ENVIRONMENTAL SAMPLING

1. GENERAL. Collecting and analyzing samples provides numerical data that describe a particular situation. The ASHG shall direct sampling procedures. The sampling criteria shall be situation and site dependent. The results then may be used for preparing a course of action. This page addresses air, soil, vegetation, water, and swipe samples.

2. AIR SAMPLING. Air sampling is conducted to determine if airborne contamination is present. It provides a basis for estimating the radiation dose that people without respiratory protection may have received. The time required to respond to an accident and initiate an air sampling program usually results in little or no data being obtained during the initial release of contamination when the highest levels of airborne contamination are expected. Most air sampling data obtained during an accident response shall reflect airborne contamination caused by resuspension. Even though this discussion is directed mainly at airborne contamination caused by resuspension, the recommended priorities and procedures shall allow as much information as possible to be collected on the initial release if air samplers are positioned soon enough. Priority should, therefore, be given to initiating an air sampling program as soon as possible after arrival on-scene. Whether or not data are obtained on the initial release, air sampling data are needed immediately to assess the hazard to people still in the area, to identify areas and operations that require respiratory protection, and to identify actions required to fix the contaminant to reduce the airborne hazard and spread of contamination. When using filtration to collect particulate samples, the selection of filter medium is extremely important. The filter used must have a high collection efficiency for particle sizes that deposit readily in the lung (5 microns or less).

a. Response plans should include provisions for establishing an air sampling program. This plan should include sufficient air monitors (battery powered or a sufficient number of portable electric generators), air monitor stands, filter paper, personnel to deploy samplers and collect filters, analysis capability, and a method to mark and secure the area monitors against tampering. Also important is a means to ensure that air samplers are properly calibrated (see Table 1.). Staplex® air samplers use the High Volume Calibration Kit (CKHV) calibrator for a 4-inch filter and CKHV-810 calibrator for the 8 x 10-inch filters. Usually, 1,000 cubic feet of air must be sampled for accurate results.

Table 1. Air Sampler Calibration

Filter Type	Calibration Kit	Flow Rate	Operation Time
4" TFA #41	CKHV	18 CFM	55 min
4" TFA #2133	CKHV	36 CFM	28 min
4" TFA “S”	CKHV	70 CFM	15 min
8" x 10" TFA-810	CKHV-810	50 CFM	20 min

3. AIR SAMPLING TIME

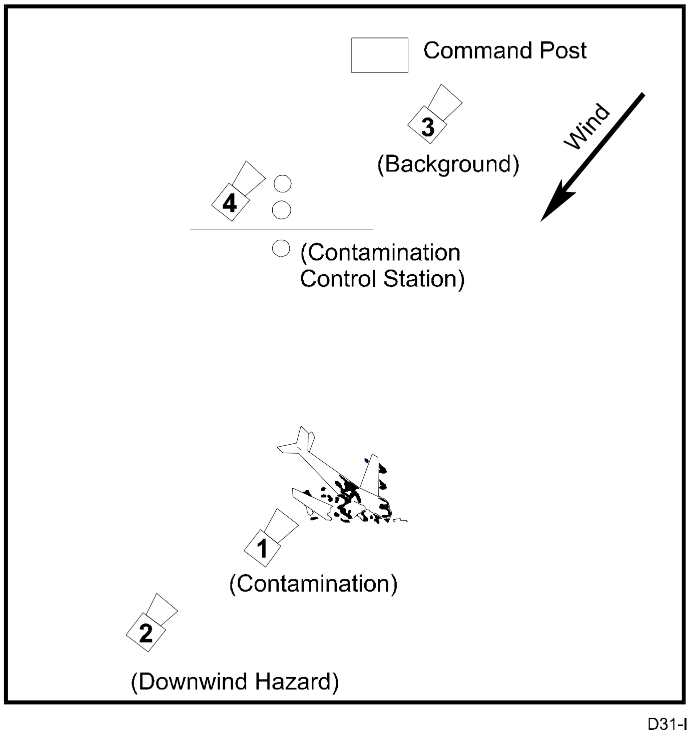
The period of time over which an air sample is collected and the volumetric sampling rate determine the volume of air sampled. Variables that affect the accuracy of air sampling results include the type of sampling equipment used, the accuracy with which contaminants on the filter may be measured, and the size of the sample. The sum of the errors may be offset, in part, by increasing the total volume of the sample collected. Increasing sample time presents no real difficulty when the interest is in long-term average concentrations, precision of results, or in detecting very low levels of contamination, as is the case during decontamination and remediation operations. During the initial response, when the interest is in rapid evaluation of air contamination to identify areas where high concentrations of airborne contamination might pose a hazard to unprotected persons in relatively short periods of time, short sampling times are appropriate. When taking samples for rapid evaluation, samplers should be operated long enough to sample at least 1,000 cubic feet of air. Once the data required for prompt evaluation are obtained, an air sampling program should be established to obtain 24-hour samples (equipment allowing), or high volume samples on a regular basis.

4. AIR SAMPLER PLACEMENT

Sampler positioning is directed toward the accident scene for the first 24 to 48 hours after an accident, or until an air sampling program tailored to the specific situation may be implemented. During this period, the number of air samplers available shall be limited and should be placed to get the maximum amount of information possible.

a. The amount of airborne contamination caused by resuspension varies from location to location as a function of surface type, physical activity, surface wind patterns, and the level of contamination on the ground. Recommendations on the initial placement of samplers assume that the mix of surface types is relatively constant throughout the area, that air samplers are placed to reduce any localized wind effects, and that the location of physical activity in the area (for example, response actions or evacuation) is known and controlled. The main variables in determining the amount of airborne contamination are ground contamination levels and wind speed. To provide the quickest and most accurate estimate of the maximum concentrations of airborne contamination, priority should be given to placing an air sampler at or near the most highly contaminated area that is accessible.

Figure 1. Air Sampler Placement



b. Figure 1. shows the recommended placement of air samplers. The sampler number indicates the priority that should be given to placement. All air sampling locations should be marked with a unique number or symbol on a stake so that data may be correlated with other information in the following days. During the initial response, sampler No. 1 is placed downwind from the accident site to determine the hazard in the immediate area of the accident and should operate continuously. The distance should be modified in a downwind direction, if necessary, to allow access by a clear path for placement and periodic readings and filter changes. The time of readings and/or filter changes should be coordinated with EOD personnel. Sampler No. 2 is placed downwind from the accident at a distance dependent on the wind velocity (see Table 2.). Changes to this location should be considered based on accessibility, the location of nearby populated areas, and microclimatology. Downwind samplers should be operated until it is found that no airborne contamination exists at their locations and that actions taken upwind of the location or changes in meteorological conditions do not result in airborne contamination. Sampler No. 3 is placed about 610m upwind of all contamination and outside the CCA to get simultaneous background air samples for use in interpreting other readings. Background samples should be collected concurrently with the sample of interest, if possible, since the amount of naturally occurring airborne radioactive particulates may vary as a function of time due to wind changes. Air sampler No. 4 is placed at the CCS and operated continuously during CCS operations, since personnel leaving the contaminated area may carry and resuspend contaminants. The amount of contamination resuspended in this manner is expected to be small. During the initial phases of response, consider using all additional samplers, if available, in downwind locations to supplement sampler No. 2, particularly when populated areas are in or near the contaminated area.

Table 2. Air Sampler Placement (No. 2) Distance

Wind Speed		**Approximate Downwind Distance**	
Miles Per Hour (MPH)	**(Knots)**	**(Meters)**	**(Feet)**
6 to 10	4 to 9	1,000	3,300
11 to 15	10 to 13	1,500	5,100
16 to 20	14 to 17	2,000	6,600
Above 20	Above 17	2,500	8,200

5. AIR SAMPLE DATA RECORDING

For air sampling data used in the overall radiological assessment and confirmation of field computations and confirmed later by laboratory analysis, all pertinent data must be recorded. An air sampling log containing all of the data in paragraphs 4.a. through 4.j. should be maintained. When filters are changed, they should be placed in a plastic bag for laboratory analysis and annotated with the following information:

a. Type and serial number of sampler.

b. Location of sampler, including identification of field marking (stake) used to mark location.

c. Average flow rate and/or volume of air.

d. Date.

e. Start and stop time of sample.

f. Wind direction and weather conditions.

g. Type of filter.

h. Field readings on filter and time made, particularly if readings were taken without changing filter, including radiation detection instrument type and serial number, as well as designation of attached probe used to monitor the filter.

i. Laboratory facility to which the filter was sent for processing.

6. AIR SAMPLE ANALYSIS

Air sampler filters may be analyzed using radioanalytical techniques by DOE/NNSA and AFRAT personnel, or by using a computation method. The computations shown in paragraphs 6.a. and 6.b. are for field use in computing gross activity on the filter. Any background radiation from naturally occurring radionuclides (i.e., radon, thoron(radon-220 isotope), and their progeny) should be subtracted when applying the computed results to protection standards. This is computed by subtracting the gross activity of the background sampler (No. 3) from the gross activity of the sampler of interest when making rapid evaluations. Background corrected results may also be obtained by letting the naturally occurring radon, thoron, and their progeny decay to background. The radon chain may be considered completely decayed after almost four hours, and the thoron chain after almost three days. Remeasurement after these times allows identification of the amount of sample activity caused by these elements. During rapid field computations early in the response, the check for radon is appropriate if, or when, levels of airborne contamination detected are at or slightly above the established levels. The three-day decay time prevents checking for thoron during the initial response.

a. The equation in Figure 2., below, may be used for initial field evaluation of air sampling data to get rough estimates of airborne contamination using the ADM-300, AN/PDR-77, or AN/PDR-56 (with the large probe attached) and 8 x 10-inch or 4-inch (round) Whatman #41 filters. Results measured in dpm/m^3.

Figure 2. Equation for Initial Field Evaluation of Air Sampling Data

$$\text{dpm/m}^3 = \frac{\text{CPM} \times \text{CF}}{\text{AFR} \times \text{T (min)}} - \text{Background Reading}$$

where:

CPM	=	Alpha meter reading on air filter in counts per minute
CF	=	Conversion factor (3,000 for ADM-300; 4,000 for AN/PDR-56) includes unit conversions, area correction factors, and other constants, assuming use of 8 x 10-inch Whatman #41 filter paper. For 4-inch, (round) filter paper, the conversion factors are 200 and 800 for the AN/PDR-77 and AN/PDR-56, respectively.
AFR	=	Average Flow Rate of the air sampler in CFM
T	=	Time in minutes the air sampler was running

b. If other alpha instruments or filters are being used, the equation in Figure 3. should be used for field evaluation of air sampling data. Results are measured in dpm/m^3.

Figure 3. Equation for Field Evaluation of Air Sampling Data

$$\text{dpm/m}^3 = \frac{\text{CPM} \times A_f}{0.5 \times m^3 \times F \times E_f \times E_c \times A_c}$$

where

CPM	=	Alpha meter reading on air filter in counts per minute
A_f	=	Area of filter used (any units)
m^3	=	Total volume of sampled air in cubic meters
F	=	Alpha absorption factor for filter used (from manufacturer's specifications)
E_f	=	Collection efficiency of filter used (from manufacturer's specifications)
E_c	=	Efficiency of counting instrument
A_c	=	Area of filter actually counted by the instrument (same units as A_f)

7. ENVIRONMENTAL SAMPLES

a. Soil. Soil sampling procedures depend on the purpose of the sampling program. In all cases, careful selection of control (background) samples is required to allow interpretation of results. The following minimum quantities are necessary for analysis:

(1) Gamma spectrometry plus gross alpha and/or gross beta: 2 kilograms of soil (about 1 square-foot area 3 inches deep).

(2) Gross alpha and/or gross beta only: 100 grams.

(3) For a specific alpha and/or beta radionuclide, particularly Pu-239, consult the appropriate Service laboratory.

b. Water. The following minimum quantities are necessary for analysis:

(1) Surface and/or waste discharge sources: 2 liters.

(2) Drinking water sources: 1 liter.

c. Vegetation. The minimum sample volume is 3 liters of densely packed sample and should be double plastic bagged or packed in a 1-gallon widemouth plastic jar.

d. Swipes. Filter paper discs are used for taking swipe tests. Whatman #41 filter paper, 4.25 cm, is recommended for swipes. If this is unavailable, other filter paper with a maximum diameter of l¾ inches may be substituted. Place a small “x” IN PENCIL ONLY on the outer edge of the filter paper on the side that is to touch the radioactive source or area being tested for contamination. Each swipe should be taken from an area of about 100 cm^2 by gently rubbing two or three times with the dry filter paper disc. The swipe is then placed, unfolded, in a properly completed Service form for a Swipe Container. If forms are unavailable, a plain envelope containing the required collection information may be substituted.