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Air Dispersion Modeling for Building 3026C/D Demolition

October 2009

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ABSTRACT

This report presents estimates of dispersion coefficients and effective dose for potential air dispersion scenarios of uncontrolled releases from Oak Ridge National Laboratory (ORNL) buildings 3026C, 3026D, and 3140 prior to or during the demolition of the 3026 Complex. The Environmental Protection Agency (EPA) AERMOD system[1-6] was used to compute these estimates. AERMOD stands for AERMIC Model, where AERMIC is the **A**merican Meteorological Society-**E**PA **R**egulatory **M**odel **I**mprovement **C**ommittee. Five source locations (three in building 3026D and one each in building 3026C and the filter house 3140) and associated source characteristics were determined with the customer. In addition, the area of study was determined and building footprints and intake locations of air-handling systems were obtained. In addition to the air intakes, receptor sites consisting of ground level locations on four polar grids (50 m, 100 m, 200 m, and 500 m) and two intersecting lines of points (50 m separation), corresponding to sidewalks along Central Avenue and Fifth Street. Three years of meteorological data (2006—2008) were used each consisting of three datasets: 1) National Weather Service data; 2) upper air data for the Knoxville-Oak Ridge area; and 3) local weather data from Tower C (10 m, 30 m and 100 m) on the ORNL reservation. Annual average air concentration, highest 1 h average and highest 3 h average air concentrations were computed using AERMOD for the five source locations for the three years of meteorological data. The highest 1 h average air concentrations were converted to dispersion coefficients to characterize the atmospheric dispersion as the customer was interested in the most significant response and the highest 1 h average data reflects the best time-averaged values available from the AERMOD code. Results are presented in tabular and graphical form. The results for dose were obtained using radionuclide activities for each of the buildings provided by the customer.[7] Radiation dose was calculated assuming complete release of the building inventory as information was lacking regarding the portion of the building inventory expected to be released. Thus the results are derived using an extremely conservative release as documented in the Preliminary Hazard Screening report.[7] To more closely approximate the result of a release, one must estimate the fraction of the total inventory released and multiply the results described above by that fraction. An example of how this calculation is accomplished is provided. Should an actual uncontrolled release occur, the results of this modeling effort could only be used to establish a rough order-of-magnitude for the event.

AIR DISPERSION MODELING FOR BUILIDING 3026C/D DEMOLITION
October 12, 2009

1. INTRODUCTION

The AERMOD system[1] was used to estimate the air concentrations resulting from a release of a pollutant from buildings 3026C, 3026D, and filter house 3140, for potential air dispersion scenarios resulting from accidental release prior to or during the demolition of buildings 3026C/D. AERMOD[2] is a complex terrain / wind-field model and is the model that EPA currently recommends for atmospheric pollutant modeling. AERMOD stands for AERMIC Model, where AERMIC is the **A**merican Meteorological Society/**E**PA **R**egulatory **M**odel **I**mprovement **C**ommittee. In this study, the scenarios were modeled using several different proposed heights and locations within the three buildings.

Three sets of receptors were considered: 1) locations at 50 m intervals following the sidewalk along Central Avenue (SW-NE direction) and roughly along Fifth Street (NW–SE direction) perpendicular to Central Avenue; 2) a set of polar grids centered on the source location; and 3) air intakes on buildings on the ORNL campus outside an inner boundary which defines the buildings involved in the downwash calculation. The modeling included the effects of terrain, land cover type, and nearby buildings. Three years (2006–2008) of meteorological data were used including ORNL Tower C data and both ground level and upper air data from the KOQT site in Oak Ridge.

2. METHODOLOGY

2.1 AERMOD CODE

The AERMOD[1] system consists of four additional preprocessors, AERMAP[3], AERMET[4], AERSURFACE[5], BPIPPRIME[6], in addition to AERMOD[2]. AERSURFACE accepts the stack (source) location and local climate information as well as U.S. Geological Survey (USGS) land cover database to produce land cover characteristics for input to AERMET. AERMET preprocesses meteorological data. It requires National Weather Service data and upper air data. It also allows the use of on-site meteorology. AERMAP preprocesses terrain data and determines the elevation of the source and receptors. It accepts USGS digital elevation model (DEM) files as input. BPIPPRIME produces input for AERMOD that is used to estimate the effects of building wake. Input data for BPIPPRIME are the source location and elevation and the locations and ground elevations of nearby building corners and building heights.

AERMOD was run for a unit release, so that the resulting air concentrations could be applied to a variety of source amounts. Each proposed source location and height and each set of receptors were modeled separately. The building wake was computed for each source location and height. The same land cover, terrain, and meteorological data were used for each. Details of the procedure are outlined in Appendix A.

2.2 PLUME TRANSPORT FORMULATION

AERMOD (and its precursor, the ISC model) uses the steady-state Gaussian plume equation for a continuous elevated stack source. For each source and each hour, the origin of the source's coordinate system is placed at the ground surface at the base of the stack. The x axis is positive in the downwind direction, the y axis is crosswind (normal) to the x axis and the z axis extends vertically. The fixed receptor locations are converted to each source's coordinate system for each hourly concentration calculation.

The hourly concentrations calculated for each source at each receptor are summed to obtain the total concentration produced at each receptor by the combined source emissions. For a steady-state Gaussian plume, the hourly concentration χ at downwind distance x (m) and crosswind distance y (m) is given by:

$$\chi(x, y) = \frac{V\,D\,Q}{2u_S\,\sigma_y\,\sigma_Z}\exp[-0.5(y/\sigma_y)^2], \qquad (1)$$

where:

χ = the airborne concentration (g/m^3) of the pollutant at location x, y,

Q = pollutant emission rate (g/s),

V = vertical term,

D = decay term, here taken to be 1.0,

σ_y, σ_z = standard deviation of lateral and vertical concentration distribution (m), and

u_s = mean wind speed (m/s) at release height.

Equation (1) includes a vertical term (V), a decay term (D), and dispersion parameters (σ_y and σ_z). Both σ_y and σ_z are functions of the atmospheric stability class (i.e., a measure of the turbulence in the ambient atmosphere) and of the downwind distance to the receptor. The decay term (D) accounts for radioactive decay of the pollutant during dispersal, which is taken to be 1.0 here, since the half-lives of the radionuclides are long relative to the travel time to the receptor location. The vertical term (V) accounts for effects of source elevation, receptor elevation, plume rise, limited mixing in the vertical, and the gravitational settling and dry deposition of particulates (with diameters greater than about 0.1 µm). The quotient of airborne concentration and the release rate, χ/Q, characterizes the dispersion conditions. If Q has units of g/s, u_s of m/s and both σ_y and σ_y have units of m, then the dispersion coefficient, χ/Q, has units of s/m^3.

2.3 DOSE CALCULATION

The radiation doses calculated here include contributions due to inhalation of the dispersing materials, exposure to penetrating radiations emitted by airborne dispersing materials (so-called submersion pathway), and exposure over a 4 h period to penetrating radiations emitted by materials deposited on the ground surface. However, it was shown (see Appendix E) that the dose is dominated by the inhalation pathway and thus only that component is addressed in the discussions below.

The effective dose $E(x, y)$ at location x, y, for a release of Q (Bq) is computed as:

$$E(x, y) = K\, BR[\chi(x, y) / Q]\, Q\, e \ , \tag{2}$$

where $\chi\,(x, y)/Q$ is the dispersion coefficient (s/m^3) applicable at x, y for the release point, e is the effective dose coefficient (Sv/Bq) for inhalation of the dispersing material, BR is the breathing rate of an adult (1.5 m^3/h), and K is 1/3600 h/s. The effective dose coefficients for the radionuclides of interest here are given in Appendix E.

Equation (2) is applicable to each radionuclide in the release; the total dose being the sum of the contributions of each of the radionuclides. Since the radionuclides are all long-lived and no nuclide-specific fractionation of the inventory is expected during the release, Eq. (2) can be rewritten as:

$$E(x, y) = K\, BR[\chi(x, y) / Q] \sum_i Q_i\, e_i \ , \tag{3}$$

where Q_i is the building inventory of nuclide i and e_i is nuclide's effective dose coefficient. Thus the doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release, one should multiply the doses shown in Tables 4 and 5 by a factor that represents that fraction of the building's inventory expected to be released.

3. DATA USED

3.1 LAND COVER CHARACTERISTICS

AERSURFACE requires the input of land cover data from the USGS National Land Cover Data 1992 archives, which is used to determine the land cover types for the user-specified location. The land cover generated is radial. For example, if AERSURFACE determines that most of the land to the north is forest, then the entire northern sector is treated as forest. It also requires the user to enter information on whether or not the site is in an arid region and whether the current year is abnormally wet or dry. Normal moisture and a non-arid region were used in this study. Up to 12 directional sectors may be used. Data may be computed on an annual, seasonal, or monthly basis. For this study, one sector and annual resolution were selected.

3.2 METEOROLOGY

AERMET requires hourly meteorological observations for one year from two sources: National Weather Service (NWS) ground surface observations and upper air soundings. It also accepts on-site data. The NWS data used was from the KOQT site in Oak Ridge, Tennessee. These data were obtained from the National Climatic Data Center. The upper air data used were the SODAR readings at the KOQT site. The on-site meteorological tower data used were from Tower C, the tower closest to the releases. All three levels of measurements (10 m, 30 m, and 100 m) were used. AERMET runs in three 'stages.' First, the data were checked for internal quality and consistency; second, the three output files were merged; and third, the AERMOD input files were created, incorporating data on the land cover characteristics. Because of the limitations on input formats, the NWS data had to be pre-processed and reformatted before they could be read by AERMET.

AERMOD was run separately for each of the three years of meteorology data (2006–2008). These three years represent a good spread on the meteorology because they were all relatively different. Years 2007 and 2008 were quite opposite one another, giving a high probability that the meteorology data covers the likely spreads in concentrations.

A separate dispersion calculation is made using each hour of weather data for a given year and three types of averages were computed: annual average, 1 h averages, and 3 h averages. The results varied across the three years with average annual concentrations being most similar to each other. Variations are more significant for 3 h and 1 h averages – the latter being the closest results to transient modeling obtainable with AERMOD. Average annual concentrations tend to follow the wind rose patterns. Wind roses for 2006–2008 for the three measurement heights of Tower C are shown in Figs. B1—B9 in Appendix B. Since we are primarily concerned with the significant events, we used the 1 h averages in this report.

3.3 BUILDING LOCATIONS

Twenty-nine existing buildings near the proposed releases were modeled using BPIPPRIME. They were buildings 3025E, 3025M, 3028, 3029, 3038, 3039, 3092, 3105, 3125, 3150, 3515, 3525, 3546, 3550, 3026C, 3026D, 3034, 3036, 3037, 3047, 3130, 3137, 3500, 3508, 3517, 3542, 3587, 3606, and 3618. The following buildings were modeled using two levels: 3026C, 3026D, 3500, 3508, and 3517. The required data are the location and ground elevation of the source, and for each building, the locations and ground elevations of the corners and the height of the building. The building data were provided by Damen Belcher. The BPIPPRIME input data files for each source are included in Appendix C.

3.4 TOPOGRAPHY

AERMAP input are the UTM coordinates of the source and receptor locations along with USGS DEM files of topographic data for the area being modeled. AERMAP produces two files for input to AERMOD, one with the source location and ground elevation and the other with the receptors and their ground elevations. AERMAP was run separately for three receptor grids: a grid of locations along sidewalks, selected building air intake locations, and a set of concentric circular grids.

3.5 SOURCE CHARACTERISTICS

Five sources (potential locations of ambient release due to collapse of structure) were modeled, three in building 3026D, one in building 3026C, and one in building 3140. The five source locations are described in Table 1. In each case, the release was modeled as a stack release with diameter of 4 m. We further assumed that the release was at ambient temperature with essentially zero release velocity. Thus, with the exception of release location, elevation and height, the source data all had the same set of physical characteristics as shown in Table 2. For each source the location (in UTM coordinates), elevation (m) and height (m) are shown in Table 3. Locations of sources are shown as stars in Fig. 1 below.

Table 1. Source descriptions

Source	Description
Source 1 (S1)	Building 3026D – NW Corner at roof level
Source 2 (S2)	Building 3026D – Center line, left side near ground level
Source 3 (S3)	Building 3026D – Center line, right side of at roof level of maintenance covering
Source 4 (S4)	Building 3026C – NW side near ground level
Source 5 (S5)	Building 3140 – Center near ground level

Table 2. Source data

Datum	Value
Release rate	1 g/s
Temperature	300 K
Exit velocity	0.01 m/s
Stack diameter	4 m

Table 3. Source locations and heights

	Location (m)		Elev (m)	Height (m)
	UTM Northing	UTM Easting		
S1	742095.5	3979226.0	243.75	14.63
S2	742104.0	3979215.0	243.40	1
S3	742111.0	3979221.0	243.41	12
S4	742080.0	3979209.0	243.49	1
S5	742090.5	3979250.8	244.69	1

Figure 1 shows a portion of area under study near buildings 3026C/D. S1 and S3 represent a failure of the roof at the location of greatest deterioration and above the two hot cells in 3026D. Results for S2 would depict a release from the floor of the Operating Area of the same building. S4 is the location of greatest roof deterioration in 3026C.

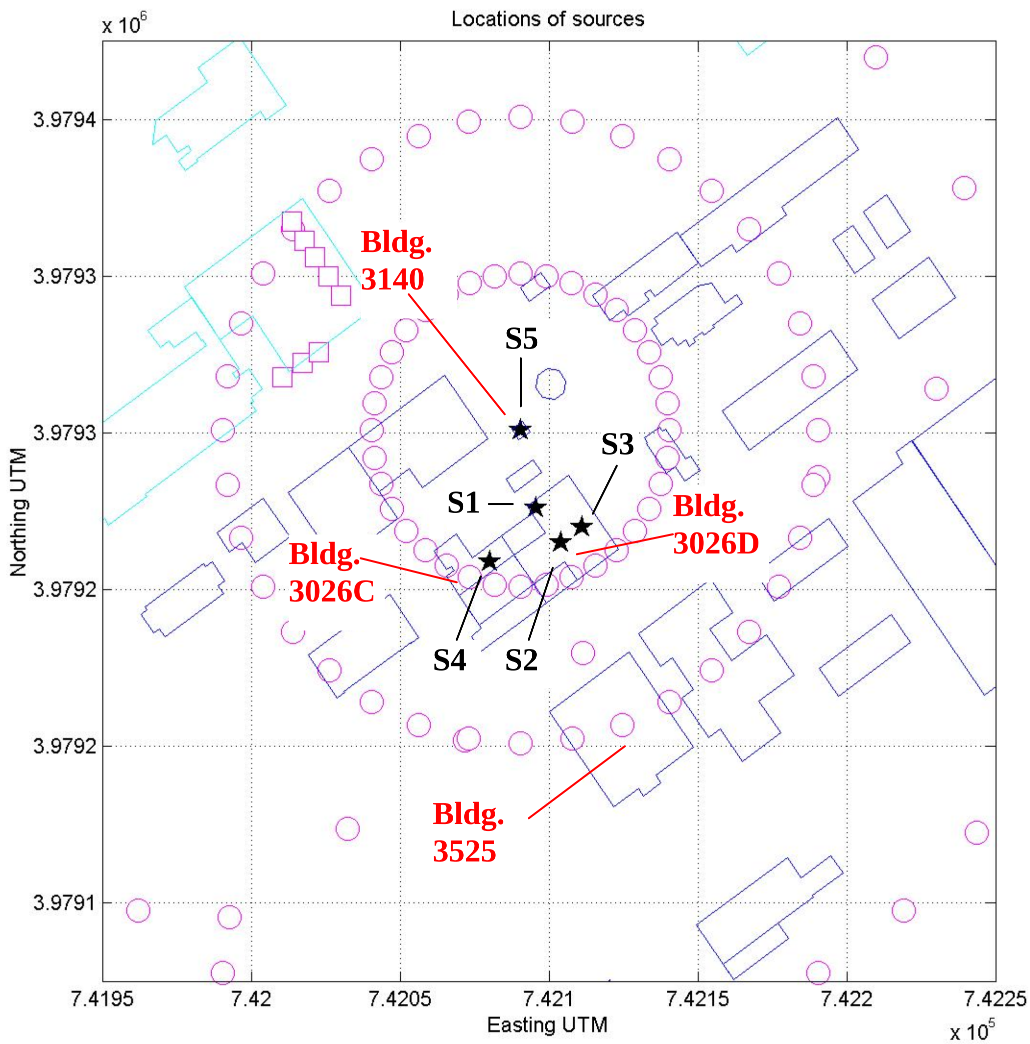


Fig. 1. Source locations are shown as stars on a map of ORNL. Polar grid receptor locations are relative to S5 (centered in filter house 3140). The other source locations are in building 3026D (S1–S3) and in building 3026C (S4).

3.6 RECEPTOR LOCATIONS

Three sets of receptors were used. The first consisted of points uniformly distributed (at 50 m intervals) along a sidewalk on the south side of Central Avenue (running SW–NE) and at 50 m intervals on a sidewalk roughly along Fifth Street (NW–SE). The second set of receptors consisted of concentric rings of polar grids of 50, 100, 200 and 500 m radius with the origin at the source UTM coordinates. The third set of receptors were taken at approximate locations of air intakes on most buildings on the ORNL campus within the area of study, but outside the region considered for the downwash calculations. The receptor grids for S5 are shown in Fig. 2 along with the location of the source. The polar grids used 36 directions, starting at 10° and incrementing by 10° clockwise. The interval between points on the sidewalk grids was 50 m. The air intake locations are marked with square symbols.

The sidewalk receptors were chosen to provide concentrations for typical heavily-trafficked pathways near the source locations and further away. The air intake receptor locations and elevations give an indication of concentrations entering buildings. The polar grid provides general broader coverage of concentration results at ground level over the entire region.

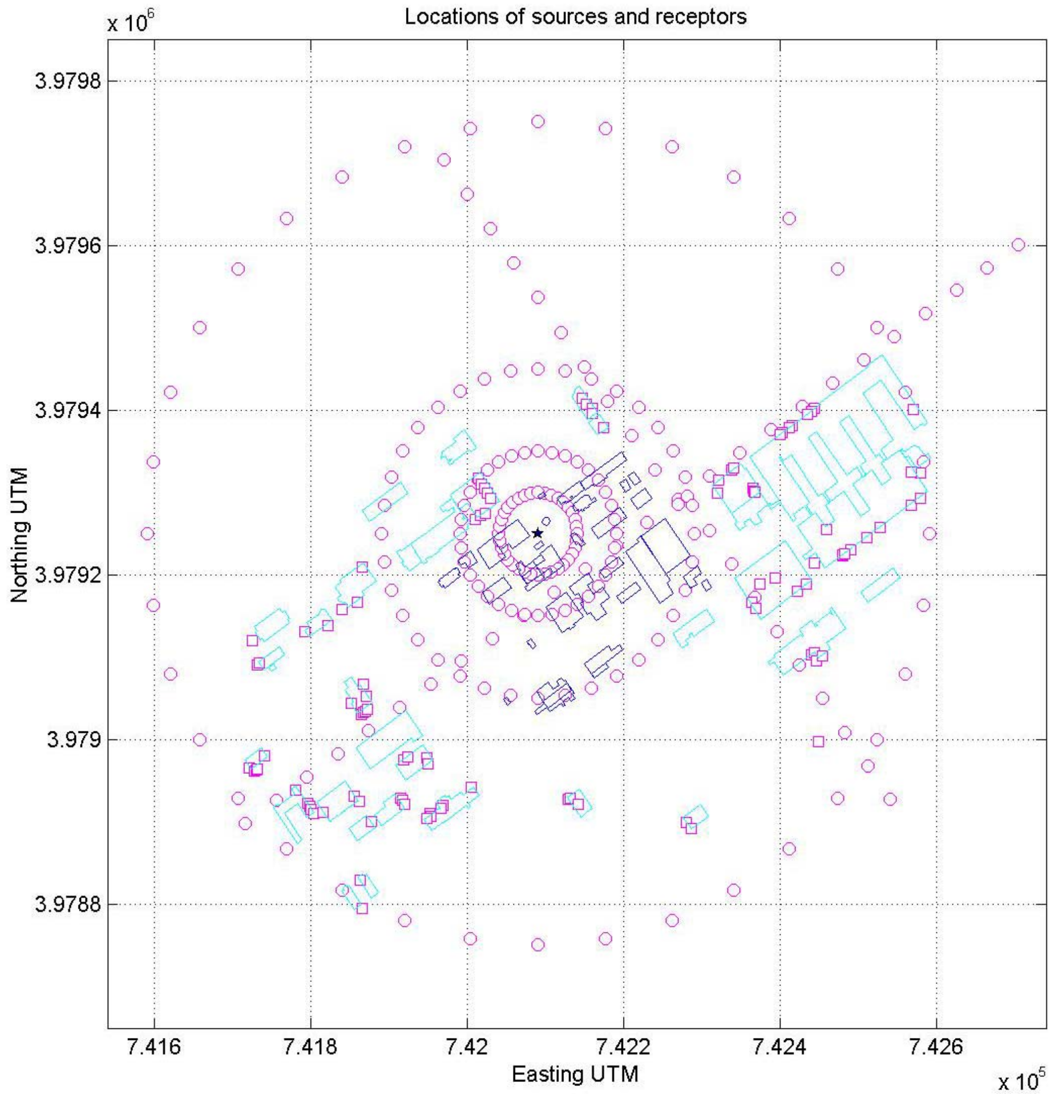


Fig. 2. Source and receptor locations for S5 at ground level in the center of filter house 3140. The polar grid and sidewalk receptor locations are shown as circles and the air intake receptor locations are shown as squares.

The AERMAP code must be run using the receptor UTM coordinates to obtain the elevations of the receptor location. An example of this is shown in Appendix D for the polar grid receptor locations for S5.

4. RESULTS

Separate computations were made using AERMOD for each of the five source locations and for the three sets of receptors (sidewalks, polar gird, and air intakes) for three years of meteorological data (2006–2008). Table 4 shows the maximum values for the annual average, highest 1 h average, and highest 3 h average dispersion coefficients (s/m^3) and associated effective dose (Sv) for sources (S1–S3) located in building 3026D for the three years of MET data (2006–2008). Results are for polar grid, sidewalk and air intake receptor locations. The maximum value in any one year (shown in bold font) is used to scale the plots for each source location for all receptors. The radioactive material inventory for building 3026D is shown in Table E.3 of Appendix E.

Table 4. Maximum annual, highest 1 h, and highest 3 h average dispersion coefficient (s/m^3) and associated effective dose (Sv) for building 3026D
Includes source locations S1–S3 for three years of MET data (2006-8)

3026D		Dispersion Coefficient (s/m^3)			Effective Dose (Sv)		
S1		2006	2007	2008	2006	2007	2008
Ann. Avg.	Polar	2.64E-4	**3.06E-4**	2.39E-4	2.31E-2	**2.67E-2**	2.09E-2
Ann. Avg.	Sidewalks	1.86E-4	1.55E-4	1.59E-4	1.62E-2	1.35E-2	1.39E-2
Ann. Avg.	Intakes	8.01E-5	1.25E-4	1.15E-4	6.99E-3	1.10E-2	1.00E-2
High 1 h	Polar	5.37E-3	**7.16E-3**	6.74E-3	4.69E-1	**6.25E-1**	5.88E-1
High 1 h	Sidewalks	5.24E-3	5.08E-3	6.59E-3	4.57E-1	4.43E-1	5.75E-1
High 1 h	Intakes	1.22E-3	3.03E-3	1.62E-3	1.07E-1	2.65E-1	1.42E-1
High 3 h	Polar	4.16E-3	4.00E-3	**4.32E-3**	3.63E-1	1.17E-1	**3.77E-1**
High 3 h	Sidewalks	3.98E-3	3.04E-3	4.19E-3	3.47E-1	2.66E-1	3.65E-1
High 3 h	Intakes	9.00E-4	1.19E-3	8.88E-4	7.85E-2	1.04E-1	7.75E-2
S2		2006	2007	2008	2006	2007	2008
Ann. Avg.	Polar	1.05E-3	**1.10E-3**	7.24E-4	9.14E-2	**9.57E-2**	6.32E-2
Ann. Avg.	Sidewalks	1.04E-3	1.06E-3	6.53E-4	9.08E-2	9.29E-2	5.70E-2
Ann. Avg.	Intakes	1.55E-4	1.70E-4	1.63E-4	1.35E-2	1.49E-2	1.42E-2
High 1 h	Polar	4.89E-2	4.78E-2	**8.74E-2**	4.27	4.17	**7.63**
High 1 h	Sidewalks	7.60E-2	7.10E-2	8.13E-2	6.63	6.19	7.09
High 1 h	Intakes	5.83E-3	7.66E-3	8.21E-3	5.09E-1	6.68E-1	7.16E-1
High 3 h	Polar	2.28E-2	2.52E-2	2.92E-2	1.99	2.20	2.55
High 3 h	Sidewalks	2.53E-2	3.30E-2	**3.34E-2**	2.21	2.88	**2.92**
High 3 h	Intakes	2.99E-3	2.99E-3	3.74E-3	2.61E-1	2.60E-1	3.26E-1
S3		2006	2007	2008	2006	2007	2008
Ann. Avg.	Polar	7.08E-4	**8.88E-4**	6.75E-4	6.17E-2	**7.75E-2**	5.89E-2
Ann. Avg.	Sidewalks	3.64E-4	4.14E-4	3.04E-4	3.18E-2	3.61E-2	2.66E-2
Ann. Avg.	Intakes	9.16E-5	1.22E-4	1.16E-4	7.99E-3	1.07E-2	1.02E-2
High 1 h	Polar	1.15E-2	1.66E-2	8.04E-3	1.00	1.45	7.01E-1
High 1 h	Sidewalks	1.31E-2	9.61E-3	**2.13E-2**	1.15	7.56E-1	**1.86**
High 1 h	Intakes	1.72E-3	2.22E-3	1.90E-3	1.50E-1	1.94E-1	1.66E-1
High 3 h	Polar	7.55E-3	**1.21E-2**	5.06E-3	6.59E-1	**1.05**	4.42E-1
High 3 h	Sidewalks	4.38E-3	6.34E-3	7.12E-3	3.83E-1	5.54E-1	6.21E-1
High 3 h	Intakes	7.04E-4	8.14E-4	1.10E-3	6.14E-2	7.10E-2	9.60E-2

Table 5 below shows the maximum values for the annual average, highest 1 h average, and highest 3 h average dispersion coefficients (s/m^3) and associated effective dose (Sv) for sources located in buildings 3026C (S4) and 3140 (S5) for the three years of meteorology data (2006–2008). Results are for polar grid, sidewalk and air intake receptor locations. The maximum value in any one year is used to scale the plots for each source location for all receptors. The radioactive material inventory for buildings 3026C and 3140 are shown as Table E.2 and Table E.4 respectively of Appendix E.

Table 5. Maximum annual, highest 1 h and highest 3 h average dispersion coefficient (s/m^3) and associated doses (Sv) for buildings 3026C and 3140

Includes sources S4 (3026C) and S5 (3140) for three years of MET data (2006-8)

3026C	Dispersion Coefficient (s/m^3)			Effective Dose (Sv)		
S4		2006	2007	2008	2006	2007	2008
Ann. Avg.	Polar	1.10E-3	**1.16E-3**	9.10E-4	1.50E-4	**1.58E-4**	1.24E-4
Ann. Avg.	Sidewalks	7.09E-4	7.50E-4	6.29E-4	9.67E-5	1.02E-4	8.57E-5
Ann. Avg.	Intakes	1.28E-4	1.44E-4	1.43E-4	1.74E-5	1.97E-5	1.95E-5
High 1 h	Polar	3.80E-2	3.67E-2	4.71E-2	5.18E-3	5.00E-3	6.42E-3
High 1 h	Sidewalks	1.67E-2	2.29E-2	**7.85E-2**	2.28E-3	3.12E-3	**1.07E-2**
High 1 h	Intakes	5.86E-3	6.45E-3	6.09E-3	8.00E-4	8.79E-4	8.31E-4
High 3 h	Polar	1.78E-2	1.66E-2	1.64E-2	2.43E-3	2.26E-3	2.23E-3
High 3 h	Sidewalks	1.06E-2	1.01E-2	**2.69E-2**	1.45E-3	1.37E-3	**3.67E-3**
High 3 h	Intakes	2.91E-3	2.31E-3	2.69E-3	3.97E-4	3.14E-4	3.67E-4
3140	Dispersion Coefficient (s/m^3)				Dose (Sv)		
S5		2006	2007	2008	2006	2007	2008
Ann. Avg.	Polar	6.53E-4	**7.92E-4**	7.16E-4	7.68E-8	**9.32E-8**	8.42E-8
Ann. Avg.	Sidewalks	4.31E-4	5.78E-4	5.02E-4	5.07E-8	6.80E-8	5.91E-8
Ann. Avg.	Intakes	2.12E-4	2.85E-4	2.56E-4	2.50E-8	3.35E-8	3.01E-8
High 1 h	Polar	2.01E-2	2.24E-2	**5.92E-2**	2.37E-6	2.64E-6	**6.97E-6**
High 1 h	Sidewalks	1.17E-2	1.91E-2	1.79E-2	1.38E-6	2.25E-6	2.11E-6
High 1 h	Intakes	4.95E-3	5.16E-3	7.33E-3	5.82E-7	6.08E-7	8.62E-7
High 3 h	Polar	7.93E-3	1.02E-2	**2.15E-2**	9.33E-7	1.20E-6	**2.54E-6**
High 3 h	Sidewalks	7.17E-3	9.85E-3	1.08E-2	8.43E-7	1.16E-6	1.66E-6
High 3 h	Intakes	3.19E-3	2.75E-3	2.51E-3	3.75E-7	3.23E-7	2.95E-7

An air concentration of 2.64E-4 g/m^3 (or 263 μg/m^3) would be predicted at a location characterized by a diffusion coefficient of 2.64E-04 s/m^3 given a release rate of 1 g/s. Correspondingly a release of 1 g would yield an integrated air concentration of 2.64E-04 g-s/m^3 at the location.

Plots of results for the effective dose (Sv) computed from the highest 1 h average dispersion coefficients (s/m^3) for each of three meteorology data sets are shown on the following pages since they represent the best illustration of a real-world release scenario. Summaries are presented for each source followed by plots of the dose for the entire study area and for an enlarged area close to the source. The source is indicated by a star.

To properly scale plots of dispersion coefficients and doses, we used the maximum value over all three years for each set of receptors (shown in bold font in Tables 4 and 5). Table 6 summarizes these scaling values for the plots of dispersion coefficients (s/m^3) and effective dose (Sv) for five source locations and for the three years of MET data (2006–2008).

Table 6. Summary of dispersion coefficient and effective dose used to scale plots

SOURCE	Scale Values for Plots		
		χ/Q (s/m^3)	Effective Dose(Sv)
S1: NW Corner of 3026D at roof level	Ann. Avg.	3.06E-4	2.67E-02
	Highest 1 h	7.16E-3	6.25E-01
	Highest 3 h	4.32E-3	3.77E-01
S2: Center line, left side of 3026D near ground level	Ann. Avg.	1.10E-3	9.57E-02
	Highest 1 h	8.74E-2	7.63
	Highest 3 h	3.34E-2	2.92
S3: Center line, above 3026D maintenance roof	Ann. Avg.	8.88E-4	7.75E-02
	Highest 1 h	2.13E-2	1.86
	Highest 3 h	1.21E-2	1.05
S4: NW corner of 3026C near ground level	Ann. Avg.	1.16E-3	1.58E-04
	Highest 1 h	7.85E-2	1.07E-02
	Highest 3 h	2.69E-2	3.67E-03
S5: Center of 3140 near ground level	Ann. Avg.	7.92E-4	9.32E-08
	Highest 1 h	5.92E-2	6.97E-06
	Highest 3 h	2.15E-2	2.54E-06

Plots of effective dose computed from highest 1 h averages using the 2006 meteorology data are shown in Figs. 3–7 for sources S1–S5 respectively. Plots of effective dose computed from highest 1 h averages using the 2007 meteorology data are shown in Figs. 8–12 for sources S1–S5 respectively. Finally, plots of effective dose computed from highest 1 h averages using the 2008 meteorology data are shown in Figs. 13–17 for sources S1–S5 respectively.

To summarize our findings, of the five locations, S2 near ground level in building 3026D produced the highest dose, due to the release being at ground level and to the particular inventory of that building. The second highest dose was for S3 at the height of the maintenance roof in 3026D, again due to the inventory, but reduced because a release at greater height will scatter material further downwind. The release at an even higher location (the roof level) at a point furthest removed from the sidewalk in front of 3026D results in even lower dose values, but above those of the other two locations (3026C and 3140). While air concentrations from the ground level release from building 3026C were high, the resulting doses were low since the activity of the inventory in building 3026C is substantially reduced below that in building 3026D according to the Preliminary Hazard Screening report.[7] Finally, the dose computed from a unit release (1g/s) from filter house 3140 produced the lowest doses due to the inventory in that building.

In general the pattern of release showed higher effective doses toward the prevailing wind directions (along the valley), which also are parallel to the sidewalk along Central Avenue. In addition, doses were generally higher to the south of the complex of buildings due to building downwash effects and the presence of the hillside to the north. While care must be taken with all areas near the 3026D/C complex, special care should be exercised to prevent exposure along the sidewalk in front of the 3026 complex and in occupied buildings that are across the street, south of the complex.

4.1 RESULTS FOR 2006 METEOROLOGY 1 H DATA

Results for S1 (Building 3026D - location is NW Corner at roof level)

Table 7. Characteristics for S1

Source Characteristics	
UTM Easting	742095.5
UTM Northing	3979226
Elevation	243.75 m
Height	14.63 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 8. Maximum values for S1 highest 1 h results for 2006

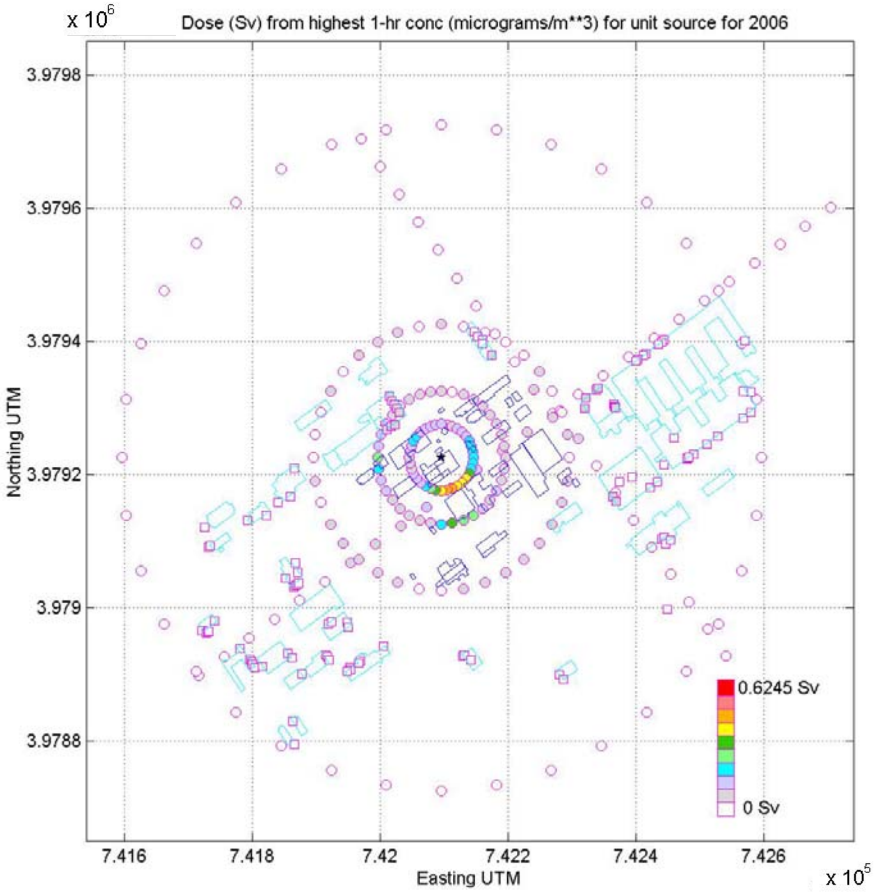
Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	2.64E-4	2.31E-02
HIGH 1HR	5.37E-3	4.69E-01

Summary of results: S1 was a high elevation (roof level) in a corner of building 3026D. The high elevation resulted in lower effective dose than occurred with locations near the ground level. For 2006 meteorology, the maximum annual average dispersion coefficient was 2.64E-4 s/m^3. Using the entire building inventory as if it were released in this location, the dose per unit release was computed to be 2.31E-2 Sv or 2.31 rem.

The limiting 1 h dispersion coefficient was 5.37E-3 s/m^3, which gave an effective dose of 0.469 Sv or 46.9 rem, given the radionuclide inventory for building 3026D. A release from S1 location in building 3026D would result in a large dose along the sidewalk and to buildings across the street to the south.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 8 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that one percent of the inventory in building 3026D is released, then the highest dose would be 0.469 Sv * 0.01 or 0.469 rem.

Highest 1 h DOSE (Sv) for S1: Building 3026D – 2006 MET Data



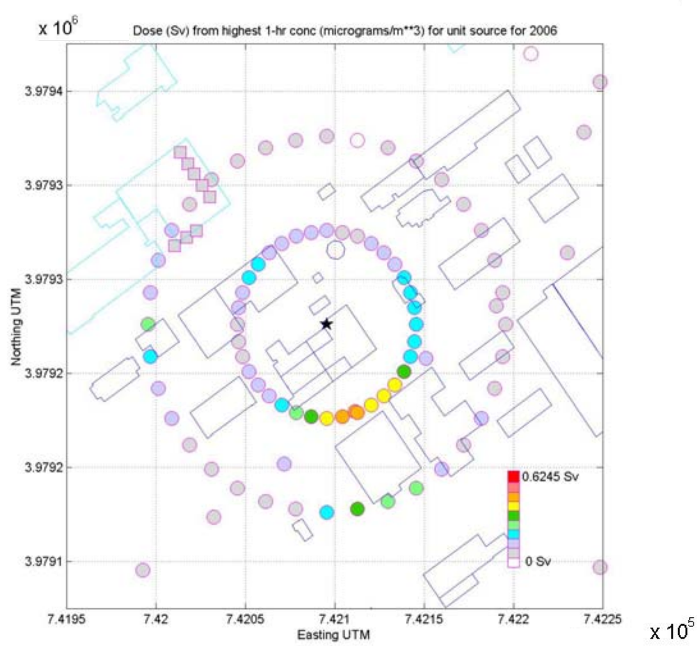


Fig. 3. Effective dose (Sv) for the limiting 1 h dispersion for S1 and 2006 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

Results for S2 (Building 3026D – location is center line, left side near ground level)

Table 9. Characteristics for S2

Source Characteristics	
UTM Easting	742104
UTM Northing	3979215
Elevation	243.4
Height	1 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 10. Maximum values for S2 highest 1 h results for 2006

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	1.05E-3	9.14E-02
HIGH 1HR	7.60E-2	6.63

Summary of results: S2 was at floor level (1 meter above ground elevation) on the center line, left side of building 3026D. The low elevation and large value of the radionuclide activity in this building resulted in the highest doses of the five sources. The maximum annual average dispersion coefficient was 1.05E-3 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 9.14E-2 Sv or 9.14 rem.

The limiting 1 h dispersion coefficient was 7.60E-2 s/m^3, which gave an effective dose of 6.63 Sv or 663 rem, given the radionuclide inventory for building 3026D. Compared with S1, a release from S2 location in building 3026D would result in a significantly larger dose along the sidewalk and to buildings across the street to the south.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 10 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that one percent of the inventory in building 3026D is released, then the highest dose would be 6.63 Sv * 0.01 or 6.63 rem.

Highest 1 h DOSE (Sv) for S2: Building 3026D – 2006 MET Data

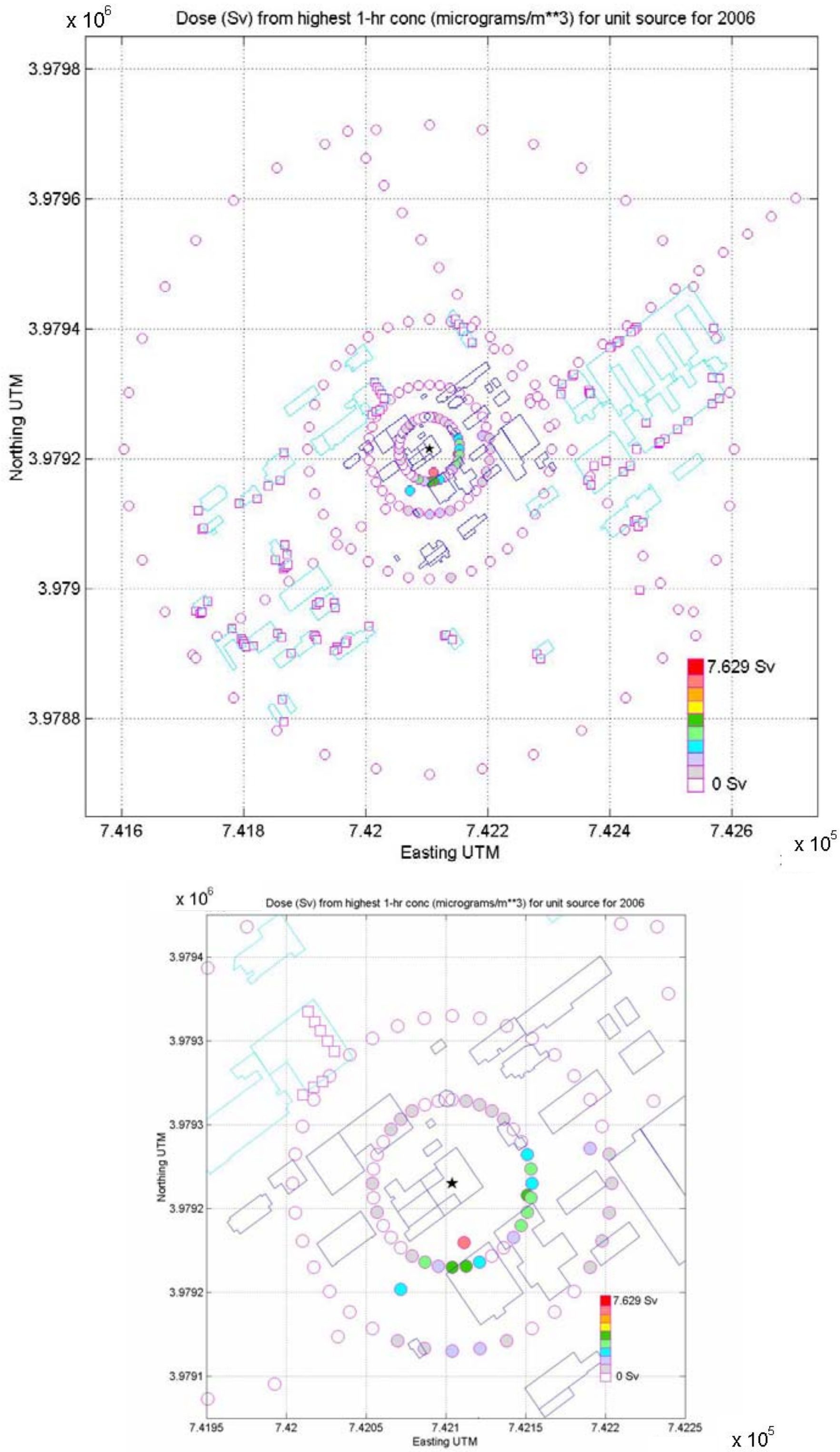


Fig. 4. Effective dose (Sv) for the limiting 1 h dispersion for S2 and 2006 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

Results for S3 (Building 3026D – location is center line, above maintenance cubicle roof)

Table 11. Characteristics for S3

Source Characteristics	
UTM Easting	742111
UTM Northing	3979221
Elevation	243.41 m
Height	12 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 12. Maximum values for S3 highest 1 h results for 2006

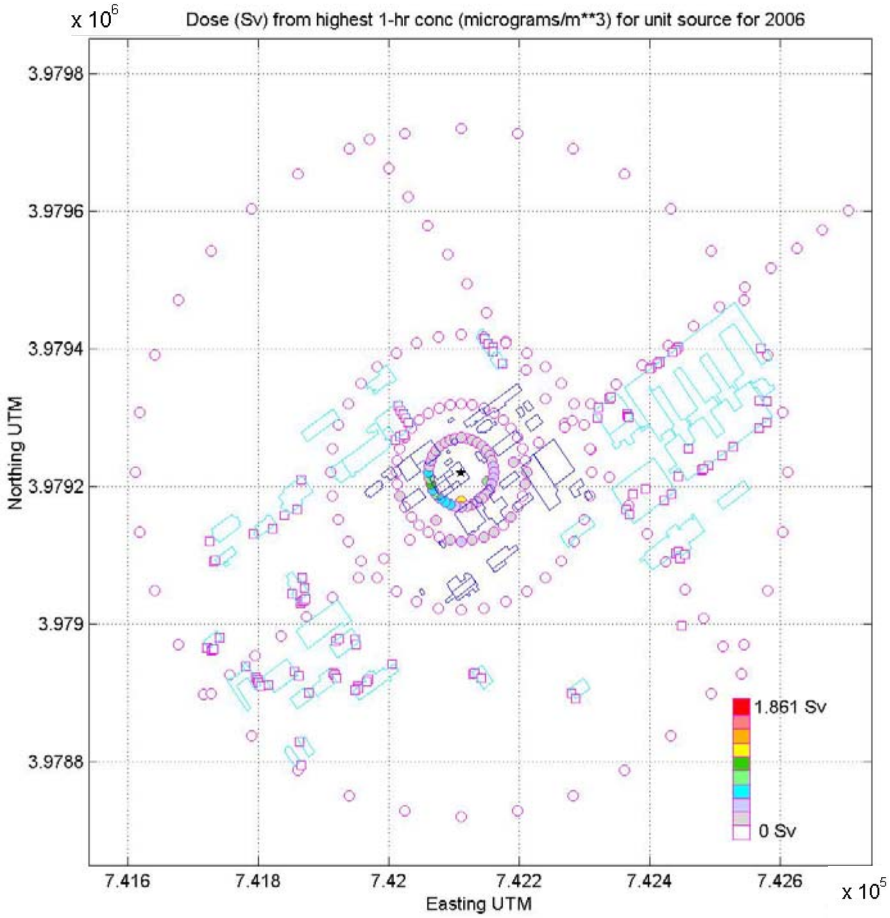
Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	7.08E-4	6.17E-02
HIGH 1HR	1.31E-2	1.15

Summary of results: S3 center line above the maintenance cubicle roof in building 3026D. The maintenance cubicle is a work area above the hot cells that allowed equipment and personnel access to the hot cells from above. The higher elevation of S3 combined with the large value of the radionuclide activity in this building resulted in the higher dose of the first source. The maximum annual average dispersion coefficient was 7.08E-4 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 6.17E-02 Sv or 6.17 rem.

The limiting 1 h dispersion coefficient was 1.31E-2 s/m^3, which gave an effective dose of 1.51 Sv or 151 rem, given the radionuclide inventory for building 3026D.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 12 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that one percent of the inventory in building 3026D is released, then the highest dose would be 1.15 Sv * 0.01 or 1.15 rem.

Highest 1 h DOSE (Sv) for S3: Building 3026D – 2006 MET Data



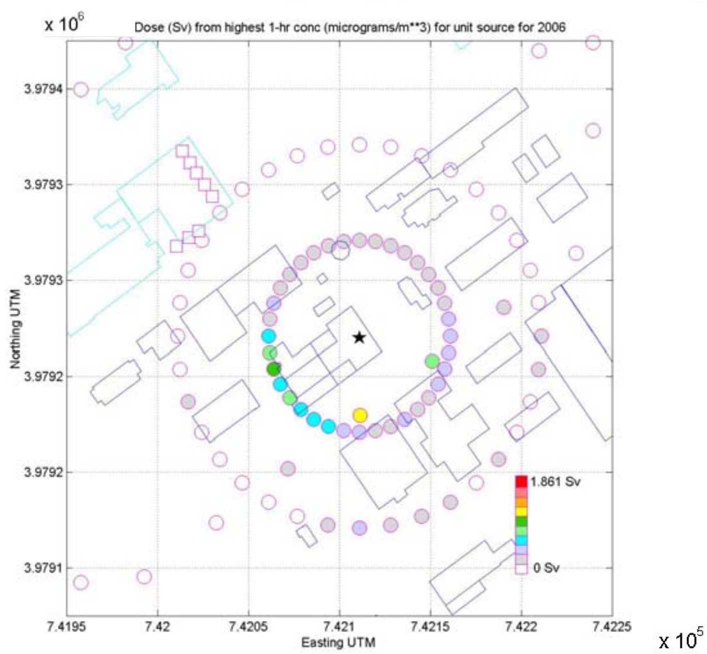


Fig. 5. Effective dose (Sv) for the limiting 1 h dispersion for S3 and 2006 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

Results for S4 (Building 3026C – location is NW side near ground level)

Table 13. Characteristics for S4

Source Characteristics	
UTM Easting	742080
UTM Northing	3979209
Elevation	243.49
Height	1 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 14. Maximum values for S4 highest 1 h results for 2006

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	1.10E-3	1.5E-04
HIGH 1HR	3.80E-2	5.18E-03

Summary of results: S4 is located on the NW side building 3026C at floor level (1 m above ground elevation). The low elevation resulted in high dispersion coefficients but the relatively small value of the radionuclide activity in this building resulted in the second lowest doses of the five sources. The maximum annual average dispersion coefficient was 1.10E-3 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 1.5E-04Sv or 0.015 rem.

The limiting 1 h dispersion coefficient was 3.80E-2 s/m^3, which gave an effective dose of 5.18E-03 Sv or 0.518 rem, given the radionuclide inventory for building 3026C. While the dispersion coefficients are high, the inventory in building 3026C results in very low doses.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 14 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that one percent of the inventory in building 3026C is released, then the highest dose would be 5.18E-3 Sv * 0.01 or 5.18E-3 rem.

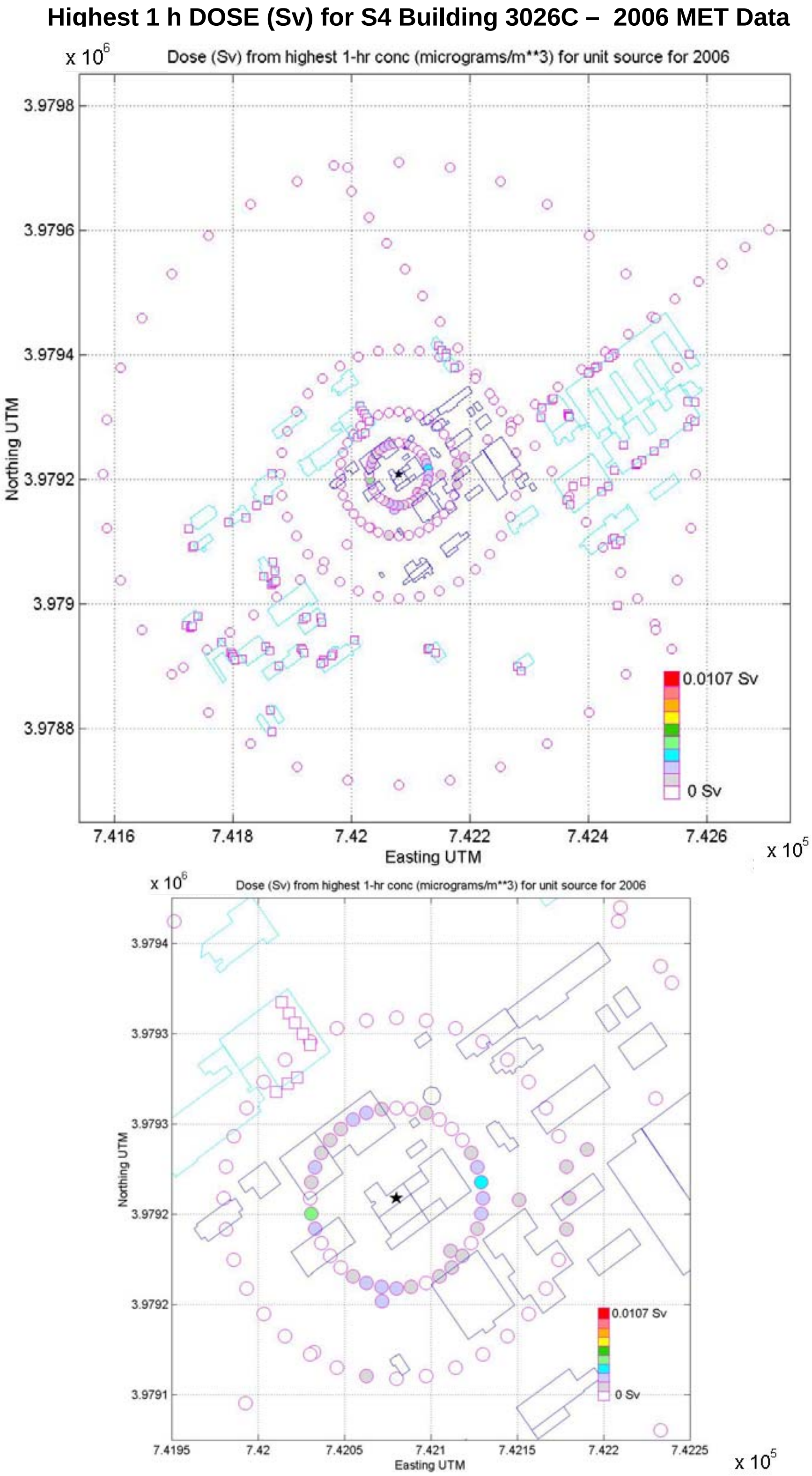


Fig. 6. Effective dose (Sv) for the limiting 1 h dispersion for S4 and 2006 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

Results for S5 (Building 3140 – location is center of building near ground level)

Table 15. Characteristics for S5

Source Characteristics	
UTM Easting	742090.5
UTM Northing	3979250.8
Elevation	244.69 m
Height	1 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 16. Maximum values for S5 highest 1 h results for 2006

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	6.53E-4	7.68E-08
HIGH 1HR	2.01E-2	2.37E-06

Summary of results: S5 is located in the center of the filter house 3140 at floor level (1 m above ground elevation). The low elevation and small value of the radionuclide activity in this building resulted in the lowest doses of the five sources. The maximum annual average dispersion coefficient was 6.53E-4 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 7.68E-08 Sv or 7.68E-6 rem.

The limiting 1 h dispersion coefficient was 2.01E-2 s/m^3, which gave an effective dose of 2.37E-06 Sv or 2.37E-04 rem, given the radionuclide inventory for filter house 3140. The combination of low dispersion coefficients and the inventory in the filter house 3140 results in extremely low doses.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 16 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that fifty percent of the inventory in filter house 3140 is released, then the highest dose would be 2.37E-06 Sv * 0.5 or 1.19E-04 rem.

Highest 1 h DOSE (Sv) for S5: Building 3140 – 2006 MET Data

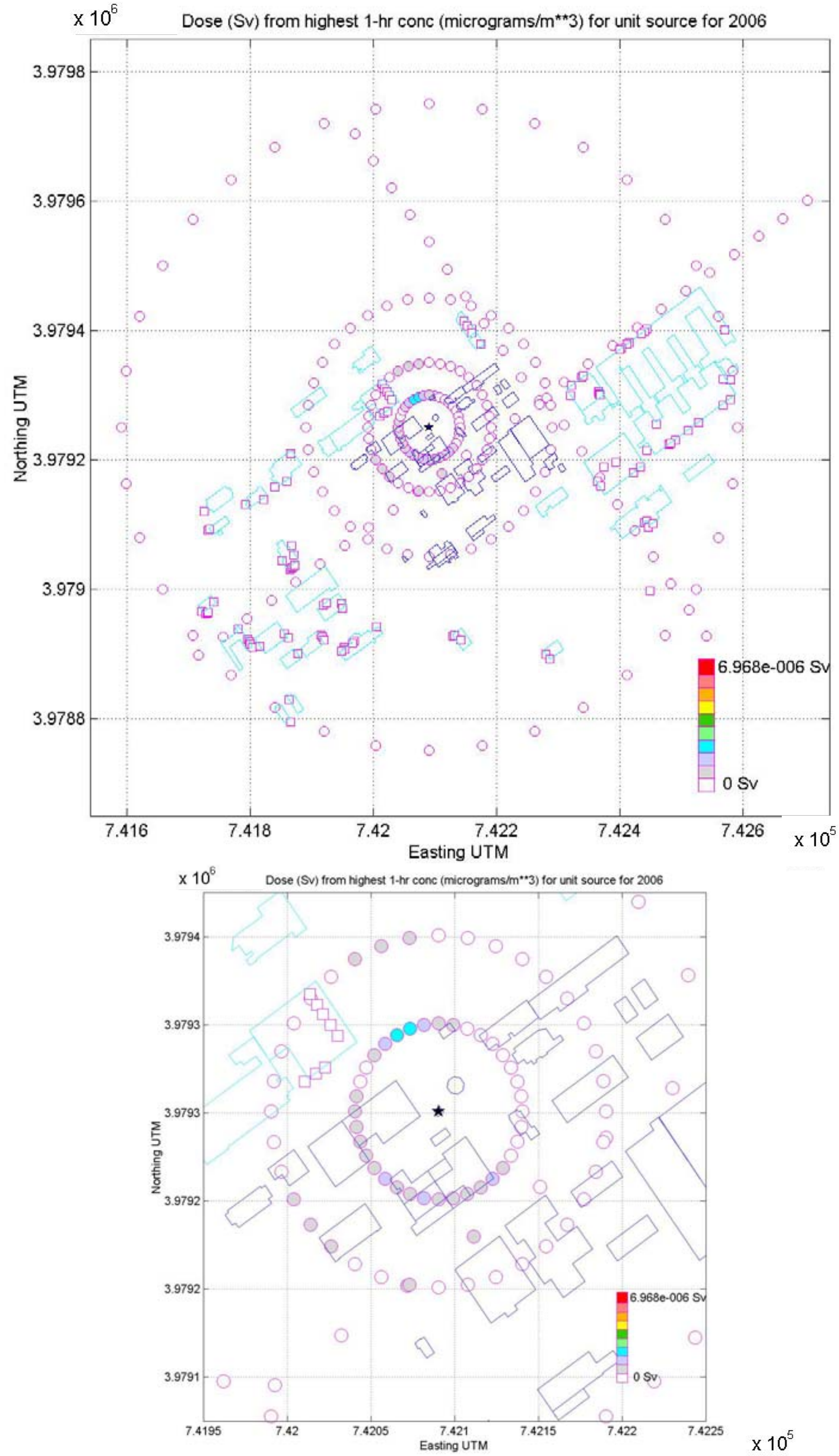


Fig. 7. Effective dose (Sv) for the limiting 1 h dispersion for S5 and 2006 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

4.2 RESULTS FOR 2007 METEOROLOGY 1 H DATA

Results for S1 (Building 3026D - location is NW Corner at roof level)

Table 17. Characteristics for S1

Source Characteristics	
UTM Easting	742095.5
UTM Northing	3979226
Elevation	243.75 m
Height	14.63 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 18. Maximum values for S1 highest 1 h results for 2007

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	3.06E-4	2.67E-02
HIGH 1HR	7.16E-3	6.25E-01

Summary of results: S1 was a high elevation (roof level) in a corner of building 3026D. The high elevation resulted in much lower doses that occurred with locations near the ground level. The maximum annual average dispersion coefficient was 3.06E-4 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 2.67E-2 Sv or 2.67 rem.

The limiting 1 h dispersion coefficient was 7.16E-3 s/m^3, which gave an effective dose of 0.625 Sv or 62.5 rem, given the radionuclide inventory for building 3026D. A release from S1 location in building 3026D would result in a large dose along the sidewalk and to buildings across the street to the south.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 18 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that one percent of the inventory in building 3026D is released, then the highest dose would be 0.625 Sv * 0.01 or 0.625 rem.

Highest 1 h DOSE (Sv) for S1: Building 3026D – 2007 MET Data

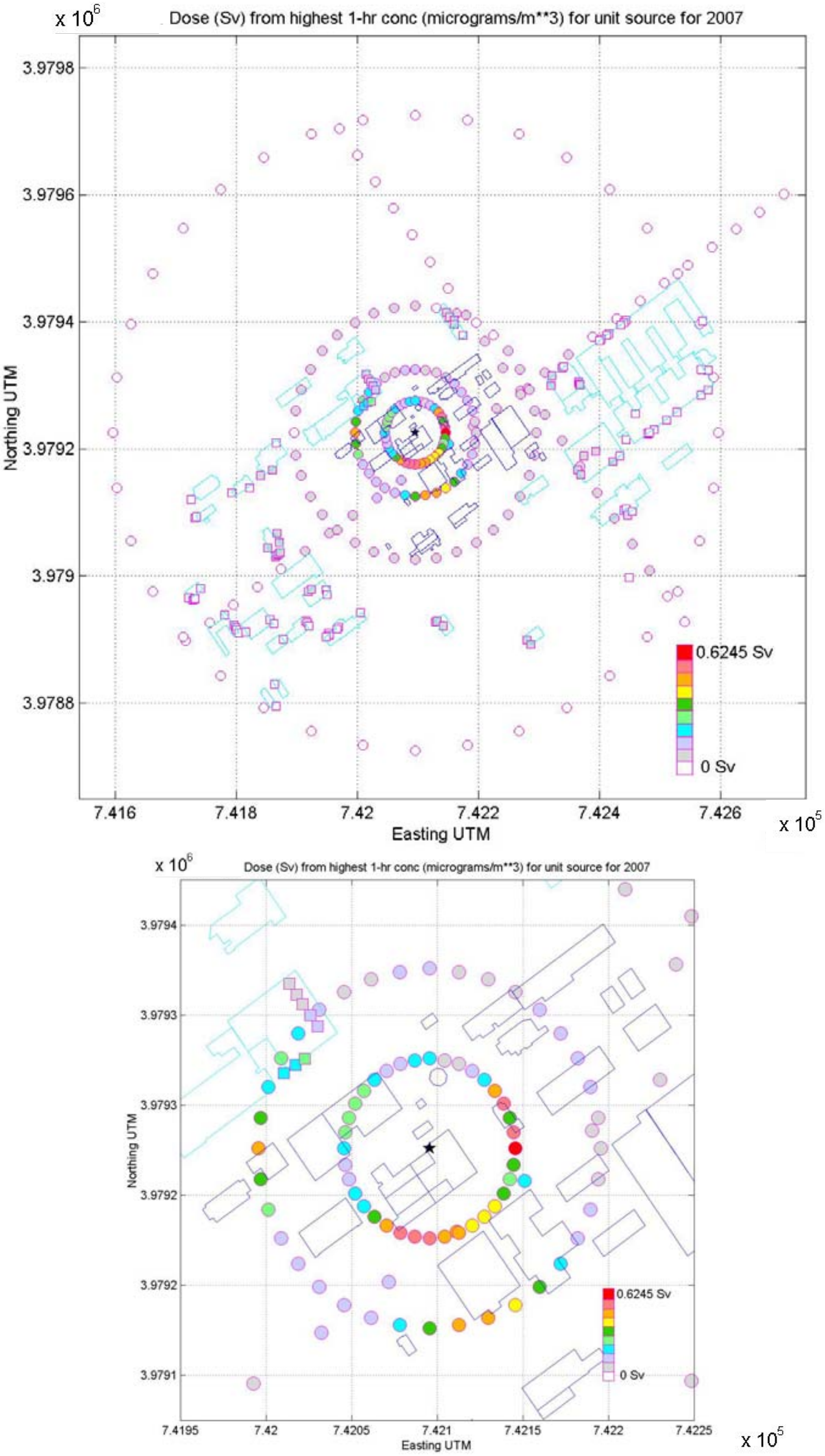


Fig. 8. Effective dose (Sv) for the limiting 1 h dispersion for S1 and 2007 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

Results for S2 (Building 3026D – location is center line, left side near ground level)

Table 19. Characteristics for S2

Source Characteristics	
UTM Easting	742104
UTM Northing	3979215
Elevation	243.4
Height	1 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 20. Maximum values for S2 highest 1 h results for 2007

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	1.10E-3	9.57E-02
HIGH 1HR	7.10E-2	6.19

Summary of results: S2 was at floor level (1 m above ground elevation) on the center line, left side of building 3026D. The low elevation and large value of the radionuclide activity in this building resulted in the highest doses of the five sources. The maximum annual average dispersion coefficient was 1.10E-3 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 9.57E-2 Sv or 9.57 rem.

The limiting 1 h dispersion coefficient was 7.10E-2 s/m^3, which gave an effective dose of 6.19 Sv or 619 rem, given the radionuclide inventory for building 3026D. Compared with S1, a release from S2 location in building 3026D would result in a significantly larger dose along the sidewalk and to buildings across the street to the south.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 20 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that one percent of the inventory in building 3026D is released, then the highest dose would be 6.19 Sv * 0.01 or 6.19 rem.

Highest 1 h DOSE (Sv) for S2: Building 3026D – 2007 MET Data

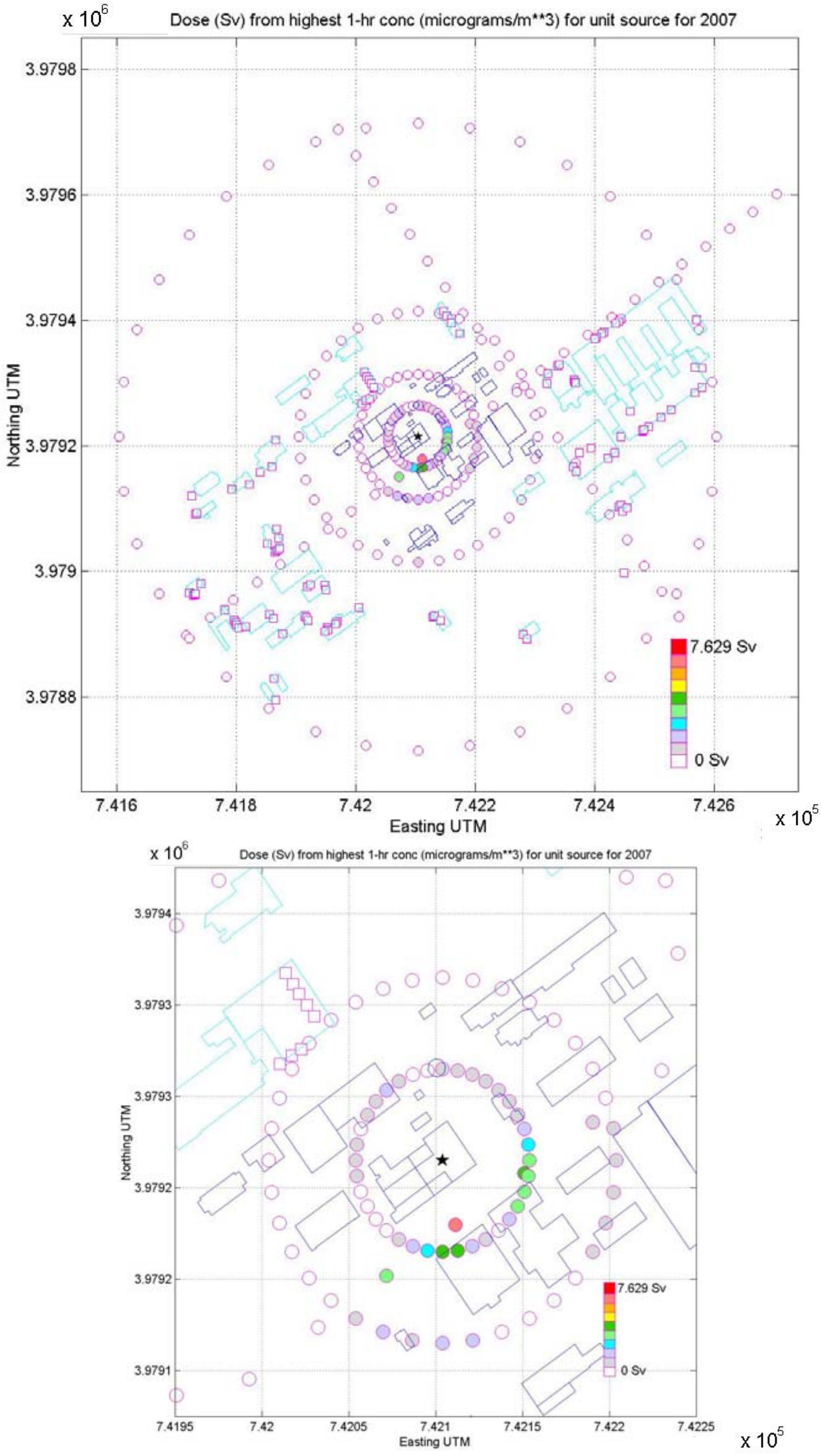


Fig. 9. Effective dose (Sv) for the limiting 1 h dispersion for S2 and 2007 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

Results for S3 (Building 3026D – location is center line, above maintenance cubicle roof)

Table 21. Characteristics for S3

Source Characteristics	
UTM Easting	742111
UTM Northing	3979221
Elevation	243.41 m
Height	12 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 22. Maximum values for S3 highest 1 h results for 2007

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	8.88E-4	7.75E-02
HIGH 1HR	1.66E-2	1.45

Summary of results: S3 center line above the maintenance roof in building 3026D. The higher elevation of S3 combined with the large value of the radionuclide activity in this building resulted in the higher dose of the first source. The maximum annual average dispersion coefficient was 8.88E-4 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 7.75E-02 Sv or 7.75 rem.

The limiting 1 h dispersion coefficient was 1.66E-2 s/m^3, which gave an effective dose of 1.45 Sv or 145 rem, given the radionuclide inventory for building 3026D.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 22 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that one percent of the inventory in building 3026D is released, then the highest dose would be 1.45 Sv * 0.01 or 1.45 rem.

Highest 1 h DOSE (Sv) for S3: Building 3026D – 2007 MET Data

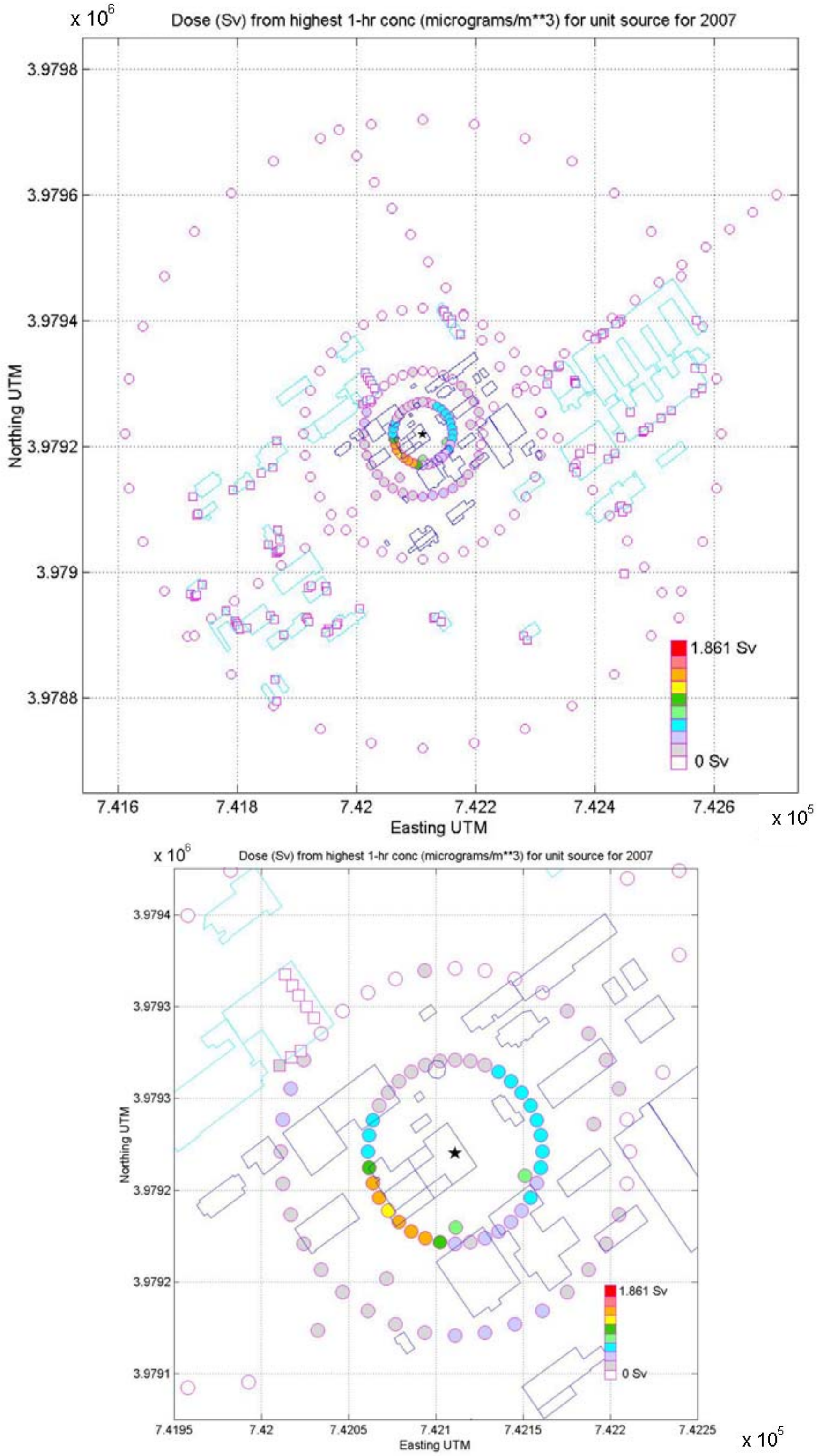


Fig. 10. Effective dose (Sv) for the limiting 1 h dispersion for S3 and 2007 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

Results for S4 (Building 3026C – location is NW side near ground level)

Table 23. Characteristics for S4

Source Characteristics	
UTM Easting	742080
UTM Northing	3979209
Elevation	243.49
Height	1 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 24. Maximum values for S4 highest 1 h results for 2007

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	1.16E-3	1.58E-04
HIGH 1HR	3.67E-2	5.0E-03

Summary of results: S4 is located on the NW side building 3026C at floor level (1 m above ground elevation). The low elevation resulted in high dispersion coefficients, but the relatively small value of the radionuclide activity in this building resulted in the second lowest doses of the five sources. The maximum annual average dispersion coefficient was 1.16E-3 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 1.58E-4 Sv or 0.0158 rem.

The limiting 1 h dispersion coefficient was 3.67E-2 s/m^3, which gave an effective dose of 5.0E-03 Sv or 0.5 rem, given the radionuclide inventory for building 3026C. While the dispersion coefficients are high, the inventory in building 3026C results in very low doses.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 24 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that one percent of the inventory in building 3026C is released, then the highest dose would be 5.0E-03 Sv * 0.01 or 5.0E-03 rem

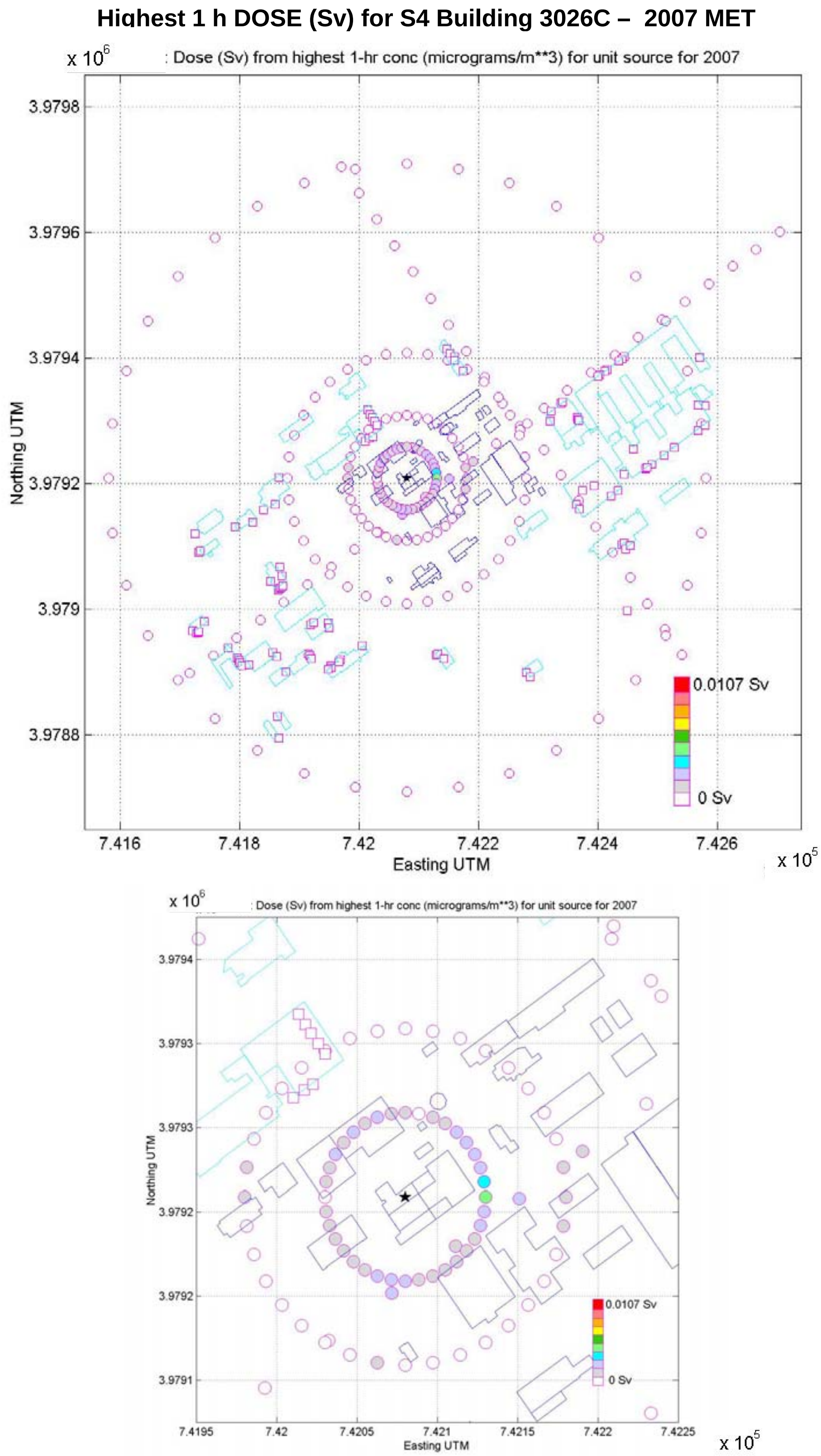


Fig. 11. Effective dose (Sv) for the limiting 1 h dispersion for S4 and 2007 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

Results for S5 (Building 3140 – location is center of building near ground level)

Table 25. Characteristics for S5

Source Characteristics	
UTM Easting	742090.5
UTM Northing	3979250.8
Elevation	244.69 m
Height	1 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 26. Maximum values for S5 highest 1 h results for 2007

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	7.92E-4	9.32E-08
HIGH 1HR	2.24E-2	2.64E-06

Summary of results: S5 is located in the center of filter house 3140 at floor level (1 m above ground elevation). The low elevation and small value of the radionuclide activity in this building resulted in the lowest doses of the five sources. The maximum annual average dispersion coefficient was 7.92E-4 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 9.32E-08 Sv or 9.32E-6 rem.

The limiting 1 h dispersion coefficient was 2.24E-2 s/m^3, which gave an effective dose of 2.64E-06 Sv or 2.64E-04 rem, given the radionuclide inventory for filter house 3140. The combination of low dispersion coefficients and the inventory in the filter house 3140 results in extremely low doses.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 26 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that fifty percent of the inventory in filter house 3140 is released, then the highest dose would be 2.64E-06 Sv * 0.5 or 1.32E-04 rem.

Highest 1 h DOSE (Sv) for S5: Building 3140 – 2007 MET Data

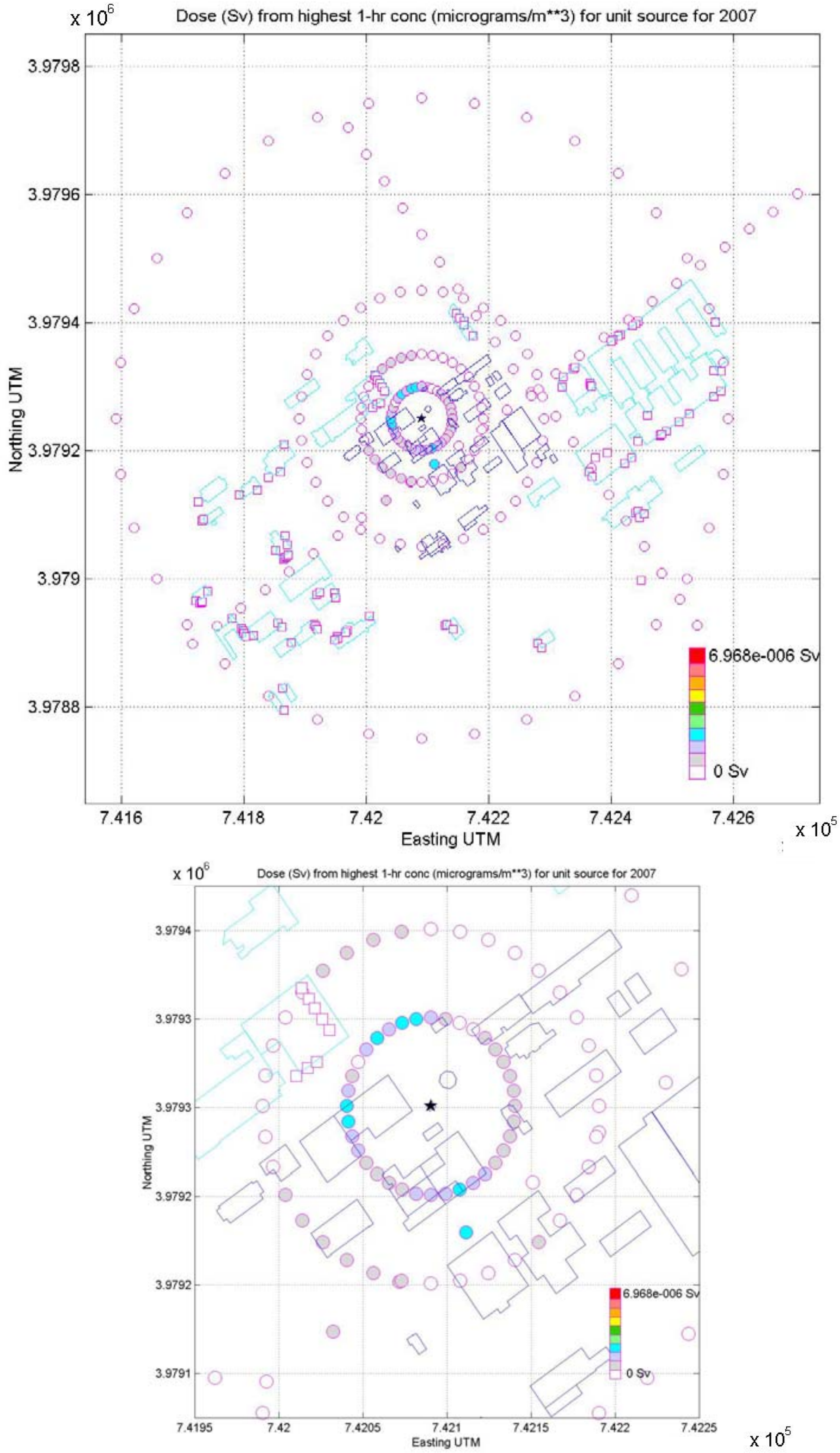


Fig. 12. Effective dose (Sv) for the limiting 1 h dispersion for S5 and 2007 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

4.3 RESULTS FOR 2008 METEOROLOGY 1 H DATA

Results for S1 (Building 3026D - location is NW Corner at roof level)

Table 27. Characteristics for S1

Source Characteristics	
UTM Easting	742095.5
UTM Northing	3979226
Elevation	243.75 m
Height	14.63 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 28. Maximum values for S1 highest 1 h results for 2008

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	2.39E-4	2.09E-02
HIGH 1HR	6.74E-3	5.88E-01

Summary of results: S1 was located at a high elevation (roof level) in a corner of building 3026D. The high elevation resulted in lower doses that occurred with locations near the ground level. The maximum annual average air dispersion coefficient was 2.39E-4 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 2.09E-02 Sv or 2.09 rem.

The limiting 1 h dispersion coefficient was 6.74E-3 s/m^3, which gave an effective dose of 0.588 Sv or 58.8 rem, given the radionuclide inventory for building 3026D. A release from S1 location in building 3026D would result in a large dose along the sidewalk and to buildings across the street to the south.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 28 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that one percent of the inventory in building 3026D is released, then the highest dose would be 0.588 Sv * 0.01 or 0.588E rem.

Highest 1 h DOSE (Sv) for S1: Building 3026D – 2008 MET Data

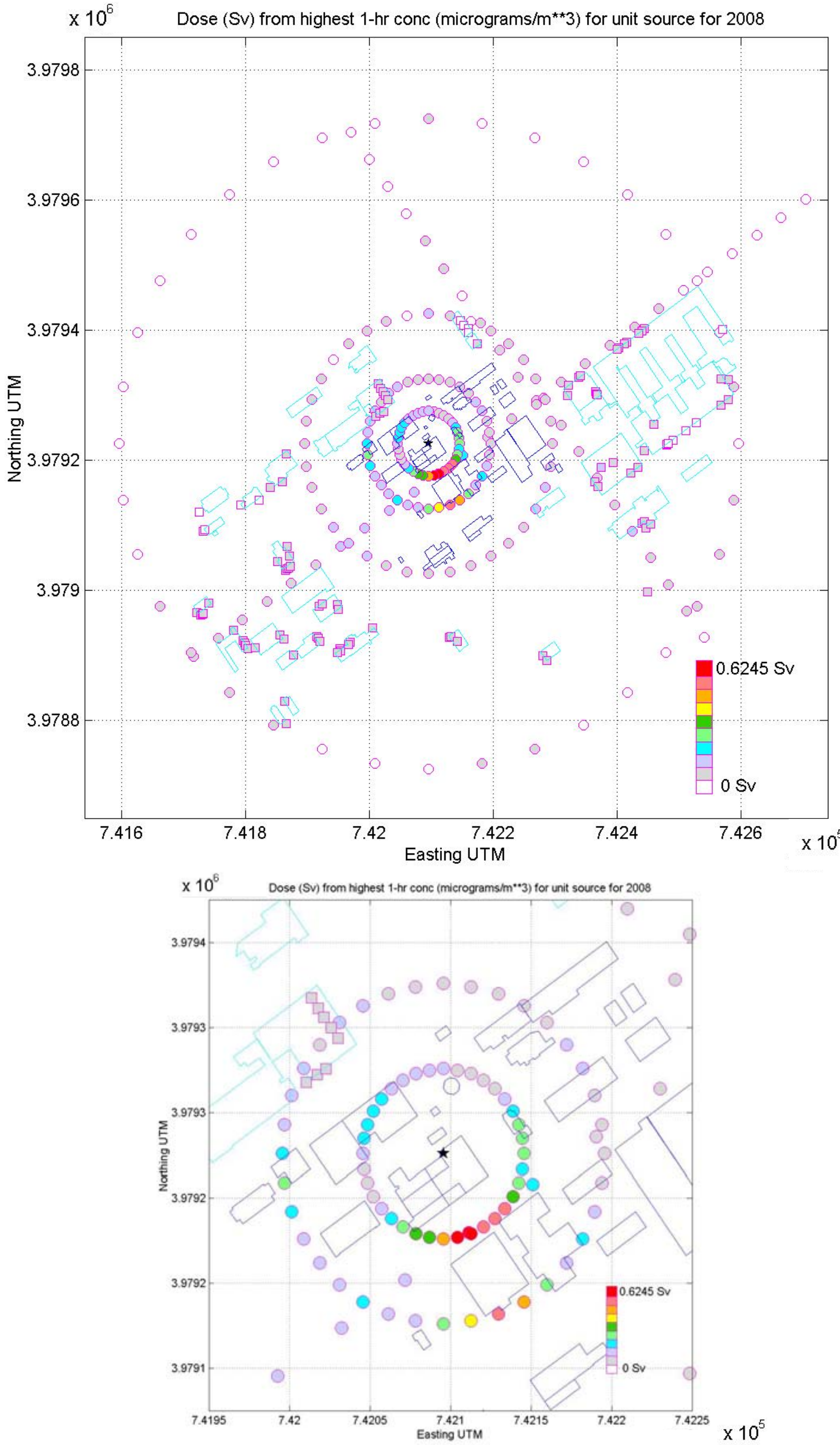


Fig. 13. Effective dose (Sv) for the limiting 1 h dispersion for S1 and 2008 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

Results for S2 (Building 3026D – location is center line, left side near ground level)

Table 29. Characteristics for S2

Source Characteristics	
UTM Easting	742104
UTM Northing	3979215
Elevation	243.4
Height	1 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 30. Maximum values for S2 highest 1 h results for 2008

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	7.24E-4	6.32E-02
HIGH 1HR	8.74E-2	7.63

Summary of results: S2 was at floor level (1 m above ground elevation) on the center line, left side of building 3026D. The low elevation and large value of the radionuclide activity in this building resulted in the highest doses of the five sources. The maximum annual average air dispersion coefficient was 7.24E-4 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 6.32E-2 Sv or 6.32 rem.

The limiting 1 h dispersion coefficient was 8.74E-2 s/m^3, which gave an effective dose of 7.63 Sv or 763 rem, given the radionuclide inventory for building 3026D. Compared with S1, a release from S2 location in building 3026D would result in a significantly larger dose along the sidewalk and to buildings across the street to the south.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 30 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that one percent of the inventory in building 3026D is released, then the highest dose would be 7.63 Sv * 0.01 or 7.63 rem.

Highest 1 h DOSE (Sv) for S2: Building 3026D – 2008 MET Data

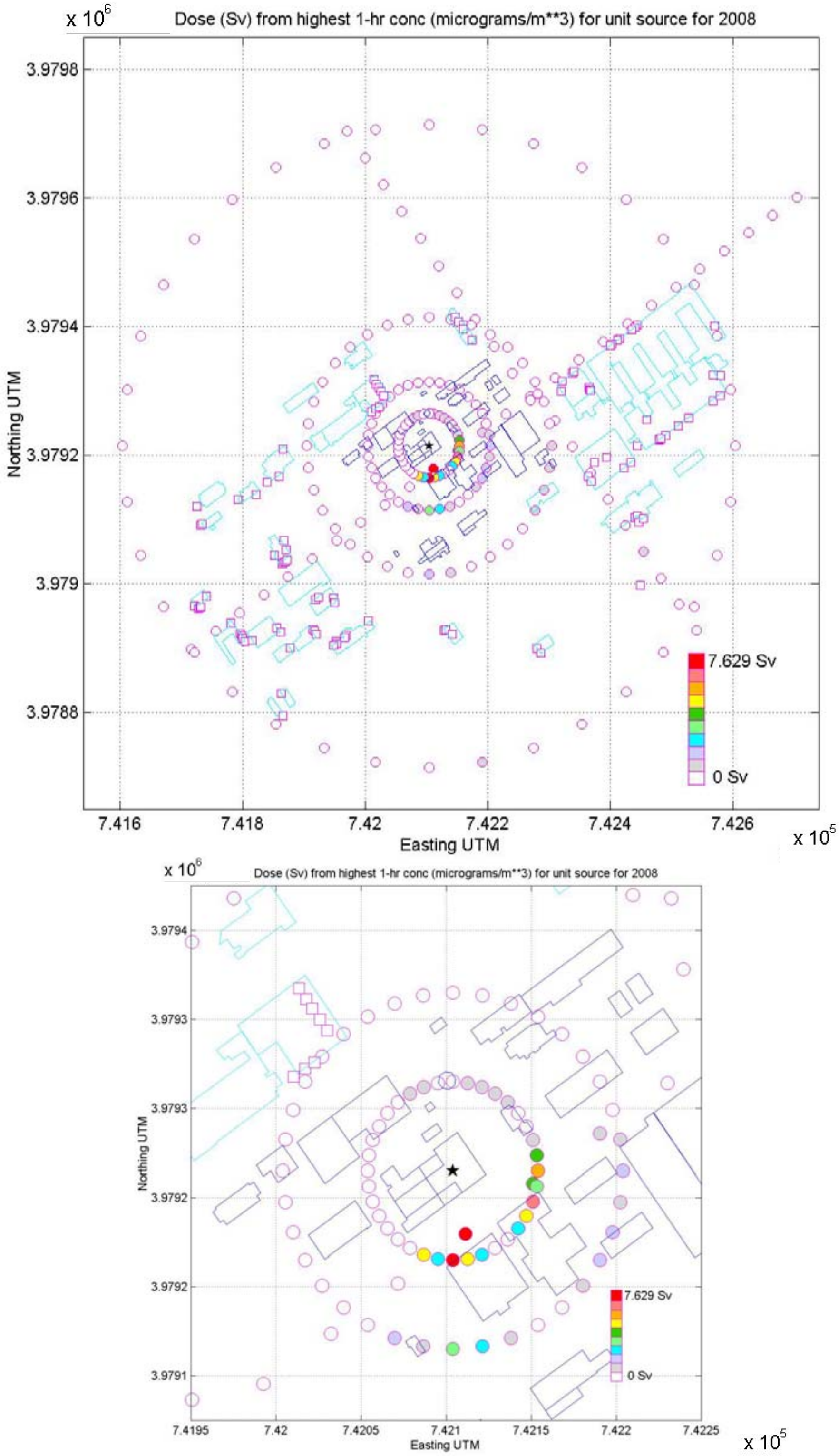


Fig. 14. Effective dose (Sv) for the limiting 1 h dispersion for S2 and 2006 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

Results for S3 (Building 3026D – location is center line, above maintenance cubicle roof)

Table 31. Characteristics for S3

Source Characteristics	
UTM Easting	742111
UTM Northing	3979221
Elevation	243.41 m
Height	12 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 32. Maximum values for S3 highest 1 h results for 2008

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	6.75E-4	5.89E-02
HIGH 1HR	2.13E-2	1.86

Summary of results: S3 center line above the maintenance roof in building 3026D. The higher elevation of S3 combined with the large value of the radionuclide activity in this building resulted in the higher dose of the first source. The maximum annual average dispersion coefficient was 6.75E-4 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 5.89E-02 Sv or 5.89 rem.

The limiting 1 h dispersion coefficient was 2.13E-2 s/m^3, which gave an effective dose of 1.86 Sv or 186 rem, given the radionuclide inventory for building 3026D.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 32 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that one percent of the inventory in building 3026D is released, then the highest dose would be 1.86 Sv * 0.01 or 1.86 rem.

Highest 1 h DOSE (Sv) for S3: Building 3026D – 2008 MET Data

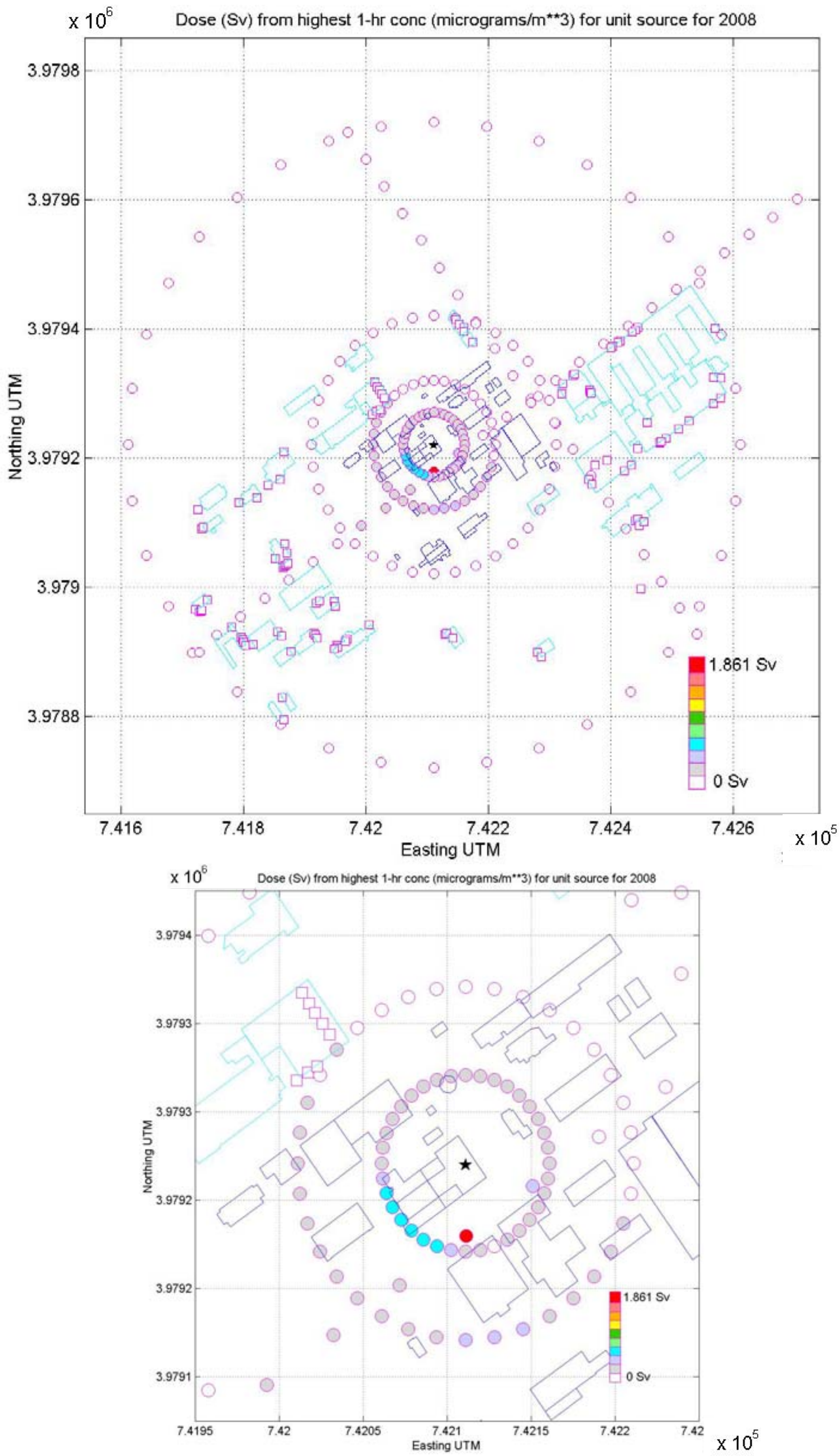


Fig. 15. Effective dose (Sv) for the limiting 1 h dispersion for S3 and 2008 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

Results for S4 (Building 3026C – location is NW side near ground level)

Table 33. Characteristics for S4

Source Characteristics	
UTM Easting	742080
UTM Northing	3979209
Elevation	243.49
Height	1 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 34. Maximum values for S4 highest 1 h results for 2008

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	9.10E-4	1.24E-04
HIGH 1HR	7.85E-2	1.07E-02

Summary of results: S4 is located on the NW side building 3026C at floor level (1 m above ground elevation). The low elevation resulted in high air concentrations, but the relatively small value of the radionuclide activity in this building resulted in the second lowest doses of the five sources. The maximum annual average air dispersion coefficient was 9.10E-4 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 1.24E-4 Sv or 0.0124 rem.

The limiting 1 h dispersion coefficient was 7.85E-2 s/m^3, which gave an effective dose of 1.07E-02 Sv or 1.07 rem, given the radionuclide inventory for building 3026C. While the dispersion coefficients are high, the inventory in building 3026C results in very low doses.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 34 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that one percent of the inventory in building 3026C is released, then the highest dose would be 1.07E-02 Sv * 0.01 or 1.07E-02 rem.

Highest 1 h DOSE (Sv) for S4: Building 3026C – 2008 MET Data

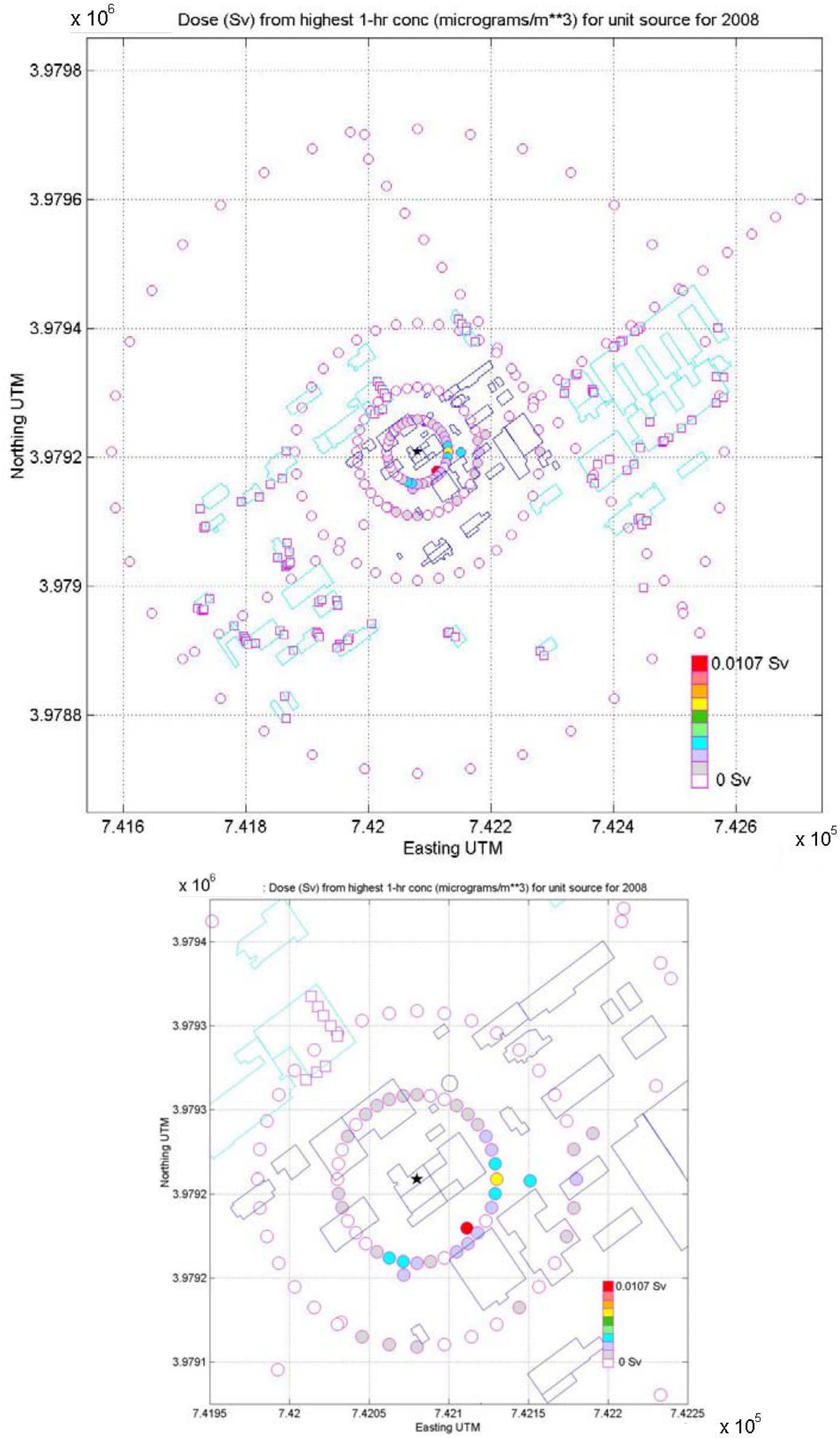


Fig. 16. Effective dose (Sv) for the limiting 1 h dispersion for S4 and 2008 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

Results for S5 (Building 3140 – location is center of building near ground level)

Table 35. Characteristics for S5

Source Characteristics	
UTM Easting	742090.5
UTM Northing	3979250.8
Elevation	244.69 m
Height	1 m
QS	1 g/s
Temp	300 K
VS	0.01 m/s
DS	4 m

Table 36. Maximum values for S5 highest 1 h results for 2008

Maximum Results		
	χ/Q (s/m^3)	Dose(Sv)
AVG	7.16E-4	8.42E-08
HIGH 1HR	5.92E-2	6.97E-06

Summary of results: S5 is located in the center of filter house 3140 at floor level (1 m above ground elevation). The low elevation and small value of the radionuclide activity in this building resulted in the lowest doses of the five sources. The maximum annual average air dispersion coefficient was 7.16E-4 s/m^3. Using the entire building inventory as if it were released in this location, the dose was computed to be 8.42E-08 Sv or 8.42E-6 rem.

The limiting 1 h dispersion coefficient was 5.92E-2 s/m^3, which gave an effective dose of 6.97E-06 Sv or 6.97E-04 rem, given the radionuclide inventory for filter house 3140. The combination of low dispersion coefficients and the inventory in the filter house 3140 results in extremely low doses.

Note that doses are calculated assuming a complete release of the building inventory. To estimate the dose for a realistic release one should multiply the doses shown in Table 36 by a factor that represents the fraction of the building's inventory expected to be released. For example, assuming that fifty percent of the inventory in filter house 3140 is released, then the highest dose would be 6.97E-06 Sv * 0.5 or 3.49E-04 rem.

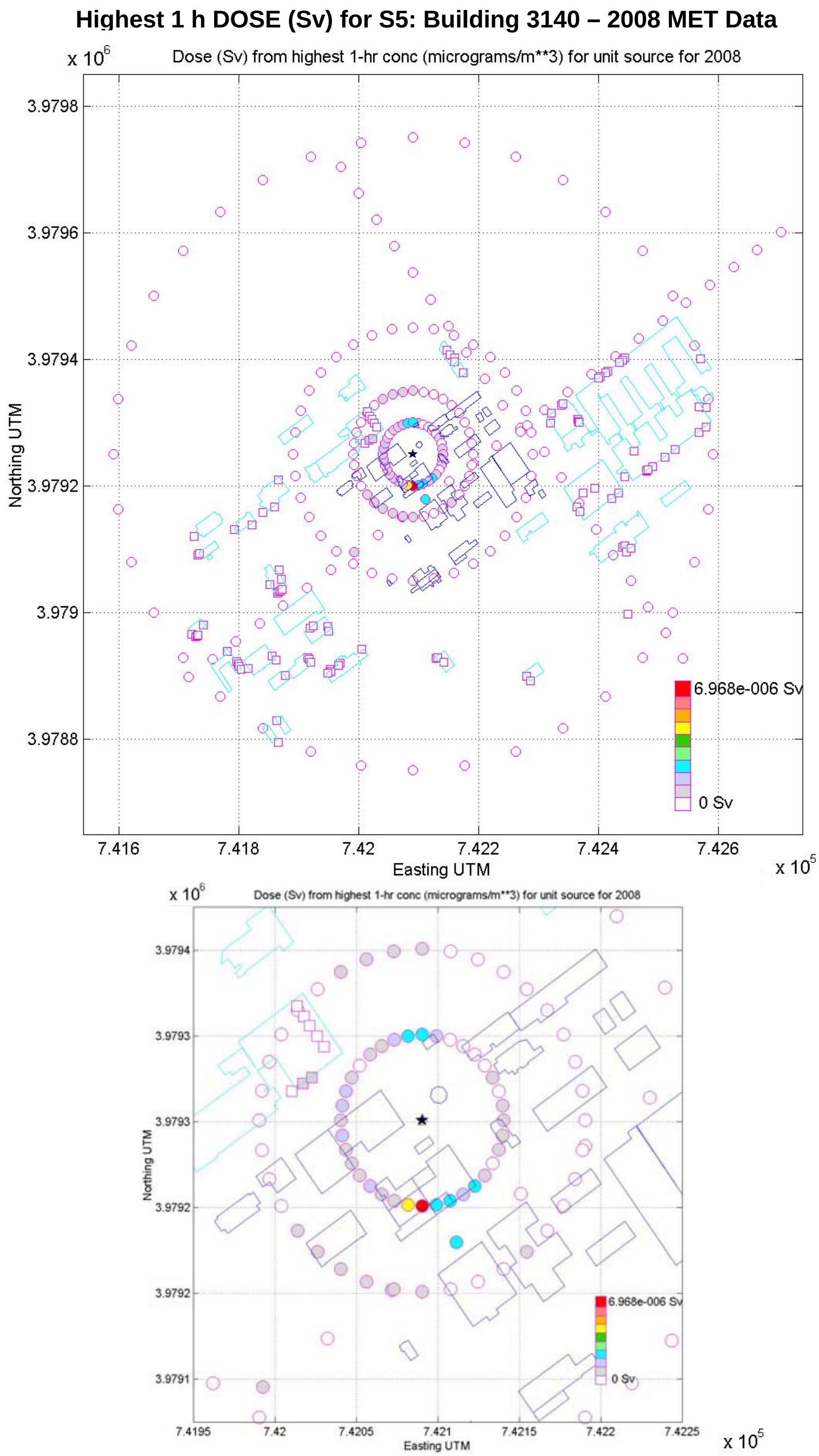


Fig. 17. Effective dose (Sv) for the limiting 1 h dispersion for S5 and 2008 meteorology. Shown are the entire study area (top) and view close in to source (bottom).

5. CONCLUSIONS

The EPA AERMOD system was used to estimate air dispersion coefficients and effective dose resulting from a release of a pollutant from ORNL buildings 3026C, 3026D, and filter house 3140, for potential air dispersion scenarios resulting from an uncontrolled release prior to or during the demolition of the 3026 complex. Five source locations (three in 3026D and one each in 3036C and 3140) and associated source characteristics in the area of study were determined with the customer. Once the area of study was determined, building footprints and intake locations of air-handling systems were obtained. In addition to air intakes, receptor locations included concentric polar grids centered on the source location (50 m, 100 m, 200 m , and 500 m), and two intersecting sidewalks corresponding to Central Avenue and Fifth Street.

The AERMET code was used to compute the meteorological input required by AERMOD. Three years of meteorological data (2006–2008) were used including: National Weather Service data and upper air data for the Knoxville-Oak Ridge area along with local weather data from Tower C (10 m, 30 m, and 100 m) on the ORNL reservation.

Annual average air concentration, highest 1 h average and highest 3 h average air concentrations were computed using AERMOD for the five source locations for the three years of meteorological data. Since the customer was interested in the most significant response and the highest 1 h average data reflects the finest time averaged values available from the AERMOD code, we chose to concentrate this analysis on the those results. Dispersion coefficients (s/m^3) were computed from the 1 h average air concentration data. A code was written to take the radionuclide inventories for the buildings (3026D, 3026C and 3140) and convert the limiting 1 h dispersion coefficients to effective doses (Sv). The resulting doses then reflect the release of the entire inventory for each building since a constant steady-state release of 1g/s was assumed in the AERMOD calculations. Suggestions are provided on how to scale these results when the amount of the inventory released can be estimated.

The source locations showed considerable variation in effective dose (Sv). Of the five locations, sources in building 3026D showed the highest doses. Source S2 near ground level in building 3026D produced the highest doses, due to the release being at ground level and to the particular inventory of that building. Source S3 at the height of the maintenance roof in 3026D showed the second highest doses, reduced from those of S2 due to greater height of the source location. The release at the highest location (S1 at the roof level) produced the lowest values for 3026D, but values above those of the other locations (3026C and 3140). Dispersion coefficients from the ground level release from building 3026C were high, but the resulting effective doses were low due to the inventory in the building provided by the Preliminary Hazard Screening report.[7] Finally, the release from the filter house 3140 produced the lowest effective doses due to the inventory in that location.

In general the pattern of release showed higher doses toward the prevailing wind directions (along the valley), which also are parallel to the sidewalk along Central Avenue. In addition, doses were generally higher to the south of the complex of buildings due to building downwash effects and the presence of the hillside to the north. Thus, while care must be taken with all areas near the 3026D/C complex, special care should be exercised to prevent exposure along the sidewalk in front of the 3026 complex and in occupied buildings that are across the street, south of the complex.

6. REFERENCES

1. Source for the AERMOD code and documentation is this EPA web site: http://www.epa.gov/scram001/dispersion_prefrec.htm; Technology Transfer Network Support Center for Regulatory Atmospheric Modeling, Last updated on Friday, May 29th, 2009.

2. AERMOD Documentation:
User's Guide for the AMS/EPA Regulatory Model – AERMOD, EPA-454/B-03-001, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina, September 2004.

3. AERMAP Documentation:
User's Guide for the AERMOD Terrain Preprocessor (AERMAP), EPA-454/B03-003, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina. October 2004.

4. AERMET Documentation:
User's Guide for the AERMOD Meteorological Preprocessor (AERMET), EPA-454/B-03-002, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina. November 2004.

5. AERSURFACE Documentation:
AERSURFACE User's Guide, EPA-454/B-08-001, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina. January 2008.

6. BPIPPRIME Documentation:
L.L. Schulman, D. G. Strimaitis. J.S. Scire, *Addendum to ISC3 User's Guide:The Prime Plume Rise and Building Downwash Model*, prepared for Electric Power Research Institute by Earth Tech, Inc. November 1997.

7. Preliminary Hazard Screening for Buildings 3026C, 3026D, and Filter House 3140. PHS-OR-3026-0997 Rev 0.

APPENDIX A. DETAILS OF THE AERMOD PROCEDURE

APPENDIX A. DETAILS OF THE AERMOD PROCEDURE.

The sequence of operation of the AERMOD suite of codes is diagramed below (Fig. A1).

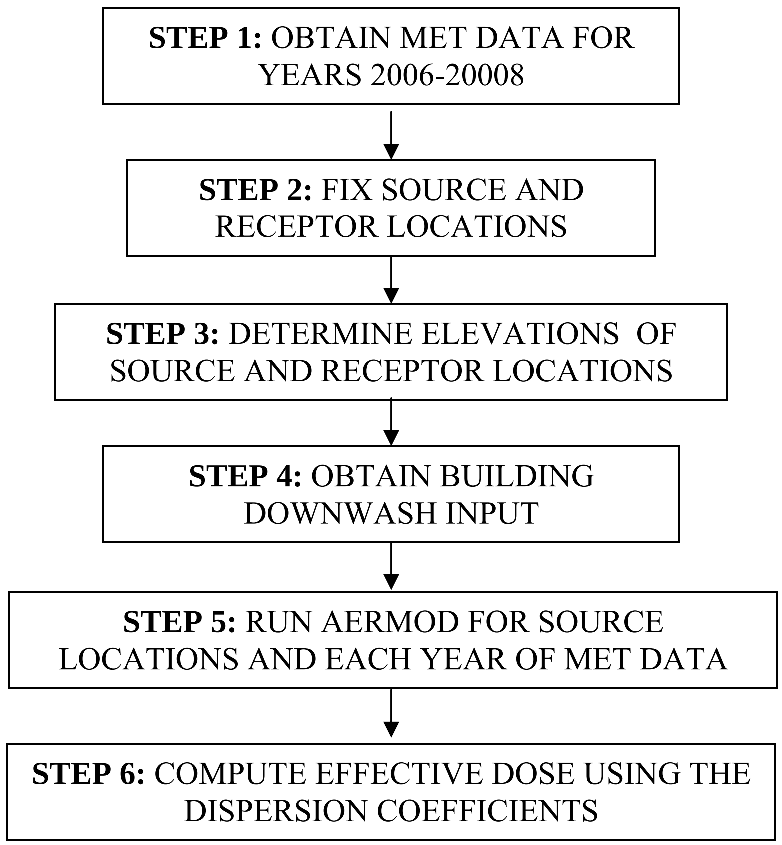


Fig. A1. Diagram of the AERMOD computational process.

1) The requisite meteorological (MET) data for one year (2006) was obtained; upper air, surface and location MET data were converted into the AERMOD formats. Once that was successful, the process was repeated using the 2007 and 2008 MET data. Wind roses for those three years are shown in Appendix B.

2) Locations for source and receptors were determined. Three types of receptors were defined: sidewalks, polar grid locations, and locations of building air intakes. Each of these receptor groups were run separately in AERMOD. The sidewalks consisted of fixed linear tracts (sidewalks) that bisect the site roughly corresponding to sidewalks along the south side of Central Avenue (roughly a SW-NE direction) and along Fifth Street (roughly a NW–SE direction). In addition, receptors were defined on four polar grids centered on the source. The polar grids had radii of 50 m, 100 m, 200 m, and 500 m and receptors were placed at 10^o intervals starting at 10^o from north and processing clockwise. Finally, we identified a number of the air intake locations on buildings (mostly outside the 200 m polar ring), to predict concentrations that might enter buildings. Coordinates for these air intake positions had to be in UTM format.

3) AERMAP, which references a topographic map of the region, was used to obtain the elevations of the source and receptors. The elevation of the air intakes were estimated or obtained from facilities managers. The elevations of the linear and polar grids were taken as ground level.

4) Once the source locations were decided upon, BPIPPRIME was used to determine the effects of downwash due to a group of buildings within about 200 meters of buildings 3026C and 3026D. This downwash result, which varies for each of the source locations, is included in AERMOD for computations for each of the source locations.

5) AERMOD was run for each of a total of five source terms and the following results extracted: a) the average air concentrations (averaged of all hours of the one year period), b) the 1st highest 1 h average concentration, and c) the 1st highest 3 h average concentration for each of the three years of MET data. In each case the units are $\mu g/m^3$. Then, these air concentration results were converted to average and limited 1 h air dispersion coefficients (s/m^3). Plots of 1-h average concentration for each source and meteorological dataset were made using MATLAB.

6) DoseCal was used to compute the effective dose (Sv) given the air dispersion coefficients (s/m^3) and the inventory for each source location (see Appendix E). DoseCal was written in PowerBasic by Keith Eckerman of the Environmental Sciences Division. The code is based on extensive previous experience in determining inhalation and air immersion doses. Plots of effective dose were made for each source and meteorological dataset were made using MATLAB and are presented in this report.

APPENDIX B. WIND ROSES FOR 2006–2008

APPENDIX B. WIND ROSES FOR 2006–2008

Wind roses for 2006 for the three measurement heights (10 m, 30 m, and 100 m) of Tower C are shown in Figs B1-B3.

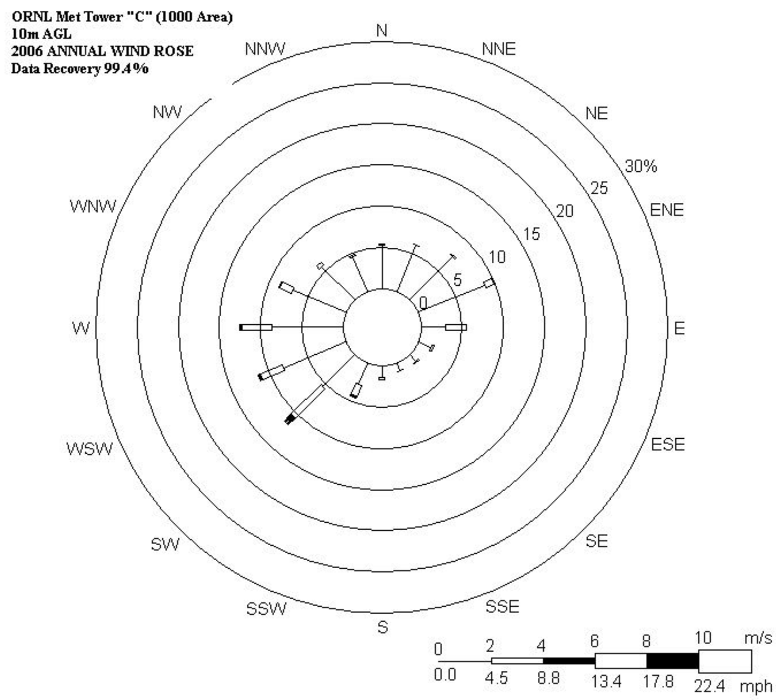


Fig. B1. Wind rose for 10 m height on Tower C for 2006

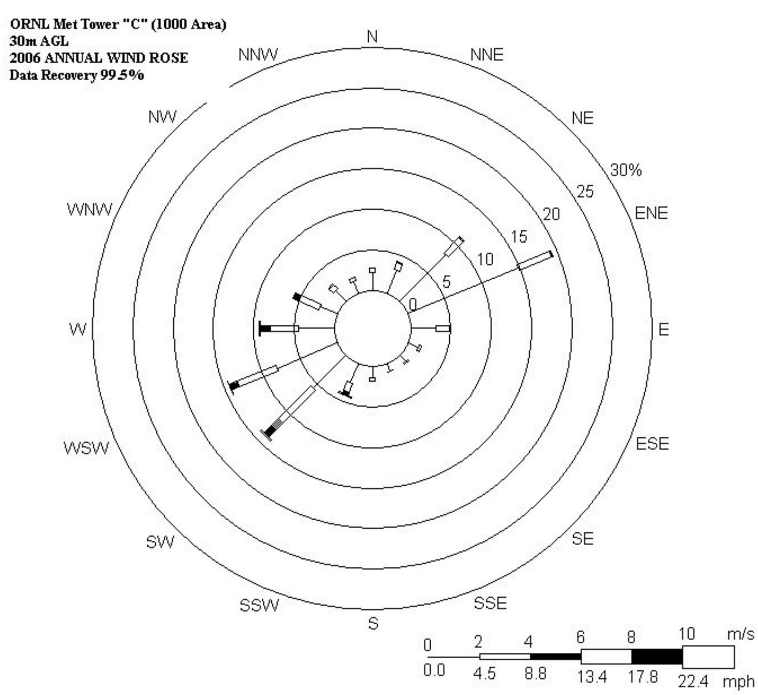


Fig. B2. Wind rose for 30 m height on Tower C for 2006

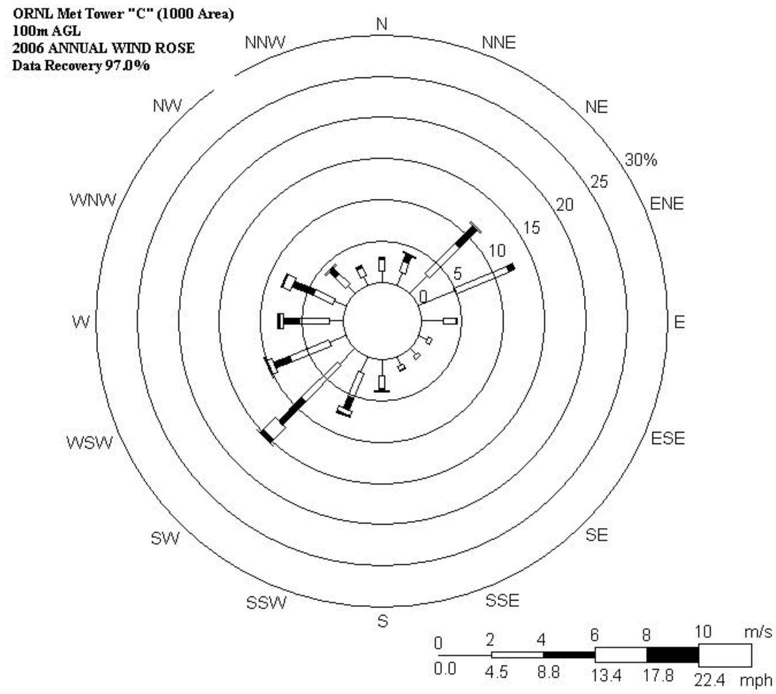


Fig. B3. Wind rose for 100 m height on Tower C for 2006

Wind roses for 2007 for the three measurement heights (10 m, 30 m, and 100 m) of Tower C are shown in Figs B4-B6.

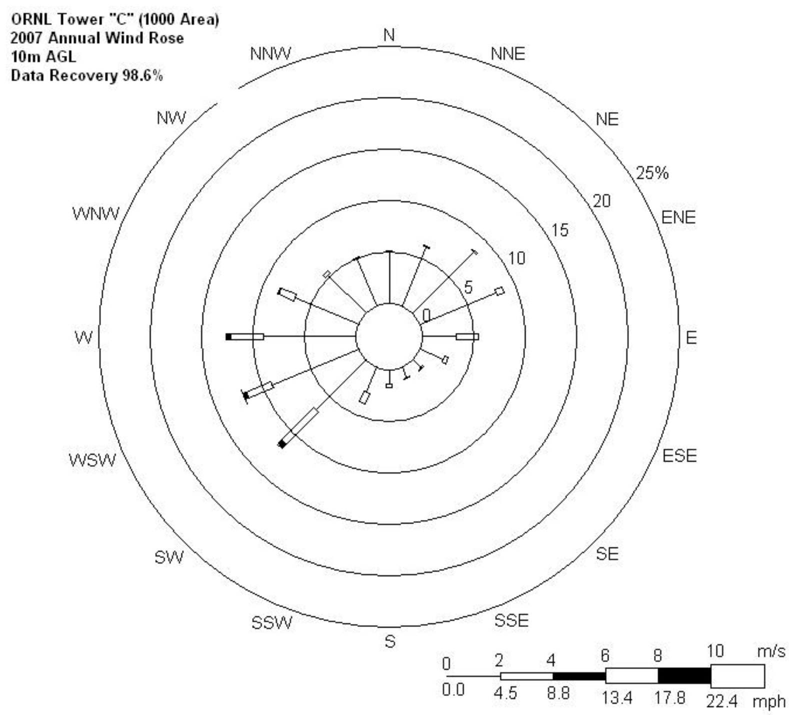


Fig. B4. Wind rose for 10 m height on Tower C for 2007.

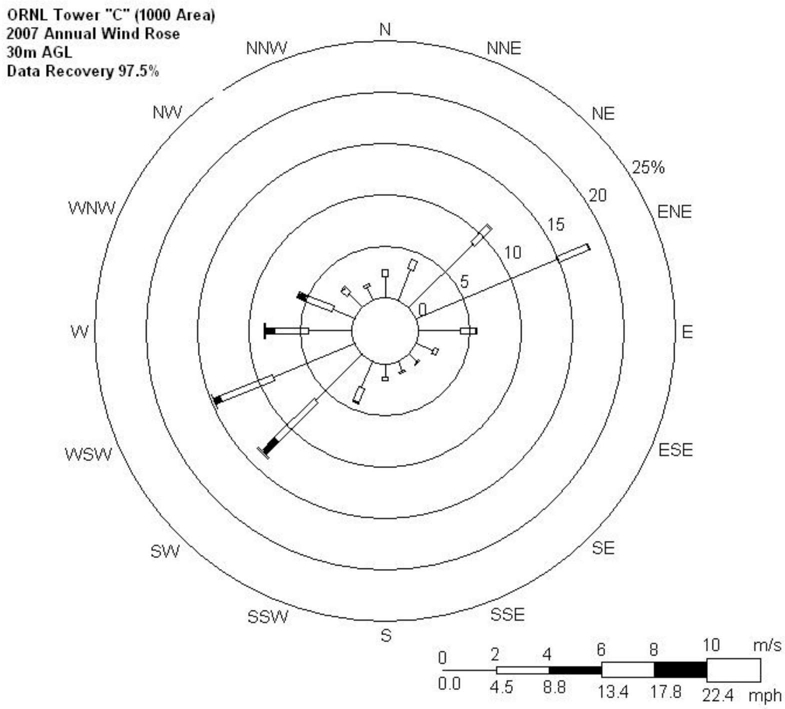


Fig. B5. Wind rose for 30 m height on Tower C for 2007.

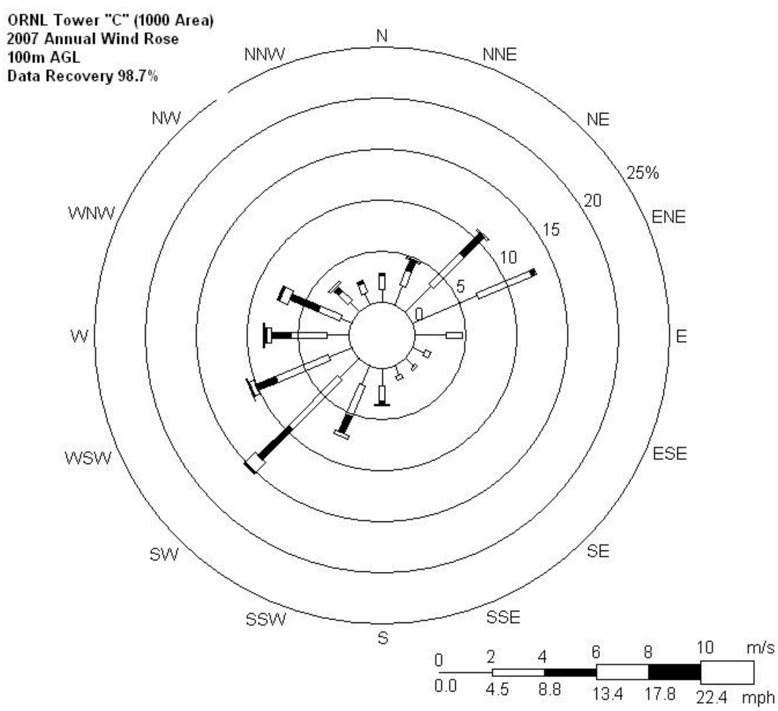


Fig. B6. Wind rose for 100 m height on Tower C for 2007.

Wind roses for 2008 for the three measurement heights (10 m, 30 m, and 100 m) of Tower C are shown in Figs B7-B9.

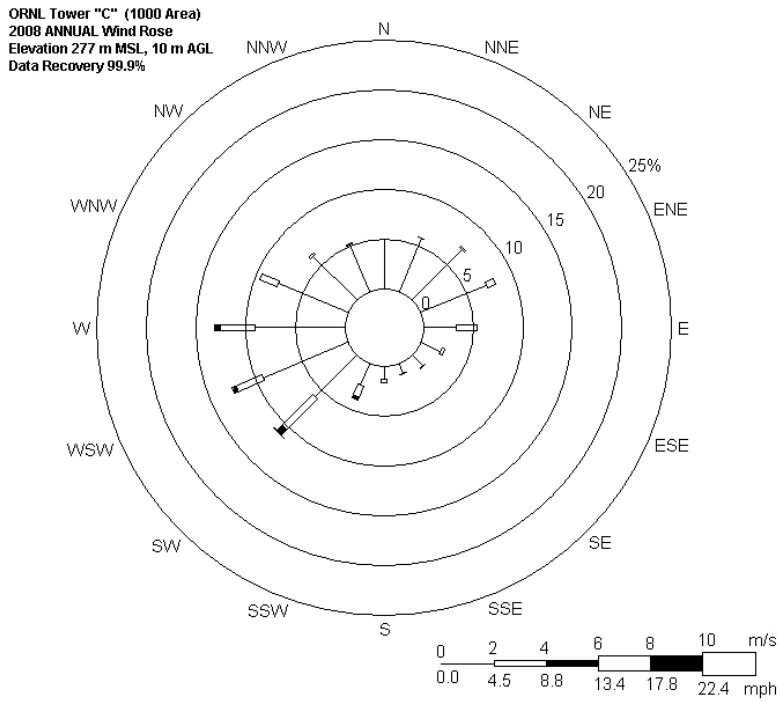


Fig. B7. Wind rose for 10 m height on Tower C for 2008.

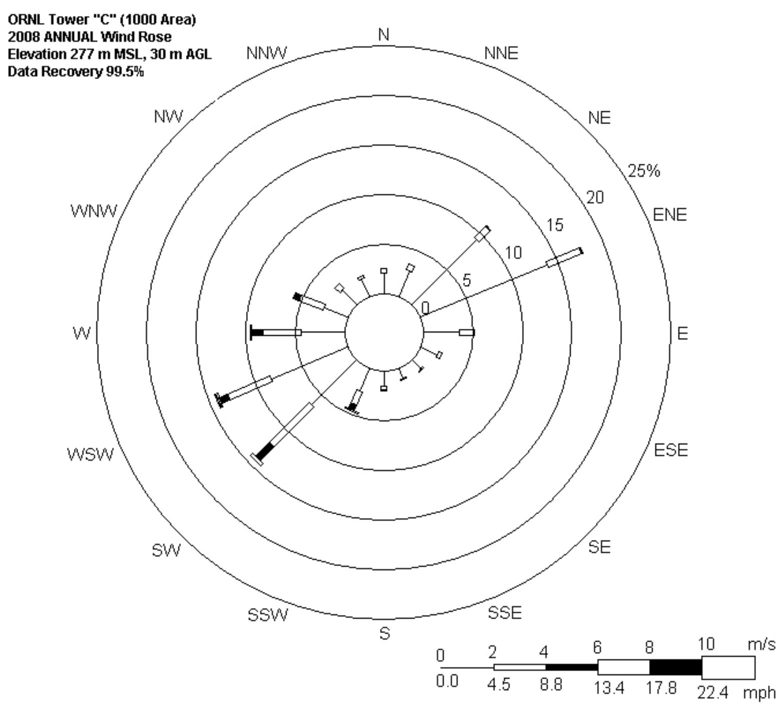


Fig. B8. Wind rose for 30 m height on Tower C for 2008.

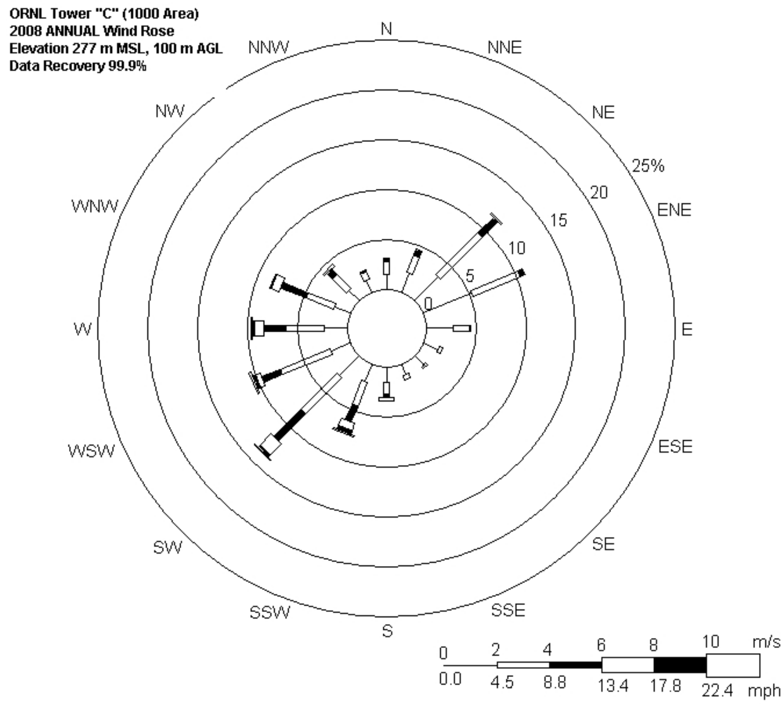


Fig. B9. Wind rose for 100 m height on Tower C for 2008.

APPENDIX C. BPIPPRIME INPUT / BUILDING DATA

APPENDIX C: BPIPPRIME INPUT / BUILDING DATA

S1: Building 3026D - NW Corner at roof level
Location: 742095.5 3979226.0 Elevation: 243.75 m Height: 14.63 m

```
'Buildings Surrounding and including 3026 - Source is single stack-like
location'
'P'
'METERS' 1.0
'UTMY' 0.00
29
'3025E'  1   247.65
6   19.66
 742065.0168      3979268.3692
 742079.4392      3979248.0524
 742057.5426      3979232.5086
 742053.2204      3979238.5974
 742042.9326      3979231.2944
 742032.8106      3979245.5069
'3025M'  1   247.65
5   19.66
 742042.9326      3979231.2944
 742049.1109      3979222.5915
 742028.7161      3979208.1137
 742012.4379      3979231.0448
 742032.8106      3979245.5069
'3028'   1   245.98
11  6.7
 742114.6820      3979293.9375
 742143.1601      3979314.1533
 742150.2575      3979304.1552
 742150.2575      3979304.1552
 742135.5086      3979293.6854
 742134.0611      3979295.7249
 742132.1111      3979294.3407
 742133.5588      3979292.3013
 742126.5798      3979287.3470
 742125.1319      3979289.3867
 742120.3317      3979285.9788
'3029'   1    245.25
19   6.7
 742135.2712      3979286.4849
 742149.9299      3979296.8900
 742154.7882      3979297.8256
 742159.2336      3979291.5634
 742162.9643      3979294.2118
 742164.8534      3979291.5506
 742154.9016      3979284.4860
 742155.5371      3979283.5906
 742152.1819      3979281.2088
 742151.5463      3979282.1042
 742148.5883      3979280.0044
 742149.2239      3979279.1090
 742147.3059      3979277.7475
 742145.9742      3979279.6236
 742143.3644      3979277.7710
 742141.4829      3979280.4214
```

```
 742138.0259      3979277.9673
 742134.2654      3979283.2646
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'3038'   1   243.89
4    7.0
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 742167.3349      3979244.4253
 742158.3296      3979257.1112
'3039'   1   245.36
8    76.2
 742099.5919      3979270.5225
 742103.4267      3979269.8718
 742105.7441      3979266.6072
 742105.0333      3979262.8040
 742101.9681      3979260.6281
 742098.0156      3979261.2336
 742095.7690      3979264.3984
 742096.4516      3979268.2933
'3092'   1   243.91
12   6.7
 742132.2115      3979248.4048
 742137.1727      3979251.9270
 742138.1791      3979250.5093
 742139.0494      3979251.1277
 742145.8114      3979241.6020
 742147.4280      3979242.7496
 742150.7296      3979238.0986
 742145.7305      3979234.5499
 742142.3757      3979239.2757
 742139.3911      3979237.1570
 742132.6825      3979246.6074
 742133.2165      3979246.9865
'3105'   1   244.23
4    6.7
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 742097.5601      3979237.3848
 742088.6062      3979231.0286
 742085.6577      3979235.1821
'3125'   1   246.64
4    3.73
 742090.4464      3979296.2355
 742097.3583      3979301.1420
 742100.4427      3979296.7971
 742093.5308      3979291.8905
'3150'   1   243.41
8    8.9
 742019.2291      3979179.0202
 742028.9976      3979165.2593
 742031.4936      3979167.0311
 742031.2581      3979167.3629
 742053.6213      3979183.2379
 742053.8523      3979182.9048
 742056.3518      3979184.6791
 742046.5879      3979198.4415
'3515'   1   242.02
8    6.7
```

```
 742079.6804      3979121.6838
 742079.8044      3979121.5091
 742081.6732      3979122.8357
 742088.0239      3979113.8895
 742083.5383      3979110.7053
 742079.2751      3979116.7109
 742078.3780      3979116.0740
 742076.1665      3979119.1894
'3525'   1   242.31
8    35.5
 742100.1893      3979160.9651
 742126.9264      3979179.9450
 742148.5023      3979149.5509
 742136.0786      3979140.7316
 742137.7388      3979138.3929
 742131.7921      3979134.1715
 742130.1319      3979136.5102
 742121.7653      3979130.5710
'3546'   1   242.28
4    7.3
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 742194.0726      3979222.6729
 742200.4284      3979213.7195
 742175.7309      3979196.1874
'3550'   1   242.45
16   6.7
 742154.3030      3979203.2315
 742161.7203      3979192.7828
 742154.1829      3979187.4322
 742161.3713      3979177.3060
 742173.1611      3979185.6752
 742182.2697      3979172.8439
 742170.4799      3979164.4746
 742177.7717      3979154.2027
 742164.9695      3979145.1148
 742157.6778      3979155.3867
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 742144.6631      3979165.4453
 742148.5691      3979168.2181
 742141.3808      3979178.3443
 742137.4747      3979175.5715
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'3026C'  2   243.06
13   7.3
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 742071.9181      3979195.3526
 742065.6273      3979204.2145
 742068.2108      3979206.0517
 742067.1998      3979207.4738
 742065.7100      3979206.4162
 742061.4643      3979212.3972
 742068.9139      3979217.6855
 742074.2210      3979210.2093
 742083.9055      3979217.0840
```

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4    14.63
 742094.9000      3979201.8000
 742088.2000      3979211.0000
 742069.8000      3979198.2000
 742076.6000      3979188.7000
'3026D'   2  243.85
8    7.3
 742106.7690      3979236.5788
 742123.4848      3979213.0313
 742109.5562      3979203.1104
 742099.2000      3979195.8000
 742083.9092      3979217.0788
 742094.2297      3979224.3270
 742094.4007      3979224.4473
 742092.8146      3979226.6805
10   14.63
 742106.7690      3979236.5788
 742123.4848      3979213.0313
 742109.5562      3979203.1104
 742105.2000      3979209.0000
 742094.9000      3979201.8000
 742088.2000      3979211.0000
 742098.8000      3979218.2000
 742094.2297      3979224.3270
 742094.4007      3979224.4473
 742092.8146      3979226.6805
'3034'   1   244.62
4     8.5
 742201.9503      3979316.2763
 742209.3654      3979305.8306
 742202.6501      3979301.0636
 742195.2350      3979311.5093
'3036'   1   244.63
4     6.1
 742205.6431      3979320.5061
 742213.4281      3979326.0324
 742221.6024      3979314.5173
 742213.8174      3979308.9910
'3037'   1   243.85
4     7.4
 742208.4475      3979292.6858
 742217.5044      3979279.9273
 742236.4816      3979293.3986
 742227.4246      3979306.1572
'3047'   1   245.98
8     10.36
 742144.0075      3979312.9595
 742196.9597      3979350.5488
 742204.0573      3979340.5504
 742178.0658      3979322.1005
 742179.8315      3979319.6132
 742163.0755      3979307.7297
 742161.3070      3979310.2140
 742151.1051      3979302.9611
'3130'   1   244.12
6     6.7
 742004.1889      3979229.1763
```

```
 742012.9751      3979216.7263
 742001.4710      3979208.5733
 741996.8873      3979215.0303
 741992.6600      3979212.0096
 741988.4131      3979217.9923
'3137'   1   244.18
12     7.0
 741983.9870      3979208.2823
 741984.6546      3979207.3418
 741986.8554      3979208.9041
 741991.1154      3979202.9030
 741988.9146      3979201.3407
 741990.7068      3979198.8161
 741971.0873      3979184.8930
 741969.2147      3979187.5309
 741967.1541      3979186.0682
 741962.9787      3979191.9546
 741965.0235      3979193.4351
 741964.3695      3979194.3563
'3500'   2   242.47
4      6.0
 742222.0258      3979247.4531
 742252.4295      3979269.0359
 742284.6024      3979223.7138
 742254.1998      3979202.1318
10     8.5
 742216.4647      3979243.8052
 742221.8849      3979247.6521
 742254.1998      3979202.1318
 742259.9013      3979194.0958
 742255.0706      3979190.6985
 742263.6568      3979178.5971
 742246.1518      3979166.1708
 742202.0283      3979228.3277
 742218.9333      3979240.3281
 742216.4647      3979243.8052
'3508'   2   240.73
4     2.74
 742176.8988      3979093.4792
 742180.4281      3979088.5075
 742162.0221      3979075.4416
 742158.4928    3979080.4133
10    6.7
 742149.6635      3979092.8512
 742180.0072      3979114.3913
 742184.6377      3979107.8682
 742194.8386      3979115.1095
 742198.7710      3979109.5699
 742188.5702      3979102.3286
 742188.8365      3979101.9534
 742176.8988      3979093.4792
 742180.4281      3979088.5075
 742162.0221      3979075.4416
'3517'   2   240.85
25    8.23
 742125.0732      3979072.3949
 742136.1942      3979056.7288
```

```
 742134.6176      3979055.6096
 742137.9252      3979050.9501
 742132.9786      3979047.4386
 742129.6709      3979052.0981
 742122.2509      3979046.8309
 742125.5586      3979042.1714
 742122.6965      3979040.2793
 742119.4548      3979044.8460
 742105.3736      3979034.8502
 742101.8072      3979039.8742
 742089.0232      3979030.7993
 742085.8473      3979035.2732
 742098.6313      3979044.3481
 742094.2527      3979050.5163
 742088.4407      3979058.7037
 742096.9487      3979064.7434
 742096.2634      3979065.7088
 742103.3569      3979070.7443
 742109.8542      3979061.5914
 742117.4744      3979067.0008
 742114.5645      3979071.0999
 742120.5868      3979075.3749
 742123.4966      3979071.2758
4     13.4
 742127.8532      3979068.4779
 742133.4142      3979060.6458
 742102.5936      3979038.7574
 742097.0327      3979046.5993
'3542'  1    242.34
4    6.7
 742046.3090      3979049.2112
 742050.8133      3979052.4086
 742055.7232      3979045.4919
 742051.2190      3979042.2945
'3587'  1    240.42
6    6.7
 742275.6366      3979198.2473
 742293.5940      3979210.9948
 742299.3673      3979202.8618
 742289.5169      3979195.8692
 742293.8069      3979189.8259
 742285.7000      3979184.0710
'3606'   1   241.34
  4  6.1
 742190.8808      3979174.8345
 742215.0759      3979192.0099
 742221.4318      3979183.0562
 742197.2368      3979165.8808
'3618'   1   239.75
4    6.7
 742306.0054      3979195.3718
 742312.8418      3979185.8995
 742305.6941      3979180.7407
 742298.8578      3979190.2130
1
'STACK' 243.75   14.63    742095.5   3979226.0
0
```

S2: 3026D - Center line, left side at ground level
Location: 742104.0 3979215.0 Elevation: 243.4 m Height: 1 m

File is the same except for changing the STACK information:

```
'STACK' 243.4   1         742104.00   3979215.00
```

S3: 3026D - Center line, right side of at roof level of maintenance covering
Location: 742111.0 3979221.0 Elevation: 243.41 m Height: 12.0 m

File is the same except for changing the STACK information:

```
'STACK' 243.41   12.0    742111.00   3979221.00
```

S4: Building 3026C – NW side of building at ground level
Location: 742080.00   3979209.00 Elevation: 243.49 m Height: 0 m

File is the same as that for building 3026D except for changing the STACK information (source location and elevation):

```
'STACK' 243.49   1       742080.00   3979209.00
```

S5: Building 3140 - Center at ground level
Location: 742090.54 3979250.83 Elevation: 244.69 m Height: 0 m

File is the same as pervious except for the addition of building 3140 and changing the STACK information (source location and elevation):

```
'3140 - Source is center of building 3140 at ground level'
'P'
'METERS' 1.0
'UTMY' 0.00
30
'3140'   1   244.69
4    2.4
 742087.5032    3979251.2458
 742091.2292    3979253.6800
 742093.5768    3979250.4135
 742089.8568    3979247.7574
.
.
.
.

'STACK' 244.69   1       742090.54   3979250.83
```

APPENDIX D. AERMAP INPUT FOR COMPUTING ELEVATION OF RECEPTOR LOCATIONS

APPENDIX D: AERMAP INPUT FOR COMPUTING ELEVATION OF RECEPTOR LOCATIONS

The AERMAP code is run using the receptor UTM coordinates to obtain the elevations, in this example, of the polar grid points. The output of AERMAP, the elevation values for each receptor location for all polar angles followed by the hill values for each of the receptor rings (50 m, 100 m, 200 m, and 500 m), are pasted into the AERMOD input file for this source.

Polar grid elevations are created using this AERMAP input (example is for S5):

```
CO STARTING
   TITLEONE  Polar Receptor Elevations for S5
   DATATYPE  DEM1
   DATAFILE  corbe.dem
   DATAFILE  johnw.dem
   DATAFILE  knoxw.dem
   DATAFILE  chatte.dem
   DOMAINXY  725000. 3965000. 16 759300. 4001000. 16

   ANCHORXY  743280.0 3978050.0 743280.0 3978050.0 16 0
   RUNORNOT  RUN
CO FINISHED

SO STARTING
SO LOCATION  TSCA      POINT      736293.1918  3980025.1298
SO FINISHED

RE STARTING
   GRIDPOLR POL1 STA
            POL1 ORIG 742090.54   3979250.83
            POL1 DIST 50. 100. 200. 500.
            POL1 GDIR 36  10.  10.
   GRIDPOLR POL1 END
RE FINISHED

OU STARTING
   RECEPTOR  Polar_Elevations_S5.REC
   SOURCLOC  SRC_S5.OUT
OU FINISHED
```

APPENDIX E. SOURCE INVENTORIES AND EFFECTIVE DOSE COEFFICIENTS

APPENDIX E: SOURCE INVENTORIES AND EFFECTIVE DOSE COEFFICIENTS

Effective dose coefficients for the radionuclides used in this study are listed in Table E.1. For all radionuclides in the inventory, effective dose coefficients were computed for inhalation intakes, exposure to radiation emitted by the dispersing airborne radionuclides, and exposure to radiation emitted by radionuclides deposited onto the ground surface. The contribution of these pathways to the receptor dose is proportional to the predicted air concentration of the radionuclide at the receptors location. We assume that exposure to deposited activity would be limited to a 4 hour period following the release and that the deposited activity reflects a deposition velocity of 0.01 m/s (1 cm/s). The relative contribution of each pathway to the receptor dose can be obtained by summing the inhalation coefficients time 1.5 m^3/h divided by 3660 s/h plus the submersion coefficient plus 0.01 m/s x 4 h x 3600 s/h times the ground plane coefficient. The last column of Table E.1 indicates, for each radionuclide, the fraction of the total dose to the receptor due to inhalation of the radionuclide. For these radionuclides and the above assumptions, the inhalation pathway is seen to dominate the total dose. For only one nuclide, Co-57, did inhalation contributed less than 96%. That nuclide only appears in the inventory of building 3026D and is a minor contributor to the total dose. Thus, in practice, one only needs to consider the inhalation pathway as reflected in Tables E.2–E.4 and thus these tables report $\sum Q_i e_i$ (Sv) for the inventory as needed in Eq. (3) of this report, where e_i is the effective dose coefficient for inhalation.

Table E.1. Dose coefficients for inhalation, submersion and ground plane exposures

	---- Effective Dose Coefficients ----			Inhalation
	Inhalation	Submersion	Ground Plane	fraction
Nuclide	Sv/Bq	Sv-m3/Bq-s	Sv-m2/Bq-s	%
H-3	2.6E-10	0.0	0.0	100.00
C-14	5.8E-09	2.60E-18	1.28E-20	100.00
Co-57	1.0E-09	4.98E-14	1.09E-16	86.42
Co-60	3.1E-08	1.19E-13	2.30E-15	96.63
Sr-90	1.6E-07	8.91E-16	1.12E-16	99.97
Cs-137	3.9E-08	2.56E-14	5.52E-16	99.38
Eu-152	4.2E-08	5.28E-14	1.07E-15	98.83
Eu-154	5.3E-08	5.76E-14	1.17E-15	98.99
Am-241	9.6E-05	6.77E-16	2.33E-17	100.00
Pu-239	1.2E-04	3.49E-18	2.84E-19	100.00
Np-237	5.0E-05	9.46E-15	2.11E-16	100.00
Cm-244	5.7E-05	3.41E-18	6.44E-19	100.00

Table E.2 Radioactive material inventory summary for Bldg. 3026C

Nuclide	Release Ci	Release Bq	Dose Coefficients Inhalation Sv/Bq
H-3	6.10E-03	2.26E+08	2.60E-10
C-14	2.16E-02	7.99E+08	5.80E-09
Co-60	1.56E-05	5.77E+05	3.10E-08
Sr-90	8.74E-03	3.23E+08	1.60E-07
Cs-137	1.45E-02	5.36E+08	3.90E-08
Np-237	1.35E-04	4.99E+06	5.00E-05

$\sum Q\ e$ = 3.27E+02 Sv

Table E.3 Radioactive material inventory summary for Bldg. 3026D

Nuclide	Release Ci	Release Bq	Dose Coefficients Inhalation Sv/Bq
Sr-90	9.43E+00	3.49E+11	1.60E-07
Pu-239	3.30E-02	1.22E+09	1.20E-04
Am-241	7.29E-04	2.70E+07	9.60E-05
Co-57	1.47E-02	5.44E+08	1.00E-09
Co-60	6.94E-02	2.57E+09	3.10E-08
Cs-137	3.01E+00	1.11E+11	3.90E-08
Eu-154	3.52E-04	1.30E+07	5.30E-08

$\sum Q\ e$ = 2.09E+05 Sv

Table E.4 Radioactive material inventory summary for Filter House 3140

Nuclide	Release Ci	Release Bq	Dose Coefficients Inhalation Sv/Bq
Cs-137	1.78E-04	6.59E+06	3.90E-08
Eu-154	1.01E-06	3.74E+04	5.30E-08
Co-60	7.12E-07	2.63E+04	3.10E-08
Sr-90	3.39E-06	1.25E+05	1.60E-07
Eu-152	1.73E-06	6.40E+04	4.20E-08

$\sum Q\ e$ = 2.82E-01 Sv