Appendix E

Connecticut Department of Energy and Environmental Protection's Review of the Seasonality of High $PM_{2.5}$ Days.

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This appendix explains the data sources, methodology and conclusions relating to an analysis of the seasonality of peak $PM_{2.5}$ concentrations. The purpose of this analysis was to determine if the highest monitored $PM_{2.5}$ concentrations in Connecticut's portion of the NY-NJ-CT $PM_{2.5}$ nonattainment area are limited to one season or can occur over two or more seasons during the year. If high $PM_{2.5}$ levels only occur in a single season, then inventory development in support of $PM_{2.5}$ redesignation efforts should be focused on that season. If high $PM_{2.5}$ levels occur in multiple seasons, then an annual inventory can be used to support redesignation.

Methodology:

Connecticut reviewed fully QA'd and certified $PM_{2.5}$ data from the 2004-2010 period, for the seven southwestern Connecticut $PM_{2.5}$ sites (Bridgeport, Danbury, Norwalk, New Haven Criscuolo Park, New Haven State St, Westport and Waterbury). For each year, daily $PM_{2.5}$ concentrations were ranked for each site from highest to lowest concentration, with the appropriate season identified for each day (i.e., Winter: Dec-Jan; Spring: Mar-May; Summer: Jun-Aug; Fall: Sep-Nov). Seasonal frequency during the 2004-2010 period was then determined for two groupings of data: 1) The highest 2% of daily values each year (since the daily $PM_{2.5}$ NAAQS is based on the 98^{th} %-ile value) and 2) The highest 10 days each year (to provide a more robust comparison). The highest 10 day analysis was repeated for the most three recent years of data (2008-2010) to determine if recent large-scale regional reductions in sulfur dioxide emissions have influenced the seasonal distribution of high $PM_{2.5}$ levels (sulfate is typically the largest contributor to high summer $PM_{2.5}$ values, with less contribution during the winter[1]).

Results and Conclusions:

Table 1 shows the seasonal distribution for the highest 2% of daily values[2] at each monitor for the period from 2004 through 2010. Overall, 49% of the highest $PM_{2.5}$ days occurred during the summer, with winter exhibiting a secondary peak at 35%, while 12% of the highest $PM_{2.5}$ days occurred during the fall season. There was minor variability between sites, with Danbury experiencing more high $PM_{2.5}$ days during the winter (43% of the total number of high $PM_{2.5}$ days) than the summer (38%) and Norwalk's spring value (10%) at least double the value for the other six sites.

[1] Bell, Michele et al. (2007) Spatial and Temporal Variation in PM2.5 Chemical Composition in the United States for Health Effects Studies. Environmental Health Perspectives. v15(7) p 989-995.

[2] For sites with once-in-three-day sampling, 2% generally represents the 3 highest daily values each year. For sites with every-day sampling, 2% generally represents the 8 highest daily values each year.

Table 1. Seasonal Distribution of the Highest 2% of Annual Daily $PM_{2.5}$ Concentrations (2004-2010)

Season	Waterbury	New Haven State St	New Haven Criscuolo	Westport	Norwalk	Danbury	Bridgeport	Overall Average
Summer	48%	48%	46%	57%	48%	38%	62%	49%
Fall	14%	14%	11%	5%	14%	14%	10%	12%
Winter	38%	38%	39%	33%	29%	43%	24%	35%
Spring	0%	0%	4%	5%	10%	5%	5%	4%

Table 2 summarizes the seasonal distribution based on the annual highest 10 daily values at each site for the full 7 year period (2004-2010). Although the same general bimodal distribution (i.e., summer/winter peaks) is observed as was found for the top 2% of $PM_{2.5}$ levels, the results based on the highest 10 days each year reflect a greater occurrence of spring days than in Table 1 (12% versus 4%).

When the highest 10 day approach is narrowed to the most recent three-year period (2008-2010), as shown in Table 3, the overall bimodal results shift such that winter becomes the predominant season (45% of the total number of high $PM_{2.5}$ days), with summer exhibiting the secondary peak (36%). In the Northeast, the sulfate contribution to $PM_{2.5}$ levels is typically greater in the summer than in the winter season due to temperature and chemistry factors. Thus, a possible reason for the recently observed seasonal shift could be more stringent regional sulfur emission limits imposed by the CAIR program on power plants.

Table 2. Seasonal Distribution of Annual Top 10 Daily $PM_{2.5}$ Concentrations (2004-2010)

Season	Waterbury	New Haven State St	New Haven Criscuolo	Westport	Norwalk	Danbury	Bridgeport	Overall Average
Summer	43%	46%	49%	43%	46%	43%	49%	45%
Fall	17%	14%	10%	10%	13%	13%	13%	13%
Winter	30%	29%	36%	36%	30%	31%	20%	30%
Spring	10%	11%	6%	11%	11%	13%	19%	12%

Table 3. Seasonal Distribution of Annual Top 10 Daily $PM_{2.5}$ Concentrations (2008-2010)

Season	Waterbury	New Haven State St	New Haven Criscuolo	Westport	Norwalk	Danbury	Bridgeport	Overall Average
Summer	37%	37%	23%	27%	43%	37%	50%	36%
Fall	10%	10%	10%	10%	10%	7%	7%	9%
Winter	43%	40%	60%	57%	37%	43%	33%	45%
Spring	10%	13%	7%	7%	10%	13%	10%	10%

Based on this analysis, high $PM_{2.5}$ levels occur throughout the year in Connecticut portion of the NY-NJ-CT area, with the highest frequency of events in the summer and winter seasons. Since high $PM_{2.5}$ levels occur in multiple seasons, annual inventories should be used to support the $PM_{2.5}$ redesignation effort.