SRNL
SAVANNAH RIVER NATIONAL LABORATORY
OPERATED BY SAVANNAH RIVER NUCLEAR SOLUTIONS

April 16, 2018

TO: S. K. Elliott, 705-C

FROM: C. H. Hunter, 773-A
A. M. Rivera-Giboyeaux, 773-A

DETERMINATION OF METEOROLOGICAL CONDITIONS REPRESENTING 95% DOSE FOR THE 2007-11 METEOROLOGICAL DATA SET

Statistics expressing the joint frequencies of occurrence of six wind speed categories by sixteen wind direction sectors as a function of Pasquill stability class (A through G) for the five years 2007-2011 were used to estimate values of wind speed and stability that correspond to the resulting 95th percent (%) downwind concentration/dose for SRS. The joint frequency statistics used in the analysis were formatted as input to SRNL's AXAIR-89Q atmospheric dispersion model (Ref. 1). AXAIR89Q is similar to the Melcor Accident Consequence Code System (MACCS) which is currently used at SRS for design safety dose calculations; i.e., both are steady state Gaussian models based on a methodology that is outlined by U. S. Nuclear Regulatory Commission's Regulatory Guide 1.145 (Ref. 2). Rather than utilize a sequential record of hourly meteorology as required by MACCS, AXAIR-89Q determines relative concentrations (χ/Q) occurring at the 95 % threshold using the joint frequency statistics.

A concentration predicted by any steady state Gaussian model is inversely proportional to wind speed and the intensity of turbulence acting to diffuse the plume. Consequently, for an extended period of record, i.e., calculated values of χ/Q for a year or more using hourly meteorology, the resulting 95% highest dose is expected to result from relatively low values of wind speed and turbulence intensity. Low values of turbulence intensity are consistent with stable atmospheric conditions, which are identified by stability class E or F.

In 2012, a wind speed and stability class producing the 95% high χ/Q was determined using hourly meteorological data in a five-year quality assured record for 2002-2006 (Ref. 3). The data was processed in accordance with Environmental Protection Agency recommendations (Ref. 3 and 4) and used to develop the joint frequency data set required for AXAIR-89Q. Values of χ/Q are calculated by the model for each of the resulting 672 combinations of wind speed category, wind direction sector, and stability class, and for each wind speed category and stability class irrespective of wind direction. The wind speed value used for each χ/Q calculation consists of the average of all observed wind speeds that were binned within the particular wind speed category, wind director sector and stability class combination.

The resulting 95% χ/Q is then determined by weighting each of the individual χ/Q values according to the observed joint occurrence frequencies of wind speed category by stability class over all wind direction sectors.

The AXAIR-89Q output for 2002-2006 period indicated that, for all contaminant release heights between ground level and 60 m, the 95 % χ/Q at the SRS boundary was produced by a wind speed occurring within the 2-4 meters per second (m/s) wind speed category under F stability. Closer inspection of the joint frequency input file for F stability showed that wind speeds of 0-2 m/s occurred 1.47 % of the time and wind speeds of 2-4 m/s occurred 5.99 % of the time. This suggests the actual wind speed for the cumulative 5% condition (i.e, 95 % high χ/Q) would likely have a value in the upper half of the 2-4 m/s range (i.e., if observed wind speed were distributed equally in the 2-4 m/s category, the mid point would give the 95.53% χ/Q). The average wind speed for all hours within the 2-4 m/s category was 3.13 m/s. Consequently, a wind speed of 3.5 m/s was selected as representative of the 95% condition. This value is based on measurements taken at 61 m above ground. Adjusting the 61-m wind speed under F stability to 10 meters using the standard power law equation (Ref. 3) resulted in a 10-m wind speed of 1.3 m/s.

The same methodology was followed to estimate conditions corresponding to the 95% χ/Q for the five-year period 2007-11. The joint frequency file, summarized in Table 1, was processed as described above for the 2002-2006 period. Occurrence frequencies of wind speed category by wind direction sector within each Pasquill stability class for 2007-2011 are very similar to those observed in the previous 5-year period. For F stability, winds in the 0-2 m/s and 2-4 m/s wind speed categories occurred 1.22 % of the time 5.95 % of the time, respectively (highlighted in the table). The cumulative occurrence frequency of observations within these two wind speed categories is 7.17 percent of the time, which is slightly lower than the 7.4 percent observed for the 2002-06 period (not shown). The average wind speed for all observations within the 2-4 m/s category for F stability is 3.18 m/s. These data again suggest that the wind speed corresponding to the 95% condition would likely be in the upper half of the 2-4 m/s wind speed category and near or equal to the value of 3.5 m/s at the 61-m measurement height (1.3 m/s for 10-m wind) that was estimated from the 2002-06 data.

Since the joint frequency statistics and wind speed values for 2007-2011 show little change from the earlier 5-year period, ATG recommends that values of Pasquill stability and wind speed of F and 1.3 m/s, respectively, should continue to be used to estimate the 95% χ/Q for ground level releases.

References

1. Jannik, G.T., and A. A. Simpkins, *Environmental Dose Assessment Manual*, WSRC-IM-91-1, Rev. 1 - Appendix G, AXAIRQ (1991).
2. U. S. Nuclear Regulatory Commission, *Atmospheric Dispersion Models for Potential Accident Consequence Assessment at Nuclear Power Plants*, Regulatory Guide 1.145, Rev. 1 (1982)
3. Hunter, C. H., Revised Meteorological Data sets for Safety Related Air Dispersion Modeling (U), SRNL-STI-2012-00648, Rev. 1 (2012)
4. U. S. Environmental Protection Agency, Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-005 (2000).

cc: G. F. Kessinger, 773-A
A.M. Vincent, 707-C
E. P. Hope, 707-C

Table 1. Joint Frequency Distribution of wind speed category by wind direction sector for each of eight Pasquill stability classes. Based on quality assured hourly meteorological data for the five years 2007-2011.

Sector	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	All
Speed (m/s)	Stability Class A																
0-2	0.17	0.16	0.14	0.14	0.15	0.14	0.15	0.14	0.13	0.14	0.16	0.2	0.2	0.22	0.15	0.16	2.55
2-4	0.2	0.25	0.3	0.4	0.45	0.34	0.26	0.24	0.33	0.34	0.43	0.66	0.73	0.39	0.25	0.23	5.8
4-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speed (m/s)	Stability Class B																
0-2	0.03	0.03	0.04	0.03	0.05	0.04	0.03	0.03	0	0.03	0.03	0.05	0.03	0.06	0.04	0.03	0.55
2-4	0.15	0.16	0.28	0.49	0.42	0.32	0.22	0.11	0.2	0.26	0.38	0.69	0.58	0.4	0.14	0.14	4.94
4-6	0.01	0.01	0.06	0.08	0.07	0.05	0.01	0	0.03	0.04	0.05	0.11	0.13	0.06	0.03	0.01	0.75
6-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speed (m/s)	Stability Class C																
0-2	0.06	0.06	0.11	0.09	0.09	0.06	0.06	0.05	0.06	0.03	0.06	0.1	0.08	0.06	0.06	0.06	1.09
2-4	0.2	0.32	0.72	0.74	0.57	0.41	0.3	0.18	0.4	0.46	0.58	0.88	0.55	0.51	0.24	0.18	7.24
4-6	0.14	0.23	0.79	0.7	0.37	0.18	0.17	0.12	0.33	0.44	0.62	1.03	0.93	0.75	0.27	0.11	7.18
6-8	0.05	0.06	0.12	0.07	0.01	0	0.02	0.05	0.05	0.06	0.11	0.21	0.28	0.24	0.05	0.01	1.39
8-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speed (m/s)	Stability Class D																
0-2	0.16	0.21	0.28	0.26	0.19	0.14	0.18	0.19	0.16	0.17	0.14	0.12	0.17	0.13	0.13	0.14	2.77
2-4	0.62	0.98	2	1.65	1.25	0.94	0.8	0.83	1.3	1.17	1.39	1.39	1.21	1.02	0.69	0.49	17.73
4-6	0.44	0.77	1.27	0.95	0.69	0.52	0.72	1.4	1.94	1.12	1.19	1.25	1.22	1.24	0.49	0.27	15.48
6-8	0.11	0.14	0.07	0.04	0.04	0.03	0.04	0.24	0.29	0.36	0.26	0.29	0.43	0.55	0.12	0.04	3.05
8-12	0.02	0.02	0.01	0	0	0	0.01	0.03	0.05	0.03	0.03	0.12	0.18	0.24	0.03	0	0.77
>12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Speed (m/s)	Stability Class E																
0-2	0.05	0.04	0.07	0.06	0.08	0.06	0.08	0.05	0.07	0.06	0.06	0.07	0.06	0.07	0.05	0.05	0.98
2-4	0.19	0.27	0.71	0.65	0.55	0.63	0.63	0.67	0.8	0.85	0.68	0.59	0.63	0.49	0.4	0.33	9.07
4-6	0.25	0.34	0.26	0.44	0.52	0.41	0.47	0.74	1.28	0.98	0.97	0.81	0.63	0.44	0.22	0.08	8.84
6-8	0	0	0	0	0	0	0	0	0.01	0.01	0.01	0	0	0	0	0	0.03
8-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speed (m/s)	Stability Class F																
0-2	0.06	0.05	0.09	0.07	0.05	0.07	0.06	0.09	0.11	0.1	0.09	0.07	0.07	0.08	0.07	0.09	1.27
2-4	0.31	0.35	0.47	0.21	0.18	0.25	0.33	0.5	0.54	0.61	0.47	0.43	0.33	0.3	0.34	0.33	5.99
4-6	0.16	0.32	0.09	0.03	0.03	0.08	0.14	0.17	0.31	0.44	0.23	0.26	0.14	0.14	0.07	0.08	2.69
6-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speed (m/s)	Stability Class G																
0-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0