Contract No:

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-08SR22470 with the U.S. Department of Energy (DOE) Office of Environmental Management (EM).

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Mercury Dispersion Modeling and Ventilation Stack Height Determination for Mega SDUs

Steve Weinbeck

December 2019

SRNL-STI-2019-00683, Rev.0

SRNL.DOE.GOV

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Prepared for
U.S. Department of Energy

Keywords: *Mercury Emissions; Z Area; SDU, SDUs, Stack Height,.STEL, ACGIH TLV, TWA,*

Retention: *Permanent*

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EXECUTIVE SUMMARY

The SRNL Atmospheric Technologies Group performed an analysis to determine the minimum stack height necessary to avoid exceedance of the ACGIH (American Conference of Governmental Industrial Hygienists) 15-minute Short-Term Exposure Limit (STEL) and 8-hour Time Weighted Average (TWA) ambient standards for worst case hazardous chemical emissions from the Z-Area Mega SDUs. The American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) was used as the dispersion modeling tool for this analysis. Receptors were placed to represent the breathing level concentrations that workers might have, placed 6-ft above the working surface (ground or SDU tank surface).

Based on the analysis conducted, the minimum SDU exhaust release height to avoid exceeding STEL and TWA is 6 feet above the SDU roof level for flow rates between 300 and 1200 cfm. The configuration of Mega SDUs, while large structures, do not produce an aerodynamic wake that impacts the stack releases and causes exceedances to the worker exposure limits.

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LIST OF ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
AMS	American Meteorological Society
AEGLs	Acute Exposure Guideline Levels
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AERMET	AERMOD Meteorological Preprocessor
AGL	Above Ground Level
ASL	Above Sea Level
ATG	Atmospheric Technologies Group
BPIP-Prime	Building Profile Input Program- Prime Algorithm
Cfm	Cubic feet per minute
EPA	Environmental Protection Agency
NAD27	North American Datum 1927
NLCD92	National Land Cover Database 1992
NWS	National Weather Service
PAC	Protection Action Criteria
SDU	Salt Disposal Units
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value
TWA	Time Weighted Average
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

1.0 Introduction

The Savannah River National Lab (SRNL) Atmospheric Technology Group (ATG) has performed dispersion modeling to assess worker exposure standards associated with chemical emissions from the Saltstone Disposal Units (SDUs) 6 and 7 stacks. These calculations will also be used to help determine other design parameters such as exhaust rate and stack diameter. Under evaluation are flow rates of: 300, 1000 and 1200 cubic feet per minute (Cfm), as well as stack diameters of 6 and 10 inches. The following chemicals are evaluated: Mercury (elemental), Dimethyl Mercury, Trimethylamine, Ammonia, Isopar, Toluene, Xylene, Benzene, Nitrosamines (Ref. 1).

2.0 Methodology

Modeling was conducted with the Environmental Protection Agency (EPA) AMS/EPA Regulatory Model (AERMOD) dispersion model, which is recommended by the EPA for regulatory air quality analyses (Ref. 2). The model allows for vertical variability in wind, turbulence, temperature and incorporates boundary layer parameters for dispersion in both stable and convective atmospheric situations (Refs. 3 and 4). More information on ATG's software quality assurance plan for AERMOD can be found in C-SQP-G-00076 (Ref. 5). For this regulatory modeling, AERMOD was executed in default (regulatory) mode. AERMOD is routinely used for tank and multiple stack emissions, and has physics included to model building wake effects. The AERMOD computer model performs plume rise as part of the internal calculation.

To predict chemical concentrations from the SDU emissions, observed weather data for SRS was taken from a five-year (2007-2011) record of hourly meteorological conditions and used to calculate the amount of atmospheric dispersion for 1-hour and 8-hour time periods on a grid of receptors in a custom designed AERMOD domain. Hourly-averaged modeled concentrations were adjusted to represent 15-minute values for comparison to the 15-minute STEL using the following equation (Ref. 6):

$$\boldsymbol{C_{15min} = C_{60min}\left(\frac{60}{15}\right)^{0.2} = 1.3\ C_{60min}} \qquad (1)$$

By multiplying the hourly concentrations by a factor of 1.3, the concentration is representative of concentrations sampled on a 15-minute time averaged period. Comparisons of the calculated concentrations can be made to the standards and estimates of worker safety and potential mitigation methods can easily be made.

Meteorological data files used as input to AERMOD were prepared using EPA's AERMOD Meteorological preprocessor (AERMET, Ref. 7), which incorporates the National Weather Service's (NWS) hourly observations from Bush Field in Augusta, GA, twice-daily upper air soundings from the NWS Atlanta, GA radiosonde station and quality assured 15-minute values of wind and temperature at four levels (4, 18, 36 and 61 meters) of the Savannah River Site (SRS) Central Climatology tower located near N-area.

For onsite data, values were extracted from the meteorological database and written to a text file only if there were no associated quality flags. When the data did not meet quality control criteria, a missing value code was assigned consistent with AERMET requirements. Quality assurance procedures for SRS meteorological data are described in Reference 8. For details on the processing of the most recent five-year quality assured dataset (2007-2011) see References 9.

Values used by AERMET for roughness length, Bowen ratio and albedo were determined from EPA's AERSURFACE algorithm. Input to the algorithm consisted of a (United States Geological Survey) USGS National Land Cover Data image for 1992 (NLCD92). This image was analyzed for the area around the Central Climatology tower. Monthly values of the three surface parameters were generated and imported into AERMET.

The modeling domain was defined by a receptor grid of about 25,386 receptors. Receptor grid spacing of 5 m was used to identify any potential excessive concentrations that may occur near the ground. The height of a receptors is nominally 1.83 m (6-ft) above the working surface to represent the breathing zone of a tall worker standing at ground level or on top of the SDU structures. The coordinate system used for this domain was a UTM grid, using the NAD27 datum. Several test runs were performed to ensure that the domain would capture the horizontal extent of the two source plumes from the top of SDUs 6 and 7. The domain size was then adjusted to ensure that any potential maxima would be contained within the model domain (see Figure 2-1). Regions that were unaffected by the SDU 6/7 plume had some receptors removed to decrease model run time.

The overall site plan (Ref. 10) was used to examine the Z-Area terrain elevation. The topography represents the planned elevations including spoils, the berms around SDUs 6 through 9, as well as other miscellaneous minor changes (hills). Since the model domain was examined in a preliminary model run, it was clear that the peak concentration values would occur at the top of the tank. Utilizing the simplifying assumption that the peak chemical concentrations will occur at the tank top, the model input of topography for ground level was input as a single elevation was used for all model elevations except the tank tops, which slope up from 312.57-ft (95.27 m) at he SDU outside edge, to 315.41-ft (p6.1 m) at the center. The highest ground elevation for the domain was found to be 88.4 meters (290 ft).

The Z-Area SDUs are large structures with workers at ground level, it was necessary to include building information in AERMOD to account for downwash and re-circulation effects. The four large SDUs were input as above ground circular tanks using inputs given in References 1 and 10. The building data was processed using the EPA utility Building Profile Input Program (BPIP-Prime) to determine how any aerodynamic wake (if any) would impact airflow patterns and generate downwash that would direct plumes from the stack towards the ground level worker breathing zone.

The stack discharge temperature was evaluated as 55°C. The inside diameter of the stacks had not been determined at the time of the writing, so stack inside diameters of 6 inches and 10 inches were performed (Ref. 1) in addition to evaluation of stack height and flow rates. The height of the exhaust blower is 6 feet above the SDU roof (Figure 2-2), even if no stack is attached. The stack height analysis was performed for stack heights of (0, 4, 9 and 14 feet), which correspondingly equal release heights of 6-, 10-, 15- and 20-ft above the SDU roof (Ref. 1).

Table 2-1 contains a list of chemicals that are suspected to be constituents of the Mega SDUs stack emissions (Ref 1). For the current study, rather than have each chemical run for each combination of model parameters, one run containing a single set of flow rate, exit diameter and stack height was performed. A unit (1 gram per second) release was initially run. Concentrations generated form the unit release were then linearly scaled by the actual release rate of each chemical. and compared to the STEL or 8-Hr TWA, in order to determine if the chemical release is of concern by exceeding the ACGIH values.

Table 2-1. 15-min STEL and 8-hr TWA for Chemicals of Concern (Ref. 11).

Chemical	15-Min STEL (ppm)	8 HR TWA (ppm)	15- min STEL (mg/m^3)	8-Hr TWA (mg/m^3)
Mercury (Elemental)[a]	-----	-----	0.03[a]	0.025
Dimethyl Mercury[b]	0.003[b]	0.001[b]	0.03	0.008
Trimethylamine	15	5	36.27	12.088
Ammonia	35	25	24.38	17.414
Isopar[c]	NA[c]	171	NA[c]	175.123
Toluene[c]	NA[c]	20	NA[c]	75.370
Xylene	150	100	651.29	434.192
Benzene	2.5	0.5	8.000	1.597
Nitrosamines[d]	0.0003	NA[d]	0.0009	NA[d]

a). There is no STEL value for Elemental Mercury (Ref. 11).
b). Dimethyl Mercury was based on the OELS listed in the Reference 11 for Mercury as Alkyl Compounds.
b). Isopar and Toluene STEL and Nitrosamines 8-Hr TWA were not compared to the ACIGH standard because there is no standard or due to IH practices at SRS (Ref 12).
d). Nitrosamine OEL is used in place of the STEL (Ref. 13).

In order to convert the chemical concentration in terms of ppm to mass concentration, the following formula was used.

$$\boldsymbol{C}\ (\mathbf{ppm}) \times\ \boldsymbol{0.0409\ x\ MW}\left(\frac{g}{mol}\right) = \mathbf{C\ (mg/m^3)}\ \ \textbf{From Reference 11} \qquad \textbf{(2)}$$

Where C (ppm) is the stack concentration from Table 2-2 and MW is the molecular weight (g/Mol).

Table 2-2. Mega SDUs Estimated Stack Concentration for Selected Chemicals.

Chemical	Stack Concentration (ppm) (Ref. 1)	Molecular Weight (g/mol)	Stack Concentration (mg/m^3)
Mercury (elemental)	5.61E-03	200.59	4.60E-02
Dimethyl Mercury	8.50E-04	230.66	8.02E-03
Trimethylamine	1.78E+01	59.112	4.30E+01
Ammonia	3.50E+01	17.031	2.44E+01
Isopar	6.00E+02	171.27	4.20E+03
Toluene	3.00E+02	92.14	1.13E+03
Xylene	3.00E+02	106.16	1.30E+03
Benzene	3.00E+01	78.11	9.58E+01
Nitrosamines	3.00E-04	74.08	9.09E-04

To have the correct units for input to AERMOD, the concentration of mercury in the stack discharge was converted to a mass release rate by using the flow rates of 300, 100, and 1200 Cfm, (Ref. 1). The emission rate for the SDU stack (in g/s) was determined using the following calculation based on inputs from Table 2-1.

$$C\left(\frac{mg}{m^3}\right) \times \frac{1\text{g}}{1000\text{mg}} \times \left(\frac{1\text{m}}{3.28\text{ft}}\right)^3 \times \mathbf{F}\left(\frac{ft^3}{min}\right) \times \frac{1\ \text{min}}{60\ \text{sec}} = \mathbf{Q}\ \mathbf{(g/s)} \quad (3)$$

Where C is the stack concentration (mg/m^3) and F is the flow rate (Cfm).

Table 2-3. Source Terms as a Function of Flow Rate

Chemical	Q at 300 cfm (g/s)	Q at 1000 cfm (g/s)	Q at 1200 cfm (g/s)
Mercury	6.52E-06	2.17E-05	2.61E-05
Dimethyl Mercury	1.14E-06	3.78E-06	4.54E-06
Trimethylamine	6.09E-03	2.03E-02	2.44E-02
Ammonia	3.45E-03	1.15E-02	1.38E-02
Isopar	5.95E-01	1.98E+00	2.38E+00
Toluene	1.60E-01	5.33E-01	6.40E-01
Xylene	1.84E-01	6.15E-01	7.38E-01
Benzene	1.36E-02	4.52E-02	5.43E-02
Nitrosamines	1.29E-07	4.29E-07	5.15E-07

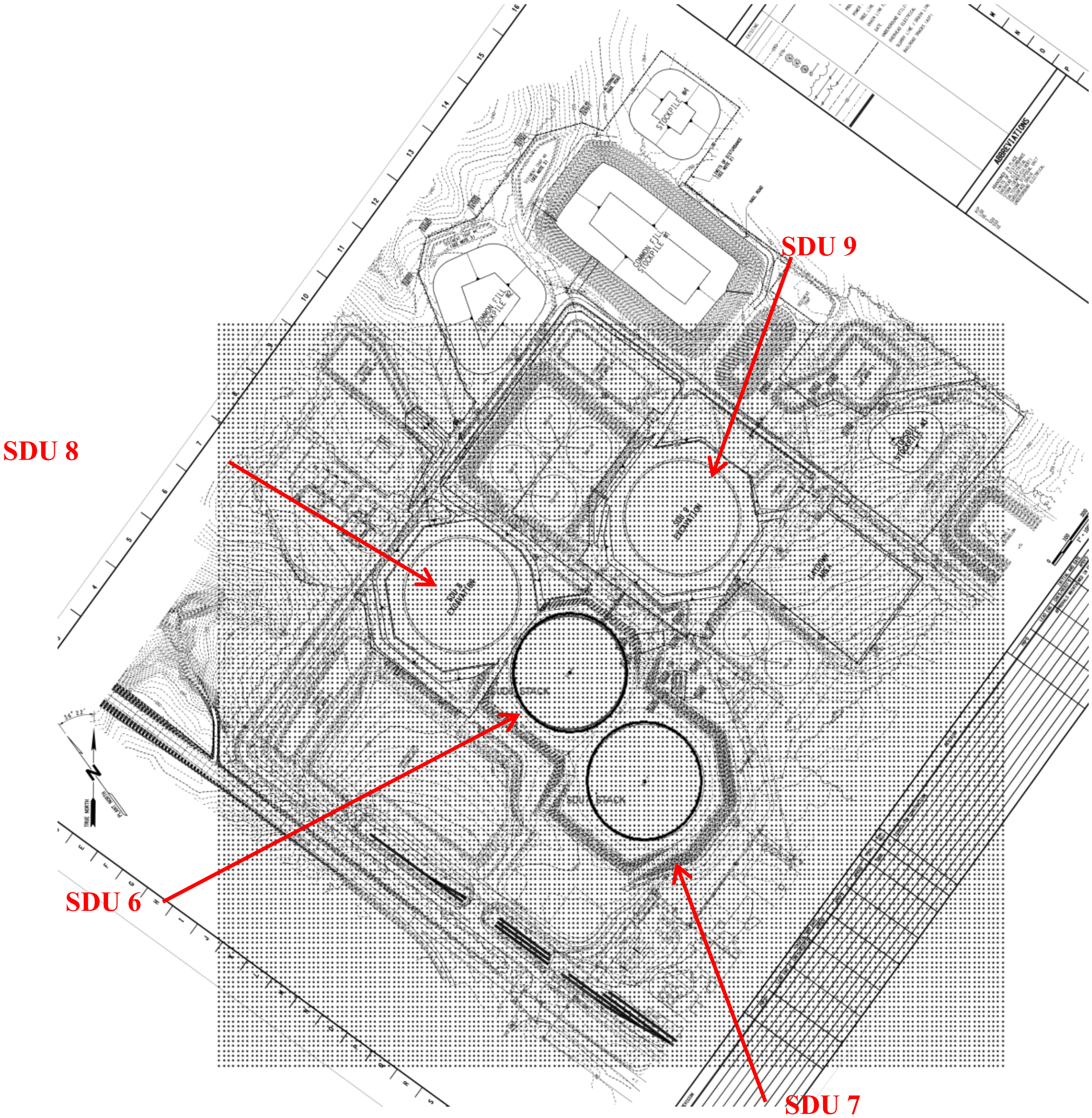

Figure 2-1. Overall Site Plan of Z-Area with elevations and receptors (dots) (Ref. 10).

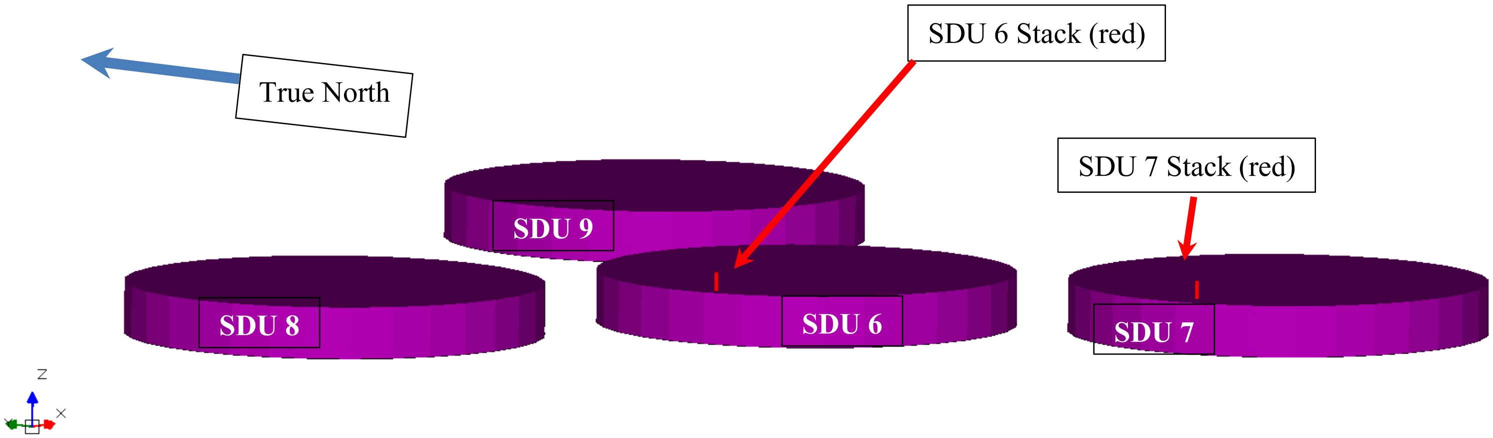

Figure 2-2. Three-dimensional view of the Mega SDUs for the 20-foot stack height from AERMOD modeling domain. The tanks are represented by purple circles and the stack is in red. Blue arrow shows the direction of the True North. View is from the True West direction and above.

3.0 Results and Discussion

The output of the unit release (1 g/s per stack) calculations for the modeling domain described in Section 2 are summarized in Tables 3-1 and 3-2. These values represent the peak (maximum concentration) values output by AERMOD within the model domain that occur when the SDUs 6 and 7 are both performing simultaneous releases. The release heights were run for various heights between 6 to 20 ft, in approximately 5-ft increments. In general, as the release height is increased all the concentrations in the breathing zone decreased.

The 1-hour averaged values are very similar between Tables 3-1 and 3-2 regardless of the stack diameter. This is because the cross-sectional area of the stack is about 2.8 times larger for the 10-inch stack diameter than the 6-inch stack diameter stack. For a given stack, if the flow rate is constant, the larger diameter stack will have a lower exit velocity than smaller diameter stack, due to mass continuity. This provides larger plume rise for the 6-inch stacks, effectively giving a slightly taller stack height. However, since the peak concentrations given the Tables 3-1 (6-inch stack) and 3-2 (10-inch stack) are nearly identical, this indicates that the difference in the effective release height is largely unimportant. This also suggests the released chemical plume is already above the turbulent wake that forms downwind of the SDUs.

The more important impact of increasing flow rate is to increase the chemical source amount. Larger flow rates bring more chemical mass from the SDUs head space to be released into the atmosphere, as described in Table 2-3.

Table 3-1. Maximum Atmospheric Dispersion Factor based on Unit Release from both SDU 6 and SDU 7 stacks with 6-inch diameter.

	300 CFM		**1000 CFM**		**1200 CFM**	
Ht (ft)	1-Hr (μg/m^3)	8-Hr (μg/m^3)	1-Hr (μg/m^3)	8-Hr (μg/m^3)	1-Hr (μg/m^3)	8-Hr (μg/m^3)
6	8.02E+04	1.99E+04	7.84E+04	2.50E+04	7.52E+04	2.46E+04
10	2.07E+04	5.29E+03	1.14E+04	2.99E+03	1.06E+04	2.84E+03
15	1.40E+04	3.28E+03	8.52E+03	2.61E+03	7.27E+03	2.49E+03
20	8.84E+03	2.72E+03	6.79E+03	2.08E+03	6.54E+03	1.92E+03

Table 3-2. Maximum Atmospheric Dispersion Factor based on Unit Release from both SDU 6 and SDU 7 stacks with 10-inch diameter.

	300 CFM		**1000 CFM**		**1200 CFM**	
Ht (ft)	1-Hr (μg/m^3)	8-Hr (μg/m^3)	1-Hr (μg/m^3)	8-Hr (μg/m^3)	1-Hr (μg/m^3)	8-Hr (μg/m^3)
6	8.02E+04	2.16E+04	7.84E+04	2.50E+04	7.52E+04	2.46E+04
10	2.08E+04	5.30E+03	1.34E+04	3.27E+03	1.32E+04	3.07E+03
15	1.43E+04	3.22E+03	8.55E+03	2.61E+03	8.27E+03	2.51E+03
20	8.72E+03	2.64E+03	7.03E+03	2.22E+03	6.91E+03	2.16E+03

Values were scaled from the 1-hour time period calculated by AERMOD using the empirical correction given in Equation 1 (multiplying by 1.3). The 1-Hr ambient concentration value for the downwind dispersion were scaled by the equation 1, and by the source values listed in Table 2-3, giving the breathing level chemical concentration. For the purposes of completeness, the 15-minute STEL and 8-Hr TWA are expressed in Tables 3-3 and 3-4 in terms of both μg/m^3 (the output units from AERMOD) and as a percentage of the STEL and 8-Hr TWA, to simplify the expression of the results. The chemical concentrations on the top of the SDUs (6, 7, 8 and 9) or at ground level are summarized in Tables 3-3 (6-inch stack diameter) and 3-4 (10-inch stack diameter).

The primary conclusion that can be drawn is that even at the initial 6-ft height (blower exit height), there are no significant impacts at receptors at the top of the SDUs or at ground level breathing zones. The largest concentrations calculated relative to the STEL and TWA were for Benzene, at 66.3% and 83.6% for the 6 ft release and 1200 Cfm. Similarly the maximum values for the other heights are for Benzene as well, although at correspondingly lower values.

Table 3-3. Peak Chemical Concentrations and Percentage TLV Exceedance for 6-Inch Stack Diameter.

Mercury	300 cfm				1000 cfm				1200 cfm			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	NA	1.298E-01	NA	0.5%	NA	5.428E-01	NA	2.17%	NA	6.414E-01	NA	2.57%
10	NA	3.446E-02	NA	0.1%	NA	6.484E-02	NA	0.26%	NA	7.405E-02	NA	0.30%
15	NA	2.138E-02	NA	0.1%	NA	5.663E-02	NA	0.23%	NA	6.486E-02	NA	0.26%
20	NA	1.772E-02	NA	0.1%	NA	4.517E-02	NA	0.18%	NA	5.015E-02	NA	0.20%
Dimethyl Mercury	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	1.183E-01	2.261E-02	0.4%	0.3%	3.854E-01	9.458E-02	1.28%	1.18%	4.437E-01	1.118E-01	1.48%	1.40%
10	3.052E-02	6.004E-03	0.1%	0.1%	5.607E-02	1.130E-02	0.19%	0.14%	6.271E-02	1.290E-02	0.21%	0.16%
15	2.069E-02	3.726E-03	0.1%	0.0%	4.191E-02	9.867E-03	0.14%	0.12%	4.293E-02	1.130E-02	0.14%	0.14%
20	1.305E-02	3.086E-03	0.0%	0.0%	3.338E-02	7.870E-03	0.11%	0.10%	3.863E-02	8.737E-03	0.13%	0.11%
Trimethylamine	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³))	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	6.346E+02	1.213E+02	1.7%	1.0%	2.067E+03	5.073E+02	5.70%	4.20%	2.380E+03	5.994E+02	6.56%	4.96%
10	1.637E+02	3.220E+01	0.5%	0.3%	3.008E+02	6.059E+01	0.83%	0.50%	3.363E+02	6.920E+01	0.93%	0.57%
15	1.110E+02	1.998E+01	0.3%	0.2%	2.248E+02	5.292E+01	0.62%	0.44%	2.303E+02	6.061E+01	0.63%	0.50%
20	7.001E+01	1.655E+01	0.2%	0.1%	1.790E+02	4.221E+01	0.49%	0.35%	2.072E+02	4.686E+01	0.57%	0.39%
Ammonia	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	3.597E+02	6.874E+01	1.5%	0.4%	1.172E+03	2.876E+02	4.81%	1.65%	1.349E+03	3.398E+02	5.53%	1.95%
10	9.279E+01	1.825E+01	0.4%	0.1%	1.705E+02	3.434E+01	0.70%	0.20%	1.907E+02	3.923E+01	0.78%	0.23%
15	6.291E+01	1.133E+01	0.3%	0.1%	1.274E+02	3.000E+01	0.52%	0.17%	1.305E+02	3.436E+01	0.54%	0.20%
20	3.968E+01	9.384E+00	0.2%	0.1%	1.015E+02	2.393E+01	0.42%	0.14%	1.174E+02	2.656E+01	0.48%	0.15%
Isopar	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	6.202E+04	1.185E+04	**NA**	6.8%	2.020E+05	4.957E+04	**NA**	28.31%	2.326E+05	5.858E+04	**NA**	33.45%
10	1.600E+04	3.147E+03	**NA**	1.8%	2.939E+04	5.921E+03	**NA**	3.38%	3.287E+04	6.762E+03	**NA**	3.86%
15	1.084E+04	1.953E+03	**NA**	1.1%	2.197E+04	5.172E+03	**NA**	2.95%	2.250E+04	5.923E+03	**NA**	3.38%
20	6.841E+03	1.618E+03	**NA**	0.9%	1.750E+04	4.125E+03	**NA**	2.36%	2.025E+04	4.580E+03	**NA**	2.62%
Toluene	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	1.668E+04	3.188E+03	**NA**	4.2%	5.434E+04	1.333E+04	**NA**	17.69%	6.256E+04	1.576E+04	**NA**	20.91%
10	4.303E+03	8.465E+02	**NA**	1.1%	7.906E+03	1.593E+03	**NA**	2.11%	8.841E+03	1.819E+03	**NA**	2.41%
15	2.917E+03	5.253E+02	**NA**	0.7%	5.908E+03	1.391E+03	**NA**	1.85%	6.053E+03	1.593E+03	**NA**	2.11%
20	1.840E+03	4.352E+02	**NA**	0.6%	4.706E+03	1.109E+03	**NA**	1.47%	5.446E+03	1.232E+03	**NA**	1.63%
Xylene	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	1.922E+04	3.673E+03	3.0%	0.8%	6.261E+04	1.536E+04	9.61%	3.54%	7.208E+04	1.815E+04	11.07%	4.18%
10	4.958E+03	9.753E+02	0.8%	0.2%	9.108E+03	1.835E+03	1.40%	0.42%	1.019E+04	2.096E+03	1.56%	0.48%
15	3.361E+03	6.052E+02	0.5%	0.1%	6.807E+03	1.603E+03	1.05%	0.37%	6.974E+03	1.836E+03	1.07%	0.42%
20	2.120E+03	5.014E+02	0.3%	0.1%	5.423E+03	1.278E+03	0.83%	0.29%	6.274E+03	1.419E+03	0.96%	0.33%
Benzene	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	1.414E+03	2.702E+02	17.7%	16.92%	4.607E+03	1.130E+03	57.59%	70.77%	5.303E+03	1.336E+03	66.29%	83.62%
10	3.648E+02	7.176E+01	4.6%	4.49%	6.702E+02	1.350E+02	8.38%	8.45%	7.495E+02	1.542E+02	9.37%	9.65%
15	2.473E+02	4.453E+01	3.1%	2.79%	5.009E+02	1.179E+02	6.26%	7.38%	5.131E+02	1.351E+02	6.41%	8.46%
20	1.560E+02	3.689E+01	2.0%	2.31%	3.990E+02	9.406E+01	4.99%	5.89%	4.617E+02	1.044E+02	5.77%	6.54%
Nitrosamine	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	1.341E-02	2.563E-03	1.5%	**NA**	4.369E-02	1.072E-02	4.85%	**NA**	5.030E-02	1.267E-02	5.59%	**NA**
10	3.460E-03	6.806E-04	0.4%	**NA**	6.356E-03	1.280E-03	0.71%	**NA**	7.108E-03	1.462E-03	0.79%	**NA**
15	2.345E-03	4.223E-04	0.3%	**NA**	4.750E-03	1.118E-03	0.53%	**NA**	4.866E-03	1.281E-03	0.54%	**NA**
20	1.480E-03	3.499E-04	0.2%	**NA**	3.784E-03	8.920E-04	0.42%	**NA**	4.378E-03	9.904E-04	0.49%	**NA**

Table 3-4. Peak Chemical Concentrations and Percentage TLV Exceedance for 10-Inch Stack

Mercury	300 cfm				1000 cfm				1200 cfm			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	NA	1.407E-01	NA	0.56%	NA	5.431E-01	NA	2.17%	NA	6.418E-01	NA	2.57%
10	NA	3.451E-02	NA	0.14%	NA	7.107E-02	NA	0.28%	NA	8.013E-02	NA	0.32%
15	NA	2.100E-02	NA	0.08%	NA	5.675E-02	NA	0.23%	NA	6.529E-02	NA	0.26%
20	NA	1.721E-02	NA	0.07%	NA	4.818E-02	NA	0.19%	NA	5.632E-02	NA	0.23%
Dimethyl Mercury	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	1.18E-01	2.45E-02	0.39%	0.31%	3.854E-01	9.461E-02	1.28%	1.18%	4.437E-01	1.118E-01	1.48%	1.40%
10	3.08E-02	6.01E-03	0.10%	0.08%	6.600E-02	1.238E-02	0.22%	0.15%	7.783E-02	1.396E-02	0.26%	0.17%
15	2.10E-02	3.66E-03	0.07%	0.05%	4.205E-02	9.888E-03	0.14%	0.12%	4.884E-02	1.138E-02	0.16%	0.14%
20	1.29E-02	3.00E-03	0.04%	0.04%	3.457E-02	8.395E-03	0.12%	0.10%	4.076E-02	9.812E-03	0.14%	0.12%
Trimethylamine	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³))	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	6.346E+02	1.315E+02	1.75%	1.09%	2.067E+03	5.075E+02	5.70%	4.20%	2.380E+03	5.998E+02	6.56%	4.96%
10	1.650E+02	3.225E+01	0.45%	0.27%	3.540E+02	6.642E+01	0.98%	0.55%	4.174E+02	7.488E+01	1.15%	0.62%
15	1.128E+02	1.963E+01	0.31%	0.16%	2.255E+02	5.304E+01	0.62%	0.44%	2.619E+02	6.101E+01	0.72%	0.50%
20	6.902E+01	1.609E+01	0.19%	0.13%	1.854E+02	4.503E+01	0.51%	0.37%	2.186E+02	5.263E+01	0.60%	0.44%
Ammonia	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	3.597E+02	7.454E+01	1.48%	0.43%	1.172E+03	2.877E+02	4.81%	1.65%	1.349E+03	3.400E+02	5.53%	1.95%
10	9.350E+01	1.828E+01	0.38%	0.10%	2.007E+02	3.765E+01	0.82%	0.22%	2.366E+02	4.244E+01	0.97%	0.24%
15	6.396E+01	1.113E+01	0.26%	0.06%	1.278E+02	3.006E+01	0.52%	0.17%	1.485E+02	3.458E+01	0.61%	0.20%
20	3.912E+01	9.118E+00	0.16%	0.05%	1.051E+02	2.552E+01	0.43%	0.15%	1.239E+02	2.983E+01	0.51%	0.17%
Isopar	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	6.202E+04	1.285E+04	**NA**	7.34%	2.020E+05	4.959E+04	**NA**	28.32%	2.326E+05	5.861E+04	**NA**	33.47%
10	1.612E+04	3.151E+03	**NA**	1.80%	3.459E+04	6.490E+03	**NA**	3.71%	4.079E+04	7.317E+03	**NA**	4.18%
15	1.103E+04	1.918E+03	**NA**	1.10%	2.204E+04	5.183E+03	**NA**	2.96%	2.560E+04	5.962E+03	**NA**	3.40%
20	6.744E+03	1.572E+03	**NA**	0.90%	1.812E+04	4.400E+03	**NA**	2.51%	2.137E+04	5.143E+03	**NA**	2.94%
Toluene	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	1.668E+04	3.457E+03	**NA**	4.59%	5.434E+04	1.334E+04	**NA**	17.70%	6.256E+04	1.577E+04	**NA**	20.92%
10	4.336E+03	8.476E+02	**NA**	1.12%	9.305E+03	1.746E+03	**NA**	2.32%	1.097E+04	1.968E+03	**NA**	2.61%
15	2.966E+03	5.159E+02	**NA**	0.68%	5.928E+03	1.394E+03	**NA**	1.85%	6.885E+03	1.604E+03	**NA**	2.13%
20	1.814E+03	4.228E+02	**NA**	0.56%	4.874E+03	1.184E+03	**NA**	1.57%	5.747E+03	1.383E+03	**NA**	1.84%
Xylene	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	1.922E+04	3.983E+03	2.95%	0.92%	6.261E+04	1.537E+04	9.61%	3.54%	7.208E+04	1.817E+04	11.07%	4.18%
10	4.996E+03	9.766E+02	0.77%	0.22%	1.072E+04	2.011E+03	1.65%	0.46%	1.264E+04	2.268E+03	1.94%	0.52%
15	3.417E+03	5.944E+02	0.52%	0.14%	6.830E+03	1.606E+03	1.05%	0.37%	7.933E+03	1.848E+03	1.22%	0.43%
20	2.090E+03	4.872E+02	0.32%	0.11%	5.616E+03	1.364E+03	0.86%	0.31%	6.622E+03	1.594E+03	1.02%	0.37%
Benzene	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	1.414E+03	2.930E+02	17.68%	18.34%	4.607E+03	1.131E+03	57.59%	70.79%	5.303E+03	1.337E+03	66.29%	83.67%
10	3.676E+02	7.185E+01	4.59%	4.50%	7.888E+02	1.480E+02	9.86%	9.27%	9.302E+02	1.668E+02	11.63%	10.45%
15	2.514E+02	4.374E+01	3.14%	2.74%	5.025E+02	1.182E+02	6.28%	7.40%	5.837E+02	1.360E+02	7.30%	8.51%
20	1.538E+02	3.585E+01	1.92%	2.24%	4.132E+02	1.003E+02	5.17%	6.28%	4.872E+02	1.173E+02	6.09%	7.34%
Nitrosamine	**300 cfm**				**1000 cfm**				**1200 cfm**			
Ht (ft)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)	15-min (μg/m³)	8-Hr (μg/m³)	15-min (% STEL)	8-Hr (% TWA)
6	1.341E-02	2.779E-03	1.49%	**NA**	4.369E-02	1.072E-02	4.85%	**NA**	5.030E-02	1.268E-02	5.59%	**NA**
10	3.486E-03	6.815E-04	0.39%	**NA**	7.481E-03	1.404E-03	0.83%	**NA**	8.822E-03	1.582E-03	0.98%	**NA**
15	2.385E-03	4.148E-04	0.26%	**NA**	4.766E-03	1.121E-03	0.53%	**NA**	5.536E-03	1.289E-03	0.62%	**NA**
20	1.459E-03	3.400E-04	0.16%	**NA**	3.919E-03	9.516E-04	0.44%	**NA**	4.621E-03	1.112E-03	0.51%	**NA**

4.0 Conclusions

Based on the analysis conducted, the SDU stack height can be selected at any value greater than the 6-foot above the SDU roof., and for any flow rate of between 300- and 1200 cfm. The Mega SDU's, while large structures, do not produce an aerodynamic wake that impacts the stack releases. Large round buildings are not "Bluff-Bodies" that produce the aerodynamic phenomena that are often associated with building induced downwash. The combination of this, along with the high flow rate through the small diameter stack provides a jet effect, which provides the chemical plume to acquire additional plume rise through conservation of momentum.

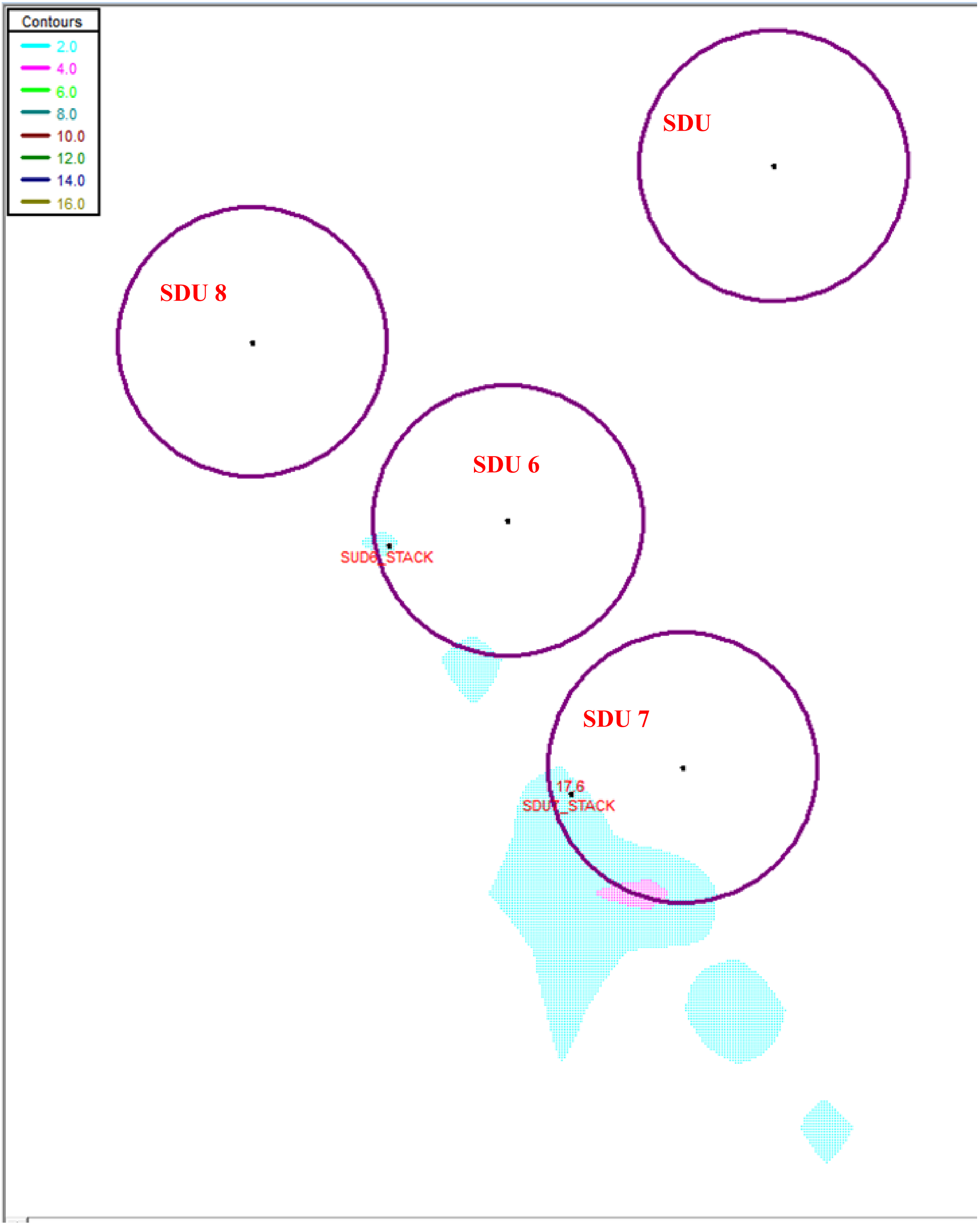

Figure 3-1. Mercury Concentration expressed as a percentage of the STEL value for a stack height of 6-ft and stack diameter of 6-inches. Blue contours enclose regions of 2% or greater STEL, and Pink are regions of 4% or greater. Peak value is 17.6% (red numbering) next to on SDU 7 stack.

5.0 References

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2. U.S. Environmental Protection Agency, Guideline on Air Quality Models, 40 Code of Federal Regulations, Part 51, Appendix W.

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5. Savannah River Nuclear Solutions, Software Quality Assurance Plan for the AMS/EPA Regulatory Model (AERMOD) Software Package, C-SQP-G-00076 (2017).

6. Hanna, S.R., G.A. Briggs and R.P. Hosker, 1982: Handbook on Atmospheric Diffusion. DOE/TIC-11223, Department of Energy, 102 pp.

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9. Scott, K.E. AERMET Meteorological Files, 2007-2011, SRNL-L2200-2013-00045, Savannah River National Laboratory (2013).

10. C-CG-Z-000124, Overall Site Plan, Rev. 0., 2018.

11. The American Conference of Governmental Industrial Hygienists, 2019 TLV's and BEI's, (2019).

12. Padgett, S., 2019, Personal Communications via email with S. Weinbeck on November 5th, 2019. Subject: RE: Potentially most troublesome chemicals.

13. Padgett, S., 2019, Personal Communications via email with S. Weinbeck on November 7th, 2019. Subject: FW. OEL For Nitrosamine - correction.

APPENDIX A

Email from Sara Padgett to S. Weinbeck November 5th, 2019.

Tue 11/05/19 3:14 PM

Sara Padgett

RE: Potentially most troublesome chemicals

To Steve Weinbeck; Richard Player; Rudolph Jolly

Cc Chuck Hunter; Frank Pennebaker; Ed Kahal; Rene Garcia

You replied to this message on 11/05/19 3:50 PM.

Good afternoon Steve. Per your request I discussed with Ed the OELs for the chemicals in question. Our response is :

For Dimethyl Mercury the OEL is 0.008 mg/m3 for the 8 hour TWA (SRR administrative control limit) and the STEL is 0.03mg/m3. This was based on the OELS listed in the TLV booklet for Mercury as Alkyl Compounds I will forward you a memo which contains the SRR Procedure Reference for Mercury Response.

For Toluene use the current 8 hour TWA in the 2019 TLV booklet of 20 ppm. I would not worry about the 15 minute STEL. I think in the past we estimated this.

For Isopar the OEL for the 8 hour TWA is 171 ppm based on the manufacturer's recommendation for Isopar L. Once again I would not worry about the STEL for Isopar.

If you have any questions please contact Ed or myself.

Thank you for your assistance in this effort.
Sara

Reference. 12.

APPENDIX B

Email from Sara Padgett to S. Weinbeck November 7th, 2019.

Thu 11/07/19 8:40 AM

Sara Padgett

FW: OEL FOR NITROSAMINE - correction

To Steve Weinbeck

From: Sara Padgett <sara.padgett@srs.gov>
Sent: Thursday, November 07, 2019 8:37 AM
To: Sara Padgett <sara.padgett@srs.gov>
Subject: FW: OEL FOR NITROSAMINE - correction

From: Alexander Brown <Alexander.Brown@srs.gov>
Sent: Thursday, May 02, 2019 10:33 AM
To: Mark Schweder <Mark.Schweder@srs.gov>; Sara Padgett <sara.padgett@srs.gov>; Ed Kahal <ed.kahal@srs.gov>; Corey Habegger <Corey.Habegger@srs.gov>
Subject: RE: OEL FOR NITROSAMINE - correction

I'm with Mark on using the 0.9 ug/m^3 as the STEL value. It's not a TLV so I don't think the 3x (STEL) and 5x (C) adjustments apply…

Thank you for your time,
Alexander Brown, CIH, CSP
803-208-1375 (Office)
803-761-1418 (Cell)
TF Industrial Hygiene
Savannah River Remediation
"…to place before mankind the common sense of the subject, in terms so plain and firm as to command their assent…"

Reference. 13.

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