Shell Chemicals

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Hand Delivered

Mr. Daniel R. Jamieson, MC-163
Texas Commission on Environmental Quality
P. O. Box 13087
Austin, Texas 78711-3087

AIR PERMITS DIVISION
APR 30 2007
RECEIVED

April 27, 2007

Subject: Submittal of BART Exemption Modeling Protocol
Shell Chemical LP - Deer Park Chemical Plant
Deer Park Refining Limited Partnership
TCEQ Air Account Number: HG-0659-W (RN 100211879)

Dear Mr. Jamieson:

Shell Chemical LP and Shell Deer Park Refining Company submit the Modeling Protocol used for BART exemption modeling analysis referenced in 30 TAC 116.1510(b). Should you require additional information or have any questions regarding this information, please contact Mr. Clay Gorham at the letterhead address.

Yours sincerely
Shell Chemical LP

Richard W. Bourns
Environmental Manager
Agent for Deer Park Refining Limited Partnership

Attachment

URS

April 30, 2007

Mr. Dan Jamieson
Air Permits Division
Texas Commission on Environmental Quality
12100 Park 35 Circle
Austin, Texas 78753

RE: Best Available Retrofit Technology (BART) Modeling Demonstration
Shell Chemical LP – Deer Park Chemical Plant and Deer Park Refining Limited Partnership (Shell)
Deer Park, Texas (Harris County)
Regulated Entity Number: RN: 100211879
Account Number: HG-0659-W

Dear Mr. Jamieson:

The enclosed modeling report demonstrates that Shell Chemical LP – Deer Park Chemical Plant and Deer Park Refining Limited Partnership (Shell) is exempt from the Best Available Retrofit Technology (BART) requirements. The modeling report was prepared by staff under my supervision. As a registered Professional Engineer in the State of Texas, I certify that information in the modeling report is accurate to the best of my knowledge.

STATE OF TEXAS
MICHAEL A. DEMNY
93038
LICENSED
PROFESSIONAL ENGINEER

DEMONSTRATION OF EXEMPTION FROM BART REQUIREMENTS

Shell Chemical LP – Deer Park Chemical Plant and Refining Limited Partnership

Deer Park, Texas

Prepared by:

URS Corporation
9400 Amberglen Blvd.
Austin, TX 78729

April 2007

DEMONSTRATION OF EXEMPTION FROM BART REQUIREMENTS

Shell Chemical LP – Deer Park Chemical Plant and Refining Limited Partnership
Deer Park, Texas

April 2007

Prepared for:

Shell Chemical LP and Deer Park Refining Partnership
Deer Park, Texas

Prepared by:

URS Corporation
9400 Amberglen Blvd.
Austin, TX 78664

April 2007

Table of Contents

1.0 INTRODUCTION 1

2.0 BART SOURCE INFORMATION 2

2.1. Model Refinements 2
2.1.1 Assumed All Emitted Particulate is $PM_{2.5}$ 2
2.1.2 Class 1 Area Specific Rayleigh Scattering 2
2.1.3 New IMPROVE Equation 3

3.0 FIRST STAGE EXEMPTION MODELING (USING NO-OBS MET) 16

4.0 SECOND STAGE EXEMPTION MODELING (USING REFINED MET) 18

5.0 REFERENCES 20

Tables

Table 2-1 Stack Parameters for BART Eligible Units 4
Table 2-2 Emission Rates for All BART Eligible Units 9

Table 3-1 Class I Areas Included in First Stage of Exemption Modeling 16
Table 3-2 Modeled Impacts from the First Stage of Exemption Modeling 17

Table 4-1 Modeled Impacts from the Second Stage of Exemption Modeling 18

Figures

Figure 4-1 Surface Meteorological Stations in Model Domain 19

Appendices

Appendix A Processing of Refined Meteorological Data
Appendix B Electronic Archive of Modeling Data

1.0 Introduction

Federal law requires Best Available Retrofit Technology (BART) for any BART-eligible source that ‘‘emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility” in any mandatory Class I federal area. Pursuant to federal regulations, states have the option of exempting a BART-eligible source from the BART requirements based on dispersion modeling demonstrating that the source cannot reasonably be anticipated to cause or contribute to visibility impairment in a Class I area. According to 40 CFR Part 51, Appendix Y (BART guideline), a BART-eligible source is considered to “contribute” to visibility impairment in a Class I area if the modeled change in deciviews (dv) is equal to or greater than the “contribution threshold.” Any BART-eligible source determined to cause or contribute to visibility impairment in any Class I area is subject to BART. Based on current regulatory guidance a “contribution threshold” of 0.5 dv is considered the value where a modeled BART eligible source may contribute to visibility impairment.

BART exemption modeling procedures for the Shell Oil Deer Park facility (SDP), were outlined in a previously submitted document titled *BART Exemption CALPUFF Modeling Protocol, Visibility Impairment Modeling Analysis for Shell Chemical LP - Deer Park Chemical Plant and Deer Park Refinery Limited Partnership*. The modeling protocol describes the process and all model settings used in the exemption modeling. This document provides additional information about the modeled sources and presents the results of the exemption modeling. The results of this modeling analysis show that SDP has a minimal impact on visibility at the modeled Class 1 Areas and is not subject to BART requirements.

2.0 BART Source Information

Emissions units at the SDP facility that are considered BART eligible were constructed or reconstructed between August 7, 1962 and August 7, 1977 and emit at least one visibility-impairing air pollutant (in this case NO_x, SO_2, PM_{10} or $PM_{2.5}$). The BART eligible units at SDP include flares, furnaces, engines, heaters, boilers, incinerators, cooling towers, and fugitive sources. A list of modeled sources, stack parameters and emission rates are provided in Table 2-1. Table 2-2 lists the basis of the modeled emission rates. Any onsite sources that are not listed in these tables are either not BART eligible or they have been shut down.

2.1 Model Refinements

The following model refinements used in the SDP BART exemption modeling that were not explicitly outlined in the modeling protocol.

2.1.1 Assumed all Emitted Particulate is $PM_{2.5}$

No speciated particulate information was readily available for the SDP facility. Instead, the emission rates for PM_{10} were used in the exemption modeling for both PM_{10} and $PM_{2.5}$. The $PM_{2.5}$ emissions listed in Table 2-2 are equal to the PM_{10} emissions. By modeling the PM_{10} emissions as PMC and the $PM_{2.5}$ emissions as PMF, these emissions are essentially being double-counted in the model. The TCEQ BART modeling protocol suggests that in the absence of particulate speciation data, it may be assumed that all particulate is $PM_{2.5}$ (PMF). This is still a conservative assumption because PMF has a greater impact on visibility impairment than does PMC. Although both PM_{10} and $PM_{2.5}$ emission rates were included in the CALPUFF runs, the PM_{10} (PMC) was removed in the CALPOST runs using the setting LVPMC = F. Please note that this refinement was only utilized with those model runs that initially predicted impacts above 0.5 dv.

2.1.2 Class 1 Area Specific Rayleigh Scattering

The default value of 10 Mm^{-1} is used to describe Rayleigh scattering in the TCEQ BART modeling protocol. This value is used in the visibility impact calculations performed in CALPOST. Rayleigh scattering is the scattering of light by particles much smaller than the wavelength of the light, and the Rayleigh scattering value describes the efficiency of such light scattering. Each Class 1 area was given a specific Rayleigh scattering value by the Interagency Monitoring of Protected Visual Environments program (IMPROVE). These values are available in Table A2 one of their "Gray Literature" documents titled *Revised IMPROVE Algorithm for Estimating Light Extinction from Particle Speciation Data*. This document is available at

http://vista.cira.colostate.edu/IMPROVE/Publications/GrayLit/gray_literature.htm.

SDP used Class 1 area specific Rayleigh scattering values from this document in the CALPOST runs for the BART exemption modeling. Please note that this refinement was only utilized with those model runs that initially predicted impacts above 0.5 dv.

2.1.3 New IMPROVE Visibility Equation

A revised algorithm used to calculate visibility was adopted for use by the IMPROVE Steering Committee in December 2005, and is described in the report listed in 2.1.2. This document is a summary report by a subcommittee established by the IMPROVE Steering Committee at their July 2005 meeting to recommend a refined algorithm that would replace or be made available as an alternative to the current approach. The subcommittee included those who worked on the internal review as well as scientists who have been critical of the original IMPROVE algorithm. The primary purpose of this document is to describe the subcommittee's recommended revised algorithm, characterize its performance, and summarize the rationale for each of the changes from the currently used algorithm.

This revised algorithm used to calculate visibility has not yet been incorporated into CALPOST. In order to take advantage of the new IMPROVE equation, a section of the CALPOST output file may be copied into a spreadsheet (included in Appendix B), which applies the new equation and predicts visibility impacts. This spreadsheet was developed by Dr. Ivar Tombach, technical consultant to the VISTAS regional planning organization. This post-processing tool and accompanying instructions can be downloaded from the VISTAS website as follows:

http://www.vistas-sesarm.org/BART/CALPOST-NewIMPROVEformulaCalculationNO2RevP_Dec92006.xls

http://www.vistas-sesarm.org/BART/CALPOST-IMPROVEWorkbook_InstructionsV2_16-Oct06.pdf

The use of this post-processing tool has been allowed by states in the VISTAS region with regard to BART exemption modeling. SDP used the new IMPROVE equation (via the use of Dr. Tombach's spreadsheet), in conjunction with the standard CALPOST runs to calculate visibility impacts. Please note that this refinement was only utilized with those model runs that initially predicted impacts above 0.5 dv.

Table 2-1 Stack Parameters for BART Eligible Units

Model ID	Unit Description	Coordinates				Base Elevation		Stack Height		Temperature		Exit Velocity		Stack Diameter	
		UTM Easting (m)	UTM Northing (m)	LCC Easting (m)	LCC Northing (m)	(ft)	(m)	(ft)	(m)	(F)	(K)	(ft/s)	(m/s)	(ft)	(m)
A1745	SR3/4 SO2 CEMS Analyzer	295080	3290513	183.340	-1135.920	21.0	6.4	4.0	1.2	68	293.2	0.003	0.001	0.003	0.001
A10823	CCU CO Analyzer	294753	3290183	183.024	-1136.264	24.0	7.3	20.0	6.1	100	310.9	0.003	0.001	0.003	0.001
A10824	CO Analyzer	294753	3290183	183.024	-1136.264	24.0	7.3	20.0	6.1	100	310.9	0.003	0.001	0.003	0.001
A10825	O2 Analyzer	294753	3290183	183.024	-1136.264	24.0	7.3	20.0	6.1	100	310.9	0.003	0.001	0.003	0.001
A10502	CCU SNCR NOX/SO2/O2 Analyzer	294753	3290183	183.024	-1136.264	24.0	7.3	20.0	6.1	100	310.9	0.003	0.001	0.003	0.001
A162	H5301 O2 Analyzer	294921	3290292	183.188	-1136.149	22.8	7.0	20.0	6.1	100	310.9	0.003	0.001	0.003	0.001
A180	H5302 O2 Analyzer	294921	3290292	183.188	-1136.149	22.8	7.0	20.0	6.1	100	310.9	0.003	0.001	0.003	0.001
A236	H5305 O2 Analyzer	294921	3290292	183.188	-1136.149	22.8	7.0	20.0	6.1	100	310.9	0.003	0.001	0.003	0.001
A34160	CR-3 Furnaces CEMS Analyzer	294945	3290291	183.212	-1136.149	22.7	6.9	20.0	6.1	100	310.9	0.003	0.001	0.003	0.001
A785	H5303 O2 Analyzer	294921	3290292	183.188	-1136.149	22.8	7.0	20.0	6.1	100	310.9	0.003	0.001	0.003	0.001
A786	H5304 O2 Analyzer	294921	3290292	183.188	-1136.149	22.8	7.0	20.0	6.1	100	310.9	0.003	0.001	0.003	0.001
AE2340	octane testing engine	293936	3289808	182.216	-1136.674	25.0	7.6	21.0	6.4	99.95	310.9	32.8	10.0	0.394	0.120
AE2636	octane testing engine	293936	3289808	182.216	-1136.674	25.0	7.6	21.0	6.4	99.95	310.9	32.8	10.0	0.394	0.120
AE2650	octane testing engine	293936	3289808	182.216	-1136.674	25.0	7.6	21.0	6.4	99.95	310.9	32.8	10.0	0.394	0.120
AE348	on-line knock engine	293936	3289808	182.216	-1136.674	25.0	7.6	21.0	6.4	99.95	310.9	32.8	10.0	0.394	0.120
AE349	on-line knock engine	293936	3289808	182.216	-1136.674	25.0	7.6	21.0	6.4	99.95	310.9	32.8	10.0	0.394	0.120
AE388	on-line knock engine	293936	3289808	182.216	-1136.674	25.0	7.6	21.0	6.4	99.95	310.9	32.8	10.0	0.394	0.120
AE389	on-line knock engine	293936	3289808	182.216	-1136.674	25.0	7.6	21.0	6.4	99.95	310.9	32.8	10.0	0.394	0.120
AE700	on-line knock engine	293936	3289808	182.216	-1136.674	25.0	7.6	21.0	6.4	99.95	310.9	32.8	10.0	0.394	0.120
AE768	on-line knock engine	293936	3289808	182.216	-1136.674	25.0	7.6	21.0	6.4	99.95	310.9	32.8	10.0	0.394	0.120
CWT10	Cooling Tower No. 10	294834	3289990	183.113	-1136.456	22.8	7.0	42.0	12.8	68	293.2	20.0	6.1	10.0	3.0
CWT11	Cooling Tower No. 11	295180	3290242	183.451	-1136.188	21.0	6.4	55.0	16.8	68	293.2	20.0	6.1	18.0	5.5
CWT12	Cooling Tower No. 12	294271	3289712	182.557	-1136.758	26.0	7.9	53.0	16.2	68	293.2	20.0	6.1	18.0	5.5
CWT14	Cooling Tower No. 14	294011	3290127	182.279	-1136.350	23.5	7.2	40.0	12.2	68	293.2	20.0	6.1	10.0	3.0
CWT15	Cooling Tower No. 15	294271	3290555	182.523	-1135.909	22.0	6.7	51.0	15.5	68	293.2	20.0	6.1	16.0	4.9
CWT16_A	Cooling Tower No. 16/16A	293604	3290063	181.872	-1136.430	24.0	7.3	40.0	12.2	68	293.2	20.0	6.1	10.0	3.0
CWT17	Cooling Tower No. 17	294939	3290376	183.203	-1136.063	22.7	6.9	40.0	12.2	68	293.2	20.0	6.1	10.0	3.0
CWT6	Cooling Tower No. 6	294148	3290170	182.415	-1136.302	23.0	7.0	40.0	12.2	68	293.2	20.0	6.1	10.0	3.0

Table 2-1 Stack Parameters for BART Eligible Units (Continued)

Model ID	Unit Description	Coordinates				Base Elevation		Stack Height		Temperature		Exit Velocity		Stack Diameter	
		UTM Easting (m)	UTM Northing (m)	LCC Easting (m)	LCC Northing (m)	(ft)	(m)	(ft)	(m)	(F)	(K)	(ft/s)	(m/s)	(ft)	(m)
CWT7	Cooling Tower No. 7	294857	3290375	183.121	-1136.067	23.0	7.0	51.0	15.5	68	293.2	20.0	6.1	16.0	4.9
CWT8	Cooling Tower No. 8	294862	3290526	183.120	-1135.915	23.0	7.0	60.0	18.3	68	293.2	20.0	6.1	10.0	3.0
CWT9	Cooling Tower No. 9	294811	3289770	183.098	-1136.678	22.3	6.8	45.0	13.7	68	293.2	20.0	6.1	10.0	3.0
COKEFLAR	Coker Flare	293786	3290435	182.040	-1136.049	17.8	5.4	100.0	30.5	1832	1273.2	65.6	20.0	3.0	0.914
EPFLARE	East Property Flare	295352	3290046	183.632	-1136.379	19.1	5.8	60.0	18.3	1832	1273.2	65.6	20.0	18.1	5.5
A1005	EP (Girbitol) Flare	295369	3290028	183.650	-1136.396	18.5	5.6	135.0	41.1	1832	1273.2	65.6	20.0	1.7	0.510
FLNFLARE	North Property Flare	294851	3290979	183.091	-1135.459	3.9	1.2	175.0	53.3	1832	1273.2	65.6	20.0	3.0	0.910
WPFLARE	West Property Flare	293739	3290478	181.991	-1136.008	17.0	5.2	60.0	18.3	1832	1273.2	65.6	20.0	17.1	5.2
COKPMFG1	Coke Pile Wind Erosion Fugitives	293385	3290375	181.639	-1136.125	23.7	7.2	10.0	3.0	68	293.2	0.003	0.001	0.003	0.001
COKPMF1A	Coke Pile 2 Fugitives	293436	3290376	181.691	-1136.122	22.1	6.7	10.0	3.0	68	293.2	0.003	0.001	0.003	0.001
COKPMFG2	Coke Pile Crane Fugitives	293369	3290375	181.623	-1136.126	23.7	7.2	10.0	3.0	68	293.2	0.003	0.001	0.003	0.001
COKPMFG3	Coke Crusher Fugitives	293369	3290375	181.623	-1136.126	23.7	7.2	10.0	3.0	68	293.2	0.003	0.001	0.003	0.001
COKPMFG4	Coke Crusher Discharge Fugitives	293369	3290375	181.623	-1136.126	23.7	7.2	10.0	3.0	68	293.2	0.003	0.001	0.003	0.001
COKPMFG5	Coke Transfer Conveyor Fugitives	293369	3290375	181.623	-1136.126	23.7	7.2	10.0	3.0	68	293.2	0.003	0.001	0.003	0.001
COKPMFG6	Coke Conveyor Discharge Fugitives	293691	3291099	181.919	-1135.384	0.0	0.0	10.0	3.0	68	293.2	0.003	0.001	0.003	0.001
COKPMFG7	Coke Barge Loading Fugitives	293711	3291096	181.939	-1135.387	0.0	0.0	10.0	3.0	68	293.2	0.003	0.001	0.003	0.001
H1000	PLAT2 Heater	294909	3289844	183.194	-1136.600	22.0	6.7	100.0	30.5	712	650.9	29.7	9.1	4.0	1.2
H1001	Guard Bed Startup Heater	294900	3289837	183.185	-1136.608	22.0	6.7	48.9	14.9	68	293.2	25.4	7.8	3.5	1.1
H1010	HDU-1 Charge Heater	294973	3289846	183.258	-1136.595	21.4	6.5	69.9	21.3	526	547.6	7.7	2.3	4.4	1.3
H1011	HDU-1 Reboiler Heater	294961	3289844	183.247	-1136.598	21.4	6.5	169.9	51.8	551	561.5	8.5	2.6	5.0	1.5
H1100	DHT Heater	294857	3289993	183.136	-1136.451	22.6	6.9	132.5	40.4	650	616.5	8.8	2.7	5.0	1.5
H1170	CFH Charge Heater	294884	3289992	183.163	-1136.452	22.5	6.9	100.0	30.5	550	560.9	7.2	2.2	5.0	1.5
H31001_2	Coker Heaters No. 1 and 2	293443	3290404	181.697	-1136.093	19.9	6.1	212.0	64.6	299.9	422.0	25.0	7.6	13.5	4.1
H31003	Coker Heater No. 3	293444	3290401	181.698	-1136.097	20.1	6.1	212.0	64.6	299.9	422.0	25.0	7.6	9.5	2.9
H3300	DHT H2 Heater	294847	3290034	183.124	-1136.411	22.8	7.0	132.5	40.4	650	616.5	8.8	2.7	5.0	1.5
H36100	CGHT Heater	294908	3290006	183.187	-1136.437	22.3	6.8	150.0	45.7	500	533.2	19.0	5.8	5.3	1.6
H5100	DU-2 South Crude Heater	294332	3290159	182.601	-1136.305	25.0	7.6	149.9	45.7	434	496.5	13.8	4.2	11.0	3.3
H5101	DU-2 North Crude Heater	294332	3290178	182.600	-1136.286	25.0	7.6	149.9	45.7	457.1	509.3	13.4	4.1	11.0	3.3

Table 2-1 Stack Parameters for BART Eligible Units (Continued)

Model ID	Unit Description	Coordinates				Base Elevation		Stack Height		Temperature		Exit Velocity		Stack Diameter	
		UTM Easting (m)	UTM Northing (m)	LCC Easting (m)	LCC Northing (m)	(ft)	(m)	(ft)	(m)	(F)	(K)	(ft/s)	(m/s)	(ft)	(m)
H5102	DU-2 South Flasher Charge Heater	294334	3290124	182.604	-1136.341	25.0	7.6	149.9	45.7	391.9	473.1	7.0	2.1	7.5	2.3
H5103	DU-2 North Flasher Charge Heater	294334	3290141	182.604	-1136.324	25.0	7.6	149.9	45.7	458	509.8	5.0	1.5	7.5	2.3
H5104	DU-2 Preflash Heater	294314	3290190	182.582	-1136.275	25.0	7.6	150.0	45.7	500	533.2	25.0	7.6	4.6	1.4
H5105	DU-2 Preflash2 Heater	294314	3290190	182.582	-1136.275	25.0	7.6	212.0	64.6	460	510.9	25.0	7.6	10.2	3.1
H5200	HDU-2 Charge Heater	294324	3290253	182.589	-1136.211	25.5	7.8	149.9	45.7	574.1	574.3	9.2	2.8	5.8	1.8
H53NN	Catalytic Reformer SCR	294921	3290292	183.188	-1136.149	22.8	7.0	150.0	45.7	450	505.4	50.0	15.2	11.0	3.4
H5400	SHCU South Charge Heater	295086	3290151	183.360	-1136.283	21.5	6.5	149.9	45.7	470	516.5	8.0	2.4	7.0	2.1
H5402	SHCU Reboiler Heater	295088	3290166	183.361	-1136.269	21.5	6.5	160.1	48.8	622	600.9	9.7	3.0	9.0	2.7
H5403	SHCU North Charge Heater	295088	3290184	183.361	-1136.250	21.4	6.5	149.9	45.7	469	515.9	5.7	1.7	7.0	2.1
H5404	SHCU Post-Frac Heater	295065	3290167	183.339	-1136.269	22.0	6.7	212.0	64.6	300	422.0	25.0	7.6	10.2	3.1
H5500A	SMR Heater A	295089	3290250	183.359	-1136.184	21.6	6.6	200.1	61.0	524.9	547.0	17.1	5.2	9.5	2.9
H5500B	SMR Heater B	295088	3290263	183.358	-1136.171	21.8	6.6	200.1	61.0	524.9	547.0	17.0	5.2	9.5	2.9
H5500C	SMR Heater C	295089	3290276	183.358	-1136.157	21.8	6.7	200.1	61.0	524.9	547.0	17.0	5.2	9.5	2.9
H5600	SGP Heat Medium Heater	294945	3290170	183.218	-1136.271	22.2	6.8	140.1	42.7	415	485.9	4.1	1.2	7.5	2.3
H600	FCCU CO Boiler	294774	3290225	183.043	-1136.222	24.0	7.3	149.9	45.7	445	502.6	70.0	21.3	11.0	3.3
H613	DU-1 Secondary Pre-Heater	294443	3290147	182.713	-1136.313	26.0	7.9	165.0	50.3	749.9	672.0	23.0	7.0	9.0	2.7
H63000	HVI Column Charge Heater	294794	3290799	183.040	-1135.643	20.9	6.4	169.9	51.8	565.1	569.3	36.4	11.1	4.9	1.5
H70001_2	GOHT Recycle Gas & Frac Reboiler Heaters	293532	3290332	181.788	-1136.162	20.0	6.1	212.0	64.6	299.9	422.0	25.0	7.6	13.5	4.1
H850S1	PERC Heater - North Stack	295202	3290796	183.451	-1135.630	18.6	5.7	60.0	18.3	450.1	505.4	21.1	6.4	1.5	0.460
H850S2	PERC Heater - South Stack	295202	3290796	183.451	-1135.630	18.6	5.7	60.0	18.3	450.1	505.4	21.1	6.4	1.5	0.460
PAINTFE	miscellaneous painting fugitives	294271	3289712	182.557	-1136.758	26.0	7.9	10.0	3.0	68	293.2	0.003	0.001	0.003	0.001
A1660B	SR-3/4 Incinerator	295080	3290513	183.340	-1135.920	21.6	6.6	212.9	64.9	1000	810.9	123.0	37.5	4.8	1.4
SR5STACK	SR5 Tail Gas Incinerator	295081	3290365	183.347	-1136.069	21.6	6.6	149.9	45.7	1000	810.9	25.0	7.6	5.7	1.7
SR6STACK	SR6 Tail Gas Incinerator	295079	3290435	183.341	-1135.998	21.6	6.6	212.9	64.9	1000	810.9	123.0	37.5	3.6	1.1
SR7STACK	SR7 Tail Gas Incinerator	295080	3290513	183.340	-1135.920	21.6	6.6	212.9	64.9	1000	810.9	123.0	37.5	3.6	1.1
SR8STACK	SR8 Tail gas incinerator	295080	3290513	183.340	-1135.920	21.6	6.6	212.9	64.9	1000	810.9	166.0	50.6	3.6	1.1
H9200	incinerator	294725	3290440	182.985	-1136.007	24.5	7.5	100.0	30.5	190	360.9	23.0	7.0	6.0	1.8
A1333	HIPA Flare	295039	3289518	183.338	-1136.923	19.3	5.9	212.0	64.6	1832	1273.2	65.6	20.0	5.2	1.6

Table 2-1 Stack Parameters for BART Eligible Units (Continued)

Model ID	Unit Description	Coordinates				Base Elevation		Stack Height		Temperature		Exit Velocity		Stack Diameter	
		UTM Easting (m)	UTM Northing (m)	LCC Easting (m)	LCC Northing (m)	(ft)	(m)	(ft)	(m)	(F)	(K)	(ft/s)	(m/s)	(ft)	(m)
BEETLE	BEETLE Stack	294395	3289134	182.704	-1137.334	27.0	8.2	70.0	21.3	120	322.0	8.5	2.6	3.0	0.914
FOL710	furnace	293899	3289074	182.208	-1137.414	27.0	8.2	120.0	36.6	525	547.0	9.5	2.9	8.0	2.4
FOL700	furnace	293880	3289076	182.189	-1137.413	27.0	8.2	120.0	36.6	525	547.0	9.5	2.9	8.0	2.4
VP31142	decoking vents	293630	3289076	181.937	-1137.423	26.0	7.9	80.0	24.4	250	394.3	0.010	0.003	3.0	0.914
FNFH3601	HT-III furnace	293848	3289039	182.158	-1137.451	27.0	8.2	58.6	17.9	610	594.3	9.0	2.7	4.3	1.3
OP2DCOK	OP-2 furnace decoking vent 1	293988	3289088	182.297	-1137.396	27.0	8.2	80.0	24.4	250	394.3	0.003	0.001	3.0	0.914
OP2DCOK2	OP-2 furnace decoking vent 2	293988	3289088	182.297	-1137.396	27.0	8.2	80.0	24.4	250	394.3	0.003	0.001	3.0	0.914
H1300	OXU Furnace	295026	3289967	183.307	-1136.472	22.0	6.7	175.0	53.3	630	605.4	13.2	4.0	9.5	2.9
FLOP3GRF	ground flare	293920	3289391	182.216	-1137.094	26.0	7.9	67.0	20.4	1832	1273.2	66.0	20.1	37.0	11.3
FOL130	pyrolysis furnace	294144	3289084	182.454	-1137.395	27.0	8.2	135.0	41.1	320	433.2	57.2	17.4	6.0	1.8
FOL170	pyrolysis furnace	293992	3289085	182.301	-1137.400	27.0	8.2	135.0	41.1	320	433.2	57.2	17.4	6.0	1.8
FOL180	pyrolysis furnace	294013	3289085	182.322	-1137.399	27.0	8.2	135.0	41.1	320	433.2	57.2	17.4	6.0	1.8
FOL100	pyrolysis furnace	294083	3289085	182.392	-1137.397	27.0	8.2	135.0	41.1	320	433.2	57.2	17.4	6.0	1.8
FOL110	pyrolysis furnace	294103	3289084	182.413	-1137.396	27.0	8.2	135.0	41.1	320	433.2	57.2	17.4	6.0	1.8
FOL120	pyrolysis furnace	294123	3289085	182.433	-1137.394	27.0	8.2	135.0	41.1	320	433.2	57.2	17.4	6.0	1.8
FP31180	Furnace F-P3-1180	293610	3289176	181.913	-1137.323	26.0	7.9	140.0	42.7	375	463.7	39.4	12.0	6.5	2.0
FP31140	Furnace F-P3-1140	293584	3289039	181.892	-1137.462	26.0	7.9	150.0	45.7	375	463.7	39.3	12.0	7.5	2.3
FP31060	Furnace F-P3-1060	293631	3289038	181.939	-1137.462	26.1	8.0	150.0	45.7	375	463.7	37.0	11.3	7.5	2.3
FP31090	Furnace F-P3-1090	293825	3289078	182.133	-1137.413	26.3	8.0	100.0	30.5	375	463.7	43.7	13.3	5.0	1.5
FP31110	Furnace F-P3-1110	293556	3289063	181.863	-1137.439	26.0	7.9	150.0	45.7	375	463.7	39.3	12.0	7.5	2.3
FP31040	Furnace F-P3-1040	293741	3289035	182.050	-1137.460	26.0	7.9	150.0	45.7	375	463.7	37.0	11.3	7.5	2.3
FP31130	Furnace F-P3-1130	293585	3289062	181.892	-1137.439	26.0	7.9	150.0	45.7	375	463.7	39.3	12.0	7.5	2.3
FP31050	Furnace F-P3-1050	293632	3289061	181.939	-1137.438	26.0	7.9	150.0	45.7	375	463.7	37.0	11.3	7.5	2.3
FOL603	Hydrogen Preheat Furnace	293942	3289017	182.253	-1137.470	27.0	8.2	125.0	38.1	575	574.8	22.6	6.9	3.5	1.1
FOL604	Gasoline Stabilizer Reboiler	294022	3289014	182.333	-1137.470	27.0	8.2	155.0	47.2	550	560.9	13.3	4.1	4.5	1.4
FOL601	Gas Oil Stabilizer Reboiler	294041	3289014	182.353	-1137.469	27.0	8.2	130.0	39.6	775	685.9	18.2	5.5	4.5	1.4
FOL602	Stage 3 Preheater Furnace	293926	3289017	182.237	-1137.471	27.0	8.2	125.0	38.1	550	560.9	19.6	6.0	2.5	0.762
H902	ACU Furnace	294724	3289859	183.007	-1136.592	23.0	7.0	185.0	56.4	300	422.0	14.7	4.5	10.5	3.2

Table 2-1 Stack Parameters for BART Eligible Units (Continued)

Model ID	Unit Description	Coordinates				Base Elevation		Stack Height		Temperature		Exit Velocity		Stack Diameter	
		UTM Easting (m)	UTM Northing (m)	LCC Easting (m)	LCC Northing (m)	(ft)	(m)	(ft)	(m)	(F)	(K)	(ft/s)	(m/s)	(ft)	(m)
FOL190	pyrolysis furnace	294036	3289084	182.345	-1137.399	27.0	8.2	135.0	41.1	320	433.2	57.2	17.4	6.0	1.8
H87920	steam boiler	294498	3289511	182.793	-1136.951	26.3	8.0	150.0	45.7	355	452.6	36.0	11.0	8.5	2.6
F8300	heavy ends furnace	294754	3290283	183.020	-1136.164	24.0	7.3	63.6	19.4	780	688.7	4.1	1.2	2.8	0.853
F8301	Regen furnace	294746	3290286	183.013	-1136.161	24.0	7.3	38.7	11.8	1600	1144.3	23.0	7.0	2.2	0.671
P87107	diesel engine (fire water pump)	294733	3289596	183.027	-1136.856	24.0	7.3	6.0	1.8	72	295.4	0.003	0.001	3.3	1.0
P87921	diesel engine (demin water pump)	294365	3289475	182.661	-1136.992	26.8	8.2	6.0	1.8	72	295.4	0.003	0.001	3.3	1.0
FOL140	pyrolysis furnace	294167	3289086	182.476	-1137.392	27.0	8.2	135.0	41.1	320	433.2	57.2	17.4	6.0	1.8
FOL150	pyrolysis furnace	293950	3289084	182.258	-1137.402	27.0	8.2	135.0	41.1	320	433.2	57.2	17.4	6.0	1.8
FOL160	pyrolysis furnace	293973	3289085	182.281	-1137.400	27.0	8.2	135.0	41.1	320	433.2	57.2	17.4	6.0	1.8
H87002	thermal oxidizer	294498	3289511	182.793	-1136.951	26.3	8.0	150.0	45.7	340	444.3	67.5	20.6	4.9	1.5
15A	loadout filter	294933	3289167	183.245	-1137.280	23.2	7.1	10.0	3.0	68	293.2	0.003	0.001	0.003	0.001
F20	hot oil furnace	294490	3289356	182.791	-1137.107	27.0	8.2	51.0	15.5	700	644.3	2.0	0.610	2.7	0.823
CG1	turbine/duct burner	294089	3289847	182.368	-1136.628	24.0	7.3	100.0	30.5	287	414.8	69.0	21.0	15.0	4.6
CG2	turbine/duct burner	294160	3289845	182.440	-1136.628	24.0	7.3	100.0	30.5	287	414.8	69.0	21.0	15.0	4.6
A1301	A&S Flare	295190	3289509	183.490	-1136.926	14.6	4.4	110.0	33.5	1832	1273.2	65.6	20.0	1.2	0.366
FP31120	Furnace F-P3-1120	293556	3289039	181.864	-1137.463	26.0	7.9	150.0	45.7	375	463.7	39.3	12.0	7.5	2.3
FP31030	Furnace F-P3-1030	293741	3289058	182.049	-1137.437	26.2	8.0	150.0	45.7	375	463.7	37.0	11.3	7.5	2.3
FP31010	Furnace F-P3-1010	293713	3289058	182.021	-1137.438	26.5	8.1	150.0	45.7	375	463.7	37.0	11.3	7.5	2.3
FP31020	Furnace F-P3-1020	293713	3289036	182.022	-1137.460	26.2	8.0	150.0	45.7	375	463.7	37.0	11.3	7.5	2.3
FP31080	Furnace F-P3-1080	293848	3289078	182.156	-1137.412	26.8	8.2	150.0	45.7	375	463.7	37.0	11.3	7.5	2.3
FP31070	Furnace F-P3-1070	293660	3289060	181.967	-1137.438	26.0	7.9	150.0	45.7	375	463.7	37.0	11.3	7.5	2.3
FP31100	Furnace F-P3-1100	293813	3289080	182.121	-1137.411	26.1	8.0	100.0	30.5	375	463.7	43.7	13.3	5.0	1.5

Table 2-2 Emission Rates for All BART Eligible Units

Model ID	Unit Description	SO_2 Emission Rate			NO_x Emission Rate			PM_{10} Emission Rate			$PM_{2.5}$ Emission Rate		
		(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis
A1745	SR3/4 SO2 CEMS Analyzer	0.01	1.26E-03	1-hr PTE	0	0		0	0		0	0	
A10823	CCU CO Analyzer	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	PM_{10}
A10824	CO Analyzer	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	PM_{10}
A10825	O2 Analyzer	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	PM_{10}
A10502	CCU SNCR NOX/SO2/O2 Analyzer	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	PM_{10}
A162	H5301 O2 Analyzer	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	PM_{10}
A180	H5302 O2 Analyzer	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	PM_{10}
A236	H5305 O2 Analyzer	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	PM_{10}
A34160	CR-3 Furnaces CEMS Analyzer	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	PM_{10}
A785	H5303 O2 Analyzer	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	PM_{10}
A786	H5304 O2 Analyzer	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	PM_{10}
AE2340	octane testing engine	6.00E-04	7.56E-05	1-hr PTE	0.012	1.51E-03	1-hr PTE	7.60E-04	9.58E-05	1-hr PTE	7.60E-04	9.58E-05	PM_{10}
AE2636	octane testing engine	6.00E-04	7.56E-05	1-hr PTE	0.012	1.51E-03	1-hr PTE	7.60E-04	9.58E-05	1-hr PTE	7.60E-04	9.58E-05	PM_{10}
AE2650	octane testing engine	6.00E-04	7.56E-05	1-hr PTE	0.012	1.51E-03	1-hr PTE	7.60E-04	9.58E-05	1-hr PTE	7.60E-04	9.58E-05	PM_{10}
AE348	on-line knock engine	5.00E-04	6.30E-05	1-hr PTE	0.01	1.26E-03	1-hr PTE	6.60E-04	8.32E-05	1-hr PTE	6.60E-04	8.32E-05	PM_{10}
AE349	on-line knock engine	6.00E-04	7.56E-05	1-hr PTE	0.012	1.51E-03	1-hr PTE	7.60E-04	9.58E-05	1-hr PTE	7.60E-04	9.58E-05	PM_{10}
AE388	on-line knock engine	5.00E-04	6.30E-05	1-hr PTE	0.01	1.26E-03	1-hr PTE	6.60E-04	8.32E-05	1-hr PTE	6.60E-04	8.32E-05	PM_{10}
AE389	on-line knock engine	6.00E-04	7.56E-05	1-hr PTE	0.012	1.51E-03	1-hr PTE	7.60E-04	9.58E-05	1-hr PTE	7.60E-04	9.58E-05	PM_{10}
AE700	on-line knock engine	5.00E-04	6.30E-05	1-hr PTE	0.01	1.26E-03	1-hr PTE	6.60E-04	8.32E-05	1-hr PTE	6.60E-04	8.32E-05	PM_{10}
AE768	on-line knock engine	5.00E-04	6.30E-05	1-hr PTE	0.01	1.26E-03	1-hr PTE	6.60E-04	8.32E-05	1-hr PTE	6.60E-04	8.32E-05	PM_{10}
CWT10	Cooling Tower No. 10	0	0		0	0		0.1	0.013	1-hr PTE	0.1	0.013	PM_{10}
CWT11	Cooling Tower No. 11	0	0		0	0		1.15	0.145	1-hr PTE	1.15	0.145	PM_{10}
CWT12	Cooling Tower No. 12	0	0		0	0		0.11	0.014	1-hr PTE	0.11	0.014	PM_{10}
CWT14	Cooling Tower No. 14	0	0		0	0		0.524	0.066	1-hr PTE	0.524	0.066	PM_{10}
CWT15	Cooling Tower No. 15	0	0		0	0		0.39	0.049	1-hr PTE	0.39	0.049	PM_{10}
CWT16_A	Cooling Tower No. 16/16A	0	0		0	0		0.25	0.032	1-hr PTE	0.25	0.032	PM_{10}
CWT17	Cooling Tower No. 17	0	0		0	0		0.21	0.026	1-hr PTE	0.21	0.026	PM_{10}

Table 2-2 Emission Rates for All BART Eligible Units (Continued)

Model ID	Unit Description	SO_2 Emission Rate			NO_x Emission Rate			PM_{10} Emission Rate			$PM_{2.5}$ Emission Rate		
		(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis
CWT6	Cooling Tower No. 6	0	0		0	0		0.12	0.015	1-hr PTE	0.12	0.015	PM_{10}
CWT7	Cooling Tower No. 7	0	0		0	0		0.67	0.084	1-hr PTE	0.67	0.084	PM_{10}
CWT8	Cooling Tower No. 8	0	0		0	0		0.53	0.067	1-hr PTE	0.53	0.067	PM_{10}
CWT9	Cooling Tower No. 9	0	0		0	0		0.58	0.073	1-hr PTE	0.58	0.073	PM_{10}
COKEFLAR	Coker Flare	5.98E-03	7.54E-04	1-hr PTE	1.34	0.168	1-hr PTE	0	0		0	0	
EPFLARE	East Property Flare	806.88	101.67	24-hr MAX-C	22.29	2.81	1-hr PTE	0.01	1.26E-03	1-hr PTE	0.01	1.26E-03	PM_{10}
A1005	EP (Girbitol) Flare	3.42	0.431	1-hr PTE	0.86	0.108	1-hr PTE	0	0		0	0	
FLNFLARE	North Property Flare	3.00E-03	3.78E-04	1-hr PTE	0.319	0.04	1-hr PTE	0	0		0	0	
WPFLARE	West Property Flare	12.35	1.56	1-hr PTE	27.82	3.51	1-hr PTE	0	0		0	0	
COKPMFG1	Coke Pile Wind Erosion Fugitives	0	0		0	0		1.19	0.15	1-hr PTE	1.19	0.15	PM_{10}
COKPMF1A	Coke Pile 2 Fugitives	0	0		0	0		1.19	0.15	1-hr PTE	1.19	0.15	PM_{10}
COKPMFG2	Coke Pile Crane Fugitives	0	0		0	0		0.29	0.037	1-hr PTE	0.29	0.037	PM_{10}
COKPMFG3	Coke Crusher Fugitives	0	0		0	0		6	0.756	1-hr PTE	6	0.756	PM_{10}
COKPMFG4	Coke Crusher Discharge Fugitives	0	0		0	0		0.3	0.038	1-hr PTE	0.3	0.038	PM_{10}
COKPMFG5	Coke Transfer Conveyor Fugitives	0	0		0	0		0.3	0.038	1-hr PTE	0.3	0.038	PM_{10}
COKPMFG6	Coke Conveyor Discharge Fugitives	0	0		0	0		0.14	0.018	1-hr PTE	0.14	0.018	PM_{10}
COKPMFG7	Coke Barge Loading Fugitives	0	0		0	0		0.1	0.013	1-hr PTE	0.1	0.013	PM_{10}
H1000	PLAT2 Heater	2.91	0.367	24-hr MAX-C	28.62	3.61	1-hr PTE	2.19	0.276	1-hr PTE	2.19	0.276	PM_{10}
H1001	Guard Bed Startup Heater	0.38	0.048	1-hr PTE	1.84	0.232	1-hr PTE	0.11	0.014	1-hr PTE	0.11	0.014	PM_{10}
H1010	HDU-1 Charge Heater	0.593	0.075	24-hr MAX-C	5.77	0.727	1-hr PTE	0.45	0.057	1-hr PTE	0.45	0.057	PM_{10}
H1011	HDU-1 Reboiler Heater	0.7	0.088	24-hr MAX-C	5.4	0.68	1-hr PTE	0.53	0.067	1-hr PTE	0.53	0.067	PM_{10}
H1100	DHT Heater	0.756	0.095	24-hr MAX-C	6.23	0.785	1-hr PTE	0.57	0.072	1-hr PTE	0.57	0.072	PM_{10}
H1170	CFH Charge Heater	0.7	0.088	24-hr MAX-C	2.28	0.287	1-hr PTE	0.53	0.067	1-hr PTE	0.53	0.067	PM_{10}
H31001_2	Coker Heaters No. 1 and 2	4.44	0.56	24-hr MAX-C	20	2.52	1-hr PTE	3.74	0.471	1-hr PTE	3.74	0.471	PM_{10}

Table 2-2 Emission Rates for All BART Eligible Units (Continued)

Model ID	Unit Description	SO_2 Emission Rate			NO_x Emission Rate			PM_{10} Emission Rate			$PM_{2.5}$ Emission Rate		
		(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis
H31003	Coker Heater No. 3	2.22	0.28	24-hr MAX-C	12	1.51	1-hr PTE	1.67	0.21	1-hr PTE	1.67	0.21	PM_{10}
H3300	DHT H2 Heater	0.4	0.05	24-hr MAX-C	1.44	0.181	1-hr PTE	0.55	0.069	1-hr PTE	0.55	0.069	PM_{10}
H36100	CGHT Heater	1.03	0.13	24-hr MAX-C	2.79	0.352	1-hr PTE	0.77	0.097	1-hr PTE	0.77	0.097	PM_{10}
H5100	DU-2 South Crude Heater	3.6	0.454	24-hr MAX-C	12.96	1.63	1-hr PTE	2.7	0.34	1-hr PTE	2.7	0.34	PM_{10}
H5101	DU-2 North Crude Heater	3.6	0.454	24-hr MAX-C	12.96	1.63	1-hr PTE	2.7	0.34	1-hr PTE	2.7	0.34	PM_{10}
H5102	DU-2 South Flasher Charge Heater	1.17	0.147	24-hr MAX-C	13.02	1.64	1-hr PTE	0.88	0.111	1-hr PTE	0.88	0.111	PM_{10}
H5103	DU-2 North Flasher Charge Heater	1.17	0.147	24-hr MAX-C	15.54	1.96	1-hr PTE	0.88	0.111	1-hr PTE	0.88	0.111	PM_{10}
H5104	DU-2 Preflash Heater	0.778	0.098	24-hr MAX-C	4.2	0.529	1-hr PTE	0.58	0.073	1-hr PTE	0.58	0.073	PM_{10}
H5105	DU-2 Preflash2 Heater	2.56	0.322	24-hr MAX-C	13.8	1.74	1-hr PTE	1.92	0.242	1-hr PTE	1.92	0.242	PM_{10}
H5200	HDU-2 Charge Heater	0.778	0.098	24-hr MAX-C	7.35	0.926	1-hr PTE	0.58	0.073	1-hr PTE	0.58	0.073	PM_{10}
H53NN	Catalytic Reformer SCR	9.54	1.2	24-hr MAX-C	14.8	1.87	24-hr MAX-C	7.16	0.902	1-hr PTE	7.16	0.902	PM_{10}
H5400	SHCU South Charge Heater	0.926	0.117	24-hr MAX-C	6.11	0.77	1-hr PTE	0.7	0.088	1-hr PTE	0.7	0.088	PM_{10}
H5402	SHCU Reboiler Heater	2.37	0.299	24-hr MAX-C	21.85	2.75	1-hr PTE	1.8	0.227	1-hr PTE	1.8	0.227	PM_{10}
H5403	SHCU North Charge Heater	0.648	0.082	24-hr MAX-C	3.9	0.491	1-hr PTE	0.49	0.062	1-hr PTE	0.49	0.062	PM_{10}
H5404	SHCU Post-Frac Heater	2.48	0.312	24-hr MAX-C	6.9	0.869	1-hr PTE	1.86	0.234	1-hr PTE	1.86	0.234	PM_{10}
H5500A	SMR Heater A	3.04	0.383	24-hr MAX-C	30.14	3.8	1-hr PTE	2.28	0.287	1-hr PTE	2.28	0.287	PM_{10}
H5500B	SMR Heater B	3.04	0.383	24-hr MAX-C	30.14	3.8	1-hr PTE	2.28	0.287	1-hr PTE	2.28	0.287	PM_{10}
H5500C	SMR Heater C	3.04	0.383	24-hr MAX-C	30.14	3.8	1-hr PTE	2.28	0.287	1-hr PTE	2.28	0.287	PM_{10}

Table 2-2 Emission Rates for All BART Eligible Units (Continued)

Model ID	Unit Description	SO_2 Emission Rate			NO_x Emission Rate			PM_{10} Emission Rate			$PM_{2.5}$ Emission Rate		
		(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis
H5600	SGP Heat Medium Heater	1.36	0.171	24-hr MAX-C	3.65	0.46	1-hr PTE	1.02	0.129	1-hr PTE	1.02	0.129	PM_{10}
H600	FCCU CO Boiler	21.02	2.65	24-hr MAX-C	24.7	3.11	24-hr MAX-C	66	8.32	1-hr PTE	66	8.32	PM_{10}
H613	DU-1 Secondary Pre-Heater	2.44	0.308	24-hr MAX-C	5.52	0.696	1-hr PTE	1.15	0.145	1-hr PTE	1.15	0.145	PM_{10}
H63000	HVI Column Charge Heater	1.06	0.133	24-hr MAX-C	5.7	0.718	1-hr PTE	0.79	0.1	1-hr PTE	0.79	0.1	PM_{10}
H70001_2	GOHT Recycle Gas & Frac Reboiler Heaters	1.22	0.154	24-hr MAX-C	6.6	0.832	1-hr PTE	0.92	0.116	1-hr PTE	0.92	0.116	PM_{10}
H850S1	PERC Heater - North Stack	3.60E-03	4.54E-04	1-hr PTE	0.21	0.026	1-hr PTE	2.62	0.33	1-hr PTE	2.62	0.33	PM_{10}
H850S2	PERC Heater - South Stack	5.00E-03	6.30E-04	1-hr PTE	0.21	0.026	1-hr PTE	2.2	0.277	1-hr PTE	2.2	0.277	PM_{10}
PAINTFE	miscellaneous painting fugitives	0	0		0	0		10.97	1.38	1-hr PTE	10.97	1.38	PM_{10}
A1660B	SR-3/4 Incinerator	24.46	3.08	24-hr MAX-C	2.8	0.353	1-hr PTE	0.48	0.06	1-hr PTE	0.48	0.06	PM_{10}
SR5STACK	SR5 Tail Gas Incinerator	20.12	2.54	24-hr MAX-C	11.67	1.47	1-hr PTE	0.52	0.066	1-hr PTE	0.52	0.066	PM_{10}
SR6STACK	SR6 Tail Gas Incinerator	7.33	0.924	24-hr MAX-C	3.44	0.433	1-hr PTE	0.27	0.034	1-hr PTE	0.27	0.034	PM_{10}
SR7STACK	SR7 Tail Gas Incinerator	11.83	1.49	24-hr MAX-C	3.44	0.433	1-hr PTE	0.27	0.034	1-hr PTE	0.27	0.034	PM_{10}
SR8STACK	SR8 Tail gas incinerator	8.57	1.08	24-hr MAX-C	4.64	0.585	1-hr PTE	0.37	0.047	1-hr PTE	0.37	0.047	PM_{10}
H9200	incinerator	0.1	0.013	1-hr PTE	6.92	0.872	1-hr PTE	0.4	0.05	1-hr PTE	0.4	0.05	PM_{10}
A1333	HIPA Flare	0	0		2.75	0.347	1-hr PTE	0	0		0	0	
BEETLE	BEETLE Stack	1.84	0.232	1-hr PTE	0	0		0	0		0	0	
FOL710	furnace	4.03	0.508	1-hr PTE	18.37	2.31	1-hr PTE	1.07	0.135	1-hr PTE	1.07	0.135	PM_{10}
FOL700	furnace	4.03	0.508	1-hr PTE	18.37	2.31	1-hr PTE	1.07	0.135	1-hr PTE	1.07	0.135	PM_{10}
VP31142	decoking vents	0	0		0.21	0.026	1-hr PTE	1.04	0.131	1-hr PTE	1.04	0.131	PM_{10}
FNFH3601	HT-III furnace	0.6	0.076	1-hr PTE	2.6	0.328	1-hr PTE	0.3	0.038	1-hr PTE	0.3	0.038	PM_{10}
OP2DCOK	OP-2 furnace decoking vent 1	0	0		0.3	0.038	1-hr PTE	1.2	0.151	1-hr PTE	1.2	0.151	PM_{10}
OP2DCOK2	OP-2 furnace decoking vent 2	0	0		0.3	0.038	1-hr PTE	1.2	0.151	1-hr PTE	1.2	0.151	PM_{10}
H1300	OXU Furnace	3.78	0.476	1-hr PTE	4.68	0.59	1-hr PTE	1.01	0.127	1-hr PTE	1.01	0.127	PM_{10}

Table 2-2 Emission Rates for All BART Eligible Units (Continued)

Model ID	Unit Description	SO_2 Emission Rate			NO_x Emission Rate			PM_{10} Emission Rate			$PM_{2.5}$ Emission Rate		
		(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis
FLOP3GRF	ground flare	301.69	38.01	24-hr MAX-C	57.22	7.21	1-hr PTE	0	0		0	0	
FOL130	pyrolysis furnace	1.2	0.151	1-hr PTE	6.48	0.816	24-hr MAX-C	3.3	0.416	1-hr PTE	3.3	0.416	PM_{10}
FOL170	pyrolysis furnace	1.2	0.151	1-hr PTE	7.4	0.933	24-hr MAX-C	3.3	0.416	1-hr PTE	3.3	0.416	PM_{10}
FOL180	pyrolysis furnace	1.2	0.151	1-hr PTE	9.88	1.24	24-hr MAX-C	3.3	0.416	1-hr PTE	3.3	0.416	PM_{10}
FOL100	pyrolysis furnace	1.2	0.151	1-hr PTE	7.74	0.975	24-hr MAX-C	3.3	0.416	1-hr PTE	3.3	0.416	PM_{10}
FOL110	pyrolysis furnace	1.2	0.151	1-hr PTE	6.35	0.801	24-hr MAX-C	3.3	0.416	1-hr PTE	3.3	0.416	PM_{10}
FOL120	pyrolysis furnace	1.2	0.151	1-hr PTE	7.92	0.998	24-hr MAX-C	3.3	0.416	1-hr PTE	3.3	0.416	PM_{10}
FP31180	Furnace F-P3-1180	6.72	0.847	1-hr PTE	28.56	3.6	1-hr PTE	1.76	0.222	1-hr PTE	1.76	0.222	PM_{10}
FP31140	Furnace F-P3-1140	10.29	1.3	1-hr PTE	29.7	3.74	24-hr MAX-P	2.7	0.34	1-hr PTE	2.7	0.34	PM_{10}
FP31060	Furnace F-P3-1060	9.3	1.17	1-hr PTE	26.85	3.38	24-hr MAX-P	2.44	0.307	1-hr PTE	2.44	0.307	PM_{10}
FP31090	Furnace F-P3-1090	5.03	0.634	1-hr PTE	22.48	2.83	24-hr MAX-P	1.32	0.166	1-hr PTE	1.32	0.166	PM_{10}
FP31110	Furnace F-P3-1110	9.3	1.17	24-hr MAX-P	26.79	3.38	1-hr PTE	2.44	0.307	24-hr MAX-P	2.44	0.307	PM_{10}
FP31040	Furnace F-P3-1040	8.4	1.06	24-hr MAX-P	55.35	6.97	1-hr PTE	2.2	0.278	24-hr MAX-P	2.2	0.278	PM_{10}
FP31130	Furnace F-P3-1130	9.3	1.17	24-hr MAX-P	25.82	3.25	1-hr PTE	2.44	0.307	24-hr MAX-P	2.44	0.307	PM_{10}
FP31050	Furnace F-P3-1050	9.3	1.17	1-hr PTE	26.85	3.38	24-hr MAX-P	2.44	0.307	1-hr PTE	2.44	0.307	PM_{10}
FOL603	Hydrogen Preheat Furnace	1.16	0.146	1-hr PTE	3.6	0.454	1-hr PTE	0.5	0.063	1-hr PTE	0.5	0.063	PM_{10}
FOL604	Gasoline Stabilizer Reboiler	1.1	0.139	1-hr PTE	4.9	0.617	1-hr PTE	0.6	0.076	1-hr PTE	0.6	0.076	PM_{10}
FOL601	Gas Oil Stabilizer Reboiler	1.2	0.151	1-hr PTE	3.8	0.479	1-hr PTE	0.6	0.076	1-hr PTE	0.6	0.076	PM_{10}
FOL602	Stage 3 Preheater Furnace	0.5	0.063	1-hr PTE	1.6	0.202	1-hr PTE	0.3	0.038	1-hr PTE	0.3	0.038	PM_{10}
H902	ACU Furnace	8	1.01	1-hr PTE	19.25	2.43	1-hr PTE	2.17	0.273	1-hr PTE	2.17	0.273	PM_{10}

Table 2-2 Emission Rates for All BART Eligible Units (Continued)

Model ID	Unit Description	SO_2 Emission Rate			NO_x Emission Rate			PM_{10} Emission Rate			$PM_{2.5}$ Emission Rate		
		(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis
FOL190	pyrolysis furnace	1.2	0.151	1-hr PTE	8.37	1.05	24-hr MAX-C	3.3	0.416	1-hr PTE	3.3	0.416	PM_{10}
H87920	steam boiler	5.11	0.644	1-hr PTE	30.24	3.81	1-hr PTE	56.35	7.1	1-hr PTE	56.35	7.1	PM_{10}
F8300	heavy ends furnace	0.33	0.042	1-hr PTE	2.02	0.255	1-hr PTE	0.2	0.025	1-hr PTE	0.2	0.025	PM_{10}
F8301	Regen furnace	0.2	0.025	1-hr PTE	0.5	0.063	1-hr PTE	0.1	0.013	1-hr PTE	0.1	0.013	PM_{10}
P87107	diesel engine (fire water pump)	0.5	0.063	1-hr PTE	7.4	0.932	1-hr PTE	0.5	0.063	1-hr PTE	0.5	0.063	PM_{10}
P87921	diesel engine (demin water pump)	0.1	0.013	1-hr PTE	1.9	0.239	1-hr PTE	0.1	0.013	1-hr PTE	0.1	0.013	PM_{10}
FOL140	pyrolysis furnace	1.2	0.151	1-hr PTE	6	0.756	24-hr MAX-C	3.3	0.416	1-hr PTE	3.3	0.416	PM_{10}
FOL150	pyrolysis furnace	1.2	0.151	1-hr PTE	8.98	1.13	24-hr MAX-C	3.3	0.416	1-hr PTE	3.3	0.416	PM_{10}
FOL160	pyrolysis furnace	1.2	0.151	1-hr PTE	10.09	1.27	24-hr MAX-C	3.3	0.416	1-hr PTE	3.3	0.416	PM_{10}
H87002	thermal oxidizer	0	0		3.15	0.397	1-hr PTE	0.15	0.019	1-hr PTE	0.15	0.019	PM_{10}
15A	loadout filter	0	0		0	0		0.2	0.025	1-hr PTE	0.2	0.025	PM_{10}
F20	hot oil furnace	0.34	0.043	1-hr PTE	1.26	0.159	1-hr PTE	0.1	0.013	1-hr PTE	0.1	0.013	PM_{10}
CG1	turbine/duct burner	7.9	0.995	1-hr PTE	10	1.26	24-hr MAX-C	12.3	1.55	1-hr PTE	12.3	1.55	PM_{10}
CG2	turbine/duct burner	7.9	0.995	1-hr PTE	10	1.26	24-hr MAX-C	12.3	1.55	1-hr PTE	12.3	1.55	PM_{10}
A1301	A&S Flare	3.42	0.431	1-hr PTE	20.31	2.56	1-hr PTE	0	0		0	0	
FP31120	Furnace F-P3-1120	9.3	1.17	24-hr MAX-P	22.1	2.78	1-hr PTE	2.44	0.307	24-hr MAX-P	2.44	0.307	PM_{10}
FP31030	Furnace F-P3-1030	8.4	1.06	24-hr MAX-P	30.44	3.84	1-hr PTE	2.2	0.278	24-hr MAX-P	2.2	0.278	PM_{10}
FP31010	Furnace F-P3-1010	8.4	1.06	24-hr MAX-P	25.96	3.27	1-hr PTE	2.2	0.278	24-hr MAX-P	2.2	0.278	PM_{10}
FP31020	Furnace F-P3-1020	8.4	1.06	24-hr MAX-P	55.35	6.97	1-hr PTE	2.2	0.278	24-hr MAX-P	2.2	0.278	PM_{10}
FP31080	Furnace F-P3-1080	9.3	1.17	1-hr PTE	26.85	3.38	24-hr MAX-P	2.44	0.307	1-hr PTE	2.44	0.307	PM_{10}
FP31070	Furnace F-P3-1070	9.3	1.17	1-hr PTE	26.85	3.38	24-hr MAX-P	2.44	0.307	1-hr PTE	2.44	0.307	PM_{10}

Table 2-2 Emission Rates for All BART Eligible Units (Continued)

Model ID	Unit Description	SO_2 Emission Rate			NO_x Emission Rate			PM_{10} Emission Rate			$PM_{2.5}$ Emission Rate		
		(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis	(lb/hr)	(g/s)	Basis
FP31100	Furnace F-P3-1100	5.03	0.634	1-hr PTE	22.48	2.83	24-hr MAX-P	1.32	0.166	1-hr PTE	1.32	0.166	PM_{10}

Basis Definitions:

1-hour PTE	1-hour Potential to Emit emission rate
24-hr MAX-C	Estimated 24-hour max emission rate based on CEMS data
24-hr MAX-P	Estimated 24-hour max emission rate based on 1-hr PTE values
PM_{10}	Assumed same emission ate as PM_{10}

3.0 First Stage Exemption Modeling (Using No-Obs Met)

The first stage of BART exemption modeling, as described in the previously submitted modeling protocol, includes the use of the preprocessed CALMET meteorological data set provided by CENRAP. This data set was processed with prognostic MM5 data only (in the No-Obs mode) and does not include observed meteorological data. The following 16 Class 1 areas were included in the modeled domain:

Table 3-1 Class I Areas Included in First Stage of Exemption Modeling

Class I Area Abbreviation	Class 1 Area Name
BAND	Bandelier, NM
BIBE	Big Bend, TX
BOAP	Bosque del Apache, NM
BRET	Breton, LA
CACR	Caney Creek, AR
CAVE	Carlsbad Caverns, NM
GRSA	Great Sand Dunes, CO
GUMO	Guadalupe Mountains, TX
HEGL	Hercules-Glades, MO
MING	Mingo, MO
PECO	Pecos, NM
SACR	Salt Creek, NM
UPBU	Upper Buffalo, AR
WHIT	White Mountain Wilderness, NM
WHPE	Wheeler Peak, NM
WIMO	Wichita Mountains, OK

In order to ensure that the modeled results are conservative, due to the use of meteorological data processed in the No-Obs mode, the maximum highest impact (rather than the 98th percentile 8th high) was compared to the 0.5 dv contribution threshold. Table 3-2 lists the results of the first stage exemption modeling.

Maximum impacts above 0.5 dv occur at Breton, Hercules-Glades, Salt Creek, Upper Buffalo, and Wichita Mountains. The 98th percentile (8th highest) impact is less than 0.5 dv at all Class 1 areas. Therefore, the second stage of the BART exemption modeling was performed with refined meteorological data so that the 8th highest impact may be compared to the contribution threshold.

Table 3-2 Modeled Impacts from the First Stage of Exemption Modeling

Initial Modeled Results:

Class I Area		Maximum Modeled Visibility Impact (dv)				No. of Days with Impacts > 0.5 dv			
		2001	2002	2003	Max	2001	2002	2003	Total
1	Bandelier, NM	0.049	0.176	0.068	0.176	0	0	0	0
2	Big Bend, TX	0.264	0.383	0.415	0.415	0	0	0	0
3	Bosque del Apache, NM	0.08	0.213	0.085	0.213	0	0	0	0
4	Breton, LA	0.848	0.409	0.488	0.848	1	0	0	1
5	Caney Creek, AR	0.518	0.564	0.472	0.564	1	1	0	2
6	Carlsbad Caverns, NM	0.379	0.316	0.261	0.379	0	0	0	0
7	Great Sand Dunes, CO	0.03	0.285	0.079	0.285	0	0	0	0
8	Guadalupe Mtns., TX	0.278	0.338	0.247	0.338	0	0	0	0
9	Hercules-Glades, MO	0.691	0.497	0.441	0.691	1	0	0	1
10	Mingo, MO	0.48	0.486	0.449	0.486	0	0	0	0
11	Pecos, NM	0.11	0.366	0.098	0.366	0	0	0	0
12	Salt Creek, NM	0.779	0.422	0.189	0.779	1	0	0	1
13	Upper Buffalo, AR	0.703	0.47	0.733	0.733	1	0	1	2
14	White Mountain Wilderness, NM	0.254	0.224	0.128	0.254	0	0	0	0
15	Wheeler Peak, NM	0.048	0.38	0.091	0.38	0	0	0	0
16	Wichita Mtns., OK	1.407	1.443	0.695	1.443	5	4	5	14

Modeled Results with Refinements[1]:

Class I Area		Maximum Modeled Visibility Impact (dv)				No. of Days with Impacts > 0.5 dv			
		2001	2002	2003	Max	2001	2002	2003	Total
4	Breton, LA	0.68			0.68	1	0	0	1
5	Caney Creek, AR	0.41	0.44		0.44	0	0		0
9	Hercules-Glades, MO	0.53			0.53	1			1
12	Salt Creek, NM	0.51			0.51	1			1
13	Upper Buffalo, AR	0.55		0.58	0.58	1		1	2
16	Wichita Mtns., OK	0.87	0.88	0.42	0.88	2	1	0	3

[1] Using model refinements with regard to particulate (section 2.1.1), Rayleigh scattering (section 2.1.2), and the new IMPROVE equation (section 2.1.3) for any impacts initially over 0.5 dv.

4.0 Second Stage Exemption Modeling (Using Refined Met)

The second stage of the BART exemption modeling involves the processing of a refined meteorological data set that includes observed data. This refined CALMET data, described in Appendix H of the modeling protocol, uses 6 km grid spacing. Additional information about the process of preparing the refined meteorological data set is provided in Appendix A of this document. The refined meteorological domain includes the SDP Facility, the Caney Creek Wilderness Area, the Wichita Mountains Wildlife Refuge, as well as a 50 km buffer. Figure 4-1 shows all of the observed met stations that were included in the refined data set.

Caney Creek and Wichita Mountains are the only two Class 1 areas to be included in the second stage of the BART exemption analysis because they are the closest and the most affected (with the highest predicted visibility impact) Class 1 areas, respectively, according to the first stage modeling results. If it can be shown that the predicted impacts to visibility are less than 0.5 dv at both of these Class 1 Areas, it is reasonable to assume that the impacts will be less than 0.5 dv at less affected (and further away) Class 1 areas. The federal regional haze rules state that, "if the highest modeled effects are observed at the nearest Class I area, you may choose not to analyze the other Class I areas any further as additional analyses might be unwarranted." Further description of this modeling method can be found in:

http://a257.g.akamaitech.net/7/257/2422/01jan20051800/edocket.access.gpo.gov/2005/pdf/05-12526.pdf.

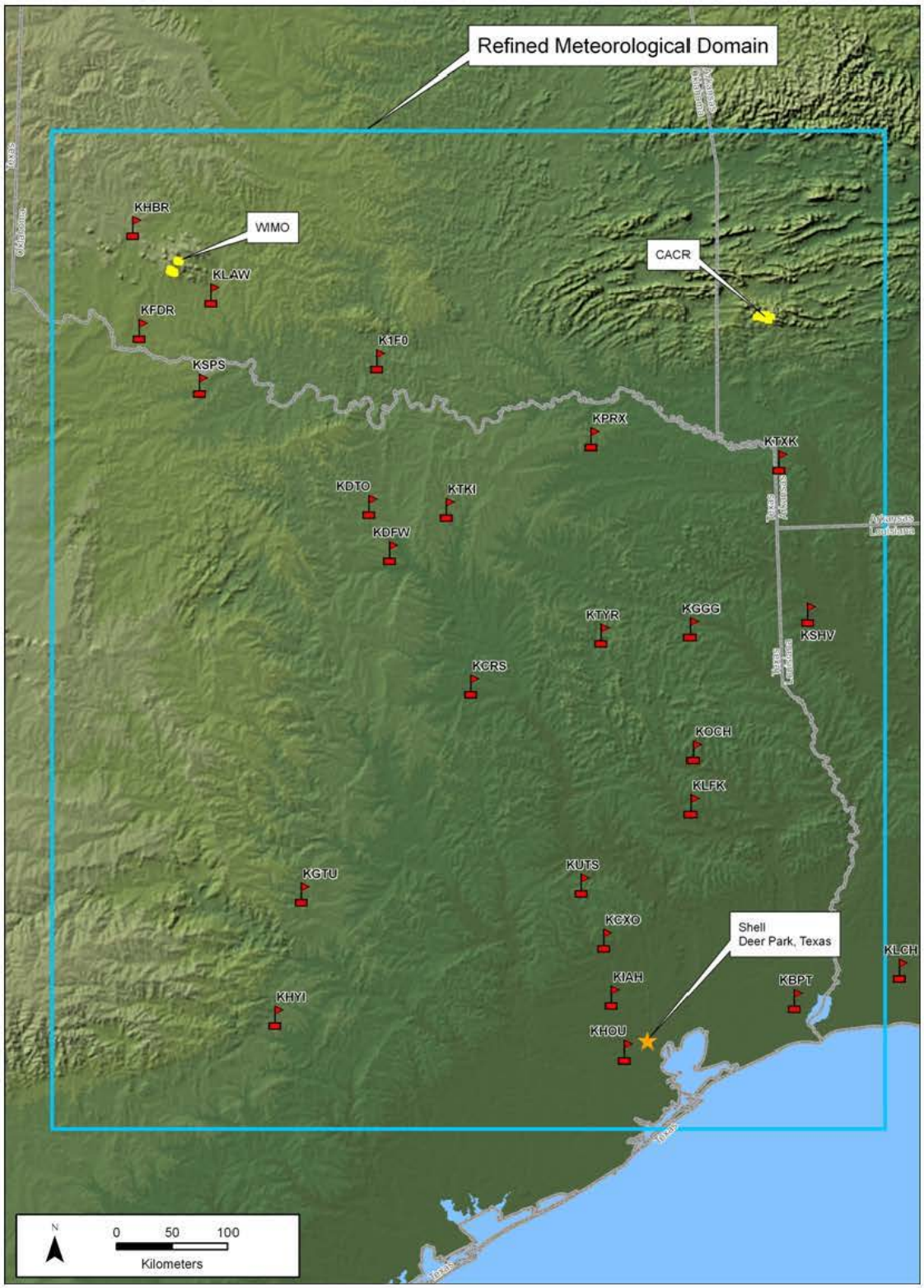
The 98th percentile highest impacts (the 8th highest impact) for each year were compared to the 0.5 dv contribution threshold. Table 4-1 lists the results of the second stage exemption modeling.

The highest modeled 8th-high impact was 0.106, which was predicted for the 2001 calendar year at Wichita Mountains. This value is below the threshold of 0.5 dv. These impacts, combined with the results of the first stage exemption modeling, indicate that the highest 8th-high impact would be less than 0.5 dv at all 16 Class 1 areas listed in Table 3-1. Therefore the SDP facility does not "contribute" to visibility impairment at any Class 1 area and is not subject to BART requirements.

Table 4-1 Modeled Impacts from the Second Stage of Exemption Modeling

Class I Area	Modeled 8th Highest Visibility Impact (dv)			8th High Impacts Over 0.5 (dv)?	No. of Days with Impacts > 0.5 dv		
	2001	2002	2003		2001	2002	2003
Caney Creek, AR	0.088	0.103	0.103	none	0	0	0
Wichita Mountains, OK	0.106	0.093	0.068	none	0	0	0

Figure 4-1 Surface Meteorological Stations in Model Domain



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Appendix A – Processing of Refined Meteorological Data

This appendix presents the configuration and settings for the refined meteorological fields using CALMET. Section 5.1 of the *CENRAP BART Modeling Guidelines* describes in detail the settings used in generating the CALMET screening meteorological fields (Alpine Geophysics, 2006). The CENRAP CALMET screening data were generated using the NOOBS option (described previously), meaning all meteorological parameters were computed directly from MM5 data alone.

For the refined CALMET data set, many of the CENRAP procedures were maintained, with the primary differences being the use of surface meteorological and precipitation data and a smaller computational grid. Other CENRAP parameters including geophysical data were used.

Hourly surface observations from 24 surface reporting stations were selected, each one within the modeled domain. These stations included the reporting of precipitation data. No upper air data was included since MM5 data have sufficiently resolved the upper air observations in time and space.

CENRAP provided the CALMET input files as well as the MM5 extracted data used to generate the CENRAP NOOBS Southern regional data set. For the most part, the same model options were used in the refined processing, except where noted.

Model Selection

The guidance provided on model section was to use the EPA-approved version of the CALPUFF/CALMET system. The TCEQ-recommended model versions are presented in Section V.C of *Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Texas (Final)*, January 2007. The selected preprocessors were those associated with the EPA-approved versions of the CALPUFF/CALMET system available from TRC's website (www.src.com). Some differences were noted from the TCEQ-stipulated preprocessor versions, as these particular versions could not be located on TRC's website. Table A-1 presents the proposed model versions and any noted differences from TCEQ guidance.

Table A-1. CALMET Processor Versions

PROCESSOR	VERSION (LEVEL)	
	TCEQ Recommended	Version Used
CTGPROC	2.42 (030709)	2.4 (030402)
TERREL	3.31 (030709)	3.3 (030402)
MAKEGEO	2.22 (030709)	2.2 (030402)
SMERGE	--	5.3 (030402)
CALMET	5.53a (040716)	Same

Domain

The domain, presented in Table A-2, encompasses the Shell Oil Deer Park facility, and both the Wichita Mountains and Caney Creek Wilderness Areas Class I areas, along with a 50 km buffer. Grid resolution was maintained at the CENRAP 6 km NOOBS grid

for consistency with the CENRAP protocols and settings although the grid was reduced in size to the area of interest. Figure 4-1, presented in Section 4.0, illustrates the domain for the refined meteorological data processing.

Table A-2. SDP Lambert Conic Conformal Modeling Domain Specifications (40.97 degree projection origin; 33 and 45 degree matching parallels).

SW Coordinate	Number of X Grid cells	Number of Y Grid cells	Horizontal Resolution (km)
-246.0, -1200.0	100	120	6

Preprocessing

CALMET requires both land use/land cover and terrain data for the application region. Land use and terrain data were obtained for the 6 km used by CENRAP. These data are generated using the CTGPROC, TERREL and MAKEGEO processors. The CALMET processing used the identical land use and terrain data sets used by CENRAP.

Terrain

Shuttle Radar Topography Mission (SRTM)-GTOPO 30 second (~1 km) resolution dataset was used to extract and process terrain data in terrel.

Land Use

United States Geological Survey (USGS) Global Land Cover Characterization (GLCC) version 2.0 database was used as supplied by CENRAP.

Surface Observations

Table A-3 presents the surface meteorological stations used in the refined modeling. Figure 4-1 in the text of the report illustrates the locations of these stations with respect to the model domain.

Surface observations for these 24 stations were extracted from the National Climatic Data Center (NCDC) Integrated Surface Hourly (ISH) compact disks (CDs) for the period of 2001 through 2003.

SMERGE

SMERGE was used to merge the 24 surface meteorological stations together into a single SURF.DAT file for input to CALMET. Rather than run PXTRACT and PMERGE, SMERGE was also used to generate the PRECIP.DAT file for input to CALMET. This is accomplished by using a modified CD144 record-- referred to as CD144 extended--which includes precipitation data. Use of this format is triggered in SMERGE via the option JDAT = 4.

Table A-3. Surface Meteorological Stations Included in Refined CALMET Processing

CALL	Description	ST	CO	LAT	LONG	ELEV	LCCX	LCCY
KLCH	LAKE CHARLES REGIONAL AR	LA	US	30.12	-93.23	4.6	365.51	-1086.44
KBPT	PORT ARTHUR JEFFERSON CO	TX	US	29.95	-94.02	4.9	289.57	-1108.24
KIAH	HOUSTON BUSH INTERCONTIN	TX	US	30	-95.37	29.0	158.31	-1105.99
KHOU	HOUSTON WILLIAM P HOBBY	TX	US	29.65	-95.28	13.4	167.79	-1144.90
KCXO	CONROE	TX	US	30.37	-95.42	75.0	152.74	-1064.82
KLFK	LUFKIN ANGELINA CO	TX	US	31.23	-94.75	85.6	215.12	-967.70
KUTS	HUNTSVILLE	TX	US	30.73	-95.58	111.0	136.64	-1024.96
KTYR	TYLER/POUNDS FLD	TX	US	32.35	-95.4	166.0	150.79	-844.56
KCRS	CORSICANA	TX	US	32.03	-96.4	136.0	56.78	-881.24
KGGG	LONGVIEW GREGG COUNTY AP	TX	US	32.38	-94.72	124.0	214.78	-839.86
KSHV	SHREVEPORT REGIONALARPT	LA	US	32.45	-93.82	77.4	299.26	-829.55
KOCH	NACOGDOCHES (AWOS)	TX	US	31.58	-94.72	108.0	217.01	-928.71
KHYI	SAN MARCOS MUNI	TX	US	29.88	-97.87	182.0	-84.63	-1120.40
KTKI	MCKINNEY MUNI ARPT	TX	US	33.18	-96.58	176.0	39.16	-753.71
KGTU	GEORGETOWN (AWOS)	TX	US	30.68	-97.68	240.0	-65.48	-1031.35
KPRX	PARIS/COX FIELD	TX	US	33.63	-95.45	167.0	143.66	-702.70
KDTO	DENTON (ASOS)	TX	US	33.2	-97.18	197.0	-16.78	-751.57
KDFW	DALLAS-FORT WORTH INTL A	TX	US	32.9	-97.02	170.7	-1.87	-784.85
KTXK	TEXARKANA WEBB FIELD	AR	US	33.45	-94	110.0	278.67	-719.27
KSPS	WICHITA FALLS MUNICIPAL	TX	US	33.98	-98.5	313.9	-138.38	-664.02
KHBR	HOBART MUNICIPAL AP	OK	US	35	-99.05	478.5	-186.57	-550.17
KFDR	FREDERICK MUNI	OK	US	34.33	-98.98	377.0	-181.82	-624.43
K1F0	ARDMORE	OK	US	34.15	-97.12	257.0	-11.05	-646.33
KLAW	LAWTON MUNICIPAL	OK	US	34.57	-98.42	338.0	-129.98	-598.83

CALMET Settings

CALMET settings used included many default values as well as values supplied in the CENRAP No-Obs analysis. Many of the settings are shown in the following tables.

Table A-4. CALMET Model Input Group 0: Input and Output File Names.

Parameter	CENRAP	Shell DP	Comments
Input	GEO.DAT		
Input	SURF.DAT		
Input	CLOUD.DAT		
Input	PRECIP.DAT		
Input	MM4.DAT		
Input	WT.DAT		
Output	CALMET.LST		
Output	CALMET.DAT		
Output	PACOUT.DAT		
NUSTA	0		Number of upper air stations
NOWSTA	0		Number of over water met stations
Input	UP1.DAT		
Input	UP2.DAT		
Input	UP3.DAT		
Input	SEA1.DAT	SEA1.DAT	
Input	DIAG.DAT	DIAG.DAT	
Input	PROG.DAT	PROG.DAT	
Output	TEST.PRT	TEST.PRT	
Output	TEST.OUT	TEST.OUT	
Output	TEST.KIN	TEST.KIN	
Output	TEST.FRD	TEST.FRD	
Output	TEST.SLP	TEST.SLP	

Table A-5. CALMET Model Input Group 1: General Run Control Parameters

Parameter	CENRAP	Shell DP	Comments
IBYR	2001	2001	Starting year (2001 thru 2003)
IBMO	1	1	Starting month (01 thru 12)
IBDY	1	1	Starting day (depends on MM5 extraction data set)
IBHR	1	1	Starting hour (depends on MM5 extraction data set)
IBTZ	0	0	Base time zone (00 = GMT)
IRLG	User	user	Length of run (depends on MM5 extraction data set)
IRTYPE	0	0	Run type (must = 1 to run CALPUFF)
LCALGRD	F	**T**	Compute CALGRID data fields
ITEST	2	2	Stop run after SETUP to do input QA

Table A-6. CALMET Model Input Group 2: Map Projection and Grid Control Parameters.

Parameter	CENRAP	Shell DP	Comments
PMAP	LCC	LCC	Map Projection
RLATO	40N	40N	Latitude (dec. degrees) of projection origin
RLONO	97W	97W	Longitude (dec. degrees) of projection origin
XLAT1	33N	33N	Matching parallel(s) of latitude for projection
XLAT2	45N	45N	Matching parallel(s) of latitude for projection
DATUM	WGS-G	WGS-G	
NX	300	**100**	Number of X grid cells in meteorological grid
NY	192	**120**	Number of Y grid cells in meteorological grid
DGRIDKM	6.0	**6.0**	Grid spacing, km
XORIGKM	-1008.	**-246.0**	Ref. Coordinate of SW corner of grid cell (1,1)
YORIGKM	0.0	**-1200.0**	Ref. Coordinate of SW corner of grid cell (1,1)
NZ	10	10	No. of vertical layers
ZFACE	0, 20 40, 80, 160, 320, 640, 1200, 2000, 3000, 4000	0, 20 40, 80, 160, 320, 640, 1200, 2000, 3000, 4000	Cell face heights in arbitrary vertical grid, m

Table A-7. CALMET Model Input Group 3: Output Options.

Parameter	CENRAP	Shell DP	Comments
LSAVE	T	T	Disk output option
IFORMO	1	1	Type of unformatted output file
LPRINT	F	F	Print met fields
IPRINF	1	1	Print intervals
IUVOUT(NZ)	NZ*0	NZ*0	Specify layers of u,v wind components to print
IWOUT(NZ)	NZ*0	NZ*0	Specify layers of w wind component to print
ITOUT(NZ)	NZ*0	NZ*0	Specify levels of 3-D temperature field to print
LDB	F	F	Print input met data and variables
NN1	1	1	First time step for debug data to be printed
NN2	1	1	Last time step for debug data to be printed
IOUTD	0	0	Control variable for writing test/debug wind fields
NZPRN2	1	0	Number of levels starting at surface to print
IPR0	0	0	Print interpolated wind components
IPR1	0	0	Print terrain adjusted surface wind components
IPR2	0	0	Print initial divergence fields
IPR3	0	0	Print final wind speed and direction
IPR4	0	0	Print final divergence fields
IPR5	0	0	Print winds after kinematic effects
IPR6	0	0	Print winds after Froude number adjustment
IPR7	0	0	Print winds after slope flows are added
IPR8	0	0	Print final wind field components

Table A-8. CALMET Model Input Group 4: Meteorological Data Options

Parameter	CENRAP	Shell DP	Comments
NOOBS	2	**1**	1 = surface air observations; use MM5 for overwater, and upper air data
NSSTA	0	**24**	Number of meteorological surface stations
NPSTA	0	**24**	Number of precipitation stations
ICLOUD	3	3	Gridded cloud fields
IFORMS	2	2	Formatted surface meteorological data file
IFORMP	2	2	Formatted surface precipitation data file
IFORMC	2	2	Formatted cloud data file

Table A-9. CALMET Model Input Group 5: Windfield Options and Parameters.

Parameter	CENRAP	Shell DP	Comments
IWFCOD	1	1	Model selection variable
IFRADJ	1	1	Compute Froude number adjustment effects?
IKINE	0	0	Compute kinematic effects?
IOBR	0	0	Use O'Brien (1970) vertical velocity adjustment?
ISLSOPE	1	1	Compute slope flow effects?
IEXTRP	-4	**1**	Extrapolate surface wind obs to upper levels?
ICALM	0	0	Extrapolate surface winds even if calm?
BIAS	NZ*0	0, 0, 0, 0, 0, 0, 0, 0, 0, 0	Layer-dependent biases weighting aloft measurements
RMIN2	4.	-1.0	Minimum vertical extrapolation distance
IPROG	14	14	14 = Yes, use winds from MM5.DAT file as initial guess field [IWFCOD = 1
ISTEPPG	1	1	MM5 output timestep
LVARY	T	T	Use varying radius of influence
RMAX1	--	**50**	Maximum radius of influence over land in sfc layer
RMAX2	--	**100**	Maximum radius of influence over land aloft
RMAX3	--	**100**	Maximum radius of influence over water
RMIN	0.1	0.1	Minimum radius of influence used anywhere
TERRAD	--	12.	Terrain features radius of influence
R1	--	1.	Weighting of first guess surface field
R2	--	15	Weighting of first guess aloft field

Table A-9. CALMET Model Input Group 5: Windfield Options and Parameters (Continued)

Parameter	CENRAP	Shell DP	Comments
RPROG	--	0.	MM5 windfield weighting parameter
DIVLIM	5.E-6	5.E-6	Minimum divergence criterion
NITER	50	50	Number of divergence minimization iterations
NSMMTH	2, 4, 4, 4, 4, 4, 4	2, 4, 4, 4, 4, 4, 4	Number of passes through smoothing filter in each layer of CALMET
NITR2	5, 5, 5, 5, 5, 5, 5, 5, 5, 5	5, 5, 5, 5, 5, 5, 5, 5, 5, 5	Maximum number of stations used in each layer for the interpolation of data to a grid point
CRITFN	1.0	1.0	Critical Froude number
ALPHA	0.1	0.1	Kinematic effects parameter
FEXTR2	NZ*0.0	NZ*0.0	Scaling factor for extrapolating sfc winds aloft
NBAR	0	0	Number of terrain barriers
IDIOTP1	0	0	Surface temperature computation switch
ISURFT	--	8	Number of sfc met stations to use for temp calcs
IDIOPT2	0	0	Domain-averaged lapse rate switch
IUPT	2	1	Upper air stations to use for lapse rate calculation
ZUPT	200.	200.	Depth through which lapse rate is calculated
IDIOPT3	0	0	Domain-averaged wind component switch
IUPWND	-1	-1	Number of aloft stations to use for wind calc
ZUPWND	1., 1000.	1., 1000.	Bottom and top of layer through which the domain-scale winds are computed
IDIOPT4	0	0	Observed surface wind component switch
IDIOPT5	0	0	Observed aloft wind component switch
LLBREZE	F	F	Use Lake Breeze Module
NBOX	0	0	Number of lake breeze regions
NLB	--	0	Number of stations in the region
METBXID(NLB)	--	0	Station ID's in the region

Table A-10. CALMET Model Input Group 6: Mixing Height, Temperature and Precipitation.

Parameter	CENRAP	Shell DP	Comments
CONSTB	1.41	1.41	Neutral stability mixing height coefficient
CONSTE	0.15	0.15	Convective stability mixing height coefficient
CONSTN	2400.	2400.	Stable stability maxing height coefficient
CONSTW	0.16	0.16	Overwater mixing height coefficient
FCORIOL	1.E-4	1.E-4	Absolute value of Coriolis parameter
IAVEZI	1	1	Conduct spatial averaging? Yes = 1
MNMDAV	1	10	Maximum search radius in averaging process
HAFANG	30.	30.	Half-angle of upwind looking cone for averaging
ILEVZI	1	1	Layers of wind use in upwind averaging
DPTMIN	0.001	0.001	Minimum potential temperature lapse rate in the stable layer above the current convective mixing ht
DZZI	200.	200.	Depth of layer above current conv. mixing height through which lapse rate is computed
ZIMIN	50.	50.	Minimum overland mixing height
ZIMAX	3000.	3000.	Maximum overland mixing height
ZIMINW	50.	50.	Minimum overwater mixing height
ZIMAXW	3000.	3000.	Maximum overwater mixing height
ITPROG	2	**1**	3D temperature from observations or from MM5?
IRAD	1	1	Type of interpolation; 1 = 1/R
TRADKM	500.	36.	Temperature interpolation radius of influence
NUMTS	5	5	Max number of stations for temp interpolation
IAVET	1	1	Spatially average temperatures? 1 = yes
TGDEFB	-.0098	-.0098	Temp gradient below mixing height over water

Table A-10. CALMET Model Input Group 6: Mixing Height, Temperature and Precipitation (Continued)

Parameter	CENRAP	Shell DP	Comments
TGDEFA	-.0045	-.0045	Temp gradient above mixing height over water
JWAT1	55	55	Beginning land use categories over water
JWAT2	55	55	Ending land use categories for water
NFLAGP	2	2	Precipitation interpolation flag; 2 = 1/R-squared
SIGMAP	50.	50.	Radius of influence for precipitation interpolation
CUTP	0.01	0.01	Minimum precipitation rate cutoff (mm/hr)

Sample CALMET input file attached

```
IP Texarkana BART Refined CALMET: Caney Creek, 4km Resolution
Run Identifier: 20070425 (ICLOUD=3; R1 = 15.)
MM5 w/ Surface Obs: 13 Sfc/Precip Stations
---------------- Run title (3 lines)
-----------------------------------------

                    CALMET MODEL CONTROL FILE
                    -------------------------

-----------------------------------------------------------------------
-------

INPUT GROUP: 0 -- Input and Output File Names


Subgroup (a)
------------
Default Name  Type          File Name
------------  ----          ---------
GEO.DAT       input    ! GEODAT=S:\CALMET\MAKEGEO\GEO.04KM.SOUTH.DAT
!
SURF.DAT      input    ! SRFDAT=S:\CALMET\SURF\SMERGE\IP_SURF.DAT
!
CLOUD.DAT     input    * CLDDAT=            *
PRECIP.DAT    input    ! PRCDAT=S:\CALMET\SURF\SMERGE\PRECIP.DAT
!
MM4.DAT       input    ! MM4DAT=S:\2002\extracted_2002_01_cenrap_
36km.unx  !
WT.DAT        input    * WTDAT=             *

CALMET.LST    output   ! METLST=CALMET_2002_01.LST     !
CALMET.DAT    output   ! METDAT=CALMET_2002_01.DAT !
PACOUT.DAT    output   * PACDAT=            *

All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = T !
         F = UPPER CASE

NUMBER OF UPPER AIR & OVERWATER STATIONS:

    Number of upper air stations (NUSTA)  No default     ! NUSTA =  0  !
    Number of overwater met stations
                                 (NOWSTA) No default     ! NOWSTA =  0
!

                       !END!
-----------------------------------------------------------------------
--------
Subgroup (b)
---------------------------------
Upper air files (one per station)
---------------------------------
Default Name  Type       File Name
------------  ----       ---------
-----------------------------------------------------------------------
--------
Subgroup (c)
----------------------------------------
Overwater station files (one per station)
----------------------------------------
```

```
Default Name  Type       File Name
------------  ----       ---------
------------------------------------------------------------------------
--------
Subgroup (d)
----------------
Other file names
----------------

Default Name  Type       File Name
------------  ----       ---------
DIAG.DAT      input      * DIADAT=                  *
PROG.DAT      input      * PRGDAT=                  *

TEST.PRT      output     * TSTPRT=                  *
TEST.OUT      output     * TSTOUT=                  *
TEST.KIN      output     * TSTKIN=                  *
TEST.FRD      output     * TSTFRD=                  *
TEST.SLP      output     * TSTSLP=                  *

------------------------------------------------------------------------
--------
NOTES: (1) File/path names can be up to 70 characters in length
       (2) Subgroups (a) and (d) must have ONE 'END' (surround by
           delimiters) at the end of the group
       (3) Subgroups (b) and (c) must have an 'END' (surround by
           delimiters) at the end of EACH LINE

                        !END!


------------------------------------------------------------------------
-------

INPUT GROUP: 1 -- General run control parameters
--------------

     Starting date:   Year (IBYR) -- No default       ! IBYR=  2002  !
                     Month (IBMO) -- No default       ! IBMO=    01  !
                       Day (IBDY) -- No default       ! IBDY=    01  !
                      Hour (IBHR) -- No default       ! IBHR=    00  !

     Base time zone        (IBTZ) -- No default       ! IBTZ=    00  !
        PST = 08, MST = 07
        CST = 06, EST = 05

     Length of run (hours) (IRLG) -- No default       ! IRLG=   744  !

     Run type            (IRTYPE) -- Default: 1       ! IRTYPE=  01 !

        0 = Computes wind fields only
        1 = Computes wind fields and micrometeorological variables
            (u*, w*, L, zi, etc.)
        (IRTYPE must be 1 to run CALPUFF or CALGRID)

     Compute special data fields required
     by CALGRID (i.e., 3-D fields of W wind
     components and temperature)
     in additional to regular            Default: T    ! LCALGRD = T !
     fields ? (LCALGRD)
     (LCALGRD must be T to run CALGRID)
```

```
      Flag to stop run after
      SETUP phase (ITEST)             Default: 2       ! ITEST=  2   !
      (Used to allow checking
      of the model inputs, files, etc.)
      ITEST = 1 - STOPS program after SETUP phase
      ITEST = 2 - Continues with execution of
                  COMPUTATIONAL phase after SETUP

!END!

-----------------------------------------------------------------------
-------

INPUT GROUP: 2 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                      Default: UTM    ! PMAP = LCC  !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                     Default=0.0     ! FEAST  = 0.000  !
     (FNORTH)                    Default=0.0     ! FNORTH = 0.000  !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                    No Default      ! IUTMZN =  14   !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                    Default: N      ! UTMHEM = N  !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                     No Default      ! RLAT0 =  40N  !
     (RLON0)                     No Default      ! RLON0 =  97W  !

         TTM :  RLON0 identifies central (true N/S) meridian of
projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of
projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of
projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
                RLAT0 is REPLACED by 0.0N (Equator)
```

```
         LAZA:  RLON0 identifies longitude of tangent-point of mapping
plane
                RLAT0 identifies latitude of tangent-point of mapping
plane

     Matching parallel(s) of latitude (decimal degrees) for projection
     (Used only if PMAP= LCC or PS)
     (XLAT1)                    No Default      ! XLAT1 =  33N  !
     (XLAT2)                    No Default      ! XLAT2 =  45N  !

         LCC :  Projection cone slices through Earth's surface at XLAT1
and XLAT2
         PS  :  Projection plane slices through Earth at XLAT1
                (XLAT2 is not used)

     ----------
     Note:  Latitudes and longitudes should be positive, and include a
            letter N,S,E, or W indicating north or south latitude, and
            east or west longitude.  For example,
            35.9  N Latitude  =  35.9N
            118.7 E Longitude = 118.7E


     Datum-region
     ------------

     The Datum-Region for the coordinates is identified by a character
     string.  Many mapping products currently available use the model of
the
     Earth known as the World Geodetic System 1984 (WGS-G ).  Other
local
     models may be in use, and their selection in CALMET will make its
output
     consistent with local mapping products.  The list of Datum-Regions
with
     official transformation parameters is provided by the National
Imagery and
     Mapping Agency (NIMA).

     NIMA Datum - Regions(Examples)

-------------------------------------------------------------------------
------
     WGS-G     WGS-84 GRS 80 Spheroid, Global coverage (WGS84)
     NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS
(NAD27)
     NWS-27    NWS 6370KM Radius, Sphere
     NWS-84    NWS 6370KM Radius, Sphere
     ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

     Datum-region for output coordinates
     (DATUM)                    Default: WGS-G     ! DATUM = WGS-G  !


     Horizontal grid definition:
     ---------------------------

     Rectangular grid defined for projection PMAP,
     with X the Easting and Y the Northing coordinate

            No. X grid cells (NX)      No default     ! NX =   30  !
```

```
            No. Y grid cells (NY)      No default     ! NY =   60  !

     Grid spacing (DGRIDKM)            No default     ! DGRIDKM = 4. !
                                       Units: km

     Reference grid coordinate of
     SOUTHWEST corner of grid cell (1,1)

        X coordinate (XORIGKM)         No default     ! XORIGKM = 207.0
!
        Y coordinate (YORIGKM)         No default     ! YORIGKM =-795.0
!
                                       Units: km


     Vertical grid definition:
     -------------------------

        No. of vertical layers (NZ)    No default     ! NZ =  10  !

        Cell face heights in arbitrary
        vertical grid (ZFACE(NZ+1))    No defaults
                                       Units: m
        ! ZFACE = 0.,20.,40.,80.,160.,320.,640.,1200.,2000.,3000.,4000.
!

!END!


------------------------------------------------------------------------
-------

INPUT GROUP: 3 -- Output Options
--------------


    DISK OUTPUT OPTION

       Save met. fields in an unformatted
       output file ?              (LSAVE)  Default: T     ! LSAVE = T !
       (F = Do not save, T = Save)

       Type of unformatted output file:
       (IFORMO)                            Default: 1    ! IFORMO =  1
!

            1 = CALPUFF/CALGRID type file (CALMET.DAT)
            2 = MESOPUFF-II type file     (PACOUT.DAT)


    LINE PRINTER OUTPUT OPTIONS:

       Print met. fields ?  (LPRINT)       Default: F     ! LPRINT = F !
       (F = Do not print, T = Print)
       (NOTE: parameters below control which
              met. variables are printed)

       Print interval
       (IPRINF) in hours                   Default: 1     ! IPRINF =  1
!
       (Meteorological fields are printed
```

```
 every  1  hours)


Specify which layers of U, V wind component
to print (IUVOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
(used only if LPRINT=T)        Defaults: NZ*0
! IUVOUT =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0  !
------------------------


Specify which levels of the W wind component to print
(NOTE: W defined at TOP cell face --  10  values)
(IWOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
(used only if LPRINT=T & LCALGRD=T)
-----------------------------------
                                     Defaults: NZ*0
 ! IWOUT =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0  !


Specify which levels of the 3-D temperature field to print
(ITOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
(used only if LPRINT=T & LCALGRD=T)
-----------------------------------
                                     Defaults: NZ*0
 ! ITOUT =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0  !

Specify which meteorological fields
to print
(used only if LPRINT=T)             Defaults: 0 (all variables)
------------------------


  Variable            Print ?
                  (0 = do not print,
                   1 = print)
  --------        ------------------

!  STABILITY  =          0           ! - PGT stability class
!  USTAR      =          0           ! - Friction velocity
!  MONIN      =          0           ! - Monin-Obukhov length
!  MIXHT      =          0           ! - Mixing height
!  WSTAR      =          0           ! - Convective velocity
scale
!  PRECIP     =          0           ! - Precipitation rate
!  SENSHEAT   =          0           ! - Sensible heat flux
!  CONVZI     =          0           ! - Convective mixing ht.


Testing and debug print options for micrometeorological module

   Print input meteorological data and
   internal variables (LDB)         Default: F       ! LDB = F !
   (F = Do not print, T = print)
   (NOTE: this option produces large amounts of output)

   First time step for which debug data
   are printed (NN1)                Default: 1       ! NN1 =  1
!
```

```
          Last time step for which debug data
          are printed (NN2)                Default: 1       ! NN2 =  1
!


       Testing and debug print options for wind field module
       (all of the following print options control output to
        wind field module's output files: TEST.PRT, TEST.OUT,
        TEST.KIN, TEST.FRD, and TEST.SLP)

          Control variable for writing the test/debug
          wind fields to disk files (IOUTD)
          (0=Do not write, 1=write)        Default: 0       ! IOUTD =  0
!

          Number of levels, starting at the surface,
          to print (NZPRN2)                Default: 1       ! NZPRN2 =
0  !

          Print the INTERPOLATED wind components ?
          (IPR0) (0=no, 1=yes)             Default: 0       !  IPR0 =  0
!

          Print the TERRAIN ADJUSTED surface wind
          components ?
          (IPR1) (0=no, 1=yes)             Default: 0       !  IPR1 =  0
!

          Print the SMOOTHED wind components and
          the INITIAL DIVERGENCE fields ?
          (IPR2) (0=no, 1=yes)             Default: 0       !  IPR2 =  0
!

          Print the FINAL wind speed and direction
          fields ?
          (IPR3) (0=no, 1=yes)             Default: 0       !  IPR3 =  0
!

          Print the FINAL DIVERGENCE fields ?
          (IPR4) (0=no, 1=yes)             Default: 0       !  IPR4 =  0
!

          Print the winds after KINEMATIC effects
          are added ?
          (IPR5) (0=no, 1=yes)             Default: 0       !  IPR5 =  0
!

          Print the winds after the FROUDE NUMBER
          adjustment is made ?
          (IPR6) (0=no, 1=yes)             Default: 0       !  IPR6 =  0
!

          Print the winds after SLOPE FLOWS
          are added ?
          (IPR7) (0=no, 1=yes)             Default: 0       !  IPR7 =  0
!

          Print the FINAL wind field components ?
          (IPR8) (0=no, 1=yes)             Default: 0       !  IPR8 =  0
!
```

```
!END!

-----------------------------------------------------------------------
-------

INPUT GROUP: 4 -- Meteorological data options
--------------

    NO OBSERVATION MODE             (NOOBS)  Default: 0     ! NOOBS =  1
!
          0 = Use surface, overwater, and upper air stations
          1 = Use surface and overwater stations (no upper air
observations)
              Use MM5 for upper air data
          2 = No surface, overwater, or upper air observations
              Use MM5 for surface, overwater, and upper air data

    NUMBER OF SURFACE & PRECIP. METEOROLOGICAL STATIONS

       Number of surface stations   (NSSTA)  No default     ! NSSTA =
13  !

       Number of precipitation stations
       (NPSTA=-1: flag for use of MM5 precip data)
                                    (NPSTA)  No default     ! NPSTA =
13  !

    CLOUD DATA OPTIONS
       Gridded cloud fields:
                                   (ICLOUD)  Default: 0     ! ICLOUD =
3  !
       ICLOUD = 0 - Gridded clouds not used
       ICLOUD = 1 - Gridded CLOUD.DAT generated as OUTPUT
       ICLOUD = 2 - Gridded CLOUD.DAT read as INPUT
       ICLOUD = 3 - Gridded cloud cover from Prognostic Rel. Humidity

    FILE FORMATS

       Surface meteorological data file format
                                   (IFORMS)  Default: 2     ! IFORMS =
2  !
       (1 = unformatted (e.g., SMERGE output))
       (2 = formatted   (free-formatted user input))

       Precipitation data file format
                                   (IFORMP)  Default: 2     ! IFORMP =
2  !
       (1 = unformatted (e.g., PMERGE output))
       (2 = formatted   (free-formatted user input))

       Cloud data file format
                                   (IFORMC)  Default: 2     ! IFORMC =
1  !
       (1 = unformatted - CALMET unformatted output)
       (2 = formatted   - free-formatted CALMET output or user input)

!END!
```

```
-----------------------------------------------------------------------
-------

INPUT GROUP: 5 -- Wind Field Options and Parameters
--------------


    WIND FIELD MODEL OPTIONS
       Model selection variable (IWFCOD)     Default: 1      ! IWFCOD =
1  !
          0 = Objective analysis only
          1 = Diagnostic wind module

       Compute Froude number adjustment
       effects ? (IFRADJ)                    Default: 1      ! IFRADJ =
1  !
       (0 = NO, 1 = YES)

       Compute kinematic effects ? (IKINE)   Default: 0      ! IKINE  =
0  !
       (0 = NO, 1 = YES)

       Use O'Brien procedure for adjustment
       of the vertical velocity ? (IOBR)     Default: 0      ! IOBR =  0
!
       (0 = NO, 1 = YES)

       Compute slope flow effects ? (ISLOPE) Default: 1      ! ISLOPE  =
1  !
       (0 = NO, 1 = YES)

       Extrapolate surface wind observations
       to upper layers ? (IEXTRP)            Default: -4     ! IEXTRP =
1  !
       (1 = no extrapolation is done,
        2 = power law extrapolation used,
        3 = user input multiplicative factors
            for layers 2 - NZ used (see FEXTRP array)
        4 = similarity theory used
        -1, -2, -3, -4 = same as above except layer 1 data
            at upper air stations are ignored

       Extrapolate surface winds even
       if calm? (ICALM)                      Default: 0      ! ICALM  =
0  !
       (0 = NO, 1 = YES)

       Layer-dependent biases modifying the weights of
       surface and upper air stations (BIAS(NZ))
         -1<=BIAS<=1
       Negative BIAS reduces the weight of upper air stations
         (e.g. BIAS=-0.1 reduces the weight of upper air stations
       by 10%; BIAS= -1, reduces their weight by 100 %)
       Positive BIAS reduces the weight of surface stations
         (e.g. BIAS= 0.2 reduces the weight of surface stations
       by 20%; BIAS=1 reduces their weight by 100%)
       Zero BIAS leaves weights unchanged (1/R**2 interpolation)
       Default: NZ*0
                                  ! BIAS =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0
,  0 ,  0 ,  0  !
```

```
       Minimum distance from nearest upper air station
       to surface station for which extrapolation
       of surface winds at surface station will be allowed
       (RMIN2: Set to -1 for IEXTRP = 4 or other situations
        where all surface stations should be extrapolated)
                                             Default: 4.    ! RMIN2 =
4.0 !

       Use gridded prognostic wind field model
       output fields as input to the diagnostic
       wind field model (IPROG)              Default: 0      ! IPROG =
14  !
       (0 = No, [IWFCOD = 0 or 1]
        1 = Yes, use CSUMM prog. winds as Step 1 field, [IWFCOD = 0]
        2 = Yes, use CSUMM prog. winds as initial guess field [IWFCOD =
1]
        3 = Yes, use winds from MM4.DAT file as Step 1 field [IWFCOD =
0]
        4 = Yes, use winds from MM4.DAT file as initial guess field
[IWFCOD = 1]
        5 = Yes, use winds from MM4.DAT file as observations [IWFCOD =
1]
        13 = Yes, use winds from MM5.DAT file as Step 1 field [IWFCOD =
0]
        14 = Yes, use winds from MM5.DAT file as initial guess field
[IWFCOD = 1]
        15 = Yes, use winds from MM5.DAT file as observations [IWFCOD =
1]

       Timestep (hours) of the prognostic
       model input data   (ISTEPPG)          Default: 1      ! ISTEPPG =
1   !

    RADIUS OF INFLUENCE PARAMETERS

       Use varying radius of influence       Default: F      ! LVARY =
F!
       (if no stations are found within RMAX1,RMAX2,
        or RMAX3, then the closest station will be used)

       Maximum radius of influence over land
       in the surface layer (RMAX1)          No default      ! RMAX1 =
50. !
                                             Units: km
       Maximum radius of influence over land
       aloft (RMAX2)                         No default      ! RMAX2 =
100. !
                                             Units: km
       Maximum radius of influence over water
       (RMAX3)                               No default      ! RMAX3 =
100. !
                                             Units: km


    OTHER WIND FIELD INPUT PARAMETERS

       Minimum radius of influence used in
       the wind field interpolation (RMIN)   Default: 0.1    ! RMIN =
0.1 !
                                             Units: km
       Radius of influence of terrain
```

```
       features (TERRAD)                     No default      ! TERRAD =
12. !

                                             Units: km
       Relative weighting of the first
       guess field and observations in the
       SURFACE layer (R1)                    No default      ! R1 = 15.
!
       (R1 is the distance from an           Units: km
       observational station at which the
       observation and first guess field are
       equally weighted)

       Relative weighting of the first
       guess field and observations in the
       layers ALOFT (R2)                     No default      ! R2 = 15.
!
       (R2 is applied in the upper layers    Units: km
       in the same manner as R1 is used in
       the surface layer).

       Relative weighting parameter of the
       prognostic wind field data (RPROG)    No default      ! RPROG =
0. !
       (Used only if IPROG = 1)              Units: km
       ------------------------

       Maximum acceptable divergence in the
       divergence minimization procedure
       (DIVLIM)                              Default: 5.E-6  ! DIVLIM=
5.0E-06 !

       Maximum number of iterations in the
       divergence min. procedure (NITER)     Default: 50     ! NITER =
50  !

       Number of passes in the smoothing
       procedure (NSMTH(NZ))
       NOTE: NZ values must be entered
            Default: 2,(mxnz-1)*4 ! NSMTH =
 2 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4  !

       Maximum number of stations used in
       each layer for the interpolation of
       data to a grid point (NINTR2(NZ))
       NOTE: NZ values must be entered       Default: 99.    ! NINTR2 =
 5 ,  5 ,  5 ,  5 ,  5 ,  5 ,  5 ,  5 ,  5 ,  5  !

       Critical Froude number (CRITFN)       Default: 1.0    ! CRITFN =
1. !

       Empirical factor controlling the
       influence of kinematic effects
       (ALPHA)                               Default: 0.1    ! ALPHA =
0.1 !

       Multiplicative scaling factor for
       extrapolation of surface observations
       to upper layers (FEXTR2(NZ))          Default: NZ*0.0
       ! FEXTR2 = 0., 0., 0., 0., 0., 0., 0., 0., 0., 0. !
       (Used only if IEXTRP = 3 or -3)
```

```
    BARRIER INFORMATION

       Number of barriers to interpolation
       of the wind fields (NBAR)             Default: 0      ! NBAR =  0
!

       THE FOLLOWING 4 VARIABLES ARE INCLUDED
       ONLY IF NBAR > 0
       NOTE: NBAR values must be entered     No defaults
             for each variable               Units: km

          X coordinate of BEGINNING
          of each barrier (XBBAR(NBAR))      ! XBBAR = 0. !
          Y coordinate of BEGINNING
          of each barrier (YBBAR(NBAR))      ! YBBAR = 0. !

          X coordinate of ENDING
          of each barrier (XEBAR(NBAR))      ! XEBAR = 0. !
          Y coordinate of ENDING
          of each barrier (YEBAR(NBAR))      ! YEBAR = 0. !


    DIAGNOSTIC MODULE DATA INPUT OPTIONS

       Surface temperature (IDIOPT1)         Default: 0      ! IDIOPT1 =
0  !
          0 = Compute internally from
              hourly surface observations
          1 = Read preprocessed values from
              a data file (DIAG.DAT)

          Surface met. station to use for
          the surface temperature (ISURFT)   No default     ! ISURFT =
8  !
          (Must be a value from 1 to NSSTA)
          (Used only if IDIOPT1 = 0)
          --------------------------

       Domain-averaged temperature lapse
       rate (IDIOPT2)                        Default: 0     ! IDIOPT2 =
0  !
          0 = Compute internally from
              twice-daily upper air observations
          1 = Read hourly preprocessed values
              from a data file (DIAG.DAT)

          Upper air station to use for
          the domain-scale lapse rate (IUPT) No default     ! IUPT   =
1  !
          (Must be a value from 1 to NUSTA)
          (Used only if IDIOPT2 = 0)
          --------------------------

          Depth through which the domain-scale
          lapse rate is computed (ZUPT)      Default: 200.  ! ZUPT =
200. !
          (Used only if IDIOPT2 = 0)         Units: meters
          --------------------------
```

```
       Domain-averaged wind components
       (IDIOPT3)                              Default: 0     ! IDIOPT3 =
0  !
          0 = Compute internally from
              twice-daily upper air observations
          1 = Read hourly preprocessed values
              a data file (DIAG.DAT)

          Upper air station to use for
          the domain-scale winds (IUPWND)    Default: -1    ! IUPWND = -
1  !
          (Must be a value from -1 to NUSTA)
          (Used only if IDIOPT3 = 0)
          --------------------------

          Bottom and top of layer through
          which the domain-scale winds
          are computed
          (ZUPWND(1), ZUPWND(2))        Defaults: 1., 1000. ! ZUPWND=
1., 1000. !
          (Used only if IDIOPT3 = 0)    Units: meters
          --------------------------

       Observed surface wind components
       for wind field module (IDIOPT4)  Default: 0     ! IDIOPT4 =  0  !
          0 = Read WS, WD from a surface
              data file (SURF.DAT)
          1 = Read hourly preprocessed U, V from
              a data file (DIAG.DAT)

       Observed upper air wind components
       for wind field module (IDIOPT5)  Default: 0     ! IDIOPT5 =  0  !
          0 = Read WS, WD from an upper
              air data file (UP1.DAT, UP2.DAT, etc.)
          1 = Read hourly preprocessed U, V from
              a data file (DIAG.DAT)

       LAKE BREEZE INFORMATION

          Use Lake Breeze Module  (LLBREZE)
                                             Default: F      ! LLBREZE = F
!

           Number of lake breeze regions (NBOX)            ! NBOX =  0
!

        X Grid line 1 defining the region of interest
                                                          ! XG1 = 0. !
        X Grid line 2 defining the region of interest
                                                          ! XG2 = 0. !
        Y Grid line 1 defining the region of interest
                                                          ! YG1 = 0. !
        Y Grid line 2 defining the region of interest
                                                          ! YG2 = 0. !

         X Point defining the coastline (Straight line)
                   (XBCST)  (KM)   Default: none    ! XBCST = 0. !

         Y Point defining the coastline (Straight line)
                   (YBCST)  (KM)   Default: none    ! YBCST = 0. !
```

```
         X Point defining the coastline (Straight line)
                   (XECST)  (KM)   Default: none    ! XECST = 0. !

         Y Point defining the coastline (Straight line)
                   (YECST)  (KM)   Default: none    ! YECST = 0. !


       Number of stations in the region     Default: none ! NLB =  0 !
       (Surface stations + upper air stations)

       Station ID's  in the region   (METBXID(NLB))
       (Surface stations first, then upper air stations)
         ! METBXID =  0 !

!END!


-----------------------------------------------------------------------
-------

INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation
Parameters
--------------

    EMPIRICAL MIXING HEIGHT CONSTANTS

       Neutral, mechanical equation
       (CONSTB)                              Default: 1.41   ! CONSTB =
1.41 !
       Convective mixing ht. equation
       (CONSTE)                              Default: 0.15   ! CONSTE =
0.15 !
       Stable mixing ht. equation
       (CONSTN)                              Default: 2400.  ! CONSTN =
2400.!
       Overwater mixing ht. equation
       (CONSTW)                              Default: 0.16   ! CONSTW =
0.16 !
       Absolute value of Coriolis
       parameter (FCORIOL)                   Default: 1.E-4  ! FCORIOL =
1.0E-04!
                                             Units: (1/s)

    SPATIAL AVERAGING OF MIXING HEIGHTS

       Conduct spatial averaging
       (IAVEZI)  (0=no, 1=yes)               Default: 1      ! IAVEZI =
1  !

       Max. search radius in averaging
       process (MNMDAV)                      Default: 1      ! MNMDAV =
1  !
                                             Units: Grid
                                                    cells
       Half-angle of upwind looking cone
       for averaging (HAFANG)                Default: 30.    ! HAFANG =
30. !
                                             Units: deg.
       Layer of winds used in upwind
       averaging (ILEVZI)                    Default: 1      ! ILEVZI =
1  !
```

(must be between 1 and NZ)

OTHER MIXING HEIGHT VARIABLES

```
       Minimum potential temperature lapse
       rate in the stable layer above the
       current convective mixing ht.         Default: 0.001  ! DPTMIN =
0.001 !
       (DPTMIN)                              Units: deg. K/m
       Depth of layer above current conv.
       mixing height through which lapse     Default: 200.   ! DZZI =
200. !
       rate is computed (DZZI)               Units: meters

       Minimum overland mixing height        Default:  50.   ! ZIMIN =
50. !
       (ZIMIN)                               Units: meters
       Maximum overland mixing height        Default: 3000.  ! ZIMAX =
3000. !
       (ZIMAX)                               Units: meters
       Minimum overwater mixing height       Default:   50.  ! ZIMINW =
50. !
       (ZIMINW) -- (Not used if observed     Units: meters
       overwater mixing hts. are used)
       Maximum overwater mixing height       Default: 3000.  ! ZIMAXW =
3000. !
       (ZIMAXW) -- (Not used if observed     Units: meters
       overwater mixing hts. are used)
```

TEMPERATURE PARAMETERS

```
       3D temperature from observations or
       from prognostic data? (ITPROG)        Default:0         !ITPROG =
1   !

          0 = Use Surface and upper air stations
              (only if NOOBS = 0)
          1 = Use Surface stations (no upper air observations)
              Use MM5 for upper air data
              (only if NOOBS = 0,1)
          2 = No surface or upper air observations
              Use MM5 for surface and upper air data
              (only if NOOBS = 0,1,2)

       Interpolation type
       (1 = 1/R ; 2 = 1/R**2)                Default:1         ! IRAD =
1  !

       Radius of influence for temperature
       interpolation (TRADKM)                Default: 500.     ! TRADKM
= 36. !
                                             Units: km

       Maximum Number of stations to include
       in temperature interpolation (NUMTS)  Default: 5        ! NUMTS =
5  !

       Conduct spatial averaging of temp-
       eratures (IAVET)  (0=no, 1=yes)         Default: 1     ! IAVET =
0  !
```

```
       (will use mixing ht MNMDAV,HAFANG
        so make sure they are correct)

       Default temperature gradient        Default: -.0098 ! TGDEFB = -
0.0098 !
       below the mixing height over
       water (K/m) (TGDEFB)

       Default temperature gradient        Default: -.0045 ! TGDEFA = -
0.0045 !
       above the mixing height over
       water (K/m) (TGDEFA)

       Beginning (JWAT1) and ending (JWAT2)
       land use categories for temperature                    ! JWAT1 =
55  !
       interpolation over water -- Make                       ! JWAT2 =
55  !
       bigger than largest land use to disable

   PRECIP INTERPOLATION PARAMETERS

       Method of interpolation (NFLAGP)      Default = 2    ! NFLAGP =
2  !
        (1=1/R,2=1/R**2,3=EXP/R**2)
       Radius of Influence (km) (SIGMAP)     Default = 100.0  ! SIGMAP =
50. !
        (0.0 => use half dist. btwn
         nearest stns w & w/out
         precip when NFLAGP = 3)
       Minimum Precip. Rate Cutoff (mm/hr)   Default = 0.01  ! CUTP =
0.01 !
        (values < CUTP = 0.0 mm/hr)
!END!


-----------------------------------------------------------------------
-------

INPUT GROUP: 7 -- Surface meteorological station parameters
--------------

     SURFACE STATION VARIABLES
     (One record per station --  13  records in all)


             1     2
         Name   ID            X coord.   Y coord.   Time   Anem.
                               (km)       (km)      zone   Ht.(m)
       ----------------------------------------------------------
! SS1  ='KTYR'   22448       150.790     -844.580    6    10  !
! SS2  ='KGGG'   22470       221.460     -843.040    6    10  !
! SS3  ='KSHV'   22480       299.260     -829.570    6    10  !
! SS4  ='KDTN'   22484       305.520     -820.460    6    10  !
! SS5  ='KBAD'   22485       313.160     -823.520    6    10  !
! SS6  ='KPRX'   22587       143.650     -702.720    6    10  !
! SS7  ='KHOT'   23415       357.320     -602.150    6    10  !
! SS8  ='KTXK'   23418       278.660     -719.290    6    10  !
! SS9  ='KELD'   23419       389.380     -740.430    6    10  !
! SS10 ='KRUE'   23429       355.480     -516.970    6    10  !
! SS11 ='KMWT'   23435       254.510     -598.180    6    10  !
```

```
! SS12 ='KFSM'   23440       238.280     -512.340    6    10  !
! SS13 ='KMLC'   23566       111.180     -562.600    6    10  !
-------------------
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Five digit integer for station ID

!END!


-----------------------------------------------------------------------
-------

INPUT GROUP: 8 -- Upper air meteorological station parameters
--------------

     UPPER AIR STATION VARIABLES
     (One record per station --  0  records in all)

            1     2
         Name    ID      X coord.   Y coord.  Time zone
                            (km)       (km)
        ----------------------------------------------
-------------------
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Five digit integer for station ID

!END!


-----------------------------------------------------------------------
-------

INPUT GROUP: 9 -- Precipitation station parameters
--------------

     PRECIPITATION STATION VARIABLES
     (One record per station --  13  records in all)
     (NOT INCLUDED IF NPSTA = 0)

            1          2
         Name   Station    X coord.  Y coord.
                  Code       (km)      (km)
         ------------------------------------

! PS1  ='KTYR'   22448    150.790   -844.580      !
! PS2  ='KGGG'   22470    221.460   -843.030      !
! PS3  ='KSHV'   22480    299.260   -829.570      !
! PS4  ='KDTN'   22484    305.520   -820.460      !
! PS5  ='KBAD'   22485    313.160   -823.520      !
! PS6  ='KPRX'   22587    143.650   -702.720      !
! PS7  ='KHOT'   23415    357.320   -602.150      !
! PS8  ='KTXK'   23418    278.660   -719.290      !
! PS9  ='KELD'   23419    389.380   -740.430      !
```

```
! PS10 ='KRUE'   23429    355.480   -516.970      !
! PS11 ='KMWT'   23435    254.510   -598.180      !
! PS12 ='KFSM'   23440    238.280   -512.340      !
! PS13 ='KMLC'   23566    111.180   -562.600      !

-------------------
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Six digit station code composed of state
        code (first 2 digits) and station ID (last
        4 digits)

!END!
```

Appendix B – Electronic Archive of Modeling Files

(DVDs and/or CDs attached)