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241-AP Tank Exhaust Comparison with 40 CFR 61, Subpart H, and Other Referenced Guidelines for Stack 296-A-40

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LIST OF ACRONYMS

AEA	alpha energy analysis
CAM	continuous air monitor
CY	calendar year
DCG	Derived Concentration Guide
EPA	U.S. Environmental Protection Agency
ERT	Emergency Response Team
HEPA	high-efficiency particulate air
HP	Health Physics
MCA	multichannel analyzer
MEI	maximally exposed individual
MSDS	material safety data sheets
NIST	National Institute of Standards and Technology
OHP	Operational Health Physics
OHS	Occupational Health and Safety
PM	preventative maintenance
PNL	Pacific Northwest Laboratory
PUREX	Plutonium-Uranium Extraction
QA	quality assurance
QAPP	quality assurance program plans
RL	U.S. Department of Energy Field Office, Richland
SST	single-shell tank
X/Q	atmospheric dispersion factor

241-AP TANK EXHAUST COMPARISON WITH 40 CFR 61, SUBPART H, AND OTHER REFERENCED GUIDELINES FOR STACK 296-A-40

40 CFR 61, SUBPART H, NATIONAL EMISSION STANDARDS FOR EMISSIONS OF RADIONUCLIDES OTHER THAN RADON FROM U.S. DEPARTMENT OF ENERGY FACILITIES

61.92 Standard. 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.

Dose calculations for atmospheric radionuclide releases from the Hanford Site for calendar year (CY) 1990 were performed by Pacific Northwest Laboratory (PNL) using the approved U.S. Environmental Protection Agency (EPA) CAP-88 computer model. Emissions from discharge points in the Hanford Site 100, 200, 300, 400, and 600 areas were calculated based on results of analyses of periodic sampling conducted at the discharge points. These calculated emissions were provided for inclusion in the CAP-88 model by area and by individual facility for those facilities having the potential to contribute more than 10% of the Hanford Site total or to result in an impact of greater than 0.1 mrem per year to the maximally exposed individual (MEI). Also included in the assessment of offsite dose modeling are the measured radioactive emissions from all Hanford Site stacks that have routine monitoring performed. Record sampling systems have been installed on all stacks and vents that use exhaust fans to discharge air that may potentially carry airborne radioactivity. Estimation of activity from ingrowth of long-lived radioactive progeny is not included in the CAP-88 model; therefore, the Hanford Site GENII code (Napier et al. 1988) was used to supplement the CAP-88 dose calculations. When the dose to the MEI located in the Ringold area was calculated, the effective dose equivalent from combined Hanford Site radioactive airborne emissions was shown to be 9.3E-03 mrem. This value was reported in the annual air emissions report prepared for the Hanford Site (RL 1991).

61.93 Emission monitoring and test procedures

(a) To determine compliance, radionuclide emissions shall be determined and effective dose equivalent values calculated suing EPA approved sampling procedures, computer models CAP-88 or AIRDOS-PC, or other procedures for which EPA has granted prior approval.

Dose calculations for atmospheric radionuclide releases from the Hanford Site for CY 1990 were performed by PNL using the approved EPA CAP-88 computer model. Emissions from discharge points in the Hanford Site 100, 200, 300, 400, and 600 areas were calculated based on results of analyses of periodic sampling conducted at the discharge points. These calculated emissions were provided for inclusion in the CAP-88 model by area and by individual facility for those facilities having the potential to contribute more than 10% of the Hanford Site total or to result in an impact of greater than 0.1 mrem per year to the MEI. Estimation of activity from ingrowth of long-lived radioactive progeny is not included in the CAP-88 model; therefore, the Hanford Site GENII code (Napier et al. 1988) was used to supplement the CAP-88 dose

calculations. When the dose to the MEI located in the Ringold area was calculated, the effective dose equivalent from combined Hanford Site radioactive airborne emissions was shown to be 9.3E-03 mrem. This value was reported in the annual air emissions report prepared for the Hanford Site (RL 1991).

(b) Stacks shall be measured in accordance with the following requirements or other procedures for which EPA has granted prior approval:

(1) Effluent flow rate measurements shall be made using the following:

(i) Reference Method 2 of Appendix A to part 60 for large stacks.

Documentation: Drawing H-2-90457, *Structural Central Exhaust Sta Sect and Det*, Sheet 3 of 4 (WHC 1992a).

Response: Stack 296-A-40 has a 10-in. inside-diameter and therefore, meets the definition of a small stack as presented in Reference Method 2C, "Determination of Stack Gas Velocity and Volumetric Flow Rate in Small Stacks or Ducts (Standard Pitot Tube)." This stack is less than 12 in. in diameter so the requirements of Method 2C apply. The apparatus, procedure, calibration, calculation, and bibliography are the same as in Method 2, Sections 2, 3, 4, 5, and 6 except as noted in Method 2C.

(ii) Reference Method 2A of Appendix A to part 60 for small stacks.

Response: Method 2A does not apply to stacks.

(iii) Frequency of measurements shall depend upon the variability of the effluent flow rate. For variable flow rates, continuous or frequent flow rate measurements shall be made. For relatively constant flow rates only periodic measurements are necessary.

Documentation: RHO-CD-1092 (Cammann and Geier 1980), Cammann (1984), and WHC (1991a).

Response: A flow rate with a variability of ±20% has been defined at Hanford as being continuous. It can be shown that the flow rate is within ±20%. Therefore, the flow rate measurement is taken periodically on a quarterly basis.

(2) Radionuclides shall be directly monitored or extracted, collected and measured using the following:

(i) Reference Method 1 of Appendix A part 60 shall be used to select monitoring or sampling sites.

Documentation: Drawing H-2-90457, *Structural Central Exhaust Sta Sect and Det*, Sheet 3 of 4.

Response: This method is not applicable to stacks less than 12 in. in diameter except as defined in the applicable method, Method 1A, *Sample and Velocity Traverses for Stationary Sources with Small Stacks or Ducts.* Stack 296-A-40 has a 10-in. (25.4 cm) inside diameter.

(ii) The effluent stream shall be directly monitored continuously with an in- line detector or representative samples of the effluent stream shall be withdrawn continuously from the sampling site following the guidance of ANSI N13.1-1969 (including Appendix A of ANSI N13.1).

(iii) Radionuclides shall be collected and measured using procedures based on the principles of measurement described in Appendix B, Method 114. Use of methods based on principles of measurement different from those described in Appendix B, Method 114 must have prior approval from the Administrator. EPA reserves the right to approve measurement procedures.

(iv) A quality assurance program shall be conducted that meets the performance requirements described in Appendix B, Method 114.

(3) When impractical to measure as in (b)(1) or to monitor or sample as in (b)(2), see this section for further requirements.

The RL has requested that the existing measurement system be approved as an alternative system instead of verbatim compliance. The additional requirements of this section are being met in part by this assessment.

(4) (i) Measurements shall be made at all release points which have a potential to discharge radionuclides into the air in quantities which could cause an effective dose equivalent (EDE) in excess of 1% of the standard. All radionuclides which could contribute greater than 10% of the EDE shall be measured. For other release points with potential to release radionuclides, periodic confirmatory measurements shall be made.

Discharge points emitting airborne effluents having the potential to contain radionuclides in concentrations 10% of the Derived Concentration Guide Public Value (DCG-Public Value) given in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, Figure III-1, are sampled periodically (DOE 1990). For discharge points with average flowrates greater than 280 cubic meters per minute (m^3/min), analyses for specific radionuclides are required when the total concentrations of alpha-emitting or beta-emitting radionuclides exceed 10% of the DCG-Public Value for the most restrictive radionuclide not known to be absent from the stream. For discharge points with average flowrates less than 280 m^3/min, analyses for specific radionuclides are required when the total concentrations of alpha-emitting or beta-emitting radionuclides exceed 50% of the DCG-Public Value for the most restrictive radionuclide not known to be absent from the stream.

The chemical forms of radionuclides emitted determine the sampling media used. Particulates are sampled using fiber filters, volatile gases are collected on charcoal absorber or silver reactor media, tritium is collected in silica gel media, and ^{14}C is collected in charcoal cartridge media. Results of Hanford Site laboratory sample analyses are combined with discharge point average flowrate and operating schedule data to derive total emissions for each discharge point at the Hanford Site. These data were reported in the annual air emissions report for CY 1990 (RL 1991) prepared in compliance with 40 CFR 61.94(b) (EPA 1989b).

For the 296-A-40 stack:

- The flowrate for stack 296-A-40 is approximately 1,000 m^3/min which is much less than 280 m^3/min (WHC 1991a).

- The total concentrations of alpha-emitting or beta-emitting radionuclides do not exceed 50% of the DCG-Public Value for the most restrictive radionuclide not known to be absent from the stream (WHC 1990).

Therefore, analyses for specific radionuclides are not required for the 296-A-40 stack.

(ii) In evaluating the potential of a release point to discharge radionuclides into the air for the purposes of this section, the estimated rad release rates shall be based on the discharge of the effluent stream that would result if all pollution control equipment did not exist, but the facility operations were otherwise normal.

Documentation: Westinghouse Hanford Company Effluent Discharges and Solid Waste Management Report for 1989: 200/600 Areas, WHC-EP-0141-2 (WHC 1990).

Response: The following tabulates the potential resultant offsite dose as well as the percentages resulting from the 296-A-40 stack with the pollution control equipment removed, but the facility operations otherwise normal. The pollution control is identified as the high-efficiency particulate air (HEPA) filters. To account for this a factor of 3,000 was used to increase emission data. The CAP-88 conversion factors were used to calculate offsite doses. Note that iodine is gaseous and would, therefore, not be contained by the HEPA filters. In other words, the emissions would be the same for iodine with or without the HEPA filters.

Radionuclide	Offsite dose--with controls (mrem)	Dose percent with controls of total	Offsite dose--without controls (mrem)	Dose percent without controls of total
^{137}Cs	1.2 E-09	4.1 E-04	3.7 E-06	6.4 E-04
^{129}I	1.1 E-04	36.2	1.1 E-04	0.019
^{106}Ru	1.9 E-04	63.6	5.8 E-01	99.6
^{113}Sn	3.3 E-07	0.11	1.0 E-03	0.17
$^{89,90}Sr$	1.1 E-09	3.7 E-04	3.4 E-06	5.8 E-04
^{125}Sb	5.0 E-07	0.16	1.5 E-03	0.26
Total offsite dose	3.0 E-04		0.58	

(5) Environmental measurements of rad air concentrations at critical receptor locations may be used instead of air dispersion calculations if:

An Environmental Surveillance program has operated at the Hanford Site since 1946. The program includes air monitoring stations, groundwater sampling, and soil, vegetation, and wildlife examinations. The program has been described in PNL-7346 (Jacquaish and Bryce 1990) (together with its references). The extremely low radionuclide levels found (often below detectable limits) supports the contention that emissions are not underestimated and that any increased monitoring capability enhancements would provide negligible enhancements to environmental safety and public health and safety.

(i) Air at point of measurement shall be continuously sampled.

(ii) Major contributing radionuclides to the EDE must be collected and measured.

(iii) Rad concentrations causing an EDE of 10% of the standard shall be readily detectable and distinguishable from background.

(iv) Net measured rad concentrations shall be compared to the concentration levels in Table 2 of App. E [part 61] to determine compliance with the standard. In the case of multiple rads, compliance is demonstrated if the value for all rad is less than the concentration levels in Table 2, and the sum of the fractions that result when each measured concentration value is divided by the value in Table 2 for each rad is less than 1.

(v) A program shall be conducted meeting the requirements of App. B, Method 114 [part 61].

(vi) Use of environmental measurements to demonstrate compliance with the standard if subject to prior approval of EPA.

61.94 Compliance and reporting.

(a) Compliance with this standard shall be determined by calculating the highest EDE to any member of the public at any offsite point where there is a residence, school, business, or office. Each facility shall submit an annual report to both EPA HQ and Regional by June 30 which includes monitoring results and dose calculations required by 61.43 (a) for the previous calendar year.

The Ringold location was chosen several years ago as the area where the offsite dose from all air pathways would be the highest for the MEI for the Hanford Site. The selection of Ringold was made because nearly all of the dose from air releases in recent years has been contributed by radionuclides from the Plutonium-Uranium Extraction (PUREX) Plant stack. The Ringold area is the closest farming area to the PUREX Plant, and it realistically matches the assumption that the MEI diet consists of 100% home-grown food. The Ringold area has historically been capable of producing all of the items in the MEI diet with the possible exception of cereal grain. The Ringold area lies very nearly in the path of the prevailing winds from the 200 East Area. The atmospheric dispersion factor (X/Q) at Ringold is historically within 10% to 20% of the maximum offsite X/Q value associated with 200 Areas releases. The maximum value usually occurs in an adjacent sector where there is no farming.

The U.S. Department of Energy Field Office, Richland (RL), provided the annual report for CY 1990 (RL 1991) to U.S. Department of Energy, Headquarters; EPA, Region X, personnel; and Washington Department of Health personnel in compliance with the regulatory deadline.

(b) The annual report shall also include: (Future annual reports will also address the following requirements.)

(1) Name and location of facility.

RL-91-10, Pages 1-6 through 1-29. The Hanford Site summary is discussed on Pages 1-1 through 1-5.

(2) List of radioactive materials used at the facility.

RL-91-10, Table 2-1 on Pages 2-2 through 2-13. Please also refer to explanatory remarks for 40 CFR 61.93(4)(i) above.

(3) Description of handling and processing of rad materials at the facility.

RL-91-10, Pages 1-6 through 1-29.

(4) List of the stacks and vents (or other points where radioactive materials are released to the atmosphere.

RL-91-10, Pages 1-6 through 1-29.

(5) A description of the effluent controls that are used on each stack vent of release point, and an estimate of the efficiency of each control device.

RL-91-10, Table 2-1 on Pages 2-2 through 2-13.

(6) Distances from the points of release to the nearest residence, school, business or office and the nearest farms producing vegetables, milk and meat.

RL-91-10, Tables 3-2, 3-3, in Section 3. These tables show the CAP-88 Dose Estimates for the Offsite Individual at Ringold Exposed to Radionuclide Emissions from Hanford Site During 1990. Please also refer to explanatory remarks for 40 CFR 61.94 above.

(7) The values used for all other input parameters for the computer models (meteorological data) and the source of these data.

RL-91-10. Input parameters are shown in Table 2-1, Pages 2-2 through 2-13. Annual average dispersion factors around the 100, 200, 300, and 400 areas during 1990 are given in Tables 3-5 through 3-8. These tables use site-specific measurements of the occurrence frequencies for wind speed, wind direction, and atmospheric stability. The products of the dispersion models are annual average dispersion factors (X/Q', in units of Ci/m^3 per Ci/s or s/m^3) that, when combined with annual average release rates, will predict average radionuclide air concentrations for the year.

(8) A brief description of all construction and modifications which were completed in the calendar year for which the report is prepared, but for which the requirement to apply for approval to construct or modify was waived under 61.96.

RL-91-10, Section 3.5.2, discusses an "Application For Approval of Construction of the In Situ Vitrification Demonstration Project."

(9) Each report shall be signed and dated by a corporate officer or public official in charge of the facility and containing a declaration of belief of accuracy and truth of the report.

RL-91-10, Page 3-13, signed by John D. Wagoner, Manager, RL.

(c) If the facility is not in compliance with the emission limits of 61.96 in the calendar year, reporting the information in (b) [above] must be done on a monthly basis starting immediately following the noncompliance annual report. Monthly reports shall also include:

The Hanford Site is in compliance with 40 CFR 61.96; hence, this section is not applicable.

(1) Controls or other changes installed to bring the facility into compliance.

(2) If the facility is under a judicial or administrative enforcement decree, the report will describe the facility performance under the terms of the decree.

(d) If this information is classified, it will be made available to EPA separately and handled in accordance with regulations.

This information is not classified; hence, this section is not applicable.

61.95 Recordkeeping requirements.

All facilities must maintain records documenting the source of input parameters including the results of all measurements, calculations, analytical methods, and procedure for determining EDE. Sufficient information to allow an independent auditor to verify the accuracy should be kept. The records must be kept at the site for at least five years and must be made available upon request to an authorized representative.

All records and data used in the generation and verification of regulatory reports are controlled in accordance with WHC-CM-4-2, QR 4.0, "Document Control," and QR 17.0, "Quality Assurance Records" (WHC 1992c).

61.96 Applications to construct or modify.

In addition to construction as defined under 40 CFR 61 A, any fabrication, erection or installation of a new building or structure within a facility that emits radionuclides is also defined as new construction for purposes of 40 CFR 61 A.

(b) Application for approval [61.07] or notification of startup [61.09] does not need to be filed for any new construction or modification if the EDE caused by all emissions from the new construction or modification is less than 1% of the standard of 61.92. EDE shall be calculated using the source term derived from Appendix D as input to dispersion described in 61.93. A facility is eligible for this exemption only if it is in compliance based on its last annual report.

(c) Conditions to approvals granted under 61.08 will not contain requirements for post approval reporting on operating conditions beyond those specified in 61.94.

This section is not applicable.

61.97 Exemption from the reporting and testing requirements of 40 CFR 61.10.

All facilities designated under subpart H are exempt from the reporting requirements of 40 CFR 61.10.

This section is not applicable.

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40 CFR 60, APPENDIX A, REFERENCE METHOD 2C, DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOWRATE IN SMALL STACKS OR DUCTS (STANDARD PITOT TUBE)

1.0 Principle and Applicability

1.1 Applicability.

1.1.1 The applicability of this method is identical to Method 2, except this method is limited to stationary source stacks or ducts less than about 0.30 meters (12 in.) in diameter or 0.071 m^2 (113 $in.^2$) in cross-sectional area, but equal to or greater than about 0.10 meter (4 in.) in diameter or 0.0081 m^2 (12.57 $in.^2$) in cross-sectional area.

Response: **This stack has a 10-in. inside diameter and, therefore, fits the applicability criteria of Method 2C.**

1.1.2 The apparatus, calculations, and bibliography are the same as in Method 2, Sections 2, 3, 4, 5, and 6 except as noted in the following sections.

1.2 Principle. The average gas velocity in a stack or duct is determined from the gas density and from measurement of velocity heads with a standard pitot tube.

2.0 Apparatus

2.1 Standard Pitot Tube (instead of Type S). Use a standard pitot tube that meets the specifications of section 2.7 of Method 2. Use a coefficient value of 0.99 unless it is calibrated against another standard pitot tube with a NBS-traceable coefficient.

Response: **A standard pitot tube is used. The standard pitot tube used for velocity traverses meets the criteria of Section 2.7. It is used in conjunction with a digital micromanometer. The internal program of the micromanometer uses unity as the baseline coefficient. This introduces insignificant error in the determination of stack velocity.**

2.2 Alternate Pitot Tube. A modified hemispherical-nosed pitot tube which features a shortened stem and enlarged impact and static pressure holes, may be used. This pitot tube is useful in liquid drop-laden gas streams when a pitot "back purge" is ineffective. Use a coefficient value of 0.99 unless the pitot is calibrated as mentioned in section 2.1 above.

2.0 Procedure

Follow the general procedures in Section 3 of Method 2, except conduct the measurements at transverse points specified in Method 1A. The static and impact pressure holes of a standard pitot tube are susceptible to plugging in PM-laden gas streams. Therefore, the tester must furnish proof that the openings of the pitot tube have not plugged during the transverse period; this proof can be obtained by first recording the velocity head (Δp) reading at the final transverse point, then cleaning out the impact and static holes of the pitot tube by "back-purging" with pressurized air, and finally by recording another Δp reading at the final transverse point. If the Δp reading made after the air purge is within 5% of the reading during the transverse, then the transverse is acceptable. Otherwise, reject the run. Note that if the Δp at the final transverse point is so low as to make this determination too difficult, then another transverse point may be selected. If "back-purging" at regular intervals is part of the procedure, then take comparative Δp readings, as above, for the last two back purges at which suitable high Δp readings are observed.

Response: **"Back-purging" is not accomplished; however, the streams may not be PM laden because of the double HEPA filter system in place before the velocity measurement location.**

Procedure from Section 3 of Method 2

3.1 Set up the apparatus as shown in Figure 2-1. Capillary tubing or surge tanks installed between the manometer and pitot tube may be used to dampen ΔP fluctuations. It is recommended, but not required, that a pretest leak-check be conducted, as follows: (1) blow through the pitot impact opening until at least 7.6 cm (3 in.) H_2O velocity pressure registers on the manometer; then, close off the impact opening. The pressure shall remain stable for at least 15 seconds; (2) do the same for the static pressure side, except using suction to obtain the minimum of 7.6 cm (3 in.) H_2O. Other leak check procedures, subject to the approval of the Administrator, may be used.

Response: **No leak checks are accomplished.**

3.2 Level and zero the manometer. Because the manometer level and zero may drift due to vibrations and temperature changes, make periodic checks during the traverse. Record all necessary data as shown in the example data sheet (Figure 2-5).

3.3 Measure the velocity head and temperature at the traverse points specified by Method 1. Ensure that the proper differential pressure gauge is being used for the range of ΔP values encountered (see Section 2.2). If it is necessary to change to a more sensitive gauge, do so, and remeasure the ΔP and temperature readings at each traverse point. Conduct a post-test leak-check (mandatory), as described in Section 3.1 above, to validate the traverse run.

Response: **No temperature readings are taken.**

3.4 Measure the static pressure in the stack. One reading is usually adequate.

Response: **No static pressure readings are taken.**

3.5 Determine the atmospheric pressure.

Response: **Atmospheric pressure readings are not taken.**

3.6 Determine the stack gas dry molecular weight. For combustion processes or processes that emit essentially CO_2, O_2, CO and N_2, use Method 3. For processes emitting essentially air, an analysis need not be conducted; use a dry molecular weight of 29.0. For other processes, other methods, subject to the approval of the Administrator, must be used.

3.7 Obtain the moisture content from Reference Method 4 (or equivalent) or from Method 5.

Response: **Moisture content readings are not taken.**

3.8 Determine the cross-sectional area of the stack or duct at the sampling location. Whenever possible, physically measure the stack dimensions rather than using blueprints.

Response: **This is accomplished via known diameters. Physical measurements are not possible because of radiation hazards. This stack has a 10-in. inside diameter.**

40 CFR 60, APPENDIX A, REFERENCE METHOD 1, SAMPLE AND VELOCITY TRAVERSES FOR STATIONARY SOURCES

1.0 Principle and Applicability

1.1 Principle. To aid in the representative measurement of pollutant emissions and/or total volumetric flow rate from a stationary source, a measurement site where the effluent stream is flowing in a known direction is selected, and the cross-section of the stack is divided into a number of equal areas. A traverse point is then located within each of these equal areas.

1.2 Applicability. This method is applicable to flowing gas streams in ducts, stacks, and flues. The method cannot be used when: (1) flow is cyclonic or swirling (see Section 2.4); (2) a stack is smaller than about 0.30 meter (12 in.) in diameter, or 0.071 m^2 (113 $in.^2$) cross-sectional area; or (3) the measurement site is less than two stack or duct diameters downstream or less than a half diameter upstream from a flow disturbance.

The requirements of this method must be considered before construction of a new facility from which emissions will be measured; failure to do so may require subsequent alterations to the stack or deviation from the standard procedure. Cases involving variants are subject to approval by the Administrator, U.S. Environmental Protection Agency.

Documentation: **Drawing H-2-90457,** ***Structural Central Exhaust STA SECT and DET*****, Sheet 1 of 4 through 4 of 4 (WHC 1992a).**

Explanatory Remarks: **This stack has a 10-in. (25.4 cm) diameter and is smaller than the 12-in-diameter applicability criteria.**

2.0 Procedure

2.1 Selection of Measurement Site. Sampling or velocity measurement is performed at a site located at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion, or contraction in the stack, or from a visible flame. If necessary, an alternative location may be selected, at a position at least two stack or duct diameters downstream and a half diameter upstream from any flow disturbance. For a rectangular cross section, an equivalent diameter (De) shall be calculated from the following equation to determine the upstream and downstream distances:

$$D_e = \frac{2LW}{L+W}$$

L+W were L = length W = width.

An alternative procedure is available for determining the acceptability of a measurement location not meeting the criteria above. This procedure, determination of gas flow angles at the sampling points and comparing the results with acceptability criteria, is described in Section 2.5.

Documentation: **Drawing H-2-90457,** ***Structural Central Exhaust STA SECT and DET*****, Sheet 1 of 4 through 4 of 4 (WHC 1992a).**

Explanatory Remarks: **This stack has a 10-in. (25.4 cm) -diameter and is smaller than the 12-in-diameter applicability criteria.**

Principle and Applicability of Method 1A

1.1 The applicability and principle of this method are identical to Method 1, except this method's applicability is limited to stacks or ducts less than about 0.30 meters (12 in.)

in diameter or 0.071 m^2 (113 in.2) in cross-sectional area, but equal to or greater than about 0.10 meter (4 in.) in diameter or 0.0081 m^2 (12.57 $in.^2$) in cross-sectional area.

1.2 In these small diameter stacks or ducts, the conventional Method 5 stack assembly (consisting of a Type S pitot tube attached to a sampling probe, equipped with a nozzle and thermocouple) blocks a significant portion of the cross section of the duct and causes inaccurate measurements. Therefore, for particulate matter (PM) sampling in small stacks or ducts, the gas velocity is measured using a standard pitot tube downstream of the actual emission sampling site. The straight run of duct between the PM sampling and velocity measurement site allows the flow profile, temporarily disturbed by the presence of the sampling probe, to redevelop and stabilize.

1.3 The cross-sectional layout and location of transverse points and the verification of absence of cyclonic flow are the same as in Method 1, Section 2.3 and 2.4, respectively. Differences from Method 1, except as noted, are given below.

2.0 Procedure

2.1 Selection of Sampling and Measuring Sites.

2.1.1 PM Measurements. Select a PM sampling site located preferably at least 8 equivalent stack or duct diameters downstream and 10 equivalent diameters upstream from any flow disturbances such as bends, expansion, or contractions in the stack, or from a visible flame. Next locate the velocity site 8 equivalent diameters downstream of the PM sampling site. If such locations are not available, select an alternate PM sampling site that is at least 2 equivalent stack or duct diameters downstream and 2 and 1/2 stack diameters upstream from any flow disturbances. Then, locate the velocity measurement site 2 equivalent stack diameters downstream from the sampling site. Follow Section 2.1 of Method 1 for calculating equivalent diameters for a rectangular cross section.

Response: The 241-A-40 stack measures 10 in. (25.4 cm) in diameter. The sample probe assembly is located 8 ft (2.4 m) above the fan discharge point into the stack and 20 in. (50.8 cm) below the top of the stack. The location chosen for velocity measurements is at the top of the stack which is nearly 10 ft (3.0 m) above the fan discharge into the stack.

To meet the <u>preferential</u> location requirements of Method 1A, the stack would require an unobstructed length equivalent to 18 stack diameters (15 ft). Because this is not possible, the *alternative* locations of Method 1A are addressed. The sampling site should be located at least two equivalent stack or duct diameters downstream and two and one-half stack diameters upstream from any flow disturbances. The velocity measurement device should then be located two equivalent stack diameters downstream from the sampling site. Present locations are presented below:

- Sample probe: Approximately 9.6 stack diameters downstream from nearest flow disturbance (fan discharge point) and two stack diameters upstream from nearest flow disturbance (top of stack).

- Velocity site: Two stack diameters downstream from nearest flow disturbance (sample probe) and 0 stack diameters upstream from nearest flow disturbance (top of stack).

2.2 Determining the Number of Traverse Points.

2.2.1 Particulate traverses. When the eight- and two-diameter criterion can be met, the minimum number of traverse points shall be: (1) twelve, for circular or rectangular stacks with diameters (or equivalent diameters) greater than 0.61 meter (24 in.); (2) eight, for circular stacks with diameters between 0.30 and 0.61 meter (12-24 in.); (3) nine, for rectangular stacks with equivalent diameters between 0.30 and 0.61 meter (12-24 in.).

When the eight- and two-diameter criterion cannot be met, the minimum number of traverse points is determined from Figure 1-1. Before referring to the figure, however, determine the distances from the chosen measurement site to the nearest upstream and downstream disturbances, and divide each distance by the stack diameter or equivalent diameter, to determine the distance in terms of the number of duct diameters. Then, determine from Figure 1-1 the minimum number of traverse points that corresponds: (1) to the number of duct diameters upstream; and (2) to the number of diameters downstream. Select the higher of the two minimum numbers of traverse points, or a greater value, so that for circular stacks the number is a multiple of 4, and for rectangular stacks, the number is one of those shown in Table 1-1.

2.2.2 Velocity (Non-Particulate) Traverses. When velocity or volumetric flow rate is to be determined (but not particulate matter), the same procedure as that for particulate traverses (Section 2.2.1) is followed, except that Figure 1-2 may be used instead of Figure 1-1.

2.3 Cross-sectional Layout and Location of Traverse Points.

2.3.1 Circular Stacks. Locate the traverse points on two perpendicular diameters according to Table 1-2 and the example shown on Figure 1-3. Any equation (for examples, see Citations 2 and 3 in the Bibliography) that gives the same values as those in Table 1-2 may be used in lieu of Table 1-2.

For particulate traverses, one of the diameters must be in a plane containing the greatest expected concentration variation, e.g., after bends, one diameter shall be in the plane of the bend. This requirement becomes less critical as the distance from the disturbance increases; therefore, other diameter locations may be used, subject to approval of the Administrator.

In addition for stacks having diameters greater than 0.61 m (24 in.) no traverse points shall be located within 2.5 centimeters (1.00 in.) of the stack walls; and for stack diameters equal to or less than 0.61 m (24 in.), no traverse points shall be located within 1.3 cm (0.50 in.) of the stack walls. To meet these criteria, observe the procedures given below.

2.3.1.1 Stacks With Diameters Greater Than 0.61 m (24 in.). When any of the traverse points as located in Section 2.3.1 fall within 2.5 cm (1.00 in.) of the stack walls, relocate them away from the stack walls to: (1) a distance of 2.5 cm (1.00 in.); or (2) a distance equal to the nozzle inside diameter, whichever is larger. These relocated traverse points (on each end of a diameter) shall be the "adjusted" traverse points.

Whenever two successive traverse points are combined to form a single adjusted traverse point, treat the adjusted point as two separate traverse points, both in the sampling (or velocity measurement) procedure, and in recording the data.

2.3.1.2 Stacks With Diameters Equal to or Less Than 0.61 m (24 in.). Follow the procedure in Section 2.3.1.1, noting only that any "adjusted" points should be relocated away from the stack walls to: (1) a distance of 1.3 cm (0.50 in.); or (2) a distance equal to the nozzle inside diameter, whichever is larger.

2.3.2 Rectangular Stacks. Determine the number of traverse points as explained in Sections 2.1 and 2.2 of this method. From Table 1-1, determine the grid configuration. Divide the stack cross-section into as many equal rectangular elemental areas as traverse points, and then locate a traverse point at the centroid of each equal area according to the example in Figure 1-4.

If the tester desires to use more than the minimum number of traverse points, expand the "minimum number of traverse points" matrix (see Table 1-1) by adding the extra traverse points along one or the other or both legs of the matrix; the final

matrix need not be balanced. For example, if a 4x3 "minimum number of points" matrix were expanded to 36 points, the final matrix could be 9x4 or 12x3, and would not necessarily have to be 6x6. After constructing the final matrix, divide the stack cross-section into as many equal rectangular, elemental areas as traverse points, and locate a traverse point at the centroid of each equal area.

The situation of traverse points being too close to the stack walls is not expected to arise with rectangular stacks. If this problem should ever arise, the Administrator must be contacted for resolution of the matter.

2.4 Verification of Absence of Cyclonic Flow. In most stationary sources, the direction of stack gas flow is essentially parallel to the stack walls. However, cyclonic flow may exist (1) after such devices as cyclones and inertial demisters following venturi scrubbers, or (2) in stacks having tangential inlets or other duct configurations which tend to induce swirling; in these instances, the presence or absence of cyclonic flow at the sampling location must be determined. The following techniques are acceptable for this determination.

Level and zero the manometer. Connect a Type S pitot tube to the manometer. Position the Type S pitot tube at each traverse point, in succession, so that the planes of the face openings of the pitot tube are perpendicular to the stack cross-sectional plane; when the Type S pitot tube is in this position, it is at "0° reference." Note the differential pressure (ΔP) reading at each traverse point. If a null (zero) pitot reading is obtained at 0° reference at a given traverse point, an acceptable flow condition exists at that point. If the pitot reading is not zero at 0° reference, rotate the pitot tube (up to ± 90° yaw angle), until a null reading is obtained. Carefully determine and record the value of the rotation angle (α) to the nearest degree. After the null technique has been applied at each traverse point, calculate the average of the absolute values of α; assign α values of 0° to those points for which no rotation was required, and include these in the overall average. If the average value of α is greater than 20°, the overall flow condition in the stack is unacceptable and alternative methodology, subject to the approval of the Administrator, must be used to perform accurate sample and velocity traverses.

The alternative procedure described in Section 2.5 may be used to determine the rotation angles in lieu of the procedure described above.

2.5 Alternative Measurement Site Selection Procedure. This alternative applies to sources where measurement locations are less than 2 equivalent stack or duct diameters downstream or less than 1/2 duct diameter upstream from a flow disturbance. The alternative should be limited to ducts larger than 24 in. in diameter where blockage and wall effects are minimal. A directional flow sensing probe is used to measure pitch and yaw angles of the gas flow at 40 or more traverse points; the resultant angle is calculated and compared with acceptable criteria for mean and standard deviation.

NOTE: Both the pitch and yaw angles are measured from a line passing through the traverse point and parallel to the stack axis. The pitch angle is the angle of the gas flow component in the plane that INCLUDES the traverse line and is parallel to the stack axis. The yaw angle is the angle of the gas flow component in the plane PERPENDICULAR to the traverse line at the traverse point and is measured from the line passing through the traverse point and parallel to the stack axis.

2.5.1 Apparatus.

2.5.1.1 Directional Probe. Any directional probe, such as United Sensor Type DA Three-Dimensional Directional Probe, capable of measuring both the pitch and yaw angles of gas flows is acceptable. (NOTE: Mention of trade name or specific products does not constitute endorsement by the U.S. Environmental Protection Agency.) Assign an identification number to the directional probe, and permanently mark or engrave the number on the body of the probe. The pressure holes or directional probes are susceptible to plugging when used in particulate-laden gas streams. Therefore, a system for cleaning the pressure holes by "backpurging" with pressurized air is required.

2.5.1.2 Differential Pressure Gauges. Inclined manometers, U-tube manometers, or other differential pressure gauges (e.g., magnehelic gauges) that meet the specifications described in Method 2, section 2.2.

NOTE: If the differential pressure gauge produces both negative and positive readings, then both negative and positive pressure readings

shall be calibrated at a minimum of three points as specified in Method 2, section 2.2.

2.5.2 Traverse Points. Use a minimum of 40 traverse points for circular ducts and 42 points for rectangular ducts for the gas flow angle determinations. Follow section 2.3 and Table 1-1 or 1-2 for the location and layout of the traverse points. If the measurement location is determined to be acceptable according to the criteria in this alternative procedure, use the same traverse point number and locations for sampling and velocity measurements.

2.5.3 Measurement Procedure.

2.5.3.1 Prepare the directional probe and differential pressure gauges as recommended by the manufacturer. Capillary tubing or surge tanks may be used to dampen pressure fluctuations. It is recommended, but not required, that a pretest leak check be conducted. To perform a leak check, pressurize or use suction on the impact opening until a reading of at least 7.6 cm (3 in.) H_2O registers on the differential pressure gauge, then plug the impact opening. The pressure of a leak-free system will remain stable for at least 15 seconds.

2.5.3.2 Level and zero the manometers. Since the manometer level and zero may drift because of vibrations and temperature changes, periodically check the level and zero during the traverse.

2.5.3.3 Position the probe at the appropriate locations in the gas stream, and rotate until zero deflection is indicated for the yaw angle pressure gauge. Determine and record the yaw angle. Record the pressure gauge readings for the pitch angle, and determine the pitch angle from the calibration curve. Repeat this procedure for each traverse point. Complete a "back-purge" of the pressure lines and the impact openings prior to measurements of each traverse point.

A post-test check as described in section 2.5.3.1 is required. If the criteria for a leak-free system are not met, repair the equipment, and repeat the flow angle measurements.

2.5.4 Calculate the resultant angle at each traverse point, the average resultant angle, and the standard deviation using the following equations. Complete the calculation retaining at least one extra significant figure beyond that of the acquired data. Round the values after the final calculations.

2.5.4.1 Calculate the resultant angle at each traverse point:

2.5.5 The measurement location is acceptable if $R \leq 20°$ and $Sd \leq 10°$.

2.5.6 Calibration. Use a flow system as described in Sections 4.1.2.1 and 4.1.2.2 of Method 2. In addition, the flow system shall have the capacity to generate two test-section velocities: one between 365 and 730 m/min (1200 and 2400 ft/min) and one between 730 and 1100 m/min (2400 and 3610 ft/min).

2.5.6.1 Cut two entry ports in the test section. The axes through the entry ports shall be perpendicular to each other and intersect in the centroid of the test section. The ports should be elongated slots parallel to the axis of the test section and of sufficient length to allow measurement of pitch angles while maintaining the pitot head position at the test-section centroid. To facilitate alignment of the directional probe during calibration, the test section should be constructed of plexiglass or some other transparent material. All calibration measurement should be made at the same point in the test section, preferably at the centroid of the test-section.

2.5.6.2 To ensure that the gas flow is parallel to the central axis of the test section, follow the procedure in Section 2.4 for cyclonic flow determination to measure the gas flow angles at the centroid of the test section from two test ports located 90° apart. The gas flow angle measured in each port must be ± 2° of 0°. Straightening vanes should be installed, if necessary, to meet this criterion.

2.5.6.3 Pitch Angle Calibration. Performs a calibration traverse according to the manufacturer's recommended protocol in 5° increments for angles from -60° to +60° at one velocity in each of the two ranges specified above. Average the pressure ratio values obtained for each angle in the two flow ranges, and plot a calibration curve with the average values of the pressure ratio (or other suitable measurement factor as recommended by the manufacturer) versus the pitch angle. Draw a smooth line through the data points. Plot also the data values for each traverse point. Determine the differences between the measured data values and the angle from the calibration curve at the same pressure ratio. The difference at each comparison must be within 2° for angles between 0° and 40° and within 3° for angles between 40° and 60°.

2.5.6.4 Yaw Angle Calibration. Mark the three-dimensional probe to allow the determination of the yaw position of the probe. This is usually a line extending the length of the probe and aligned with the impact opening. To determine the accuracy of measurements of the yaw angle, only the zero or null position need be calibrated as follows. Place the directional probe in the test section, and rotate the probe until the zero position is found. With a protractor or other angle measuring device, measure the angle indicated by the yaw angle indicator on the three-dimensional probe. This should be within 2° of 0°. Repeat this measurement for any other points along the length of the pitot where yaw angle measurements could be read in order to account for variations in the pitot markings used to indicate pitot head positions.

ANSI N13.1-1969, GUIDE TO SAMPLING AIRBORNE RADIOACTIVE MATERIALS IN NUCLEAR FACILITIES 4.2.1.2

ANSI N13.1-1969, Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities

4.2.1.2 Sampling point should be a minimum of five diameters (or 5 times the major dimension for rectangular ducts) downstream from abrupt changes in flow direction or prominent transitions.

Documentation: Drawing H-2-90457, *Structural Central Exhaust STA SECT and DET*, Sheet 1 of 4 through 4 of 4 (WHC 1992a).

Explanatory Remarks: The sampling probe position does meet the location requirement given in ANSI N13.1-1969, but it does not meet the requirements of Method 1 or Method 1A in 40 CFR 60, Appendix A (ANSI 1969; EPA 1989a).

4.2.2 Samples should be representative with respect to physical and chemical composition of airstream.

Documentation: None.

Explanatory Remarks: Particle size studies are currently under way. This study is under the direction of the Environmental Protection group.

4.3.1 Sensitivity and accuracy of the analytical or counting method will determine the minimum volume of air which must be sampled to obtain the requisite accuracy and precision of results.

4.3.2 If possible, the sample should be large enough to permit 1/10 the permissible level to be determined with reliability.

Documentation: Health Physics (HP), Sections 5.2.2.4 and 5.2.2.7, of WHC-EP-0692 (WHC 1991b).

Explanatory Remarks: The frequency of the record sample filter and silver zeolite cartridge exchange is based on loading. If at all possible, record air samples are left running for a full 168-hour (7-day) week, to ensure a representative sample. The silver zeolite cartridges are exchanged as follows:

- When the cartridges have been in the sample for 1 week.
- When radiation readings indicate a buildup of greater than 16 mR/hour within the last 8 hours.
- When requested by operations management.

5.2.2 Airborne particulate matter should be evaluated and characterized at regular intervals and before any anticipated process change.

See response under ANSI N13.1-1969, Section 4.2.2.

5.2.2.1 Appropriate filtration should be chosen for sampling.

Documentation: **Gelman (1991); Section 5.2.2.7 of WHC-IP-0692 (WHC 1991b).**

Explanatory Remarks: **47-mm Versapor 3000 or equivalent air sample filter is used for the record sampler. This filter is a membrane filter good for collecting 0.3-μm size particles with a collection efficiency of 95.8%.**

5.2.2.1.7 Filter holders and support should be chosen for proper chemical compatibility, mechanical strength, sealing, and ease of operation in changing filters. Sample air movers should have the capability of delivering the necessary air flow against the resistance of the sampling system.

Proper location and choice of flow measurement device and flow rate control is important.

Documentation: **Cammann and Geier (1980); Cammann (1984); Section 5.2.2.7 of WHC-IP-0692 (WHC 1991b); and Drawings H-2-92486,** *Generic Stack Sampler/Monitor Flow Diagram*; **H-2-92487,** *Generic Stack Sampler/Monitor Monitor Assemblies*; **H-2-92488,** *Generic Stack Sampler/Monitor Modified Monitor Assy.*; **H-2-92489,** *Generic Stack Sampler/Monitor Record Sample Loop Assembly*; **H-2-92490,** *Generic Stack Sampler/Monitor Sample Extraction Assembly*; **H-2-92491, Sheets 1 and 2 of 2,** *Generic Stack Sampler/Monitor System Alarm Elementary*; **H-2-92492, Sheets 1 and 2 of 2,** *Generic Stack Sampler/Monitor Local Alarm Box Assembly*; **H-2-92493,** *Generic Stack Sampler/Monitor Local Alarm Box Wiring Diagram*; **H-2-92494, Sheets 1 and 2 of 2,** *Generic Stack Sampler/Monitor Connection Box Assembly*; **H-2-92495, Sheets 1 and 2 of 2,** *Generic Stack Sampler/Monitor Connection Box Wiring Diagram*; **H-2-92496,** *Generic Stack Sampler/Monitor Shorting Plug Assembly*; **H-2-92497, Sheets 1 and 2 of 2,** *Generic Stack Sampler/Monitor Basic Cabinet Assembly*; **H-2-92498, Sheets 1 and 2 of 2,** *Generic Stack Sampler/Monitor Basic Rack Assembly*; **H-2-92499,** *Generic Stack Alpha, Beta, Record, Cabinet Assembly*; **H-2-92500,** *Generic Stack Alpha, Beta, Record, Rack Assembly*; **H-2-92501,** *Generic Stack Beta, Record, Cabinet Assembly*; **H-2-92502,** *Generic Stack Beta, Record, Rack Assembly*; **H-2-92503,** *Sample Flow Splitter Assembly*; **and H-2-92504,** *Sample Flow Splitter Details* **(WHC 1992a).**

Explanatory Remarks: The Record Sample Holder is described as follows:

- Large outside diameter with knurled outer ring for ease of opening.
- Rubber "O" ring gaskets used to seal the sample holder.
- Fine mesh screen behind the sample filter to keep the sample a constant distance from the inlet.
- Sample vacuum side is connected by a flexible line for ease of access.

The record sample vacuum system consists of the following components:

- Rotameter (FI): Reads out in std ft^3/min or ft^3/min of air flow through the sample paper. Certified accurate to ±10% @ 2.2 std ft^3/min. Operating range: 0.0 to 3.0 std ft^3/min ±5%
- Gas Meter Totalizer (FIQ): Industry standard gas meter. Reads out in m^3. Measures the total volume of air pulled through the sample filter. Certified accurate to ±5% @ 2.2 std ft^3/min.
- Flow Alarm Switch (FAS): Trips an alarm at the loss of flow (@ 1.25 ft^3/min) due to vacuum pump failure and/or sample filter clogging. Accurate to within ±10%.
- Vacuum Line to the Vacuum Pump (Tygon): Equipped with a standard quick-disconnect for connection to alternate pumps and for sample filter retrieval.
- Stack Flow Switch: Controls a "switched" power outlet providing power to the record sample vacuum pump. Automatically shuts down the record sample vacuum when the stack fans cease operation.
- Record Sample Timer: Provides integrated timing of power supplied to the "switched" power outlet. Resettable five-digit to 99999. Normally reset to zero when the record sample is exchanged. Certified accurate to ±1%.

5.3 Airborne radioactive gases or volatile materials should be sampled by an appropriate method if present.

Documentation: Section 5.2.2.4 of WHC-IP-0692 (WHC 1991b).

Explanatory Remarks: Silver zeolite cartridges are used and are designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru. The Hanford Site uses two manufacturers at this time:

SAIC/RADECO
10373 Roselle Street
San Diego, Ca 92121

or

HI-Q Environmental Products Co
PO Box 2847
LaJolla, Ca 92038-2847

The gross filter efficiency of a silver zeolite is based upon the particular absorbed/adsorbed radionuclide being evaluated and the porosity of the filter. For uses at Hanford (e.g., ruthenium, iodine) the efficiency is 99.2 to 99.98 (taken from Table O-2 of Air Sampling Instruments [ACGIH 1989]).

A1. Minimization of the length and bends of sample delivery lines will contribute to representative sampling.

Documentation: Cammann and Geier (1980); Cammann (1984); Drawing H-2-90509, Sheets 2 and 3 of 5, *Instm Exhaust Unit Encl Exhaust Stack* (WHC 1992a).

Explanatory Remarks: The drawing specifies that the sample tubing is 0.75 in. outer diameter (OD) x 0.065 (1.9 cm x 1.65 mm) wall and made of 300 series stainless steel tubing. Also specified is that the bend radius shall not be less than 10 in. (25.4 cm). The sample tubing length between the stack and the cabinet is minimized as much as is physically practical.

A2. Selection of sampling position along a stack.

See response under ANSI N13.1-1969, Section 4.2.1.2 (ANSI 1969).

A3.1 Velocity and flow distribution should be known for the sampling point, and particle and gaseous composition should be representative.

Documentation: Procedure 7-GN-56 (WHC 1991a).

Explanatory Remarks: Particle size studies are explained in the response under ANSI N13.1-1969, Section 4.2.2. Velocity measurements are accomplished by Procedure 7-GN-56, *Airflow Capacity and Distribution Tests*. Comparison of these measurements to Table A1 in the Standard show that the flow is turbulent. The ANSI Standard states in section A3.3.2 that "as the flow becomes more turbulent, the velocity becomes more nearly uniform across the duct." The closest flow disturbances are described under Method 1A above.

A3.2 A multiple number of withdrawal points each representing approximately equal areas based on the duct or stack dimensions is desirable.

Documentation: Procedure 7-GN-56 (WHC 1991a) and Drawing H-2-91245, *K1 Primary Tank 10 in. Exhaust Stack Probe Assembly* (WHC 1992a).

Does System Meet the Guidance? Yes.

Explanatory Remarks: This drawing shows the probe with two nozzles. This is as recommended in this section of the ANSI Standard for this size stack (10 in.). Although the inner probe (center of stack) represents approximately 70% of the stack cross-sectional area sampled and the outer probe represents approximately 30% of the area, it is easily shown (from Table A1, ANSI N13.1-1969, and from stack flowrate data) that the flow within the stack is highly turbulent resulting in a uniform velocity distribution across the cross-sectional area of the stack.

A3.3 The velocity distribution across the duct or stack should be known in order to establish isokinetic flow and representative sample points.

Documentation: Procedure 7-GN-56 (WHC 1991a).

Does System Meet the Guidance? Yes.

Explanatory Remarks: The velocity distribution is not known. However, it is known that the stack flow is turbulent. As stated in the ANSI Standard, Section A3.3.2, "as the flow becomes more turbulent, the velocity becomes more nearly uniform across the duct." Based on this assumption, it can be shown with a reasonable degree of accuracy whether the sampling and monitoring probes are isokinetic or not.

A3.4 Sampling probe configuration is recommended by figures in this standard, with minimum radius bends and precisely tapered probe end edges.

Documentation: Drawing H-2-91245, *K1 Primary Tank 10 in. Exhaust Stack Probe Assembly* (WHC 1992a).

Explanatory Remarks: The specifications listed on this drawing show that these requirements are met.

B1. Sampling line length should be kept to a minimum length. An estimate of the fraction of particles deposited in sampling lines under various conditions should be made using the experimental data presented in this appendix.

Documentation: Drawing H-2-90509, Sheets 2 and 3 of 5, *Instm Exhaust Unit Encl Exhaust Stack* (WHC 1992a).

Explanatory Remarks: The estimate has not been accomplished. See explanation under ANSI N13.1-1969, Section 4.2.2 above. Particle size and density are not known. However an estimate may be made by using Table B3 in the ANSI Standard together with the following facts and assumptions:

- The sampling line is 1.6 cm in diameter.
- The sampling line length is less than 500 cm.
- The HEPA filters remove all particles greater in size than 0.3 μm.

The resulting fraction of particles lost in the sampling line as determined from this table is 0.00 to 0.01.

Velocities must be kept high enough to avoid appreciable losses by Brownian diffusion.

Documentation: Procedure 7-GN-56 (WHC 1991a).

Does System Meet the Requirement? Yes.

Explanatory Remarks: The flow velocity is very high and the flow is turbulent and as explained in the ANSI Standard, Section B1, "The principle mechanism by which particles are deposited are ..., Brownian diffusion when the flow is laminar, and by turbulent deposition when the flow is turbulent."

Elbows in sampling lines should be avoided if at all possible. When required, the bend radius of the elbow should be as long as practical, and design flow rates through any line containing an elbow should be kept low. When possible, the sampler installation should allow for probe removal in order to evaluate the losses in the probe entry elbow and to permit cleaning.

Documentation: Drawing H-2-90509, Sheets 2 and 3 of 5, *Instm Exhaust Unit Encl Exhaust Stack* (WHC 1992a).

Explanatory Remarks: The probes are not removed for cleaning at the present time. The flowrate is high, the flow is turbulent, and there are elbows in the sampling lines. The bend radii of the elbows are kept as long as is practical.

METHOD 114 COMPARISON FOR STACK 296-A-40

1.0 Purpose and Background

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

2.0 Stack Monitoring and Sample Collection Methods

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

See response under ANSI N13.1-1969, Section 5.2.2.1, above.

2.2 Radionuclides as Gases.

Documentation: **Section 5.2.2.4 of WHC-IP-0692 (WHC 1991b).**

Explanatory Remarks: **Silver zeolite cartridges are used and are designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru.**

2.3 Definition of Terms

No response required.

3.0 Radionuclide Analysis Methods

A series of methods based on "principles of measurement" are described which are applicable to the analysis of radionuclides collected from airborne effluent streams at stationary sources. These methods are applicable only under the conditions stated and within the limitations described. Some methods specify that only a single radionuclide be present in the sample or the chemically separated sample. This condition should be interpreted to mean that no other radionuclides are present in quantities which would interfere with the measurement.

Also identified (Table 1) are methods for a selected list of radionuclides. The listed radionuclides are those which are most commonly used and which have the greatest potential for causing dose to members of the public. Use of methods based on principles of measurement other than those described in this section must be approved in advance of use by the Administrator. For radionuclides not listed in Table 1, any of the described methods may be used provided the user can demonstrate that the applicability conditions of the method have been met.

The type of method applicable to the analysis of a radionuclide is dependent upon the type of radiation emitted, i.e., alpha, beta or gamma. Therefore, the methods described below are grouped according to principles of measurements for the analysis of alpha, beta and gamma emitting radionuclides.

The analysis methods have been evaluated by 222-S Laboratory cognizant personnel and are included in Section 3.0 of WHC-EP-0536 (WHC 1991c).

3.1 Methods for Alpha Emitting Radionuclides

3.1.1 Method A-1, Radiochemistry-Alpha Spectrometry.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemical techniques. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a very thin film by electrodeposition or by coprecipitation on a very small amount of carrier, such as lanthanum fluoride. The deposited element is then counted with an alpha spectrometer. The activity of the nuclide of interest is measured by the number of alpha counts in the appropriate energy region. A correction for chemical yield and counting efficiency is made using a standardized radioactive nuclide (tracer) of the same element. If a radioactive tracer is not available for the element of interest, a predetermined chemical yield factor may be used.

Applicability: This method is applicable for determining the activity of any alpha-emitting radionuclide, regardless of what other radionuclides are present in the sample provided the chemical separation step produces a very thin sample and removes all other radionuclides which could interfere in the spectral region of interest. APHA-605(2), ASTM-D-3972(13).

Response: **Our method involves dissolution (LA-549-112), chemical separation (LA-943-123), electrodeposition (LA-542-101), followed by alpha spectrometry (LA-508-051) (WHC 1992d). It meets all the requirements of the EPA-suggested method. This is used for analyzing ^{241}Am, ^{238}Pu, and ^{239,240}Pu in the air filter samples. The activities of these radionuclides are determined by direct comparison with the recoveries of (National Institute of Standards and Technology ([NIST] traceable) ^{243}Am and ^{236}Pu tracers.**

3.1.2 Method A-2, Radiochemistry-Alpha Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemistry. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a thin film and counted with a alpha counter. A correction for chemical yield (if necessary) is made. The alpha count rate measures the total activity of all emitting radionuclides of the separated element.

Applicability: This method is applicable for the measurement of any alpha-emitting radionuclide, provided no other alpha emitting radionuclide is present in the separated sample. It may also be applicable for determining compliance, when other radionuclides of the separated element are present, provided that the calculated emission rate is assigned to the radionuclide which could be present in the sample that has the highest dose conversion factor. IDO-12096(18).

Response: **Because the tracer technique is used in the separation process, this method is not used for air filter analysis.**

3.1.3 Method A-3, Direct Alpha Spectrometry.

Principle: The sample, collected on a suitable filter, is counted directly on an alpha spectrometer. The sample must be thin enough and collected on the surface of the filter so that any absorption of alpha particle energy in the sample or the filter, which would degrade the spectrum, is minimal.

Applicability: This method is applicable to simple mixtures of alpha emitting radionuclides and only when the amount of particulates collected on the filter paper are relatively small and the alpha spectra is adequately resolved. Resolutions should be 50 keV (FWHM) or better, ASTM-D-3084(16).

Response: **Our method follows the procedure LO-150-133, then LA-508-110 for total alpha counts, and finally LA-508-051 for alpha spectrometry (WHC 1992d). It partially meets the requirements of the EPA method. This method is usually used for emergency air samples. The sample is counted on the alpha counter of known efficiency to obtain the total alpha counts. In the alpha energy analysis (AEA), the relative peak fractions of different alpha emitters identified in the sample are determined. The peak fractions are then used to correct the total alpha counts and thus determine the activities of individual alpha radionuclides present in the sample.**

3.1.4 Method A-4, Direct Alpha Counting (Gross alpha determination).

Principle: The sample, collected on a suitable filter, is counted with an alpha counter. The sample must be thin enough so that self-absorption is not significant and the filter must be of such a nature that the particles are retained on the surface.

Applicability: Gross alpha determination may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, or the identity and isotopic ratio of the radionuclides in the sample are well known, and (2) measurements using either Method A-1, A-2 or A-5 have shown that this method provides a reasonably accurate measurement of the emission rate. Gross alpha measurements are applicable to unidentified mixtures of radionuclides only for the purposes and under the conditions described in section 3.7. APHA-601(3), ASTM-D-1943(10).

Response: **Our method follows the procedure LA-508-110 or LA-508-114 (WHC 1992d). It meets all of the requirements stated in the EPA-suggested method.**

3.1.5 Method A-5, Chemical Determination of Uranium.

Uranium: Uranium may be measured chemically by either colorimetry or fluorometry. In both procedures, the sample is dissolved, the uranium is oxidized to the hexavalent form and extracted into a suitable solvent. Impurities are removed from the solvent layer. For colorimetry, dibenzoylmethane is added, and the uranium is measured by the absorbance in a colorimeter. For fluorometry, a portion of the solution is fused with a sodium fluoride-lithium fluoride flux and the uranium is determined by the ultraviolet activated fluorescence of the fused disk in a fluorometer.

Applicability: This method is applicable to the measurements of emission rates of uranium when the isotopic ratio of the uranium radionuclides is well known. ASTM-E318(15), ASTM-D-2907(14).

Response: **Total uranium is determined by procedure LA-925-107 (WHC 1992d). The laser-induced kinetic phosphorescence analyzer is an improvement over the old fluorometric method for uranium determination. It is highly sensitive (lower detection level of 50 ppt is quite**

possible) because the laser frequency is used specifically for excitation of uranium atoms. It is faster and produces quality numbers. Quality can also be monitored during analysis. It exceeds the requirements mentioned in the EPA method.

3.1.6 Method A-6, Radon-222-Continuous Gas Monitor.

Principle: Radon-222 is measured directly in a continuously extracted sample stream by passing the air stream through a calibrated scintillation cell. Prior to the scintillation cell, the air stream is treated to remove particulates and excess moisture. The alpha particles from radon-222 and its decay products strike a zinc sulfide coating on the inside of the scintillation cell producing light pulses. The light pulses are detected by a photomultiplier tube which generates electrical pulses. These pulses are processed by the system electronics and the read out is in pCi/l of radon-222.

Applicability: This method is applicable to the measurement of radon-222 in effluent streams which do not contain significant quantities of radon-220. Users of this method should calibrate the monitor in a radon calibration chamber at least twice per year. The background of the monitor should also be checked periodically by operating the instrument in a low radon environment. EPA 520/1-89-009(24).

Response: **Not applicable at the 222-S Laboratory.**

3.1.7 Method A-7, Radon-222-Alpha Track Detectors

Principle: Radon-222 is measured directly in the effluent stream using alpha track detectors (ATD). The alpha particles emitted by radon-222 and its decay products strike a small plastic strip and produce submicron damage tracks. The plastic strip is placed in a caustic solution that accentuates the damage tracks which are counted using a microscope or automatic counting system. The number of tracks per unit area is corrected to the radon concentration in air using a conversion factor derived from data generated in a radon calibration facility.

Applicability: Prior approval from EPA is required for use of this method. This method is only applicable to effluent streams which do not contain significant quantities of radon-220, unless special detectors are used to discriminate against radon 220. This method may be used only when ATDs have been demonstrated to produce data comparable to data obtained with Method A-6. Such data should be submitted to EPA when requesting approval for the use of this method. EPA 520/1-89-009(24).

Response: **Not applicable; direct monitoring of ^{222}Rn is not performed at the 222-S Laboratory.**

3.2 Methods for Gaseous Beta Emitting Radionuclides.

3.2.1 Method B-1, Direct Counting in Flow-Through Ionization Chambers.

Principle: An ionization chamber containing a specific volume of gas which flows at a given flow rate through the chamber is used. The sample (effluent stream sample) acts as the counting gas for the chamber. The activity of the radionuclide is determined from the current measured in the ionization chamber.

Applicability: This method is applicable for measuring the activity of a gaseous beta emitting radionuclide in an effluent stream that is suitable as a counting gas, when no other beta-emitting nuclides are present. DOE/EP-0096(17), NCRP-58(23).

Response: **Not applicable; not performed.**

3.2.2 Method B-2, Direct Counting With In-line or Off-line Beta Detectors.

Principle: The beta detector is placed directly in the effluent stream (in-line) or an extracted sample of the effluent stream is passed through a chamber containing a beta detector (off-line). The activities of the radionuclides present in the effluent stream are determined from the beta count rate, and a knowledge of the radionuclides present and the relationship of the gross beta count rate and the specific radionuclide concentration.

Applicability: This method is applicable only to radionuclides with maximum beta particle energies greater then 0.2 MeV. This method may be used to measure emissions of specific radionuclides only when it is known that the sample contains only a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent stream are well known. Specific radionuclide analysis of periodic grab samples may be used to identify the types and quantities of radionuclides present and to establish the relationship between specific radionuclide analyses and gross beta count rates.

This method is applicable to unidentified mixtures of gaseous radionuclides only for the purposes and under the conditions described in section 3.7.

Response: **Not applicable; not performed.**

3.3 Methods for Non-Gaseous Beta Emitting Radionuclides.

3.3.1 Method B-3, Radiochemistry-Beta Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix by radiochemistry. This may involve precipitation, distillation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet, and counted with a beta counter. Corrections for chemical yield and decay (if necessary) are made. The beta count rate determines the total activity of all radionuclides of the separated element. This method may also involve the radiochemical separation and counting of a daughter element, after a suitable period of ingrowth, in which case it is specific for the parent nuclide.

Applicability: This method is applicable for measuring the activity of any beta-emitting radionuclide, with a maximum energy greater than 0.2 MeV, provided no other radionuclide is present in the separated sample. APHA-608(5).

Response: **Our method for determining ^{89}Sr, $^{90}Sr/^{90}Y$ in air filter samples is carried out using procedures LA-549-112 (dissolution) and LA-220-103 (for chemical separation), followed by procedure LA-508-111 (total beta counting) (WHC 1992d). The laboratory method certainly meets the requirements stated above.**

3.3.2 Method B-4, Direct Beta Counting (Gross beta determination).

Principle: The sample, collected on a suitable filter, is counted with a beta counter. The sample must be thin enough so that self-absorption corrections can be made.

Applicability: Gross beta measurements are applicable only to radionuclides with maximum beta particle energies greater than 0.2 MeV. Gross beta measurements may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, and (2) measurements made using Method B-3 show reasonable agreement with the gross beta measurement. Gross beta measurements are applicable to mixtures of radionuclides only for the purposes and under the conditions described in section 3.7. APHA-602(4), ASTM-D-1890(11).

Response: **For gross beta determination, procedure LA-508-110 or LA-508-114 is followed. It satisfies the method requirements.**

3.3.3 Method B-5, Liquid Scintillation Spectrometry.

Principle: An aliquot of a collected sample or the result of some other chemical separation or processing technique is added to a liquid scintillation "cocktail" which is viewed by photomultiplier tubes in a liquid scintillation spectrometer. The spectrometer is adjusted to establish a channel or "window" for the pulse energy appropriate to the nuclide of interest. The activity of the nuclide of interest is measured by the counting rate in the appropriate energy channel. Corrections are made for chemical yield where separations are made.

Applicability: This method is applicable to any beta-emitting nuclide when no other radionuclide is present in the sample or the separated sample provided that it can be incorporated in the scintillation cocktail. This method is also applicable for samples which contain more than one radionuclide but only when the energies of the beta particles are sufficiently separated so that they can be resolved by the spectrometer. This method is most applicable to the measurement of low-energy beta emitters such as tritium and carbon-14. APHA.609(6), EML LV-539-17(19).

Response: **It is used for determining ^{147}Pm in air filter samples (LA-549-112 for dissolution, LA-613-111 for chemical separation, LA-548-111 for incorporating into scintillation cocktail, and LA-508-121 for liquid scintillation counting). This is also used for determination of ^{14}C (LA-348-101, LA-548-111, and LA-508-121, sequentially) and ^{3}H (LA-218-112, LA-548-111, and LA-508-121, sequentially) in gas samples. This method satisfies all of the requirements (WHC 1992d).**

3.4 Gamma Emitting Radionuclides

3.4.1 Method G-1. High Resolution Gamma Spectrometry.

Principle: The sample is counted with a high resolution gamma detector, usually either a Ge(Li) or a high purity Ge detector, connected to a multichannel analyzer or computer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclide. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radio-chemical separations may be made prior to counting but are usually not necessary.

Applicability: This method is applicable to the measurement of any gamma emitting radionuclide with gamma energies greater than 20 keV. It can be applied to complex mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gases. The method may also be applied to the analysis of gaseous gamma emitting radionuclides directly in an effluent stream by passing the stream through a chamber or cell containing the detector. ASTM-3649(9), IDO-12096(18).

Response: **Our method uses gamma ray spectroscopy with high-resolution germanium detectors and follows procedure LA-508-052 (WHC 1992d). It meets all the requirements explained in the EPA method.**

3.4.2 Method G-2, Low Resolution Gamma Spectrometry.

Principle: The sample is counted with a low resolution gamma detector, a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube and connected to a multichannel analyzer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclides. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest.. Radiochemical separation may be used prior to counting to obtain less complex gamma spectra if needed.

Applicability: This method is applicable to the measurement of gamma emitting radionuclides with energies greater than 100 keV. It can be applied only to relatively simple mixtures of gamma emitting radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector. ASTM-D-2459(12), EMSL-LV-0539-17(19).

Response: **Not applicable because this method is not used in air filter analysis.**

3.4.3 Method G-3, Single Channel Gamma Spectrometry.

Principle: The sample is counted with a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube connected to a single channel analyzer. The activity of a gamma emitting radionuclide is determined from the gamma counts in the energy range for which the counter is set.

Applicability: This method is applicable to the measurement of a single gamma emitting radionuclide. It is not applicable to mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector.

Response: **Not applicable because this technique is not used in air filter analysis.**

3.4.4 Method G-4, Gross Gamma Counting.

Principle: The sample is counted with a gamma detector usually a thallium activated sodium iodine crystal. The detector is coupled to a photomultiplier tube and gamma rays above a specific threshold energy level are counted.

Applicability: Gross gamma measurements may be used to measure emissions of specific radionuclides only when it is known that the sample contains a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent stream are well known. When gross gamma measurements are used to determine emissions of specific radionuclides periodic measurements using Methods G-1 or G-2 should be made to demonstrate that the gross gamma measurements provide reliable emission data. This method may be applied to analysis of gaseous radionuclides directly in an effluent stream by placing the detector directly in or adjacent to the effluent stream or passing an extracted sample of the effluent stream through a chamber or cell containing the detector.

Response: **Not applicable.**

3.5 Counting Methods. All of the methods with the exception of Method A-5 involve counting the radiation emitted by the radionuclide. Counting methods applicable to the measurement of alpha, beta and gamma radiations are listed below. The equipment needed and the counting principles involved are described in detail in ASTM-3648(8).

3.5.1 Alpha Counting:

- Gas Flow Proportional Counters. The alpha particles cause ionization in the counting gas and the resulting electrical pulses are counted. These counters may be windowless or have very thin windows.

- Scintillation Counters. The alpha particles transfer energy to a scintillator resulting in a production of light photons which strike a photomultiplier tube converting the light photons to electrical pulses which are counted. The counters may involve the use of solid scintillation materials such as zinc sulfide or liquid scintillation solutions.

- Solid-State Counters. Semiconductor materials, such as silicon surface-barrier p-n junctions, act as solid ionization chambers. The

alpha particles interact which the detector producing electron hole pairs. The charged pair is collected by an applied electrical field and the resulting electrical pulses are counted.

- Alpha Spectrometers. Semiconductor detectors used in conjunction with multichannel analyzers for energy discrimination.

Response: **Alpha proportional counters (home-built chambers with EG&G ORTEC electronics), window-type gas flow proportional counters (some having automatic sample changer), surface-barrier solid-state detectors connected to a multichannel analyzer (Series 85, Jupiter system manufactured by Canberra Industries, Inc.) are used for air filter analysis in 222-S Laboratory. Laboratory equipment meets the EPA specifications.**

3.5.2 Beta Counting:

- Ionization Chambers. These chambers contain the beta-emitting nuclide in gaseous form. The ionization current produced is measured.

- Geiger-Muller (GM) Counters-or Gas Flow Proportional Counters. The beta particles cause ionization in the counting gas and the resulting electrical pulses are counted. Proportional gas flow counters which are heavily shielded by lead or other metal, and provided with an anti-coincidence shield to reject cosmic rays, are called low background beta counters.

- Counters. The beta particles transfer energy to a scintillator resulting in a production of light photons, which strike a photomultiplier tube converting the light photon to electrical pulses which are counted. This may involve the use of anthracene crystals, plastic scintillator, or liquid scintillation solutions with organic phosphors.

- Liquid Scintillation Spectrometers. Liquid scintillation counters which use two photomultiplier tubes in coincidence to reduce background counts. This counter may also electronically discriminate among pulses of a given range of energy.

Response: **Window-type gas flow proportional counter (some having an automatic sample changer) liquid scintillation spectrometers manufactured by Beckman Instruments, Inc., are used for analysis. Our counting equipment meets the requirements.**

3.5.3 Gamma Counting:

- Low-Resolution Gamma Spectrometers. The gamma rays interact with thallium activated sodium iodide or cesium iodide crystal resulting in the release of light photons which strike a photomultiplier tube converting the light pulses to electrical pulses proportional to the energy of the gamma ray. Multi-channel analyzers are used to separate and store the pulses according to the energy absorbed in the crystal.

- High-Resolution gamma Spectrometers. Gamma rays interact with a lithium-drifted (Ge(Li)) or high-purity germanium (HPGe) semiconductor detectors resulting in a production of electron-hole pairs. The charged pair is collected by an applied electrical field. A very stable low noise preamplifier amplifies the pulses of electrical charge resulting from the gamma photon interactions. Multichannel analyzers or computers are used to separate and store the pulses according to the energy absorbed in the crystal.

- Single Channel Analyzers. Thallium activated sodium iodide crystals used with a single window analyzer. Pulses from the photomultiplier tubes are separated in a single predetermined energy range.

Response: High-resolution gamma detectors (high-purity Ge detectors for both low and high energies) from EG&G ORTEC and Princeton Gamma Tech, well-type pure Ge detectors connected to MCA (Canberra's Jupiter system) are available and used for air filter analysis. Our equipment exceeds the EPA requirements.

3.5.4 Calibration of Counters. Counters are calibrated for specific radionuclide measurements using a standard of the radionuclide under either identical or very similar conditions as the sample to be counted. For gamma spectrometers a series of standards covering the energy range of interest may be used to construct a calibration curve relating gamma energy to counting efficiency.

In those cases where a standard is not available for a radionuclide, counters may be calibrated using a standard with energy characteristics as similar as possible to the radionuclide to be measured. For gross alpha and beta measurements of the unidentified mixtures of radionuclides, alpha counters are calibrated with a natural uranium standard and beta counters with a cesium-137 standard. The standard must contain the same weight and distribution of solids as the samples, and be mounted in an identical manner. If the samples contain variable amounts of solids, calibration curves relating weight of solids present to counting efficiency are prepared. Standards other than those prescribed may be used provided it can be shown that such standards are more applicable to the radionuclide mixture measured.

Response: A mixed-gamma standard (NIST traceable) emitting various gamma-rays ranging from 59 to 1850 keV is used, using vendor-supplied calibration software, for constructing efficiency-versus-energy calibration curves for different geometrical configurations used in gamma analysis. The calibration procedure for gamma ray spectrometer is documented in LQ-508-003. Our calibration procedure meets the EPA criteria for gamma ray spectroscopic analysis.

For calibration of beta detectors for $^{90}Sr/^{90}Y$ analysis, procedure LQ-508-002 is used in conjunction with LQ-508-005. It meets the requirements of the EPA-suggested method. A method standard also is used to check the performance and calibration of the detector.

For calibration of alpha/beta proportional counters, the procedure LQ-508-002 is carried out (WHC 1992d). It partially deviates from the EPA requirements. For gross alpha and gross beta measurements, our instruments are calibrated with ^{241}Am and ^{60}Co standards, respectively. The reasons for choosing the ^{241}Am standard for alpha calibration are as follows:

- It is commonly found in the main stack air samples.
- Alpha counting efficiency usually is the same for other alpha emitters that also are found in the air stack samples
- The ^{241}Am standard also can be checked independently by gamma analysis.

The reason for using the ^{60}Co standard for beta calibration is the lower counting efficiency with ^{60}Co (beta max =

317 keV) compared to those with ^{137}Cs (beta max = 511 keV) and ^{90}Sr (beta max = 546 keV). Consequently, it will generate conservative numbers in our analysis.

The calibration curves relating weight of solids present to counting efficiencies are not done in alpha/beta analysis, but currently are being evaluated.

3.6 Radiochemical Methods for Selected Radionuclides. Methods for a selected list of radionuclides are listed in Table 1. The radionuclides listed are those which are most commonly used and which hove the greatest potential for causing doses to members of the public. For radionuclides not listed in Table 1, methods based on any of the applicable "principles of measurement" described in section 3.1 through 3.4 may be used.

Response: The air samples from the main stacks are well characterized. Some of the radionuclides identified (^{241}Am, ^{238}Pu, $^{239,240}Pu$, ^{90}Sr, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{14}C, ^{3}H, and ^{131}I) are listed in Table 1 of Method 114 (EPA 1991) and are analyzed according to the approved methods given in the table. Other radionuclides (^{95}Nb, ^{95}Zr, ^{129}I, $^{106}Rh/^{106}Ru$, ^{113}Sn, ^{125}Sb, and ^{103}Ru) not listed in the table are analyzed by the methods outlined in Method 114, depending on the type of emitted radiations. It is important to note here that the radionuclides ^{95}Zr, ^{95}Nb, and ^{103}Ru have nearly decayed to nondetectable levels because no product is being produced.

3.7 Applicability of Gross Alpha and Beta Measurements to Unidentified Mixtures of Radionuclides. Gross alpha and beta measurements may be used as a screening measurement as a part of an emission measurement program to identify the need to do specific radionuclide analyses or to confirm or verify that unexpected radionuclides are not being released in significant quantities.

Gross alpha (Method A-4) or gross beta (Methods B-2 or B-4) measurements may also be used for the purpose of comparing the measured concentrations in the effluent stream with the limiting "Concentration Levels for Environmental Compliance" in Table 2 of Appendix E. For unidentified mixtures, the measured concentration value shall be compared with the lowest environmental concentration limit for any radionuclide which is not known to be absent from the effluent stream.

Response: This is not applicable because the air effluents from the Hanford Site main stacks are well characterized. However, gross alpha and beta analyses for weekly and daily air samples are routinely performed in the 222-S Laboratory before starting specific radionuclide analyses. Following this practice, the facility can verify a significant release of a radionuclide into the air so corrective actions to minimize radionuclide emission into the environment can be taken promptly by facility personnel. The gross alpha and beta results from analysis are compared to those listed in the appendix of DOE Order 5400.5 (DOE 1990) for compliance.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

For the organizational structure, refer to Section 6.2 of WHC-EP-0536 (WHC 1991c).

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

WHC-CM-4-12, Section 1.14, REV 0, "Alarm Response and Management" (WHC 1992c). Provides guidance and sets requirements for managing the responses to alarms that are the responsibility of Occupational Health and Safety (OHS). This practice is applicable to all members of the OHS organization. Area OHS managers shall ensure that all members of their organizations are aware of and adhere to this practice.

WHC-CM-4-12, Section 2.1, REV 0, "Radiological Problem Reporting Program." The purpose of the radiological problem report program is to provide a documented record of observed radiological problems, a mechanism for reporting these problems to management for action, a capability to track and monitor the progress of the planned corrective actions, and a database for assessing trends in radiological program performance and needed actions.

WHC-CM-4-12, Section 12.1, REV 1, "Emergency Response." An emergency is a sudden unexpected event requiring immediate response to mitigate impacts to people, property, or the environment. When radioactive material is involved, HP plays a major role in evaluating, controlling, and recovering from the event. To be able to perform this function, HP personnel receive training to respond to a variety of emergency situations. Procedures for HPs (WHC-CM-4-12 and WHC-IP-0692) are written to provide guidelines to respond to emergencies. Together, the training and the written procedures detail the HP emergency response program.

Emergency Response. The HP personnel are, in many situations, the first to respond to a radiological emergency. The ability to assess and evaluate the situation and take immediate steps to minimize the effects of the event is crucial for controlling the emergency. The HP personnel must use their training and experience to make good decisions during the initial response to an emergency.

An emergency response may be initiated by (1) personnel observing the event, (2) alarms, (3) the Patrol Operation Center, or (4) the Emergency Control Center(s) once they are manned. For a planned response, HP personnel shall be in teams of at least two. Out of necessity (e.g., backshift response), one member could be an Operations person or other emergency service person, such as a firefighter or patrol officer. A rapid response is required; however, no undue risks should be taken nor should employee safety be compromised. The type of emergency determines the level of

planning for HP response. For example, a continuous air monitor (CAM) alarm or a small radioactive spill requires little planning for the initial response. However, when an emergency causes a facility evacuation, preplanning (e.g., stay time, entry route) and approval of the Building or Facility Emergency Director is necessary to re-enter.

Although HP personnel respond to an emergency using basic guidelines, an area or facility may have specific procedures that have priority over these guidelines.

WHC-IP-0692, Section 12.1.2.1, REV 0, "OHP Response to Double-Shell/Aging Waste Tank Pressurization Alarm" (WHC 1991b). This procedure establishes the method of Operational Health Physics (OHP) response to tank pressurization alarms on double-shell or aging waste tanks. This procedure describes the steps and material necessary to respond to, and perform investigative surveys after, tank pressurization alarms.

WHC-IP-0692, Section 12.1.2.3, REV 2, "Effluent Exhaust CAM Alarm Response." This procedure establishes the standard method of handling samples from, and response to alarms at, effluent exhaust CAM systems. This procedure describes the steps and material necessary to exchange, perform field concentration calculations, and submit suspect samples for "rush" or "Red Envelope" analysis, when responding to alarms on effluent exhaust CAM systems.

WHC-IP-0692, Section 12.1.6, REV 1, "Stack Effluent Release Response." This procedure establishes guidelines for responding to a potential or actual release of radioactive material through exhaust stacks. This procedure describes the immediate actions to respond to an exhaust (CAM) stack alarm (i.e., CAM monitoring downstream or upstream of the final filtration).

WHC-IP-0692, Procedure No. 12.2.1, REV 2, "Emergency Response Air Sampling." This procedure establishes the instruction and guidelines for air sampling in an emergency situation. This procedure describes the steps for air sampling both inside and outside facilities when a release of radioactive material is suspected.

WHC-IP-0692, Section 12.2.3, REV 0, "Health Physics Emergency Response Team." This procedure provides the organizational structure of, the instructions for, and the responsibilities of the HP Emergency Response Team (ERT) and the HP Technicians Field Survey Teams. This procedure describes the steps for an initial emergency response by the HP ERT and HP Technicians Field Survey Teams. The HP ERT and the HP Technicians Field Survey Teams may be requested to respond to an emergency when it is deemed that an environmental release of radioactive material may extend beyond the control of a facility or outside the boundaries of the Hanford Site. These teams will have monitoring responsibilities only outside the boundaries of the event site.

WHC-IP-0692, Section 12.2.4, REV 2, "Emergency Radioactive Plume Tracking." This procedure establishes the instructions to track a radioactive beta-gamma plume created from a radioactive material release to the environment and determine if it is at ground level or at an elevated level.

Notifications and reporting of specific events related to environmental releases and/or events involving effluents and/or hazardous materials are reported via instruction given in WHC-CM-5-7, *Tank Farms, Grout, and Solid Waste Management Administration Manual*, Section 1.22, "Tank Farms Occurrence Reporting and Processing of Operations Information" (WHC 1992c) The purpose of this procedure is to establish and implement specific criteria and requirements for the identification, categorization, notification, and reporting of occurrences at the tank farms, as required by WHC-CM-1-3, MRP 5.14, "Occurrence Reporting and Processing of Operational Information" (WHC 1992c).

4.3 The sample collection and analysis procedures used in measuring the emissions shall be described including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rationale for site selections.

See response under Method 1, Section 2.1, "Selection of Measurement Site and ANSI N13.1-1969," Appendix A, Section A3.2 (ANSI 1969).

4.3.2 A description of sampling probes and representativeness of the samples.

See response under ANSI N13.1-1969, Appendix A, Sections A3.1 and A3.2.

4.3.3 A description of any continuous monitoring systems used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

Facility compliance has determined that this section is not applicable.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

See response under Method 1, Section 2.1, "Selection of Measurement Site, and ANSI N13.1-1969," Sections 4.3.2, 5.2.2.1, 5.2.2.1.7, and 5.3.

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured, including frequency of analysis calibration procedures and frequency of calibration.

- Total alpha/total beta activity is determined by procedure LA-508-110 or LA-508-114 on weekly samples, and occasionally on daily air samples, per collection point. The calibration procedure is documented in LQ-508-002. It is done only when deemed necessary by a responsible scientist. The counting system is recalibrated only in case of (1) major repairs or

adjustments to the power supply or detector or (2) calibration shift as indicated by the instrument control standards. The performance of the counting systems is checked by running the instrument control standards (^{147}Pm for low-energy beta, ^{60}Co for mid-energy beta, ^{137}Cs for high-energy beta, and ^{241}Am for alpha activity) separately. When a batch of air filter samples is run, all the performance standards and the background (for counting frequency refer to LO-150-115) also are run with it. To verify that the counting system is working properly, the standard values from analysis should fall within the administrative limits set according to appropriate quality assurance program plans (QAPP).

- Our laboratory method for analysis of alpha emitters (^{241}Am, ^{238}Pu, and ^{239,240}Pu) involves various steps (LA-549-112 for dissolution, LA-943-123 for chemical separation, LA-542-101 for electrodeposition, and LA-508-051 for final alpha spectrometry). The analysis of alpha emitters is done on a quarterly composite of weekly/daily air filter samples. The energy resolution and calibration of the AEA system over the energy range of 4 to 6 MeV are checked once a month by the preventive maintenance (PM) Procedure 2S18006. Efficiency calibration of the AEA is not needed in our analysis method because direct comparison of the sample with recoveries of the tracers (^{243}Am and ^{236}Pu) is made to determine the activities of the radionuclides present in the sample. To carry out the sample analysis, AEA system performance is checked once every 24 hours for alpha energy shift with a certified mixed-alpha source standard. Each alpha energy peak identified in the standard must fall within administratively assigned certain channels (+10) on the MCA. For counting frequency of performance check standards, Procedure LO-150-115 is referred to. The recovery of the radionuclides and the calibration of the system are checked on a batch basis by running a method standard under the identical conditions as the sample.

- The laboratory method for determining beta activity (^{89}Sr, ^{90}Sr/^{90}Y) consists of a dissolution step (LA-549-112), chemical separation (LA-220-103), and total beta counting (LA-508-111). Analysis is done on a quarterly composite of weekly/daily air filter samples per collection point. The calibration procedure LQ-508-002 (for window-type gas flow proportional counter) is used in conjunction with LQ-508-005 (for mother/daughter case, i.e., ^{90}Sr/^{90}Y in growth calibration). It is performed only when the responsible scientist finds it necessary. The reasons are the same as stated for total alpha/total beta. The performance of the counting system is checked once per shift by running instrument control standards (^{60}Co, ^{137}Cs, and ^{147}Pm for beta activity). The complete procedure for the ^{90}Sr/^{90}Y analysis in the sample is carried out with a method standard (several

filter papers spiked with ^{90}Sr, ^{147}Pm, ^{60}Co, ^{241}Am, ^{239}Pu, and U provided by the 222-SA Standard Laboratory) on a batch basis. This checks the overall performance of our method. The chemical yield is determined by using appropriate carrier.

- Determination of beta activity (^{147}Pm, ^{14}C, and ^{3}H) involves processing (LA-549-112 and LA-613-111 for ^{147}Pm, LA-348-101 for ^{14}C, and LA-218-112 for ^{3}H), mounting in scintillation cocktail (LA-508-111), and finally, liquid scintillation counting (LA-508-121). The ^{147}Pm analysis is done on quarterly composites of weekly/daily air filter samples. The ^{14}C and ^{3}H analyses are done on biweekly gas samples. For calibration, the quality assurance (QA) section of procedure LA-508-121 is referenced. The calibration of the instrument is checked by the manufacturer's supplied sources (^{14}C and ^{3}H) and its software.

  For ^{147}Pm analysis, the method standard is run once per quarter. The method standard is always run with a batch of samples for ^{3}H and ^{14}C analysis. The results of the method standard checks the overall performance, including the calibration of the counting system. The instrument calibration check is done a minimum of once a week (refer to LO-150-115).

- For analysis of gamma emitters ^{95}Nb, ^{95}Zr, ^{134}Cs, ^{137}Cs, and ^{144}Ce the procedure LA-508-052 is followed. Analysis is done on quarterly composites of weekly/daily air filter samples. For analysis of volatile radionuclides (^{129}I, ^{131}I, $^{106}Rh/^{106}Ru$, ^{113}Sn, ^{125}Sb, and ^{103}Ru) collected weekly on silver zeolite cartridge, the procedure LA-288-101 is used in conjunction with procedure LA-508- 052. Calibration of the gamma ray spectrometer is done with the procedure documented in LQ-508-003 using a (NIST traceable) certified mixed-gamma ray standard. It is carried out only when it is deemed necessary by a responsible scientist. To check efficiency and energy calibration daily, the performance of each detector of the GEA system over the whole energy range is done once every shift by running a mixed-gamma standard consisting of ^{241}Am for low energy, ^{137}Cs for mid energy, and ^{60}Co for high energy. The results of each of these radionuclides should fall within the administrative limits set according to the appropriate QAPP to continue analysis of samples. The daily performance results are documented. Minor adjustments of the electronics (e.g., fine gain, pole zero of the amplifiers, lower level discriminator of analog-to-digital converter) are done from time to time when necessary for proper energy calibration. Whenever a minor electronic adjustment is done on a detector, it is followed by analysis of a performance standard. For a major shift in the calibration, the system is then thoroughly calibrated using LQ-508-003.

- The content of the 222-S Laboratory's procedures, test plans, supporting documents, and drawings provide a sufficient level of detail to allow trained personnel to produce quality results safely. Laboratory procedures are controlled as required by WHC-CM-5-4, Section 5.4, "Analytical Laboratory Procedures." The specific content of laboratory procedures is defined by its author, based on accepted methods such as 40 CFR 61, Appendix B, Method 114 (EPA 1991). The content must be agreed to by the peer and technical reviewers. While authors are responsible for the specific content of their procedures, they address the topics below.

  Summary--MANDATORY--A short description or abstract of the procedure containing enough information to distinguish it from other procedures.

  Applications--MANDATORY--Defines the scope and purpose of the specific procedure. This section may be combined with the following element under the title "Applications and Limitations."

  Limitations--MANDATORY--Briefly describes those areas in which the procedure is not applicable. A statement of accuracy and precision will be given where appropriate.

  Quality Control Protocol--Procedures used to support environmental projects that have specific quality control requirements. For these procedures, the source of the quality control requirements will be identified. The samples or project that this element applies to will be identified. The following information is typical of quality control requirements: frequency and type of calibration, reagent blank analysis, spike sample analysis, and duplicate sample analysis.

  Impact Level Identifier--MANDATORY--An impact level will be identified for each procedure following WHC-CM-1-3, MRP 5.43, with a brief basis of determination statement. This MRP lists several descriptive paragraphs delineating what constitutes an Impact Level 1, 2, 3, or 4 activity. The following parts of MRP 5.43 cover most analytical laboratory procedures.

  1. Section 5, Paragraph 6, Part c., Impact Level 3 - work authorization documentation associated with work involving occupational hazards not covered by approved procedure, such as Operational Safety Assessments, Radiation Work Permits, or Industrial Safety Standards.

  2. Section 5, Paragraph 6, Part c., Impact Level 4 - Documentation for any activity not classed as Impact Level 1, 2, or 3.

The laboratories' procedures are usually specific to one activity. These activities are well defined using common scientific instrumentation and equipment operated in an acceptable manner. The chemicals and materials used are normally small quantities with limited potential for environmental or personnel safety impact. In general, the equipment used in the laboratory is not classified as Safety Class 3 or higher.

Safety--MANDATORY--The procedure must identify applicable safety hazards.

The following documents identify Hanford Site safety requirements:

- WHC-CM-4-3, *Volume 1-3, Industrial Safety*
- WHC-CM-4-10, *Radiation Protection*
- WHC-CM-4-15, *Radiation Work Requirements and Work Permits Manual*
- WHC-CM-4-29, *Nuclear Criticality Safety.*

Supporting document WHC-SD-CP-LB-003, *Safety in the Analytical Laboratory*, is the laboratory general safety document. The authors must review safety requirements and include safety warnings appropriate to the actions directed by the procedure.

Reagents--If the procedure requires analytical reagents, a list of reagents will be provided. The material safety data sheets (MSDS) number will be placed in brackets by each chemical name. Reagent makeup, storage container requirements, unique storage needs, shelf-life requirements, special labeling, and special preparation steps will be included. Special notations for any known or suspected carcinogen as listed on WHC-CM-4-3, Volume 2, Table 1, "WHC Master Carcinogen List," will be made on the reagent list.

Reagent preparation described fully in other current Hanford Site documentation may be included by reference.

Equipment--Special equipment needs will be listed. Standard hood or glovebox equipment is assumed to be available at the work station and does not need to be listed. The fabrication of off-standard equipment will be referenced or described in this section.

Procedure Steps--MANDATORY--A step-by-step description of operations necessary to perform the task will be presented in a logical and sequentially numbered order or an assignment of responsibilities. CAUTIONS and WARNINGS notations will be included for the applicable safety hazard before the action is described. Steps with potential for criticality specification violation will be identified.

Explanatory "Notes" may be included for clarification of process.

Calculations--Calculations required to complete the work will be described in this section. Examples with sample values may be included. All combined factors will be fully described and units noted.

Calibrations--When calibrations are required, a description of how to carry out required calibrations will be given.

Discussion--A discussion of the theoretical aspects of the procedure. Brief identification of unique characteristics and interfaces to aid in troubleshooting may be included.

References--A reference list of published information to provide technical basis for the procedure may be included.

The mandatory topics are addressed in both procedures. However, the laboratories have technical, analytical, and administrative procedures. Nonmandatory topics are included if appropriate to the activity covered by the procedure.

The calibrations of all laboratory instruments are controlled by the Laboratory Instrument Calibration Control System (LICCS) (WHC-CM-5-4, Section 8.2). The LICCS documents the requirements for and the performance of calibration activities for each analytical instrument or measurement device.

Methods used for analysis of radionuclides must be based on principles of measurements described in 40 CFR 61, Appendix B, Method 114. Use of methods based on principles of measurement other than those described in Method 114, Section 3, must be approved before use by the EPA Administrator.

Refer to the main part of this document for laboratory implementing procedures.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

A representative airborne sample is extracted from the exhaust stack (296-A-40) via two separate sampling probes (each sampling probe is identical; see Section 4.3.2) and sample lines. The sample transport lines are 1.9-cm (3/4-in.) OD stainless steel tubing approximately 4.3-m (14-ft) long. These lines are heat treated and kept at a nominal temperature of 43.3 °C (110 °F). This is assumed to be above dewpoint (i.e., the temperature at which condensation of water vapor in air takes place).

One line directs the sample through a record sampler and two silver zeolite cartridges. The record sampler and silver zeolite cartridges operate at 62.3 L/min (2.2 ft^3/min). The record sampler collects particulates on a 47-mm filter. This filter is exchanged weekly and analyzed by the 222-S Laboratory for the presence and quantity of alpha and beta radiation and is isotopically analyzed quarterly to quantify the amount of specific radionuclides. The results become the record of stack emissions. The record sampler flow (2.2 std ft^3/min ±5%) is indicated on a gauge and the flow is totalized (2.2 std ft^3/min ±10%). A timer records the duration of the sample interval. The flow, total flow, and time are indicated on local instruments. A low record sample gas flowrate activates a local alarm.

The record sample gas train for tank exhausts includes two silver zeolite cartridges in series that measure the ^{106}Ru and ^{129}I released during the period of record. The normal procedure is to exchange the silver cartridges weekly or when radiation readings rise at a rate of greater than 16 mrem/hour within the last 8 hours. The sample is replaced with a new cartridge, and the spent cartridge is packaged and transported to the 222-S Laboratory. The second cartridge is also checked at this time. This silver zeolite cartridge is removed from the holder and the radiation is measured with a hand-held instrument. If the radiation reading is low, the sample cartridge is reinstalled. A system leak check is required during changeout of the silver zeolite cartridge. The air flow through the record sample head is blocked and the sample line rotameter checked for any indication of flow.

The second line directs the sample through a beta CAM*. This independent sample extraction probe continuously withdraws a sample from the tank farm stack exhaust at a rate of 2.0 std ft^3/min (56.6 L/min) ±10%. Radioactive effluent particulates are collected on a filter and the radioactivity measured by an Eberline** Model AMS-3 beta-gamma monitor with a count rate meter output accuracy of ±1%. The instrument has a range of 10 to 100,000 cpm on a four-decade scale. The strip chart recorder in the enclosure has been replaced with an ammeter and the strip chart is remotely located in a control room or instrument building.

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*The CAMs serve as warning devices to alert personnel to releases that exceed normal operating parameters. the CAMs collect particulates on a filter monitored continuously by a radiation detector. The CAM filter may be used as a backup for the record sample.

**Trademark of Eberline Instrument Corporation.

Independent vacuum pumps are provided for each loop of the system. Redundant vacuum systems are not furnished, but failure annunciation (low flowrates) is provided and checked periodically to demonstrate operability.

The record sample holder is described as follows:

- Large outside diameter with knurled outer ring for ease of opening
- Rubber "O" ring gaskets used to seal the sample holder
- Fine mesh screen behind the sample filter to keep the sample a constant distance from the inlet
- Sample vacuum side is connected by a flexible line for ease of access.

The record sample vacuum system consists of the equipment described below.

- Rotameter (FI): Reads out in std ft^3/min or ft^3/min of air flow through the sample paper. Certified accurate to ±10% @ 2.2 std ft^3/min. Operating range: 0.0 to 3.0 std ft^3/min ±5%.
- Gas meter totalizer (FIQ): Industry standard gas meter. Reads out in cubic meters. Measures the total volume of air pulled through the sample filter. Certified accurate to ±5% @ 2.2 std ft^3/min.
- Flow alarm switch (FAS): Trips an alarm at the loss of flow (@ 1.25 ft^3/min) due to vacuum pump failure and/or sample filter clogging. Accurate to within ±10%.
- Vacuum line to the vacuum pump: Equipped with a standard quick disconnect for connection to alternate pumps and for sample filter retrieval.
- Stack flow switch: Controls a "switched" power outlet providing power to the record sample vacuum pump. Automatically shuts down the record sample vacuum when the stack fans cease operation.
- Record sample timer: Provides integrated timing of power supplied to the "switched" power outlet. Resettable five-digit to 99999. Normally reset to zero when the record sample is exchanged. Certified accurate to ±1%.

Calibration and inspection of the system are accomplished as follows:

Procedure	Frequency
WHC-IP-0692, Section 5.2.2.6	Weekly
PSCP-3-002	Monthly
PSCP-3-003	Monthly
PSCP-4-007	6 Months
PSCP-4-091	6 Months
PSCP-6-029	6 Months
PSCP-7-001	6 Months

The titles of these procedures are as follows (WHC 1991b and WHC 1992b):

- "Gaseous Effluent Sampling and Monitoring System Operability Inspection," Section 5.2.2.6, REV 2
- Maintenance Engineering Services Calibration Procedure, "Eberline Beta Air Monitor, Models AMS-3, AMS-3A, And 700300," Calibration Procedure PSCP-3-002
- Maintenance Engineering Services Calibration Procedure, "Eberline Alpha-4, -5, and 5A," Calibration Procedure PSCP-3-003
- Maintenance Engineering Services Calibration Procedure, "Rockwell Type Gas Meter," Calibration Procedure PSCP-4-007
- Maintenance Engineering Services Calibration Procedure, "Pressure and Vacuum Gauges," Calibration Procedure PSCP-4-091
- Maintenance Engineering Services Calibration Procedure, "Chem-Tec Adjustable Flow Switch Model 500," Calibration Procedure PSCP-6-029
- Maintenance Engineering Services Calibration Procedure, "Air Rotometer," Calibration Procedure PSCP-7-001.

4.3.7 A description of the effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

For the 241-AP Tank Farm primary exhaust stack, flow measurements are accomplished via Procedure 7-GN-56 on a quarterly basis. The location chosen for velocity measurements is at the top of the stack, which is nearly

3.0 m (10 ft) above the fan discharge into the stack. This is two stack diameters downstream from the nearest flow disturbance (the sample probe) and zero stack diameters upstream from the nearest flow disturbance (top of stack).

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy and completeness of the emission measurement data including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of data obtained compared to the amount expected under normal conditions.

The objectives are documented in the *Environmental Protection Quality Assurance Project Plan* (WHC 1992e).

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

The quality control program are documented in the *Environmental Protection Quality Assurance Project Plan* (WHC 1992e).

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sample collection, analysis and reporting system. Sample handling and preservation procedures shall be established to maintain the integrity of samples during collection, storage and analysis.

Refer to Section 6.2.3 of WHC-EP-0536 (WHC 1991e).

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

Refer to Section 7.0 of WHC-EP-0536.

4.8 A corrective action program shall be established including criteria for when corrective action is needed, what corrective action will be taken and who is responsible for taking the corrective action.

Refer to Section 8.0 of WHC-EP-0536.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emissions measurements program. These reports should include assessment of the quality of the data, results of audits and description of corrective actions.

Refer to Section 9.0 of WHC-EP-0536.

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