Separations Process Research Unit - Disposition Project (SPRU-DP)

Radioactive Air Emissions Application for Approval To Construct or Modify

G2 Enclosure Ventilation System

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Section A

Site Information

Separations Process Research Unit - Disposition Project (SPRU-DP)

Site Information

The Separations Process Research Unit (SPRU), located near Schenectady, New York, was operated from February 1950 to October 1953 for laboratory scale research and development on the REDOX (reduction/oxidation) and PUREX (plutonium-uranium extraction) processes. It supported operations at the Hanford Site (Washington State), and the Savannah River Site (South Carolina). The research was performed on a laboratory scale; SPRU never was a production plant. These activities left radioactive contamination inside the facilities.

- The main upper level SPRU Disposition Project facilities occupy approximately five acres on the 170-acre Knolls Atomic Power Laboratory (KAPL) site in Niskayuna, New York near the Mohawk River. KAPL is a U.S. Naval Nuclear Propulsion Program research and development facility operated under the auspices of the U.S. Department of Energy.

The SPRU facility (Figure A-1) consists primarily of two interconnected buildings (G2 and H2), portions of which lie underground:

- Building G2 – housed the laboratories, hot cells, separations process testing equipment, and the tunnel system beneath Building G2. Building G2 hot cells, equipment, ventilation/process piping systems, and tunnels contain residual radioactive contamination.
- Building H2 – used for liquid and solid waste processing. All areas of this building are contaminated or potentially contaminated.
- H2 Tank Farm (also known as the tank vaults) – a series of seven underground stainless steel tanks in concrete vaults along the eastern side of Building H2 used for storing liquid radioactive waste. The contents of these tanks have been consolidated into tank 509E.
- Pipe Tunnels – two concrete passageways: the first connecting Building H2 to Building G2; the second connecting Buildings G2, G1 and E1 (E1/G1 tunnels) which lie to the south and east of Building G2. The Pipe Tunnels contain radioactive piping and contaminated materials.

Figure A-1. Location of the SPRU Disposition Project (DP) Site

The facility is currently undergoing decontamination and decommissioning activities under the purview of the Department of Energy's (DOE) Office of Environmental Management (EM). In September 1992, the Department's Office of Nuclear Energy, (current organization is Office of Naval Reactors Laboratory Field Office [NRLFO]) and EM signed a Memorandum of Agreement (MOA) on decontaminating and decommissioning the SPRU facilities. The MOA was supplemented with the SPRU Functions, Assignments, and Responsibilities Agreement (FAR) in 2000, (current Revision 2, dated February 2009) establishing the roles and responsibilities of each Office regarding the decontamination and decommissioning of SPRU.

Upon the completion of the demolition and clean-up, and sampling to ensure the clean-up levels have been met, the land will be transferred back to the NRLFO for their continued mission use. EM and KAPL meet periodically to discuss mutual operations, and Project progress and issues.

Environmental Restoration

The SPRU site process facilities and adjacent land areas are managed by the U.S. Department of Energy. The entire Project scope is the removal of Buildings G2 and H2, including the G2 and H2 tunnels, as well as the decontamination of the E1/G1 tunnels and the tank vaults, and removal of contaminated soils. By the end of 2010, a considerable amount of work to this end had been accomplished.

Section B

Technical Emission Point Information

I. Name & Address of Applicant

(Owner) US Department of Energy – Separations Process Research Unit- Disposition Project
Knolls Atomic Power Laboratory
Knolls Site
2425 River Road
Niskayuna, NY 12309

(Project Contractor) URS (previously Washington Group International [WGI])
Separations Process Research Unit – Disposition Project Office
2345 Nott Street East, Suite 201
Niskayuna, NY 12309

II. Name & Location of Proposed Source

G2 Enclosure Ventilation System

Separations Process Research Unit Disposition Project
Knolls Atomic Power Laboratory
Knolls Site
2425 River Road
Niskayuna, NY 12309

Facility Coordinates:

Latitude	42 Degrees 49 Minutes North
Longitude	73 Degrees 52 Minutes West
Estimated Date of Shutdown:	To Be Determined

III. Release Point Information – Emission Point ID: G2 Enclosure Ventilation Exhaust

Ground Elevation - 330 ft. MSL (approximate),
Stack Height –6 ft (approximate, to centerline of horizontal stack),
Height above Structure – Not applicable. Horizontal stack approx. 6 ft above grade
Exhaust Duct Inside Dimensions - 48 inches dia. (nominal),
Exhaust Exit Temperature - 20-95°F, (ambient air),
Exhaust Exit Velocity - 30-45 ft/sec,
Exhaust Exit Flow Rate -32,000 actual cubic feet per minute (ACFM) nominal
Monitoring Category – Potential Impact Category (PIC) 2 (ANSI/HPS N13.1-1999, Table 2)

IV. Technical Information About Source

Ventilation Unit Nature (typical unit)

- Modular HEPA filtration unit capable of providing High Efficiency Particulate Air (HEPA) filtration
- HEPA filters are each tested by the manufacturer to 99.97% efficiency with 0.3 µm AD aerosol
- Installed system has two parallel filtration trains
- Each train has a pre-filter and two banks of HEPA filters in series
- Each HEPA filter bank is tested in place to 99.95% efficiency with 0.7 µm AD aerosol

Size

- Two trains with 24"W X 24"H X 11.5"D HEPA filters in banks of 12 filters (3 x 4 array), two banks (stages) in series (double HEPA)
- HEPAs and pre-filter rated design flow capacity of 16,000 ACFM for each train
- One (1) air mover on each train
- Overall dimensions of each of two (2) filter train modules – 30 ft L x 10 ft W x 8 ft H
- Overall dimensions of the exhaust air mixer (approximate) – 25ft L x 8 ft W x 8 ft H

Design

- Centrifugal fan air mover, with conventional bag-in/bag-out HEPA filter housing on each bank.
- Alarmed (high and low) differential pressure gage across each filter bank and flow indicators mounted in a modular horizontally-placed housing.

Design Operating Capacity (nominal)

- 32,000 ACFM @ 12" w.g.

Representative Sample Withdrawal

- Two (2) modular HEPA filter trains discharge through a common generic air mixing device. A shrouded probe mounted in a representative sampling location has been qualified in accordance with ANSI/HPS N13.1-1999 [Ref.1]
- 20-100 liter per minute (LPM) adjustable sample rate
- 47 mm dia. particulate sample filter
- Integrated sample volume indication
- Exhaust air flow rate indication

V. Method of Source Operation and Description of Emission Controls

This application is for installation and operation of a HEPA-filtered ventilation exhaust system for an enclosure to be constructed over the G2 building. The ventilation system will exhaust the G2 enclosure by discharging HEPA-filtered air to the environment through an integrated mixing and sampling system.

A source term that includes the estimated radioactive material inventory of Building G2 is the basis source term for this application. Use of this ventilation system will result in actual emissions of lesser magnitude than modeled because the modeled filtration efficiency for each stage (99%) is conservative with respect to the actual in-place tested efficiency for each bank (99.95%). Each train with the dual HEPA filtration is tested to be 99.999975% efficient. The optional use of portable HEPA ventilation units (PVUs) inside the enclosure for actual work in the more contaminated areas adds another expected abatement factor which is not included in the G2 Building enclosure abatement calculation. The type of work supported by this enclosure ventilation system includes, but is not limited to, packaging and removal of the G2 Building components from rooms and cells, decontamination of rooms and cells, and decontamination of the accessible portions of the structure covered by the enclosure.

Portable HEPA ventilation units (PVUs) operating on localized contaminated areas within the enclosure will also discharge to the G2 enclosure exhaust system. PVU emissions are not calculated in this application since their discharges will be monitored by the G2 enclosure ventilation sampling system.

The G2 enclosure ventilation system has two trains of equipment in parallel. Each train is equipped with a spark arrestor, pre-filter, and two HEPA filter stages in series. The HEPA filters are tested and operated according to DOE regulations and guidance, and in accordance with Project procedures. These procedures include preoperational and annual in-place testing, annual calibrations of flow meters, and frequent monitoring by technicians for dose rate buildup, filter loading, and filter breaches. The G2 enclosure ventilation emissions are monitored for radioactivity with a continuous air particulate sampler near the point of discharge. Differential pressure across each HEPA filter bank is monitored, alarmed and interlocked to automatically place the system in a safe condition if the differential pressure is outside the acceptable operating range. Both sample flow rate and ventilation duct flow rate are measured and displayed using calibrated instruments.

It should be noted that this system consists of two dual-HEPA-filtered exhaust trains operating singly or in combination. The system discharges to the environment through a single mixing chamber and a continuously sampled exhaust duct. (See Attachment D, Equipment Sketches and Specification Details.) Depending upon the configuration required to maintain enclosure negative air pressure, one or both trains may be in operation at a given time.

Radioactive Emission Estimates

The source terms (emissions) herein have been derived from analytical data, empirical measurements, and estimates of contaminant distribution based upon historical documentation and process knowledge. The dose to the maximally exposed offsite individual (MEOSI) was calculated using an EPA-approved dispersion code, CAP88-PC Version 3. 0. [Ref. 2] Due to the density and close proximity of residences to several sector boundaries, the location of the MEOSI may shift year-to-year if annual dispersion results change slightly in relation to the 1989-2004 base period used in this analysis.

The source term that is used to calculate the effective dose equivalent (EDE) to the MEOSI is derived from the entire radioactive material inventory of the components and structures within the G2 enclosure. Dose calculations are based on G2 enclosure emissions from a duct at a six foot (approximately two-meter) elevation. The abated dose to the MEOSI based on processing the entire radioactive material inventory (G2 Building and sumps) is calculated to be 3.2E-05 mrem/year, as shown in Attachment A.

Technical Information About Sampling

The sampler unit for collecting airborne particulate from the G2 enclosure ventilation exhaust ducting will be a stand-alone unit consisting of a filter assembly and a vacuum pump of sufficient capacity to withdraw a sample continuously through a 47 mm diameter filter for up to ten days without unacceptable filter loadup. The sampler will be a continuous system designed and operated as a PIC 2 source as defined in ANSI N13.1-1999. Typically, samples will be changed weekly for units in continuous operation. Sampler system maintenance, filter handling, operation, calibration, and documentation will be specified in Project procedures. The sampling will be in compliance with the Quality Assurance Project Plan [Ref. 3] specific to SPRU's radiological NESHAP-related activities, and with ANSI/HPS N13.1-1999.

The sample withdrawal point will be within the center area of the duct, and will be a shrouded probe design as described in ANSI/HPS N13.1-1999. The use of a mixing box that is scaled from a tested stack design that has successfully passed proof testing per Section 5.2.2.2 of ANSI/HPS N13.1-1999 will ensure collection of a representative sample.

Sample filters will generally be changed and assayed for gross radioactivity weekly. The filters will be composited in quarterly batches and analyzed for the radionuclides of concern listed in Table A-1 in Attachment A, using 40 CFR 61 Appendix B, Method 114, EPA-approved measurement techniques. [Ref. 4; also see the Quality Assurance Project Plan, Ref.3.]

Analytical detection levels allow monitoring sample activity at levels that would indicate an increase before it became a cause for operational concern. Detection of radioactivity above normal operational levels will be cause for management notification, verification testing, and evaluation of the potential release.

Summary

In summary, the management of G2 enclosure emissions presented here shows that, under normal operating conditions, the planned G2 enclosure ventilation unit will, through a combination of engineered controls and operational limitations, limit environmental releases of radioactivity to levels well below the 40 CFR 61 Subpart H dose limits.

Section C

G2 Enclosure Ventilation Exhaust Monitoring for Radioactivity

G2 Enclosure Ventilation Exhaust Monitoring for Radioactivity

Purpose

The G2 enclosure ventilation exhaust monitoring at the Separations Process Research Unit (SPRU) Disposition Project (SPRU-DP) has two major purposes:

- Provide accurate assessment of normal operations
- Provide accurate and timely assessment of upset radioactivity releases.

To properly quantify and assess the impacts of radioactivity present in effluent air, a continuous integrated sample is periodically withdrawn and measured offline. This provides for accurate and quality-controlled laboratory measurement of radionuclides present in the discharge stream. Radiological screening of particulate radioactivity on the sample filters is conducted using onsite gas proportional alpha-beta counters. The screening data are used to assess weekly and cumulative emissions for radioactivity trends. The filters are composited quarterly and sent to a laboratory offsite for isotopic analysis.

Upon identification of elevated gross particulate radioactivity in either workspace airborne monitoring or in ventilation exhaust samples, further filter analysis will be conducted onsite, and area surveys will provide information required for rapid dose assessment. Additional off-normal processes are described in the SPRU-DP NESHAPs Quality Assurance Project Plan. [Ref. 3]

Scope

The sampling pump is sized to provide the sample flow rate required for the shrouded probe. The shrouded probe has been tested and qualified for specific combinations of exhaust flow velocity and nozzle inlet velocity. The sample pump installed on the exhaust duct sample train is sized to the nozzle's operating requirements with the design sampling range of 30 -70 LPM for an exhaust flow range of 16,000 - 32,000 CFM. The normal sampling rate is 55 - 60 LPM for an exhaust flow rate of 30,000 - 32,000 CFM. This design provides optimum sensitivity for the sampler by collecting suitably-sized volumes, consistent with the ANSI/HPS N13.1-1999 requirements. [Ref. 1] The analysis of the sample filters will provide documented radioactive airborne particulate emissions data when combined with the measured system exhaust flow rate and sample withdrawal rate.

System Design

The G2 enclosure ventilation sampling system is designed to meet the applicable criteria in ANSI/HPS N13.1-1999, as referenced by 40 CFR 61 Subpart H. [Ref. 4] The shrouded withdrawal probe is specifically sized and ported to withdraw a sample from a single representative point, a well-characterized measurement location with uniform velocity and particulate distributions within the effluent duct, and the sample line and nozzle are designed to meet the Standard's requirements for aspiration and transport efficiency of 10 µm diameter particles. (See Attachment D for nozzle specifications.)

The measured exhaust flow rate is used to adjust the sampling rate if the ventilation flow changes. Sample transport lines to the collection devices are sized to provide nonrestrictive turbulent flow under normal conditions. The sample line provides a long-radius bend for ninety-degree turns. Joints in the sample withdrawal section use butt-joined connectors that allow easy maintenance and component replacement as well as internally smooth surfaces critical to ensuring adequate particle penetration. Materials used in sample transport lines and connectors are corrosion resistant conductive metals non-reactive to the intended sample stream (e.g., stainless steel) in order to maintain stable internal pipe wall conditions and prevent line loss due to static electricity buildup. Heat tracing will be used if needed to maintain sample line temperatures well above the dew point for the sample stream being monitored, although for typical ambient air use this is not expected to be necessary.

The accurate quantification of radionuclide emission relies on several variables, including precise unbiased measurement of sample volume. This critical factor is controlled by utilizing air flow measuring devices calibrated by traceable instruments corrected for temperature, vacuum, and intrinsic instrument bias to initially qualify the sampling system and periodically verify accuracy. Installed calibrated air flow indicators provide system performance stability verification and total sample volume for routine sample collection.

The exhaust flow from the ventilation system will initially be tested for velocity, temperature, humidity, and flow direction in accordance with Methods 1 and 2 of 40 CFR 60, Appendix A. [Ref. 5] Testing and inspection will be performed and documented for the operational life of each system, as applicable, in accordance with ANSI/HPS N13.1-1999. The full qualification and maintenance requirements will be applied as applicable under the ANSI/HPS Standard graded approach recommendations.

The ventilation system sampling and filtration equipment, flow measurements, sampling system operation, sample media controls, system parameter data management, and attendant data reduction and calculations are subject to an overall site quality assurance plan. In addition, a NESHAPs-specific quality requirements document, SPRU-ENV-012, Quality Assurance Project Plan for Measurements of Radionuclide Air Concentrations for Rad NESHAP Compliance at the SPRU-DP, consistent with Method 114 of Appendix B in 40 CFR 61 and in accordance with ANSI/HPS N13.1-1999, is specifically directed to radioactive airborne emissions-related monitoring.

System Operation

The 47 mm diameter filter sample media are typically changed on a weekly schedule, at which time any minor adjustments to flow rate or sample line temperature are made and recorded. Sample media are counted upon removal and after a holding period (for natural isotope decay) on a laboratory instrument for gross radioactivity, and filter composites are analyzed quarterly for Sr-90, gamma emitters (Cs-137), and alpha isotopic (Pu-238/239/240, Am-241) parameters at an offsite laboratory.

The sample flow and exhaust flow will be determined empirically and documented for the G2 enclosure ventilation system. The radioactivity release quantity will be calculated based upon the relative flow rates and the radionuclide analytical values in a given sample composite or individual filter.

System Performance

For a sampler operating at 60 LPM, the sensitivity is typically 5E-18 µCi/mL for alpha isotopes, 5E-17 µCi/mL for Sr-90, and 5E-17 µCi/mL for Cs-137 in a quarterly composite. Actual flow rates will be measured and emission calculations will be based upon the empirical measurements.

Section D

Ventilation Exhaust Filtration Efficiency Testing and Acceptance Criteria

G2 Enclosure Ventilation Exhaust Filtration Efficiency Testing and Acceptance Criteria

G2 Enclosure Ventilation Exhaust Filtration Efficiency Testing

Ventilation is filtered through two (2) HEPA filter trains. Each train at minimum has a pre-filter, and two (2) HEPA filter banks (stages) in series that meet nuclear air cleaning efficiency standards and have been tested to demonstrate compliance with those standards. In addition, a filter differential pressure indicator allows an objective measurement of filter resistance (loading) for maintaining adequate design filtration within equipment specifications, and feedback for limit controls. Periodic (annual) challenge testing of each bank (stage) of the in-place HEPA filters is documented.

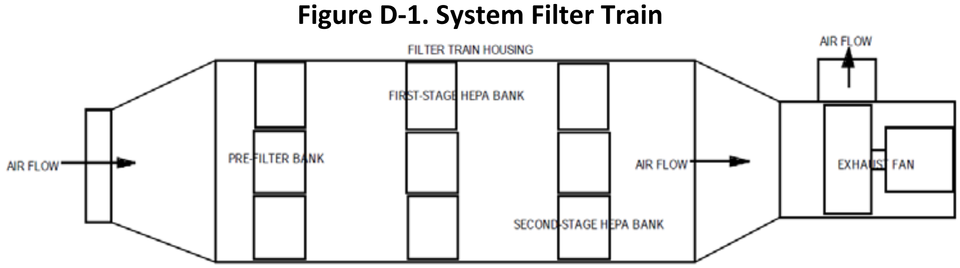
Filter differential pressures are checked to be within the unit recommended operating range (per the manufacturer's recommendations) prior to startup in a radiological application. An alarm indicates if the filter's differential pressure exceeds high or low set point limits during operation.

G2 Enclosure Ventilation System Aerosol Test Procedures and Acceptance Criteria

HEPA filters are used at the SPRU-DP in forced air ventilation systems to remove radioactive particulates from ventilation exhaust streams. These filters are individually tested by the manufacturer to be 99.97% efficient or greater for removal of particles of 0.3 µm aerodynamic diameter (AD). To assure that these filters are installed and functioning properly, a dioctyl phthalate (DOP), or approved equivalent aerosol challenge test is performed on each bank (stage) of the HEPA filter train prior to initial operation and after filter replacement. The test is conducted on each as-installed bank of HEPA filters in the ventilation system. For HEPA filters in series, each bank (stage) is separately tested. HEPA filter systems operating at the SPRU-DP are tested annually. Systems tested in place, including the G2 enclosure ventilation system module HEPA banks, must demonstrate a removal efficiency of at least 99.95% (0.0005 penetration) for 0.7 µm AD aerosols per DOE standards. A double HEPA filter train (filter banks in series) would have a tested efficiency of 0.0005 times 0.0005 (0.00000025 penetration, or 99.999975% removal efficiency) for 0.7 µm AD aerosols. [Ref. 6] Pre-filters are installed per manufacturer's instructions, and are not given an efficiency rating.

The G2 enclosure ventilation system will consist of two (2) parallel filter trains each containing a pre-filter (non-tested), a first-stage HEPA filter bank (tested), a second-stage HEPA filter bank (tested), and an exhaust fan.

Figure D-1. System Filter Train



Section E

References

References

1. American National Standards Institute, *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*, ANSI/HPS N13.1-1999

2. CAP88-PC Version 3.0 User Guide, USEPA Office of Radiation and Indoor Air, Washington, DC. December 09, 2007

3. Quality Assurance Project Plan for Measurements of Radionuclide Air Concentrations for Rad NESHAP Compliance at the SPRU-DP, SPRU-ENV-012, May 2011

4. 40 CFR 61 Subpart H, National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities

5. 40 CFR 60, Standards of Performance for New Stationary Sources, Appendix A, Test Method 1, Sample and Velocity Traverses for Stationary Sources; and Method 2, Determination of Gas Velocity and Volumetric Flow Rate

6. DOE HDBK-1169-2003, Nuclear Air Cleaning Handbook, 2003

Supporting References:

1. Andrew R. McFarland et al. *A Generic Mixing System for Achieving Conditions Suitable for Single Point Representative Effluent Air Sampling*, Health Physics 76(1)17-26, January 1999

2. Mark L. Maiello and Mark D. Hoover, *Radioactive Air Sampling Methods*, CRC Press, 2011

Attachment A

Source Term and Radiological Impact Modeling

Source Term and Radiological Impact Modeling

Introduction

Section B, "Technical Emission Point Information," and Section C, "G2 Enclosure Ventilation Exhaust Monitoring for Radioactivity," provide a description of the G2 enclosure ventilation system and associated sampler unit. These sections also provide the methodology for monitoring and managing the emissions from the G2 Building enclosure ventilation system. This section (Attachment A) provides the inventories, source terms (calculated emissions), and the resulting effective dose equivalent (EDE) to the maximally exposed offsite individual (MEOSI).

Source Term Identification

The source term is derived from the entire inventory of radioactive materials associated with the G2 Building process equipment, sumps, and rooms.

The G2 Building will be covered with an enclosure that maintains a negative internal pressure. The enclosure will be exhausted through a ventilation system equipped with pre-filters and dual HEPA filters, which consist of two banks in series. The removal of the G2 building contents and the decontamination of the remaining structural shell will be conducted within the enclosure.

The prospective dose assessment related to work activities inside the G2 enclosure is based on the following assumptions:

- All emissions from the work activities are exhausted through the G2 enclosure ventilation system
- All emissions are released from the G2 enclosure exhaust duct. Prospective doses to offsite receptors are calculated from a location in the center of the SPRU DP work area and occur within a single calendar year Note that retrospective doses that are included in compliance reports would typically be calculated based on a single emission point in the center of the KAPL site, which also is consistent with the location specified in Section B II.
- The doses for the nearby businesses and residents were determined using CAP88-PC Version 3.0 [Ref. A-1] with KAPL meteorological data from 1989 to 2004 and calculated emissions.
- The abated point source emission is based on the physical state factor in Appendix D of 40 CFR 61, [Ref. A-2] and the abatement provided by air filtration systems (0.01 for each of two HEPA filters in series)
- The emissions are modeled as point sources from a two-meter high horizontal stack with an assigned discharge momentum of zero. Because the momentum is assumed to be zero (no

direct upward direction, i.e. zero velocity), the calculated dose is conservative. The diameter of the duct at the point of discharge does not affect the calculated doses within the calculation uncertainty range. If the velocity is set to 0.001 m/s, as is the practice in some models, there is no difference in the reported dose.

- For receptor locations, the rural food option in CAP88-PC was selected. The doses reported by CAP88 at the business locations are divided by three to obtain the receptor dose at each business location
- The analysis includes all radionuclides that are expected to be in the process source term as well as all radionuclides that were detected in analyzed characterization samples. Four radionuclides (Cs-137, Sr-90, Pu-239 and Am-241) accounted for 98% of the potential dose to an offsite receptor.

Background of Calculation

CALCULATION METHODS

The radioactive material inventory from Building G2 is used to determine the source term for the EDE calculation. Appendix D factors are used in both the abated and unabated calculations to determine the emissions amount in curies: [Ref. 2]

$$E = (ST)(PS)(CF) \qquad \text{(A-1)}$$

Where

E = Emissions, curies

ST = Source Term or source inventory, curies

PS = Physical State factor, dimensionless

CF = Effluent Control Factor adjustment, dimensionless

And:

The Physical State factor (PS) for particulates is given in Appendix D of 40 CFR 61 (for materials below 100 degrees C):

$PS_{particulate}$ = 1E-03

The PS for C-14 is conservatively assumed to be one, although it was collected in particulate form in SPRU-DP characterization samples. For C-14, the CF_{HEPA} of 0.01 was applied for each of two HEPA filters since there is no process that would produce a gaseous product from the particulate form.

And:

The effluent Control Factors (CF) are those given in Table 1 of Appendix D.

For emission estimates:

$CF_{unabated} = 1$

$CF_{HEPA} = 0.01$ (for each of two HEPA filters)

Radioactive Material Inventory

The radioactivity inventory estimates for the material inside the G2 Building enclosure are tabulated in Table A-1. The relative abundance of each minor radionuclide was proportioned to Pu-239 for plutonium and alpha emitters, or to the total Cs-137 plus Sr-90 inventory for beta-gamma emitters, based on laboratory analysis of characterization samples. Note that Sr-90 and Cs-137 progeny are included.

Table A-1. G2 Building Enclosure Radioactive Material Inventory[1] (Ci)

Radionuclide	G2 Building Inventory in Curies (ST)
Cs-137 *	5.7
Ba-137m	5.7
Pu-239 *	1.2
Am-241 *	0.18
Sr-90 *	1.2
Y-90	1.2
U-233	1.0E-03
U-234	7.5E-03
U-235	3.1E-04
U-238	5.2E-03
C-14	4.2E-04
Fe-55	2.3E-04
Ni-63	3.2E-04
Pu-238	1.6E-02

[1] G2 quantities were determined from a combination of sources including sludge results from Tank 509E (H2TS-C-2), the Historical Site Assessment, SPRU-REC-10-012 and SPRU-REC-10-015.

Pu-241	1.6E-01
Pm-147	2.2E-02
Tc-99	5.4E-04
Th-228	5.8E-05
Th-230	5.2E-06
Th-232	4.7E-05
TOTAL	**15.39**

***** Radionuclide of concern

Unabated Source Term Calculation

Using the Physical State factors from Appendix D, an unabated source term, which is the emissions potential without engineered controls, was developed from the radioactive material inventory, using equation A-1. The estimated emissions using Equation A-1 for Cs-137 for the G2 enclosure are:

$$E = (ST)(PS)(CF)$$

$$E = (5.7)(1.00E-03)(1)$$

$$E = 5.7E-03\,Ci$$

The unabated emissions (source term) results for the G2 Building enclosure radionuclide inventory are provided in Table A-2.

Table A-2. G2 Building Enclosure Unabated Source Term

Radionuclide	G2 Building Inventory in Curies (ST)	Physical State Factor (PS)	Control Factor (CF)	Source Term in Curies (E)
Cs-137	5.7E+00	1E-03	1	5.70E-03
Ba-137m	5.7E+00	1E-03	1	5.70E-03
Pu-239	1.2E+00	1E-03	1	1.20E-03
Am-241	1.8E-01	1E-03	1	1.80E-04
Sr-90	1.2E+00	1E-03	1	1.20E-03
Y-90	1.2E+00	1E-03	1	1.20E-03
U-233	1.0E-03	1E-03	1	1.00E-06
U-234	7.5E-03	1E-03	1	7.50E-06
U-235	3.1E-04	1E-03	1	3.10E-07
U-238	5.2E-03	1E-03	1	5.20E-06
C-14	4.2E-04	1	1	4.20E-04
Fe-55	2.3E-04	1E-03	1	2.30E-07
Ni-63	3.2E-04	1E-03	1	3.20E-07
Pu-238	1.6E-02	1E-03	1	1.60E-05
Pu-241	1.6E-01	1E-03	1	1.60E-04
Pm-147	2.2E-02	1E-03	1	2.20E-05
Tc-99	5.4E-04	1E-03	1	5.40E-07
Th-228	5.8E-05	1E-03	1	5.80E-08
Th-230	5.2E-06	1E-03	1	5.20E-09
Th-232	4.7E-05	1E-03	1	4.70E-08

Abated Source Term Calculation

The emissions potential that includes engineered controls was developed from the radioactive material inventory given in Table A-1. The estimated abated emissions using Equation A-1 for Cs-137, for example, are:

$$E = (ST)(PS)(CF)$$

$$E = (5.7)(1.00E-03)(0.01)(0.01)$$

$$E = 5.7E-07\ Ci$$

The abated emissions results for the G2 Building enclosure radionuclide inventory are provided in Table A-3.

Table A-3. G2 Building Enclosure Abated Source Term

Radionuclide	G2 Building Inventory in Curies (ST)	Physical State Factor (PS)	Control Factor (CF)	Source Term in Curies (E)
Cs-137	5.7E+00	1E-03	1E-04	5.7E-07
Ba-137m	5.7E+00	1E-03	1E-04	5.7E-07
Pu-239	1.2E+00	1E-03	1E-04	1.2E-07
Am-241	1.8E-01	1E-03	1E-04	1.8E-08
Sr-90	1.2E+00	1E-03	1E-04	1.2E-07
Y-90	1.2E+00	1E-03	1E-04	1.2E-07
U-233	1.0E-03	1E-03	1E-04	1.0E-10
U-234	7.5E-03	1E-03	1E-04	7.5E-10
U-235	3.1E-04	1E-03	1E-04	3.1E-11
U-238	5.2E-03	1E-03	1E-04	5.2E-10
C-14	4.2E-04	1	1E-04	4.2E-08
Fe-55	2.3E-04	1E-03	1E-04	2.3E-11
Ni-63	3.2E-04	1E-03	1E-04	3.2E-11
Pu-238	1.6E-02	1E-03	1E-04	1.6E-09
Pu-241	1.6E-01	1E-03	1E-04	1.6E-08
Pm-147	2.2E-02	1E-03	1E-04	2.2E-09
Tc-99	5.4E-04	1E-03	1E-04	5.4E-11
Th-228	5.8E-05	1E-03	1E-04	5.8E-12
Th-230	5.2E-06	1E-03	1E-04	5.2E-13
Th-232	4.7E-05	1E-03	1E-04	4.7E-12

MEOSI Dose Calculation

The estimated dose to the MEOSI residing at a location 540 meters from the center of the SPRU-DP work area in the south-southwest sector has been calculated for the activities that could occur during the identified scope of work within the ventilated G2 enclosure.

The unabated dose was calculated using CAP88-PC Version 3.0. The resulting CAP88 dose reports demonstrate that four major radionuclides (Cs-137, Sr-90, Pu-239, and Am-241) account for more than 98% of the dose to an offsite individual. Table A-4 (from Attachment C-1, Unabated CAP88-PC Dose Runs) shows the relative percentage of doses attributed to the radionuclides (including daughters) within the G2 Building enclosure. Therefore monitoring of other radionuclides in the point source effluent is not required.

Table A-4. G2 Enclosure Unabated Dose Summary by Key Radionuclide

Nuclide	Dose to MEOSI (mrem/yr)	% of Total Dose
Cs-137	5.69E-02	**17.8%**
Ba-137m	1.45E-03	**0.5%**
Pu-239	1.71E-01	**53.5%**
U-235	0.00E+00	0.0%
Th-231	2.26E-09	0.0%
Pa-231	0.00E+00	0.0%
Ac-227	0.00E+00	0.0%
Th-227	0.00E+00	0.0%
Fr-223	0.00E+00	0.0%
Sr-90	2.20E-02	**6.9%**
Y-90	7.61E-05	0.0%
U-233	8.28E-05	0.0%
Th-229	0.00E+00	0.0%
Ra-225	0.00E+00	0.0%
U-234	6.08E-04	0.2%
Th-230	6.15E-07	0.0%
Ra-226	0.00E+00	0.0%
Rn-222	0.00E+00	0.0%
Po-218	0.00E+00	0.0%
Pb-214	0.00E+00	0.0%
At-218	0.00E+00	0.0%
U-235	2.27E-05	0.0%
U-238	3.61E-04	0.1%
Th-234	2.14E-07	0.0%

Nuclide	Dose to MEOSI (mrem/yr)	% of Total Dose
Pa-234m	2.13E-07	0.0%
Pa-234	0.00E+00	0.0%
C-14	2.90E-05	0.0%
Fe-55	8.13E-09	0.0%
Ni-63	1.72E-08	0.0%
Pu-238	2.28E-03	0.7%
U-234	0.00E+00	0.0%
Pu-241	2.58E-04	0.1%
Am-241	6.45E-02	**20.2%**
Np-237	0.00E+00	0.0%
Pa-233	0.00E+00	0.0%
U-237	0.00E+00	0.0%
Pm-147	1.10E-06	0.0%
Sm-147	0.00E+00	0.0%
Tc-99	1.90E-06	0.0%
Th-228	1.95E-05	0.0%
Ra-224	5.32E-09	0.0%
Rn-220	0.00E+00	0.0%
Th-232	9.85E-06	0.0%
Ra-228	0.00E+00	0.0%
Ac-228	0.00E+00	0.0%
TOTAL	**3.20E-01**	**100.0%**

Table A-5 presents a source term development summary for these four key radionuclides identified in Table A-4. Note that the unabated emissions were used as input for the CAP88-PC run represented in Attachment C-1, and abated emissions for the CAP88-PC run represented in Attachment C-2.

Table A-5. G2 Enclosure Source Term Development Summary by Key Radionuclide

	Cs-137	Sr-90	Pu-239	Am-241
Radioactive Material Inventory (Ci)	5.7E+00	1.2E+00	1.2E+00	1.8E-01
Physical State (PS) Factor	1E-03	1E-03	1E-03	1E-03
Unabated Source Term (CAP88-PC Input) (Ci)	5.7E-03	1.2E-03	1.2E-03	1.8E-04

	Cs-137	Sr-90	Pu-239	Am-241
Control Factor for Two(2) HEPA Filters in Series	(0.01*0.01)	(0.01*0.01)	(0.01*0.01)	(0.01*0.01)
Abated Source Term (CAP88-PC Input) (Ci)	5.7E-07	1.2E-07	1.2E-07	1.8E-08

These calculations overestimate likely releases because filtration systems are tested to 99.9+% efficiency performance. Table A-6 summarizes the doses estimated using the above emissions.

Table A-6. G2 Building Enclosure MEOSI Dose Summary (mrem/yr)

Source Area	Cs-137*	Sr-90*	Pu-239	Am-241	TOTAL
G2 Enclosure - **Unabated Dose** (see Attachment C-1)	5.84E-02	2.21E-02	1.71E-01	6.45E-02	3.16E-01
G2 Enclosure - **Abated Dose** (see Attachment C-2)	5.84E-06	2.21E-06	1.71E-05	6.35E-06	3.15E-05

* Includes progeny

Summary

The source terms, calculated emissions, and calculated abated EDE are provided in Table A-6. Given the unabated dose (EDE) of 0.32 mrem to the MEOSI, per 40 CFR 61.93(e) and 40 CFR 61(f), the designated monitoring category (in accordance with ANSI/HPS N13.1-1999) is PIC 2, requiring continuous sampling for record of emissions with retrospective offline periodic analysis. [Ref. A-3]

The calculated EDE to the MEOSI is 3.2E-05 mrem/yr for the abated emissions. This dose is based on the source terms, adjustment factors and abatement factors from 40 CFR 61 Appendix D, and the activities that could occur during the identified scope of work. It is a conservative dose calculation that overestimates the actual dose because the HEPA filters are more effective than modeled, and because the Project ALARA program will further reduce actual emissions.

Based upon unabated emissions and to verify operations as expected, the G2 Building enclosure ventilation exhaust will be continuously measured with an ANSI/HPS N13.1-1999 compliant sampler operating under PIC 2 requirements. [Ref. 1] (See Attachment D)

References

A-1. CAP88-PC Version 3.0 User Guide, USEPA Office of Radiation and Indoor Air, Washington, DC. December 09, 2007

A-2. 40 CFR 61, Appendix D, Methods for Estimating Radionuclide Emissions, December 1989

A-3. American National Standards Institute, Sampling and Monitoring Release of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities, ANSI/HPS N13.1-1999

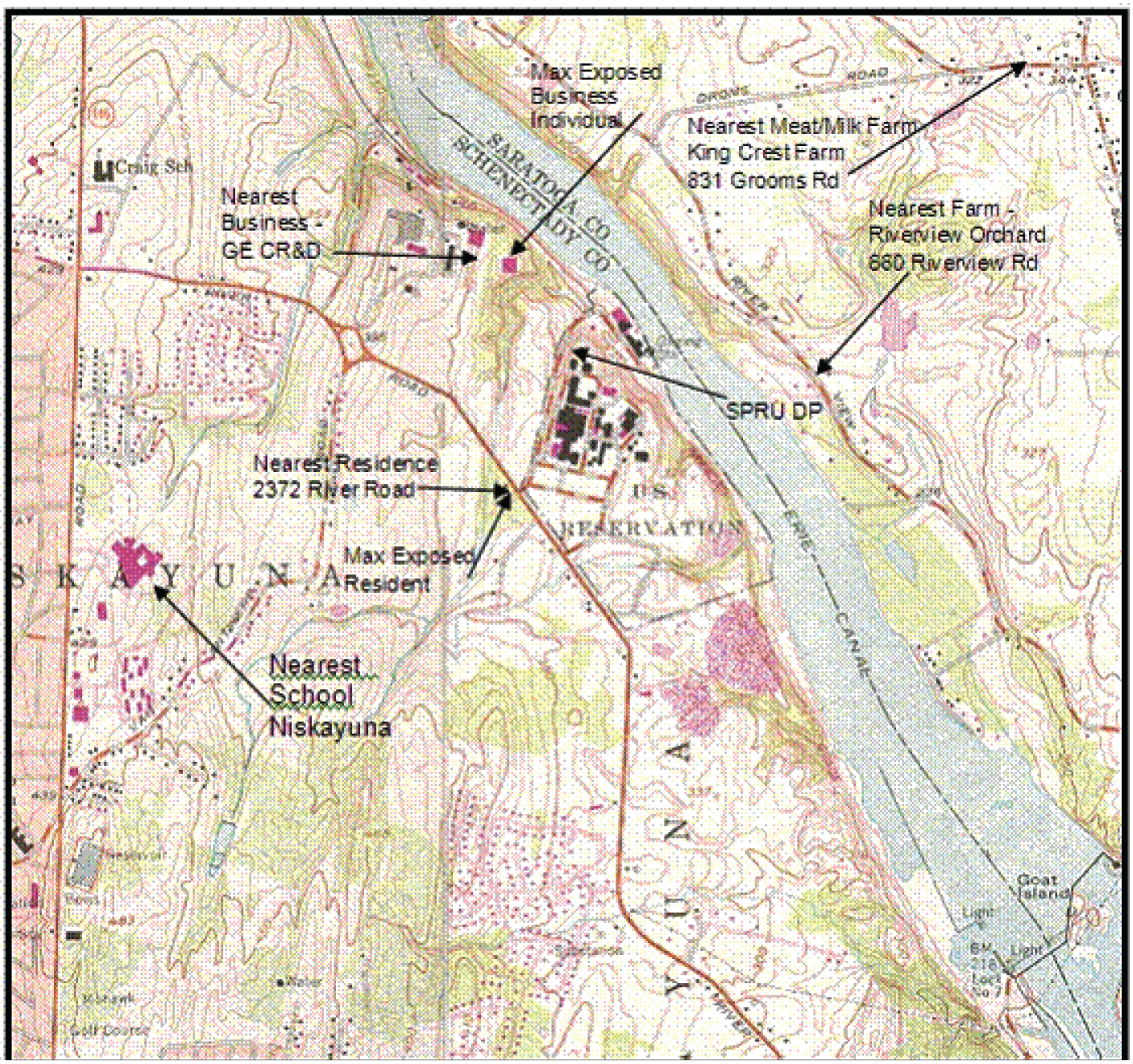
Attachment B

Meteorological Monitoring and Airborne Radionuclide Dispersion Modeling at SPRU-DP

Meteorological Monitoring and Airborne Radionuclide Dispersion Modeling at SPRU

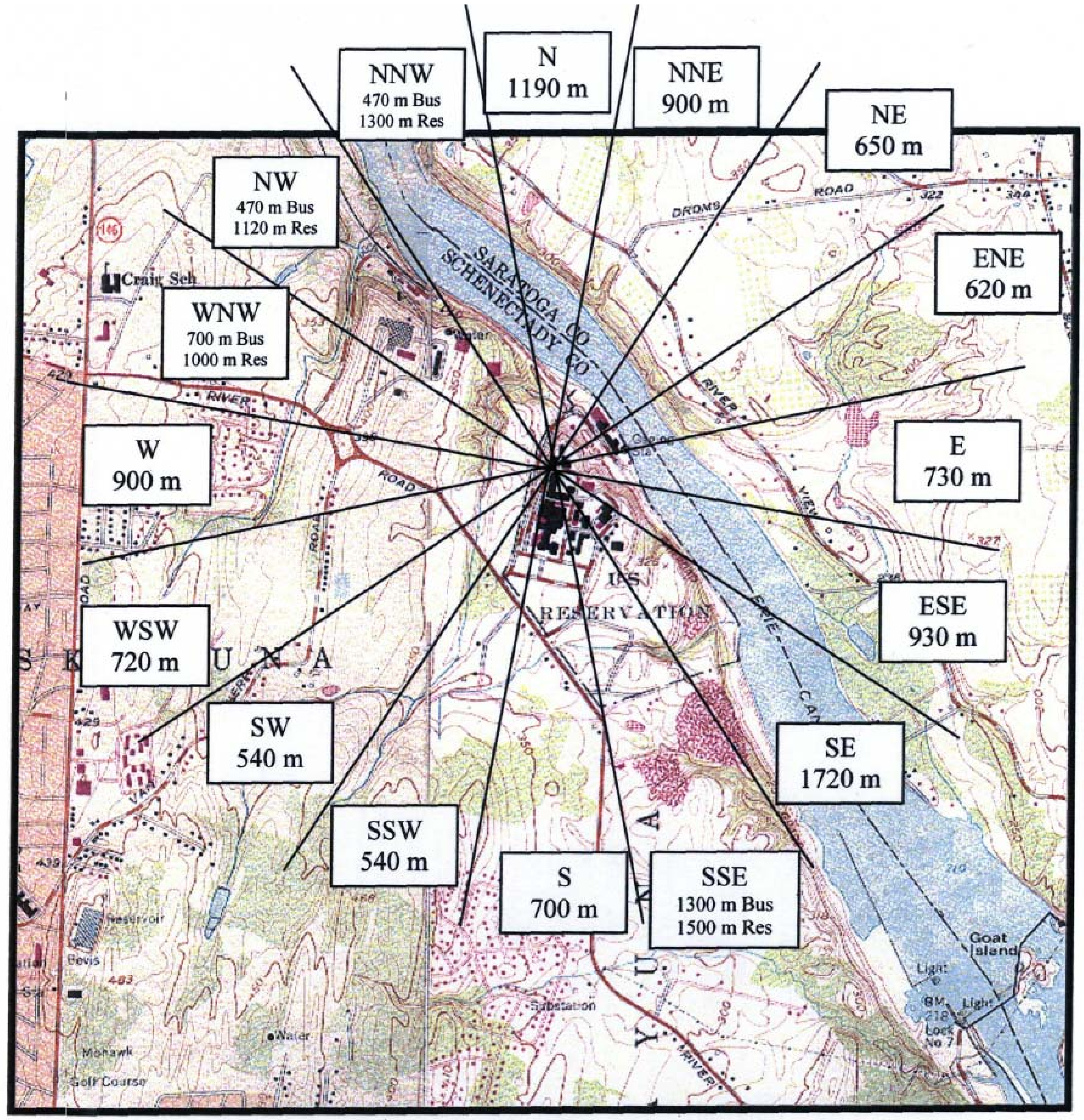
All meteorological data are derived from KAPL. The environs and key receptor locations are shown below in Figure B-1. Figure B-2 lists the locations of receptors in each of 16 sectors around the center of the SPRU-DP work area.

Figure B-1. Location of the SPRU-DP Relative to Adjacent Sites and Key Receptors



The KAPL meteorological program data from 1989-2004 were used to prepare prospective dose estimates for the planned activities associated with G2 D&D. Appropriate annual meteorological datasets will be used for retrospective compliance reporting.

Figure B-2. Location of the SPRU-DP Relative to Nearest individual Receptors



ATTACHMENT C

CAP88-PC Dose Runs for SPRU-DP G2 Enclosure Ventilation System

ATTACHMENT C-1

CAP88-PC Dose Runs Using SPRU-DP Source Term for G2 Building Enclosure Ventilation System

Unabated

C A P 8 8 - P C

Version 3.0

Clean Air Act Assessment Package - 1988

S Y N O P S I S   R E P O R T

Non-Radon Individual Assessment
Jun 14, 2011 07:39 pm

Facility: SPRU DP
Address: 2425 River Road
City: Niskayuna
State: NY   Zip: 12309

Source Category: G2 unabated
Source Type: Stack
Emission Year: 2011

Comments: DnD of G2 building
89-2004 wind data rural food path

Effective Dose Equivalent (mrem/year)
3.20E-01

At This Location: 540 Meters South Southwest

Dataset Name: G2 Point Source
Dataset Date: 6/14/2011 7:37:00 PM
Wind File: C:\Program Files\CAP88-PC30\WndFiles\knol890

```
Jun  14, 2011  07:39 pm                                        SYNOPSIS
                                                               Page  1

                  MAXIMALLY EXPOSED INDIVIDUAL

       Location Of The Individual:    540 Meters South Southwest
       Lifetime Fatal Cancer Risk:          1.42E-07
```

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SYNOPSIS
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RADIONUCLIDE EMISSIONS DURING THE YEAR 2011

Nuclide	Type	Size	Source #1 Ci/y	TOTAL Ci/y
Cs-137	F	1	5.7E-03	5.7E-03
Ba-137m	M	1	5.7E-03	5.7E-03
Pu-239	S	1	1.2E-03	1.2E-03
Am-241	M	1	1.8E-04	1.8E-04
Sr-90	F	1	1.2E-03	1.2E-03
Y-90	M	1	1.2E-03	1.2E-03
U-233	S	1	1.0E-06	1.0E-06
U-234	S	1	7.5E-06	7.5E-06
U-235	S	1	3.1E-07	3.1E-07
U-238	S	1	5.2E-06	5.2E-06
C-14	M	1	4.2E-04	4.2E-04
Fe-55	M	1	2.3E-07	2.3E-07
Ni-63	M	1	3.2E-07	3.2E-07
Pu-238	S	1	1.6E-05	1.6E-05
Pu-241	S	1	1.6E-04	1.6E-04
Pm-147	M	1	2.2E-05	2.2E-05
Tc-99	M	1	5.4E-07	5.4E-07
Th-228	S	1	5.8E-08	5.8E-08
Th-230	S	1	5.2E-09	5.2E-09
Th-232	S	1	4.7E-08	4.7E-08

SITE INFORMATION

Temperature: 10 degrees C
Precipitation: 100 cm/y
Humidity: 8 g/cu m
Mixing Height: 1000 m

User specified location of max exposed individual.
(ILOC, JLOC): 8, 2

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SYNOPSIS
Page 3

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	1.80
Diameter (m):	1.22
Plume Rise Momentum (m/s): (Exit Velocity)	0.00

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.400	0.440
Fraction From Assessment Area:	0.300	0.600	0.560
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

470	540	620	650	700	720	730
900	930	1000	1120	1190	1300	1500

C A P 8 8 - P C

Version 3.0

Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
Jun 14, 2011 07:39 pm

```
Facility:  SPRU DP
 Address:  2425 River Road
    City:  Niskayuna
   State:  NY          Zip:    12309

Source Category:  G2 unabated
    Source Type:  Stack
  Emission Year:  2011

Comments:  DnD of G2 building
           89-2004 wind data rural food path

   Dataset Name:  G2 Point Source
   Dataset Date:  6/14/2011 7:37:00 PM
      Wind File:      C:\Program Files\CAP88-
PC30\WndFiles\knol8904.WND
```

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SUMMARY
Page 1

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	8.82E-02
INHALATION	2.30E-01
AIR IMMERSION	4.89E-06
GROUND SURFACE	1.52E-03
INTERNAL	3.18E-01
EXTERNAL	1.52E-03
TOTAL	3.20E-01

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SUMMARY
Page 2

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
Cs-137	5.69E-02
Ba-137m	1.45E-03
Pu-239	1.71E-01
U-235	0.00E+00
Th-231	2.26E-09
Pa-231	0.00E+00
Ac-227	0.00E+00
Th-227	0.00E+00
Fr-223	0.00E+00
Sr-90	2.20E-02
Y-90	7.61E-05
U-233	8.28E-05
Th-229	0.00E+00
Ra-225	0.00E+00
U-234	6.08E-04
Th-230	6.15E-07
Ra-226	0.00E+00
Rn-222	0.00E+00
Po-218	0.00E+00
Pb-214	0.00E+00
At-218	0.00E+00
U-235	2.27E-05
U-238	3.61E-04
Th-234	2.14E-07
Pa-234m	2.13E-07
Pa-234	0.00E+00
C-14	2.90E-05
Fe-55	8.13E-09
Ni-63	1.72E-08
Pu-238	2.28E-03
U-234	0.00E+00
Pu-241	2.58E-04
Am-241	6.45E-02
Np-237	0.00E+00
Pa-233	0.00E+00
U-237	0.00E+00
Pm-147	1.10E-06
Sm-147	0.00E+00
Tc-99	1.90E-06
Th-228	1.95E-05
Ra-224	5.32E-09
Rn-220	0.00E+00

Th-232	9.85E-06
Ra-228	0.00E+00
Ac-228	0.00E+00
TOTAL	3.20E-01

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
Esophagu	6.64E-10
Stomach	2.32E-09
Colon	8.23E-09
Liver	6.70E-09
LUNG	9.30E-08
Bone	3.07E-09
Skin	5.58E-11
Breast	1.91E-09
Ovary	1.40E-09
Bladder	1.70E-09
Kidneys	4.00E-10
Thyroid	1.60E-10
Leukemia	1.37E-08
Residual	8.41E-09
Total	1.42E-07
TOTAL	2.83E-07

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	4.29E-08
INHALATION	9.81E-08
AIR IMMERSION	2.65E-12
GROUND SURFACE	7.90E-10
INTERNAL	1.41E-07
EXTERNAL	7.93E-10
TOTAL	1.42E-07

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
Cs-137	2.88E-08
Ba-137m	7.83E-10
Pu-239	8.70E-08
U-235	0.00E+00
Th-231	1.02E-15
Pa-231	0.00E+00
Ac-227	0.00E+00
Th-227	0.00E+00
Fr-223	0.00E+00
Sr-90	1.28E-08
Y-90	2.33E-11
U-233	6.20E-11
Th-229	0.00E+00
Ra-225	0.00E+00
U-234	4.57E-10
Th-230	3.18E-13
Ra-226	0.00E+00
Rn-222	0.00E+00
Po-218	0.00E+00
Pb-214	0.00E+00
At-218	0.00E+00
U-235	1.70E-11
U-238	2.69E-10
Th-234	3.04E-13
Pa-234m	3.42E-14
Pa-234	0.00E+00
C-14	2.00E-11
Fe-55	5.67E-15
Ni-63	1.70E-14
Pu-238	1.24E-09
U-234	0.00E+00
Pu-241	4.98E-11
Am-241	1.02E-08
Np-237	0.00E+00
Pa-233	0.00E+00
U-237	0.00E+00
Pm-147	7.97E-13
Sm-147	0.00E+00
Tc-99	1.83E-12
Th-228	1.67E-11
Ra-224	3.19E-15
Rn-220	0.00E+00

Th-232	4.37E-12
Ra-228	0.00E+00
Ac-228	0.00E+00
TOTAL	1.42E-07

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SUMMARY
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INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	470	540	620	650	700	720	730
N	3.8E-01	3.0E-01	2.4E-01	2.2E-01	1.9E-01	1.9E-01	1.8E-01
NNW	9.6E-01*	7.5E-01	5.8E-01	5.3E-01	4.7E-01	4.4E-01	4.3E-01
NW	3.8E-01*	2.9E-01	2.3E-01	2.2E-01	1.9E-01	1.8E-01	1.8E-01
WNW	2.5E-01	2.0E-01	1.6E-01	1.5E-01	1.3E-01*	1.2E-01	1.2E-01
W	2.5E-01	2.0E-01	1.6E-01	1.5E-01	1.3E-01	1.3E-01	1.2E-01
WSW	2.5E-01	2.0E-01	1.6E-01	1.4E-01	1.3E-01	1.2E-01	1.2E-01
SW	2.7E-01	2.1E-01	1.7E-01	1.6E-01	1.4E-01	1.3E-01	1.3E-01
SSW	4.1E-01	3.2E-01	2.5E-01	2.3E-01	2.1E-01	2.0E-01	1.9E-01
S	5.2E-01	4.1E-01	3.2E-01	2.9E-01	2.6E-01	2.5E-01	2.4E-01
SSE	5.0E-01	3.9E-01	3.1E-01	2.8E-01	2.5E-01	2.4E-01	2.3E-01
SE	4.4E-01	3.4E-01	2.7E-01	2.5E-01	2.2E-01	2.1E-01	2.0E-01
ESE	5.4E-01	4.2E-01	3.3E-01	3.1E-01	2.7E-01	2.6E-01	2.5E-01
E	6.4E-01	5.0E-01	3.9E-01	3.6E-01	3.2E-01	3.0E-01	3.0E-01
ENE	3.7E-01	2.9E-01	2.3E-01	2.1E-01	1.9E-01	1.8E-01	1.7E-01
NE	3.1E-01	2.5E-01	2.0E-01	1.8E-01	1.6E-01	1.5E-01	1.5E-01
NNE	3.1E-01	2.5E-01	2.0E-01	1.8E-01	1.6E-01	1.5E-01	1.5E-01

	Distance (m)						
Direction	900	930	1000	1120	1190	1300	1500
N	1.3E-01	1.3E-01	1.1E-01	9.8E-02	9.1E-02	8.2E-02	7.0E-02
NNW	3.0E-01	2.8E-01	2.5E-01	2.1E-01	1.9E-01	1.7E-01	1.4E-01
NW	1.3E-01	1.2E-01	1.1E-01	9.6E-02	8.9E-02	8.0E-02	6.9E-02
WNW	9.1E-02	8.7E-02	7.9E-02	7.0E-02	6.6E-02	6.0E-02	5.3E-02
W	9.2E-02	8.8E-02	8.0E-02	7.1E-02	6.6E-02	6.1E-02	5.4E-02
WSW	9.0E-02	8.6E-02	7.9E-02	7.0E-02	6.5E-02	6.0E-02	5.3E-02
SW	9.8E-02	9.3E-02	8.5E-02	7.5E-02	7.0E-02	6.4E-02	5.6E-02
SSW	1.4E-01	1.3E-01	1.2E-01	1.0E-01	9.5E-02	8.5E-02	7.3E-02
S	1.7E-01	1.6E-01	1.4E-01	1.2E-01	1.1E-01	1.0E-01	8.6E-02
SSE	1.6E-01	1.6E-01	1.4E-01	1.2E-01	1.1E-01	9.9E-02*	8.3E-02
SE	1.5E-01	1.4E-01	1.2E-01	1.1E-01	1.0E-01	9.0E-02	7.6E-02
ESE	1.8E-01	1.7E-01	1.5E-01	1.3E-01	1.2E-01	1.1E-01	9.0E-02
E	2.1E-01	2.0E-01	1.8E-01	1.5E-01	1.4E-01	1.2E-01	1.0E-01
ENE	1.3E-01	1.2E-01	1.1E-01	9.3E-02	8.7E-02	7.8E-02	6.7E-02
NE	1.1E-01	1.0E-01	9.5E-02	8.3E-02	7.7E-02	7.0E-02	6.1E-02
NNE	1.1E-01	1.0E-01	9.4E-02	8.3E-02	7.7E-02	7.0E-02	6.1E-02

Underlined values indicate the location of the nearest receptor in the designated direction.

*Business locations

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INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Direction	Distance (m) 470	540	620	650	700	720	730
N	1.7E-07	1.3E-07	1.1E-07	9.8E-08	8.7E-08	8.3E-08	8.1E-08
NNW	4.2E-07	3.3E-07	2.6E-07	2.4E-07	2.1E-07	2.0E-07	1.9E-07
NW	1.7E-07	1.3E-07	1.0E-07	9.6E-08	8.5E-08	8.1E-08	8.0E-08
WNW	1.1E-07	8.8E-08	7.1E-08	6.6E-08	5.9E-08	5.6E-08	5.5E-08
W	1.1E-07	9.0E-08	7.2E-08	6.7E-08	6.0E-08	5.7E-08	5.6E-08
WSW	1.1E-07	8.7E-08	7.0E-08	6.5E-08	5.8E-08	5.6E-08	5.5E-08
SW	1.2E-07	9.5E-08	7.6E-08	7.1E-08	6.4E-08	6.1E-08	6.0E-08
SSW	1.8E-07	1.4E-07	1.1E-07	1.0E-07	9.2E-08	8.8E-08	8.6E-08
S	2.3E-07	1.8E-07	1.4E-07	1.3E-07	1.1E-07	1.1E-07	1.1E-07
SSE	2.2E-07	1.7E-07	1.4E-07	1.3E-07	1.1E-07	1.1E-07	1.0E-07
SE	1.9E-07	1.5E-07	1.2E-07	1.1E-07	9.8E-08	9.3E-08	9.1E-08
ESE	2.4E-07	1.9E-07	1.5E-07	1.4E-07	1.2E-07	1.1E-07	1.1E-07
E	2.8E-07	2.2E-07	1.7E-07	1.6E-07	1.4E-07	1.3E-07	1.3E-07
ENE	1.6E-07	1.3E-07	1.0E-07	9.3E-08	8.3E-08	7.9E-08	7.8E-08
NE	1.4E-07	1.1E-07	8.8E-08	8.1E-08	7.2E-08	6.9E-08	6.8E-08
NNE	1.4E-07	1.1E-07	8.7E-08	8.1E-08	7.2E-08	6.9E-08	6.8E-08

Direction	Distance (m) 900	930	1000	1120	1190	1300	1500
N	5.9E-08	5.7E-08	5.1E-08	4.5E-08	4.2E-08	3.8E-08	3.3E-08
NNW	1.3E-07	1.3E-07	1.1E-07	9.5E-08	8.7E-08	7.7E-08	6.3E-08
NW	5.8E-08	5.5E-08	5.0E-08	4.4E-08	4.1E-08	3.7E-08	3.2E-08
WNW	4.2E-08	4.0E-08	3.6E-08	3.2E-08	3.1E-08	2.8E-08	2.5E-08
W	4.2E-08	4.0E-08	3.7E-08	3.3E-08	3.1E-08	2.9E-08	2.5E-08
WSW	4.1E-08	4.0E-08	3.6E-08	3.2E-08	3.0E-08	2.8E-08	2.5E-08
SW	4.5E-08	4.3E-08	3.9E-08	3.5E-08	3.3E-08	3.0E-08	2.6E-08
SSW	6.2E-08	5.9E-08	5.4E-08	4.7E-08	4.3E-08	3.9E-08	3.4E-08
S	7.6E-08	7.3E-08	6.5E-08	5.6E-08	5.2E-08	4.7E-08	3.9E-08
SSE	7.4E-08	7.0E-08	6.3E-08	5.4E-08	5.0E-08	4.5E-08	3.8E-08
SE	6.6E-08	6.3E-08	5.6E-08	4.9E-08	4.5E-08	4.1E-08	3.5E-08
ESE	8.0E-08	7.6E-08	6.8E-08	5.9E-08	5.5E-08	4.9E-08	4.1E-08
E	9.3E-08	8.8E-08	7.9E-08	6.8E-08	6.2E-08	5.6E-08	4.7E-08
ENE	5.7E-08	5.4E-08	4.9E-08	4.3E-08	4.0E-08	3.6E-08	3.1E-08
NE	5.0E-08	4.8E-08	4.3E-08	3.8E-08	3.6E-08	3.3E-08	2.9E-08
NNE	5.0E-08	4.8E-08	4.3E-08	3.8E-08	3.6E-08	3.3E-08	2.8E-08

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Version 3.0

Clean Air Act Assessment Package - 1988

W E A T H E R   D A T A

Non-Radon Individual Assessment
Jun 14, 2011 07:39 pm

```
Facility:  SPRU DP
 Address:  2425 River Road
    City:  Niskayuna
   State:  NY                     Zip:    12309

Source Category:  G2 unabated
    Source Type:  Stack
  Emission Year:  2011

Comments:  DnD of G2 building
           89-2004 wind data rural food path

   Dataset Name:  G2 Point Source
   Dataset Date:  6/14/2011 7:37:00 PM
      Wind File:  C:\Program Files\CAP88-PC30\WndFiles\knol8904.WND
```

Jun 14, 2011 07:39 pm WEATHER
Page 1

HARMONIC AVERAGE WIND SPEEDS (WIND TOWARDS)

Pasquill Stability Class

Dir	A	B	C	D	E	F	G	Wind Freq
N	1.428	1.768	1.898	1.971	1.042	0.663	0.000	0.097
NNW	1.539	1.808	2.332	2.139	1.073	0.711	0.000	0.130
NW	1.387	1.444	1.400	1.248	0.838	0.702	0.000	0.044
WNW	1.303	1.365	1.193	0.882	0.701	0.563	0.000	0.027
W	1.143	1.134	0.909	0.792	0.631	0.613	0.000	0.022
WSW	1.149	1.078	1.033	0.913	0.666	0.615	0.000	0.021
SW	1.297	1.372	1.445	1.322	0.938	0.660	0.000	0.038
SSW	1.380	1.712	1.779	1.961	1.135	0.820	0.000	0.068
S	1.297	1.420	1.398	1.357	1.035	0.782	0.000	0.057
SSE	1.433	1.539	1.555	1.374	0.981	0.715	0.000	0.050
SE	1.628	2.068	2.500	2.116	1.082	0.700	0.000	0.068
ESE	1.911	2.708	3.690	3.554	1.425	0.785	0.000	0.190
E	1.735	2.592	3.292	2.957	1.308	0.750	0.000	0.101
ENE	1.599	1.833	2.230	1.635	0.909	0.676	0.000	0.035
NE	1.459	1.806	1.810	1.199	0.918	0.643	0.000	0.026
NNE	1.425	1.590	1.218	1.003	0.820	0.615	0.000	0.027

ARITHMETIC AVERAGE WIND SPEEDS (WIND TOWARDS)

Pasquill Stability Class

Dir	A	B	C	D	E	F	G
N	1.774	2.251	2.847	3.130	1.528	0.914	0.000
NNW	1.839	2.323	3.177	3.125	1.554	1.041	0.000
NW	1.660	1.934	2.060	2.160	1.306	1.019	0.000
WNW	1.540	1.674	1.659	1.606	1.167	0.812	0.000
W	1.341	1.436	1.368	1.404	1.009	0.861	0.000
WSW	1.356	1.451	1.653	1.896	1.049	0.842	0.000
SW	1.554	1.873	2.212	2.446	1.450	0.944	0.000
SSW	1.660	2.264	2.866	3.155	1.640	1.154	0.000
S	1.585	1.991	2.311	2.474	1.576	1.146	0.000
SSE	1.666	2.145	2.544	2.218	1.399	1.023	0.000
SE	1.912	2.639	3.548	3.315	1.506	0.980	0.000
ESE	2.130	3.077	4.303	4.520	1.921	1.146	0.000
E	2.026	2.952	4.182	4.253	1.831	1.125	0.000
ENE	1.913	2.527	3.687	3.035	1.430	0.981	0.000
NE	1.794	2.398	3.034	2.335	1.396	0.891	0.000
NNE	1.715	2.187	2.104	1.884	1.270	0.822	0.000

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FREQUENCIES OF STABILITY CLASSES (WIND TOWARDS)

	Pasquill Stability Class						
Dir	A	B	C	D	E	F	G
N	0.0166	0.0272	0.0957	0.3246	0.1128	0.0496	0.0000
NNW	0.0545	0.0977	0.3024	0.6829	0.1892	0.1114	0.0000
NW	0.1726	0.1982	0.2801	0.3102	0.1571	0.1343	0.0000
WNW	0.3168	0.2595	0.2241	0.1501	0.1260	0.1430	0.0000
W	0.3407	0.2808	0.1912	0.1379	0.1484	0.2055	0.0000
WSW	0.3033	0.2154	0.1907	0.1714	0.1769	0.2088	0.0000
SW	0.1651	0.1754	0.1730	0.1833	0.1429	0.1270	0.0000
SSW	0.0990	0.1235	0.1747	0.2745	0.1366	0.1343	0.0000
S	0.1012	0.1067	0.1444	0.3154	0.2270	0.2020	0.0000
SSE	0.0900	0.0926	0.1268	0.3648	0.2827	0.1904	0.0000
SE	0.0595	0.0805	0.1347	0.3520	0.1984	0.1184	0.0000
ESE	0.0221	0.0672	0.1973	0.4392	0.0981	0.0398	0.0000
E	0.0493	0.0984	0.3142	0.7300	0.1996	0.1051	0.0000
ENE	0.0573	0.0792	0.1773	0.3875	0.2655	0.1989	0.0000
NE	0.0593	0.0815	0.1454	0.2847	0.2817	0.2338	0.0000
NNE	0.0495	0.0546	0.0897	0.2538	0.2790	0.2020	0.0000
TOTAL	0.0798	0.1019	0.1989	0.4155	0.1711	0.1176	0.0000

ADDITIONAL WEATHER INFORMATION

Average Air Temperature: 10.0 degrees C
283.16 K
Precipitation: 100.0 cm/y
Humidity: 8.0 g/cu m
Lid Height: 1000 meters
Surface Roughness Length: 0.010 meters
Height Of Wind Measurements: 10.0 meters
Average Wind Speed: 2.660 m/s

Vertical Temperature Gradients:
STABILITY E 0.073 k/m
STABILITY F 0.109 k/m
STABILITY G 0.146 k/m

ATTACHMENT C-2

CAP88-PC Dose Runs Using SPRU-DP Source Term for G2 Building Enclosure Ventilation System

Abated

C A P 8 8 - P C

Version 3.0

Clean Air Act Assessment Package - 1988

S Y N O P S I S   R E P O R T

Non-Radon Individual Assessment
Jun 14, 2011 01:08 pm

Facility: SPRU DP
Address: 2425 River Road
City: Niskayuna
State: NY   Zip: 12309

Source Category: G2 abated
Source Type: Stack
Emission Year: 2011

Comments: DnD of G2 building
89-2004 wind data rural food path

Effective Dose Equivalent
(mrem/year)

3.17E-05

At This Location: 540 Meters South Southwest

Dataset Name: G2 Point Source
Dataset Date: 6/14/2011 1:07:00 PM
Wind File: C:\Program Files\CAP88-PC30\WndFiles\knol890

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 540 Meters South Southwest
Lifetime Fatal Cancer Risk: 1.41E-11

RADIONUCLIDE EMISSIONS DURING THE YEAR 2011

Nuclide	Type	Size	Source #1 Ci/y	TOTAL Ci/y
Cs-137	F	1	5.7E-07	5.7E-07
Ba-137m	M	1	5.7E-07	5.7E-07
Pu-239	S	1	1.2E-07	1.2E-07
Am-241	M	1	1.8E-08	1.8E-08
Sr-90	F	1	1.2E-07	1.2E-07
Y-90	M	1	1.2E-07	1.2E-07
U-233	S	1	1.0E-10	1.0E-10
U-234	S	1	7.5E-10	7.5E-10
U-235	S	1	3.1E-11	3.1E-11
U-238	S	1	5.2E-10	5.2E-10
C-14	M	1	4.2E-08	4.2E-08
Fe-55	M	1	2.3E-11	2.3E-11
Ni-63	M	1	3.2E-11	3.2E-11
Pu-238	S	1	1.6E-09	1.6E-09
Pu-241	S	1	1.6E-08	1.6E-08
Pm-147	M	1	2.2E-09	2.2E-09
Tc-99	M	1	5.4E-11	5.4E-11
Th-228	S	1	5.8E-12	5.8E-12
Th-230	S	1	5.2E-13	5.2E-13
Th-232	S	1	4.7E-12	4.7E-12

SITE INFORMATION

Temperature: 10 degrees C
Precipitation: 100 cm/y
Humidity: 8 g/cu m
Mixing Height: 1000 m

User specified location of max exposed individual.
(ILOC, JLOC): 8, 2

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	1.80
Diameter (m):	1.22
Plume Rise Momentum (m/s): (Exit Velocity)	0.00

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.400	0.440
Fraction From Assessment Area:	0.300	0.600	0.560
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

470	540	620	650	700	720	730
900	930	1000	1120	1190	1300	1500

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Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
Jun 14, 2011 01:08 pm

```
      Facility:  SPRU DP
       Address:  2425 River Road
          City:  Niskayuna
         State:  NY          Zip:    12309


Source Category:  G2 abated
    Source Type:  Stack
  Emission Year:  2011


      Comments:  DnD of G2 building
                 89-2004 wind data rural food path


   Dataset Name:  G2 Point Source
   Dataset Date:  6/14/2011 1:07:00 PM
      Wind File:      C:\Program Files\CAP88-
PC30\WndFiles\knol8904.WND
```

Jun 14, 2011 01:08 pm

SUMMARY
Page 1

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	8.69E-06
INHALATION	2.29E-05
AIR IMMERSION	4.89E-10
GROUND SURFACE	1.52E-07
INTERNAL	3.16E-05
EXTERNAL	1.52E-07
TOTAL	3.17E-05

Jun 14, 2011 01:08 pm SUMMARY
Page 2

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
Cs-137	5.69E-06
Ba-137m	1.45E-07
Pu-239	1.71E-05
U-235	0.00E+00
Th-231	0.00E+00
Pa-231	0.00E+00
Ac-227	0.00E+00
Th-227	0.00E+00
Fr-223	0.00E+00
Sr-90	2.20E-06
Y-90	7.61E-09
U-233	0.00E+00
Th-229	0.00E+00
Ra-225	0.00E+00
U-234	0.00E+00
Th-230	0.00E+00
Ra-226	0.00E+00
Rn-222	0.00E+00
Po-218	0.00E+00
Pb-214	0.00E+00
At-218	0.00E+00
U-235	0.00E+00
U-238	0.00E+00
Th-234	0.00E+00
Pa-234m	0.00E+00
Pa-234	0.00E+00
C-14	0.00E+00
Fe-55	0.00E+00
Ni-63	0.00E+00
Pu-238	2.17E-07
U-234	0.00E+00
Pu-241	2.36E-08
Am-241	6.35E-06
Np-237	0.00E+00
Pa-233	0.00E+00
U-237	0.00E+00
Pm-147	9.19E-11
Sm-147	0.00E+00
Tc-99	0.00E+00
Th-228	0.00E+00
Ra-224	0.00E+00
Rn-220	0.00E+00

```
Th-232              0.00E+00
Ra-228              0.00E+00
Ac-228              0.00E+00

TOTAL               3.17E-05
```

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CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
Esophagu	6.63E-14
Stomach	2.31E-13
Colon	8.19E-13
Liver	6.66E-13
LUNG	9.22E-12
Bone	3.03E-13
Skin	5.57E-15
Breast	1.91E-13
Ovary	1.39E-13
Bladder	1.70E-13
Kidneys	3.98E-14
Thyroid	1.60E-14
Leukemia	1.37E-12
Residual	8.40E-13
Total	1.41E-11
TOTAL	2.81E-11

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	4.27E-12
INHALATION	9.73E-12
AIR IMMERSION	2.65E-16
GROUND SURFACE	7.89E-14
INTERNAL	1.40E-11
EXTERNAL	7.92E-14
TOTAL	1.41E-11

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SUMMARY
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NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
Cs-137	2.88E-12
Ba-137m	7.83E-14
Pu-239	8.70E-12
U-235	0.00E+00
Th-231	0.00E+00
Pa-231	0.00E+00
Ac-227	0.00E+00
Th-227	0.00E+00
Fr-223	0.00E+00
Sr-90	1.28E-12
Y-90	2.33E-15
U-233	0.00E+00
Th-229	0.00E+00
Ra-225	0.00E+00
U-234	0.00E+00
Th-230	0.00E+00
Ra-226	0.00E+00
Rn-222	0.00E+00
Po-218	0.00E+00
Pb-214	0.00E+00
At-218	0.00E+00
U-235	0.00E+00
U-238	0.00E+00
Th-234	0.00E+00
Pa-234m	0.00E+00
Pa-234	0.00E+00
C-14	0.00E+00
Fe-55	0.00E+00
Ni-63	0.00E+00
Pu-238	1.23E-13
U-234	0.00E+00
Pu-241	4.75E-15
Am-241	1.00E-12
Np-237	0.00E+00
Pa-233	0.00E+00
U-237	0.00E+00
Pm-147	5.39E-17
Sm-147	0.00E+00
Tc-99	0.00E+00
Th-228	0.00E+00
Ra-224	0.00E+00
Rn-220	0.00E+00

Th-232	0.00E+00
Ra-228	0.00E+00
Ac-228	0.00E+00
TOTAL	1.41E-11

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INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	470	540	620	650	700	720	730
N	3.8E-05	3.0E-05	2.4E-05	2.2E-05	1.9E-05	1.8E-05	1.8E-05
NNW	9.5E-05*	7.4E-05	5.8E-05	5.3E-05	4.6E-05	4.4E-05	4.3E-05
NW	3.7E-05*	2.9E-05	2.3E-05	2.1E-05	1.9E-05	1.8E-05	1.8E-05
WNW	2.5E-05	2.0E-05	1.6E-05	1.4E-05	1.3E-05*	1.2E-05	1.2E-05
W	2.5E-05	2.0E-05	1.6E-05	1.5E-05	1.3E-05	1.3E-05	1.2E-05
WSW	2.5E-05	1.9E-05	1.5E-05	1.4E-05	1.3E-05	1.2E-05	1.2E-05
SW	2.7E-05	2.1E-05	1.7E-05	1.6E-05	1.4E-05	1.3E-05	1.3E-05
SSW	4.0E-05	3.2E-05	2.5E-05	2.3E-05	2.0E-05	2.0E-05	1.9E-05
S	5.2E-05	4.0E-05	3.2E-05	2.9E-05	2.6E-05	2.4E-05	2.4E-05
SSE	5.0E-05	3.9E-05	3.1E-05	2.8E-05	2.5E-05	2.4E-05	2.3E-05
SE	4.3E-05	3.4E-05	2.7E-05	2.5E-05	2.2E-05	2.1E-05	2.0E-05
ESE	5.3E-05	4.2E-05	3.3E-05	3.0E-05	2.7E-05	2.6E-05	2.5E-05
E	6.4E-05	5.0E-05	3.9E-05	3.6E-05	3.2E-05	3.0E-05	2.9E-05
ENE	3.6E-05	2.9E-05	2.3E-05	2.1E-05	1.8E-05	1.8E-05	1.7E-05
NE	3.1E-05	2.5E-05	1.9E-05	1.8E-05	1.6E-05	1.5E-05	1.5E-05
NNE	3.1E-05	2.5E-05	1.9E-05	1.8E-05	1.6E-05	1.5E-05	1.5E-05

	Distance (m)						
Direction	900	930	1000	1120	1190	1300	1500
N	1.3E-05	1.2E-05	1.1E-05	9.7E-06	9.0E-06	8.2E-06	7.0E-06
NNW	3.0E-05	2.8E-05	2.5E-05	2.1E-05	1.9E-05	1.7E-05	1.4E-05
NW	1.3E-05	1.2E-05	1.1E-05	9.5E-06	8.8E-06	8.0E-06	6.8E-06
WNW	9.0E-06	8.6E-06	7.8E-06	6.9E-06	6.5E-06	6.0E-06	5.3E-06
W	9.1E-06	8.7E-06	7.9E-06	7.0E-06	6.6E-06	6.0E-06	5.3E-06
WSW	8.9E-06	8.6E-06	7.8E-06	6.9E-06	6.5E-06	6.0E-06	5.2E-06
SW	9.7E-06	9.3E-06	8.4E-06	7.4E-06	7.0E-06	6.4E-06	5.6E-06
SSW	1.4E-05	1.3E-05	1.2E-05	1.0E-05	9.4E-06	8.5E-06	7.2E-06
S	1.7E-05	1.6E-05	1.4E-05	1.2E-05	1.1E-05	1.0E-05	8.5E-06
SSE	1.6E-05	1.6E-05	1.4E-05	1.2E-05	1.1E-05	9.8E-06*	8.3E-06
SE	1.5E-05	1.4E-05	1.2E-05	1.1E-05	9.9E-06	8.9E-06	7.6E-06
ESE	1.8E-05	1.7E-05	1.5E-05	1.3E-05	1.2E-05	1.1E-05	9.0E-06
E	2.1E-05	2.0E-05	1.7E-05	1.5E-05	1.4E-05	1.2E-05	1.0E-05
ENE	1.2E-05	1.2E-05	1.1E-05	9.2E-06	8.6E-06	7.8E-06	6.7E-06
NE	1.1E-05	1.0E-05	9.4E-06	8.2E-06	7.7E-06	7.0E-06	6.0E-06
NNE	1.1E-05	1.0E-05	9.4E-06	8.2E-06	7.7E-06	7.0E-06	6.0E-06

Underlined values indicate the location of the nearest receptor in the designated direction.

*Business locations

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INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	470	540	620	650	700	720	730
N	1.7E-11	1.3E-11	1.0E-11	9.7E-12	8.6E-12	8.2E-12	8.1E-12
NNW	4.2E-11	3.3E-11	2.5E-11	2.3E-11	2.0E-11	2.0E-11	1.9E-11
NW	1.6E-11	1.3E-11	1.0E-11	9.5E-12	8.5E-12	8.1E-12	7.9E-12
WNW	1.1E-11	8.7E-12	7.0E-12	6.5E-12	5.8E-12	5.6E-12	5.5E-12
W	1.1E-11	8.9E-12	7.1E-12	6.6E-12	5.9E-12	5.7E-12	5.6E-12
WSW	1.1E-11	8.7E-12	7.0E-12	6.5E-12	5.8E-12	5.6E-12	5.5E-12
SW	1.2E-11	9.5E-12	7.6E-12	7.1E-12	6.3E-12	6.1E-12	5.9E-12
SSW	1.8E-11	1.4E-11	1.1E-11	1.0E-11	9.1E-12	8.7E-12	8.5E-12
S	2.3E-11	1.8E-11	1.4E-11	1.3E-11	1.1E-11	1.1E-11	1.1E-11
SSE	2.2E-11	1.7E-11	1.4E-11	1.2E-11	1.1E-11	1.1E-11	1.0E-11
SE	1.9E-11	1.5E-11	1.2E-11	1.1E-11	9.7E-12	9.3E-12	9.1E-12
ESE	2.4E-11	1.8E-11	1.5E-11	1.3E-11	1.2E-11	1.1E-11	1.1E-11
E	2.8E-11	2.2E-11	1.7E-11	1.6E-11	1.4E-11	1.3E-11	1.3E-11
ENE	1.6E-11	1.3E-11	1.0E-11	9.3E-12	8.2E-12	7.9E-12	7.7E-12
NE	1.4E-11	1.1E-11	8.7E-12	8.1E-12	7.2E-12	6.9E-12	6.7E-12
NNE	1.4E-11	1.1E-11	8.7E-12	8.0E-12	7.2E-12	6.9E-12	6.7E-12

	Distance (m)						
Direction	900	930	1000	1120	1190	1300	1500
N	5.9E-12	5.6E-12	5.1E-12	4.4E-12	4.1E-12	3.8E-12	3.3E-12
NNW	1.3E-11	1.3E-11	1.1E-11	9.4E-12	8.6E-12	7.6E-12	6.3E-12
NW	5.8E-12	5.5E-12	5.0E-12	4.3E-12	4.1E-12	3.7E-12	3.2E-12
WNW	4.1E-12	4.0E-12	3.6E-12	3.2E-12	3.0E-12	2.8E-12	2.5E-12
W	4.2E-12	4.0E-12	3.7E-12	3.3E-12	3.1E-12	2.8E-12	2.5E-12
WSW	4.1E-12	3.9E-12	3.6E-12	3.2E-12	3.0E-12	2.8E-12	2.5E-12
SW	4.4E-12	4.2E-12	3.9E-12	3.4E-12	3.2E-12	3.0E-12	2.6E-12
SSW	6.2E-12	5.9E-12	5.3E-12	4.6E-12	4.3E-12	3.9E-12	3.4E-12
S	7.6E-12	7.2E-12	6.5E-12	5.6E-12	5.2E-12	4.6E-12	3.9E-12
SSE	7.3E-12	7.0E-12	6.3E-12	5.4E-12	5.0E-12	4.5E-12	3.8E-12
SE	6.5E-12	6.2E-12	5.6E-12	4.9E-12	4.5E-12	4.1E-12	3.5E-12
ESE	8.0E-12	7.6E-12	6.8E-12	5.9E-12	5.4E-12	4.9E-12	4.1E-12
E	9.2E-12	8.8E-12	7.8E-12	6.7E-12	6.2E-12	5.5E-12	4.6E-12
ENE	5.6E-12	5.4E-12	4.8E-12	4.2E-12	4.0E-12	3.6E-12	3.1E-12
NE	5.0E-12	4.7E-12	4.3E-12	3.8E-12	3.5E-12	3.2E-12	2.8E-12
NNE	4.9E-12	4.7E-12	4.3E-12	3.8E-12	3.5E-12	3.2E-12	2.8E-12

```
                         C A P 8 8 - P C

                          Version 3.0

             Clean Air Act Assessment Package - 1988


                       W E A T H E R   D A T A

                 Non-Radon Individual Assessment
                      Jun  14, 2011  01:08 pm


     Facility:  SPRU DP
      Address:  2425 River Road
         City:  Niskayuna
        State:  NY                      Zip:    12309


     Source Category:  G2 abated
         Source Type:  Stack
       Emission Year:  2011


     Comments:  DnD of G2 building
                89-2004 wind data rural food path


        Dataset Name:  G2 Point Source
        Dataset Date:  6/14/2011 1:07:00 PM
           Wind File:  C:\Program Files\CAP88-PC30\WndFiles\knol8904.WND
```

Jun 14, 2011 01:08 pm

WEATHER
Page 1

HARMONIC AVERAGE WIND SPEEDS (WIND TOWARDS)

Dir	Pasquill Stability Class A	B	C	D	E	F	G	Wind Freq
N	1.428	1.768	1.898	1.971	1.042	0.663	0.000	0.097
NNW	1.539	1.808	2.332	2.139	1.073	0.711	0.000	0.130
NW	1.387	1.444	1.400	1.248	0.838	0.702	0.000	0.044
WNW	1.303	1.365	1.193	0.882	0.701	0.563	0.000	0.027
W	1.143	1.134	0.909	0.792	0.631	0.613	0.000	0.022
WSW	1.149	1.078	1.033	0.913	0.666	0.615	0.000	0.021
SW	1.297	1.372	1.445	1.322	0.938	0.660	0.000	0.038
SSW	1.380	1.712	1.779	1.961	1.135	0.820	0.000	0.068
S	1.297	1.420	1.398	1.357	1.035	0.782	0.000	0.057
SSE	1.433	1.539	1.555	1.374	0.981	0.715	0.000	0.050
SE	1.628	2.068	2.500	2.116	1.082	0.700	0.000	0.068
ESE	1.911	2.708	3.690	3.554	1.425	0.785	0.000	0.190
E	1.735	2.592	3.292	2.957	1.308	0.750	0.000	0.101
ENE	1.599	1.833	2.230	1.635	0.909	0.676	0.000	0.035
NE	1.459	1.806	1.810	1.199	0.918	0.643	0.000	0.026
NNE	1.425	1.590	1.218	1.003	0.820	0.615	0.000	0.027

ARITHMETIC AVERAGE WIND SPEEDS (WIND TOWARDS)

Dir	Pasquill Stability Class A	B	C	D	E	F	G
N	1.774	2.251	2.847	3.130	1.528	0.914	0.000
NNW	1.839	2.323	3.177	3.125	1.554	1.041	0.000
NW	1.660	1.934	2.060	2.160	1.306	1.019	0.000
WNW	1.540	1.674	1.659	1.606	1.167	0.812	0.000
W	1.341	1.436	1.368	1.404	1.009	0.861	0.000
WSW	1.356	1.451	1.653	1.896	1.049	0.842	0.000
SW	1.554	1.873	2.212	2.446	1.450	0.944	0.000
SSW	1.660	2.264	2.866	3.155	1.640	1.154	0.000
S	1.585	1.991	2.311	2.474	1.576	1.146	0.000
SSE	1.666	2.145	2.544	2.218	1.399	1.023	0.000
SE	1.912	2.639	3.548	3.315	1.506	0.980	0.000
ESE	2.130	3.077	4.303	4.520	1.921	1.146	0.000
E	2.026	2.952	4.182	4.253	1.831	1.125	0.000
ENE	1.913	2.527	3.687	3.035	1.430	0.981	0.000
NE	1.794	2.398	3.034	2.335	1.396	0.891	0.000
NNE	1.715	2.187	2.104	1.884	1.270	0.822	0.000

Jun 14, 2011 01:08 pm WEATHER
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FREQUENCIES OF STABILITY CLASSES (WIND TOWARDS)

	Pasquill Stability Class						
Dir	A	B	C	D	E	F	G
N	0.0166	0.0272	0.0957	0.3246	0.1128	0.0496	0.0000
NNW	0.0545	0.0977	0.3024	0.6829	0.1892	0.1114	0.0000
NW	0.1726	0.1982	0.2801	0.3102	0.1571	0.1343	0.0000
WNW	0.3168	0.2595	0.2241	0.1501	0.1260	0.1430	0.0000
W	0.3407	0.2808	0.1912	0.1379	0.1484	0.2055	0.0000
WSW	0.3033	0.2154	0.1907	0.1714	0.1769	0.2088	0.0000
SW	0.1651	0.1754	0.1730	0.1833	0.1429	0.1270	0.0000
SSW	0.0990	0.1235	0.1747	0.2745	0.1366	0.1343	0.0000
S	0.1012	0.1067	0.1444	0.3154	0.2270	0.2020	0.0000
SSE	0.0900	0.0926	0.1268	0.3648	0.2827	0.1904	0.0000
SE	0.0595	0.0805	0.1347	0.3520	0.1984	0.1184	0.0000
ESE	0.0221	0.0672	0.1973	0.4392	0.0981	0.0398	0.0000
E	0.0493	0.0984	0.3142	0.7300	0.1996	0.1051	0.0000
ENE	0.0573	0.0792	0.1773	0.3875	0.2655	0.1989	0.0000
NE	0.0593	0.0815	0.1454	0.2847	0.2817	0.2338	0.0000
NNE	0.0495	0.0546	0.0897	0.2538	0.2790	0.2020	0.0000
TOTAL	0.0798	0.1019	0.1989	0.4155	0.1711	0.1176	0.0000

ADDITIONAL WEATHER INFORMATION

Average Air Temperature: 10.0 degrees C
283.16 K
Precipitation: 100.0 cm/y
Humidity: 8.0 g/cu m
Lid Height: 1000 meters
Surface Roughness Length: 0.010 meters
Height Of Wind Measurements: 10.0 meters
Average Wind Speed: 2.660 m/s

Vertical Temperature Gradients:
STABILITY E 0.073 k/m
STABILITY F 0.109 k/m
STABILITY G 0.146 k/m

ATTACHMENT D

Equipment Sketches and Specification Details

(Typical)

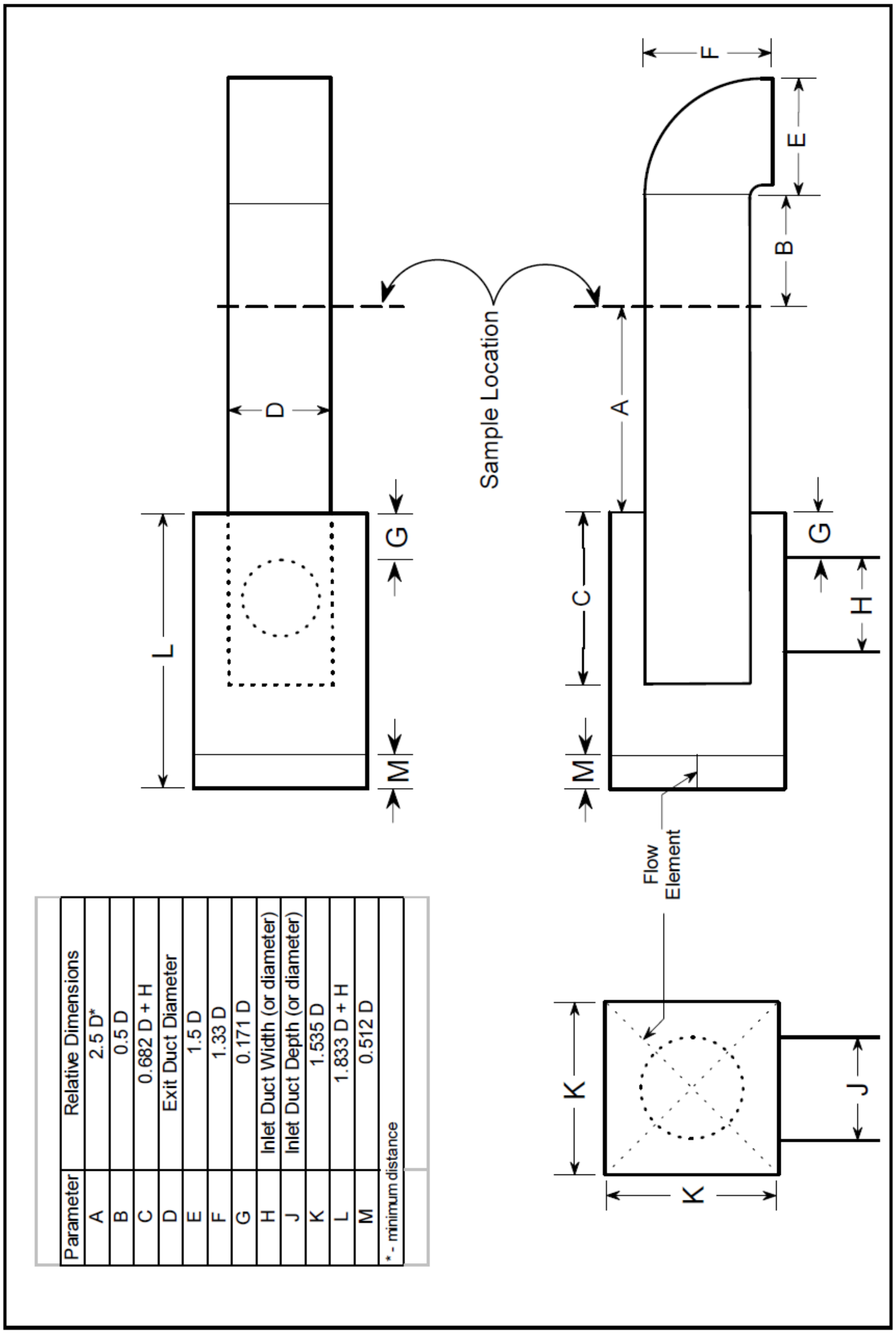
Ventilation Air Mover and Filtration System

Sampling Section and Sampler/Withdrawal Location

A mixing box and sampling duct apparatus according to Figure 15.11 K of Radioactive Air Sampling Methods by Maiello and Hoover (2011) will be provided. Off-the-shelf air sample pumps, filter holders, and ANSI N13.1-1999 sample probes with custom designed air mixers and sample ducts that match the required flow rates of the enclosure ventilation systems will be installed. The sample probes are stainless steel. Nominal parameters for the mixer and sampling systems are:

1. For a HEPA filtered air handler rated at 32,000 ACFM (nominal):
   a. Overall length, width and height – 25 feet L, 8 feet W, and 8 feet H
   b. Sampling duct diameter - 48 inches (nominal)
   c. Duct inlet connection - 48 inches (nominal)
   d. Delta P at maximum flow rate - 12 inches H_2O
   e. Mixer, duct, air sampler and protective “doghouse” mounted on a structural frame.
2. Vendor testing prior to delivery will certify the following:
   a. A certificate of conformance for each air sampling system attesting that the sampling system has been tested and/or analyzed as required to satisfy ANSI N13.1-1999 Section 5.2.2.2. Testing of individual systems for gas or particulate COV is not required if suitable prototype testing is documented and the Vendor certifies that the item sold to buyer conforms to the tested unit and/or configuration.
   b. The vendor will perform velocity COV testing on each unit.
   c. Calibration certificates for the air sample pump and air flow instruments will be provided with each air monitoring system.

Generic Mixing System



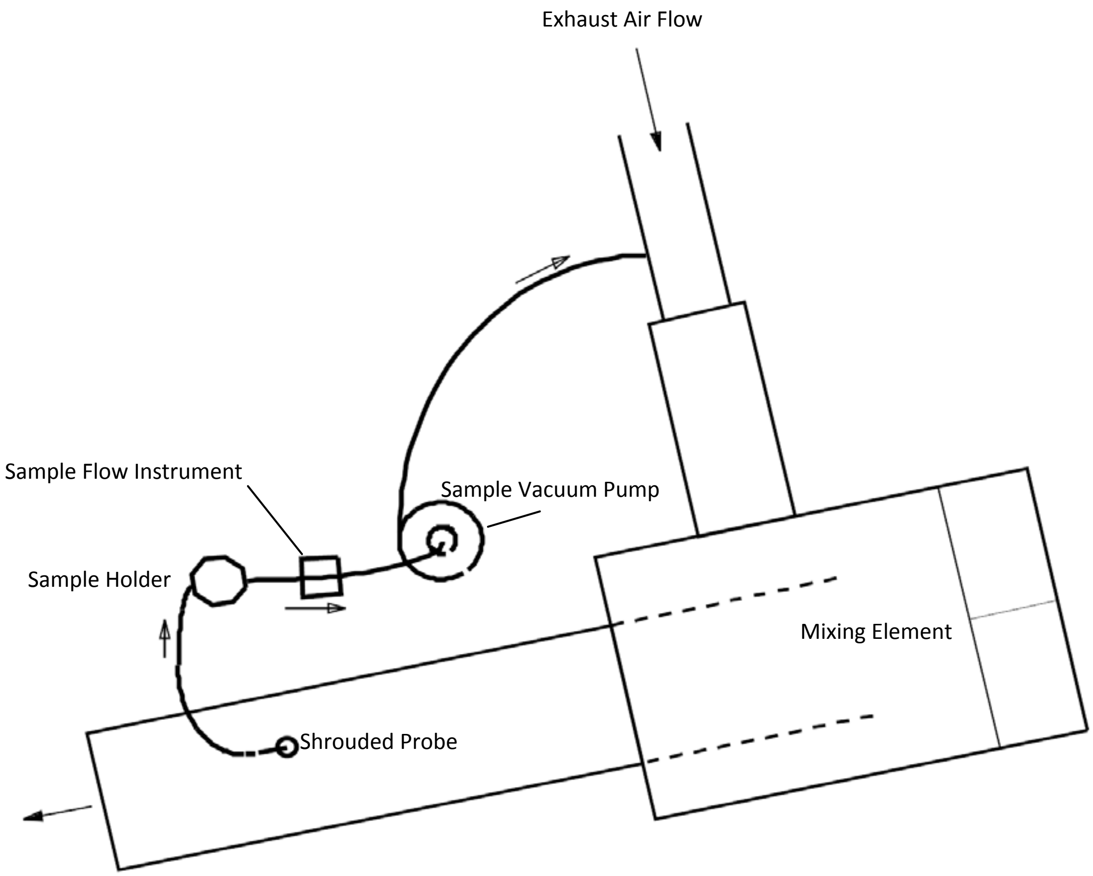
Parameter	Relative Dimensions
A	2.5 D*
B	0.5 D
C	0.682 D + H
D	Exit Duct Diameter
E	1.5 D
F	1.33 D
G	0.171 D
H	Inlet Duct Width (or diameter)
J	Inlet Duct Depth (or diameter)
K	1.535 D
L	1.833 D + H
M	0.512 D

* - minimum distance

Note: End elbow (E) not required unless wind will affect sample location flow profile

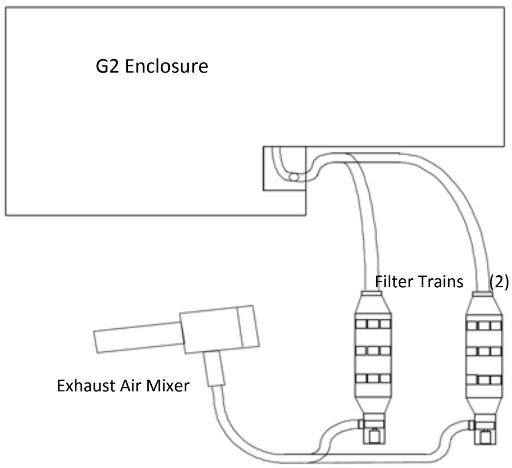
G2 Enclosure Exhaust Air Mixer

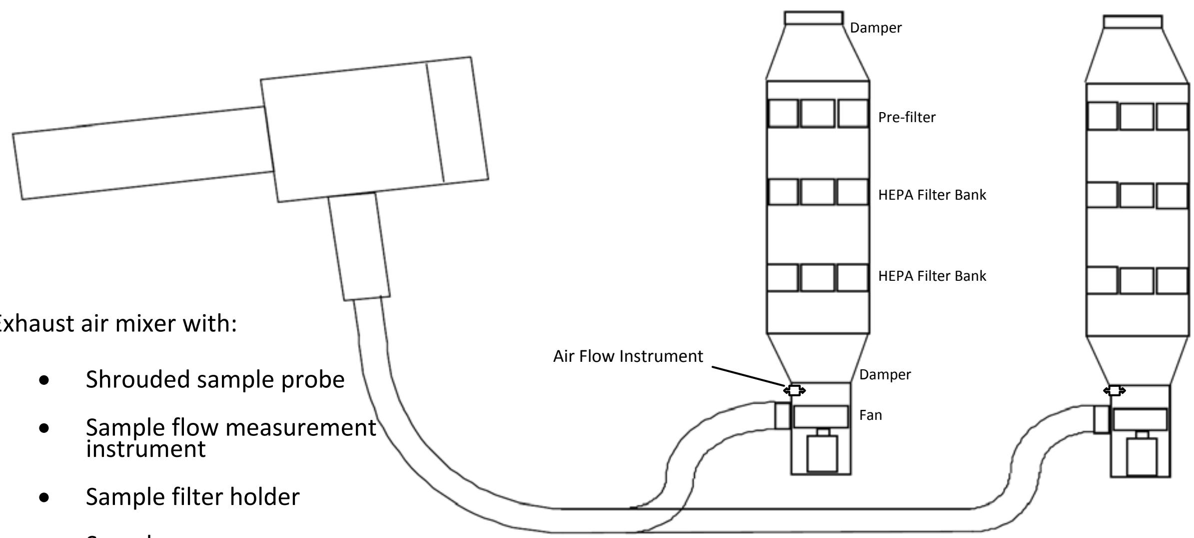
General Arrangement (not to scale)



G2 Enclosure Ventilation System

Proposed General Arrangement (not to scale)





Exhaust air mixer with:

- Shrouded sample probe
- Sample flow measurement instrument
- Sample filter holder
- Sample vacuum pump

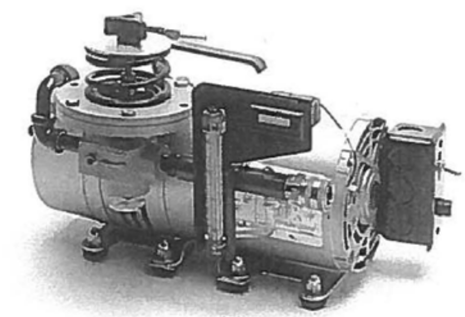
Two (2) filter trains each with:

- Inlet damper,
- Pre-filter,
- First-stage HEPA filter,
- Second-stage HEPA filter,
- Outlet damper,
- Flow measurement instrument, and
- Fan.

RADēCO
17 West Pkwy Plainfield , Ct. 06374
TEL: (860) 564-1220 FAX (860) 564-6631 www.radecoinc.com

PORTABLE CONSTANT FLOW AIR SAMPLER MODEL AVS-28A

- **CONSTANT AIRFLOW MAINTAINED WITH ΔP ACROSS THE FILTER OF UP TO 17" Hg (FLOW RATE DEPENDENT)**
- **BALANCED, EASY TO CARRY COMPACT SYSTEM**
- **FLOW RATE INDICATION ON ROTOMETER, CFM OR LPM**
- **RATED FOR CONTINUOUS DUTY**
- **LOW NOISE LEVEL**
- **MINIMUM MAINTENANCE**
- **OPTIONAL ELAPSED TIME INDICATOR**
- **ALL UNITS INDIVIDUALLY CALIBRATED AND TRACEABLE TO NIST**



Industry Workhorse Continues to Lead the Field

The Model AVS-28A Portable Constant Flow Air Sampler is a continuous duty, constant flow device. It can be used with filters and cartridges in the collection of airborne contaminates, or as a regulated, positive displacement vacuum supply for continuous air monitors and stack sampling systems.

The ability of the AVS-28A to maintain a preset sample flow rate is controlled by the unique side-mounted regulator valve. The RADēCO regulator valve is not a bypass design, and therefore the exhaust contains only sampled air. The AVS-28A has the superior ability to compensate for added ΔP across sampling media.

The sampling flow rate is read out on a side-mounted rotometer which measures the differential pressure across the in-line anodized aluminum venturi. All units are individually calibrated and traceable to NIST.

RADēCO

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PORTABLE CONSTANT FLOW AIR SAMPLER MODEL AVS-28A

Specifications

Air Flow Rate: Adjustable from 0.5 to 3.5 CFM (10 to 100 LPM).

Air Flow Regulation: ±5% of set air flow rate up to maximum capability of pump.

Dimensions/Weight: 12" Long x 14" Wide 9" High, (30.5 cm x 35.6 cm x 22.9 cm), 38 lbs (17.27 kg).

Power Requirement/Cable: 115V, 60Hz, 4.6 Amps; 230V, 50hz, 2.3 Amps. Three wire, (6) six feet (10) Ten Amp rating; British and European available.

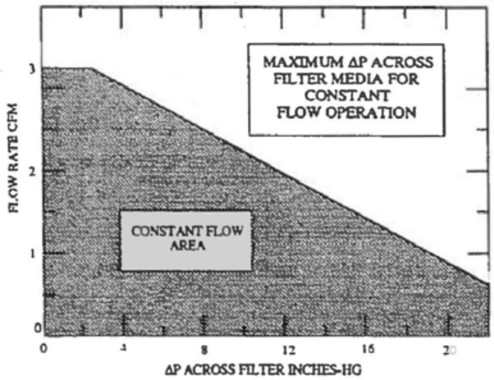
Air Flow Indicator: Venturi mounted rotometer.

Air Mover/Motor: Self-adjusting carbon vane type. Pump is designed for continuous operation at 26" Hg vacuum. Rated at 1/4 horsepower with thermal overload protection.

Input Connection: 3/8" Female Quick Disconnect.

Re-settable Elapsed Time Meter: 99999 hours and 59 minutes, pushbutton re-

Sample Holders Available	
Model No.	**Description**
2500-04	2" diameter filter, open face
2500-42	47 mm diameter filter, open face
2500-21	2" diameter filter/RADēCO cartridge, open face
2500-46	47 mm diameter filter/RADēCO cartridge, open face
2500-45	2" diameter filter/RADēCO cartridge, in-line
2500-44	47 mm diameter filter/RADēCO cartridge, in-line
Other style holders available. Please call for selection information.	



Typical Air Sample Flow Instrument

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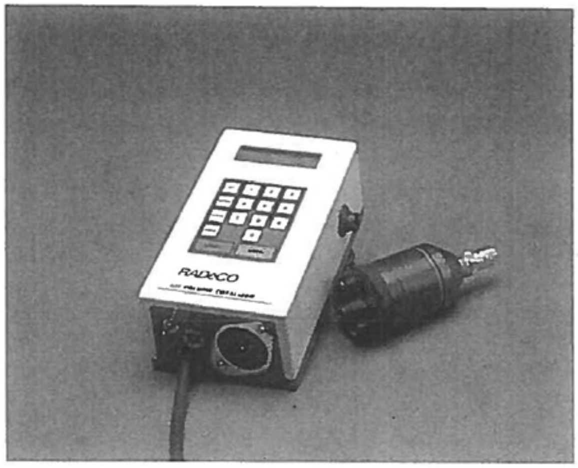
TEL: (860) 564-1220 FAX: (860) 564-6631 Email: info@radecoinc.com www.radecoinc.com

CONTINUOUS AIR VOLUME TOTALIZER MODEL AVT-100

- **EASILY ADAPTS TO MOST POSITIVE DISPLACEMENT PUMPS**
- **RUGGED TURBINE MONITORS FLOW**
- **LCD DISPLAYS:**
  - **-Elapsed Sample Time**
  - **-Flow Rate**
  - **-Total Volume**
- **BATTERY-BACKED DATA MEMORY**
- **MICROPROCESSOR BASED**
- **CIRCUIT BREAKER**
- **EASE OF CALIBRATION**



The **Model AVT-100** has been designed for use in continuous air sampling applications. This microprocessor based unit is a reliable alternative to the use of rotometers, venturi and mechanical time meters, simplifying air sampling procedures while adding significantly higher accuracy to air sampling data.

The **Model AVT-100** is composed of two assemblies—the display chassis assembly and the remote air turbine assembly. The two assemblies are interconnected by an 18" cable with locking connectors. The remote air turbine assembly can be attached to the exhaust of any non-lubricated positive displacement pump. The air turbine rotates at speeds proportional to the air velocity of the pump's inlet (sampled air). The turbine's rotation is sensed by a reflective sensor/breaker disc. The microprocessor converts the signal to volume and displays the FLOW RATE, TOTAL VOLUME, and ELAPSED TIME on the LCD readout.

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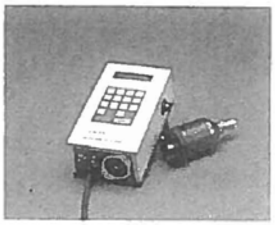
MODEL AVT-100 CONTINUOUS AIR VOLUME TOTALIZER



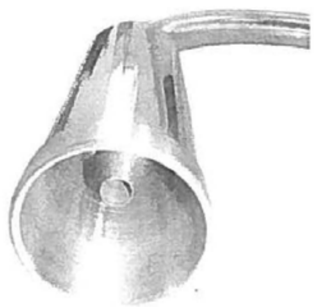
When the sampling pump is plugged into the **AVT-100**, the **AVT-100** will control the AC power applied to the pump, should the AC power be interrupted, the **AVT-100** will store all sampling data and restart the sampler when the AC power is restored

Specifications

Operational Range:	Up to 999,999 cubic feet or 999,999 cubic meters
Accuracy of Totalizer:	± 5% FS
Timer Circuit:	Microprocessor-controlled crystal oscillator
Operational Voltage:	95 to 135V, 50 to 60 Hz, 1 Phase, or 205—240V, 50 Hz, 1 Phase
Chassis Dimensions:	8" Long x4.75" Wide x 4" High 203mm x 121mm x 102mm
Turbine Dimensions:	4" Long x 2" Diameter, with 18" Cable 102mm x 51mm, with 457mm Cable
Weight:	3 Pounds (1.4 Kg)
Turbine Inlet:	1/4" NPT (Female Thread)
Turbine outlet:	1/8" NPT (Female Thread)
Readout of Totalizer:	LCD; Two lines 16 characters, backlit. Continuous display of cumulative volume + flowrate + elapsed time. Toggles between CFM and LPM
Controls:	ON/OFF Switch (circuit breaker) Keypad, 16 key controls function and calibration

Air Sample Withdrawal Nozzle

SHROUDED SAMPLING PROBE



The Shrouded Sampling Probe is anisokinetic probe manufactured by Lab Impex Systems (LIS) under licence from Texas A & M University. The probe is designed for high efficiency extraction of aerosols from ventilation stacks, and for the nuclear industry is most commonly used in radioactive effluent sampling and measurement systems.

This probe design has several advantages over non-shrouded probes (such as the traditional isokinetic variety): lower internal wall losses, better off-angle performance, lower sensitivity to flow stream turbulence, and the ability to operate in either a fixed flow or variable flow rate mode.

Information & specifications may change without notice

- **Meets requirements for ANSI N13.1-1999 and ISO 2889 2008**
- **Available for 1.0 inch or 1.5 inch sample lines**
- **Improved transmission efficiency over range of flow velocities**
- **Improved transmission efficiency over range of flow angles**
- **Lower internal wall losses than isokinetic sample probes**
- **Less sensitive to flow turbulence**
- **Use in fixed or variable sample flow systems**

Another significant benefit is that a single probe design may be used for a range of stack velocities and geometries, thereby allowing a single shrouded sampling probe design to be used for a variety of different stack applications (diameters and flow rates). Shrouded probes are typically less expensive than a custom sampling rake designed for a single stack.

Optimal Efficiency

In a stack installation, the shrouded probe will be used with a transport system specifically designed to ensure that aerosol losses within the sample probe and transport lines are kept to a minimum. Typically a system will comprise a shrouded probe, an in-stack transport line, a mounting flange, and an external transport line that conveys the aerosol sample from the stack to the sampling or monitoring system.

Transport system design is an important step in optimizing overall sampling efficiency, and Lab Impex Systems can assist clients in the design process by using software modelling to determine the transmission efficiency of aerosol through the transport system.

Lab Impex Systems

Laboratory Impex Systems. 21 Harwell Road, Poole, Dorset, BH17 0GE, UK. Tel: +44 (0) 1202 684848 Fax: +44 (0) 1202 683571

Laboratory Impex Systems Inc. Suite C4, 103 Rio Rancho Dr. NE, Rio Rancho, NM 87124-1442 Tel: (505) 892 9654 Fax: (505) 890 6319

sales@lab-impex-systems.com www.lab-impex-systems.com

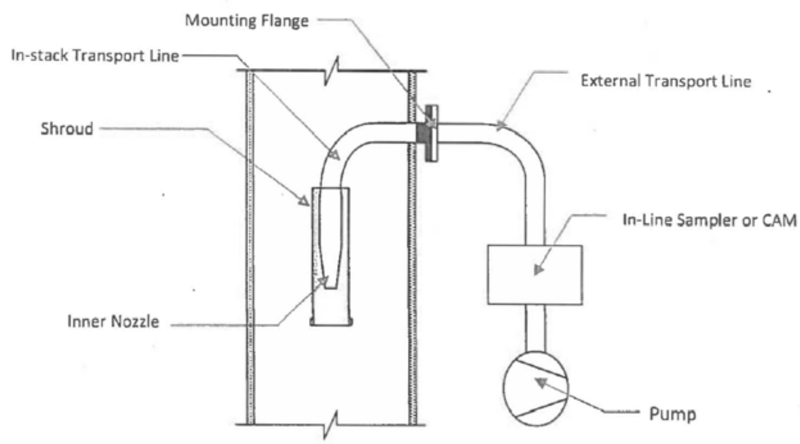
SHROUDED SAMPLING PROBE

Information & specifications may change without notice

Principle of Operation

A vacuum pump (installed downstream of the sampling or monitoring system) will draw a continuous sample of stack gas through the probe and transport system.

At the entrance to the probe, the stack gas will be decelerated by the shroud to a velocity about one third that of the free stream in the stack. The inner nozzle will sample the central core of the gas stream which enters the shroud, while the remainder of the gas is exhausted at the rear of the shroud via the annular gap between the shroud and the inner nozzle.



The Advantages of Using the Shrouded Probe

1) A single probe design is suitable for the majority of stacks. Custom probe design is not required for each stack.
2) The shrouded probe can sample over a range of stack velocities. Isokinetic sampling is only valid when the draw off velocity is equal to free-stream velocity.
3) In ventilation systems where the stack velocity does change, the variation of transmission with velocity is lower than a traditional isokinetic probe.
4) The shrouded probe allows representative sampling to be achieved through a single point measurement. A sampling rake is not required to achieve representative sampling.

Performance Characteristics

ANSI N13.1-1999 specifies that over the range of anticipated operating conditions (sampling flow rate and stack velocity) an acceptable aerosol sampling probe must have a transmission ratio * between 80% and 130% and an aspiration ratio** less than 150% for 10 µm aerodynamic diameter aerosol particles.

*The transmission ratio is the concentration of aerosol at the exit plane of a probe divided by the concentration in the stack at the probe location.

**The aspiration ratio is the aerosol concentration at the probe entrance plane divided by the concentration in the stack at the probe location.

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SHROUDED SAMPLING PROBE

Shrouded Sampling Probe

PHYSICAL CHARACTERISTICS

The shrouded probes are manufactured to close tolerances using 304 stainless steel.

DIMENSIONS (Height x Depth x Width)

The shrouded probes use the same external shroud (and dimensions) but have different internal dimensions based on the application.

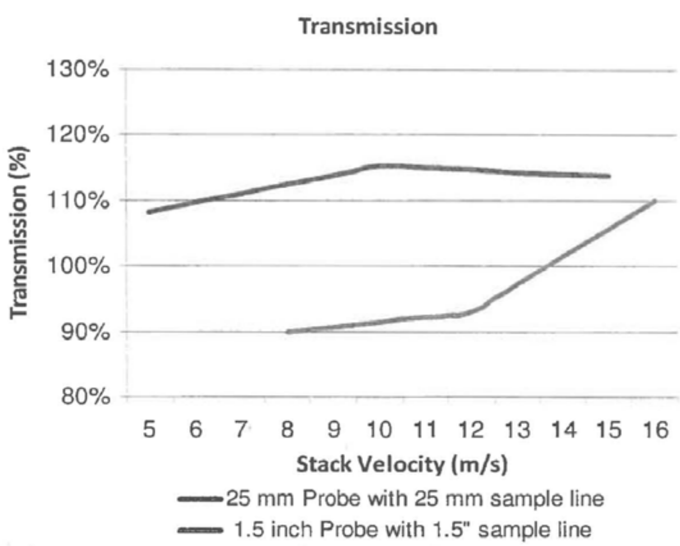
- Overall Length: 242 mm (probe only - without sample lines)
- Diameter: 60 mm diameter (at widest point, lip on inlet)
- Connection: 25 mm ID, 1.0-inch ID, or 1.5-inch ID depending on the model of probe selected

Information & specifications may change without notice

ISO-2889 2009 Requirements

While not a comprehensive list of requirements, the bullet points listed below summarize the primary requirements of ISO-2889 *Sampling Airborne Radioactive Materials from the Stacks and Ducts of Nuclear Facilities* as issued in 2009.

- Sampling location provides the ability to extract a representative sample.
- Determine the properties of the sampling location through a series of tests.
- Determine penetration of contaminants though the system.
- Penetration 10-µm AD particles greater than 50%
- Actual penetration should be measured.
- Extract, deliver, and collect ≥ 50% of gases or vapours etc.
- Demonstrate performance of multi-nozzle probes in the same way as a single nozzle.



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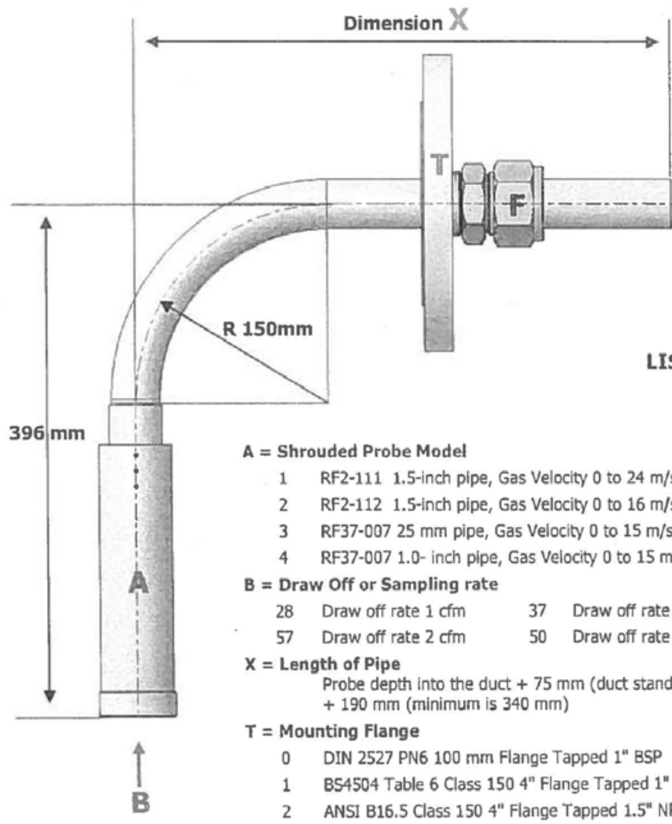
SHROUDED SAMPLING PROBE



Part Numbering

The shrouded probe is available as a standard assembly with probe, in-stack transport line, flange and couplings. However Dimension X will change with stack diameter.
For non-standard applications, please contact Lab Impex Systems.

Information & specifications may change without notice

LIS-SP2000-A-B-X-T-F-75

A = Shrouded Probe Model

1 RF2-111 1.5-inch pipe, Gas Velocity 0 to 24 m/s
2 RF2-112 1.5-inch pipe, Gas Velocity 0 to 16 m/s
3 RF37-007 25 mm pipe, Gas Velocity 0 to 15 m/s
4 RF37-007 1.0- inch pipe, Gas Velocity 0 to 15 m/s

B = Draw Off or Sampling rate

28 Draw off rate 1 cfm
57 Draw off rate 2 cfm
37 Draw off rate 37 liters/min
50 Draw off rate 50 liters/min

X = Length of Pipe

Probe depth into the duct + 75 mm (duct stand-off distance) + 190 mm (minimum is 340 mm)

T = Mounting Flange

0 DIN 2527 PN6 100 mm Flange Tapped 1" BSP
1 BS4504 Table 6 Class 150 4" Flange Tapped 1" BSP
2 ANSI B16.5 Class 150 4" Flange Tapped 1.5" NPT
3 1" BSP universal Flange Mounting
4 1.5" NPT Universal Flange Mounting

F = Flange Coupling

0 1.5" NPT Stud Coupling for 1.5" Pipe
1 1" BSP Stud Coupling for 25 mm pipe
W Probe length fixed , probe welded to flange

75mm = Standoff distance between the outside of the duct and the mounting surface of the flange

References:

ANSI/HPS N13.1-1999 *"Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities"*
ISO 2889 *"Sampling Airborne Radioactive Materials from the Stacks and Ducts of Nuclear Facilities"* issued in 2009
Chandra, S.; McFarland, A. R. (1995) Comparison of aerosol sampling with shrouded probe and unshrouded probes. *Am. Ind. Hyg. Assoc. J.* 56:459-466
Chandra, S.; McFarland, A. R. (1997) Shrouded probe performance: Variable flow operation and effect of free stream turbulence. *Aerosol Sci. Technol.* 26:111-126

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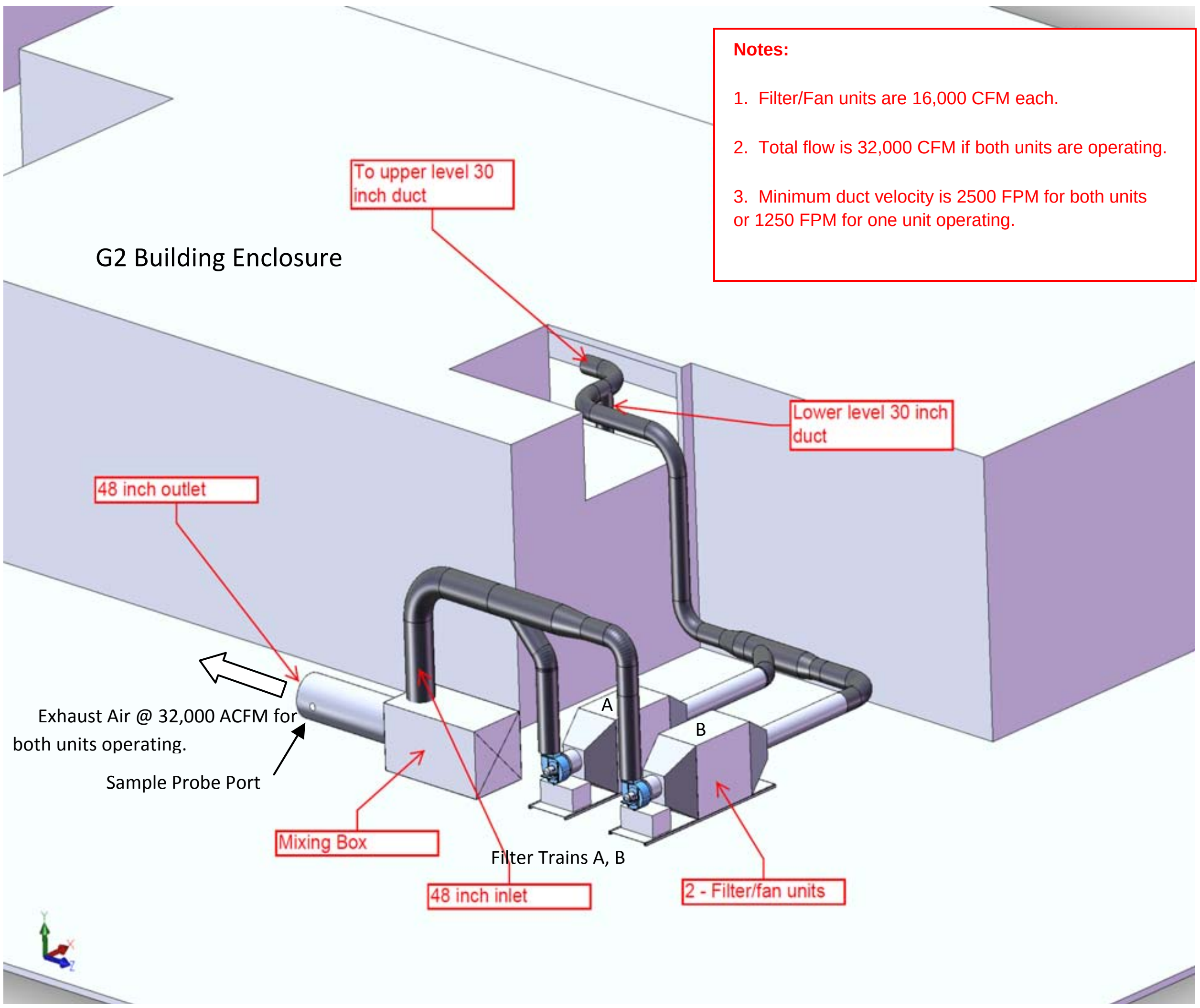
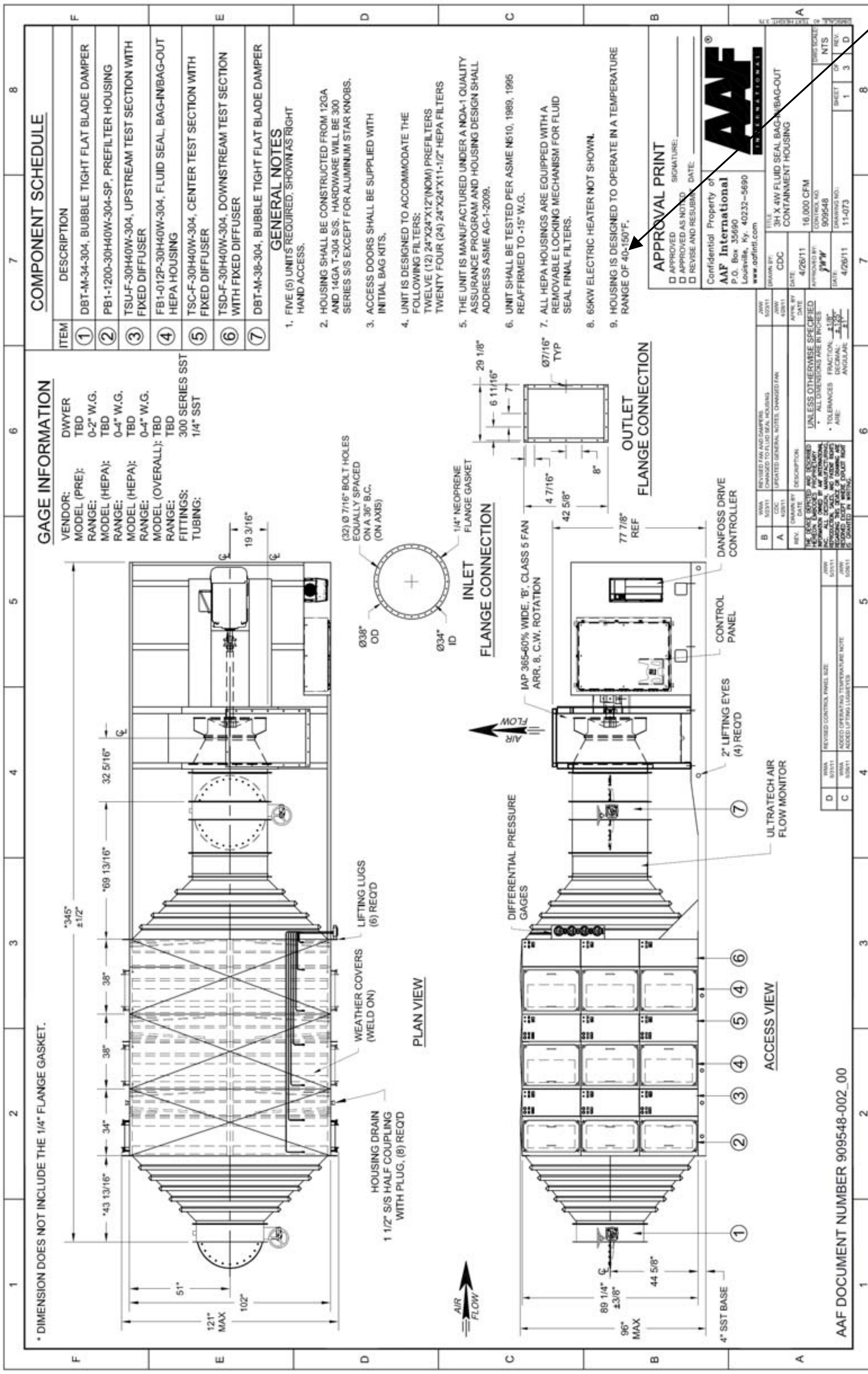
G2 Enclosure Ventilation Exhaust System Component Arrangement

(Preliminary Design)



G2 Enclosure Ventilation Exhaust HEPA /Fan Unit Assembly (Preliminary Design)



The manufacturer will change General Note 9 to read Ambient to 150°F and revise its drawing.