Appendix P

Future Design Value Calculations

According to EPA's documents *Guidance on the Use of Modeled Results to Demonstrate Attainment of the Ozone NAAQS* (1996), and *Guideline for Regulatory Application of the Urban Airshed Model* (1991), the attainment test is based on the results of photochemical modeling. That is, a future attainment year case is modeled with one or more control strategies and if the modeling shows that all grid cells are less than 125 ppb (0.12 ppm), the area meets the 1-hour ozone NAAQS. However, actual monitored compliance with the standard is based on an area having no more than three expected exceedances at any monitor over a three year period. Due to the discrepancy of the modeled test versus the monitored compliance test, EPA developed the concept of Weight of Evidence (WOE). Weight of Evidence allows states to use additional corroborative information to demonstrate that an area would attain the standard in the future, even though the area could not meet the modeled attainment test. For 1-hour ozone SIPs, WOE approaches may include correlation of modeled results with monitored values, analysis of trends from monitoring data (ozone and precursors), empirical analyses based only on monitoring data (observational data), and other modeling metrics beyond the maximum concentration test.

In EPA's draft guidance document entitled *Use of Models and Other Analyses in Attainment Demonstrations for the 8-Hour Ozone NAAQS (Draft)* (1998), additional WOE approaches are discussed that include methods that relate modeled ozone concentrations to monitored design values for a particular area. This method couples relative model response to controls of precursors back to actual monitored data, thus allowing a more robust comparison between the deterministic model and the probabilistic standard. A problem with using the deterministic test is that model performance can be biased high, yet still meet EPA performance criteria. In cases where model performance is biased high, it can be argued that solely tying attainment to a modeled test would result in over control of ozone precursors. An advantage of being able to tie relative model response to actual monitored values would be to dampen out or account for inherent model overprediction. In EPA's 1998 draft document, this approach is suggested as an integral part of the attainment demonstration. Since this approach is relevant to the 1-hour standard, TNRCC is applying this concept, called the future design value, to the B/PA 1-hour ozone attainment demonstration SIP.

Description of Methodology

The approach used here is based on EPA's *Use of Models and Other Analyses in Attainment Demonstrations for the 8-Hour Ozone NAAQS (Draft)* (1998). Since the ozone modeling conducted over the B/PA 3-county area was based on 4 km by 4 km grid cells, a 15-km radius centered on a particular monitor is best approximated by a 9 cell by 9 cell array about the monitor. The EPA guidance suggests using monitoring data from the 3 year time frame around the modeled episode. Since both B/PA episodes occurred in 1993, monitoring data from 1992 to 1994 was used. The design values (4^{th} highest monitored value at each monitor for 1992-1994) for both TNRCC and SETRPC monitors from that time period are found in Table 1.

Table 1 Design Values for B/PA Area Monitors

Site	UTM Easting	UTM Northing	Description	1992-1994 Design Value (DVC) (ppb)
BMTC	396.4	3323.4	**CAMS2, Beaumont, Jefferson County**	124
PAWC	404.6	3307.3	**CAMS28, Port Arthur West, Jefferson County**	119
WORA	426.6	3328.4	**CAMS9, West Orange, Orange County**	123
S40S	413.2	3287.7	**SETRPC 40, Sabine Pass, Jefferson County**	135
S42S	415.9	3338.8	**SETRPC 42, Mauriceville, Orange County**	134
S43S	403.1	3312.0	**SETRPC 43, Jefferson County Airport, Jefferson County**	136
KTZA	373.6	3361.6	**CAMS85, Kountze, Hardin County**	109

For each of these sites, the 1993 base case maximum modeled concentration, for each day of the two episodes, found within the 9 by 9 cell array surrounding the monitor was selected. This is denoted as P_c. P_c values that met the following criteria were excluded from future consideration: (1) DVc was less than or equal to 125 ppb and P_c was less than 100 ppb or (2) DVc was less than 125 ppb and P_c was less than DVc minus 20 ppb (DVc - 20). This is done because model results will probably not show much response to emission reductions for these scenarios and these values are significantly less than the standard. In addition, it is possible that values listed as the maximum concentration within the 9 by 9 array may actually be greater than the modeled maximum found over the 3-county area. This is because all values within the 9 by 9 array are used, even those that occur outside the 3-county area or occur over water (e.g. Sabine Pass). Table 2 lists the P_c values for each of the monitors, for each of the episode days. The last column is the mean of the maximum modeled values for each monitor over all episode days.

Table 2 Model Predicted Maximum Ozone Concentrations Near B/PA Monitors - 1993 base case

Site	92-94 DVC	9/1/93	9/2/93	9/8/93*	9/9/93	9/10/93	9/11/93 **	Mean P_c
BMTC	124	***	114.9	155.8	121.4	140.7	160.7	138.7
PAWC	119	99.6	107.6	155.8	124.1	142.6	145.1	129.1
WORA	123	110.8	132.6	149.3	144.2	138.2	132.1	134.5
S40S	135	103.0	***	149.0	117.8	157.8	122.6	130.0
S42S	134	106.2	129.0	130.8	132.7	130.6	152.6	130.3
S43S	136	***	115.6	155.8	123.3	142.6	152.4	137.9
KTZA	109	***	122.3	120.5	116.9	95.5	162.8	123.6

* Base case model performance for 9/8/93 is outside EPA performance criteria.

** B/PA area affected by rebound of boundary conditions.

*** Data excluded because of DVc <= 125 ppb and P_c < 100 ppb or DVc < 125 ppb and P_c < (DVc -20) ppb

The next step in applying the future design value approach is to develop a similar table, only using future base case and/or additional control strategy model runs. Table 3 has the corresponding modeled concentrations based on the 2007 future base case modeling for both episodes. The predicted values are referred to as P_f. The 2007 future case accounts for both growth, as well as controls that will be in place by this time. As before, the P_f values are based on the maximum modeled concentration within the 9 by 9 array of cells centered on the monitoring site.

Table 3 Model Predicted Maximum Ozone Concentrations Near B/PA Monitors - 2007 Future Base Case

Site	92-94 DVC	9/1/93	9/2/93	9/8/93*	9/9/93	9/10/93	9/11/93 **	Mean P_f
BMTC	124	***	104.5	141.6	110.1	129.3	146.8	126.5
PAWC	119	90.5	98.0	141.6	113.3	131.8	133.0	118.0
WORA	123	100.7	120.3	135.7	130.0	126.9	122.7	122.7
S40S	135	96.9	***	133.5	108.8	145.3	112.5	119.4
S42S	134	96.5	116.1	118.7	120.4	115.5	138.3	117.6
S43S	136	***	104.6	141.6	111.9	131.8	141.8	126.3
KTZA	109	***	111.1	110.0	106.7	90.0	147.3	113.0

* Base case model performance for 9/8/93 is outside EPA performance criteria.

** B/PA area affected by rebound of boundary conditions.

*** Data excluded because of DVc <= 125 ppb and P_c < 100 ppb or DVc < 125 ppb and P_c < (DVc -20) ppb

In order to calculate the future design value, DVf, it is necessary to develop a ratio of the predicted future case model results to that of the original base case modeling results. There are two methods proposed to do this. One is referred to as the (1) mean of the ratios, while the other is (2) the ratio of the means. In Method (1), for each combination of monitor location and episode day, the relative reduction factor (RRF) is calculated as the ratio of the modeled maximum concentration for the future condition, P_f in Table 3, divided by the corresponding maximum concentration for the base case, P_c in Table 2. Then the mean of these ratios is calculated for each monitor site.

Table 5 DVf for B/PA sites using Ratio of Means Approach - 2007 Future Base Case

Site	DVc	Mean P_c	Mean P_f	RRF (P_f/P_c)	DVf (1)
BMTC	124	138.7	126.5	0.91	113.1
PAWC	119	129.1	118.0	0.91	108.8
WORA	123	134.5	122.7	0.91	112.2
S40S	135	130.0	119.4	0.92	124.0
S42S	134	130.3	117.6	0.90	120.9
S43S	136	137.9	126.3	0.92	124.6
KTZA	109	123.6	113.0	0.91	99.7

Table 4 is a list of the Relative Reduction Factors (RRF) for each combination of P_f/ P_c for each day of both episode. The Mean column is the average of each day/monitor's RRF. This value is multiplied by the DVc in column 2 to calculate DVf(2) in the last column.

Table 4 Daily Relative Reduction Factors for 2007 Future Base Case - Means of the Ratios

Site	92-94 DVc	9/1/93	9/2/93	9/8/93*	9/9/93	9/10/93	9/11/93 **	Mean (2)	DVf (2)
BMTC	124	***	0.91	0.91	0.91	0.92	0.91	0.91	113.0
PAWC	119	0.91	0.91	0.91	0.91	0.92	0.92	0.91	108.7
WORA	123	0.91	0.91	0.91	0.90	0.92	0.93	0.91	112.2
S40S	135	0.94	***	0.90	0.92	0.92	0.92	0.92	124.2
S42S	134	0.91	0.90	0.91	0.91	0.88	0.91	0.90	120.9
S43S	136	***	0.90	0.91	0.91	0.92	0.93	0.92	124.5
KTZA	109	***	0.91	0.91	0.91	0.94	0.90	0.92	99.9

Method (2) uses average P_c and P_f values, calculated for each monitor across all episode days. These averages are denoted in the last columns of Tables 1 and 2. Table 5 illustrates the use of the ratio of the means approach to develop the future design value, DVf.
Comparing the results of Table 4 and Table 5, one can see that the results area essentially the same.

For the purposes of the rest of the this analysis, only Method 2, the Ratio of the Means, will be used. In addition, values for September 8 will also be discarded, since base case model performance on this day was outside EPA acceptability criteria. Note that the RRF for this day are similar to the mean, so exclusion will not significantly alter the results.

Application to B/PA Control Scenarios

Table 6 is similar to Table 5, except that instead of the future base case, this reflects modeling results based on control scenario 5b (e.g. lean-burn engines in B/PA). Table 7 uses the ratio of the means to calculate DVfs for scenario 5b.

Table 6 Model Predicted Maximum Ozone Concentrations Near B/PA Monitors - Control Scenario 5b

Site	92-94 DVC	9/1/93	9/2/93	9/8/93*	9/9/93	9/10/93	9/11/93 **	Mean P_f
BMTC	124	***	95.6	139.2	100.5	124.8	141.7	120.4
PAWC	119	86.1	89.2	139.2	102.9	127.5	128.1	112.2
WORA	123	97.3	114.6	133.3	121.1	121.1	116.8	117.4
S40S	135	92.6	***	131.3	92	139.0	107.7	112.5
S42S	134	93.1	109.4	116.3	113.1	108.7	133.1	112.3
S43S	136	***	96.7	139.2	101.4	127.5	136.7	120.3
KTZA	109	***	86.3	91.1	89.1	82.5	142.1	98.2

Table 7 DVf for B/PA sites using Ratio of Means Approach - Scenario 5b

Site	**DVc**	**Mean P_c**	**Mean P_f**	**RRF (P_f/P_c)**	**DVf (1)**
BMTC	124	138.7	120.4	0.87	107.6
PAWC	119	129.1	112.2	0.87	103.4
WORA	123	134.5	117.4	0.87	107.3
S40S	135	130.0	112.5	0.87	116.8
S42S	134	130.3	112.3	0.86	115.5
S43S	136	137.9	120.3	0.87	118.6
KTZA	109	123.6	98.2	0.79	86.6

The same approach is also done for scenario 5b1,which includes the Tier I point source controls within the B/PA 3-county nonattainment area. Table 8 lists the maximum predicted ozone concentrations within the 9 by 9 cell matrix around each monitor, and Table 9 shows the DVf calculations based upon the Ratio of the Means.

Table 8 Model Predicted Maximum Ozone Concentrations Near B/PA Monitors - Control Scenario 5b1

Site	92-94 DVC	9/1/93	9/2/93	9/8/93*	9/9/93	9/10/93	9/11/93 **	Mean P_f
BMTC	124	***	93.5	133.6	97.6	120.4	136.5	116.3
PAWC	119	85.8	87.4	133.6	101.2	121.8	127.0	109.5
WORA	123	91.7	108.7	127.6	114.7	114.8	116.3	112.3
S40S	135	92.6	***	125.6	91.5	131.3	105.9	109.4
S42S	134	88.7	104.6	112.8	108.6	102.9	129.1	107.8
S43S	136	***	93.0	133.6	98.5	121.8	133.3	116.0
KTZA	109	***	86.3	90.9	89.0	82.2	136.1	96.9

Table 9 DVf for B/PA sites using Ratio of Means Approach - Scenario 5b1

Site	**DVc**	**Mean P_c**	**Mean P_f**	**RRF (P_f/P_c)**	**DVf (1)**
BMTC	124	138.7	116.3	0.84	104.0
PAWC	119	129.1	109.5	0.85	100.9
WORA	123	134.5	112.3	0.83	102.7
S40S	135	130.0	109.4	0.84	113.6
S42S	134	130.3	107.8	0.83	110.8
S43S	136	137.9	116.0	0.84	114.4
KTZA	109	123.6	96.9	0.78	85.5

This technique demonstrates that although the modeled maximum concentration over the domain for Scenario 5b1 is 129 ppb (for September 10), the calculated future design value is 114.4 ppb, which is less than the 1-hour standard of 0.12 ppm (125 ppb). This is illustrated in Table 10.

Table 10 Summary of Modeled Maximum Concentrations vs DVf

Scenario	9/8/93 P_f*	9/9/93 P_f	9/10/93 P_f	9/11/93 P_f**	DVf
1993 Base	165 (P_c)	139 (P_c)	155 (P_c)	162 (P_c)	n/a
2007 future base	150	126	142	147	124.6
5b	139	117	136	142	118.6
5b1	133	111	129	136	114.4

* Base case model performance is outside EPA acceptability criteria within B/PA area for 9/8/93.
** B/PA affected by rebound of overestimated boundary conditions.

Changes to Future Design Values with new Future Base Case

As a result of comments received, TNRCC reran the future base case and control case scenarios to assess the impact of adding back banked and shutdown emissions. This revised modeling also included new boundary conditions to account for the previously overestimated boundary conditions occurring in the B/PA area on September 11. Since the maximum concentrations changed, so did the calculated Future Design Values. Table 11 shows the results of this revised 2007 base case run.

Table 11 Model Predicted Maximum Ozone Concentrations Near B/PA Monitors - Revised 2007 Future Base Case

Site	92-94 DVC	9/1/93	9/2/93	9/8/93*	9/9/93	9/10/93	9/11/93 **	Mean P_f
BMTC	124	***	104.5	142.9	112.2	132.5	149.1	128.2
PAWC	119	90.5	98.0	142.9	114.2	134.8	134.6	119.2
WORA	123	100.7	120.3	138.1	133.2	130.3	123.0	124.3
S40S	135	96.9	***	135.0	109.1	149.3	111.7	120.4
S42S	134	96.5	116.1	122.1	122.4	119.0	140.9	119.5
S43S	136	***	104.6	142.9	113.9	134.8	141.9	127.6
KTZA	109	***	111.1	110.0	106.6	89.9	150.3	113.6

* Base case model performance for 9/8/93 is outside EPA performance criteria.

Table 12 lists the future design values, using the ratio of the means approach for the revised 2007 future base case.

Table 12 DVf for B/PA sites using Ratio of Means Approach - 2007 Revised Future Base Case

Site	DVc	Mean P_c	Mean P_f	RRF (P_f/P_c)	DVf (1)
BMTC	124	138.7	128.2	0.92	114.6
PAWC	119	129.1	119.2	0.92	109.8
WORA	123	134.5	124.3	0.92	113.6
S40S	135	130.0	120.4	0.93	125.0
S42S	134	130.3	119.5	0.92	122.9
S43S	136	137.9	127.6	0.93	125.8
KTZA	109	123.6	113.6	0.92	100.2

Similarly, Tables 13 and 14 show the maximum predicted concentration and ratio of the means-based future design value, respectively, for the revised 5b scenario.

Table 13 Model Predicted Maximum Ozone Concentrations Near B/PA Monitors - Revised Control Scenario 5b

Site	92-94 DVC	9/1/93	9/2/93	9/8/93*	9/9/93	9/10/93	9/11/93 **	Mean P_f
BMTC	124	***	95.6	140.7	101.2	125.9	142.5	121.2
PAWC	119	86.1	89.2	140.7	102.8	129.1	128.2	112.7
WORA	123	97.3	114.6	135.7	123.5	123.6	115.4	118.3
S40S	135	92.6	***	132.8	92.9	142.0	105.5	113.2
S42S	134	93.1	109.4	119.1	113.1	111.6	134.2	113.4
S43S	136	***	96.7	140.7	102.5	129.1	136.0	121.0
KTZA	109	***	86.3	91.1	89.1	81.9	143.5	98.4

Table 14 DVf for B/PA sites using Ratio of Means Approach - Revised Scenario 5b

Site	DVc	Mean P_c	Mean P_f	RRF (P_f/P_c)	DVf
BMTC	124	138.7	121.2	0.87	108.3
PAWC	119	129.1	112.7	0.87	103.8
WORA	123	134.5	118.3	0.88	108.2
S40S	135	130.0	113.2	0.87	117.5
S42S	134	130.3	113.4	0.87	116.6
S43S	136	137.9	121.0	0.88	119.3
KTZA	109	123.6	98.4	0.80	86.8

Finally, Tables 15 and 16 show the maximum predicted concentration and ratio of the means-based future design value, respectively, for the revised 5b1 scenario.

Table 15 Model Predicted Maximum Ozone Concentrations Near B/PA Monitors - Revised Control Scenario 5b1

Site	92-94 DVC	9/1/93	9/2/93	9/8/93*	9/9/93	9/10/93	9/11/93 **	Mean P_f
BMTC	124	***	93.5	136.2	98.1	121.6	137.5	117.4
PAWC	119	85.8	87.4	136.2	100.7	123.2	125.4	109.8
WORA	123	91.7	108.7	130.1	116.8	116.5	114.2	113.0
S40S	135	92.6	***	127.8	91.1	133.5	105.4	110.1
S42S	134	88.7	104.6	114.0	109.6	105.0	128.7	108.4
S43S	136	***	93.0	136.2	98.9	123.2	133.9	117.0
KTZA	109	***	86.3	91.0	89.0	80.8	137.3	96.9

Table 16 DVf for B/PA sites using Ratio of Means Approach - Revised Scenario 5b1

Site	DVc	Mean P_c	Mean P_f	RRF (P_f/P_c)	DVf
BMTC	124	138.7	117.4	0.85	104.9
PAWC	119	129.1	109.8	0.85	101.2
WORA	123	134.5	113.0	0.84	103.3
S40S	135	130.0	110.1	0.85	114.3
S42S	134	130.3	108.4	0.83	111.5
S43S	136	137.9	117.0	0.85	115.4
KTZA	109	123.6	96.9	0.78	85.4

This technique demonstrates that although the modeled maximum concentration over the domain for Scenario 5b1 is 131 ppb (for September 10), the calculated future design value is 115.4 ppb, which is less than the 1-hour standard of 0.12 ppm (125 ppb). This is illustrated in Table 17.

Table 17 Summary of Modeled Maximum Concentrations vs DVf (for revised 2007 base case)

Scenario	9/8/93 P_f*	9/9/93 P_f	9/10/93 P_f	9/11/93 P_f	DVf
1993 Base	165 (P_c)	139 (P_c)	155 (P_c)	162 (P_c)	n/a
2007 future base	150	128	146	150	125.8
5b	140	119	139	143	119.3
5b1	136	113	131	137	115.4

* Base case model performance is outside EPA acceptability criteria within B/PA area for 9/8/93.