

NUCLEAR INDUSTRY STANDARD PROCESS

Radiological Protection

Level 3 – Information Use

Radiological Air Sampling

NISP-RP-003

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This is an industry document for standardizing radiation protection processes. Standard processes and requirements are established to eliminate site-specific radiation protection procedures. The Institute for Nuclear Power Operations (INPO) maintains current procedures on the INPO website. Approval authority is granted by the industry contingent on a structured review and approval process by representatives of utility radiation protection organizations.

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1.0 Purpose

- 1.1 This procedure describes when air samples must be collected and the processes for sample collection, determining airborne concentrations, and taking appropriate actions based on analytical results. Sampling methods are described for airborne particulates, iodine and noble gas.

2.0 Scope and Applicability

- 2.1 This procedure describes processes that RP personnel perform to assess radiological hazards from airborne radioactivity. Generic instructions are provided to enable personnel to sample and assess airborne hazards with air samplers and counting instruments typically used in the industry. Site-specific training is required if personnel are expected to perform gamma spectroscopy analysis or use programmed instruments that simultaneously count both alpha and beta radiation.
- 2.2 The forms referenced by this procedure are examples used to describe the pertinent information that should be recorded for future reference. Plant procedures may specify the use of equivalent forms or the use of electronic media for the same purposes.
- 2.3 Instructions are provided to analyze particulate air samples to determine the following:
- a. A DAC fraction from beta-gamma emitters using a counting system and assuming the total activity is Co-60, or other nuclide(s) as directed by site procedures.
 - b. A β/α Ratio when required by this procedure.
 - c. An estimate of the total DAC fraction, including alpha, assuming all alpha emitting activity measured with a counting system is Am-241, or other nuclide(s) as directed by site procedures.
 - d. An estimate of the total DAC fraction, including alpha, as directed by RP supervision for completing an alpha analysis. If such estimates are required, the site is responsible for specifying a TRU multiplier based on site characterization and/or conservative assumptions. This procedure does not provide instructions for site characterization.
- 2.4 This procedure does not provide instructions for sampling tritium, analyzing iodine sample cartridges, or analyzing noble gas samples since these are tasks that are rarely performed by supplemental RP technicians. Refer to site specific processes for these analyses. Site specific training and qualification should be performed if personnel are expected to sample for tritium or analyze iodine sample cartridges or noble gas samples.

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- 2.5 Calculations described in this procedure are provided to define how sample parameters are used to evaluate the magnitude and significance of airborne radioactivity. Site procedures may use alternative equations, provide graphs to substitute for calculations, direct the use of software for the same purposes, and/or authorize only site personnel to perform calculations.
- 2.6 Member utilities are expected to use this standard to enable supplemental workers to transition between nuclear power plants. Compliance with these instructions is expected without additional site requirements or process deviations being imposed that may require additional training or challenge the performance of supplemental workers.
- 2.7 Member utilities will implement these process requirements in site procedures and update site procedures whenever requirements or process steps in this Nuclear Industry Standard Process (NISP) are revised. Current revisions are maintained on the INPO website.

3.0 Definitions

- 3.1 Terms, acronyms, and definitions are provided in NISP-RP-013, Radiation Protection Standard Glossary of Terms.

4.0 Responsibilities

- 4.1 Radiation Protection is responsible for the implementation of the requirements of this procedure per Efficiency Bulletin 17-01 and the nuclear industry standard process initiative.
- 4.2 Radiation Protection Management should ensure that the counting of air samples is prioritized to ensure high risk air samples are counted in a timely fashion.

5.0 General Requirements

- 5.1 Evaluation of air sample results requires comparison of airborne concentrations to the Derived Air Concentration (DAC) values in 10 CFR 20, Appendix B.
- 5.2 Air samples are classified based on the location and purpose for collecting the sample as follows:

NOTE: The definition of a breathing zone air sample is defined by NRC Regulatory Guide 8.25, Revision 1, §3.1. The set-up of a personal air sampler is described in Reference 8.2.3. Breathing zone samples may be obtained using a personal air sampler or sample media connected to a remote sampler with tubing. If the air sample will be used to assign dose to an individual, then a Lapel air sampler should be used for this purpose.

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- 5.2.1 Breathing Zone Air Sample – An air sample where the filter media is approximately 10 to 12 inches of a worker’s head.
- a. A personal air sampler (i.e. a lapel) is set up with the filter media approximately 10 to 12 inch radius of the worker’s nose and mouth.
 - b. A lapel air sampler should be assigned to the individual if the results will be used to assign dose to a worker.
- 5.2.2 Work Area Air Sample – An air sample where the filter media is located to provide an average measurement of airborne radioactivity to which workers are exposed in a work area.
- a. Either grab samples or continuous sampling may be used provided sample volumes are controlled to obtain an MDA less than 0.3 DAC for the nuclides being sampled.
 - b. Place sampling media as close to the breathing zone as practicable without interfering with the work or the worker.
 - c. Place the sampling media downstream of the airborne source if airflow patterns may affect dispersion.
- 5.2.3 General Area Air Sample – An air sample located to accomplish one or more of the following:
- a. Determine potential airborne hazards.
 - b. Verify postings and boundaries.
 - c. Determine the effectiveness of engineering controls.
 - d. Measure general or average concentrations.
 - e. Detect unexpected releases into a work place.
- 5.3 Plant RP organizations are responsible for categorizing plant systems and areas based on the potential contribution to the internal dose of workers. Categories are defined as follows:
- 5.3.1 Alpha Level 1 Area – The internal dose from alpha is not likely to exceed 10% of the total internal dose from inhalation. Alpha Level 1 Areas have a $\beta\gamma/\alpha$ Ratio greater than 30,000 or alpha activity levels are less than 20 dpm/100 cm². An area not posted as an Alpha Level 2 or 3 Area is an Alpha Level 1 Area. Postings are not required for an Alpha Level 1 Area.

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- 5.3.2 Alpha Level 2 Area – Alpha is likely to contribute between 10% and 90% of the total internal dose from inhalation. Alpha Level 2 Areas have a $\beta\gamma/\alpha$ Ratio between 300 and 30,000. Alpha Level 2 Areas are posted per NISP-RP-004, *Posting and Labeling of Radiological Areas*.
- 5.3.3 Alpha Level 3 Area – The internal dose from alpha is likely to exceed 90% of the total internal dose from inhalation. Alpha Level 3 Areas have a $\beta\gamma/\alpha$ Ratio less than 300. Alpha Level 3 Areas are posted per NISP-RP-004.
- 5.4 Analyze a particulate air sample for alpha using the following criteria:
- 5.4.1 An air sample measures a $fDAC_{\beta\gamma} \geq 1.0$ DAC in an Alpha level 1 area.
- 5.4.2 As required by the option used by the site as described in Attachment 4 for Alpha Level 2 Areas.
- 5.4.3 An air sample was collected in an Alpha Level 3 Area.
- 5.5 Prejob planning should ensure personnel collecting air samples understand the following:
- 5.5.1 When samples are needed based on the conditions listed in section 6.1 of this procedure.
- 5.5.2 Required breathing zone, work area, and general area air samples.
- 5.5.3 Minimum sample volumes required by site procedures. Typical requirements for sample volume are provided below:
- a. Sample 250 liters (8.8 ft³) for corrosion and fission products.
 - A 250 liter sample can collect a sufficient amount of Co-60 to measure 0.3 DAC if the counting system has an MDA less than 1,600 dpm of Co-60.
 - b. Sample 1,000 liters (35.3 ft³) for alpha.

NOTE: Calculations are based on the equations provided in Reference 8.2.3, Appendix D.

- A 1,000 liter sample can collect a sufficient amount of Am-241 to measure 0.3 DAC if the counting system has an MDA of 2.8 dpm and there is negligible self-absorption within the sample filter.

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- 5.6 Air samples should be collected to evaluate the airborne hazards due to the specific work activities performed.
 - 5.6.1 Collect grab samples during expected periods of actual or potentially highest airborne concentrations and evaluate them as quickly as practicable to determine the need for adjusting engineering controls, respirators, area evacuation, area posting, or worker relief from unnecessary respirator use.
 - 5.6.2 For work that has the potential to generate airborne radioactivity for a longer period of time, e.g. over an hour, operate an air sampler continuously while work is in progress.
 - a. Change out filters with the objective to evaluate sample results from specific activities more likely to generate airborne radioactivity, e.g. a system breach, lapping of a valve seat, decontamination, etc.
- 5.7 Review and comply with site procedures for the issue and return of air sampling equipment and portable instruments.
- 5.8 Always inspect air sampling equipment and sample media prior to use to ensure the following, as applicable:
 - 5.8.1 Physical damage does not exist that could affect operation.
 - 5.8.2 Sample pumps have been calibrated within the required time frame.
 - 5.8.3 Any batteries that are required are charged for operation.
 - 5.8.4 Any AC power cords are not damaged and AC power is available where the sample will be taken.
 - 5.8.5 Operability is checked by starting the sampler and observing expected parameters.
 - 5.8.6 Sample holders or Marinelli beakers are not damaged.
 - 5.8.7 Sample holders do not have any cracked or missing O-rings or screens.
 - 5.8.8 Threads and connectors are not damaged and function as expected.
 - 5.8.9 The age of filter media has not exceeded a required shelf-life, e.g. iodine cartridges.
- 5.9 Avoid placing sampler motors directly on contaminated surfaces (e.g. greater than 10,000 dpm/100 cm²) where the motor exhaust could create airborne radioactivity.
 - 5.9.1 Consider covering the surface or suspending the sampler motor to minimize the potential for airborne.

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- 5.10 Do not use electrical devices in atmospheres that may be approaching the Lower Explosive Limit, e.g. 2% to 4% H₂.
 - 5.11 Exercise care to prevent cross contamination of sample filters during the removal and bagging process.
 - 5.12 If air sample results indicate airborne concentrations exceeded 0.3 DAC, or a personal air sampler indicates an intake could occur greater than 4 DAC-hours, in an area that is not posted and controlled as an Airborne Radioactivity Area, take the following actions:
 - 5.12.1 Determine if the airborne activity was expected in accordance with an approved ALARA plan. If yes, follow the actions in the ALARA plan and perform steps 5.12.2 to 5.12.6 as appropriate.
 - 5.12.2 If radon interference is suspected during field analysis, consult RP supervision to determine if follow-up actions should be delayed until a radon-discriminating analysis is completed.
 - 5.12.3 Stop work, evacuate workers from the affected area, and collect grab samples to determine if airborne concentrations are sustained and to identify the source if unknown.
 - 5.12.4 Inform workers in the area without respiratory protection that airborne radioactivity was measured and potential exposures will be evaluated.
 - 5.12.5 If the conditions causing the airborne radioactivity may still exist or are unknown, immediately post and control the area as an Airborne Radioactivity Area.
 - 5.12.6 Notify RP supervision and ensure the occurrence is documented in the plant corrective action program to identify the cause of the conditions and any corrective actions, including an assessment of potential doses to workers.

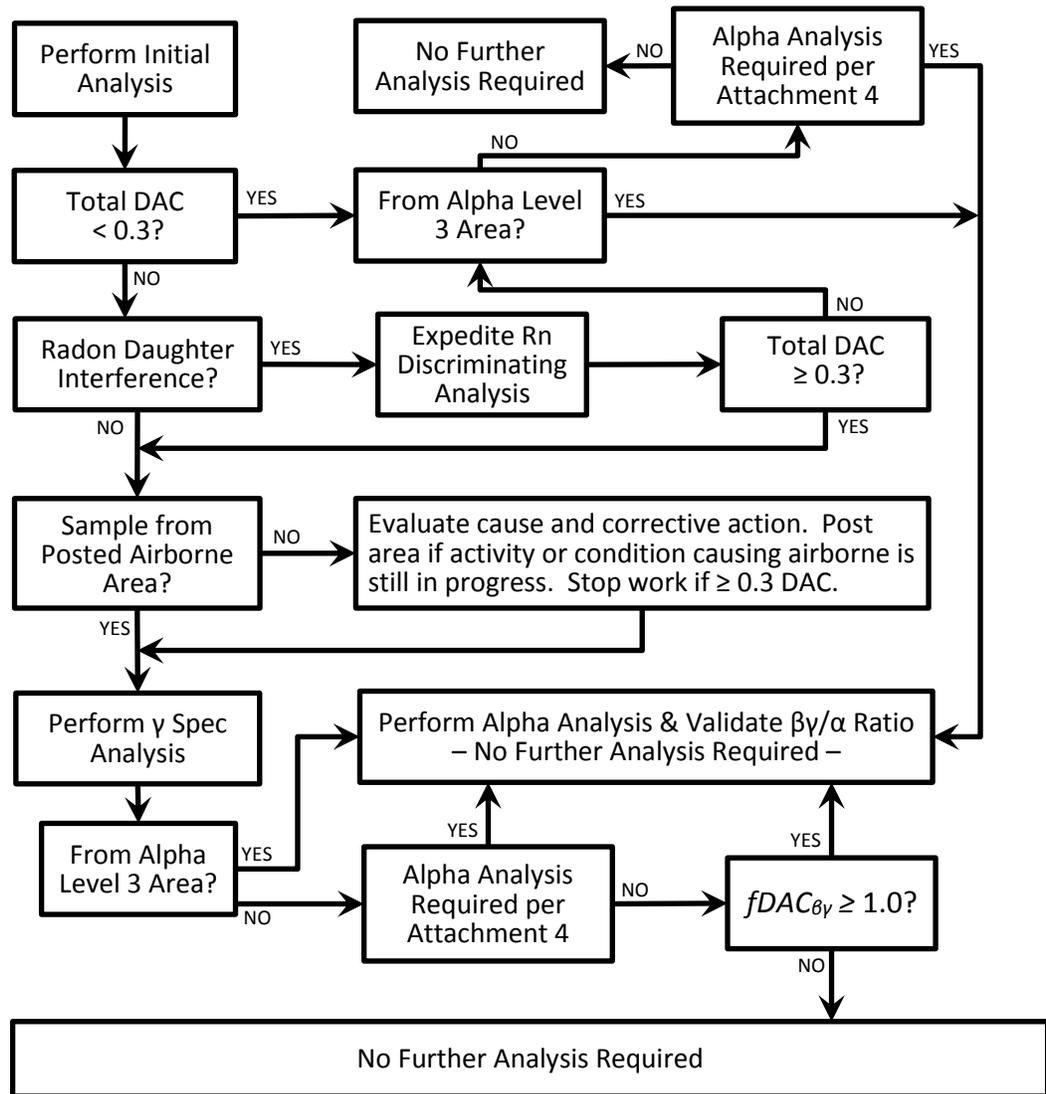
6.0 Process Instructions

- 6.0.1 The basic process for air sampling is to obtain a sample, analyze the sample, and then take the appropriate actions if airborne concentrations exceed 0.3 DAC. Appropriate actions include ensuring the area is posted as an Airborne Radioactivity Area per NISP-RP-004, *Radiological Posting and Labeling* and to determine cause and corrective actions if the airborne radioactivity was not anticipated.

Notes apply to the process diagram

- Initial analysis may be performed using field or laboratory instruments to determine the Total DAC. If an assessment of the airborne hazard is needed prior to performing alpha analysis, the Total DAC may be estimated per the instructions in Attachment 2.
- If radon interference is suspected during field analysis, consult RP supervision to determine if follow-up actions should be delayed until a radon-discriminating analysis is completed.
- An expedited radon-discriminating analysis may include gamma spectroscopy or the use of counting instruments that discriminate against the radon daughters to quantify only licensed material.
- Gamma spectrometry analyses do not have to be repeated if performed in an earlier step.

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6.1 Determine the Need for an Air Sample

- 6.1.1 Comply with the air sampling requirements as stated in plant procedures, RWPs, ALARA Plans or as directed by RP supervision.
- a. Notify RP supervision if an activity may warrant air sampling but the need for an air sample has not been identified.
- 6.1.2 Collect work area air samples whenever respiratory protective equipment is worn to validate that the protection factor was sufficient to limit the intake of radioactive material.
- 6.1.3 Use the following guidelines to identify the need for an air sample.

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- a. During any work or operation that is known to have a potential for causing airborne radioactivity such as:
 - Grinding, welding, burning, cutting, hydrolasing, vacuuming, sweeping, or using compressed air on contaminated equipment.
 - Using volatile substances on contaminated surfaces.
 - When compacting waste.
 - When removing contaminated insulation.
- b. During any work or operation that involves the breach of a radioactive system for which the potential for measurable airborne radioactivity is known to exist.
- c. Prior to or during initial entry into a known or suspected airborne radioactivity area such as:
 - Steam leaks from a primary system.
 - Steam leaks from a BWR secondary system.
 - Leaks from a BWR off-gas systems
 - Leaks from a gaseous waste processing system.
- d. When working in an area with levels of dry removable contamination that could become suspended in concentrations greater than 0.3 DAC such as:
 - Greater than 100,000 dpm/100 cm² of $\beta\gamma$ emitting nuclides.
 - When aggressive work (e.g. cutting, grinding, welding, etc.) is performed in Alpha Level 2 Areas or on systems with suspected but unknown amounts of alpha.
 - Work in Alpha Level 3 Areas.
- e. Initial entry into a PWR containment or BWR drywell during power operation with subsequent air samples as directed by RP supervision.
- f. Initial entry into a PWR containment or BWR drywell following shutdown as directed by RP supervision.
- g. Prior to or during initial entry into any high-risk area such as steam generators, reactor cavities, reactor vessels, or radioactive waste tanks, and periodically thereafter.

- h. When environmental factors such as heat, air flows, low humidity, etc. increase the potential for highly contaminated surfaces, components, and filters to dry and the contamination to become suspended in air.
- i. A significant spill or spread of contamination has occurred.
- j. System leakage or work activities can result in airborne radioactivity and an area sample is needed to provide a timely alert of the changing condition.
- k. When DAC-Hour tracking is used to monitor worker intakes.
- l. When fuel leaks have occurred elevating noble gas, iodine, and transuranic nuclides in the RCS. Plant-specific procedures are used in response to fuel failure to monitor potential doses to workers.
- m. A potential airborne pathway exists for a release to the environment. Consult with personnel responsible for effluent monitoring to ensure appropriate locations and parameters are established for airborne monitoring.

6.2 Collect a Particulate and Iodine Air Sample

WARNING

Do not use electrical devices in atmospheres that may be approaching the Lower Explosive Limit, e.g. 2% to 4% H₂.

- 6.2.1 Use an iodine sampling cartridge as required by site RP supervision, RWPs and/or ALARA Plans.
 - a. Site RP management may discontinue sampling for iodine when sample trends show that iodine is not a concern.
 - b. Use silver zeolite cartridges in noble gas atmospheres when directed by RP supervision.
 - Ensure, through prejob planning, that hydrogen is not present when using a silver zeolite cartridge per Reference 8.2.5.
- 6.2.2 Select an appropriate sampling method considering the following:
 - a. Use a grab sampler to obtain an air sample in a short period of time.
 - Grab samples are used to quickly verify airborne concentrations during a system breach, monitor work area concentrations for short duration work, or in conjunction with low volume air samplers to determine peak airborne concentrations.

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- b. Use a continuous air sampler to collect samples over a longer period of time such as the entire duration of the work or continuously for routine verification that airborne radioactivity is not present.
- c. Use a sample head connected to a remote pump with tubing when conditions limit placing the air pump at the sampling location.
 - Refer to site procedures to determine the allowable length of tubing.
 - Avoid the use of tubing prior to the inlet of the sample head due to potential plate out of radioactive material in the tubing prior to the air entering the filter media.

6.2.3 Obtain the appropriate air sampling pump for the type of sampling required.

6.2.4 Follow the guidelines in Attachment 5 to set up and operate the sampler.

6.2.5 Inspect the equipment to ensure it is operable and reliable.

- a. Ensure current calibration of instrument.
- b. Ensure no obvious signs of damage.

NOTE: Use iodine cartridges with particulate filters unless RP supervision has authorized using particulate filters only.

6.2.6 Load the particulate filter and iodine cartridge in the sample holder.

- a. Ensure filters are aligned or marked as needed to indicate the collection side that should face the detector during analysis.

6.2.7 Position the air sample filters as needed for a breathing zone, work area, or general area sample and commence operation of the sampler to coincide with the activities expected to generate airborne radioactivity.

- a. Collect a minimum volume as specified in section 5.5.3 of this procedure unless otherwise specified by work instructions, the RWP, ALARA Plan, or RP supervision.

6.2.8 Exercise care to prevent cross contamination of the filters during the removal and bagging process.

6.2.9 Caution should be taken in dusty and dirty environments to minimize filter loading since filter loading may mask the quantity of alpha contamination present.

6.2.10 Complete Attachment 1 (or site equivalent form) to record important sample parameters for required analyses.

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- 6.2.11 If the sample was obtained in a noble gas atmosphere, consider purging the gas from the sample media by running the sampler 1 to 2 minutes in an area where noble gas, airborne particulates, or iodine are not present.

6.3 Collect a Noble Gas Sample

NOTE: Marinelli breakers may come in various sizes. Most common in use are 1 or 4 liters but other sizes may be used based on site specific requirements.

- 6.3.1 Open the lid of a Marinelli and wave the Marinelli in the atmosphere for 15 to 30 seconds to allow the Marinelli contents to equilibrate with the atmosphere.
- a. Place and seal the lid on the Marinelli prior to leaving the sampling area.
- 6.3.2 Use water displacement to collect noble gas.
- a. Obtain a 1 liter or 4 liter Marinelli beaker approved for gamma spectroscopy that has a removable lid.
 - b. Fill the container completely with demineralized water and seal the container.
 - c. Proceed to the area where the sample is to be collected, open the container, pour the water into a floor drain or another container, and re-seal the sample container.
 - d. Complete Attachment 1 (or site equivalent form) to record important sample parameters for required analyses.
- 6.3.3 Use a sample pump to collect noble gas per site procedures. Generic steps are listed below.
- a. Obtain a 1 liter or 4 liter Marinelli beaker that has stopcocks and is approved for gamma spectroscopy.
 - b. Obtain a low flow air pump (e.g. 15 lpm).
 - c. Perform an inspection to ensure the equipment is operable.
 - d. Connect the sample pump to the sample container with vacuum tubing.
 - e. Open the valves on the container and start the sample pump.
 - f. Allow a sufficient purge time to totally displace the container volume with the sampled atmosphere (e.g., for a 4 liter container, a volume of at least 20 liters is needed).

- g. Stop the pump and close the inlet and outlet valves.
- h. Complete Attachment 1 (or site equivalent form) to record important sample parameters for required analyses.
- i. Submit the sample for gamma spectroscopy analysis.

6.4 Operate a Continuous Air Monitor (CAM)

6.4.1 When assigned responsibility to monitor or maintain a CAM, ensure prejob planning activities provide instructions for the following:

- a. Identification of status lights that indicate normal operation.
- b. Identification of status lights and any alarms that indicate increased airborne concentrations.
- c. The proper sequence for manipulating the CAM to change out filters.

6.4.2 Take the following actions if an unexpected alarm occurs from a continuous air monitor.

- a. If a work activity is causing increased airborne radioactivity in the area, stop work and evacuate workers from the immediate area.
- b. Collect grab air samples for confirmation of airborne concentrations.
- c. If it is unlikely that a work activity is causing increased airborne radioactivity, survey the area to determine if an increase in background radiation levels caused the alarm.
- d. Notify RP supervision of the alarm and known conditions for further direction.

6.5 Set Up and Operate a Personal Air Sampler

6.5.1 Issue personal air samplers as required by the RWP.

6.5.2 Issue personal air samplers to each worker in an Alpha Level 2 or 3 Area based on the following criteria:

- a. Work in Alpha Level 3 Areas.
- b. Aggressive work in Alpha Level 2 Areas or on systems with suspected but unknown amounts of alpha.
 - Examples of aggressive work include cutting, grinding, welding, etc.
- c. Exceptions may be made for the following:

- When air supplied suits are worn if the industrial hazards associated with the use of a personal air sampler outweigh the benefits.
- Where a periodic (non-incident based) alpha excreta sampling program is in place.
- During a specific task evolution where it is concluded that a personal air sampler is not necessary, because the potential for airborne alpha had been evaluated and is considered improbable, and appropriate stop work controls are in place and communicated to the workers.
- Where engineering controls, (e.g. a glove box) adequately contain the source term.

6.5.3 Ensure work area sampling is also performed where personal air samplers are in use to provide a complete assessment of the airborne hazard.

- a. Measurements from a personal air sampler are not reliable for a complete hazard assessment, including posting criteria, due to:
 - Difficulties in controlling the sampling volume required to measure 0.3 DAC.
 - Potential movement of the workers in and out of the area with the highest airborne radioactivity.

6.5.4 Perform the following steps when setting up the personal air sampler for use:

- a. Attach the pump to the worker using the belt that is provided.
- b. Secure the tygon tubing with the air sampler head over the worker's shoulder and neck.
- c. Locate the sampler head approximately 10-12 inches of the workers nose and mouth.
- d. Secure the air sample head to the worker by tape or other means making sure not to restrict air flow through the tube.
- e. Turn the pump on and verify the flow rate is within specification.
- f. Inform the worker to leave the work area if they believe the pump is turned off for more than 30 seconds or is otherwise malfunctioning.
- g. Document the person's name and any other identifying information on the site-specific document (e.g. air sample bag or an accompanying form) along

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with the time the pump was turned on and any other pertinent information such as flow rate, job location time, etc.

6.5.5 Perform the following steps when removing a personal air sampler:

- a. Turn off the sampler pump.
- b. Remove the air sampler head, tygon tubing, and pump from the worker.
- c. Remove the air sample from the air sample head and place in the air sample bag or petri dish as required by site procedures.
- d. Use site-specific procedures and forms to record parameters and analyses.

6.6 Analyze a Particulate Air Sample Filter

6.6.1 Use Attachment 1 to record air sample parameters that are required to calculate airborne concentrations.

- a. Use site-specific forms to record sample parameters from a personal air sampler to calculate a potential intake.

6.6.2 Use Attachment 1 and the instructions in Attachment 2 to analyze air sample filters and compare airborne concentrations to Derived Air Concentrations (DAC).

7.0 Records/Documentation

7.1 Air sampling surveys shall be documented in appropriate logs, RWP, and survey records as applicable.

7.2 Attachment 1 and computer equivalent forms shall be filed in accordance with the Standard Records Retention Schedule.

7.3 The forms referenced by this procedure are examples used to describe the pertinent information that should be recorded for future reference. Plant procedures may specify the use of equivalent forms or the use of electronic media for the same purposes.

8.0 References

8.1 Commitments

8.1.1 NONE

8.2 General

8.2.1 10 CFR 20, Standards for Protection Against Radiation

8.2.2 INPO 05-008, "Radiological Protection at Nuclear Power Stations"

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- 8.2.3 EPRI Alpha Monitoring Guidelines for Operating Nuclear Power Stations, Revision 2, EPRI Technical Report 3002000409, August 2013
- 8.2.4 NRC Information Notice No. 86-43: Problems with Silver Zeolite Sampling of Airborne Radioiodine
- 8.2.5 NISP-RP-004, *Posting and Labeling of Radiological Areas*
- 8.2.6 NISP-RP-010, *Radiological Job Coverage*
- 8.2.7 NISP-RP-013, *Radiation Protection Standard Glossary of Terms*

9.0 Attachments

- 9.1 Attachment 1: Airborne Radioactivity Calculation Worksheet – Sample
- 9.2 Attachment 2: Instructions to Complete Airborne Radioactivity Worksheet
- 9.3 Attachment 3: TRU Multiplier Based on Co-60 and Am-241
- 9.4 Attachment 4: Alpha Analysis Requirements for Samples from Alpha Level 2 Areas
- 9.5 Attachment 5: Sample Particulates and Iodine Using Standard Air Sampler

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ATTACHMENT 1 Airborne Radioactivity Calculation Worksheet – Sample Page 1 of 1

Each parenthetical number on the worksheet corresponds to instructions in Attachment 2.

Section I: Air Sample Collection Information

(1) Location/Description:	RWP:	(2) Air Sampler Type:	
	Survey #:		Serial Number:
	Sampled by:		Cal Due Date:

(3) Reason for Sample:	(4) <input type="checkbox"/> Grab Sample <input type="checkbox"/> Continuous Sample (5) <input type="checkbox"/> Breathing Zone <input type="checkbox"/> Work Area <input type="checkbox"/> General Area
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(6) Sample Start	Sample Stop	Total Time (minutes)	Flow Rate		Total Volume	Total Volume (ml)	
			Start	Stop		ft ³	x 28,320 =
Date:	Date:			cfm			
Time:	Time:			lpm	liters	x 1,000 =	ml

(7) Sample Collected From: <input type="checkbox"/> Alpha Level 1 Area	<input type="checkbox"/> Alpha Level 2 Area	<input type="checkbox"/> Alpha Level 3 Area
(8) NOTE: Use a TRU Multiplier only if an estimate of $fDAC_{Total}$ is needed as directed by RP supervision for alpha analysis.	$\beta\gamma/\alpha$ Ratio:	_____
	TRU Multiplier:	_____

(9) Analyses Requested	<input type="checkbox"/> Gamma spec (Part and/or Iodine) <input type="checkbox"/> Noble Gas <input type="checkbox"/> Beta-Gamma Analysis <input type="checkbox"/> Alpha Analysis
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Section II: Beta-Gamma ($\beta\gamma$) Analysis

(6) $\beta\gamma$ Analysis	Date/Time	ncpm	dpm	fDAC _{$\beta\gamma$}	RPT Initials	Serial Number	Cal. Due Date	Eff
(10) Initial								
(11) Follow-Up								

(12) $fDAC_{Total}$ if Needed in Lieu of Alpha Analysis ($fDAC_{\beta\gamma} \times TRU$ Multiplier): _____

Section III: Alpha (α) Analysis

(6) α Analysis	Date/Time	ncpm	dpm	By/ α Ratio	fDAC _{α}	RPT Initials	Serial Number	Cal. Due Date	Eff
(13) Initial									
(14) Follow-Up									
(15) Rn Comp									
(16) Long-Lived									

Comments:

Section IV: Final Summary	(17) $fDAC_{\beta\gamma}$ = _____	(18) $fDAC_{\alpha}$ = _____	(19) $fDAC_{Total}$ = _____
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(20) Reviewed by: _____ Approved by: _____
Print/Sign
Print/Sign

ATTACHMENT 2
Instructions to Complete Airborne Radioactivity Worksheet
Page 1 of 5

Section I: Air Sample Collection Information

Complete this section for each air sample except samples from personal air samplers. Use site-specific procedures and forms for recording parameters and analyses of personal air samples.

- (1) Record sufficient information to describe where the sample was taken, the RWP number for the work at the sampling location, the survey number documenting the final results, and the printed name of the RP technician collecting the sample.
- (2) Record the type of sampler, e.g. hi-volume, lo-volume, gas, etc., the serial number of the sampler, and the calibration due date.
- (3) Record the reason for the sample, e.g. job coverage, system breach, HEPA maintenance, etc.
- (4) Check the applicable box for one of the following:
 - a. Grab Sample – A short duration sample to measure the airborne concentration at a single moment in time.
 - b. Continuous Sample – A sample taken to measure the average airborne radioactivity over a period of time; continuous samples are typically collected from 30 minutes to several hours.
- (5) Check the applicable box for:
 - c. Breathing Zone
 - d. Work Area Sample
 - e. General Area Sample
- (6) Record the sample collection data required to determine the total volume of air sampled. Record “n/a” if a sample pump was not used, e.g. a noble gas grab sample.
 - a. Record the date and time for starting and stopping the sampler and the total time for sampling in minutes.
 - b. Record the flow rate at the start and end of the sampling period.
 - c. Calculate and record the total volume sampled.
 - d. Record the total volume in ml.
- (7) Check the box showing the classification of the area where the sample was collected: Alpha Level 1 Area, Alpha Level 2 Area, or Alpha Level 3 Area.
- (8) Record the $\beta\gamma/\alpha$ Ratio and, if an estimate of $fDAC_{Total}$ is needed for alpha analysis, the Transuranic (TRU) Multiplier applicable to the air sample as approved by RP supervision. These values may be obtained using Attachment 3 or provided by RP supervision based on site characterization. The Total DAC is determined by multiplying the $fDAC_{\beta\gamma}$ by the TRU Multiplier. A TRU Multiplier is derived as follows.

$$TRU \text{ Multiplier} = 1 + \frac{fDAC_{\alpha}}{fDAC_{\beta\gamma}}$$

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Instructions to Complete Airborne Radioactivity Worksheet
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- (9) Use this section to check the types of analysis needed. Samples may be submitted to a laboratory for all analyses or technicians may complete all or portions of the Beta Analysis and/or Alpha Analysis sections prior to submittal to the laboratory.

Section II: Beta-Gamma ($\beta\gamma$) Analysis

Use this section to document an initial screening of the sample using a beta detector with either a scaler or ratemeter. This section is not required if the sample has been submitted to the laboratory for gamma spectroscopy.

- (10) Record data in the row designated for an initial $\beta\gamma$ analysis to record data from the first analysis performed after the sample was collected.
- Record the following information:
 - Date and time of the analysis
 - Serial number of the instrument
 - Calibration due date
 - Efficiency factor (use 0.1 for a pancake GM detector unless otherwise instructed by RP supervision)
 - If using a gas flow proportional counter or other instrument, record the efficiency factor posted with the specific instrument.
 - Record the net counts per minute (ncpm) above background. Ensure background is less than 200 cpm when using a pancake GM detector.
 - Record ND (for not detected) if there is not an observable count rate above background or scaler counts are below the MDA value posted with the instrument.
 - Divide the observed ncpm by the efficiency and record the dpm value.
 - Record ND if there is not an observable count rate above background or scaler counts are below the MDA value posted with the instrument.
 - Use the following equation to calculate $fDAC_{\beta\gamma}$ if activity is detected above background. RP supervision may direct using a different DAC value based on the plant source term. Use an equation as directed by RP supervision.

$$fDAC_{\beta\gamma} = \frac{\text{Filter Activity dpm}}{(\text{Sample Vol. ml})(2.22e-2 \text{ dpm/ml})}$$

Where;

$$2.22e-2 \text{ dpm/ml} = (2.22e+6 \text{ dpm}/\mu\text{Ci}) \times (1e-8 \mu\text{Ci/ml})$$

$$1e-8 \mu\text{Ci/ml} = \text{DAC Value for Co-60}$$

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Instructions to Complete Airborne Radioactivity Worksheet
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- f. If $fDAC_{\beta\gamma}$ is ≥ 0.3 DAC, notify RP supervision and collaborate to accomplish or verify the following:
- If radon interference is suspected during field analysis, consult RP supervision to determine if follow-up actions should be delayed until a radon-discriminating analysis is completed.
 - Ensure the area is properly posted as an Airborne Radioactivity Area per NISP-RP-004.
 - Submit the sample and worksheet to the laboratory for gamma spectroscopy analysis with a priority as established by RP supervision.
 - Determine cause and corrective action if the airborne radioactivity was not anticipated.
- g. Complete the following Section III for alpha analysis for any one of the following conditions:
- The $fDAC_{\beta\gamma}$ is ≥ 1.0 .
 - The sample was from an Alpha Level 2 Area and an alpha analysis is required as determined using Attachment 4.
 - The sample was from an Alpha Level 3 Area.
- (11) Record data in the row designated for a follow-up $\beta\gamma$ analysis as an option to determine if the initial results were impacted by the presence of radon daughters.
- a. Perform the follow-up analysis approximately 30 minutes to 1 hour after the initial analysis. Perform the same steps as described for an initial analysis.
 - b. Any observed decay indicates the presence of short-lived radon daughters. The half-life of radon daughters ranges from 35 to 40 minutes depending on the time after sample collection.
 - c. If the results are affected by radon daughters, submit the sample and worksheet to the laboratory for analysis using gamma spectroscopy or alternatively with a priority as established by RP supervision.
- (12) If the sample was collected in an Alpha Level 2 or 3 Area, multiply $fDAC_{\beta\gamma}$ by the TRU Multiplier to approximate $fDAC_{Total}$ if an estimate is needed for alpha analysis as approved by RP supervision.

Section III: Alpha (α) Analysis

Use this section to document an analysis performed with an alpha detector using a scaler. This section is used to determine the $\beta\gamma/\alpha$ ratio for a sample collected from an Alpha Level 3 Area, Alpha Level 2 Area, or an Alpha Level 1 Area when $fDAC_{\beta\gamma}$ is ≥ 1.0 .

- (13) Record data in the row designated for an initial α analysis to record data from the first analysis performed after the sample was collected.
- a. Record the date and time of the analysis, the serial number of the instrument, the calibration due date, and the initials of the RP technician performing the analysis.
 - b. Record the efficiency factor as posted with the instrument. Ensure the efficiency factor includes the self-absorption factor for the filter media being analyzed.
 - c. Record the net counts per minute (ncpm) above background.

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Instructions to Complete Airborne Radioactivity Worksheet
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- Record ND (for not detected) if counts are below the MDA value posted with the instrument.
- d. Divide the observed ncpm by the efficiency and record the dpm value.
 - Record ND if counts are below the MDA value posted with the instrument. No further analyses are required.
- e. Calculate and record the $\beta\gamma/\alpha$ Ratio by dividing the dpm value from the $\beta\gamma$ Analysis (or gamma spectroscopy results) by the dpm value from the α Analysis.
- f. Use the following equation to calculate $fDAC_{\alpha}$. RP supervision may direct using a different DAC value based on the plant source term. Use an equation as directed by RP supervision.

$$fDAC_{\alpha} = \frac{\text{Filter dpm}}{(\text{Sample Vol, ml})(6.66e - 6)}$$

where:

$$\begin{aligned} 6.66e-6 &= (2.22e+6 \text{ dpm}/\mu\text{Ci}) \times (3e-12 \mu\text{Ci}/\text{ml}) \\ 3e-12 &= \text{DAC value for Am-241} \end{aligned}$$

- (14) Record data in the row designated for a follow-up analysis using the same steps as described for the initial α analysis to determine if short-lived radon daughters are present. If radon daughter contribution is suspected, perform this follow-up count 1 to 2 hours after the initial count. If radon daughters are interfering with the analysis, complete the next step.
- (15) If radon daughters are interfering with the analysis, the actual contribution to the count from alpha may be estimated by using one or more of the following methods:
- a. A counting instrument may be used that is designed to discriminate the radon contribution.
 - b. Plant-specific software such as a spreadsheet may be used to calculate the radon contribution.
 - c. A subject matter expert may be assigned to perform the evaluation.
 - d. The following equation may be used to estimate the transuranic concentration from the follow-up count on line 15. Consult with RP supervision on desired decay times between counts.

$$ncpm_{tr} = \frac{(ncpm_2 - ncpm_1 e^{-(0.017)(\Delta t)})}{1 - e^{-(0.017)(\Delta t)}}$$

where:

- $ncpm_{tr}$ = Net count rate due to alpha emitting transuranic nuclides
- $ncpm_1$ = Net count rate from initial analysis
- $ncpm_2$ = Net count rate from follow-up analysis
- Δt = Time between analyses, minutes
- 0.017 = Decay constant for a 40 minute half-life, min^{-1}

ATTACHMENT 2
Instructions to Complete Airborne Radioactivity Worksheet
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- e. Record the radon compensated results ($ncpm_{tr}$) in the ncpm column on line 15. Complete line 15 using the radon compensated results. This is only an estimate and should not be used for record values. Only the results after full radon decay should be used for record results.
- (16) Record long-lived analysis data after the sample has decayed ≥ 72 hours using the same steps as described for the initial α analysis. This analysis should provide the basis for the record value of $fDAC_{\alpha}$ if radon daughters interfered with the initial analysis.

Section IV: Summary

This section is used to record the final DAC values from the sample as described below.

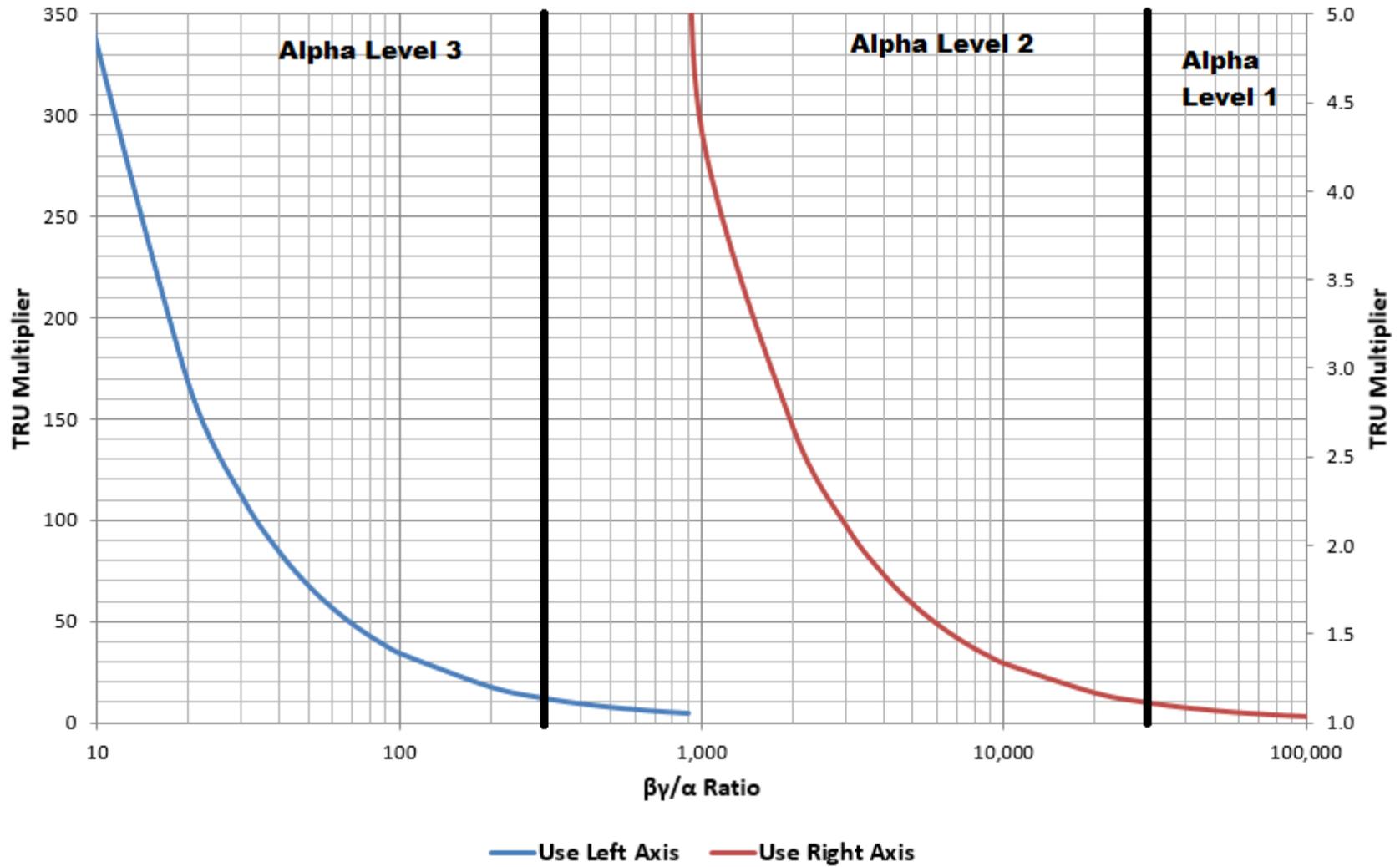
- (17) Record the value for $fDAC_{\beta\gamma}$ as follows:
- a. Record gamma spectroscopy results if performed. Attach the gamma spectroscopy printout or reference the analysis reference number used by the site.
 - b. Record the results from the beta-gamma analysis from Section II if gamma spectroscopy was not performed.
 - c. Record ND if $\beta\gamma$ activity was not detected.
- (18) Record the value for $fDAC_{\alpha}$ as follows:
- a. Record ND if alpha activity was not detected.
 - b. If alpha activity was detected, record the initial or long-lived results from (16).
 - c. Record n/a if alpha analysis was not performed.
- (19) Record the $fDAC_{Total}$ by summing the values from (17) and (18).
- (20) Submit the results for review and approval. Immediately notify RP supervision to alert them to any one of the following conditions:
- a. The $\beta\gamma/\alpha$ Ratio is less than 30,000 in an Alpha Level 1 Area
 - b. The $\beta\gamma/\alpha$ Ratio is less than 300 in an Alpha Level 2 Area
 - c. The $\beta\gamma/\alpha$ Ratio is less than or equal to 50 in an Alpha Level 3 Area
 - d. Beta-gamma activity was not detected but alpha activity was detected.

Nuclear Industry Standard Process Radiological Air Sampling

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ATTACHMENT 3 TRU Multiplier Based on Co-60 and Am-241 Page 1 of 1



ATTACHMENT 4
Alpha Analysis Requirements for Samples from Alpha Level 2 Areas
Page 1 of 2

Purpose

This attachment provides instructions for determining when a particulate air sample from an Alpha Level 2 Area must be analyzed for alpha emitting transuranics; three options are available as follows:

- Option 1** – Perform alpha analysis on all particulate air samples or on all particulate air samples with a measured $fDAC_{\beta\gamma}$ greater than a site-specified value, e.g. 0.025 DAC.
- Option 2** – Perform an alpha analysis on a particulate air sample that indicates a Total DAC ≥ 1.0 DAC when applying a TRU Multiplier as determined by site characterization.
- Option 3** – Perform an alpha analysis on a particulate air sample that indicates a Total DAC ≥ 1.0 DAC assuming the most restrictive alpha emitter (e.g. Am-241) and the most restrictive beta emitter (e.g. Co-60 or Cs-137) expected in the nuclide mixture.

RP supervision at each plant is responsible for directing supplemental RP personnel on the acceptable options to use based on plant procedures.

Option 1

For particulate air samples from Alpha Level 2 Areas meeting site-specific criteria, record both the beta analysis results and the alpha analysis results on Attachment 1. Use these values to determine the Total DAC.

Option 2

11.0 Multiply the $fDAC_{\beta\gamma}$ by the TRU Multiplier provided by site procedures, RWPs and/or ALARA Plans.

12.0 If the Total DAC fraction is ≥ 1.0 , perform an alpha analysis and record the results using Attachment 1.

Option 3

13.0 If this option is used, the $\beta\gamma/\alpha$ Ratio for the area where the air sample was collected will be documented in plant procedures, ALARA planning documents, and/or the RWP.

13.1 The $\beta\gamma/\alpha$ Ratio is normally determined based on the nuclide mixture collected from loose surface contamination.

14.0 Record the $\beta\gamma/\alpha$ Ratio on Attachment 1.

15.0 Use a graph to determine if alpha analysis is required as described below. Graphs may be based on assuming a Co-60 and Am-241 mixture (shown below) or based on actual characterization of the nuclide mixture.

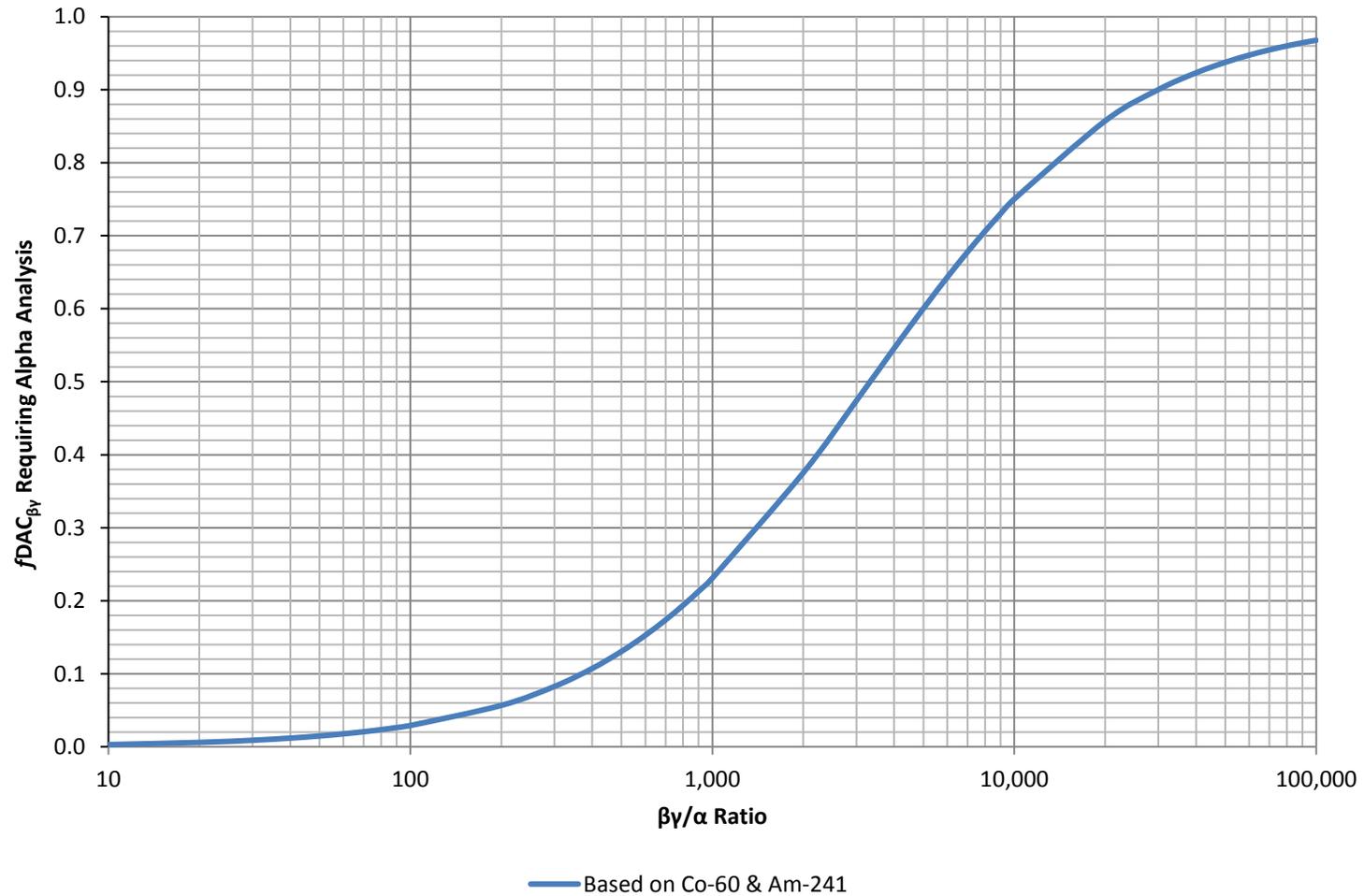
15.1 Locate the intersection of the following:

- a. The $\beta\gamma/\alpha$ Ratio for the area where the air sample was collected.
- b. The $fDAC_{\beta\gamma}$ measured from the air sample.

15.2 If the intersection is to the left of the line, alpha analysis is required. Document the analysis results on Attachment 1.

15.3 If the intersection is to the right of the line, alpha analysis is not required.

ATTACHMENT 4
Alpha Analysis Requirements for Samples from Alpha Level 2 Areas
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ATTACHMENT 5
Sample Particulates and Iodine Using Standard Air Sampler
Page 1 of 2

16.0 Obtain equipment listed below as needed:

- Sample head
- Particulate filter
- Iodine Cartridge
- Air Sampler
- Sample label
- Poly bags or equivalent
- Sample tubing

17.0 Check rubber O-rings on sampling head to ensure positive seals as required for the model of head being used.

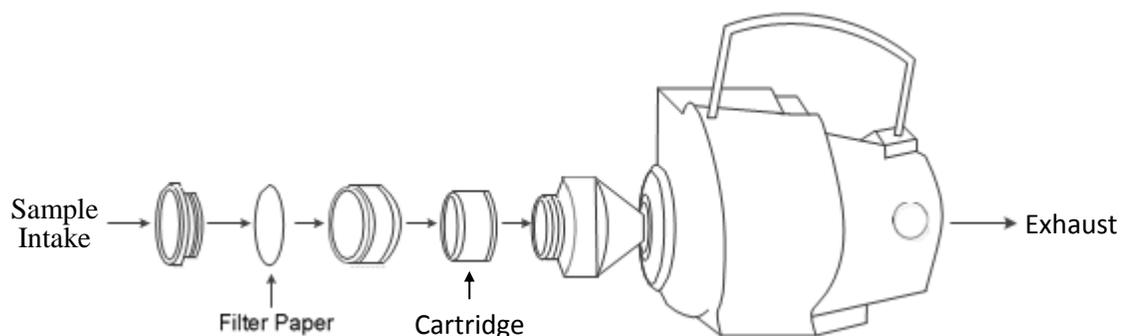
18.0 Place filter paper into filter holder with collection side toward sample intake. If the collection side is not indicated by the manufacturer, mark the collection side with a pen or marker so that any subsequent analyses can be performed on the collection side.

19.0 If iodine sampling is required, then place new iodine cartridge into holder with arrow pointing with direction of air flow. A dummy cartridge may be used if iodine sampling is not required and the air sampler has been calibrated with an iodine cartridge.

20.0 Set up sampler as shown below.



Example Sample Head – Ensure O-rings are in good condition and placed as required.



21.0 Place sample inlet in a location representative of the desired sample; a location that is far enough from a contaminated surface to prevent pulling surface contamination into the sample media.

ATTACHMENT 5

Sample Particulate and Iodine Using Standard Air Sampler

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22.0 For grab samples, estimate the time required to obtain the minimum volume by dividing the required sample volume by the flow rate; ensure units are consistent and convert as needed.

CAUTION

Do not operate a sampler where hydrogen may be approaching the Lower Explosive Limit (e.g. 2% to 4% H₂). Notify industrial safety personnel as needed for confirmation.

23.0 Turn on the sampler and verify, or adjust, the flow rate to be within 20% of the calibrated flow rate.

24.0 When the predetermined sample time or longer has passed, then stop the sampler and record the information as listed in section (6) on Attachment 1.

25.0 Remove sample collection media and place in a bag, exercising care to prevent cross contamination.

26.0 Determine the sample volume by multiplying the sampling time by the observed sample flow rate; ensure units are consistent and converted as needed.