The New NO_2/SO_2 1-Hour Ambient Standards

Effects Illustrations and Implementation Issues

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NO_2 and SO_2 1-hour Ambient Standards Presentation Outline

- **Introduction/Background**
- **NOx to NO_2 Issues**
- **Sensitivity Study – individual source effects**
- **Example Application – Mock Refinery**
- **Illustration: Measured data as background**
- **Summary of Key Points**

Why are the new NAAQS relevant now?

- **New NAAQS effective immediately**
- **New projects (modifications, expansions) that are major must address compliance with new NAAQS**
- **Air quality assessments for new projects face new challenges: low SILs, high background, low NAAQS**
- **Existing sources:**
  - Modeling now required for SO_2 attainment designations
  - Neighbors multi-source analysis

Air Quality Assessments for Major Modifications/ Expansions

- **Air quality models used to estimate impacts of modification/expansion**
- **If new project < significant impact level (SIL), no further review required**
- **If new project > SIL, multi-source analysis required**
  - Multi-source analysis generally resource and time intensive
  - Can expose existing sources to scrutiny
  - Must include measured background for NAAQS assessment

NO_2 Specifics: NOx Conversion

- **Most NOx emitted by combustion sources is in the form of NO; converts to NO_2 in the presence of ozone**
- **3-Tier process:**
  - Tier 1 – Complete Conversion
  - Tier 2 – Use 0.75 ratio *needs justification*
  - Tier 3 – Use ozone data to drive conversion *needs justification/EPA approval*
- **AERMOD currently has two techniques (OLM, PVMRM) that can be used to estimate conversion of NOx to NO_2 based on default or hourly measured ozone concentrations; *need EPA approval***
- **Collectively, not much experience with Tier 3**

NOx Conversion: Justifications

- **Use of 0.75 Ratio**
  - Consider met conditions for worst-case impacts
- **Use of OLM/PVMRM**
  - Characteristics of area – NOx limited? substantial VOC emissions? ozone seasonality; characteristics of other NOx emitters
  - In-stack NO_2/NOx Ratio (Default 0.1)
  - Equilibrium Ratio (Default 0.9)
- **Recent experience with OLM/PVMRM:**
  - Results in NO_2/NOx ratios from 0.15 to 0.9
  - Ratio is lowest with high NOx concentrations, highest with low NOx concentrations
  - Techniques not helpful for showing SIL compliance; critical for demonstrating NAAQS compliance

NOx Conversion: Oddities

- **Example:**

Emissions		8TH high daily max		
lbs/hr	Concentration	Ratios		
	No transformation	OLM	PVMRM (0.9)	PVMRM (0.75)
1.1	81	90%	87%	73%
0.1	165	54%	90%	75%
185.3	1532	17%	13%	13%
90% Reduction in emissions		**Effective Reduction in Impacts**		
18.5	90%	44%	42%	42%

- **A new source modeled with background sources can have significantly lower impacts than the new source modeled by itself**

ILLUSTRATIONS

- **Used EPA AERMOD model, five years of met data**
- **Part 1: Sensitivity modeling of individual stacks**
  - Base case compared to SILs and new 1-hour NAAQS
  - Effects of downwash, terrain, and buoyancy
- **Part 2: Results illustration for “mock refinery”**
- **Part 3: Evaluation of ambient NO_2 and SO_2 concentrations and use for determining background**

Part 1 Sensitivity Illustrations – Effect of Downwash

	SIL (SO2, NO2)					NAAQS SO2					NAAQS NO2					
lbs/hr:	2	6	23	114	228	2	6	23	114	228	2	6	23	114	228	
Tons/yr:	10	25	100	500	1000	10	25	100	500	1000	10	25	100	500	1000	
Height/ft:																
30	36	89	356	1779	3558	35	89	354	1771	3541	26	65	259	1294	2587	Base Case
50	14	34	136	679	1358	11	27	109	545	1090	8	20	80	398	795	
75	7	18	71	356	711	6	15	61	307	613	5	11	46	228	455	
100	5	12	48	239	479	4	11	45	223	446	3	8	32	162	324	
150	3	7	29	143	286	3	6	25	126	253	2	4	17	86	172	
200	2	5	20	99	198	2	4	15	75	150	1	3	11	53	105	
250	1	4	15	74	147	1	3	11	57	114	1	2	8	40	81	
300	1	3	13	63	127	1	2	9	47	94	1	2	6	31	63	
30	75	187	750	3748	7496	72	181	723	3616	7233	52	131	525	2625	5249	With Downwash
50	49	122	486	2430	4860	48	120	481	2404	4809	36	90	358	1791	3583	
75	30	74	296	1482	2965	29	72	288	1440	2880	21	53	213	1063	2126	
100	21	51	206	1028	2056	19	48	193	964	1927	14	35	141	706	1412	
150	16	40	159	793	1586	12	29	118	588	1175	8	20	81	407	815	
200	12	31	123	613	1226	9	23	92	460	920	5	14	54	272	545	
250	10	25	98	492	985	7	17	68	339	678	4	10	39	197	393	
300	8	19	78	388	775	6	14	56	278	557	3	8	33	167	333	

green <SIL; yellow >SIL

green <NAAQS; yellow >50% NAAQS; red >NAAQS

Part 1 Sensitivity Illustrations –Effect of Terrain

Base Case

	SIL (SO2, NO2)					NAAQS SO2					NAAQS NO2				
lbs/hr:	2	6	23	114	228	2	6	23	114	228	2	6	23	114	228
Tons/yr:	10	25	100	500	1000	10	25	100	500	1000	10	25	100	500	1000
Height/ft:															
30	36	89	356	1779	3558	35	89	354	1771	3541	26	65	259	1294	2587
50	14	34	136	679	1358	11	27	109	545	1090	8	20	80	398	795
75	7	18	71	356	711	6	15	61	307	613	5	11	46	228	455
100	5	12	48	239	479	4	11	45	223	446	3	8	32	162	324
150	3	7	29	143	286	3	6	25	126	253	2	4	17	86	172
200	2	5	20	99	198	2	4	15	75	150	1	3	11	53	105
250	1	4	15	74	147	1	3	11	57	114	1	2	8	40	81
300	1	3	13	63	127	1	2	9	47	94	1	2	6	31	63

With Terrain

Height/ft	SIL 2 / 10	SIL 6 / 25	SIL 23 / 100	SIL 114 / 500	SIL 228 / 1000	SO2 2 / 10	SO2 6 / 25	SO2 23 / 100	SO2 114 / 500	SO2 228 / 1000	NO2 2 / 10	NO2 6 / 25	NO2 23 / 100	NO2 114 / 500	NO2 228 / 1000
30	179	448	1792	8961	17923	44	110	440	2200	4401	32	80	321	1605	3210
50	198	495	1978	9891	19781	36	90	360	1800	3600	26	66	263	1316	2631
75	138	345	1380	6901	13802	36	90	360	1802	3603	26	64	258	1288	2576
100	209	523	2090	10452	20903	35	87	349	1746	3492	25	63	254	1269	2539
150	210	526	2104	10522	21044	36	91	362	1812	3624	26	66	264	1320	2639
200	212	529	2115	10575	21151	41	103	413	2067	4134	30	74	298	1489	2977
250	214	536	2144	10719	21438	47	119	475	2374	4748	34	84	338	1689	3379
300	56	139	555	2776	5553	54	136	545	2725	5450	39	98	392	1960	3920

green <SIL; yellow >SIL

green <NAAQS; yellow >50% NAAQS; red >NAAQS

Part 1 Sensitivity Illustrations - Effect of Buoyancy

	SIL (SO2, NO2)					NAAQS SO2					NAAQS NO2					
lbs/hr:	2	6	23	114	228	2	6	23	114	228	2	6	23	114	228	
Tons/yr:	10	25	100	500	1000	10	25	100	500	1000	10	25	100	500	1000	
Height/ft:																
30	36	89	356	1779	3558	35	89	354	1771	3541	26	65	259	1294	2587	Base Case
50	14	34	136	679	1358	11	27	109	545	1090	8	20	80	398	795	
75	7	18	71	356	711	6	15	61	307	613	5	11	46	228	455	
100	5	12	48	239	479	4	11	45	223	446	3	8	32	162	324	
150	3	7	29	143	286	3	6	25	126	253	2	4	17	86	172	
200	2	5	20	99	198	2	4	15	75	150	1	3	11	53	105	
250	1	4	15	74	147	1	3	11	57	114	1	2	8	40	81	
300	1	3	13	63	127	1	2	9	47	94	1	2	6	31	63	
30	5	12	46	231	462	1	3	11	53	106	1	1	5	27	55	High Buoyancy
50	3	7	29	143	286	1	2	7	37	75	0	1	4	20	41	
75	1	3	12	60	119	0	1	5	24	49	0	1	3	16	32	
100	1	2	8	40	80	0	1	4	18	36	0	1	3	13	26	
150	0	1	3	17	33	0	1	2	12	23	0	0	2	8	16	
200	0	1	3	13	26	0	0	2	9	19	0	0	1	7	13	
250	0	1	2	12	25	0	0	1	7	15	0	0	1	5	11	
300	0	1	2	12	23	0	0	1	6	12	0	0	1	4	8	

green <SIL; yellow >SIL

green <NAAQS; yellow >50% NAAQS; red >NAAQS

Part 1 Observations – Single Source

- **SILs are virtually impossible to meet, leading to more frequent requirements for multi-source analyses**
- **Downwash and nearby significant terrain produces results that are substantially greater than the base case;**
- **Increased buoyancy has a pronounced beneficial effect (NAAQS may be less of an issue with large power plant stacks);**
- **Emergency equipment can very easily exceed the NAAQS (low stack, high short-term)**

Part 2 Results Illustrations – "Mock" Refinery

Downwash	Close Far Terrain	SO2 1hr	NO2 No Chemistry	Default 0.75	OLM Indiv	OLM Group	PVMRM S0.1 E0.9	PVMRM S0.05 E0.9	PVMRM S0.3 E0.9	PVMRM S0.1 E0.75
Rural Meteorology										
No DW	Close	48	72	54	72	54	60	58	62	51
DW	Close	185	198	148	185	107	99	97	124	95
No DW	Far	43	60	45	60	17	50	50	50	41
DW	Far	161	160	120	142	20	77	77	82	64
No DW	Terrain	365	548	411	270	78	146	134	219	146
"Urban" Meteorology										
No DW	Close	53	85	63	84	55	59	58	62	51
DW	Close	174	164	123	157	99	86	82	108	84
No DW	Far	44	80	60	77	15	53	53	57	47
DW	Far	148	134	101	108	18	66	66	73	57
No DW	Terrain	351	402	302	232	71	131	122	187	131

green <NAAQS; yellow >50% NAAQS; red >NAAQS
for PVMRM S: In-stack Ratio; E: Equilibrium Ratio

Downwash	Close Far Terrain	Default 0.75	OLM Indiv	OLM Group	PVMRM S0.1 E0.9	PVMRM S0.05 E0.9	PVMRM S0.3 E0.9	PVMRM S0.1 E0.75
Rural Meteorology								
No DW	Close	75%	100%	75%	84%	80%	86%	70%
DW	Close	75%	93%	54%	50%	49%	63%	48%
No DW	Far	75%	100%	28%	83%	83%	83%	69%
DW	Far	75%	89%	13%	48%	48%	51%	40%
No DW	Terrain	75%	49%	14%	27%	24%	40%	27%
"Urban" Meteorology								
No DW	Close	75%	100%	65%	70%	68%	74%	61%
DW	Close	75%	96%	60%	52%	50%	66%	51%
No DW	Far	75%	96%	19%	67%	67%	71%	59%
DW	Far	75%	80%	13%	49%	49%	54%	43%
No DW	Terrain	75%	58%	18%	33%	30%	46%	33%

Part 2 Results Illustrations – "Mock" Refinery with Background

Downwash	Close Far Terrain	SO2 1hr	NO2 No Chemistry	Default 0.75	OLM Indiv	OLM Group	PVMRM S0.1 E0.9	PVMRM S0.05 E0.9	PVMRM S0.3 E0.9	PVMRM S0.1 E0.75
Rural Meteorology										
No DW	Close	142	170	152	170	152	158	156	160	149
DW	Close	279	296	246	283	205	197	195	222	193
No DW	Far	137	158	143	158	115	148	148	148	139
DW	Far	255	258	218	240	118	175	175	180	162
No DW	Terrain	459	646	509	368	176	244	232	317	244
"Urban" Meteorology										
No DW	Close	147	183	161	182	153	157	156	160	149
DW	Close	268	262	221	255	197	184	180	206	182
No DW	Far	138	178	158	175	113	151	151	155	145
DW	Far	242	232	199	206	116	164	164	171	155
No DW	Terrain	445	500	400	330	169	229	220	285	229

green <NAAQS; yellow >50% NAAQS; red >NAAQS
for PVMRM S: In-stack Ratio; E: Equilibrium Ratio

BG = 50% NAAQS

Downwash	Close Far Terrain	SO2 1hr	NO2 No Chemistry	Default 0.75	OLM Indiv	OLM Group	PVMRM S0.1 E0.9	PVMRM S0.05 E0.9	PVMRM S0.3 E0.9	PVMRM S0.1 E0.75
Rural Meteorology										
No DW	Close	189	219	201	219	201	207	205	209	198
DW	Close	326	345	295	332	254	246	244	271	242
No DW	Far	184	207	192	207	164	197	197	197	188
DW	Far	302	307	267	289	167	224	224	229	211
No DW	Terrain	506	695	558	417	225	293	281	366	293
"Urban" Meteorology										
No DW	Close	194	232	210	231	202	206	205	209	198
DW	Close	315	311	270	304	246	233	229	255	231
No DW	Far	185	227	207	224	162	200	200	204	194
DW	Far	289	281	248	255	165	213	213	220	204
No DW	Terrain	492	549	449	379	218	278	269	334	278

green <NAAQS; yellow >50% NAAQS; red >NAAQS
for PVMRM S: In-stack Ratio; E: Equilibrium Ratio

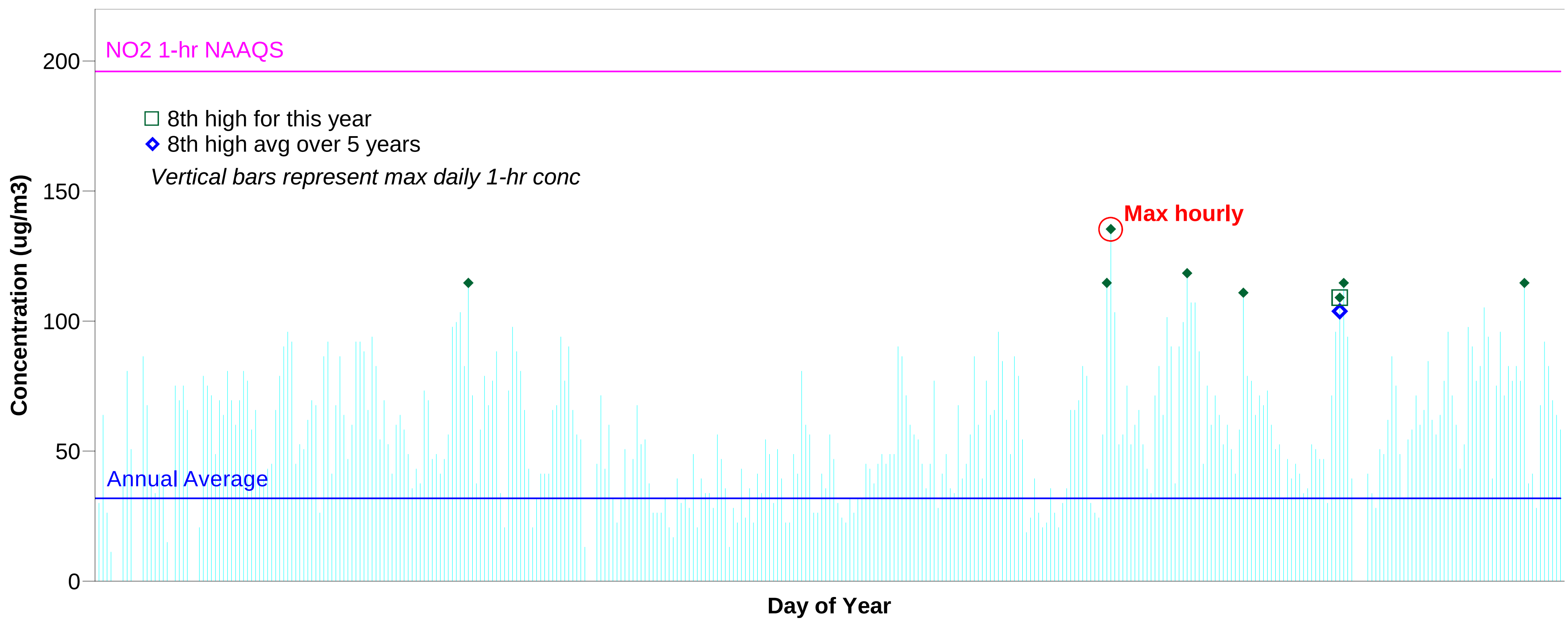
BG = 75% NAAQS

Part 3 - Illustration of Measured Concentrations and Background

- **Five years hourly data for NO_2 (San Antonio)**
- **Modeled time series also illustrated ("mock" refinery)**
- **Background Options:**
  - First tier (per EPA recommendation)
  - Time coincident
  - Average (per EPA Modeling Guidelines)

    "For shorter averaging periods, the meteorological conditions accompanying the concentrations of concern should be identified. Concentrations for meteorological conditions of concern, at monitors not impacted by the source in question, should be averaged for each separate averaging time to determine the average background value."

Part 3 NO_2 Monitored Concentrations



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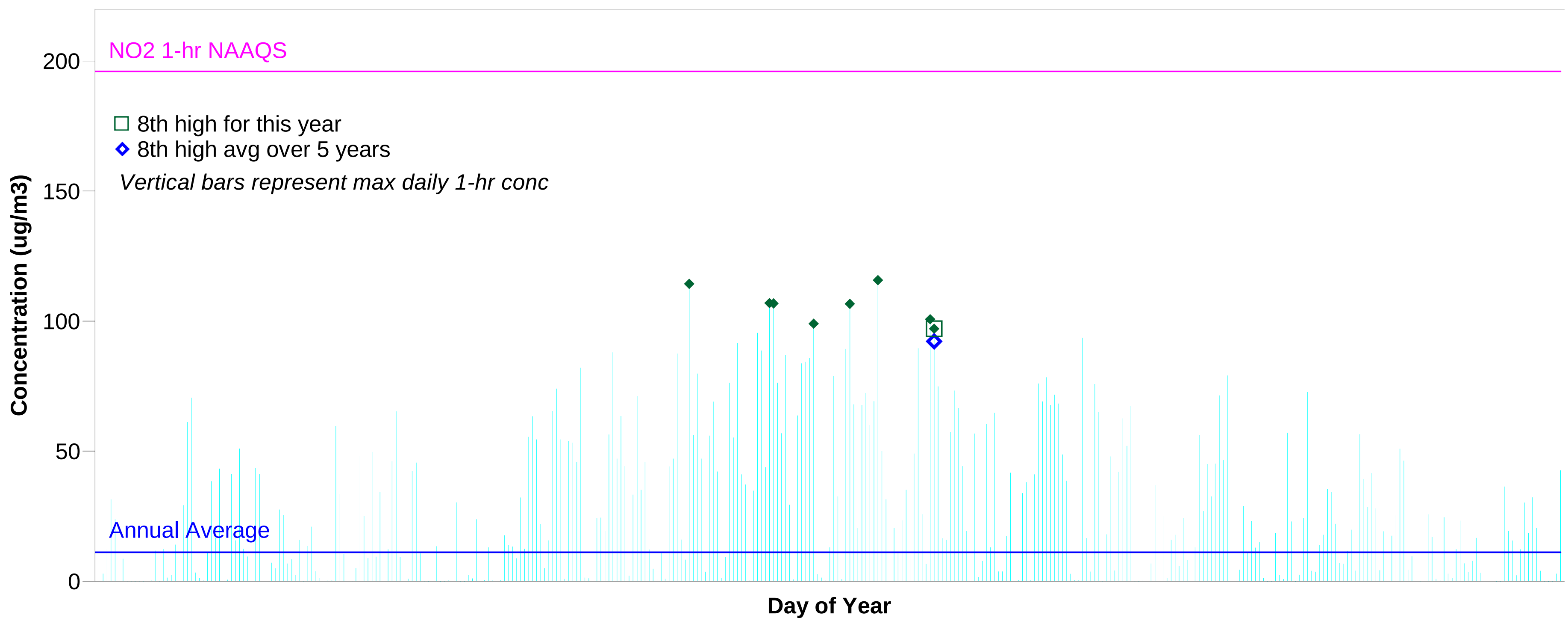
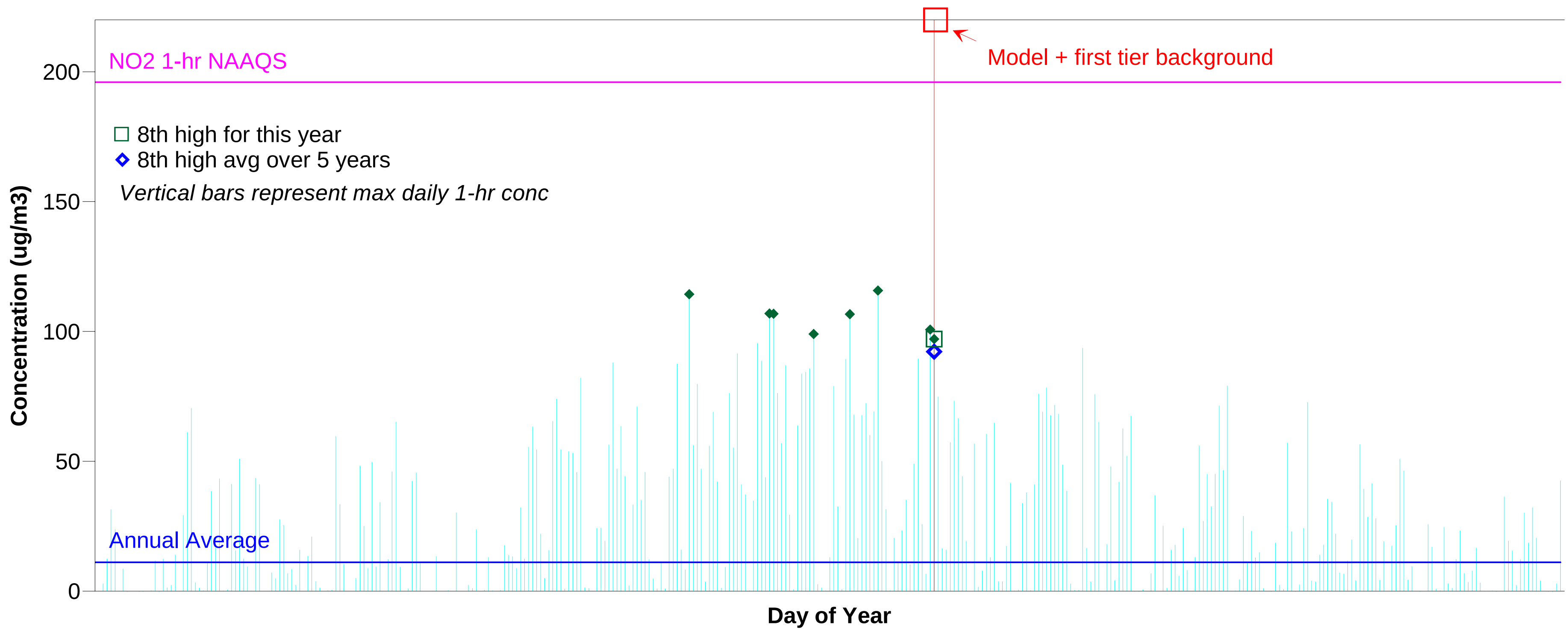
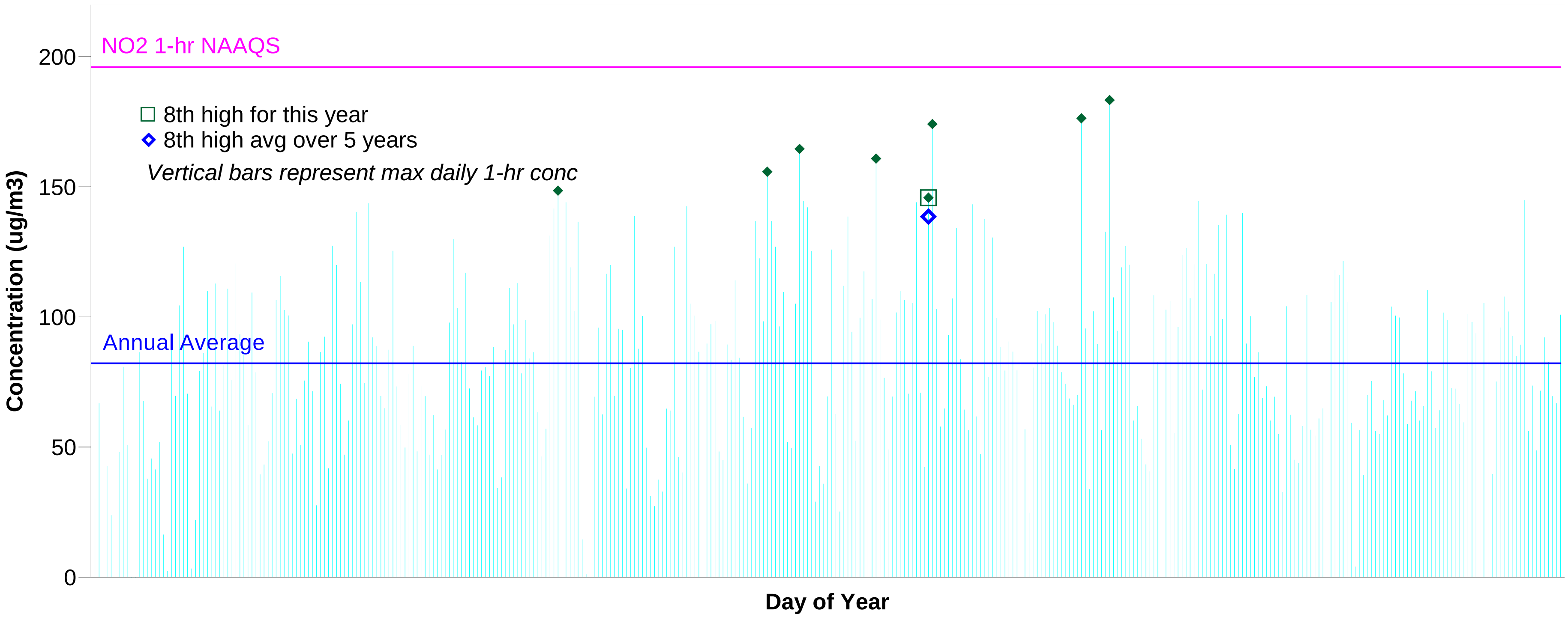
Part 3 NO_2 Concentrations (Modeled)



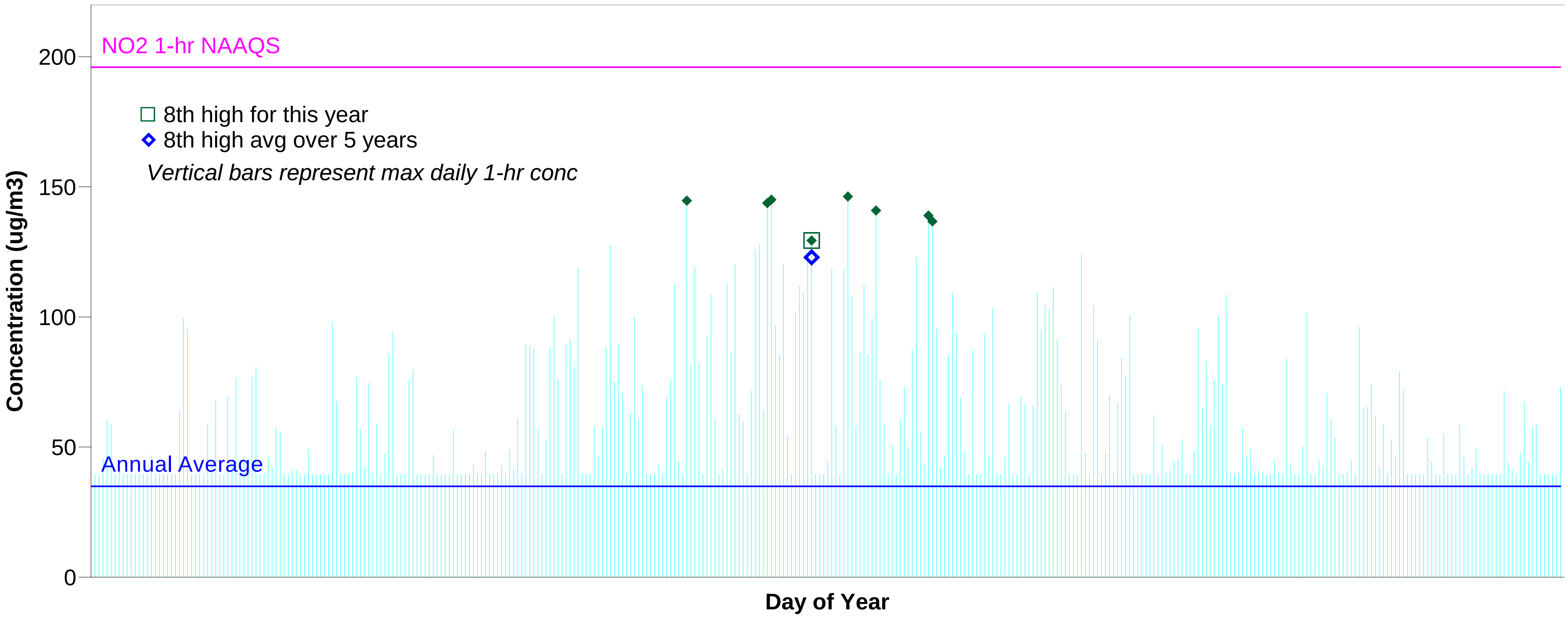
Part 3 NO_2 With Background (First Tier)



Part 3 NO_2 With Background (Time coincident)



Part 3 NO_2 With Background (Average per Guidelines)



Observations: Background Concentrations

- First tier can be very conservative
- Similar patterns/issues for SO_2
- Time-coincident pairing of predictions and observations provides a more realistic projection of the combined effects of model and measurement; "average by condition" is also more realistic but needs justification
- These techniques have not been applied widely since with previous NAAQS, measurements are a small fraction of the standard – being conservative works; now measurements are much closer to the NAAQS

Summary of Key Points (1 of 3)

- **Interim SIL levels will be difficult to demonstrate for even small modification/ expansion projects, leading to an increased potential to conduct multi-source analyses with accompanying risks and schedule delays**
- **Implementation of a practical and realistic methodology for determining NO to NO_2 conversion is important for demonstrating compliance with the NO_2 1-hour NAAQS**

Summary of Key Points (2 of 3)

- **Implementation of a practical and realistic methodology for determining background, beyond the recommended tier 1 methodology, will be important for demonstrating compliance with the NO2 and SO2 1-hour NAAQS**
- **Future generic acceptance of these approaches, without the need for case-by-case determinations, will be extremely helpful in dealing with the new NAAQS**

Summary of Key Points (3 of 3)

- SO_2 modeling requirements for attainment demonstrations (and greater frequency of multi-source analyses for SO_2 and NO_2) can expose existing facilities to scrutiny and possible need for further control
- Realistic policy for dealing with emergency equipment is needed
- Recent publication of SILs, Increments, SMCs for PM2.5 will mean that these issues will be very relevant to PM2.5

Discussion Topics

- **Emergency Equipment**
- **Considerations for 0.75 justification**
- **Considerations for OLM/PVMRM justification**
- **In-stack ratios: stack tests required?**
- **Practical considerations: new AERMOD, 3d party software**