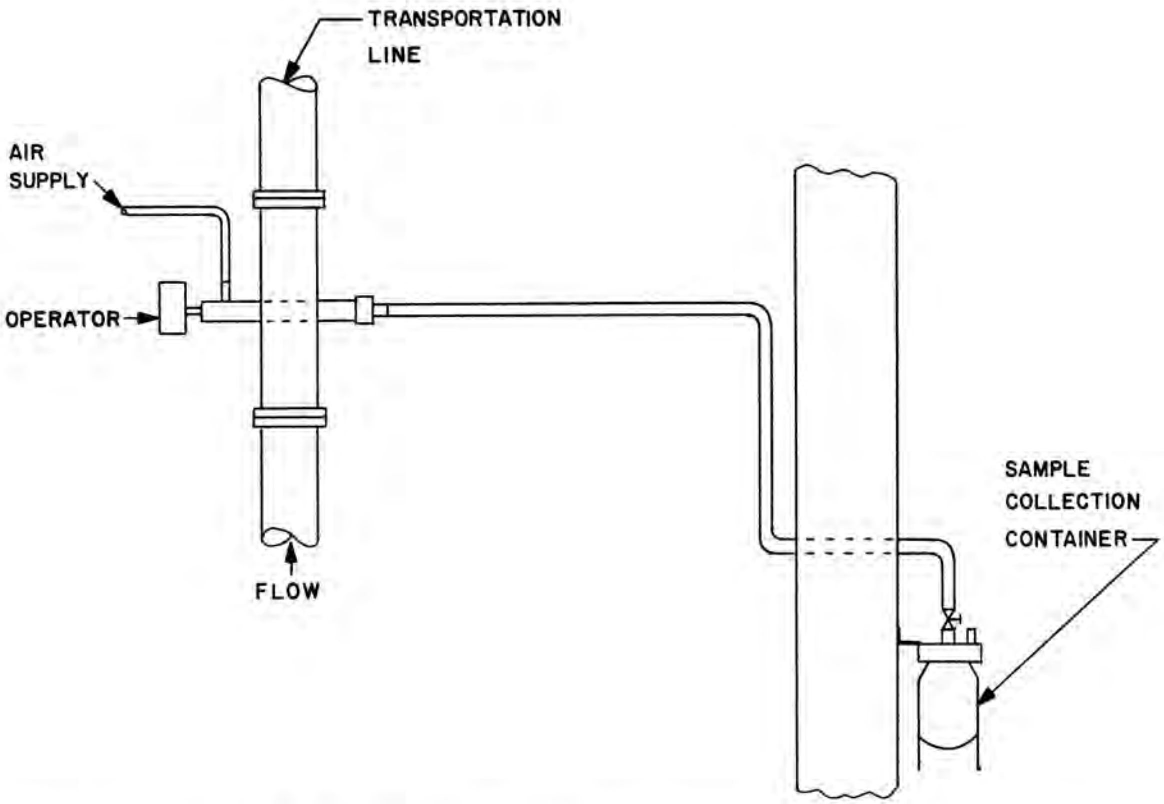

Fig. 2. Schematic of the Duke Sampler Installed in a Typical Resin Sampling Application

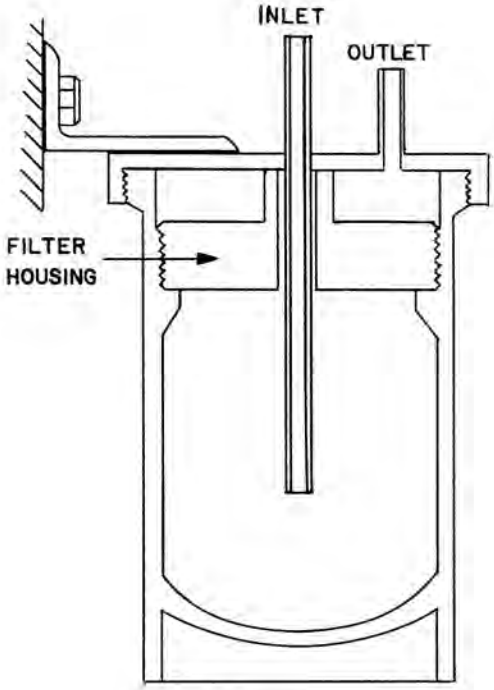

Fig. 3. Sample Collection Container