SESSION 6

PANEL SESSION: AEROSOL SAMPLING IN EFFLUENT AIR STREAMS

Tuesday: July 26, 1994
Chairman: A. R. McFarland

Panel Members: K. Duvall
J. A. Glissmeyer
J. M. Karhnak
G. J. Newton

OPENING COMMENTS OF SESSION CHAIRMAN MCFARLAND

SINGLE POINT AEROSOL SAMPLING: EVALUATION OF MIXING AND PROBE PERFORMANCE IN A NUCLEAR STACK
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RADIONUCLIDE AIR EMISSIONS AT DEPARTMENT OF ENERGY FACILITIES
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PANEL DISCUSSION

CLOSING COMMENTS OF SESSION CHAIRMAN MCFARLAND

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The session this morning is entitled, "Aerosol Sampling in Effluent Air Streams", but I think the title could also be, "What Has Been and What May Be in Aerosol Sampling." The current ANSI air sampling standard needs many changes. The current version contains problems that call for revisions that are currently under way. The last time the ANSI standard was up for revision, it was reaffirmed for another ten years. The latest revision has been a rather substantial exercise, as you will see from John Glissmeyer's presentation. I might mention that several of the committee members who participated in writing the ANSI standard are present as panelists and in the audience, and we would like to get your feedback on the proposed ANSI standard. I would like to start by describing the existing regulatory environment and then indicate where we are now and where the ANSI standard may eventually lead us.

SINGLE POINT AEROSOL SAMPLING: EVALUATION OF MIXING AND PROBE PERFORMANCE IN A NUCLEAR STACK*

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Abstract

Alternative Reference Methodologies (ARMs) have been developed for sampling of radionuclides from stacks and ducts that differ from the methods required by the U.S. EPA. The EPA methods are prescriptive in selection of sampling locations and in design of sampling probes whereas the alternative methods are performance driven. Tests were conducted in a stack at Los Alamos National Laboratory to demonstrate the efficacy of the ARMs. Coefficients of variation of the velocity tracer gas, and aerosol particle profiles were determined at three sampling locations. Results showed numerical criteria placed upon the coefficients of variation by the ARMs were met at sampling stations located 9 and 14 stack diameters from flow entrance, but not at a location that is 1.5 diameters downstream from the inlet. Experiments were conducted to characterize the transmission of 10 μm aerodynamic equivalent diameter liquid aerosol particles through three types of sampling probes. The transmission ratio (ratio of aerosol concentration at the probe exit plane to the concentration in the free stream) was 107% for a 113 L/min (4-cfm) anisokinetic shrouded probe, but only 20% for an isokinetic probe that follows the EPA requirements. A specially designed isokinetic probe showed a transmission ratio of 63%. The shrouded probe performance would conform to the ARM criteria; however, the isokinetic probes would not.

I. INTRODUCTION

The U.S. Department of Energy (DOE) is required under the U.S. Environmental Protection Agency (EPA) National Emission Standards for Hazardous Pollutants (NESHAPs) to continuously monitor radionuclide emissions from stacks and ducts that could contribute more than 0.1 millirem per year to the most affected member of the public[1]. The NESHAPs require use of EPA Method 1[2] for determining the location of the sampling station in the duct, and use of American National Standards Institute N13.1-1969[3] for guidance in conducting the sampling. EPA Method 1 states that the sampling should be no closer than eight duct diameters from the nearest upstream flow disturbance (elbow, fan, etc.) and no closer than two duct diameters from the nearest downstream disturbance. This so-called '8- and 2-criterion,' is intended to provide users with assurance that the sampling site is suitable for collection of representative samples with the minimum number of sampling points (probes). Closer spacing between the sampling plane and the nearest disturbances is allowed if the '8- and 2-criterion' cannot be met, provided larger numbers of sampling points are used. EPA Method 1 also requires that the average swirl angle in the flow should not

*Funding was provided by the Radiological Air Emissions Management Group of Los Alamos National Laboratory and by the US NRC under Grants 04-89-353, 04-90-115 and 04-92-080.

exceed 20°, which ostensibly limits problems that might be created by off-axis sampling by probes and minimizes errors in flow measurements in stacks and ducts..

ANSI N13.1-1969 serves several roles in implementation of the requirements of the nuclear NESHAPs. First, it is intended to provide guidance on the number of sampling points that should be used at a given site, with larger ducts requiring more sampling points than smaller ducts, and rectangularly-shaped ducts requiring more sampling points than circular ducts. As many as 20 sampling points are recommended for large rectangular ducts. However, the ANSI standard recognizes that fewer points may be used if careful evaluation of the sample extraction location shows that the concentration profile is relatively flat as a result of good mixing in the stack or duct. Second, the ANSI standard provides guidance on the design of probes; it recommends sharp-edged probes followed by 90° bends, with a constant internal diameter from the inlet through the elbow. Third, when multiple probes are required under the guidance of the ANSI standard, it provides designs for rakes of such probes.

It has been known for some time[4,5,6] that the methodology prescribed in the NESHAPs needed to be improved and updated. Use of the '8- and 2-criterion' is not a reliable predictor of stack mixing conditions. In particular, it does not provide assurance that fluid momentum and contaminant concentration are both well mixed at the sampling location. Hampl et al.[7] showed that 50 duct diameters may be needed for mixing of a tracer gas in a straight pipe whereas only two duct diameters were needed for mixing downstream of two elbows in series that are placed out-of-plane. Turner et al. [5] showed that representative aerosol samples could be obtained at a distance of 1.5 diameters from a downstream disturbance (elbow).

Use of ANSI-type probes can lead to significant internal wall losses of aerosol particles. Fan et al.[8] tested such a probe and found that approximately 75% of liquid 10 μm aerodynamic equivalent diameter (AED) aerosol particles were impacted on the internals walls and only 25% transmitted through an ANSI probe to a filter collector. As a consequence of these limitations, Los Alamos National Laboratory has prepared Alternative Reference Methodologies (ARMs) for representative sampling of stacks and ducts for emissions of radionuclides[6.] These have been submitted to the EPA Administrator for approval under the provisions of 40CRF61, Subpart H.

The core concept of the performance-based ARMs is that true representative sampling of stack effluents, whether contaminated by gaseous or particulate radioactive contaminants, requires that the contaminants have become well mixed with the effluent flow across the entire cross sectional area at the sampling location. Good mixing can be the result of natural turbulence in the flow, or as a result of the use of engineered mixing devices. A most important consequence of requiring demonstration that mixing at the desired sampling location meets certain performance criteria, is that sample extraction from a single point in that profile is amply justified.

We show here that the most accurate and effective method of achieving continuous representative sampling of radioactive aerosol effluents is through the use of a suitably designed shrouded probe extracting samples from a single properly prepared and located point in the flow. There are two components of the ARMs proposed for achieving representative samples from a single point. The first component is the use of numerical performance criteria for determining the suitability of a sampling location in lieu of the present prescriptive method. Extractive sampling will take place at suitably qualified locations where both fluid momentum (manifested by the shape of the velocity profile) and contaminant concentration (characterized by the shape of the concentration profile) are demonstrated by measurements to be well mixed. If only gaseous radionuclides could be sampled at the site, the criteria for suitability are that the coefficients of variation in the data for the velocity profile and the concentration profile of a tracer gas will each be ≤20% over the center 2/3 of the stack or duct area. The coefficient of variation, *COV* is defined as the ratio of the standard deviation of a data set to the mean value of the data set, i.e.:

$$COV = \frac{s}{\bar{x}} \qquad (1)$$

where the mean and standard deviation of the data are defined as:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \qquad (2)$$

and:

$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n} (x_i - \bar{x})^2} \qquad (3)$$

The parameter n is the number of data points; and, x_i is the value of the random variable (velocity or tracer concentration) at the ith location on a sampling grid.

To address the possibility of narrowly confined, high concentration flow envelopes being averaged out in the general performance criterion, an additional requirement is that over a grid set up in accordance with EPA Method 1[2], the concentration of tracer gas at any point will not be more than 30% greater than the mean concentration across the duct cross section. If aerosol radionuclide particles could be sampled at the site, the suitability criteria are the same as for gaseous radionuclides, but with the additional requirement that the *COV* of 10 µm AED aerosol particles will be ≤ 20% over the center 2/3 of the duct.

To preclude the possibility of significant emissions from a secondary flow being trapped in the boundary layer of a primary flow, no lateral flows may be introduced at a location downstream of the fan in a primary duct in a manner in which the secondary flow entrance would be flush with the wall of the primary flow duct without provision for downstream mixing elements which achieve complete mixing of the flows. This would not be a problem with junctions where the flows are of approximately the same magnitude.

The second component of the ARMs is the use of an anisokinetically operated shrouded probe for single point sampling of aerosols. This probe was developed by McFarland et al.[9]. Such a probe concept is a break with the provisions of ANSI N13.-1969 methods, which emphasize isokinetic sample withdrawal from multiple points in the profile to overcome limitations in mixing. A properly designed shrouded probe, operated at a single location in a well-mixed, stable profile, will provide more representative samples than a rake of numerous small probes due to dramatically reduced wall losses of larger size particles. For a shrouded probe to be acceptable for a given application, the design must have been tested in an aerosol wind tunnel with 10 µm AED aerosol particles over the range of anticipated operational free stream velocities and sampling flow rates. The transmission ratio must be between 0.80 and 1.30 for these conditions.

At Los Alamos National Laboratory, a Waste Assay Facility (WAF) has been constructed that will serve the role of providing non-intrusive examinations of containers of radioactive waste prior to their disposal. Building ventilation air from the WAF is passed through HEPA filters before being discharged to the environment through two stacks (one that is 250 mm, or 10-inches inner diameter, and the second that is 300 mm or 12-inches inner diameter); however, because of the potential for emissions of radionuclides, the stacks will be continuously monitored. The WAF stacks are new and preceded by HEPA filters, so it is unlikely that they have been contaminated. As a consequence, we selected this facility for studies on emissions monitoring. Tests were carried out in the 300 mm diameter stack. With reference to Figure 1, effluent air from the WAF passes through the bank of HEPA filters, into an induced draft fan and then into the 300 mm diameter stack. Air, discharged from the fan, enters the stack through a rectangularly-shaped lateral element on the south side of the stack. Thus, the flow pattern in the stack initially has a

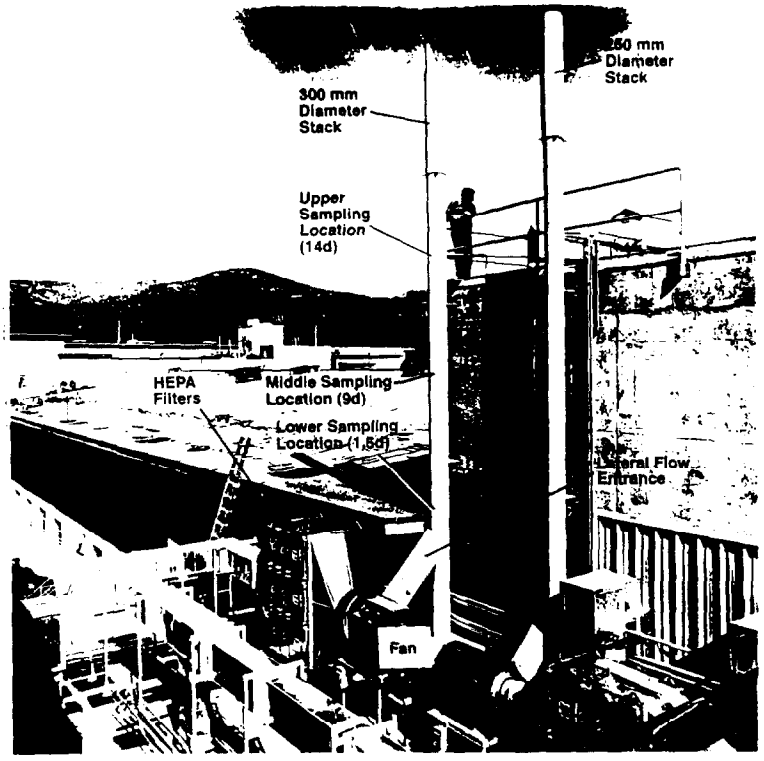

Figure 1. The air exhaust stacks of the Waste Assay Facility at Los Alamos National Laboratory.

pronounced north-south axis of disturbance. Based on pitot tube measurements that were taken by a facilities contractor before we started the study, the nominal mean velocity in the stack was assumed to be 21 m/s. Sampling stations, Figure 2, were placed in the stack at distances of 1.5 diameters, 9 diameters and 14 diameters from the flow entrance location. Totally, the height of the stack is over 20 diameters.

For single point representative sampling to be appropriate, the site must be qualified in terms of meeting numerical mixing criteria for both fluid momentum and contaminant concentration as manifested by the uniformity of the velocity and concentration profiles. In our study of the application of the proposed methodology and criteria in an unmodified operating stack, measurements were made at the three sampling locations of the velocity and concentration profiles. Two types of tests were conducted to characterize the concentration profiles; one set of tests dealt with a tracer gas and the second set dealt with aerosol particles. Sulfur hexafluoride was used as the gas tracer and oil droplets (oleic acid tagged with an analytical tracer) were used as the test aerosol.

Aerosol sampling experiments were conducted with both shrouded probes and isokinetic probes at a qualified location. We tested two different shrouded probes that had been designed to accommodate two different sampling flow rates, and made a comparison of their performances with those of corresponding isokinetic sampling probes. For these tests, 1 to 20 μm AED aerosol particles were used to challenge the probes.

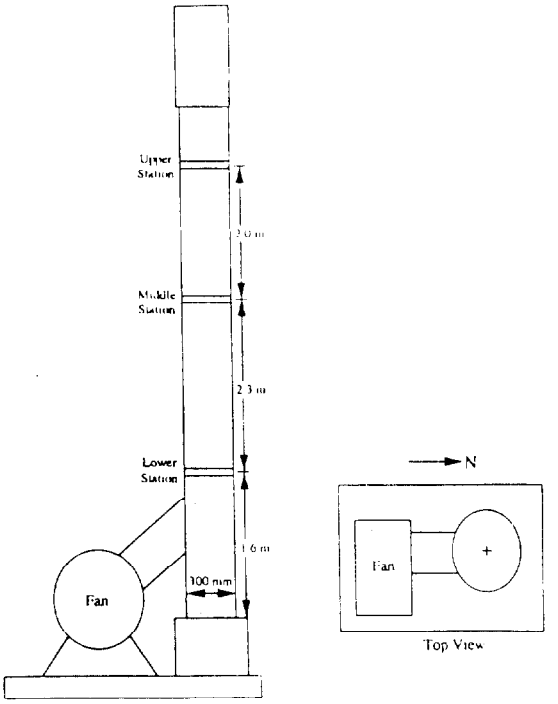

Figure 2. Location of sampling stations on the 300 mm diameter stack.

II. EXPERIMENTAL METHODS

Velocity Profiles

Velocity data were obtained at each of the three sampling locations with a two-channel hot film anemometer (TSI Model IFA 100/200, TSI, Inc., St. Paul, MN). The grid over which the velocity values were taken at each sampling location is shown in Figure 3. The hot film anemometer was initially calibrated at five different velocities in a free air jet against a pitot tube to establish the relationship between instrument output and air velocity. A daily single point calibration was used for assurance that the calibration had not shifted.

Velocity data from a hot film device are output in terms of a fixed set of reference conditions. These data were converted to actual velocity values in the stack through use of:

$$V = V_{ref}\left(\frac{P_{ref}}{P}\right)\left(\frac{T}{T_{ref}}\right) \qquad (4)$$

where: V = velocity; P = pressure; T = temperature; the subscript *ref* refers to the reference conditions for the hot film output; and, the unsubscripted parameters refer to the actual stack conditions.

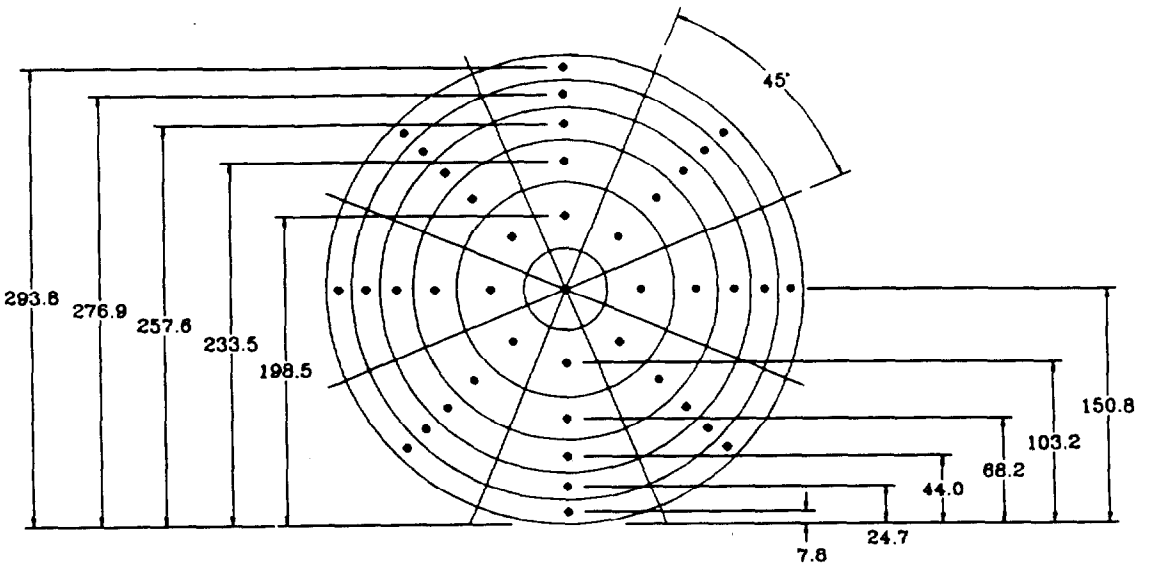

Figure 3. Grid over which velocity readings were taken. All dimensions are in mm.

Tracer Gas Profiles

Sulfur hexafluoride (SF_6) was introduced into the center of the lateral element at the stack entrance. A multipoint probe was used to sample SF_6 at various locations on two perpendicular diameters in the stack at each sampling location. The traverses were selected to be on north-south and east-west axes due to the orientation of the injected flow. Sampling positions in the stack were at distances of 13, 25, 46, 69, 104, 200, 236, and 279 mm (0.5, 1, 1.8, 2.7, 4.1, 7.9, 9.3, 10.2, 11, and 12 inches). The SF_6 concentration was determined with a photoacoustic infrared spectrometer (Multi-gas Monitor, Type 1302, Bruel & Kjaer, Naerum, Denmark).

Aerosol Concentration Profiles

Monodisperse particles were generated with a Berglund-Liu vibrating jet atomizer (TSI, Inc., St. Paul, MN) from the mixture of oleic acid and the analytical tracer, sodium fluorescein, dissolved in isopropyl alcohol. This aerosol was introduced into the center of the rectangular lateral flow element, which is located just upstream of the stack. Light scattering particle counters (MET-1, Grants Pass, OR) were used to measure the particle concentrations in the stack. Average particle size generated by the vibrating jet atomizer was 10.5 μm, which allowed a channel in an optical particle counter with a lower limit of 10 μm to provide size discrimination. The actual particle size was determined microscopically using the technique of Olan-Figureroa et al.[10]. Two particle counters were operated simultaneously at a given sampling location during a stack testing. One particle counter sampled through a probe from a position near the center of the stack profile. Data from this device was used as a reference for the experiments. The second particle counter sampled through a probe that was sequentially placed at each position on a traverse across the stack profile. The initial point was 25 mm (1 inch) from the stack wall and subsequent points were spaced 50 mm (2 inches) apart. Two traverses, at 90° to each other, were made at each of the sampling locations. The traverses were oriented so that one was along a north-south axis and the other along an east-west axis. Triplicate measurements were conducted at each location.

Tests of Sampling Probes

The Berglund-Liu vibrating jet atomizer was used to generate monodisperse aerosol, which was introduced into the lateral entrance section of the stack. Testing of the probes was performed only at the upper (14 diameter) location. The test protocol consisted of operating each probe alternately at the center of the stack for a period of 5 minutes and then replacing that probe with the next to be tested.

A set of tests was conducted to determine the effect of particle size on aerosol transmission through the probes. These tests were conducted with particle sizes from 1 to 20 μm AED at a velocity of 25 m/s. A second set of tests explored the effect of velocity upon the transmission of 10 μm AED aerosol particles. Here, the probes were tested at free stream velocities of 13 and 25 m/s. At least four replicate tests were conducted with each probe at each set of experimental conditions.

One of the isokinetic probes was constructed similar to the recommendations given in the ANSI standard -- it consists of a sharp edged inlet that is 6.5 mm (0.255 inch) in diameter followed by an expansion to 8.7 mm rather than having a constant internal diameter. Because the straight section of the probe and the subsequent elbow have a larger internal diameter than the inlet, it is to be expected the wall losses in this ANSI probe would be less than those in a probe that perfectly matches the ANSI recommendation. For the experiments reported herein, a filter was placed at the exit of the elbow. In the discussion that follows, this probe shall be referred to as the 'ANSI' probe.

A second isokinetic probe was fabricated following the design of Chandra[11]. It has a sharp-edged inlet that is 7.54 mm (0.297 inches) in diameter and it is followed by a gradual expansion of the flow stream to a diameter of 32 mm (1.25 inches). A filter sampler was placed at the exit of the expansion. In the discussion that follows, this probe shall be referred to as the 'isokinetic' probe.

Two shrouded probes were tested to determine aerosol transmission; one of the shrouded probes was designed to be operated at a nominal flow rate of 57 L/min (2 cfm) and the second was designed to be operated at 113 L/min (4 cfm). The shroud diameter of the 57 L/min unit was 50 mm (2-inches) and the diameter of the inner probe inlet was 15.5 mm (0.610-inches). The corresponding dimensions of the 113 L/min unit were a shroud diameter of 75 mm (3-inches) and an inlet diameter of the internal probe of 20.8 mm (0.818 mm).

Typically in the nuclear industry, the nominal flow rate for a stack sampling device is 57 L/min (2 cfm); however, it is commonplace to have two sampling systems operated at the same location with one used for alarming purposes and the second for collection of archival samples. In some applications a 113 L/min (4 cfm) probe is used to collect samples for both purposes. A flow splitter, placed outside of the duct, divides the flow stream so that a representative sample will be provided to each sampling device.

The parameter of principal interest in characterizing the probes is the transmission ratio, T, which is defined as the ratio of aerosol concentration at the exit plane of the sampling system to the aerosol concentration in the free stream. The parameter is determined for liquid aerosol particles and takes into account losses on the internal walls of a probe. Symbolically, it is expressed as:

$$T = \frac{C_e}{C_\infty} \tag{5}$$

where C_e = aerosol concentration in at the exit plane of the probe; and, C_∞ = aerosol concentration in the free stream. The parameter C_e is established from measurements of the aerosol mass that is transmitted through the probe and that which is collected on the filter, together with data on the volume of air sampled by the probe. Aerosol concentration in the free stream was determined from use of the Chandra-type probe. That probe was operated isokinetically, so the aerosol concentration at the 'isokinetic' probe inlet, $C_{i,iso}$ was the same as the free stream concentration, i.e.:

$$C_{i,iso} = C_{-} \quad (6)$$

A sample collected by a filter at the exit of this probe is deficient because of losses of aerosol particles to the internal walls of the probe, i.e.:

$$C_{e,iso} = C_{i,iso} - C_{wl,iso} \quad (7)$$

where: $C_{e,iso}$= aerosol concentration at the exit plane of the 'isokinetic' probe; and, $C_{wl,iso}$= aerosol concentration that is lost to the walls. In these experiments, the wall losses from the 'isokinetic' (Chandra-type) probe were recovered by washing the internal walls of the probe with isopropyl alcohol. Combining the concentration determined from the wall losses together with the concentration determined from aerosol transmitted through the probe allowed calculation of concentration at the probe inlet, which, from Equation 6, provided the value of the free stream aerosol concentration.

III. RESULTS

Velocity Profiles

With reference to Figures 4, plots are shown of the velocity profiles at the three sampling locations. Average velocity in the stack at operational conditions was about 25 m/s; however, data were also taken with the stack operated at about 1/2 that velocity to determine if the stack flow Reynolds number would significantly affect the mixing.

The profile at the 1.5 diameter station (Figure 4a) shows a reverse flow on the south side of the stack where the flow enters laterally, and a high speed region on the opposite side of the stack (north) where the velocity reaches a value of approximately 32 m/s. The *COV* of velocity at this station, calculated for the entire flow, is 28% while that over the region that includes 2/3 of the stack cross sectional area is 22%. These values, together with other *COV*s are shown in Table 1.

Data obtained at the second (9 diameters) level are shown in Figure 4b, where it may be noted the back flow has disappeared and the profile is much more uniform than at the lower level. However, there is still an excess velocity on the south side as compared with the north side. The coefficient of variation for the entire profile is 13% while that for the center 2/3 of the stack cross sectional area is 6%.

The velocity profile at the upper sampling station, which is 14 diameters downstream from the lateral entry, is shown in Figure 4c. Here, the profile is well developed, with a *COV* across the entire cross section of 12% and a *COV* of 4% for the center 2/3 of the stack. To determine if there was a flow Reynolds number influence on mixing, we measured the velocity profile at a flow rate of approximately 1/2 that of the normal operational value for the system. With reference to Figure 4d, the velocity profile for the middle (9 diameter) station at the reduced flow rate is still well developed and has a *COV* of 16% for the entire cross section.

Tracer Gas Profiles

Average velocity in the stack was 23 m/s when the SF_6 measurements were made. The SF_6 concentration profile at the lower level is shown in Figure 5a. The units of concentration are relative, with the measured concentration at each point normalized to the mean concentration. The range of relative concentration values shown in Figure 5a is 0.59 to 1.39. The *COV* is 26% for both the entire data set and for the center 2/3 of the duct area.

Mixing of tracer gas is much improved at the 9 diameter station as compared with that at the 1.5 diameter location. A plot of the concentration profile at the former location is shown in Figure 5b. The *COV* is 5.9% full data set, and 4.2% for the center 2/3 of the stack. At no location on the entire grid is the

Table 1. A comparison of the uniformity of velocity and concentration profiles recommended in the Alternative Reference Methodologies with the values experimentally observed in the WAF stack. All data are for the high velocity condition.

Criterion	ARM acceptability criteria	1.5 diameter location	9 diameter location	14 diameter location
Velocity *COV* over the center 2/3 of stack area	≤20%	27%	6%	4%
Velocity *COV* over the entire grid	No criterion	28%	13%	12%
Tracer gas *COV* over the center 2/3 of the stack area	≤20%	26%	4.2%	2.1%
Maximum of tracer gas relative to the mean	≤30%	39%	12%	5%
10 μm AED aerosol particle *COV*. Center 2/3 of stack area	≤20%	74%	5%	5%
Average swirl angle	≤20°	9°	6°	9°

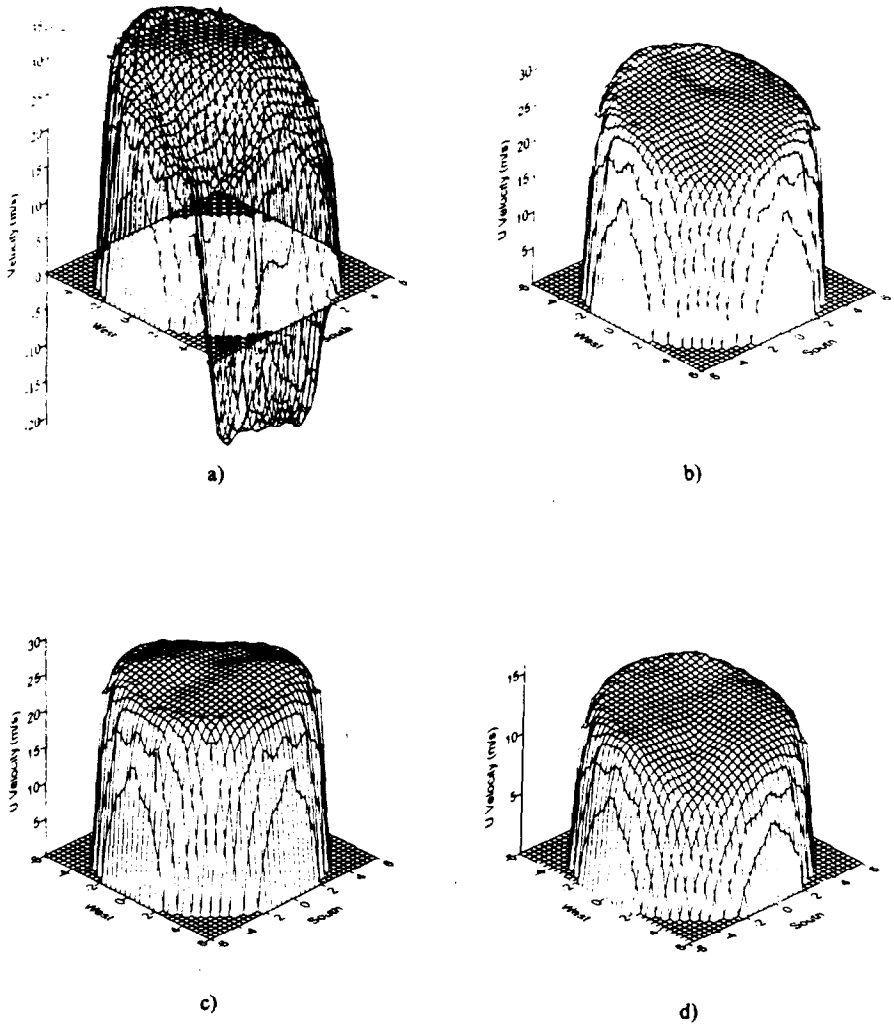

Figure 4. Velocity profiles at the three sampling locations: a) the 1.5 diameter location when the mean velocity was 26 m/s; b) the 9 diameter location when the mean velocity was 26 m/s; c) the 14 diameter location when the mean velocity was 26 m/s; and, d) the 14 diameter location at when the mean velocity was 11 m/s.

concentration more than 12% greater than the mean concentration (the range of measured concentration values was 0.92 - 1.12).

At the upper (14 diameter) location, Figure 5c, the mixing is slightly improved over that at the 9 diameter location. The coefficient of variation for the full set of data points at the upper level is calculated to be 2.8% and the *COV* for the center 2/3 of the stack area is 2.1%. The range of concentration values was 0.97 to 1.05.

Aerosol Concentration Profiles

The aerosol concentration profiles for the 1.5, 9 and 14 diameter locations are shown in Figure 6. The particle size for these data is 10.5 μm and the average velocity in the stack was 24 m/s. The concentration profile at the 1.5 diameter location, Figure 6a shows considerable skewness. Aerosol was introduced into the lateral on the south side of the stack and the data for a north-south traverse show the

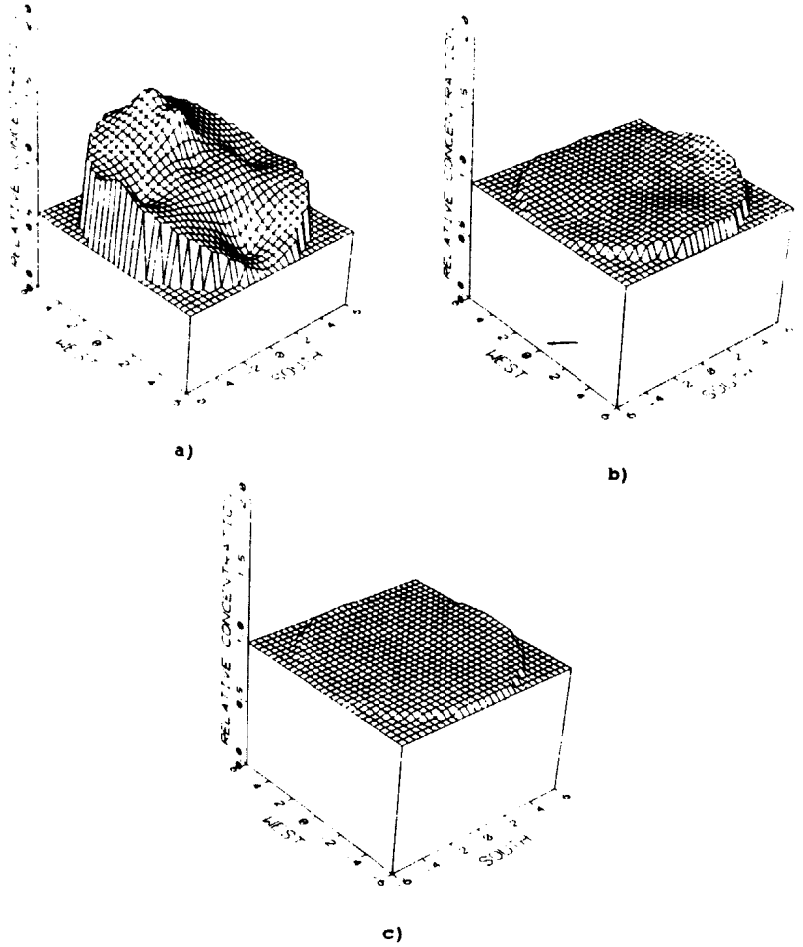

Figure 5. Tracer gas concentration profiles. Mean stack velocity was 23 m/s during these tests. a) The 1.5 diameter location. b) The 9 diameter location. c). The 14 diameter location.

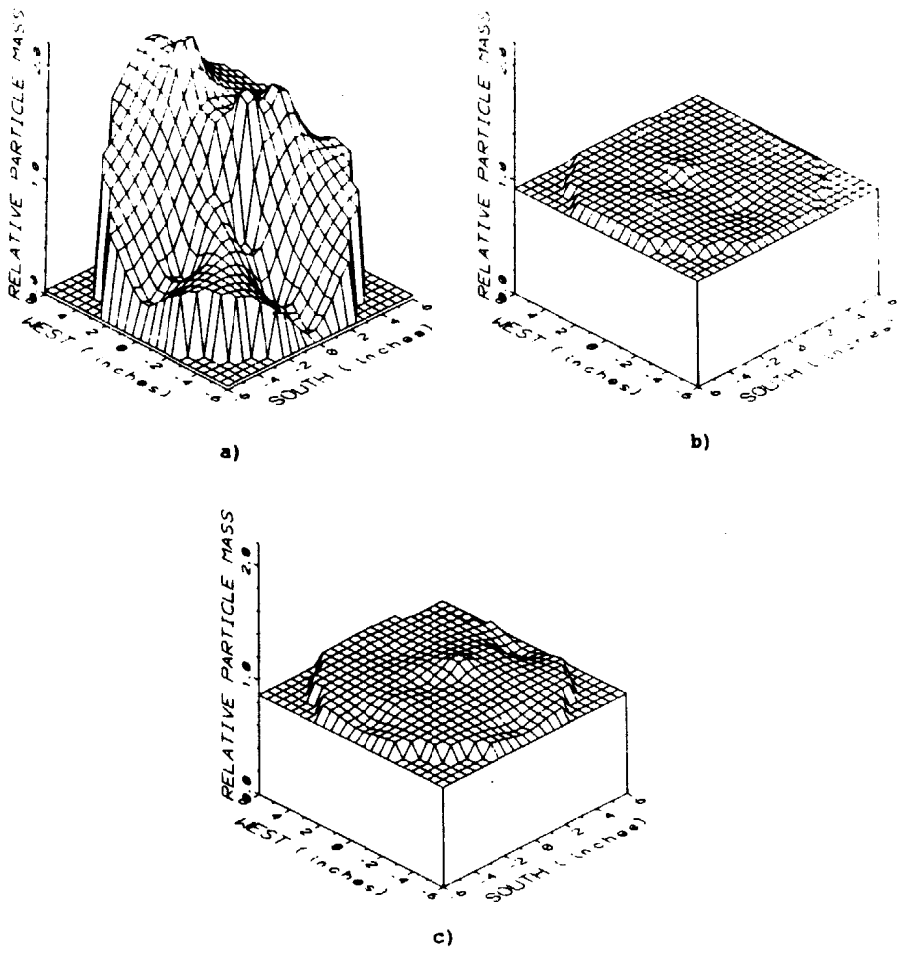

Figure 6. Aerosol concentration profiles for 10.5 μm diameter particles. The average stack velocity during these tests was 24 m/s. a) The 1.5 diameter location. b) The 9 diameter location. c) The 14 diameter location.

south side has a concentration defect and the north side has considerable concentration enrichment. The peak concentration on the north side of the stack is about 200 relative mass units while a near-zero concentration was measured at a distance of 25 mm (1 inch) from the wall on the south side. The *COV* for the full data set at this location is approximately 80% while that for the center 2/3 of the stack is 74%. Also, the maximum concentration across the entire grid is 212% of the mean concentration.

The large-scale mixing produced by the lateral entrance has a significant effect on the particle concentration profile as may be observed from the data taken at the middle station (9 diameters), Figure 6b. Both of the traverses show relatively uniform concentration values. The *COV* of the entire data set is 4% and that for the center 2/3 of the duct area is 5%, where the latter value is an acceptable level under the ARMs (which stipulates the maximum *COV* should not exceed 20% over the center 2/3 of the stack). The ratio of the maximum concentration to the mean concentration across the entire sampling grid is 8%.

The traverses for aerosol concentration at the upper level produced the data shown in Figure 6c. A *COV* of 8% is associated with the full data set, while the *COV* for the data points that correspond to the center 2/3 of the stack area is 5%. The maximum concentration is 14% greater than the mean value over the entire sampling grid.

Probe Performance

The transmission ratios as functions of particle sizes for the four tested probes are shown in Figure 7. At a particle size of 1.0 μm AED, the transmission ratio of all probes is approximately unity. Larger particle sizes had an adverse effect upon the ANSI probe transmission performance. At 10 μm AED, the transmission ratio was 20% and at 20 μm AED, the transmission was only 4%. In contrast, both shrouded

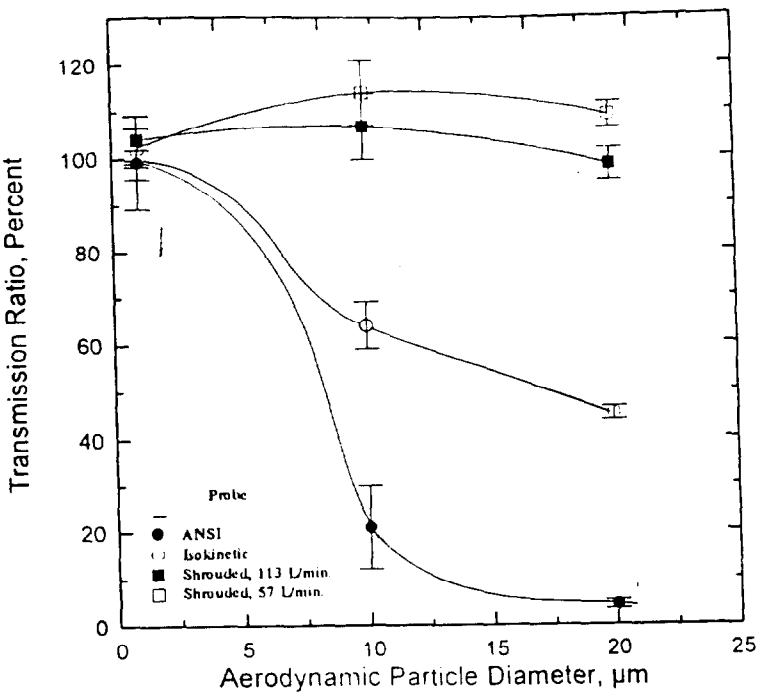

Figure 7. Effect of particle size on the transmission ratios of four different aerosol sampling probes. Mean velocity in the stack during these tests was 24 m/s.

probes showed relatively constant performance, with the 113 L/min (4 cfm) shrouded probe having transmission ratio values from 98% to 107% over the range of particle sizes of 1 to 20 μm AED. The 57 L/min (2 cfm) shrouded probe showed transmission values from 102 to 115% over the same range of particles sizes. Data for the 'isokinetic' probe showed transmission values intermediate to those of the ANSI and shrouded probes, with observed transmission ratio being 63% for a particle size of 10 μm AED.

The effect of stack velocity upon the transmission ratio of 10 μm AED aerosol particles through the various probes are shown in Figure 8. The transmission ratio of the 113 L/min shrouded probe changes from 107% to 92% (a relative change of 14%) as the velocity is decreased from 25 m/s to 13 m/s. In contrast, for the same change in velocity, the transmission ratio of the ANSI probe increases from 20% to 33% (a relative change of 65%). The transmission ratio of the 'isokinetic' was constant at about 63% as the velocity was changed.

Under the Alternate Reference Methodologies, a qualified probe will need to have a transmission ratio within the range of 80% to 130% for 10 μm AED aerosol particles and for the anticipated range of operational conditions. The data from stack tests show both of the shrouded probes (57 L/min and 113 L/min flow rate units) meet these criteria; however, neither the ANSI probe nor the Chandra-type 'isokinetic' probe would be suitable.

Estimate of Experimental Errors.

Replicate tests were conducted with each type of experiment. The normalized average standard deviation (standard deviation of the velocity measurements at each point divided by the mean at that point) of the velocity profile tests was 7% for the upper station, 9% for the mid station, and 16% for the lower station. For tests with tracer gas, the normalized average standard deviation averaged for all sampling

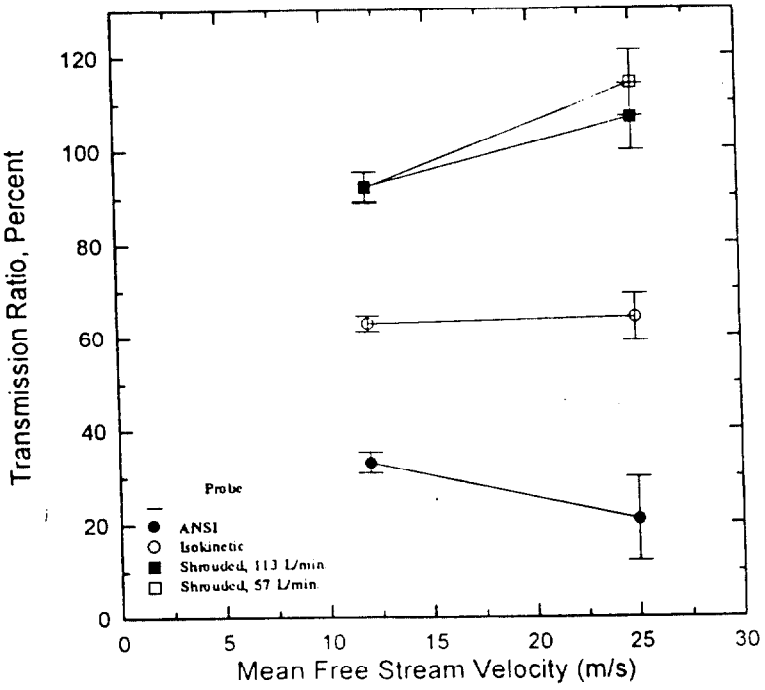

Figure 8. Effect of stack velocity on the transmission ratios of sampling probes. Particle size for these tests was 10 μm AED.

stations was 2%. Data for tests with aerosol particles showed the normalized average standard deviation was 18% at the lower lever and 10% at both the intermediate and upper levels. With respect to reproducibility of tests with probes, error bars that represent ± one standard deviation on the transmission ratio are shown in Figure 7.

IV. DISCUSSION

A comparison of the experimental results with the criteria presented as Alternative Reference Methodologies (ARMs) is given in Table 1. At the lower sampling station (1.5 diameters), the velocity profile over the center 2/3 of the stack area is 27% in contrast with the maximum value of 20% under the ARM . Also, the *COV*s of tracer gas and particle concentration are in excess of the proposed maximum values. Over the entire stack area, the maximum value of tracer gas was 39% more than the average value, which exceeds the proposed range of ≤30%. Average swirl angle was 9° at the lower location. Clearly, as indicated by the *COV*s of the velocity profile, tracer gas, and 10.5 μm diameter particle data, mixing at the lower sampling station is inadequate. However, the swirl data suggest that sampling stations located further downstream would not be rejected by the swirl angle criterion because it is anticipated that in a straight stack, the swirl angle would only decrease with downstream distance.

The 9 diameter location meets all of the numerical mixing criteria of the ARMs. The *COV*s over the center 2/3 of the stack area for velocity, tracer gas, and 10 μm aerosol particles are 6%, 4.2% and 5% respectively, which all compare favorably with maximum *COV*s of 20% stipulated in the ARMs. The maximum concentration of tracer gas was 12% greater than the mean value, as compared with the maximum of 30% allowed under the ARMs. Average swirl angle was 6°.

It should be anticipated that if mixing is suitable at a given location in a straight stack, then the mixing should also be suitable at any subsequent location, provided that indeed there are no obstructions or changes in the internal geometry. Data for velocity, tracer gas concentration and aerosol particle concentration demonstrate the nine diameter location is suitable for single point sampling and the data summarized in Table 1 show that the mixing is even better at the 14 diameter location. Although the nine diameter location would be suitable, the 14 diameter location is to be used for sampling the WAF stack because it can be serviced from the roof of the building.

The EPA '8- and 2-criterion'[2] may have provided acceptable guidance for selection of a sampling site in this stack. A sampling station placed at the 8-diameter location would probably have tested satisfactorily because the 9-diameter location is suitable. However, as demonstrated by the work of Hampl et al.[7], the guidance of the '8-and 2-criterion' would not be satisfactory as judged by the ARMs criteria for many configurations of stack flow. In the case of the WAF stacks, where there is a lateral entry followed by a straight section, the large scale eddy mixing transfers both sufficient fluid momentum and contaminant mass across the stack to render the profiles acceptable within a 9-diameter (and probably an 8-diameter) distance.

A test was conducted to determine if flow Reynolds number would produce a significant change in the mixing. The velocity profile at the 14 diameter location was characterized for a mean velocity of 11 m/s as well as for the velocity condition of 24 m/s. The results for the entire flow cross sectional grid showed a *COV* of 16% for the low flow condition as compared with a *COV* of 12% for the high flow rate. We do not consider this to be a major effect (see the section on experimental errors), and conclude that the Reynolds number, as impacted by mean velocity, does not appear to have a substantial effect on the mixing.

Tests of sampling probes showed the 113 L/min (4 cfm) shrouded probe to have the best performance. At the high velocity condition, the transmission ratio for this probe was between 98% and 107% for particles sizes in the range of 1 to 20 μm AED. In contrast, the ANSI probe and the 'isokinetic' probes only showed only 20% and 63% transmission of 10 μm AED aerosol particles at the high velocity

condition. The Alternate Reference Methodologies includes a performance criterion for probes; namely, that the transmission ratio of a acceptable probe should within the range of 80% to 130% over the range of anticipated operating conditions. Based on the results of the stack tests, both of the shrouded probes would satisfy this criterion; but, neither the ANSI probe nor the 'isokinetic' probe would be acceptable.

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DISCUSSION

ADAMS: How do you think your methods would have changed had there been a stack or a duct that had internal stiffeners every four feet?

MCFARLAND: I assume that the internal stiffeners would be angle iron or something of that order. In general, they would not change things very much, because the stiffeners would not, for the most part, block flow. I would go away from a stiffener to get out of its wake. If a stiffener was only a couple of inches across, acceptable sampling could be conducted a couple feet away. The stiffeners would do a little mixing too; not much, but a little.

MISHIMA: I noticed that the 7 mm diameter sharp edged single tube had the knee close to the end where you expanded to 9 mm. How much internal deposition does that knee cause?

MCFARLAND: I think that is a very astute observation. The probe was not designed exactly in accordance with the ANSI standard. The ANSI standard requires a constant internal diameter. The probe that we tested happened to be one that had already been fabricated at a DOE facility. It was just through serendipity that I happened to encounter it. The unit was gold plated. The question is, how much deposition would occur at the elbow compared to that if it had a constant internal bore? The answer is that this is an improvement over the ANSI probe. We have done some studies with these types of expansions, and there is not a great deal of deposition. On the other hand, the expansion causes a reduction in velocity, which lowers deposition in the elbow. As a consequence I believe this probe is a better probe than the standard ANSI device.

RADIONUCLIDE AIR EMISSIONS AT DEPARTMENT OF ENERGY FACILITIES

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Abstract

Facilities operated by the U. S. Department of Energy (DOE) handle and process radioactive materials in conjunction with their research, nuclear materials production, remediation and waste disposal activities. Radionuclide emissions to the atmosphere from DOE facilities are regulated by the Environmental Protection Agency (EPA) under 40 CFR Part 61, Subpart H for emissions other than radon. Subpart H requires DOE to monitor emissions from stacks and calculate a potential offsite dose to an individual using EPA approved methods and procedures. DOE has applied to EPA for approval to use alternative methods for some of the EPA requirements for continuous monitoring. The use of alternative methods such as single-point sampling with a shrouded probe will have an impact at several major DOE facilities. These facilities are identified.

I. Introduction

The Department of Energy (DOE) is responsible for implementing the nations energy strategy. DOE also is responsible for the development and maintenance of the nations nuclear weapons arsenal. DOE facilities handle and process radioactive materials in conjunction with their research, nuclear materials production, remediation and waste disposal activities. During normal operations, some of these facilities have the potential to release radionuclides to the environment. DOE site reports indicate that about 90% of the release is to the atmosphere. Radionuclide emissions to the atmosphere from DOE facilities are regulated by the Environmental Protection Agency (EPA) under the authority of Section 112 of the Clean Air Act (CAA). The EPA regulations are codified in 40 CFR Part 61, National Emission Standards for Hazardous Air Pollutants (NESHAPs). Subpart H of the NESHAPs applies to radionuclide emissions from DOE facilities other than radon.

DOE is in compliance with the dose standard of Subpart H. However, meeting all of the EPA requirements for continuous emission monitoring at major stacks has been a challenge to DOE, particularly at the older facilities. DOE is attempting to use alternate methods to meet some of these EPA requirements. To utilize the alternate methods provision of 40 CFR Part 61, DOE must obtain EPA approval for its use. The use of alternative methods such as single-point sampling with a shrouded probe will have an impact at several major DOE facilities and should facilitate compliance with the EPA regulations for continuous monitoring. A brief discussion of the DOE facilities that are subject to Subpart H of 40 CFR Part 61, the

types of radionuclide emissions, the emission levels, and the corresponding potential doses to the public will be given.

II. DOE Facility Emissions

In Figure 1., DOE facilities that have radionuclide inventory, and therefore, subject to the radionuclide NESHAPs, are located on the map of the United States with respect to their cognizant EPA region and state. The names of the facilities corresponding to the site abbreviations shown are listed in Appendix A. There are about forty-five of these DOE sites that are spread out through ten EPA regions, and twenty-two states. Each EPA region is responsible for interpreting and implementing the regulations as they determine appropriate for the sites under their purview. EPA is beginning to delegate the authority for regulatintg these sites under the radionuclide NESHAPs to the states. DOE headquarters has the role of forging consistency and uniformity in the implementation of radionuclide NESHAPs across the DOE complex.

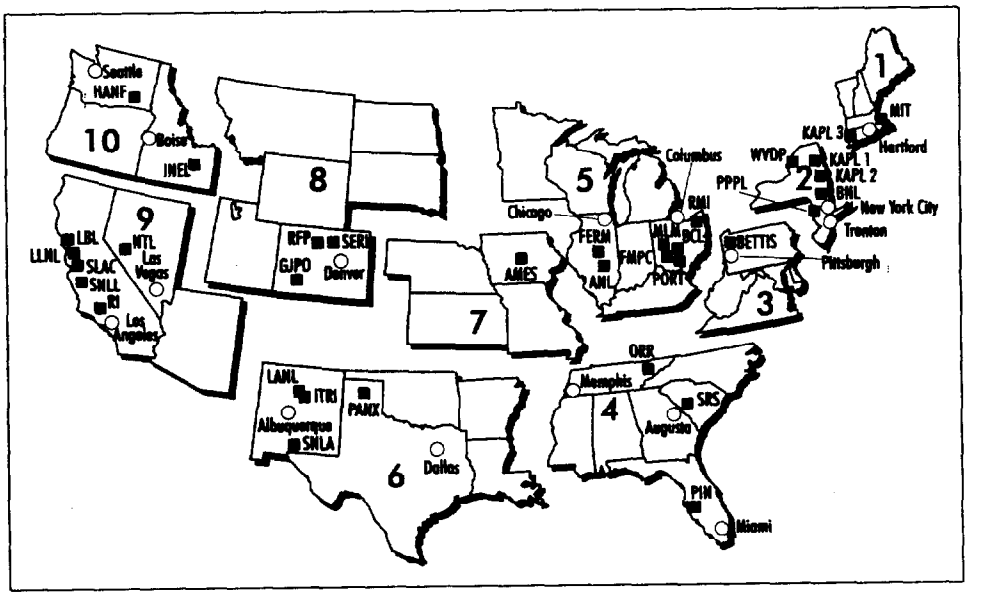

Figure 1. Department of Energy Site Locations and Environmental Protection Agency Regions

The types of radionuclide emissions from DOE facilities are illustrated in Figure 2. For calendar year 1992, most of the radioactivity released to the atmosphere was tritium. Tritium is a component of the emissions for over half of the DOE facilities reporting under NESHAPs. The category of other radionuclides, which mainly consists of air activation products produced by accelerators such as the Los Alamos Meson Physics Facility (LAMPF), was a major contributor to emissions. The nobel gas emissions are typically from nuclear reactor operations. The transuranic emissions, which were extremely low, are closely observed by DOE because this category represents a long term potential risk to the public at sufficient levels.

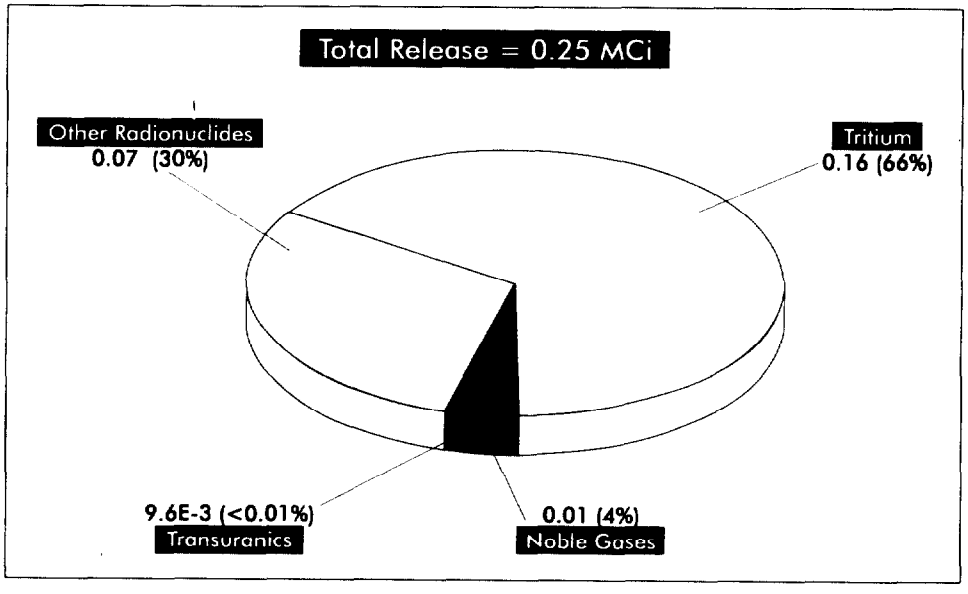

Figure 2. Composition of 1992 Airborne Releases from DOE Facilities (Megacuries)

Figure 3. indicates the level of emissions from DOE over a five year period. The levels of radioactivity released to the atmosphere have been reducing over this period and are expected to continue to decline as a result of a reduction in production activities DOE-wide.

III. DOE Facility Compliance

The radionuclide NESHAPs regulations in Subpart H of 40 CFR Part 61 have three basic tenets for which DOE must comply with. Each DOE site must (1) demonstrate compliance with the dose standard, (2) provide a report on June 30 of each year describing annual emissions, and (3) meet the prescriptive requirements for emission monitoring at its stacks. DOE sites have provided reports to EPA on an annual basis by the required date and are in compliance with the reporting requirement.

The EPA regulations identify specific methods and procedures for demonstrating compliance with the 10 mrem/year dose standard. The dose standard is defined at the receptor or individual who is most likely to receive the highest exposure from DOE operations. DOE emissions from its stacks are considered point sources of emission. The regulations require stack emissions to be monitored in accordance with EPA approved methods and procedures. The data from the stack emissions are used to assemble the source term that is input into computer air dispersion models, such as CAP88-PC. CAP88-PC models the dispersion of the radionuclides through the atmosphere and determines the fraction of the source term that reaches the location of the receptor where it is either inhaled or ingested. The radionuclide release fraction at the receptor is

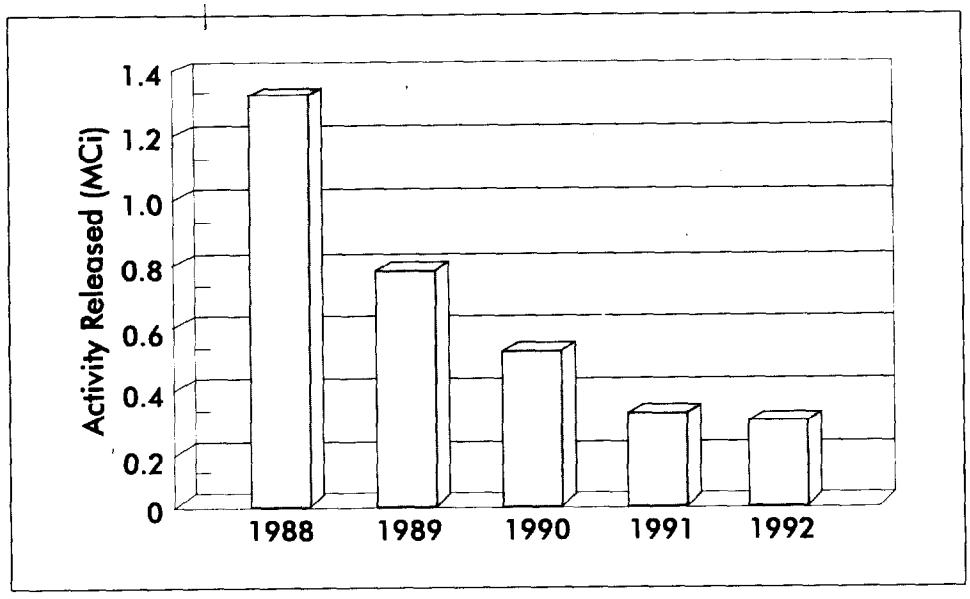

Figure 3. Total Airborne Radionuclide Releases from DOE Facilities

converted to dose and compared with the 10 mrem/year dose standard to ensure that the standard is not exceeded for that year. There are also contributions to the receptor dose from diffuse or non-point source emissions, however, EPA has not prescribed specific methods or procedures for assessing these emissions.

The overall status of DOE facility compliance with the 10 mrem/year dose standard for 1992 is illustrated in Figure 4. Los Alamos National Laboratory (LANL) is our highest emitter at 7.9 mrem/year with that dose resulting mainly from the operation of the LAMF accelerator. Next is the Oak Ridge Site which is at 1.4 mrem/year. There are a few other sites that are just above one percent of the standard such as Savannah River Site, Portsmouth Gaseous Diffusion Plant, and Brookhaven National Laboratory. However, in general, about eighty-five percent of the DOE sites are at least two orders of magnitude below the 10 mrem/year dose standard for their point source emissions. These results indicate that DOE is in compliance with the dose standard and continues to provide ample protection of the public from activities involving radionuclide release to the atmosphere.

Subpart H requires DOE to continuously monitor emissions from some of its stacks using EPA approved methods and procedures. These specific requirements were instituted when the rule was promulgated on December 15, 1989. The rule adopts the continuous monitoring guidelines established by the American National Standards Institute (ANSI) standard N13.1 which was finalized in 1969. Many of the monitoring systems in place at DOE facilities predate the considerations used to develop N13.1 and therefore these systems do not normally comply with the methods and procedures specified in the standard. It is these emission monitoring requirements for which DOE has had the most difficulty in meeting. DOE facilities are

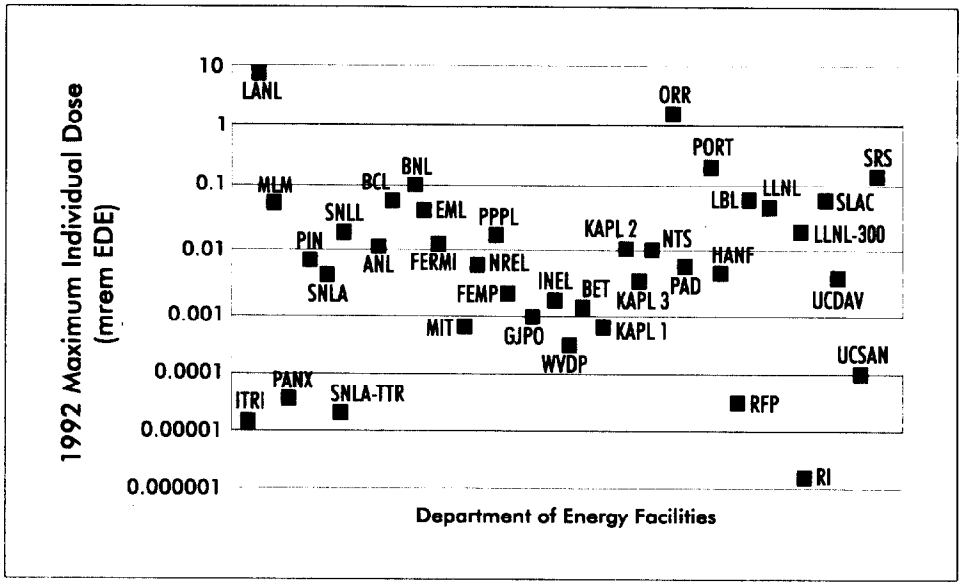

Figure 4. 1992 Annual Maximum Individual Dose Reported for Each DOE Facility

negotiating agreements with EPA on compliance plans and schedules for meeting the continuous monitoring requirements.

IV. Alternate Methods for Continuous Monitoring

The continuous emission monitoring requirements are imposed on those DOE stacks whose potential emissions exceed 1% of the dose standard, with no emission controls in place. These stacks are considered major point sources and compliance with emission monitoring requirements involves the implementation of EPA reference methods and procedures. The periodic confirmatory measurement (PCM) requirement applies to all other stacks. DOE interpretation of the rule implies that the Quality Assurance requirements of Method B114 apply to data collection at major point sources. The emission monitoring systems and plans must also be fully documented.

There are twelve DOE sites where continuous emission monitoring systems are required by 40 CFR Part 61, Subpart H. These sites are listed in Table 1 along with the cognizant EPA region. Some of these sites may require the use of alternate methods to demonstrate compliance with the continuous monitoring provisions. In many of these cases, use of single-point sampling with a shrouded probe is a viable alternative to EPA reference methods. Particularly, stacks that are not configured appropriately to meet the sample siting criteria are prime candidates for use of alternate methods. Furthermore, it has been demonstrated that single-point sampling with the shrouded probe provides more representative sampling and produces higher quality data. DOE sites may prefer to utilize the better technology in stack emissions measurement if that option is available. DOE has requested approval from EPA to utilize the

Table 1 DOE Facilities Subject to Continuous Monitoring

Facility	EPA Region
Brookhaven National Laboratory	2
Oak Ridge Site	4
Paducah Gaseous Diffusion Plant	4
Savannah River Site	4
Mound Site	5
Portsmouth Gaseous Diffusion Plant	5
Los Alamos National Laboratory	6
Rocky Flats Plant	8
Lawrence Berkeley Laboratory	9
Lawrence Livermore Laboratory	9
Hanford Site	10
Idaho National Engineering Laboratory	10

single-point sampling/shrouded probe approach DOE-wide. EPA is reviewing and evaluating the documentation submitted by DOE to determine if the approach is acceptable for alternate use on DOE major stacks.

Facilities that do not have at least one major stack are declared minor facilities and are required to meet only the PCM requirement. These facilities would not need EPA approval to use the single-point sampling/shrouded probe approach but could implement the newer technology based on the technologies own merits.

V. Conclusion

DOE has submitted a request to EPA for DOE-wide use of the single-point sampling/shrouded probe approach at major stacks that require continuous emission monitoring. EPA is evaluating this request and considering its approval. Twelve major DOE sites could benefit from the use of this approach in establishing compliance with the emission monitoring requirements. Other DOE sites could utilize the alternate approach because of the newer technologies' improved performance and higher data quality. In any case, EPA approval of the this alternate will enhance the widespread use of this measurement technology at DOE sites.

Appendix A

U.S. Department of Energy Sites by Operations Office and Location

DOE Operations Office	Site Abbreviation	Site Name	Site Location
U.S. DOE Production Sites and Research Facilities			
Albuquerque (AL)	ITRI	Inhalation Toxicology Research Institute	Albuquerque, NM
	KCP	Kansas City Plant, Allied-Signal Aerospace Co.	Kansas City, MO
	LANL	Los Alamos National Laboratory	Los Alamos, NM
	MLM	Mound Plant	Miamisburg, OH
	PANX	Pantex Plant	Amarillo, TX
	PIN	General Electric Neutron Devices Pinellas Plant	Largo, FL
	SNLA	Sandia National Laboratories, Albuquerque	Albuquerque, NM
	SNLA-TTR	Sandia National Laboratories, Albuquerque, Tonopah Test Range	Tonopah, NV
	SNLL	Sandia National Laboratories, Livermore	Livermore, CA
Chicago (CH)	AMES-1	Ames Laboratory, Iowa State University Site	Ames, IA
	AMES-2	Ames Laboratory, Alpha Containment Facility	Ames, IA
	ANL	Argonne National Laboratory	Argonne, IL
	BCL	Battelle Columbus Laboratory, West Jefferson Site	Columbus, OH
	BNL	Brookhaven National Laboratory	Upton, NY
	EML	Environmental Measurements Laboratory	New York, NY
	FERMI	Fermi National Accelerator Laboratory	Batavia, IL
	MIT	Massachusetts Institute of Technology Bates Linear Accelerator Center	Middleton, MA
	NREL	National Renewable Energy Laboratory	Golden, CO
	PPPL	Princeton Plasma Physics Laboratory	Princeton, NJ
Fernald (FN)	FEMP	Fernald Environmental Management Project	Fernald, OH
Idaho (ID)	GJPO	U.S. DOE Grand Junction Projects Office	Grand Junction, CO
	INEL	Idaho National Engineering Laboratory	Idaho Falls, ID
	WVDP	West Valley Demonstration Project	West Valley, NY
Naval Reactors (4) (NR)	BET	Bettis Atomic Power Laboratory, Bettis Site	West Mifflin, PA
	KAPL-1	Knolls Atomic Power Laboratory, Knolls Site	Schenectady, NY
	KAPL-2	Knolls Atomic Power Laboratory, Kesselring Site	West Milton, NY
	KAPL-3	Knolls Atomic Power Laboratory, Windsor Site	Windsor, CT
Nevada (NV)	NTS	Nevada Test Site	Mercury, NV
Oak Ridge (OR)	ORR	Oak Ridge Reservation	Oak Ridge, TN
	PAD	Paducah Gaseous Diffusion Plant	Paducah, KY
	PORT	Portsmouth Gaseous Diffusion Plant	Piketon, OH
	RMI	RMI Titanium Company Extrusion Plant	Ashtabula, OH
Richland (RL)	HANF	Hanford Site	Richland, WA
Rocky Flats (RFO)	RFP	Rocky Flats Plant	Golden, CO
San Francisco (SF)	LBL	Lawrence Berkeley Laboratory	Berkeley, CA
	LLNL	Lawrence Livermore National Laboratory	Livermore, CA
	LLNL Site 300	Lawrence Livermore Explosive Test Site	Livermore, CA
	RI	Rockwell International, Santa Susana Field Lab.	Canoga Park, CA
	SLAC	Stanford Linear Accelerator Center	Stanford, CA
	UCDAV	Laboratory for Energy-Related Health Research, University of California, Davis	Davis, CA
	UCSAN	Laboratory of Radiobiology and Environmental Health, University of California, San Francisco	San Francisco, CA
Savannah River (SR)	SRS	Savannah River Site	Aiken, SC

DISCUSSION

ANON: Since the standards are basically set for dose at the property line, are there any of the DOE facilities in which direct measurements at the property line can be used in lieu of stack sampling?

DUVALL: Yes there are and I can name a couple, Fernald and Pantex. This is because Fernald and Pantex do not have any major stacks, they have to measure. Most of their emissions are from diffuse, or non-point, sources. Since there are no stacks, there are no EPA required monitoring procedures. EPA has not specified how to assess emissions from diffuse sources. Ambient monitoring at the boundary is applicable to those sites but you have to request EPA approval. I think we are in the process of doing that for a couple of sites.

HULL: You mentioned that tritium was a major radionuclide in emissions. It ought to be relatively easy to monitor tritium in the field, particularly if it is in the form of HTO. A long sampling period would permit collection of a measurable sample that could be translated into a low integrated dose. Do you have any comment on that?

DUVALL: I do not know much about tritium monitoring. There is quite a bit of tritium emitted from DOE activities, but it represents a very low dose to the receptors. I have not heard of any problems from the sites in measuring tritium. Some sites have elaborate controls in place to reduce emissions, but tritium, in general, does not seem to be a problem except in modeling where they utilize a worst case situation, such as considering tritium as HTO, instead of HT. This overestimates emissions and needs to be corrected. I do not think it is a real problem.

EPA PERSPECTIVE ON RADIONUCLIDE AEROSOL SAMPLING

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Abstract

The Environmental Protection Agency (EPA) is concerned with radionuclide aerosol sampling primarily at Department of Energy (DOE) facilities in order to insure compliance with national air emission standards, known as NESHAPs. Sampling procedures are specified in "National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Sites" (Subpart H). Subpart H also allows alternate procedures to be used if they meet certain requirements. This paper discusses some of the mission differences between EPA and DOE and how these differences are reflected in decisions that are made. It then describes how the EPA develops standards, considers alternate sampling procedures, and lists suggestions to speed up the review and acceptance process for alternate procedures. The paper concludes with a discussion of the process for delegation of Radionuclide NESHAPs responsibilities to the States, and responsibilities that would be retained by EPA.

The Difference in Perspective between EPA and DOE

Most of the EPA experience in radionuclide aerosol sampling involves facilities owned or operated by DOE. Those sites are subject to the requirements of 40 CFR 61, Subpart H, National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Sites (Subpart H). The facilities typically are, or have been involved with weapons production or research. They are mostly large facilities, with some monitored stacks. The facilities may have some unmonitored stacks, and may have radionuclide emissions from fugitive or diffuse sources, such as contaminated soil. DOE reported radionuclide emissions from 38 facilities in 1992.

The DOE Approach

In order to characterize the EPA perspective on radionuclide aerosol sampling, it is necessary to start by characterizing the differences between the roles of EPA and DOE. The two organizations serve different roles in the Federal Government. The DOE has been production or research oriented, often working under severe time and security constraints. "Sufficient documentation" of a project was enough to show a small audience of supervisors and peers, educated in the science, that it was reasonable to proceed. Projects used sound logic, scientific laws and principles, and in some cases, educated assumptions. "Success" could be measured by verifiable experimental results or a functioning piece of hardware or software.

The EPA Mission

The EPA was formed on December 2, 1970. Less than a year before that, during the signing of the National Environmental Policy Act, President Nixon stated that he had "become further convinced that the 1970's absolutely must be the years when America pays its debt to the past by reclaiming the purity of its air, its waters, and our living environment. It is literally now or never." EPA's mission statement includes the commitment to ensuring that "National efforts to reduce environmental risks are based on the best available scientific information communicated clearly to the public." Note the need to communicate *scientific* information to the *public*, not to peers in the scientific community. Further, EPA is charged with protecting the public, as exemplified by the standard for the DOE facilities: "Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr." (40 CFR 61.92).

"Members of the public" tend to be a diverse group whose interest in a problem varies, depending on the problem. The decisions made by EPA have an effect on both industry and members of the public. It is not uncommon for an EPA rule to be criticized by one group as being too stringent and by another as being too lenient.

EPA Standards Development

The development process includes research to determine the need for standards, selection of appropriate standards, and identification or development of the tests necessary to validate that the standards have been met. Since point source (stack or vent) emissions are the most significant at most DOE facilities, the emission monitoring and test procedures concentrate on point sources. The standard includes EPA Reference Method 1 (where to take a sample); EPA Reference Method 2 and 2a (velocity and volumetric flow rates); and inclusion by reference of ANSI N13.1-1969, Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," (how to get a good sample). Analysis methods, and quality control and quality assurance procedures are included as well. The procedures described above are used to determine emissions which are then used as input to computer models that calculate dose.

Once a standard is in place, EPA provides training for the technical staff and inspectors (who may be part of the technical staff) who will be dealing with the standard. For Subpart H, the training includes a review of the standard, the procedures for determining compliance and the computer codes used for calculating the dose. During the same session, the instructors present a class on sampling and analysis, which includes a detailed review of the test methods and the ANSI standard. The Subpart H training has been presented four times at four locations across the country. Current plans call for videotaping the course for future availability.

Roles of EPA Headquarters and Regions

EPA headquarters staff is responsible for developing regulations,

such as Subpart H, as described above. Once the regulations are in place, they are responsible for providing technical training, guidance on the uniform application of the regulation, and support to the regions on issues of national significance. The headquarters staff would also be responsible for any changes that subsequently might be made to the regulations.

Staff from the EPA Regions may participate in the regulation development process, depending on the skills available. Regional staff are the primary contact with the DOE facilities, and are responsible for inspections and determining facility compliance with the regulations. They work with the facilities to develop Federal Facility Compliance Agreements or other agreements as needed. The regions may call on support from the EPA laboratories, headquarters, or specialized expertise from EPA contractors for inspections. They also have authority to approve applications for construction and some alternate procedures for sampling as described below.

Alternate Procedures to Demonstrate Compliance

Because new technologies are constantly emerging, many EPA standards include a provision for approving alternate procedures for determining compliance. If a facility does not employ the procedures that are prescribed in the standard, the facility may request that EPA consider an alternate. Specific requirements are detailed in the standards, but generally are these: 1) the requirements in the original standard are impractical; 2) the alternate procedure will not significantly underestimate the emissions; 3) the alternate procedure is fully documented; and 4) the facility receives prior approval before using the alternate. An alternate procedure will typically include caveats on its use.

There are two possible review paths for an alternate procedure. If the request will apply to only one facility (or to the facilities in one region) the EPA region can approve the procedure. Frequently the EPA region discusses the application with headquarters before this decision is made. Generally, the approval will apply to only those facilities for which the original request was made. In some cases, there is a need or desire for the procedure to apply to a large number of facilities. In this case, approval would be a joint effort between EPA headquarters and the regions. Determining the level of review and the applicability of the alternate procedure calls for a cooperative effort between headquarters and regional staff.

Problems with alternate procedures

There has been some concern expressed about the length of time necessary for the review and approval of alternate procedures. EPA shares that concern, and has reviewed several requests to determine the cause of delays.

The review looked at the comparison of the requests with the requirements for approval. The first requirement is that the procedures in the standard for measuring the effluent flow rate, or monitoring or sampling the effluent stream are impractical. Although "impractical" is subject to some interpretation, EPA has been willing

to consider what would constitute sufficient evidence that a procedure was impractical.

The second requirement is that the alternate procedure does not underestimate the emissions. Proving that the new procedure does not underestimate emissions can be difficult. In order to show that the new procedure does not underestimate emissions, the procedure must be developed and tested. Simply comparing the new procedure with the standard procedure may not be possible, since site-specific conditions may affect the results. and the standard procedure is not used on the application, or the alternate would not be needed. Therefore, laboratory testing, calculations, and the use of scientific principles may be needed to provide enough information to convince EPA and *the public* (if necessary) that the procedure is indeed acceptable.

The third requirement is that the alternate procedure be fully (and properly) documented. This ties in somewhat with the second requirement, and is the one most frequently overlooked. One suggestion for a test of completeness is for someone familiar with the science but not with the application to be able to critically review the package and determine that the documentation is complete.

An example serves to illustrate the point. One request included a simple line drawing which were assumed to be a building and a stack. The drawing was not accurate from a mechanical drafting point of view, and had a notation at the bottom, "Flange Location for Stack Monitor". Only one dimension appeared on the drawing, and the only other notation was "Flange size and distance between to be determined." (The one dimension in the drawing was in conflict with the corresponding one in the text.) There was no identification of the facility on the drawing, no date, no location; in short, nothing that would lead the reader to any conclusion that the drawing was intended to be part of the submittal. The text was only slightly more informative. One statement from the request was "Ports are sufficiently downstream of the last major flow obstruction to provide a representative sample."

The fourth requirement, that the facility have approval for the procedure before it is used, would appear to be self-explanatory. However, it is worth noting that a positive approval is needed, not just a lack of a rejection.

Speeding up approval

What can be done to speed the approval process? The same things that lead to successes in other matters work here, too. Facilities that have had successes note that they work closely with, and have good working relationships with the personnel in their respective EPA regional offices. Good communication will alert EPA that a request is coming, and help to confirm that the level of detail supplied is sufficient for the review that is needed.

Internally, the facility should review the four criteria for the approval of an alternate procedure. The request and supporting doucments should be simple, clear and direct. The request should be complete enough to make the point without being verbose. Including

everything that has been ever written on the subject will only slow up the review. Data tables and figures should be clearly marked and referenced to the text. The bounds of applicability (ie, flowrates, temperatures, duct sizes, fluid viscosities, etc) should be clearly stated.

The facility should select an internal reviewer who has some knowledge of the science (to insure accuracy) but is not associated with the project (to insure an unbiased review.) The reviewer should put himself in the place of an EPA reviewer who could be subject to criticism by any member of the public for approving an alternate proposal that is not properly documented.

Incorporation of a Revised ANSI N13.1

The ANSI Standard, N13.1-1969, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities" is presently being rewritten, and will likely contain significant changes from the version now in effect. Subpart H contains the current version of the ANSI standard. When the new version is approved, EPA will review it to determine its applicability to Subpart H and whether the current version should be replaced. Note that simply replacing the old version with the new version could lead to some problems for facilities. Sampling systems based on the old standard might not be in conformance with the new standard, and could lead to the need for retest or rework of the sampling systems. Thus EPA will have to determine if both versions should be accepted for a period of time. In the interim, a facility can propose to use the ANSI procedures as alternate procedures under Subpart H.

DOE "Shrouded Probe" Request

DOE has submitted a request for approval of a set of alternative procedures that have become known as the "Shrouded probe package". The package was submitted by DOE headquarters to EPA headquarters on behalf of all DOE facilities. DOE requested a generic approval that would be applicable in any DOE facility. As a result, EPA headquarters served as a focal point for the review, combining the responses from personnel in all EPA regions.

The individual procedures are 1) to use single-point sampling instead of multiple probe inlets; 2) use of a shrouded probe instead of an ANSI design probe; 3) use of test data to determine the proper placement of a probe, instead of the "8 and 2 rule"; and 4) use of the computer code DEPOSITION to determine particle losses in the sample transport lines, rather than the ANSI guidelines.

The four proposals provide performance-based criteria for approval. However, the first submission by DOE included a generic request, without information on the limitations of the procedures, or application guidelines. Although it appeared that the proposals would provide good data, there was not sufficient information to help the EPA reviewer to decide if this probe in this application would behave the same as the one in the request, even though the dimensions, flow rate, or other parameters might be different. A detailed request for

additional information was forwarded to DOE, and a response has just been received.

State Delegation of Authority

One of the priorities of the Administrator of EPA is to develop partnerships with state and local governments. To that end, EPA actively seeks to delegate to the states the authority to enforce the NESHAPs program. EPA is working with interested states to provide technical support, financial support in the form of grants, and technical training. To date, five states have received grants, and over 60 students from 12 states have participated in Subpart H training.

Delegation is important to DOE, since it changes the regulatory organization. To delegate its authority, EPA must make a finding that the State's procedures for implementing and enforcing the radionuclide NESHAPs are adequate. The EPA Regional Administrator must insure that several elements are addressed prior to delegating EPA's authority to the state. These elements include:

1) insuring that emission limits and test methods are consistent with federal regulations;
2) the NESHAPs reporting and monitoring requirements are implemented;
3) the state agency has adequate enforcement provisions;
4) procedures for public notification and disclosure of non-confidential source information are in place; and
5) the state has sufficient resources to implement the program.

After delegation of NESHAPs authority to a state, EPA retains concurrent authority to enforce the radionuclide NESHAPs in federal court where a State is unwilling or unable to pursue legal action in its own State court system. EPA will only exercise its concurrent authority when necessary to secure effective enforcement of radionuclide NESHAPs.

Responsibilities Not Delegated

Generally, there are two categories of responsibilities that will not be delegated to the States: any decision that requires a rulemaking to implement; or any decision where Federal oversight is needed to insure National consistency. For example, the EPA will retain the authority to approve an alternative method which effectively replaces a reference method, in order to insure uniformity and technical quality in the test methods used for enforcement. Or, approval of an equivalent means of emission limitation to any design, equipment, work practice, or operational standard must be adopted as a change to the individual subpart, and therefore can not be delegated to the States. These decisions would be proposed and subsequently promulgated in the Federal Register and will become part of 40 CFR Part 61. At that point, the methods are available for general use. These authorities will be retained by the Director, Office of Radiation and Indoor Air.

Conclusion

EPA has in place in its regulations standards for sampling radionuclides in air streams, primarily at DOE facilities. These standards are based on the state of the art that was available at the time the regulations were promulgated. As the state of the art advances and improves, EPA attempts to make use of the procedures in the regulations to allow the use of the improved procedures. In order to insure that the mission of protecting the public is properly carried out, EPA must insist on scientifically sound technical backup for the alternate procedures, and that the procedures provide at least the same level of protection as the procedures they replace. And finally, as states assume more responsibility for the regulations, EPA must insure that the states have adequate technical support to be able to discharge these duties properly.

References

(1) USEPA 1983. "Good Practices Manual for Delegation of NSPS and NESHAPs." U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, February 1983.

(2) USEPA 1989. National Emission Standards for Hazardous Air Pollutants: Radionuclides; Final Rule and Notice of Reconsideration. 40 CFR Part 61, December 15, 1989.

(3) Colli, et.al. "State Delegation of National Emission Standards for Hazardous Air Pollutants - Radionuclides". U.S. EPA Office of Radiation Programs.

(4) Clean Air Act 1990; 42 U.S.C.A. 7401 et.seq.

(5) USEPA 1991. Radionuclide NESHAP Grant Guidance. U.S. Environmental Protection Agency, Office of Radiation Programs.

(6) USEPA 1991. Requirements for Approval of State Requests for Delegation of Authority.

(7) Title 40, Code of Federal Regulations, Part 60, Appendix A, Test Methods

DISCUSSION

PALMER: I think Ohio has been one of the states designated to enforce NESHAPS. Will they be the people to whom we will send an alternative sampling request if we want to use alternative means for both near and long term? Or would it be a region office?

KARHNAK: There will be a time period during which the transition will take place. Ohio does not have delegation yet. When authority is eventually turned over to the state, it will include procedures to maintain national consistency. No state has taken delegation for NESHAPS yet and there is going to be a transition period during which we are going to have to work together. Once a state has complete delegation, it will be the one to get the application, but I do not want to commit EPA to something where there may be overriding circumstances. I think that it will go to the state, but EPA will have oversight to make sure there is not a national overriding concern that we should be involved with. There is not going to be a confrontation between EPA and the states, we are going to be working together, I anticipate, for five years.

OSBORNE: I have two questions. First, a lot of DOE facilities have spent millions of dollars to upgrade their monitoring equipment to meet the current requirements. After the ANSI standard is revised, will the facilities be grandfathered if their existing systems meet the old standard, or will they have to be upgraded again to meet the new ANSI standard? The way I see it, it makes more sense to grandfather them and have new sources meet the new standard. My second question is, some of the states, particularly Colorado, do not want to take over the NESHAPS program. This will cause problems for us with a Title 5 operating permit, e.g., who is going to issue the operating permit, the state or EPA?

KARHNAK: You gave me one very easy one and one very tough one. The first is rather easy but it is a very good question and I am glad you raised it. The question deals with whether or not the current ANSI standard will be grandfathered for facilities that have upgraded to meet it. We have discussed it ourselves, because it does not make sense to require everyone to make a change again. Let me talk just a moment about the procedure that is being proposed as an alternative to the ANSI standard specified in the rule. It would permit both to coexist. In order for the rule to be changed, and an updated ANSI N13.1 to be incorporated, we would have to go through a formal rule making process that includes publication in the Federal Register. We probably would not have to have an open hearing, because it is an administrative-type change rather than a change of dose level, which would be more significant. Until there is a rule change, both will coexist. After a rule change, we will have to consider that some facilities, that may have just been upgraded under the old rule, will not have to upgrade for some period of time. I am not sure that it makes sense for us to require changes, simply because we have incorporated the new standard in the rule, even though it contains improvements. My answer is that I expect both will be allowed for at least some period of time.

The second question deals with the states, what happens if a state does not take delegation, and how that will apply to Title 5. I do not have time this morning to answer that one, that is how big a question it is. There is a separate group working on the Title 5 issue and state delegation. I would like to talk to you about it, but it is too much to

get into now. There are some states that do not want the delegation, but there is a requirement that they take the delegation if they take any part of NESHAPS. Some of the states are balking at that because they do not want to have to take on the radiation NESHAPS, and I am not sure how that is all going to play out.

HULL: I assume that if a state is an NRC agreement state, they automatically have responsibility for NESHAPS, too? It sort of seems to go hand in hand.

KARHNAK: You would think that would be the case, wouldn't you. Let me try to explain, because it is an interesting subject. The 1990 Clean Air Act Amendment said that if EPA found the NRC program was sufficiently protective of public health, we could withdraw our rule and NRC could go forward. Legally, we could not make that finding and, as a result, Sub-part I went into effect. There are NRC agreement states, but they inspect according to the ALARA requirements, not to the 10 mrem limit and not to the COMPLY computer code. As a result, there is a difference. They are not far apart, but the two are different. To state it diplomatically, and politically correctly, we have been negotiating with NRC over some period of time to try to get them to agree as closely as possible.

HULL: Does that mean war?

KARHNAK: I did not say that. There is a difference of philosophy between the way the two organizations operate, and we have been trying to bridge the gaps to get together.

PROGRESS OF REVISION TO ANSI N13.1-1969

GUIDE TO SAMPLING AIRBORNE RADIOACTIVE MATERIALS IN NUCLEAR FACILITIES

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Abstract

The ANSI N13.1-1969 *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities* is currently being revised. The revision is being drafted by a working group under the auspices of the Health Physics Society Standards Committee. The main differences between the original standard and the proposed revision are a narrowed scope, a greater emphasis on the design process, and the verification of meeting performance criteria. Compliance with the revised standard will present new challenges, especially in the area of performance validation. The progress made in the revision and key portions of the standard are discussed. The DOE has recently petitioned EPA for alternate approaches to complying with air-sampling regulations. Dealing with compliance issues until the revised standard is adopted will be a challenge for both designers and regulators.

I. Introduction

The objective of this paper is to briefly describe the content of the proposed revision, to point out significant differences from the old standard, and to describe new challenges that the proposed revision will present.

II. Change in Scope of the Standard

The original version of ANSI N13.1-1969, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*, covered air sampling in the workplace, in the environment, and in stacks and ducts. The scope of the revision has been narrowed to air sampling in stacks and ducts; however, some supplementary material may be provided on sampling from calm air. This change was made to allow more coverage of the latest developments in this technology. Workplace air sampling will now be covered under Planco-57 (*Procedures and Instrumentation for Characterizing Airborne Radioactivity in the Workplace*, draft) and environmental air sampling will be covered in ANSI N13.9 (*Guide to Environmental Surveillance Around Nuclear Facilities*, draft). The proposed title for ANSI N13.1-199X is *Guide To Sampling Airborne Radioactive Materials in Stacks and Ducts.*

* Operated for the U.S. Department of Energy by Battelle Memorial Institute under contract DE-AC06-76RLO 1830.

III. Objectives and Approaches for Sampling Programs

The first major section of the revision covers the factors for selecting the objectives and design approaches for a sampling problem. This section emphasizes defining the objectives for a given sampling situation. Failure to understand the sampling objectives can lead to inappropriate or ineffective system design and implementation. The typical objective is to monitor the performance of air treatment systems that ensure that people in the surrounding environment are not exposed to levels of airborne materials deleterious to their health. Some examples of other objectives follow:

- To assess the need for a permanent sampling or monitoring program
- To call attention to deteriorating equipment, faulty processes, or other conditions leading to the loss of effective control of airborne materials in an operation, and to subsequently determine the effectiveness of corrective measures
- To help assess the possible consequences of non-routine incidents and to help in the selection of appropriate corrective action. This can include the integration of radioactive contamination released to the environment over various time periods.

The proposed revision describes a methodology for meeting the most stringent regulatory requirements; however, these requirements may not be universally applicable to all sampling programs, especially those with such limited objectives as process control. Therefore, when designing systems with objectives other than regulatory compliance, the designer must exercise judgment in the application of these requirements and explicitly document the sampling objectives and the reasons for any exceptions to the requirements of the standard.

After an agreement is reached on the purpose of a given sampling effort, the technical approach for meeting the objective must be formulated. Three factors determine the design approach to the sampling problem: 1) the potential emissions from the source, 2) the types of contaminants to be sampled, and 3) tne desired detection limits. For the first factor, the revision suggests a possible graded approach based on potential emissions that could be used to determine some basic sampling program capabilities as shown in Table 1. Guidelines are given for estimating potential emissions where actual measurements are not available.

The second factor determining the sampling approach is the type of contaminants being sampled. The differences in sampling for particles, gases, and vapors are discussed at a general level to draw attention to how they affect the choice of sampling methods. Particular problems associated with large particles, reactive gases, and off-normal conditions are discussed.

The third factor determining the sampling approach is the desired detection limits or action levels. Measurement uncertainties play a key role in determining practical action levels. The sources of uncertainty typical of air sampling and how they propagate are discussed. Guidance is then given to rank the sources of uncertainty and to control the most highly variable ones. Using this information, the designer can then set achievable action levels.

When going through this process, the designer also sets performance criteria for various measurement uncertainties specific for the particular sampling problem.

Table 1 Sample Graded Approach to Application of Sampling and Monitoring

Potential Effective Dose Equivalent Category	Required Monitoring and Sample Analysis Procedures	Potential Effective Dose Equivalent Range (mrem/y)
1	Continuous extractive sampling for a record of emissions, and real-time monitoring with alarm capability; consideration of separate accident monitoring system	>5
2	Continuous extractive sampling for record of emissions, with retrospective, off-line periodic analysis	>0.1 and ≤5
3	Periodic confirmatory extractive sampling and off-line analysis	>0.001 and ≤0.1
4	Annual administrative review of facility uses to confirm absence of radioactive materials in forms and quantities not conforming to prescribed specifications and limits	≤0.001

IV. Determining Representative Sampling Locations

Choosing the location from which to extract samples that are representative of the contaminant concentration in the airstream is the next topic covered in the proposed revision. This section includes characterizing the airstream, including composition, geometry, velocity mapping, and contaminant mapping. The original standard's requirement to locate the sampling plane at a certain distance from a flow disturbance or discharge point was never proven to be an effective means of ensuring sample extraction from a well-mixed system, and has been shown in instances to be ineffective. Also, the requirement for multi-point probes was a means to compensate for poor mixing by obtaining a mixed sample from several locations in the cross-section. The result was often poor sample penetration through complex probe designs and small extraction inlets. The proposed default criterion to ensure that samples are representative of the airstream is to demonstrate that the coefficient of variation of the contaminant is within +/- 15% over the cross section of the sampling plane. This demonstration is one of the major technical challenges of the revision, but the result will be simpler and more effective probe designs. Guidelines are given for measuring the contaminant distribution in the sampling plane.

V. Design of Effective Sampling Systems

The next major section covers, in general terms, the hardware aspects of designing effective sample systems. The requirements for bulk stream flow measurements are first discussed. Guidance is given concerning when to use continuous or periodic flow measurements. The methods appropriate for both of these modes are briefly described and literature references are given to detailed procedures.

Probe inlet designs are treated next. The relative merits of single inlet and multiple inlet probes are discussed. The proposed default requirement for demonstrated particle penetration through record or compliance sampling probes is given as 80 - 130% for particles of 10 micrometers aerodynamic equivalent diameter (AED). Slightly lesser requirements are proposed for systems used for alarm or trending purposes. Guidelines for probe materials, construction, and maintenance are provided. Performance demonstration methods are also given.

Other topics covered in this section are briefly described below.

- The minimization of sample line-loss for particles and reactive gases is discussed.
- Current data and references are given on selecting filters and gas collection devices.
- Guidelines are given on sample flow rate measurements and the pitfalls to avoid when using various instruments. Maintenance and calibration of flow instrumentation are discussed.
- The sampling system components that should have alarms and warning devices to indicate losses of performance and function are addressed.
- The optimization and upgrading of existing and new systems are discussed. Bringing existing systems up to new standards will be a major challenge, and each emission point's dose potential and the contaminant characteristics will be factors to consider in upgrade decisions. In analyzing the priority of an existing system's upgrade, the objective and approach issues described above must be re-evaluated. The use of the air-stream mixing and characterization methods and other performance testing methods are tools in determining whether upgrades will be necessary. The application of decision-aiding techniques in system upgrades is described.

VI. Quality Control and Quality Assurance

The final main section of the proposed revision addresses quality control and assurance issues. The first subject covered is the documentation of the system design. The design files will contain the rationale used in selecting objectives and approaches. Effluent stream characterization studies, detailed design drawings, vendor information, and operating procedures will also be maintained in the file. This section gives guidelines on the system components requiring regular inspections and calibrations. Inspection points will include probe position, corrosion, wear, leak

tightness, and the functioning of flow meters, pumps, controls, heat tracing, detectors, and other instruments. Operator training records will also be maintained. Sample handling will also be addressed.

VII. Appendices

The proposed revision was designed to present the general guidelines and requirements in the main body. To allow for more convenient standard updating, the appendices contain information on important methods for which there is a likelihood of continued technical developments. These include

- Air-stream flow measurements
- Techniques for characterizing sampling sites
- Current techniques for particle and iodine line-loss estimation
- Probe designs
- Methods for performance testing or sample validation.

VIII. Conclusion

The emphasis of the proposed revision is more on performance verification and less on look-alike design. The structure of the original standard made it easier to use as a source of a default design than to embrace the nuggets of performance-based design that it contained. The simplicity of the design concepts it contained were easy subjects for derivative guides and training materials that did not present information that the user needs to consider in the design phase and to verify adequate system performance. The requirements to demonstrate that the contaminants are well mixed in the sampling plane and that the system extracts and delivers a representative sample will be the major challenges of the proposed revision to system designers and users. The impact of the proposed revision on some existing systems may be significant, but careful consideration of the system objectives and the effluent dose impact will focus the upgrade efforts where they are most needed.

PANEL DISCUSSION

DAVIS: A general comment, we are in a Catch-22, so I would like to emphasize again the need for speed. We are spending multi-millions of dollars upgrading systems and, from what we are hearing, the upgrades we are making to our systems may become "junk". I would think that the EPA would be quite concerned about the fact that some of these probes we are putting in may have line losses, or probe deposition, upwards of 80%.

ANON: Your point is well taken. However, I would like to make the observation that the probe is only one portion of the sampling train and, in fact, there is a requirement in the ANSI standard, as it now exists, to look for deposition in the system. It has not gotten to the detail of using a deposition computer program to help plan how you put your lines in, but based on what you have learned, we certainly would not object to your putting in 1-in. sample lines instead of 0.5-in. lines, to make sure that what gets past the probe gets all the way to the collection point. There are things you can do without asking DOE to make changes or accept alternative procedures. On the other hand, we are moving ahead. I said that I do not think we have moved as fast as I would have liked to have moved, but, nonetheless, I think we are fairly close to closure.

NEWTON: As a prudent steward of the public money, I think that the least one should do is to say I am somewhat committed to putting in the ANSI probes. If I go ahead, in a few weeks' time you will probably okay a single point shrouded probe if you approve the supporting data. But if you run the deposition code, you can make your choice on which way to go. That is what I plan on doing for the people that I am advising.

GLADDEN: We do an awful lot of air sampling in our testing programs, etc. Would you advocate using the shrouded probe for sampling other things than radionuclides? Is there a commercial source for this new probe?

MCFARLAND: Let me address that, if I may. The answer is, I think the concept is generally applicable to situations that involve aerosols of larger sizes. When the particles are 0.3μm, or when it is a gas, it really does not matter what you sample with. For the nuclear industry, where 10μm particles could be present under accident conditions, such a system as has been proposed has some benefits. For sampling in other kinds of stacks that the EPA regulates, for example cement plants, a shrouded probe appears to offer benefits. I think it would also offer benefits in situations such as you have at Dugway, where you are interested in particles in the size range of 1-10μm. The probe appears to be able to tolerate variations in wind speed while sampling at a fixed flow rate, which would be appropriate for the type of sampling that you do. Graseby-Anderson of Atlanta has the license for manufacturing the probe.

ANON: I think it is important that the shrouded probe has brought a lot of visibility and a lot of attention to some of the other conditions that go along with sampling. A shrouded probe in a flow that is not well developed and not properly mixed is still not going to give you a representative sample. But I think the attention it has brought to these other points has helped to improve the science and process of sample taking.

ANON: In general terms, when you look at stack sampling, the real key is to be able to

sample representatively at a single point.

MISHIMA: I was the chairman for the Sub-part H, and we were sort of inclined to accept those things that were approved. But even then, we realized that there were very serious problems with ANSI 13.1. With respect to the gentleman who asked about being grandfathered in, that is a worthwhile effort, but I think we should bear in mind that ANSI 13.1 was not well based technically for such elements as the deposition code, as well as for others. When you need to upgrade, or when you have problems, a new code is the way to go. Because it is better based technically, it seems like a significant improvement over what we had available in the past to look at the nature of the pollutants, how to get the best sample, and how best to transport it. And as you pointed out, it extends further back into the system.

OSBORNE: A simple question for Mr. Glissmeyer. You showed a graded approach in your presentation for determining the monitoring required based on potential dose. Was that a controlled, or uncontrolled, potential dose?

GLISSMEYER: Uncontrolled.

MCFARLAND: I hope there will be a good correlation between the requirements of EPA sub-part H and the ANSI standard, so they won't be mutually contradictory.

KARHNAK: I think the goal of the committee was to make it easy to adhere to the rule. We wanted to make it simple, we wanted to have a little more guidance on when to make choices. When you see the final rule, it is going to be a lot thicker than it was, but there will be a lot more information. You won't be forced to accept rules of thumb without a technical basis. I think that the final result will be that we will have better, more reliable sampling procedures. We do not think it is necessary to convert all existing ANSI-style probes to the new design until you are faced with an upgrade, or a noncompliance situation. If you have a major source it is going to have to be negotiated, but if you have a minor source, it does not matter how you take your samples, as far as NESHAPS compliance is concerned. So, we hope that this is going to be an easy rule to follow.

DUVALL: I want to point out that the experience of getting the shrouded probe technology approved by EPA is an indication of what we need to have in the rule: a way to address new technology as it comes on line. There are a lot of EPA methods indicated in the rule that can be replaced as technology moves forward. A recent example is sampling uranium using the laser method; it gives much better sensitivity than the EPA method. Technology is going to move forward, and we need to be able to implement it across the DOE complex. One way we can do this is to adopt the new technologies, get them approved by EPA, and implement them across the DOE complex. I do not think that the development of technology was specifically addressed in the rule, but I think we now have an avenue to move forward on it.

GLISSMEYER: One quick comment. Now that you know that there will be deposition in a probe, when you order one, even when it is an ANSI-style probe, one of the hammers that you have over your suppliers is to ask for the deposition rate and ask for confirming

data. You are paying for that probe, so push them in the direction of less deposition in the probe. It probably can be done.

CLOSING COMMENTS OF SESSION CHAIRMAN MCFARLAND

I certainly appreciate the contributions of you the audience and the panelists. I would also like to mention that our colleague John Rogers who was scheduled to be the co-chairman for this session was unable to make it because of a medical problem. I would like to acknowledge his contributions over a very long period of time (since 1986) in attempting to improve the quality of air sampling in the nuclear industry.